Blockchains, Smart Contracts, and International Arbitration – The Emergence of a Crypto Autonomous Legal Order

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St. Gallen, October 27, 2021

The President:

Prof. Dr. Bernhard Ehrenzeller

For my parents

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Zusammenfassung

Die vorliegende Doktorarbeit untersucht das Aufkommen von Streitbeilegungsmechanismen auf Blockchains aus der Sicht des internationalen Handelsschiedsrechts und dessen Rechtstheorien. Die zugrunde liegende These ist, dass die Blockchain Technologie mit Hilfe von *Smart Contracts* das Potential hat, die Dynamiken gesellschaftlicher Vorgänge, Institutionen und auch des Rechts zu verändern. Das Aufkommen sogenannter Dezentraler Autonomer Organisationen lässt die Entwicklung hin zu neuen Machtstrukturen im Cyberspace erahnen. Dies kann weitreichende Folgen für den internationalen Handel haben, in dem Schiedsverfahren erfahrungsgemäß eine bedeutende Rolle spielen. Die Dissertation erklärt die Grundzüge der Blockchain Technologie und stellt die historische Entwicklung von Lösungsvorschlägen für die Streitbeilegung auf Blockchains dar. Damit liefert sie erstmals eine umfassende und anschauliche Konzeptualisierung von Blockchain-Streitigkeiten und Blockchain-Streitbeilegungsansätzen. Das neue Phänomen der „Krypto Schiedsgerichtsbarkeit“ wird sodann eingehend untersucht und mit der internationalen Handelsschiedsgerichtsbarkeit verglichen. Schließlich erweitert diese Doktorarbeit den Rahmen der vorhandenen Rechtstheorien im Bereich der internationalen Schiedsgerichtsbarkeit um ein sog. „Krypto Autonomes Rechtssystem“ – ein vertraglich intelligent gesteuertes Rechtssystem, das das bereits vorhandene ergänzen kann, mit diesem aber auch konkurriert.

Summary

This thesis explores the emergence of dispute resolution mechanisms on blockchains from the perspective of international commercial arbitration law and its legal theories. The underlying thesis is that blockchain technology, with the help of smart contracts, has the potential to change the dynamics of social processes, institutions, and even law. The emergence of so-called Decentralized Autonomous Organizations foreshadows new power structures in cyberspace, which can have far-reaching consequences for international trade, where experience has shown that arbitration plays a pivotal role. This thesis explains blockchain technology in its basic features and presents the historical development of proposed solutions for dispute resolution on blockchains. Thus, for the first time, it provides a comprehensive and descriptive conceptualization of blockchain disputes and blockchain dispute resolution approaches. The new "crypto arbitration" phenomenon is then examined in-depth and contrasted to international commercial arbitration. Finally, this dissertation extends the framework of existing legal theories in the field of international arbitration law and private ordering by a so-called "crypto autonomous legal order". While this new smart contract-enabled legal order may complement the existing legal system, it also competes with it.

Résumé

Cette thèse explore l'émergence de mécanismes de résolution des conflits sur les blockchains du point de vue du droit de l'arbitrage commercial international et de ses théories juridiques. La thèse sous-jacente est que la technologie blockchain, avec l'aide des *smart contracts* (contrats intelligents), a le potentiel de changer la dynamique des processus sociaux, des institutions et même du droit. L'émergence d'organisations autonomes dénommées *Decentralized Autonomous Organizations* préfigure une évolution vers de nouvelles structures de pouvoir décisionnel dans le cyberespace. Cela peut avoir des conséquences considérables pour le commerce international, où l'expérience a montré que l'arbitrage y joue un rôle central. Cette thèse explique la technologie blockchain dans ses caractéristiques de base et présente le développement historique des solutions proposées pour la résolution des conflits sur les blockchains. Ainsi, pour la première fois, cette thèse propose une représentation complète et descriptive des litiges et des approches de résolution des litiges sur les blockchains. Le nouveau phénomène de "crypto arbitrage" est ensuite examiné en profondeur et comparé à l'arbitrage commercial international. Enfin, cette thèse étend le cadre des théories juridiques existantes dans le domaine du droit de l'arbitrage international et de l'ordre privé en introduisant un "ordre juridique crypto autonome". Si ce nouvel ordre juridique fondé sur les *smart contracts* peut compléter le système juridique existant, il lui fait également concurrence.

List of Abbreviations

ADR	Alternative Dispute Resolution
AI	Artificial Intelligence
ANT	Aragon (Network) Native Token
ASA	Swiss Arbitration Association
B2B	Business to Business
B2C	Business to Consumer
BBLLC	Blockchain-Based Limited Liability Companies
BC	Before Christ
BIT	Bilateral Investment Treaty
BTC	Bitcoin's native cryptocurrency bitcoin
CAS	Court of Arbitration for Sport
CBDC	Central Bank Digital Currency
CDR	Crypto Dispute Resolution
DAMN	Decentralized Arbitration and Mediation Network
DAO	Decentralized Autonomous Organization
DApp	Decentralized Application
DeFi	Decentralized Finance
DEX	Decentralized Exchange
dGov	Decentralized Governance
DLT	Distributed Ledger Technology
dPoS	Delegated Proof of Stake
DRC	Dispute Resolution Contract
DSFT	Decision Swiss Federal Tribunal
e.g.	exempli gratia
ECHR	European Convention of Human Rights
ECtHR	European Court of Human Rights
EIB	European Investment Bank
EIP	Ethereum Improvement Proposals
EOA	Externally Owned Account
EOS	EOS Blockchain
ERC	Ethereum Request for Comments
ERP	Ethereum Recovery Proposal

et al.	et alii
et seq.	et sequentia
etc.	et cetera
ETH	Ethereum's native cryptocurrency ether
EU	European Union
EVM	Ethereum Virtual Machine
EWG	Exploratory Working Group
FAQ	Frequently Asked Questions
FINMA	Swiss Financial Market Supervisory Authority
GLBC	Global Legal Blockchain Consortium
i.e.	id est
IBA	International Bar Association
IBA Rules	International Bar Association Rules on the Taking of Evidence in International Arbitration
ibid	ibidem
ICANN	Internet Corporation for Assigned Numbers and Names
ICC	International Chamber of Commerce
ICO	Initial Coin Offering
ICSID	International Centre for Settlement of Investment Disputes
ICT	Information and Communication Technologies
IoT	Internet of Things
IP	Internet Protocol
IPFS	Interplanetary File System
LLC	Limited Liability Company
Model Law	UNCITRAL Model Law on International Commercial Arbitration of 1985 with amendments as adopted in 2006
Mt. Gox	Magic the gathering exchange
New York Convention	Convention on the Recognition and Enforcement of Foreign Arbitral Awards of 1958

NFT	Non-Fungible Token
ODR	Online Dispute Resolution
P2P	Peer-to-peer
PNK	Pinakion, native cryptocurrency of the Kleros protocol
PoH	Proof of Humanity
PoS	Proof of Stake
PoW	Proof of Work
SCC	Stockholm Chamber of Commerce
SCL	Society for Computers and Law
SDK	Software Development Kit
SEC	Securities and Exchange Commission
SHA	Secure Hash Algorithm
Singapore Convention	United Nations Convention on International Settlement Agreements Resulting from Mediation
Swiss PILA	Swiss Private International Law Act
TBNOA	Telos Blockchain Network Operating Agreement
TCP	Transmission Control Program
TCR	Token Curated Registry
tps	Transactions per second
UDRP	Uniform Domain Name Dispute Resolution Policy
UKJT	United Kingdom Jurisdiction Taskforce
UN	United Nations
UNCITRAL	United Nations Commission on International Trade Law
UNCTAD	United Nations Conference on Trade and Development
UNIDROIT	The International Institute for the Unification of Private Law
US	United States
USD	United States Dollar
UTXO	Unspent Transaction Outputs
vs.	versus

WEF	World Economic Forum
Web3	Third Generation of the Internet
WIPO	World Intellectual Property Organization

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Timeline[1]

Date	Modern Arbitration and ODR	Date	Internet/Blockchains[2]
1923	ICC establishes the International Court of Arbitration		
	Geneva Protocol on Arbitration Clauses		
1927	Geneva Convention on the Execution of Foreign Arbitral Awards		
1958	New York Convention replaces both the Geneva Protocol and the Geneva Convention		
		1964	ARPANet, the first packet-switched network
1966	UN General Assembly establishes the United Nations Commission on International Trade Law (UNCITRAL)		
		1974	Ethernet
			TCP/IP Transmission Control Protocol and Internet Protocol introduced (first use of the term "Internet")
			First PC Altair 8800 created by Micro Instrumentation and Telemetry Systems (MITS)

[1] Own timeline.

[2] Timeline data on blockchains mainly retrieved from: 'Bitcoin Timeline' <https://bitcoinsaints.blogspot.com/p/timelinie.html>.

1976	UNCITRAL Arbitration Rules (later amended in 2010 and 2013) Frank Sander gives a talk on the "multidoor courthouse"	1976	Whitfield Diffie and Martin E. Hellman's New Directions in Cryptography
		1978	RSA public-key cryptography
		1979	Ralph Merkle invents cryptographic hash functions
		1982	David Chaum's Digital cash
		1984	Domain Name System (DNS)
1985	Adoption of the UNCITRAL Model Law (later amended in 2006)		
1989	Tim Berners Lee's hypertext protocol		
		1990	David Chaum founds Digicash, closed it in 1998
1991	Tim Berners Lee develops the World Wide Web		
		1992	Tim May writes The Crypto anarchist manifesto
		1993	March Eric Hughes creates the Cypherpunk mailing list, writes the Cypherpunk manifesto
1994	Nick Szabo starts writing about smart contracts		
		1997	Adam Beck creates Hashcash

1998 ICANN (Internet Corporation for Assigned Names and Numbers) is founded, a non-profit that coordinates and assigns names on the Internet

Nick Szabo creates Bit Gold

1999 ICANN's UDRP (Uniform Domain-Name Dispute Resolution Policy) is launched

Ethan Katsh and Janet Rifkin conduct the eBay pilot project

2004 Ian Grigg writes about Ricardian contracts

2004 Hal Finney creates the first reusable proof of work system

2008 Satoshi Nakamoto releases the Bitcoin white paper

2009 Bitcoin Genesis block is mined

2010 Laszlo Hanyecz buys two pizzas for 10,000 bitcoins

2010 Satoshi Nakamoto shares ideas of how to implement escrow in Bitcoin in the Bitcointalk Forum, and users start sharing ideas about arbitration

2011 eBay resolves 60 million disputes each year

eBay and PayPal spinoff Modria is created

2011 Satoshi Nakamoto's last words "I've moved on to other things, it is in good hands with Gavin and everyone."

2012 Vitalik Buterin and Mihai Alisie found Bitcoin Magazine

2013 First Bitcoin ATM

2015 Ethereum is launched

2016	The DAO Hack, DAO Wars, and Ethereum hard fork
	Ethereum classic maintains the notion of "code is law"
	Andreas Antonopoulos and Pamela Morgan propose a Decentralized Arbitration and Mediation Network ("DAMN")
	Vitalik Buterin shares his idea of a "decentralized court" for Ethereum
2017	Parity freeze and several EIPs do not lead to a community consensus
	ICO boom
2018	Kleros, a decentralized arbitration platform, performs an ICO
	The "governed" EOS blockchain and ECAF (EOS Core Arbitration Forum) are launched
	Swiss Arbitration Association's first conference on Blockchain, Smart Contracts, and Arbitration
2019	UNCITRAL and UNIDROIT start to jointly explore the need for updated international legislation for the new digital economy and release reports
2020	Covid-19 pandemic accelerates digitalization, crypto, and blockchain adoption
	DeFi summer
2021	Kleros launches the Humanity Court for Proof of Humanity
	Jur launches new platform
	ArbTech is launched, a community focused on arbitration and technology
	UK Jurisdiction Taskforce publishes Digital Dispute Resolution Rules
	NFT boom, Bitcoin hits a new all-time high, Ethereum hits a record of 1,7 million transactions in a single day

Glossary

This glossary, which explains some technical terms in alphabetical order, may serve as a quick reference while reading the thesis.

Term	Definition
Address	Addresses are used to identify cryptocurrency holders, senders, and recipients. A public address is the hashed version of a public key, and a private address is the hashed version of a private key. While both Bitcoin and Ethereum addresses consist of letters and numbers, they are encoded in different ways. This is a Bitcoin address: 1A1zP1eP5QGefi2DMPTfTL5SLmv7DivfNa.[3] This is an Ethereum address: 0xAb5801a7D398351b8bE11C439e05C5B3259aeC9B.[4] Ethereum addresses are based on an account-based model, and users use the same or a limited number of addresses for many transactions. Bitcoin, however, runs on an unspent transaction outputs (UTXO) model, generating new addresses for each transaction. While the public address can be made available to receive payments, the private address is best kept secret. See ⇒ Public Key, ⇒ Private Key

[3] This is the Bitcoin address to which the first block reward (coinbase transaction) was sent, the genesis block, thought to be owned by Satoshi Nakamoto. To analyze transactions of this address or any other Bitcoin address, one can use this tool: 'Example of a Bitcoin Address' <https://www.blockchain.com/btc/address/1A1zP1eP5QGefi2DMPTfTL5SLmv7DivfNa>.

[4] This is Vitalik Buterin's Ethereum address. He is the influential co-founder of Ethereum. To analyze transactions of this address or any other Ethereum address, one can use this tool: 'Example of an Ethereum Address' <https://etherscan.io/address/0xab5801a7d398351b8be11c439e05c5b3259aec9b>.

Term	Definition
Asymmetric cryptography	A field of study in cryptography, which is also called public-key cryptography. It enables e.g., secure Internet shopping and was pioneered by Martin Hellman and Whitfield Diffie in the 1970s.[5] Parties generate a public-private key pair, of which they share their public key and keep the private key secret, this way they do not have to share a single key to encrypt and decrypt messages.[6] See ⇒ Cryptography
Bitcoin (bitcoin)	Bitcoin (capitalized) refers to the Bitcoin network; when not capitalized, describes the currency, such as with dollars or euros.[7] Satoshi Nakamoto, who published a whitepaper in a cryptography mailing list on Halloween in 2008 after the financial crash, introduced Bitcoin. It is considered the first and most successful digital monetary system that solved the double-spend problem. Interested users started building the system. The first block was mined in early 2009. Bitcoin enables the transfer of the cryptocurrency bitcoin on a blockchain without intermediaries. This revolutionary system does not need a central bank and is outside of the direct control of governments.

[5] See Primavera De Filippi and Aaron Wright, *Blockchain and the Law - The Rule of Code* (Harvard University Press 2018) 14. See also Steve Fyffe and Tom Abate, 'Stanford Cryptography Pioneers Whitfield Diffie and Martin Hellman Win ACM 2015 A.M. Turing Award' <https://news.stanford.edu/2016/03/01/turing-hellman-diffie-030116/>.

[6] See Daniel Drescher, *Blockchain Basics: A Non-Technical Introduction in 25 Steps* (2017) 96 et seq. See Aleksander Berentsen and Fabian Schär, *Bitcoin, Blockchain Und Kryptoassets: Eine Umfassende Einführung* (2017) 144–145.

[7] See Kevin Werbach, *The Blockchain And The New Architecture Of Trust* (The MIT Press 2018) 14.

Term	Definition
Block reward	A block reward is an incentive for miners in a proof of work blockchain to find and create a new block.[8] Bitcoin miners receive a certain amount of bitcoin as a block reward when performing proof of work. The amount of bitcoin received halves approximately every four years. This event is called "halving". In total, three halvings have occurred so far; the last one took place in 2020. The block reward was reduced from 12,5 to 6,25 bitcoins. Through block rewards, new bitcoins are created. See ⇒ Consensus, ⇒ Miners, ⇒ Proof of Work
Blockchain	A blockchain is a digital data storage of transactions assembled in blocks, enabled through cryptography and distributed computing. Each block references the previous one, up to the genesis block, which is the first block in a blockchain.[9]
Byzantine Generals' Problem	The Byzantine Generals' Problem, first mentioned in the 1980s, is a computer science problem that relies on a military metaphor.[10] Some generals plan to attack a city, but at least one could have malicious intentions and try to sabotage the plan.[11] This problem is relevant for distributed p2p systems, which seek to maintain integrity, such as blockchains, when a number of participants could be malicious.[12] This problem remained unsolved until Nakamoto presented a solution in 2008.[13] See ⇒ Consensus, ⇒ Miner, ⇒ Proof of Work

[8] See also a guide on the Bitcoin block reward and halving, Vitalik Buterin, 'Block Reward Halving: A Guide' (*Bitcoin Magazine*, 2012) <https://bitcoinmagazine.com/articles/block-reward-halving-a-guide-1354053560>.
[9] See Andreas Antonopoulos, *Mastering Bitcoin: Programming the Open Blockchain* (O'Reilly 2017) xxiii.
[10] See Drescher (n 6) 31–32. See Andreas Antonopoulos, *The Internet of Money: A Collection of Talks by Andreas M. Antonopoulos* (1st edn, Merkle Bloom LLC 2016) 1–2.
[11] See Werbach (n 7) 42–44.
[12] See Drescher (n 6) 31–32. See Antonopoulos, *The Internet of Money: A Collection of Talks by Andreas M. Antonopoulos* (n 10) 1–2.
[13] See Antonopoulos, *The Internet of Money: A Collection of Talks by Andreas M. Antonopoulos* (n 10) 2.

Term	Definition
Consensus	A technical term for reaching agreement.[14] In a shared and distributed ledger, which is p2p, participating entities need to come to agreement on which version is the "correct" one, which then gets reflected in every copy.[15] Nakamoto consensus refers to the solution provided by Satoshi Nakamoto to the "Byzantine Generals problem" in his proof of work blockchain called Bitcoin, which aligns the participants' financial interests.[16] See ⇒ Bitcoin (bitcoin), ⇒ Byzantine Generals' Problem, ⇒ Proof of Work, ⇒ Miner
Crypto Dispute Resolution (CDR)	CDR is a novel alternative dispute resolution method harnessing a blockchain infrastructure with smart contracts. In one category of CDR, namely crypto arbitration, a game-theoretical model incentivizes randomly assigned pseudonymous actors to decide on disputes as a third-party oracle collectively. Subject to fulfilling the specific requirements of the framework of international commercial arbitration, parties can make use of crypto arbitration as a form of fast-track arbitration.
Cryptoeconomics	Cryptoeconomics studies consensus and incentive design mechanisms in blockchains.[17]
Cryptocurrency	Currency, which is based on and secured through cryptography without a central authority, completely p2p.[18] See ⇒ Token

[14] See Drescher (n 6) 167.
[15] See Werbach (n 7) 7. See also Drescher (n 6) 167.
[16] See Werbach (n 7) 119. See also Antonopoulos, *The Internet of Money: A Collection of Talks by Andreas M. Antonopoulos* (n 10) 1–2.
[17] See Chris Berg, Sinclair Davidson and Jason Potts, *Understanding the Blockchain Economy - An Introduction to Institutional Cryptoeconomics* (Edward Elgar Publishing 2019) 1.
[18] See 'Cryptocurrency' (*Binance Academy*) <https://academy.binance.com/en/glossary/cryptocurrency>.

Term	Definition
Cryptography	The science of exchanging data in a secure way.[19] See ⇒ Asymmetric Cryptography
Decentralized Autonomous Organizations (DAOs)	DAOs are novel organizational designs harnessing a blockchain infrastructure. They can operate according to pre-coded smart contracts and self-enforcing rules. Some jurisdictions have started recognizing DAOs under company law. The general concept of DAOs is not to be confused with "The DAO", a project launched in 2016 on Ethereum. It was hacked, which led to an Ethereum-wide debate on whether code can be law.
DApp	A DApp is a decentralized application built on top of public blockchains, such as Ethereum. A DApp is usually accessible through a browser via web3 extensions and allows users to interact with smart contracts, without a central authority. Much of DeFi is powered by DApps, which allow anyone to participate. See ⇒ Web3
DeFi	DeFi or Decentralized Finance is an emerging and growing ecosystem of blockchain-based financial instruments, allowing for many different activities, such as lending and borrowing. The term itself emerged in a telegram discussion between Ethereum innovators in August 2018.[20] This industry is expanding rapidly. The amount held by smart contracts in DeFi Dapps (TVL, total value locked) has reached billions in USD value by mid-2021.

[19] See Bruce Schneier, *Applied Cryptography: Protocols, Algorithms, and Source Code in C* (John Wiley & Sons 1996) 1. See also Werbach (n 7) 40.

[20] See Inje Yeo, '@injeyeo on Twitter 1 August 2019' (*Twitter,* 2019) <https://twitter.com/injeyeo/status/1157001562457174016?s=21>. See also Camila Russo, 'What Is Decentralized Finance?' (*The Defiant,* 2020) <https://thedefiant.io/what-is-decentralized-finance/>.

Term	Definition
Digital Signature	In blockchains, digital signatures use asymmetric cryptography to ensure that only the holder of a specific cryptocurrency can transfer it.[21] See ⇒ Address, ⇒ Private Key, ⇒ Public Key
Distributed Ledger Technology (DLT)	DLT is a broad term that encompasses blockchains.[22] DLT can be seen as a whole variety of protocols that enable secure exchange and verification of data on a p2p basis.[23]
Difficulty	In blockchains, difficulty refers to how much computational energy the proof of work mechanism needs, which gets adjusted depending on how many miners participate.[24] See ⇒ Proof of Work
Double Spending	Double spending refers to the act of spending money more than once, which is something that up until the innovative solution of Bitcoin stood in the way of digital currencies.
Ether	Ether or ETH is the native cryptocurrency of the Ethereum blockchain, which is used for transactions and gas fees. See ⇒ Gas

[21] See Drescher (n 6) 103–104.
[22] See e.g., Werbach (n 7) 14.
[23] See Jeremy M Sklaroff, 'Smart Contracts and the Cost of Inflexibility' (2018) 166 University of Pennsylvania Law Review 263, 267–268 <https://scholarship.law.upenn.edu/prize_papers>.
[24] See Antonopoulos, *Mastering Bitcoin: Programming the Open Blockchain* (n 9) xxiv.

Term	Definition
Ethereum	Ethereum provides a blockchain with a built-in Turing complete programming language, which enables smart contracts. Presently, it is the most used blockchain for smart contracts and DApps. Ethereum split into Ethereum and Ethereum classic in 2016 after a hard fork due to The DAO hack. See ⇒ DAO, ⇒ DApp, ⇒ Fork, ⇒ Smart Contract
Fork	Forks can happen because of governance disputes, such as in the DAO hack on Ethereum.[25] There are soft and hard forks. While soft forks are upgrades of a blockchain protocol that do not require a node to upgrade, hard forks require a client upgrade to get on the new chain.[26] Therefore, hard forks create a more permanent change in blockchains.[27]
Gas	Gas is used in Ethereum to virtually fuel and execute smart contracts. Gas fees on Ethereum have been very high in 2020 and 2021 due to increased use and limited space, thus limited supply of transaction space and greater demand. This can be seen as a sign of more adoption. Layer 2 solutions try to circumvent paying high gas fees. See ⇒ Ethereum

[25] See on forks e.g., Berentsen and Schär (n 6) 73.
[26] See e.g., Berentsen and Schär (n 6) 73. See Vitalik Buterin, 'Hard Forks, Soft Forks, Defaults and Coercion' (Vitalik Buterin's Website, 2017) <https://vitalik.ca/general/2017/03/14/forks_and_markets.html>.
[27] See Antonopoulos, *Mastering Bitcoin: Programming the Open Blockchain* (n 9) xxv.

Term	Definition
Genesis Block	The first block in a blockchain is called the genesis block.
Hash	A fingerprint of data, which consists of a fixed length.[28]
Miner	A miner creates or mints a new block in a blockchain that works based on proof of work. Due to increased difficulty and large amounts of computational power needed to perform proof of work, mining pools have emerged that combine their hashing power and share their profits. See ⇒ Proof of Work
NFT	A Non fungible token ("NFT") is a unique token as opposed to fungible tokens that are not. On Ethereum the standards used are ERC-721 and ERC-1155. NFTs allow for the representation of rarity and scarcity on blockchains. See ⇒ Token
Nodes (light, full)	A connected computer (or network participant) running a software client.[29]
Off-chain	An event that occurs off-chain happens outside of a blockchain.
On-chain	An event that occurs on-chain happens on a blockchain.
Oracles	Oracles connect blockchain applications (on-chain) with the off-chain world, and they feed outside data and information which is not available on-chain into a DApp or smart contract on a blockchain. They are best thought of as bridges between on- and off-chain, enhancing the capabilities of blockchains. See ⇒ DApp, ⇒ Smart Contract

[28] See Andreas M Antonopoulos and Gavin Wood, *Mastering Ethereum: Building Smart Contracts and DApps* (O'Reilly 2019) xxix. See also Schneier (n 19) 30, 429.
[29] See Antonopoulos and Wood (n 28) xxxii.

Term	Definition
Private Key	A private key is a number with a corresponding public key that should be kept secret as it can sign transactions and unlock crypto assets. See ⇒ Address
Private Blockchain	As opposed to public blockchains, private blockchains are not fully transparent and participation can be restricted to pre-approved and identified parties (permissioned).[30]
Proof of Work (PoW)	PoW is a consensus mechanism in a blockchain that requires considerable computational power to find a solution to a hash puzzle.[31] PoW is used in the Bitcoin blockchain and has led to a "modern-day gold rush".[32] While in the beginning anyone with a PC could mine bitcoin, the mining business has turned into a sophisticated industry, which is highly criticized for its high energy consumption. See ⇒ Block Reward, ⇒ Byzantine Generals Problem, ⇒ Consensus, ⇒ Difficulty, ⇒ Miner
Proof of Stake (PoS)	A method to attain distributed consensus.[33] In a PoS blockchains, there are no miners as in a Proof of Work (PoS) blockchain, instead users can "stake" their cryptocurrency and earn rewards.[34] This makes it a more sustainable alternative to PoW in terms of energy consumption.

[30] See Shobhit Seth, 'Public, Private, Permissioned Blockchains Compared' (*Investopedia,* 2021) <www.investopedia.com/news/public-private-permissioned-blockchains-compared>. See also Michèle Finck, *Blockchain Regulation and Governance in Europe* (Cambridge University Press 2019) 15. A prominent example in this area is 'R3' <https://www.r3.com>.
[31] See Antonopoulos, *Mastering Bitcoin: Programming the Open Blockchain* (n 9) xxix.
[32] Tech Vision, 'Inside Iceland's Massive Bitcoin Mine' (*Youtube*, 2021) <https://www.youtube.com/watch?v=f0HC1Udk6-E>.
[33] See Antonopoulos, *Mastering Bitcoin: Programming the Open Blockchain* (n 9) xxix.
[34] See Antonopoulos, *Mastering Bitcoin: Programming the Open Blockchain* (n 9) xxix.

Term	Definition
Public Blockchain	Public blockchains are fully transparent. They are usually permissionless, *i.e.*, open to anyone, regardless of their identity.
Public Key	A public key corresponds to a private key. Unlike a private key, it does not confer access to one's crypto funds, which makes it viable to be shared to receive cryptocurrencies and verify digital signatures.[35] See ⇒ Address
Ricardian Contract	The concept of a smart contract that both human and machines can read, first described by Ian Grigg.[36]
Satoshi Nakamoto	The name used by the individual or group of people that designed the Bitcoin blockchain whose real identity remains unknown. The first to solve the double-spending problem for digital currencies. The name appeared for the first time in a cryptography mailing list in 2008 as the author of the Whitepaper "Bitcoin: A Peer-to-Peer Electronic Cash System". See ⇒ Bitcoin
Smart Contract	A software program that is stored and executes on a programmable blockchain, such as on Ethereum. It may or may not be legally binding depending on the specific features and the intention of the parties. The notion of smart contracts was first described by Nick Szabo. See ⇒ Ethereum

[35] See Antonopoulos and Wood (n 28) xxxiii.
[36] See Ian Grigg, 'The Ricardian Contract' (Proceedings. First IEEE International Workshop on Electronic Contracting, 2004).

Term	Definition
Token	Tokens can have various purposes, ranging from tokens that confer voting rights, tokens that serve as digital cash to non-fungible tokens ("NFTs") used as a store of value. The term "crypto asset" is used as an umbrella term encompassing all forms of tokens. See ⇒ Cryptocurrency, ⇒ NFT
Wallet	One can distinguish between hardware, software, and paper wallets (even brain wallets). They store secret keys, provide access to one's crypto funds and/or enable the signing of transactions.[37]
Web3	The evolution of the Internet from web 2 to a third generation, including various novel technologies such as DApps built on blockchains.[38] Users can interact with programmable blockchains using web3 applications.[39] See ⇒ DApp

[37] See Antonopoulos, *Mastering Bitcoin: Programming the Open Blockchain* (n 9) xxxi.
[38] See Antonopoulos and Wood (n 28) xxxv.
[39] See Antonopoulos and Wood (n 28) 10-11.

1 Chapter 1: Introduction

1.1 Introduction

1 Disputes are a facet of life, depicted in artworks, spanning prose, poetry, and music. Humans seem to be obsessed with disputes, so much so that the best stories always portray a hero's inner or outer conflict. Without such conflict, without a dilemma, there is no tension, no story to tell. In the fictional world, disputes are a welcome sight, but in the real world they can have dire consequences. Major historical events, at their core, tell a story about disputes and their impact on the world.[40] Our world is shaped by how society has overcome disputes.

2 How disputes are resolved in a society is very much a reflection of that society's values, beliefs, and costumes. The spectrum of possibilities ranges from the extreme of resorting to violence to resolving a dispute through amicable settlement — place and time matter. Nowadays, disputes can be resolved in a civilized manner both nationally and internationally. At an international level, efforts towards harmonization result in conventions, model laws, guidelines, and soft laws. Here, history informs the present and gives a directory to the future. Whereas primitive societies may have been more inclined towards violence, the advent of civilization brought along forms of resolving disputes in a peaceful manner. Moreover, one may argue that the necessity for resolving disputes is where the very birthplace of the concept of law itself can be found.[41]

3 As civilization advances and becomes more and more digitized, one may ask whether disputes will disappear altogether. The resolution of disputes has a peace-making function. How much better would the world be if disputes became a story of the past? In a sense, it would mean a more peaceful world. However, it is hard to imagine disputes going away for good. Miscommunication and conflicts are bound to happen where

[40] This is true for wars, but even in science there are disputes. At different junctures in the past, history could have taken a completely different course. Take the war of the currents in 1880s between Thomas Edison and Nikola Tesla, for example.

[41] See Karl Llewellyn, who was a US legal philosopher, he noted the following almost a hundred years ago about disputes and the law: "What, then, is this law business about? It is about the fact that our society is honeycombed with disputes. Disputes actual and potential; disputes to be settled and disputes to be prevented; both appealing to law, both making up the business of the law.", see Karl Llewellyn, *The Bramble Bush: On Our Law and Its Study 1930 (Kindle Version, 2012 Reprint)* (Quid Pro Books), Chapter "The Bramble Bush 1. What Law Is About". See also, Ethan Katsh, *The Electronic Media and the Transformation of Law* (Oxford University Press 1989) 49–50.

humans interact with each other. After all, humans do not live in a monotonic world, which is also true for a digitized world.[42]

4 The disruption of society saw an unprecedented acceleration in 2020 because of the COVID-19 pandemic, the accompanying necessity for social distancing, and the adoption of new technologies. The world was forced into a terrain of bits and bytes all at once, as families, students, businesses, and entire industries relied on communication channels and video conferencing online. Modern life moved into a state of home-office, and only those whose face-to-face work was essential for the functioning of society, left their homes to serve in hospitals, pharmacies, and supermarkets, for example. Naturally, this also affected many justice systems. Like most countries worldwide, Switzerland took extreme measures to curb the pandemic.[43] As airports and restaurants closed and the world went into shutdown, the digitized revolution, having trained for some time, extended its wings, and took flight. In what seemed like dark moments for humanity, a new type of creature powered by the internet's connectivity hitch-hiked on the wings of this revolution and was then silently released to span an entire globe. A creature not easily understood, mostly hidden beneath many layers of mystification and whose name elicits as much perplexity as it does curiosity: Blockchains.

5 The world has seen a rise from local to global and digitized. Blockchains power a whole new infrastructure for people to enter contractual relationships and exchange goods and services. Today's economic reality is enabled by technology, is distributed worldwide, and has become more digitized. A new economy of tokenized or native token assets, including non-fungible tokens ("NFTs"), is advancing. Transactions can now be

[42] Does this mean that disputes will always have a role to play? From what can be gathered today, disputes are inherently human and will remain – at least until the robots take over. Artificial intelligence ("AI") is advancing at such rapid speed that human level AI may arrive sooner than previously anticipated, see Peter Diamandis, 'CRISPR, AI & Brain-Machine Interface: The Future Is Faster Than You Think' (*Summit LA19*) <https://www.youtube.com/watch?v=cRvzrg02gmc&t=174s>. It is possible that in the future disputes may be more easily prevented or reduced due to more advanced AI.

[43] See 'Coronavirus: Gerichtsferien in Zivil- Und Verwaltungsverfahren werden verlängert' (*Medienmitteilungen, Bundesrat*, 2020) <https://www.admin.ch/gov/de/start/dokumentation/medienmitteilungen.msg-id-78502.html>. In mid-April 2020 the Swiss Federal Council adopted a regulation on measures in the judiciary and in procedural law in connection with the coronavirus, see 'Covid-19-Verordnung Justiz Und Verfahrensrecht' (*Fedlex - Die Publikationsplattform des Bundesrechts*, 2020) <https://www.fedlex.admin.ch/eli/oc/2020/234/de>. Arbitral practice was also affected. On 16 April 2020, as a response to the COVID-19 crisis, thirteen arbitral institutions issued a joint message highlighting, that each institution looks to ensure that they "make the best use of digital technologies for working remotely." See 'Arbitration and COVID-19' (2020) <https://sccinstitute.com/media/1658123/covid-19-joint-statement.pdf>.

conducted using cryptocurrencies, allowing for international payments without intermediaries. Since approximately mid-2020, on average, over a million transactions have occurred on the Ethereum blockchain daily, many of which are powered by so-called smart contracts.[44] The tendency is that the network, along with other competing programmable blockchains, will continue to grow and handle even more transactions.[45]

6 Blockchain technology can be placed alongside "the printing press, the telephone, or the Internet".[46] Indeed, it can be considered a technological breakthrough in the sense that for the first time in human history, digital assets can be held and transferred digitally without the need for a central authority.[47] Naturally, there is much hype and enthusiasm about the potential of blockchain technology to be "transformative for every human practice".[48] However, one must be careful not to fall into the trap of becoming a true believer, focusing only on the advantages while turning a blind eye to the risks that come with this technology.[49] Although it is more thrilling to contemplate the potential of blockchains, tackling the risks if something does not work as planned is fundamental for the technology's further development.[50] This thesis is situated in the risk section of blockchains' potential: If something goes wrong, what can be done? – and aims to analyze a possible answer, *i.e.,* arbitration, with its most pertinent implications.

7 In the aftermath of the 2008 financial crisis, Satoshi Nakamoto[51] published an article entitled "Bitcoin: A Peer-to-Peer Electronic Cash System", in which he introduced the

[44] See 'Ethereum Daily Transactions Chart' <https://etherscan.io/chart/tx>.

[45] The block size of Ethereum transaction has historically grown ever since the Ethereum blockchain went live, see 'Ethereum Averge Block Size Chart' <https://etherscan.io/chart/blocksize>. Furthermore, the number of new addresses is increasing daily, indicating a wider adoption, see 'Ethereum Unique Addresses Chart' <https://etherscan.io/chart/address>.

[46] Werbach (n 7) 91.

[47] See Berentsen and Schär (n 6) 2.

[48] See Angela Walch, 'In Code(rs) We Trust: Software Developers as Fiduciaries in Public Blockchains' in Philipp Hacker and others (eds), *Regulating Blockchain: Techno-Social and Legal Challenges* (Oxford University Press 2019) 59 ("In a broader sense, blockchain technology is being lauded as transformative for every human practice that uses recordkeeping (so, all of them).").

[49] See Werbach (n 7) 227 ("Inevitably, at a time of boundless enthusiasm about the potential of blockchains and distributed-ledger technologies, most discussions focus on the benefits rather than the risks.").

[50] See Werbach (n 7) 227 ("It is more exciting to describe how systems are supposed to work than to speculate about what would happen if they did not. […] The cheerleaders and the naysayers make the same mistake: They confuse parts of the story for the whole.").

[51] For ease of reference, Nakamoto will be referred to as a single person, although there could also have been a group of people behind the name. Satoshi Nakamoto disappeared from the public in April 2011, leaving the Bitcoin project in the hands of some key developers of the Bitcoin community, see 'Email Exchange between Mike Hearn and Satoshi Nakamoto, Final Email by Satoshi Nakamoto' <https://pastebin.com/syrmi3ET> ; 'New Satoshi Nakamoto E-Mails Revealed' <https://www.trustnodes.com/2017/08/12/new-satoshi-nakamoto-e-mails-revealed>. Among the many

concept of a "chain of blocks".[52] Nakamoto's real identity to this date is unknown. The paper introducing blockchains is considered a breakthrough because it managed to overcome one of the biggest obstacles in achieving decentralized electronic payment, the so-called "double-spending" problem.[53] Its major innovation is the solution to this problem without the need for a central authority. Essentially, blockchains are decentralized digital databases spread across a distributed peer-to-peer ("p2p") network of computers and secured by advanced cryptography.[54]

8 No outside authority, such as governments, can halt blockchains[55] or exert power over their operations,[56] which creates many challenges in regulating this technology. However, public blockchains are not entirely out of reach of the legal system.[57] Intermediaries still exist and can be regulated, such as platform and service providers or centralized exchanges.[58]

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rumors who Satoshi Nakamoto could be, one is that he may be British because of the fact that Bitcoin's first transaction makes reference to an article in a British newspaper and the spelling in the whitepaper is British as well. See Bill Buchanan, 'Satoshi Was British?' <https://medium.com/asecuritysite-when-bob-met-alice/satoshi-was-british-1ba1f75cf09c>. For different theories on who Nakamoto could be, see 'Satoshi Nakamoto' <https://www.coindesk.com/people/satoshi-nakamoto>. To this date, Satoshi's identity remains a mystery.

[52] Interestingly, the whitepaper never mentions the term "blockchain". See Satoshi Nakamoto, 'Bitcoin: A Peer-to-Peer Electronic Cash System' <https://bitcoin.org/bitcoin.pdf>. Sherman et al. trace the history of blockchains back to David Chaum in the late 1970s. See Alan T Sherman and others, 'On the Origins and Variations of Blockchain Technologies' <https://arxiv.org/abs/1810.06130>. A fun fact is a printed "blockchain", which appears weekly in the New York Times, see Daniel Oberhaus, 'The World's Oldest Blockchain Has Been Hiding in the New York Times Since 1995' (*Vice*, 2018) <https://www.vice.com/en/article/j5nzx4/what-was-the-first-blockchain>. See also 'MIT 15.S12 Blockchain and Money, Fall 2018 Prof. Gary Gensler' (*Youtube*, 2020) <https://www.youtube.com/watch?v=5auv_xrvoJk>.

[53] The "double spending problem" was one of the main problems standing in the way of previous attempts at creating digital currencies because without an intermediary or central authority, anyone can just spend money twice. For an explanation of the double spending problem, see Jake Frankenfield, 'What Is Double-Spending?' (*Investopedia*, 2020) <https://www.investopedia.com/terms/d/doublespending.asp>.

[54] The computers in such a network are referred to as "nodes" and locally store the distributed ledger. Blockchain is a type of distributed ledger technology ("DLT"). To date, there is no uniform definition. Blockchains and all the technical components of Bitcoin stemmed from years of academic research in cryptography and related areas, especially from the 1980s and 1990s, see Arvind Narayanan and Jeremy Clark, 'Bitcoin's Academic Pedigree' (2017) 60 Communications of the ACM 36. See also 'ISO 22739:2020 Blockchain and Distributed Ledger Technologies — Vocabulary' (2020) <https://www.iso.org/standard/73771.html>, where the International Organization for Standardization ("ISO") defines blockchains and other terms.

[55] For ease of readability the term "the blockchain" may be used sometimes, although there are many. Thus, when this term is used it may stand representatively for all the different ones which enable peer-to-peer ("p2p") transactions and applications such as smart contracts based on a distributed ledger that assembles in blocks; thus, in short, this term represents "blockchain technology" as such. Note that there can be DLT that does not use blockchains at all.

[56] See De Filippi and Wright (n 5) 173 et seq.

[57] See De Filippi and Wright (n 5) 173 et seq.

[58] See De Filippi and Wright (n 5) 173 et seq.

9 While Bitcoin aimed to enable p2p digital cash - and has gained considerable traction with more than 658 million transactions registered to date[59] - it also demonstrated for the first time that it was possible to transfer value cross-border and digitally in a pseudonymous manner.[60] With the emergence of smart contracts,[61] that initial capability was subsequently enhanced. Smart contracts enable automatic transactions that minimize, possibly even eliminate the need for third parties.[62] At a basic level, smart contracts are hence about autonomous systems designed to conduct transactions with minimal human oversight.[63]

10 Kaal and Calcaterra, for example, argue that smart contracts effectively allow for "[a]ny existing business logic [to] be coded into the blockchain" and be executed automatically.[64] The term itself implies an improvement from traditional contracts as it portrays contracts as being "smart". However, smart contracts have often been criticized as being "neither smart nor a contract."[65] In fact, smart contracts rarely can do more than what they were programmed to do and need so-called "oracles" to access off-chain information. Oracles can be thought of as a bridge that connects the off-chain world with the blockchain.[66]

[59] See 'Blockchain Explorer - Total Number of Transactions' <https://www.blockchain.com/charts/n-transactions-total> (28 July 2021).

[60] See De Filippi and Wright (n 5) 3.

[61] See *infra* Chapter 3. See also 'Arizona House Bill 2417' <https://legiscan.com/AZ/text/HB2417/id/1588180>. **(**One of the first legal definitions of a smart contract can be found in the legislation of the state of Arizona in the US: "'Smart contract' means an event-driven program, with state, that runs on a distributed, decentralized, shared and replicated ledger and that can take custody over and instruct transfer of assets on that ledger").

[62] See Andres Guadamuz, 'All Watched over by Machines of Loving Grace: A Critical Look at Smart Contracts' (2019) 35 Computer Law and Security Review 1.

[63] See Guadamuz (n 62) 6.

[64] Wulf A Kaal and Craig Calcaterra, 'Crypto Transaction Dispute Resolution' [2018] The Business Lawyer 5. See also Finck (n 30) 24–25.

[65] See, e.g. Antonopoulos and Wood (n 28) 127. See David Alderstein, 'Are Smart Contracts Smart? A Critical Look at Basic Blockchain Questions' (*Coindesk*, 2017) <https://www.coindesk.com/when-is-a-smart-contract-actually-a-contract>. See Ed Felten, 'Smart Contracts: Neither Smart nor Contracts?' (2017) <https://freedom-to-tinker.com/2017/02/20/smart-contracts-neither-smart-not-contracts/>.

[66] See Finck (n 30) 24–25. See Chainlink, 'Smart Contract Development 101 | Chainlink Engineering Tutorials' (*Youtube*, 2021) <https://www.youtube.com/watch?v=rFXSEEQG9YE&t=260s>. For an overview of Oracles with examples, see: Julien Thevenard, 'Decentralised Oracles: A Comprehensive Overview' (*Medium*, 2019) <https://medium.com/fabric-ventures/decentralised-oracles-a-comprehensive-overview-d3168b9a8841>.

11 Currently, Ethereum[67] is the leading blockchain platform that enables smart contracting.[68] Smart contracts may reflect simple vending machine-style mechanisms to more complicated contractual structures.[69] An elaborate web of laws accompanies the countless "traditional" contracts that are concluded every single day.[70] When parties enter a contractual relationship, they create their own set of laws and are free to agree on anything they want, but they must respect public policy.[71] Their agreement creates rights and obligations which are necessarily connected to some legal system.[72] In contrast, smart contracts which rely on software may in some instances offer parties binding and enforceable contracts outside the reach of any legal system.[73]

12 In its purest form, smart contracts are free from disputes, executing whatever they have been coded to do, self-enforcing, even autonomous.[74] However, the first Decentralized Autonomous Organization ("DAO") project has shown that they are not failproof.[75] According to Kevin Werbach and Nicolas Cornell "[c]ontract law is a remedial institution [that does not] ensure performance ex ante, but [adjudicates] the grievances that may arise ex post*"*.[76] "[T]he role of a traditional court [is to act as an] *ex post* provider of trust".[77] The traditional justice system's function seems to be diminished in a smart contract environment,[78] which is also in line with what is often considered one of blockchain's most important features: its immutability.[79]

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[67] Ethereum is the most used smart contracts blockchain. It was proposed in 2013 by Vitalik Buterin and is Turing complete or computationally universal.

[68] See 'Top Smart Contracts Tokens by Market Capitalization' (*coinmarketcap*, 2021) <https://coinmarketcap.com/de/view/smart-contracts/>.

[69] See James Grimmelmann, 'All Smart Contracts Are Ambiguous' (2019) 2 Journal of Law & Innovation 2–3, 5-6 <https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3315703>.

[70] See Nigel Blackaby and others, *Redfern and Hunter on International Arbitration* (Oxford University Press 2015) para 3.03.

[71] See Blackaby and others (n 70) para 3.03. Therein reference is made to Lord McNair, Q.C., 'The General Principle of Law Recognized by Civilized Nations' [1957] 33 Brit. Y.B. Int'l L. 1, 7.

[72] See Blackaby and others (n 70) para 3.03. Therein reference is made to Lord McNair, Q.C., 'The General Principle of Law Recognized by Civilized Nations' [1957] 33 Brit. Y.B. Int'l L. 1, 7.

[73] See Grimmelmann (n 69) 3.

[74] See Kaal and Calcaterra (n 64) 5-6, 49, where they explain that blockchain technology has dispute resolution as part of its makeup design, but that "smart contracting in a commercial setting will eventually require additional dispute resolution mechanisms".

[75] See Kevin Werbach and Nicolas Cornell, 'Contracts Ex Machina' (2017) 67 Duke Law Journal 313, 350 et seq. See *infra* Chapter 5.3.1.1.

[76] Werbach and Cornell (n 75) 318. Footnote omitted.

[77] Berg, Davidson and Potts (n 17) 11.

[78] See Berg, Davidson and Potts (n 17) 11.

[79] See Jörn Erbguth, 'Lösung Blockchain-Basierter Konflikte' (*Jusletter IT*, 2017) <https://jusletter-it.weblaw.ch/issues/2017/IRIS/losung-blockchain-ba_4a9ae0f020.html>.

13 This feature also creates trust between parties.[80] However, in exceptional cases, changes may be necessary, *e.g.*, to remedy a faulty activity or transaction.[81] In 2015, there were estimates that disputes arise "in 3-5 percent of online transactions", which is no surprise because insofar as commerce and social interactions move online, so do conflicts, and the tendency is not a decrease but only an increase in transactions and disputes.[82] Colin Rule states that "the power of technology to resolve disputes is dwarfed by the power of technology to generate new disputes".[83]

14 The trend of innovation is likely to continue.[84] Although smart contracts may provide for more efficient and cheaper transactions, disputes cannot be eradicated entirely, and parties will need appropriate means for solving their conflicts.[85] Therefore, adequate dispute resolution mechanisms and regulations are necessary. The entire blockchain dispute resolution area is still in its very early stages, but a growth tendency can be observed.[86] The blockchain market is estimated at approx. $5 billion, expected to climb to over $39 billion by 2025, while the legal services market is estimated at nearly one trillion worldwide.[87]

15 It seems that for disputes arising out of blockchains, suitable dispute resolution needs to operate within the realms of this technology. Such mechanisms have been termed, for example, "smart dispute resolution", "blockchain dispute resolution", "blockchain

[80] See Erbguth (n 79).
[81] See Erbguth (n 79).
[82] Ethan Katsh and Orna Rabinovich-Einy, *Digital Justice: Technology and the Internet of Disputes* (Oxford University Press 2017) 67. There they reference to an email between Colin Rule and Ethan Katsh from 2015.
[83] See Colin Rule, 'Using Online Dispute Resolution to Expand Access to Justice' (*Oklahoma Bar Journal*, 2019) <https://www.okbar.org/barjournal/aug2019/obj9006rule/>. Quote originally attributed to Ethan Katsh. See Oladeji Tiamiyu, 'Convergence: A Podcast on Dispute Resolution and Technology, Episode 1: Colin Rule – Online Dispute Resolution's Origin Stories' <https://hnmcp.law.harvard.edu/hnmcp/podcast/convergence-ep-1/>.
[84] An observation frequently made in technical academic literature as well, see Lewis Gudgeon and others, 'SoK: Layer-Two Blockchain Protocols' in Joseph Bonneau and Nadia Heninger (eds), *Financial Cryptography and Data Security, 24th International Conference, FC 2020, Lecture Notes in Computer Science, vol. 12059* (Springer, 2020) 202.
[85] See, generally, Orna Rabinovich-Einy and Ethan Katsh, 'Blockchain and the Inevitability of Disputes: The Role for Online Dispute Resolution' (2019) Journal of Dispute Resolution 47.
[86] See Yann Aouidef, Federico Ast and Bruno Deffains, 'Decentralized Justice: A Comparative Analysis of Blockchain Online Dispute Resolution Projects' (2021) 4 Frontiers in Blockchain 3, 7 <https://www.frontiersin.org/article/10.3389/fbloc.2021.564551>.
[87] See Aouidef, Ast and Deffains (n 86) 7. See Statista, 'Size of the Legal Services Market Worldwide from 2015 to 2023 (in Billion U.S. Dollars)' (*Statista*) <https://www.statista.com/statistics/605125/size-of-the-global-legal-services-market/>. See Statista, 'Size of the Blockchain Technology Market Worldwide from 2018 to 2025' <https://www.statista.com/statistics/647231/worldwide-blockchain-technology-market-size/>.

arbitration" or "smart (contract) arbitration".[88] Blockchain technology has also been described as enabling the emergence of so-called "decentralized justice"[89] and arbitration is the dispute resolution of choice in the crypto economy. It allows for maximum flexibility, party autonomy, free choice of arbitrators, and other significant advantages. However, the international arbitration framework relies on the New York Convention on the Recognition and Enforcement of Foreign Arbitral Awards of June 10, 1958 ("New York Convention"), which came into force in the 1950s. It aimed at facilitating international trade of a time long past, where the Internet, blockchains, and smart contracts would have been considered something akin to magic.

16 This study demystifies the phenomenon of disputes on blockchains and uncovers "crypto arbitration", an entirely new way of solving disputes. At the outset, this form of arbitration conducted on blockchains can be seen as distinct from traditional international arbitration and incorporates its own set of laws, which one may refer to as *lex cryptographica arbitri*.[90] The fundamental differences between traditional and smart arbitration can be tentatively depicted in a simplified manner as follows:

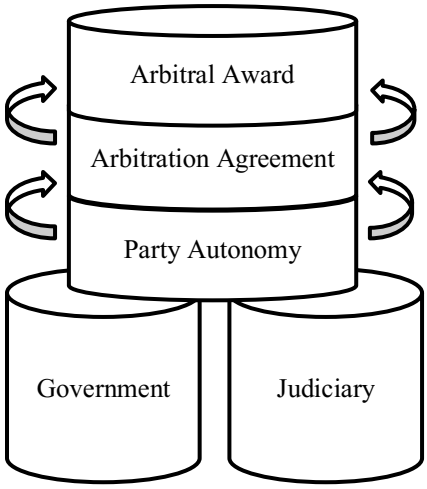

Figure 1. Traditional International Arbitration[91]

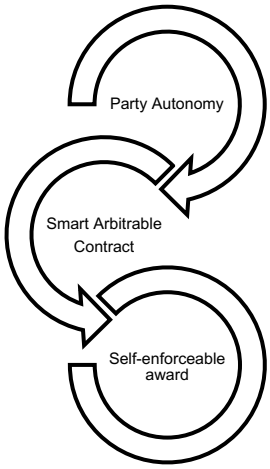

Figure 2. Crypto Arbitration[92]

[88] See, e.g., Mateja Durovic, 'How to Resolve Smart Contract Disputes: Smart Arbitration as a Solution' in Nikita Aggarwal et al. (ed), *Autonomous Systems and the Law* (Nomos 2019) 24.

[89] See Kleros, *Dispute Revolution - The Kleros Handbook of Decentralized Justice - Revised and Augmented Edition* (2020) 124 et seq. <https://kleros.io/book.pdf>.

[90] See Blackaby and others (n 70) paras 3.73-3.74. (They mention the idea of a "universal *lex arbitri* [in order to have] a 'level playing field' for the conduct of international arbitrations wherever they took place".) In a blockchain context, this is quite interesting. In a self-enforceable system such as a blockchain infrastructure could be, party autonomy becomes the very fundament of the procedure, the be-all and end-all of arbitration, with no government or judiciary interfering. See for the term "lex cryptographica", first introduced by De Filippi and Wright (n 5) 49–50. Note that the authors changed it slightly from "lex cryptographia" in their 2015 article to "lex cryptographica".

[91] Own figure.

[92] Own figure.

17 Figure 1 depicts traditional international arbitration and the different actors needed for this system to function properly. In traditional arbitration, the recognition of an arbitration agreement and the enforcement of an arbitral award is dependent on the promise of both the government and the judiciary, guaranteed by the New York Convention on the Recognition and Enforcement of Foreign Arbitral Awards of June 10, 1958 ("New York Convention"). The whole robust construct of arbitration rests and falls on this promise, represented by the two pillars in the picture supporting the structure.

18 Figure 2 shows "crypto arbitration" or a more general term "crypto dispute resolution" ("CDR").[93] This form has a more independent structure. Party autonomy seamlessly leads to recognition of arbitration agreements and the enforcement of an arbitral award without any promises from the government or the judiciary. It is a self-contained system without any intervention, a parallel universe functioning based on cryptography, hashes, and code.

19 With the invention of blockchain smart contracts, which automate and self-enforce commercial transactions, the quest to automate dispute resolution has readily followed suit.[94] The novelty of blockchains has also brought about novel approaches to resolving disputes, and tech enthusiasts have developed different forms of arbitration.

20 It is important to recognize how a revolutionary new technology such as blockchains structurally changes and possibly even reinvents one of the main and most essential features of our justice systems: the resolution of disputes. More than a decade has passed since the first Bitcoin block was mined, leading the way for smart contracts platforms to join the scene. The development continues to unfold in real-time. As Schultz has put it, "[d]ispute settlement, at heart, is anything but a dry, technical, mechanical field. It is about justice. It is about our fundamental human aspirations. It is about where there is law and where there is not."[95] Hopefully, this dissertation will have contributed to providing its readers with the knowledge and ideas to be part of the discussion on the

[93] Other terms used frequently may be "smart arbitration", interchangeably used with blockchain arbitration and smart contract arbitration, on-chain arbitration, on-chain dispute resolution, blockchain dispute resolution, crypto dispute resolution. This thesis adopts the terms "crypto arbitration" and "crypto dispute resolution" ("CDR").

[94] See Durovic (n 88) 24.

[95] Thomas Schultz, *Transnational Legality: Stateless Law and International Arbitration* (Oxford University Press 2014) 6.

future of dispute resolution, justice, and the law. A future that will only be shaped by those who choose to partake.

1.2 Purpose and Aim of the Study

21 This dissertation examines blockchains, a form of distributed ledger technology ("DLT"), from a legal perspective, focusing on international arbitration law. More specifically, the purpose of this study is to offer a structured and systematic analysis of dispute resolution on blockchains, justice by decentralized means, and autonomous arbitration. It aims to serve as a guide and tool to maneuver this largely unsettled and complex area within the law. Another important aim is to create awareness of the potential new disputes arising out of blockchains and smart contracts and the need for a proper dispute settlement mechanism for future disputes. An overarching goal is to articulate limitations of existing blockchain systems and to offer guidance based on principles of international arbitration law, drawing comparisons with other laws and legal orders where appropriate.

22 This study contributes to the scholarship dealing with international arbitration law, the nature of arbitration, law without the state, and the emerging "blockchain law". It does so by combining novel approaches to methodology and seeking to combine aspects of different disciplines in such a way as to demonstrate in a coherent account what consequences may come about from the intersection of arbitration with blockchains.

23 This study aims to advance the novel field of research at the intersection of blockchains and law. It also aims to give an informed insight into the *status quo* and how arbitration may be showing its most versatile nature yet. With the help of blockchains, arbitration might be breaking free entirely from the national constraints it has found itself in for centuries, becoming completely autonomous. It must be analyzed whether this is favorable, and if not, what corrective measures can be taken. Relevant issues are analyzed to show how the settlement of disputes is influenced by blockchain technology. Qualitative empirical research and a varied selection of literature and sources have been used, along with studies of actual examples of the use of blockchains and smart contracting.

1.3 Problem Definition

24 When negotiating contracts, parties create their own laws to the extent that party autonomy allows within the legal framework of the jurisdiction to which their interaction pertains. However, the complexity of the issues that individuals face when it comes to blockchain technology does not fit into the accustomed legal frameworks. Blockchains create a sort of parallel reality, extending borders, the implications of which are innumerous. Current regulatory efforts struggle to address the complexity of this technology, which is embedded in a mysterious narrative that bears little resemblance to what is already known.

25 Human biology is essentially the same as it was a thousand or even tens of thousands of years ago because the evolution of DNA is slow compared to the evolution of technology. In contrast to that, technology accelerates at rapid speed. The world is changing fast due to rapidly evolving technology and its wider adoption.[96] Paradigm shifts are bound to happen more frequently. Aside from artificial intelligence ("AI"), blockchain technology plays a critical role in this development of radical change.[97] In a sense, blockchains allow for entirely new infrastructures in which human beings and artificial intelligence can cooperate. Goertzel highlights that "the ways in which blockchain technology is developed right now will be part of the nexus of factors influencing what sort of outcome eventuates for humanity generally".[98] It lies in the responsibility of today's society to make sure that the infrastructures underlying the information and value transfers of the future are sound and compatible with fundamental human rights and fairness principles.

26 The future cannot be left to technologists alone who are coding the underlying programs. The major problem is that the legal and technical communities largely operate in different spheres, speak different languages, and do not have many contact points. It is now that bridges need to be built and intensified between disciplines. The legal community's attention and active participation in developing this emerging technology, even if and precisely because it is not ripe for prime time, is needed now more than ever. Interdisciplinary discussions are of utmost importance. The risks associated with

[96] See Diamandis (n 42). See also Youtube Originals, 'How Far is Too Far? | The Age of A.I.' (2019) <https://www.youtube.com/watch?v=UwsrzCVZAb8> .

[97] See Ben Goertzel, 'Say Hello to the Singularity' (*Coindesk*, 2020) <https://www.coindesk.com/say-hello-to-the-singularity>.

[98] Goertzel (n 97).

interacting with this technology and the types of disputes deserve particular attention because that is when law is needed the most.

1.4 Research Questions

27 Because blockchain technology is global and decentralized, it is *de facto* delocalized.[99] Therefore, it finds itself in a challenging position *vis-à-vis* the territorial approach followed by courts in terms of jurisdiction.[100] Systematically analyzing some of the most pressing open questions and challenges as the technology develops is critical. In order to conceptualize crypto arbitration, this study will answer several guiding questions:

1. What are the approaches to dispute resolution on blockchains? (Sub questions How does crypto arbitration differ from traditional international commercial arbitration? How can blockchain disputes generally be conceptualized?)

2. What are the legal effects of an arbitration agreement as smart contract code? (Sub question: Can such an agreement be entered into validly?)

3. Do the rules that govern crypto arbitration comply with international due process and fairness standards? (Sub questions: What are the basic principles of fair procedure that need to be maintained? Can these fundamental standards be transposed to and safeguarded within the blockchain context? Does a game-theoretical approach to decision-making in arbitration, as proposed in Kleros' blockchain dispute resolution process, constitute a fair process?)

4. Which legal theory of international arbitration can be applied to crypto arbitration? (Sub questions: What are the legal theories of international commercial arbitration? Does resolving disputes on a blockchain create a separate, autonomous legal order?)

[99] See Pietro Ortolani, 'The Impact of Blockchain Technologies and Smart Contracts on Dispute Resolution: Arbitration and Court Litigation at the Crossroads' (2019) 24 Uniform Law Review 430, 431.
[100] See Ortolani, 'The Impact of Blockchain Technologies and Smart Contracts on Dispute Resolution: Arbitration and Court Litigation at the Crossroads' (n 99) 431.

1.5 Literature Review and the Current State of Research

28 The study contributes to the current state of learning regarding blockchains and dispute resolution. The literature on international arbitration is vast, as is the literature on blockchains. However, the amount of comprehensive and in-depth literature on the relationship between the two is limited. Blockchain research is growing in popularity each year, and this is true for its intersection with dispute resolution as well. However, smart contracts, DAOs, and DApps appear to be too recent a phenomenon for case law to have already developed. [101]

29 The existing legal infrastructure cannot adequately address the types of disputes generated by blockchain technology and smart contracting, which has led to blockchain-native alternatives. This can initially be explained by the blockchain communities' strong dislike for the state system, incorporating the spirit of Barlow's "A Declaration of the Independence of Cyberspace", in which he proclaimed: "Governments derive their just powers from the consent of the governed. You have neither solicited nor received ours. We did not invite you. You do not know us, nor do you know our world."[102] How conflicts on blockchains can be resolved and claims enforced is thus still largely unsettled. There are many gaps to be filled at the intersection of dispute resolution and blockchain.

30 Many legal issues connected to blockchain, which have already surfaced in practice or are bound to surface, require a more detailed legal analysis. The application of arbitration law to blockchain arbitration is further complicated by the technical design of the technology, whose complexity when merged with other technologies is only bound to increase. Blockchains are not merely an idea anymore, the "[t]echnology has let the genie

[101] For an overview of litigations regarding cryptocurrencies brought before US courts, see Thibault Schrepel, 'Analyzing One Decade of Blockchain Litigation' (*CONCURRENTIALISTE*) <https://leconcurrentialiste.com/decade-blockchain-litigation/>. In terms of rulings on arbitral awards, there are a select few court cases, such as the Shenzhen Court that set aside China's First Arbitral Award on Bitcoin due to public policy grounds. See Helen Tang, Anthony Crockett and Briana Young, 'PRC Court Sets Aside Cryptocurrency Award on Public Interest Grounds' <https://arbitrate.com/prc-court-sets-aside-cryptocurrency-award-on-public-interest-grounds/>.

[102] John Perry Barlow, 'A Declaration of the Independence of Cyberspace' (*Electronic Frontier Foundation*, 1996) <https://www.eff.org/cyberspace-independence>. See Schrepel (n 101).

out of the bottle".[103] Although many of the applications are in a proof-of-concept stage, substantial economic activity occurs.

31 Although blockchain and smart contracts are gaining popularity in academic legal research, legal studies at the intersection of blockchain and dispute resolution are still limited and seem to essentially repeat the same narrative. An inquiry into specialized databases, such as Kluwer Arbitration, Kluwer Arbitration Blog, International Arbitration Journals, and (Online) Dispute Resolution Journals, both international and national, has shown an increased interest in blockchain and smart contracts. However, the amount of literature or academic studies on the use of blockchain technology and dispute resolution can be further developed.

32 Some major works on blockchain and the law, namely by Primavera de Fillipi and Aaron Wright "Blockchain and the Law – The Rule of Code" (Harvard University Press 2018), "Blockchain Regulation and Governance in Europe" (Cambridge University Press 2019) by Michèle Finck, "The Blockchain and the New Architecture of Trust" (The MIT Press 2018) by Kevin Werbach do not tackle questions relating to the adjudication and justice systems being advanced through blockchain technologies in detail. In general, when the literature does address the phenomenon of crypto dispute resolution, it highlights the number of unresolved issues and encourages further debates.

33 Some legal scholars, such as Pietro Ortolani[104] and Riika Koulu[105] delve into the concepts of stateless justice and the impact of blockchain technology on dispute resolution and Bitcoin adjudication systems and online dispute resolution. Ortolani rightly points out that especially "one aspect of the bitcoin white paper […] has not received extensive attention so far: bitcoin's inherent tendency towards judicialization - that is, the development of its own dispute resolution architecture".[106] Pietro Ortolani has published

[103] Timothy C. May, 'Crypto Anarchy and Virtual Communities' (1994) <http://groups.csail.mit.edu/mac/classes/6.805/articles/crypto/cypherpunks/may-virtual-comm.html>. See De Filippi and Wright (n 5) 71.

[104] See e.g., Pietro Ortolani, 'Self-Enforcing Online Dispute Resolution: Lessons from Bitcoin' (2016) 36 Oxford Journal of Legal Studies 595; Pietro Ortolani, 'The Three Challenges of Stateless Justice' (2016) 7 Journal of International Dispute Settlement 596; Ortolani, 'The Impact of Blockchain Technologies and Smart Contracts on Dispute Resolution: Arbitration and Court Litigation at the Crossroads' (n 99).

[105] See Riikka Koulu, 'Blockchain and Online Dispute Resolution: Smart Contracts as an Alternative to Enforcement' (2016) 13 SCRIPTed 41.

[106] Ortolani, 'The Impact of Blockchain Technologies and Smart Contracts on Dispute Resolution: Arbitration and Court Litigation at the Crossroads' (n 99) 432.

various thought-provoking articles on the topic, dating back to 2015, starting with "Self-Enforcing Online Dispute Resolution: Lessons from Bitcoin".[107] Although they lay excellent foundations for the present study, his articles mainly deal with the Bitcoin blockchain. They do not address in-depth novel dispute resolution applications developed on programmable blockchains, such as Ethereum.

34 Colin Rule and Amy Schmitz have published several excellent articles on Online Dispute Resolution for Smart Contracts,[108] and have spoken at conferences. They are preeminent authorities on online dispute resolution. Schmitz expresses her concern about the fact that "technologists and corporations that are pouring billions of dollars into smart contracts are not attending ADR/ODR conferences or thinking about how smart contract disputes will be resolved".[109] This only highlights the importance of the present study.

35 Wulf A. Kaal and Craig Calcaterra published "Crypto Transaction Dispute Resolution", in which they address governance issues and raise awareness to the difficulties that arise out of transactions on blockchains in relation to the notion of jurisdiction, and they alert to the flaws inherent in the existing infrastructures concerning smart contract disputes.[110] They propose "[b]ased on the concept of distributed jurisdiction […] an open source platform ecosystem for smart contracting dispute resolution that allows users to opt into a conflict resolution mechanism".[111] Like most of the other works that have been published in the intersection of blockchains and dispute resolution so far, this paper does not address arbitration's framework and leading principles.

36 Orna Rabinovich-Einy and Ethan Katsh have analyzed the topic in "Blockchain and the Inevitability of Disputes: The Role for Online Dispute Resolution".[112] Rabinovich-Einy is an authority in the ODR field, and Katsh is considered the "father of ODR". Their analysis is thus shaped by the ODR field, which is quite different from international

[107] See Pietro Ortolani, 'Self-Enforcing Online Dispute Resolution: Lessons from Bitcoin' (2016) 36 Oxford Journal of Legal Studies 595. The article had an advance access in 2015.
[108] See, e.g., Amy J Schmitz and Colin Rule, 'Online Dispute Resolution for Smart Contracts' [2019] Journal of Dispute Resolution 103. See also Amy J Schmitz, 'Resolving a New Kind of Trade War Through ODR' [2020] University of Missouri, School of Law, Legal Studies Research Paper Series No. 2020-02 <http://ssrn.com/abstract=3525767>.
[109] Schmitz (n 108).
[110] See Kaal and Calcaterra (n 64).
[111] Kaal and Calcaterra (n 64) 1.
[112] Rabinovich-Einy and Katsh (n 85).

commercial arbitration. They neither refer to the New York Convention nor to party autonomy or other essential frameworks and principles that constitute modern-day international arbitration.

37 Michael Buchwald in "Smart Contract Dispute Resolution: The inescapable flaws of blockchain-based arbitration"[113] lays out the flaws and limitations of the recent phenomenon of on-chain dispute resolution, taking a US-centric approach. He identifies critical issues and explores them in-depth, focusing mainly on discovery, the juror incentive mechanism, and scalability. The central focus, however, lies on whether on-chain resolution is "perpetually bound to inferiority".[114] The author concludes that on-chain arbitration cannot "successfully emulate any off-chain alternative [dispute resolution] without sacrificing the guiding principles of blockchain", such as decentralization and pseudonymity.[115] While he compares on-chain dispute resolution with both litigation and arbitration, his analysis does not address the international commercial arbitration framework at all, as there is no mention of any of arbitration's principles or laws. When he does address arbitration, his focus lies solely on the US.

38 Besides legal scholars, some practitioners have also spoken or written on the subject. Markus Kaulartz, for example, published a paper entitled "Smart Contract Dispute Resolution" and has introduced the concept of a "smart contract dispute resolution library", which he recommends can be used to pause a smart contract transaction until a dispute that arises is resolved.[116] Some authors seem to want crypto arbitration to fit the requirements established in conventional international arbitration. Ibrahim Shehata, for example, explains that parties to a smart contract "should prioritize their choice of the seat of arbitration".[117] The seat of arbitration is of fundamental importance to international arbitration. However, for crypto arbitration, a distinction must be made. Is the seat really that important in the blockchain framework? It is necessary to accentuate and delineate the differences between traditional and crypto arbitration and to what extent

[113] Michael Buchwald, 'Smart Contract Dispute Resolution: The Inescapable Flaws of Blockchain-Based Arbitration' (2020) 168 University of Pennsylvania Law Review 1369.
[114] See Buchwald (n 113) 1384.
[115] See Buchwald (n 113) 1374.
[116] See Markus Kaulartz, *Smart Contract Dispute Resolution* in Martin Fries and Boris P Paal (eds), *Smart Contracts* (Mohr Siebeck GmbH and Co KG 2019) 78. See also *infra* Chapter 5.4.9.
[117] See Ibrahim Shehata, 'Arbitration of Smart Contracts Part 3 – Issues to Consider When Choosing Arbitration to Resolve Smart Contracts Disputes' [2018] *Kluwer Arbitration Blog* <http://arbitrationblog.kluwerarbitration.com/2018/08/30/arbitration-smart-contracts-part-3/>.

– if at all – international arbitration law can be applied in a blockchain context. There is also the question of whether established concepts of international arbitration still apply in the blockchain context or whether arbitration on blockchains creates its own concepts and rules. This study, therefore, approaches the topic in a more nuanced way.

39 The research done so far generally introduces the reader to the concept of blockchain and its potential use cases for dispute resolution, lays necessary foundations, and enriches the debate. It can be observed that scholars mostly from the ODR field have become interested in the topic, whereas arbitration scholarship is still scarce. None of the studies and articles give a sufficiently thorough account of the applications being developed today in their wider context, and the legal concepts and implications are mostly discussed without much historical background and theoretical underpinnings. None of the research published so far addresses international commercial arbitration law in such depth as the present study, and hardly any embeds the discussion in historical, theoretical, socially relevant, and methodologically sound context. Comprehensive conceptualizations are largely missing, as are accounts on the evolution of dispute resolution approaches in the blockchain community, and matters related to legal theory often stay unaddressed. Some research publications are inaccurate, and most of the information is already outdated – that is understandable due to the nature of this rapidly evolving technology.

40 There is an evident lack of research at the intersection of international arbitration and blockchains. This study aims to fill this gap. Its ambition is to give a *status quo* account by portraying the arbitration solutions being developed today and take that further step of contrasting the approaches within the wider legal and international arbitration framework to conceptualize this new phenomenon and offer new perspectives. This study aims to be of foundational character, it cannot tackle all the open legal questions as regards this vast topic but will select a few pertinent ones in order to systematize the concepts for continuous and meaningful debates as well as to give an impetus to academic discussions.

1.6 Scope and Limitations

41 The study examines writings in the fields of arbitration law and legal theory, jurisprudence and blockchain technology. The range of theoretical and practical matters

addressed needs to be tailored. This dissertation represents one possible way the interaction between dispute resolution and blockchain technology may be examined.

42 The present study examines blockchains from the perspective of international arbitration. International commercial arbitration has become the standard means for resolving disputes arising from international commercial contracts.[118] This dissertation focuses on a contractual form of arbitration, *i.e.*, international commercial arbitration instead of "treaty-based" arbitration between investors and states.[119] Further, although relevant and interesting to discuss in the context of blockchains, consumer arbitration lies outside the scope of the present study.

43 International commercial arbitration is a diverse and vast field, and there can be considerable differences between jurisdictions. The research questions are not jurisdiction-specific, instead this thesis relies on international sources of international commercial arbitration law, such as international conventions and model laws, to discuss the varied topics in a general manner. However, if this study were to be anchored at any particular "seat of arbitration", it would be Switzerland; its *lex arbitri* will thus serve for comparison purposes and to elaborate on specific points in the analysis.

44 The present study focuses on the procedure rather than on substantive matters of law. An empirical analysis as to whether traditional legal contracts are concluded through smart contracts is beyond the scope of this thesis, as is an analysis under what circumstances and to what extent smart contracts constitute legal contracts in different jurisdictions. Recognizing that contracts form the basis of arbitration, however, this thesis will discuss arbitration agreements concluded by way of smart contracts in the analysis section. The present study concerns itself with questions regarding dispute resolution and conceptualizes in a foundational manner the different blockchain-related phenomena for future ongoing discussions. A legal relationship is thus presupposed, whether by smart contract[120] or some prior defined legal relationship in connection with a smart contract or enabled by blockchains. However, even if a smart contract does not reflect a legal relationship or is subject to some fault or mistake, it will execute as programmed. The

[118] See e.g., B Garth, 'International Arbitration', *International encyclopedia of the social & behavioral sciences* (Elsevier 2001) 7765.
[119] See *infra* Chapter 4.3.2.3.
[120] Also "smart legal contract".

current architectural environment does not allow for mistakenly lost funds to be retrieved on public permissionless blockchains like Ethereum. Although discussions on smart contracts may be premature as the development is still ongoing, the present study offers the opportunity to engage with this development and therefore enter regulatory discussions in shaping the technology's future when it comes to its intersection with the law.

45 Blockchains are multifaceted and varied. There is not only one blockchain but many different blockchains with different characteristics, consensus mechanisms, and designs. They may vary in their nature, access, and purpose. While some are open and public, others are private and access restricted. The public and permissionless types of blockchain are a paradigm shift and represent a breakthrough innovation.[121] This thesis will primarily discuss public and permissionless blockchains, which enable decentralized cooperation. Chapter 2 outlines the differences between these types for a better understanding.

46 As noted in the introduction, the crypto economy is developing rapidly. Antonopoulos, a recognized thought leader and writer on blockchains, remarked in a talk that his book on Bitcoin was outdated the moment it was published.[122] Besides the rapid development, uncertainties about the future of blockchains are among the challenges the present study faces. To mitigate the risk that a rapidly evolving research environment brings, this study focuses on two major blockchains that dominate the market and have had the most success and traction so far: Bitcoin and Ethereum.

47 Bitcoin is the mother of all blockchains, and Ethereum is the first and most used platform for smart contracts. Ethereum's lead in the market is not set in stone. 2020 and 2021 have seen an extreme increase in Ethereum transaction fees, mostly due to the Decentralized Finance ("DeFi") trend. Gas fees of $20 onwards per smart contract transaction have become customary. In May 2021, the average transaction price has reached more than $60.[123] On 10 May 2021, the total transaction fees paid amounted to $89 million, which

[121] See De Filippi and Wright (n 5) 32.
[122] Andreas M Antonopoulos, 'Bitcoin Is Punk-Rock, You Can't Control It' (*Youtube Wired UK*, 2015) <https://www.youtube.com/watch?v=A6kJfvuNqtg>. See also Finck (n 30) 2-3.
[123] See Colin Harper, 'DOGE Imitators Help Send Ethereum Transaction Fees to All-Time Highs' (*Coindesk*, 2021) <https://www.coindesk.com/ethereum-gas-fees-all-time-high-doge-imitators>.

was reportedly "the most ever recorded in a single day" up until that time.[124] The scalability problem that Ethereum is struggling with has enabled competitors to gain ground. Researchers have been working on solutions to the Layer 1 scalability problem for years.[125] Other blockchains are trying to dethrone Ethereum by creating innovative solutions. Examples include Solana, Cardano, Polkadot, Binance Smart Chain, and Dfinity. Notwithstanding these developments, Ethereum has the largest and most dynamic community and application diversity of any open, permissionless, and programmable blockchain.

48 The dissertation aims to provide an overview of relevant blockchain dispute resolution projects and analyze certain aspects which are of particular interest to the research questions. Based on an assessment of the literature and the research conducted, some blockchain companies, such as Kleros, Aragon, Jur, and Mattereum, stood out. These projects were the ones most accessible, whose representatives were available for interviews and shared insights about their vision and the development of their blockchain applications. In the fast-developing realm of blockchain technologies, companies may cease to exist in the blink of an eye. However, the companies chosen for this study and in particular to be interviewed present low likelihood of having vanished by the time of this publication. The assessment was made on the following parameters: (i) the company's website is accessible and regularly updated; (ii) the founder(s) are active on social media and/or in the community; (iii) the whitepaper/yellow paper is available; (iv) there is an active community (e.g., on telegram, discord, twitter); (v) the company representatives and/or employees respond to e-mails or other forms of communication; and (vi) the company representative(s) and/or employees agreed to be interviewed.

49 Out of the four companies interviewed and looked at in-depth, Kleros has a working product on the Ethereum main net, which the author was able to test herself on the Kovan Ethereum test network. The advances made by the Kleros protocol were the most intriguing ones challenging conventional dispute resolution wisdom and knowledge. In

[124] See Samyuktha Sriram, 'DOGE Copycats And Meme Coins Send Ethereum Gas Fees To Record Highs' (*Benzinga*, 2021) <https://www.benzinga.com/markets/cryptocurrency/21/05/21052285/doge-copycats-and-meme-coins-send-ethereum-gas-fees-to-record-highs>. News outlets explain this by reference to the rise of meme coins, such as $Shib on the Ethereum platform, coins that follow the example of Dogecoin which has become popular due to celebrity endorsements, such as by Elon Musk.

[125] Ethereum is a Layer 1 chain, meaning that it is the blockchain protocol, the base layer. Layer 2 allows to transact off the main chain. Layer 2 solutions enable faster transactions for very low costs. See 'What's Layer 1 vs Layer 2?' (*The Defiant*, 2021) <https://thedefiant.io/whats-layer-1-vs-layer-2/>.

the analysis section, it therefore stands to represent the evolution of so-called crypto dispute resolution ("CDR") or crypto arbitration, which leverages blockchain technology to decentralize the arbitral process, applying game theory to incentivize strangers to cooperate and render a decision. Although Kleros will have a center stage in the analysis, other identified projects are outlined to give a broader understanding of the novel ideas at the intersection of arbitration and blockchains, thereby enriching the present study with more than one perspective. Comparisons are made whenever it seems suitable. The development until the summer of 2021 is taken into consideration.

1.7 Academic and Practical Relevance

50 Blockchain technology is developing rapidly.[126] It is sometimes called a "bleeding-edge technology", and is not yet mature.[127] However, there is growing agreement that blockchains are revolutionary.[128] Some go so far as to say that blockchain "has the potential for disrupting all areas of our current economy".[129]

51 Many of the major traditional intermediaries in the finance industry, such as banks and insurance companies, are already exploring blockchains and smart contracts. They are looking for avenues to enter the crypto economy. The European Investment Bank ("EIB"), for example, made headlines after it used Ethereum to issue $121 million worth of bond tokens.[130]

52 McLuhan observed that "[o]nce a new technology comes into a social milieu it cannot cease to permeate that milieu until every institution is saturated".[131] As blockchain technology begins to permeate one industry after the other, the importance of smart contracts will likely increase, as already today, the software code supporting those smart

[126] Note, there is not only one blockchain technology but a growing body of different designs and projects. See e.g., "Global Legal Blockchain Consortium" <https://legalconsortium.org/what-is-the-glbc/>, whose members are law firms, large companies, and academic institutions.

[127] See Finck (n 30) 33. In Interview #12, Christian Scharr calls blockchains a "bleeding-edge technology"; see also João Pedro Quintais et al., 'Blockchain and the Law: A Critical Evaluation' (2019) 2.1 Stanford Journal of Blockchain Law & Policy 86 <https://stanford-jblp.pubpub.org/pub/blockchain-and-law-evaluation/release/2>.

[128] See Quintais and others (n 127).

[129] See Kaal and Calcaterra (n 64) 4.

[130] See Tanzeel Akhtar, 'European Investment Bank Issues $121M Digital Notes Using Ethereum' (*Coindesk*, 2021) <https://www.coindesk.com/european-investment-bank-issues-121m-digital-notes-using-ethereum>.

[131] Marshall McLuhan, *Understanding Media - The Extensions of Man* (The MIT Press 1994) 177. See also Leah Wing et al., 'Designing Ethical Online Dispute Resolution Systems: The Rise of the Fourth Party' (2021) 37 Negotiation Journal 49, 51.

contracts control billions of dollars of digital assets.[132] According to a Hackernoon report, the DeFi space has grown exponentially and has gone from $540 million in total value locked in March 2020 to over $43.6 billion by March 2021.[133] Smart contracts, even if open-source and audited, might have exploitable weaknesses, that if abused can lead to considerable losses.[134]

53 In his book *The Blockchain and the New Architecture of Trust*, Werbach makes reference to the National Research Council ("NRC") of the United States' 1996 report entitled "The Unpredictable Certainty", which in his mind "captured perfectly the prospects for the Internet then, and for the blockchain today":[135] There is uncertainty about how blockchains will develop and how they will impact people's lives, but there is a sense of certainty that fundamental changes in many areas will take place.[136] However, the exact nature of these changes is as unpredictable as it was for the Internet.[137]

54 Andressen, who coined the famous phrase "software is eating the world",[138] captures this notion vividly:[139]

> "A mysterious new technology emerges, seemingly out of nowhere, but actually the result of two decades of intense research and development by nearly anonymous researchers. Political idealists project visions of liberation and revolution onto it; establishment elites heap contempt and scorn on it. On the other hand, technologists – nerds – are transfixed by it. They see within it enormous potential and spend their nights and weekends tinkering with it. Eventually mainstream products, companies and industries emerge to

[132] See Kai Sedgwick, 'The Billion-Dollar Quest to Eliminate Smart Contract Bugs' (*Bitcoin.com*, 2018) <https://news.bitcoin.com/the-billion-dollar-quest-to-eliminate-smart-contract-bugs/>. See Christopher Fowler, 'Smart Contract Vulnerabilities Are A Ticking Time Bomb Holding Billions of Unsuspecting $$$ Hostage' (*Hackernoon*, 2021) <https://hackernoon.com/smart-contract-vulnerabilities-are-a-ticking-time-bomb-holding-billions-of-unsuspecting-dollardollardollar-hostage-km3i3341>.

[133] See Fowler (n 132).

[134] See Fowler (n 132).

[135] Werbach (n 7) 225 et seq. See also 'The Unpredictable Certainty: Information Infrastructure Through 2000 (National Research Council, 1996)' <https://www.nap.edu/read/5130/chapter/1>.

[136] Werbach (n 7) 225 et seq. See also 'The Unpredictable Certainty: Information Infrastructure Through 2000 (National Research Council, 1996)' <https://www.nap.edu/read/5130/chapter/1>.

[137] See Werbach (n 7) 225 et seq. See also 'The Unpredictable Certainty: Information Infrastructure Through 2000 (National Research Council, 1996)' (n 135).

[138] See Marc Andreessen, 'Why Software Is Eating The World' (*The Wall Street Journal*, 2011) <https://www.wsj.com/articles/SB10001424053111903480904576512250915629460>.

[139] Marc Andreessen, 'Why Bitcoin Matters' (*New York Times*, 2014) <https://dealbook.nytimes.com/2014/01/21/why-bitcoin-matters/>.

commercialize it; its effects become profound; and later, many people wonder why its powerful promise wasn't more obvious from the start. What technology am I talking about? Personal computers in 1975, the Internet in 1993, and – I believe – Bitcoin in 2014."

55 Besides scholars and investors, large institutions and governmental entities have also expressed their views and observed blockchain's importance. The European Parliament, for example, already in 2016, recognized the "still unfolding potential of DLT well beyond the financial sector, including crypto-equity crowdfunding, *dispute mediation services, in particular in the financial and juridical sectors***,** and the potential of smart contracts combined with digital signatures, applications allowing for heightened data security and synergies with the development of the Internet of Things".[140] Dispute resolution is listed among the areas which it sees as most affected.

56 The area of dispute resolution and blockchain has further been highlighted by the European Commission's "Blockchains for social good" initiative, recognizing the importance of this topic.[141] Furthermore, UNCITRAL and UNIDROIT joined forces in 2019 and 2020 to explore possible cooperation, which shows they have recognized the importance of emerging technologies and their impact on international trade, identifying a clear need for updated international legislation for the new digital economy. Dispute resolution was one of its main focus areas in the exploratory work.[142] Some jurisdictions have already recognized the importance of dispute resolution for blockchain transactions. In 2021, the UK Jurisdiction Taskforce published its Digital Dispute Resolution Rules,

[140] 'European Parliament Resolution of 26 May 2016 on Virtual Currencies (2016/2007(INI))' (2018) 2014 79 <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52016IP0228&rid=9> para 9. Emphasis added.

[141] See 'Blockchains for Social Good EIC Prize Winners Announced' <https://www.ngi.eu/news/2020/06/30/blockchains-for-social-good-eic-prize-winners-announced/#comefrom>. Kleros (see *infra* Chapter 5.4.5), a dispute resolution layer project for blockchains, was one of the selected companies to win considerable funding.

[142] See UNCITRAL, Note by the Secretariat, 'Legal Issues Related to the Digital Economy' (*United Nations General Assembly, United Nations Commission on International Trade Law, Fifty-third session, New York 6-17 July 2020*) <https://undocs.org/en/A/CN.9/1012> (para 36: "Another line of enquiry that has emerged from the exploratory work carried out so far is the interaction between emerging technologies and their applications and the resolution of disputes."). The report includes proposals for continued work with the aim to guide international legislative harmonization efforts.

which are designed to enable effective resolution of disputes which originated digitally, primarily smart contract and on-chain disputes.[143]

57 Therefore, it is valuable and timely to study how blockchain ecosystems impact dispute resolution and what novel and innovative approaches to resolving disputes are being developed. The results of the study can aid policy decision-makers and legislators in understanding the nature of blockchain disputes and the implications they may have on legal systems. Legislators may realize the need to set up their own task forces to further explore the phenomenon of crypto dispute resolution and disputes arising out of blockchain applications and possibly experiment with these novel mechanisms in their judicial systems.

58 The topic of this study is important because it is a new phenomenon that fits into the larger discussion concerning disruption brought by digitization and deserves further analysis. As these technologies are malleable, much can still be shaped.[144] It is thus fundamental to explore the theoretical underpinnings of the evolution of crypto dispute resolution processes to become aware of its risks. That is also why this study is of practical relevance: It explores the inherent contradictions and embedded risks of blockchain-related arbitration that have the potential to erode parties' fundamental rights. This topic matters not only to lawyers, legal scholars, and legal practitioners but also to users and to those designing the systems that may shape the future economy of digital assets. Thus, ultimately this topic concerns the public in general.

59 While predicting is hard, especially about the future,[145] it will be necessary to infer future developments from the many current possibilities. The study considers the technology in its present form and tries to systematize and conceptualize it to understand this complex phenomenon in its interaction with the arbitration framework - this way, enabling meaningful discussions surrounding the topic on common ground. It is crucial to pay

[143] See Jenifer Swallow, 'Groundbreaking Rules Published for Technology Disputes' (*Tech Nation*, 2021) <https://technation.io/news/rules-published-to-enable-rapid-resolution-of-disputes-digital-transactions/>. The rules can be found here: 'UK Jurisdiction Taskforce (UKJT) Digital Dispute Resolution Rules' <https://technation.io/lawtech-uk-resources/#rules>.

[144] See on blockchain's malleability, Finck (n 30) 33.

[145] This quote is attributed to the physicist Niels Bohr. See e.g., David Anker, 'Forecasting – Prediction Is Very Difficult, Especially If It's about the Future!' (*Cranfield University Blog*, 2017) <https://blogs.cranfield.ac.uk/leadership-management/cbp/forecasting-prediction-is-very-difficult-especially-if-its-about-the-future>.

particular attention to the design of such systems and compare them to traditional and well-functioning systems. It is important to ensure the accountability of such systems. This does not only concern consumer transactions where a weaker party is involved but any kind of business transaction. Scholars have observed blockchain technology's tendency to marginalize courts, which puts parties in a precarious position where no viable recourse to state courts exists; [146] this makes the careful study of this phenomenon the more important.

1.8 Methodology and Materials

1.8.1 Introduction

60 Generally, the primary method in legal research is the doctrinal approach, where it is common to distinguish between *lex lata* and *lex ferenda*.[147] However, this distinction is too narrow to classify the research carried out in this study.

61 Moreover, performing legal research into a new technology without the possibility of accessing a rich pool of literature from the outset is one of the most challenging aspects the present study faces. This challenge, however, also presents an opportunity. Blockchain, as an emerging and disruptive technology, is a complex construct. Comparison can be drawn to the emergence of the Internet and the questions posed by legal scholars in the 1990s.

62 There is a vast literature on the "technology life cycle".[148] Distilling findindings from this body of scholarship, blockchain technology may be at the stage of the "period of ferment, during which rivalry and competition among variations of the original breakthrough eventually lead to the selection of a single dominant configuration".[149] "The dominant

[146] See about blockchain's tendency to marginalize state courts in Ortolani, 'The Impact of Blockchain Technologies and Smart Contracts on Dispute Resolution: Arbitration and Court Litigation at the Crossroads' (n 99).

[147] See Jan M Smits, 'What Is Legal Doctrine? On the Aims and Methods of Legal-Dogmatic Research' (*Maastricht European Private Law Institute Working Paper No. 2015/06*, 2015) 3-4, 8-10.

[148] Margaret Taylor and Andrew Taylor, 'The Technology Life Cycle: Conceptualization and Managerial Implications' (2012) 140 International Journal of Production Economics 541, 543 <http://dx.doi.org/10.1016/j.ijpe.2012.07.006>. See also Paolo Tasca and Claudio J Tessone, 'Taxonomy of Blockchain Technologies. Principles of Identification and Classification' (arXiv, 2017) 3 <https://arxiv.org/abs/1708.04872>.

[149] Taylor and Taylor (n 148) 543. Footnote omitted. See also Tasca and Tessone (n 148) 3.

design becomes the industry standard" and clears away previous uncertainty.[150] The methodology must thus be naturally informed and limited by the stage of evolution at which blockchain technology finds itself.

63 The field of international arbitration on its own is already a methodologically challenging area of law as it does not have any clear hierarchical order of sources, which are often spread transnationally. Arbitral doctrine is formulated by a web of national lawmakers, arbitrators, arbitral institutions, creators of soft law, and the international arbitration community's practice. These sources can form a basis for a doctrinal system upon which one can analyze the law of international arbitration's applicability to blockchain arbitration. The evolutionary nature of law, the transnational feature of arbitration law, and the rapid development of blockchain technology represent a unique challenge.

64 In this multifaceted system, law is not designed coherently, instead it evolves. Consequently, arbitration law is continuously in flux; what yesterday was *de lege ferenda* might today be *de lege lata*. Coincidentally, precisely these characteristics may make international arbitration law suitable to adapt to blockchain technology, which itself is in a state of evolution and change. Therefore, there is a dynamic element in both arbitration law and innovative technology.

65 This thesis ventures into jurisprudence to gain a deeper understanding of the nature of arbitration law and the arbitral legal order within blockchain systems. The question asked is, what is the nature of arbitration, and is it different from crypto arbitration? Analytical jurisprudence helps in identifying the nature of a legal system,[151] and legal theory can be seen as part of political philosophy[152] that "proposes a reflection on the ways in which social relationships are organized".[153] Such reflections in turn "may assist practitioners, theorists, and citizens alike to better understand themselves and the social world in which they operate".[154]

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[150] Taylor and Taylor (n 148) 543. See also Tasca and Tessone (n 148) 3.
[151] See William A Edmundson, 'Why Legal Theory Is Political Philosophy' (2014) 19 Legal Theory 331, 332. See Scott Shapiro, *Legality* (The Belknap Press of Harvard University Press 2011) 7.
[152] See Edmundson (n 151) 331.
[153] Emmanuel Gaillard, *Legal Theory of International Arbitration* (Martinus Nijhoff Publishers 2010) 9.
[154] Craig Scott, "'Transnational Law'" as Proto-Concept: Three Conceptions' [2009] Comparative Research in Law & Political Economy. Research Paper No. 32/2009 862.

66 Generally, the method in this study needs to be tailored to the research questions explored. There is no clear-cut recipe for understanding the blockchain phenomenon as it intersects with the law and dispute resolution. That is due to blockchain's recent history, the limited availability of legal scholarship on the topic, the interconnectedness between disciplines, and the increasing complexity that this brings about. Stephen Hawking appropriately termed the twenty-first century the "century of complexity."[155]

67 This calls for a broader and more systematic methodology: A meaningful study into the state of crypto dispute resolution must move beyond legal sources that immediately and explicitly address the issue. This study is interdisciplinary in its very nature; besides law, it spans computer science, political science, social science, philosophy, economics, and history. While the predominant angle from which the phenomenon will be analyzed remains a legal one, the areas the study touches upon inform the methodology.

68 One of the main tasks of legal science is to ensure the maintenance of fundamental principles.[156] Well-known principles such as the rights to freedom and equality, the rule of law or democracy, and the legal conceptual apparatus may have to be examined in this new blockchain context.[157]

69 Derek Roebuck explains that the "history of arbitration [can] increase understanding of present systems of resolving disputes by showing how arbitration [has] operated and developed in other times and places".[158] This "[u]nderstanding can be increased by comparing two or more contemporary societies or by comparing the same or different societies at different periods of history".[159] He further explains that "great care must be taken to ensure that the societies in which the disputes arose are well understood, so that

[155] See A.N. Gorban and G.S. Yablonsky, 'Grasping Complexity', (*arXiv*, 2013) <https://arxiv.org/pdf/1303.3855.pdf> (with reference to the "millennium" interview Stephen Hawking gave on 23 January 2000 to San Jose Mercury News).

[156] See Wissenschaftsrat, 'Perspektiven Der Rechtswissenschaft in Deutschland. Situation, Analysen, Empfehlungen (Drs. 2558-12)' (2012) 29 <https://www.wissenschaftsrat.de/download/archiv/2558-12.html> ("Eine wesentliche Aufgabe der Rechtswissenschaft besteht darin, durch kontinuierliche Pflege unhintergehbare Prinzipien wie den Eigenwert des Menschen, seiner Würde, seiner Autonomie-, Freiheits- und Gleichheitsrechte sowie Demokratie und Rechtsstaatlichkeit abzusichern.").

[157] See Wissenschaftsrat, 'Perspektiven Der Rechtswissenschaft in Deutschland. Situation, Analysen, Empfehlungen (Drs. 2558-12)' (n 156). See also on the nature of principles, Robert Alexy, 'On the Structure of Legal Principles' (2000) 13 Ratio Juris 294.

[158] Derek Roebuck, *Ancient Greek Arbitration* (Holo Books 2001) 3.

[159] Roebuck (n 158) 3.

when differences and similarities are discovered and discussed, they are significant and not superficial".[160]

70 In line with this strain of thought, this thesis attempts to apply such care when drawing comparisons and informing the current development. In terms of blockchain technology, this will include the early days of the Internet, the cypherpunk movement, and the very recent history of the last decade in which the Bitcoin network has been operating. Ideas and concepts reflect a specific time and context.[161] Ancient Greece gives one of the earliest accounts of how a society settled disputes by arbitration.[162] Moreover, arbitration could probably be found even as far back as 1,900 BC in Mesopotamia.[163]

71 From a linguistic angle, the use of (legal) terminology by software engineers might be the topic of a whole other dissertation on its own and naturally lies outside the scope of this thesis.[164] A delineation of the vocabulary of dispute resolution as used by the communities building crypto arbitration, for comparative purposes and in order to achieve the aim of the thesis, which is to enable the reader to understand as accurately as possible the processes of dispute resolution in the context of blockchains, will, however, be instructive.

72 Given the limited availability of scholarly literature at the outset of this research endeavor, self-study, attendance of (online) courses, the exchange of ideas, and attendance of workshops and conferences on law, technology, and blockchain were essential components in writing this dissertation. Some courses and conferences attended as a participant had more relevance than others and were thus particularly valuable for the advancement of the study; these included, for example, the Law & Economics Foundation St. Gallen Alps Forum Blockchain Conferences (2018, 2019), the ASA Conference on Blockchain, Arbitration and Smart Contracts (2018), the Swiss Legal Tech

[160] Roebuck (n 158) 3.
[161] See Dave de Ruysscher, 'Conceptualizing Lex Mercatoria: Malynes, Schmitthoff and Goldman compared' (2020) 27 Maastricht Journal of European and Comparative Law 465, 466.
[162] See Roebuck (n 158) 6.
[163] See also Roebuck (n 158) 6, Footnote 10, referencing Sophie Lafont, 'L'Arbitrage en Mésopotamie' [2000] Revue de l'arbitrage 557.
[164] Brägelmann explains that one of the reasons for the terminological uncertainties are software engineers' use of legal terminology without reliance on legal expertise. See Tom Brägelmann, 'Der Klügere Vertrag Vollstreckt Sich Selbst' (2018) Rethinking Law 34, 35. The term "smart contract" can be traced back to Nick Szabo, a computer scientist, who in the early 1990s invented the concept and also studied law. See for more on Szabo's education, Werbach (n 7) 203 et seq.

Conference (2018), the Nordic Arbitration Conference (2019), Lawyering in the Digital Age Conference (2019), the Blockchain and the Law Trustsquare Event (2019), the Max Planck Institute Luxembourg Seminars: Blockchain and Procedural Law and Justice in the Age of Disintermediation – 2nd Seminar – Automating Legal Instruments (2019) and 3rd Seminar – Blockchain Technologies at the Domestic and International Levels (2020), the University of Leicester Conference: When Blockchain meets arbitration: the birth of Decentralized justice (2020), the American Bar Association's Spring Conference Online (2020), Lectures at the University of Basel by Professor Dr. Fabian Schär on Bitcoin, Blockchain, Cryptoassets, and on Smart Contracts and Decentralized Applications (2020), and Professor Dr. David Yermack's Gerzensee Law and Economics Course on the Governance and Regulation of Blockchain and Fintech (2021).

73 The study further builds on qualitative empirical research from semi-structured interviews. According to Jaremba and Mak "[q]ualitative interviewing […] is a relatively new method in the field of legal studies".[165] There is a trend towards adopting interdisciplinary approaches with a steady increase of "law and …" disciplines.[166] The present research study may be categorized as being situated in the broader field of "law and technology". Individuals were primarily selected based on their involvement in building innovative approaches to dispute resolution on blockchains, such as founders or employees of arbitration/dispute resolution companies in the blockchain ecosystem. Experts in blockchain in general and/or smart contracts in specific were also interviewed. An institutional perspective has been identified as being advantageous. Therefore, some interviewed individuals were employees at arbitral institution or have had considerable expertise working in an arbitral institution. A survey was also prepared to gather quantitative data on counsels', arbitrators', and arbitral institutions' perspectives. However, the questionnaire would have exceeded the scope of this thesis and will therefore be included in the future research avenues chapter.

[165] See Urszula Jaremba and Elaine Dr Mak, 'Interviewing Judges in the Transnational Context' (*Law and Method*, 2014) <https://www.bjutijdschriften.nl/tijdschrift/lawandmethod/2014/05/RENM-D-13-00002/fullscreen>.

[166] This trend originated in the United States and is catching on in parts of continental Europe as well, see Jaremba and Mak (n 165).

1.8.2 Interview Data

74 Qualitative empirical data was collected by way of semi-structured interviews. Interviewees included blockchain experts, blockchain (legal) companies' founders or researchers, futurists, employees of arbitral institutions, smart contract developers, and an arbitrator who has expertise in blockchain and emerging technologies matters. All interviews were conducted virtually in-person between January 2021 and May 2021 on Zoom and on Microsoft Teams meetings. Interviews lasted between forty minutes and two hours and were, on average, one hour twelve minutes long.

75 Interviewees who agreed to have quotations produced and attributed to them in this dissertation are:

- Federico Ast, PhD (Cooperative Kleros, Co-Founder and President)
- Dr. William George (Cooperative Kleros, Director of Researcher)
- Clément Lesaege (Cooperative Kleros, Co-Founder and CTO)
- Dr. Alessandro Palombo (Jur, Co-Founder and CEO)
- Raffaele Battaglini (Jur, Legal Advisor)
- Jorge Izquierdo (Aragon, Co-Founder & Aragon One, former CEO)
- Vinay Gupta (Mattereum, Founder and CEO)
- Sophie Nappert (International Arbitrator in independent practice and Co-Founder of ArbTech)
- Dr. Günther Dobrauz (PwC Legal Switzerland, Partner & Leader), conducted in German. Own translations into English.
- Christian Scharr (CSS Insurance, Software Engineer; Graduate in Business Information Systems (UCE), Graduate in Data Science (UAS)), conducted in German. Own translations into English.
- Dr. Philip C. Hanke (Weblaw Publishing Director, Lecturer in LegalTech at Zurich University of Applied Sciences), conducted in German. Own translations into English.
- Monique Morrow (Syniverse, Senior Distinguished Architect Emerging Technologies)
- Lise Alm (Worldfavor, CSO & previous Head of Business Development at the Arbitration Institute of the Stockholm Chamber of Commerce)

76 Two interviewees working at arbitral institutions and a co-founder of a DEX startup spoke on the condition of anonymity. Information about these was kept strictly confidential and quotes are reproduced to avoid indications about their identity.

1.9 Structure of the Thesis

77 Chapter 1 of the dissertation introduces the topic of this study and lays the foundation in terms of methodology, purpose, and aim, academic and practical relevance, captures the broader problem in which the research questions are embedded, provides a literature review, and narrows down the topic while limiting this thesis' scope.

78 Since the topic of this study is interdisciplinary and requires a certain level of technological understanding, Chapter 2 (blockchains in general) and Chapter 3 (smart contracts in specific) give the basics for further analysis and allow non-technical readers an introduction into this field.

79 Chapter 4 briefly looks into the past, which may inform the future regarding dispute resolution as a necessary trust layer in all economies and societies at large. This chapter defines international arbitration, contrasts it to other forms of alternative dispute resolution, and outlines the major legal foundations on which this transnational institution stands.

80 Chapter 5 is at the very heart of the study. Drawing from the previous groundwork, the previously distinct areas of blockchains and arbitration meet for the first time. These sections guide the reader through the complex topic of blockchains disputes and provide a first comprehensive conceptualization. The thesis outlines the evolution of the blockchain community's perception regarding disputes and on how to resolve them. The different main approaches are presented, from the earliest ones, such as those contemplated during the early moments of Bitcoin, to the contemporary solutions on Ethereum, distinguishing between off-chain and on-chain arbitration. Finally, the chapter outlines some of the major reactions from international organizations, arbitral institutions, and jurisdiction taskforces.

81 Chapter 6 dissects what this thesis calls "crypto arbitration", a novel form of resolving disputes by means of blockchain technology, first developed by a company called Kleros. This chapter critically analyzes some of the key elements of crypto arbitration. Since arbitration breathes life from the parties' consent, arbitral agreements concluded on-chain are analyzed. Further, the pseudonymity of both the parties and the arbitral tribunal, the incentive design structure, which supposedly provides fairness through mathematics, and the idea of self-enforceable awards will be touched upon. A closer look at game theory and its application on arbitration will be explored to understand important concepts of the incentive mechanisms, which arrive at a resolution differently than what traditional arbitration has held as a *status quo*. This discussion allows for future reflections upon the traditional procedures and principles that have developed and informed today's international commercial arbitration framework. The Chapter concludes with a comprehensive table comparing the different elements of crypto arbitration and international commercial arbitration.

82 Chapter 7 delves into what has captured the imagination of much scholarly writing in international commercial arbitration, *i.e.,* arbitration's nature or essence. After an introduction into legal theory, the thesis maps the debate from *lex mercatoria* to balancing party autonomy and *lex arbitri*, to then arrive at the views developed by three influential grandmasters of arbitration on arbitration's great paradox, which has been met with criticism. The "foundational question", to some even the question that should be avoided at all costs, is then asked to uncover some truth about arbitration's essence. A game-theoretical perspective rounds up this journey. Arbitration is freed to create a new crypto autonomous legal order in cyberspace of a future ultramodern society, whose development is tentatively sketched.

83 Chapter 8 rounds up the whole dissertation by distilling the essence of previous chapters in a meaningful, all-encompassing way, providing answers to the research questions, and summarizing this study's contribution. The thesis then makes suggestions for future research and concludes with closing remarks.

2 Chapter 2: Blockchain Technology Foundations

2.1 Introduction

84 Before diving into blockchain's most important concepts and the terminology as a foundation for the subsequent analysis, this chapter introduces and explains blockchains as a disruptive innovation. Realizing the nature of this technology as not only entirely new but disruptive as well allows for a more open-minded outlook. This dissertation can hardly answer all the open questions at the intersection of blockchains and dispute resolution or claim completeness. Blockchain, although developing rapidly, is still very much in its infancy. This thesis is situated in a wider, on-going discussion that requires the attention of policymakers.

85 Society is living "a dramatic moment in world history",[167] where "[n]othing will be left untouched."[168] Everything seems to be getting "smarter": from smart cities to smart phones,[169] and now smart contracts. The speed of recent technological change is radical and will continue at an even faster pace.[170] Francis Bacon, the father of the scientific method, who first paid attention to the concept of progress,[171] asserted that "[a]s the births of living creatures at first are ill-shapen, so are all innovations, which are the births of time. […] Surely every medicine is an innovation; and he that will not apply new remedies must expect new evils; for time is the greatest innovator."[172] Bacon poetically observes the intrinsic links between innovation and time when he not only refers to innovation as the birth of time but time itself as the greatest innovator. There is a cyclic

[167] Will Hutton, *How Good We Can Be: Ending the Mercenary Society and Building a Great Country* (Abacus 2015) 17. See Roger Brownsword, Eloise Scotford and Karen Yeung (eds), *The Oxford Handbook of Law, Regulation and Technology* (Oxford University Press 2017) 4.

[168] Hutton (n 167) 17. See Brownsword, Scotford and Yeung (n 167) 4.

[169] See Hutton (n 167) 17. See Brownsword, Scotford and Yeung (n 167) 4.

[170] In his essay on *The Law of Accelerating Returns*, Ray Kurzweil explains "that technological change is exponential" and "became too fast for evolution through DNA-guided protein synthesis". According to Kurzweil the progress will not be of 100 but of 20,000 years in the 21st century, see Ray Kurzweil, 'The Law of Accelerating Returns' (*Kurzweil Essays*, 2001) <https://www.kurzweilai.net/the-law-of-accelerating-returns>. Humans drastically underestimate exponential growth. A study related to the COVID-19 pandemic, for example, found that the perception and bias regarding exponential growth also depends on how such growth is communicated to the public - see Martin Schonger and Daniela Sele, 'How to Better Communicate the Exponential Growth of Infectious Diseases' [2020] PLoS ONE 15(12): e0242839 <https://doi.org/10.1371/journal.pone.0242839>.

[171] See Terence Kealey and Martin Ricketts, 'Innovative Economic Growth: Seven Stages of Understanding' (*Cato Institute Economic Policy Brief*, 2020) <https://www.cato.org/sites/cato.org/files/2020-04/economic-policy-brief-3-updated.pdf>.

[172] Francis Bacon, 'Essays, Civil and Moral', *Harvard Classics, Vol. 3, Part 1* <https://www.bartleby.com/3/1/24.html>.

motion in the interaction between innovation and time, where one conditionally affects the other. Innovation brings forth a new age, which itself brings forth innovation and so forth, refining the "ill-shapen" into "well-shapen", which produces the new "ill-shapen", which then gets refined, only to be replaced again. The Austrian economist Joseph Schumpeter reflects on this idea from an economics perspective by stating that "the same process of industrial mutation – if I may use that biological term – that incessantly revolutionizes the economic structure *from within*, incessantly destroying the old one, incessantly creating a new one. This process of Creative Destruction is the essential fact about capitalism."[173]

86 Innovation is a complex phenomenon that is hard to grasp and even harder to predict and regulate. It is as much about the relationship between a society and its past, especially the ability to detach oneself from what has been the *status quo*, as it is about the bridge leading society into its future. Moses asserts that "regulation (whatever its target and purpose) must adapt to the changing sociotechnical context in which it operates."[174] This statement recognizes that regulating innovation must consistently adapt to the fast-paced environment of constant and ever-increasing change.

87 There is a broad consensus in the law and technology literature recognizing the disconnect between innovation and regulation and its inherent insufficiencies.[175] Günther Dobrauz, a renowned legal expert on exponential technologies, compares this to the concept of carriages vs. cars:[176] "If someone tried to build cars using carriage parts, meaning old technology, that would not result in a good car".[177] Dobrauz says that when it comes to blockchains "we try to regulate cars with carriage rules, we have great new cars, but we are still using carriage rules."[178] Technological innovation is advancing

[173] Joseph A Schumpeter, *Capitalism, Socialism and Democracy* (Taylor & Francis e-Library 2003) 83. Footnotes omitted.
[174] Lyria Bennett Moses, 'Regulating in the Face of Sociotechnical Change' in Roger Brownsword, Eloise Scotford and Karen Yeung (eds), *The Oxford Handbook of Law, Regulation and Technology* (Oxford University Press 2017) 574.
[175] See e.g., Wulf A Kaal, 'Dynamic Regulation for Innovation' (*SSRN Electronic Journal*, 2016) 5 ("The law and technology literature recognizes that legal institutions' capacity to react to innovative technologies is diminishing because innovation driven by science and technology is accelerating while federal and state agencies' regulatory processes have slowed down and are continuing to slow down." Footnotes omitted).
[176] Interview #10, Günther Dobrauz.
[177] Interview #10, Günther Dobrauz.
[178] Interview #10, Günther Dobrauz.

further while regulators struggle to keep pace.[179] From the outset and by its very nature, disruptive innovation thus challenges regulators.[180]

88 Innovation may be an evolutionary process interlinked with an evolving economy. Millard observes that "[b]lockchain[s have] joined a long line of technological innovations [branded] as disruptive", and that such claims of something new making established frameworks obsolete are not uncommon in the history of science and technology.[181] Blockchain technology allows for shared data storage and digital value transfer among distrusting participants without the need for a central entity. This was not possible before applying the first use-case of blockchain technology in 2008: the cryptocurrency Bitcoin.

89 In his book "The Innovator's Dilemma", Clayton Christensen introduces his theory of disruptive innovation; he categorizes technology as sustaining or disruptive.[182] Sustaining technologies improve a product, whereas disruptive technology underperforms the mainstream product at first but brings an entirely new value proposition that was not available before.[183] This theory is well established in management studies and tries to answer questions such as how firms should react to disruptive innovation and which approaches are suitable.[184] This theory, however, has applicability in many other domains, such as in regulatory decision-making. Examples of disruptive innovations span various industries, and range from transportation, such as automobiles and airplanes, to communication technologies, such as the Internet, personal computers, and portable smart phones.[185] Innovation's disruptive force often manifests itself unexpectedly, as can be witnessed with examples such as Google advertising, Spotify, Airbnb, uber, and others.[186]

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[179] See Kaal (n 175) 5.
[180] See Nathan Cortez, 'Regulating Disruptive Innovation' (2014) 29 Berkeley Technology Law Journal 175. See also Kaal (n 175).
[181] See Christopher Millard, 'Blockchain and Law: Incompatible Codes?' (2018) 34 Computer Law and Security Review 843.
[182] See Clayton M Christensen, *The Innovator's Dilemma: When New Technologies Cause Great Firms to Fail* (Harvard Business School Press 1997) xv.
[183] See Christensen (n 182) xv.
[184] See Clayton M Christensen and others, 'Disruptive Innovation: An Intellectual History and Directions for Future Research' (2018) 55 Journal of Management Studies 1043, 1062.
[185] See Cortez (n 180) 177.
[186] See Cortez (n 180) 183.

90 In order to establish whether blockchain technology is disruptive, one needs to be cautious so as not to misuse the term "disruptive innovation", which is often used to describe any new technology that aims to transform a market.[187] Based on Christensen's elaboration, Nesbitt identifies the following factors as indicators of an early stage disruption which would indicate the need to take action: (i) novelty in the sense of having a new value proposition, (ii) limited reach, (iii) limited applicability, (iv) defies an established technology, and (v) is in the process of creating a new industry.[188]

91 From the outset, blockchain technology meets all these requirements: (i) it is a new technology that introduces the ability for participants of a distributed ledger network to interact pseudonymously[189] with each other on a p2p basis without the need for intermediaries; it allows for the transfer of value digitally; (ii) blockchain technology, with its first use-case Bitcoin, first appealed to libertarians; today blockchain's reach, although increasing, is still quite limited; (iii) as well as its applicability; although the ecosystem has grown considerably and initiatives, projects, and many startups operate in the blockchain space to find solutions to complex problems,[190] the practical application is limited and oftentimes difficult and cumbersome; (iv) blockchains replace established centralized network technologies, and offer new possibilities for global value transfer; (v) this technology has already created a whole new industry, which one may label the "crypto industry" or "blockchain industry", starting with specialized hardware solutions for miners that are becoming ever more sophisticated, to wallet providers and cryptocurrency exchanges, to the establishment of the so-called "Crypto Valley" in Zug, Switzerland,[191] which houses many startups, companies and unicorns in the industry.

92 Beyond the hype, blockchain technology fulfills the indicators of a disruptive technology

[187] See Christensen and others (n 184) 1044. Some regard blockchains not as a disruptive technology but rather as a "foundational technology", such as Marco Iansiti and Karim R Lakhani, 'The Truth About Blockchain' (*Harvard Business Review*, 2017) <https://hbr.org/2017/01/the-truth-about-blockchain>.

[188] See generally, Christensen (n 182). See Audrey Nesbitt, 'Is Blockchain Technology Disruptive?' (*Medium*, 2019) <https://medium.datadriveninvestor.com/is-blockchain-technology-disruptive-c391128a1ccb>. ("Disruptive technology lacks refinement, faces challenges because it is new, appeals to a limited audience and may not yet have a proven practical application. It exists on the fringes. When it ultimately takes hold in the marketplace, it usually starts at the lower end or in new-market footholds, it displaces an established technology or its groundbreaking technology and it creates a whole new industry.")

[189] See, e.g., Thibault Schrepel, 'Anarchy, State and Blockchain Utopia: Rule of Law Versus Lex Cryptographia' in General Principles and Digitalisation (Hart Publishing, 2020), 367, 370-371.

[190] See e.g., Berg, Davidson and Potts (n 17) 9.

[191] In the Swiss Canton of Zug cryptocurrencies are even accepted as a means of payment, also by government agencies to pay taxes, for example.

that demands regulators' attention as it already has. Governments worldwide recognize the significant potential for innovation in blockchain technology. The Swiss Federal Council, for example, issued a statement stating that "[t]he development of DLT is predicted to have significant potential for innovation and efficiency gains in the financial sector as well as other sectors of the economy."[192] The financial sector is the one most readily impacted by blockchain technology, but other sectors will be impacted as well. Dobrauz says that "blockchain technology is really big in areas that are in development but that we do not even see yet, for example, the tokenization of assets. This means that 90% of assets that surround us and are not bankable will become bankable and thus can be brought into circulation".[193] He also explains that "disruptive technologies develop in an S-curve, where there is no actual transition but a complete replacement by new and unforeseen players when a new dominant design emerges".[194]

93 Berg, Davidson and Potts highlight the economic significance of this new institutional innovation, which they term "institutional cryptoeconomics".[195] They argue that blockchain is a discovery as significant as Adam Smith's discovery of the importance of markets and the factory system, which led to industrialization.[196] Blockchain-based transformations, they argue, "will change how economies work".[197] This technology is a "type of attractor", and enables communities to come together and build institutions.[198] The economic analysis relevant to this dissertation is how blockchains may "facilitate contracting and economic cooperation".[199] Dobrauz remarks that only a few, hardly anyone could accurately predict or foresee in 1999, when people started to open email accounts, that the world would look the way it does today with videoconferencing, circular economies, cloud computing, e-commerce, social media networks, and more.[200]

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[192] 'Swiss Federal Council Wants to Further Improve Framework Conditions for DLT/Blockchain' <https://www.admin.ch/gov/en/start/documentation/media-releases.msg-id-77252.html>.

[193] Interview #10, Günther Dobrauz. Interestingly, this also seems to be the key to unlock arbitration on blockchains. See Interview #16, Lise Alm ("One of the key pieces of the puzzle for that to really work with an arbitration is that we need to have more assets being traded on blockchain. And when assets are traded on blockchain, then we could move to having something similar to a smart contract, but it being a smart award instead. Something that could automatically enforce the award through blockchain and an automatic transfer. That of course requires that the asset that you are fighting over is tradable on blockchain, and that means a societal infrastructure for this needs to be in place first.").

[194] Interview #10, Günther Dobrauz. (He illustrates this by saying: "I don't know any carriage manufacturers who make cars today; I don't know any typewriter manufacturers who make laptops today.").

[195] See Berg, Davidson and Potts (n 17) 1.

[196] See Berg, Davidson and Potts (n 17) vii, viii.

[197] Berg, Davidson and Potts (n 17) viii.

[198] Berg, Davidson and Potts (n 17) vii, ix.

[199] Berg, Davidson and Potts (n 17) vii.

[200] Interview #10, Günther Dobrauz.

Dobrauz argues that when it comes to blockchains and other exponential technologies, "we are at the beginning, not at the very beginning, but still early on".[201]

94 Blockchain technology's vast potential for innovation has been recognized widely. Because of its unique features of enabling p2p transactions without intermediaries, blockchain can be considered a disruptive technology due to its unique value proposition. In fact, it has already and continues to challenge a variety of industries, starting from the financial sector to voting, personal identity, art, and many more.[202] For the first time in human history, it is possible to transfer value digitally across borders without the need for a central authority.[203] This brings about benefits, but may also pose considerable, unforeseen risks.

95 One should not overlook that much like innovation can be a disruption, a dispute when it happens to parties is quite disruptive as well.[204] When looking at innovation, arbitration is not usually at the forefront. There is wide agreement that "bleeding-edge technologies" like blockchains, AI, and others, will change a lot of the technical infrastructure the world rests on; "they will be omnipresent".[205] Alm asserts that "this transformation will affect arbitration as well".[206] Disputes will arise wherever they do in society, and "arbitration as a reflection of society will follow the societal development".[207]

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[201] Interview #10, Günther Dobrauz.

[202] See for more examples: 'Banking Is Only The Beginning: 58 Big Industries Blockchain Could Transform' (*CB Insights, Research Briefs*, 2021) <https://www.cbinsights.com/research/industries-disrupted-blockchain/>.

[203] See Berentsen and Schär (n 6) 2.

[204] Interview #16, Lise Alm ("Dispute is a disruption, it's not something that companies generally are built for, it is something that they endure when it happens, and they try to just get out of it as soon as possible. So generally, they won't be the ones creating all the innovations around how it happens. Then you have law firms, and you can talk a lot about how innovative they are, and generally they do have some head of innovation, and they have resources, but they represent one of the parties, which means in this adversarial world it is hard for them to push through their technological solutions to the entire dispute, since that would require that the other party accepts it. As arbitral institutions we have access, and we can cater to the full system … we are the neutral player and it's our role to handle the dispute in a neutral way, to handle the arena for the dispute. In sum, when you're involved in a dispute as a party, you generally just want to get rid of it. As external counsel … I doubt they will say "we have this multimillion-dollar dispute, let's try this completely new and untested tool", and even if they do, they can only cater to one side of the table. That explains why neither the parties nor the lawyers are in a good position to bring innovation to the full ecosystem, which leaves the institutions.").

[205] Interview #16, Lise Alm. Bleeding-edge technologies are very new, untested, and risky.

[206] Interview #16, Lise Alm.

[207] Interview #16, Lise Alm.

2.2 Capturing Blockchains

96 Besides being a nascent technology, still in its infancy and rapidly changing as it develops, blockchain's mystery is accentuated by the challenge of a fluid vocabulary together with an uncertain regulatory landscape.[208] The terminology can be understood and used in different ways.[209] Antonopoulos points out that "[w]hen someone tells you that something is a blockchain, you have not received an answer; rather, you need to start asking a lot of questions to clarify what they mean when they use the word 'blockchain'".[210] Tasca and Tessone identify at least eight broad parameters by which blockchains can differ: (i) consensus mechanism design, (ii) transaction capabilities, (iii) native currency/tokenization, (iv) extensibility, (v) security and privacy, (vi) codebase, (vii) identity management, and the (viii) charging and rewarding system.[211]

97 In the first years of its inception, the first blockchain prototype, the Bitcoin network, did not receive much attention outside the small and closed circle of cryptography aficionados.[212] Nowadays, it has become the topic of serious research both in practice and academia, has brought about new legislation in an effort by governments to regulate the technology,[213] and has seen the advent of ever-expanding and novel ecosystems that did not exist before. Within a decade, blockchain technology has made it to the ranks of earlier revolutionary technologies.[214]

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[208] See Angela Walch, 'The Path of the Blockchain Lexicon (and the Law)' 36 Review of Banking & Financial Law 713, 717, 764–765.

[209] See Werbach (n 7) 14.

[210] See Antonopoulos and Wood (n 28) 3. The use of "blockchains" in some instances is dubious as they may not be blockchains at all, see, e.g., David Floyd, 'Banks Claim They're Building Blockchains. They're Not' (*Investopedia*, 2019) <https://www.investopedia.com/news/banks-building-blockchains-distributed-ledger-permission/>.

[211] See Tasca and Tessone (n 148) 8 et seq.

[212] However, those who were involved in the technology, thought about ways in which to get a wider audience interested in Bitcoin, see, e.g., *Vitalik Buterin, 'Bitcoin Adoption Opportunity: Teenagers' (Bitcoin Magazine*, 2012) <https://bitcoinmagazine.com/articles/bitcoin-adoption-opportunity-teenager-1330407280>.

[213] Liechtenstein was the first country to introduce a comprehensive regulation of the token economy which entered into force in January 2020, see 'Landtag Stimmt Dem Blockchain-Gesetz Einstimmig Zu' <https://www.regierung.li/de/mitteilungen/222957/?typ=news>. In September 2020, Switzerland in a final vote adopted a "Distributed Ledger Technology Federal Law", see Céline Amaudruz et al, 'Anpassung Des Bundesrechts an Entwicklungen Der Technik Verteilter Elektronischer Register' <https://www.parlament.ch/de/ratsbetrieb/suche-curia-vista/geschaeft?AffairId=20190074>. The European Commission in 2020 proposed a new regulation tackling distributed ledger technologies, see 'Proposal for a Regulation of The European Parliament and of the Council on a Pilot Regime for Market Infrastructures Based on Distributed Ledger Technology' <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52020PC0594&from=EN>.

[214] See, e.g., Werbach (n 7) 91.

98 Bitcoin and blockchains, in general, pose a threat to the established banking system and traditional power structures since no central authority or central bank is required; the disruption thus initially concerned the financial industry.[215] Its potential to disrupt other industries, however, is widely recognized.[216] Ideas and visions of a decentralized future and infrastructure often underlie the blockchain narrative.[217]

99 All of these aspects, including the sense of doubt and uncertainty that comes with all the promise of this nascent technology, complicate the pursuit of understanding blockchains.[218] Often the term "blockchain" is associated with Bitcoin and other cryptocurrencies. Besides cryptocurrencies, however, blockchain technology enables other developments, such as smart contracts and decentralized autonomous organizations ("DAOs"). Since there are many different blockchains and variations of blockchains, depending on the use case, this thesis first explains the main elements of blockchain using the mother of all blockchains as an example: Bitcoin.[219]

100 Vitalik Buterin, co-founder of Ethereum, defines blockchains as a decentralized system that contains a shared memory.[220] Blockchains are essentially protocols for consensus on a shared and distributed ledger, they can be seen as means of coordination.[221] They rely

[215] For an analysis and affirmation of the hypothesis that blockchain will lead to disruption of banks' traditional operations, see, e.g., Viktoria Rajnak and Thomas Puschmann, 'The Impact of Blockchain on Business Models in Banking' (2021) 19 Information Systems and e-Business Management 809 <https://doi.org/10.1007/s10257-020-00468-2>.

[216] See Seth C Oranburg and Joseph R Stead, 'Blockchain—Not Bitcoin—Represents the Next Step in Financial Evolution and Beyond' (*Oxford Business Law Blog*, 2020) <https://www.law.ox.ac.uk/business-law-blog/blog/2020/07/blockchain-not-bitcoin-represents-next-step-financial-evolution-and>. See Don Tapscott and Alex Tapscott, 'The Impact of the Blockchain Goes Beyond Financial Services' (*Harvard Business Review,* 2016) <https://hbr.org/2016/05/the-impact-of-the-blockchain-goes-beyond-financial-services>. For a critical analysis of the Bitcoin ecosystem and its potential disruption beyond the financial sector, see Dominic Wörner and others, 'The Bitcoin Ecosystem: Disruption beyond Financial Services?' [2016] 24th European Conference on Information Systems, ECIS, Istanbul Turkey.

[217] See 'Decentralizing Everything with Ethereum's Vitalik Buterin | Disrupt SF 2017' (*Youtube, 2017*) <https://www.youtube.com/watch?v=WSN5BaCzsbo&feature=youtu.be>.

[218] See generally, Walch (n 208). Blockchain cryptographically links the actions in a chain of blocks, such as in Bitcoin. The term distributed ledger technology ("DLT") is often used synonymously. However, DLT is a broader concept that does not necessarily include blocks, other examples include Hashgraph and IOTA. See also Berg, Davidson and Potts (n 17) 43.

[219] This is for simplicity reasons to transmit a general and basic understanding of the basics of the technical foundation for the upcoming analysis. Where a more nuanced explanation is necessary because of the legal implications on dispute resolution, it will be pointed out in the respective chapters.

[220] See 'Decentralizing Everything with Ethereum's Vitalik Buterin | Disrupt SF 2017' (n 217).

[221] See Berg, Davidson and Potts (n 17) 37.

on the TCP/IP protocol,[222] which transmits data between the network nodes.[223] This shared digital database gets synchronized across the network.[224]

101 Blockchains are operated by software developers and miners who have their own incentives and there is a whole ecosystem made up of hardware producers, service providers, among others.[225] Since public permissionless blockchains are spread across the globe and users interact pseudonymously or anonymously, the concept of jurisdiction is challenged and makes legal compliance with any local authority extremely hard.[226]

2.3 Historical Background

102 Bitcoin's roots lie in the cypherpunk movement. Cypherpunks are activists interested in preserving privacy and freedom online through cryptography.[227] The movement started in the late 1980s and early 1990s with a group of young mathematicians and computer scientists who identified themselves as "cypherpunks".[228] They started discussing and sharing ideas about what the Internet would and should mean for society.[229] They sought ways in which cryptography could be used to resist governments, which they regarded as the very threats to privacy and personal freedom.[230] They thus understood cryptography as a defense against privacy erosion online.[231] However, cryptography was reserved for the military, and in the United States, cryptography research publication was even illegal.[232] The cypherpunks envisioned a censorship-resistant online world.[233] Much of

[222] See 'TCP/IP - Internet Protocols' <https://www.britannica.com/technology/TCP-IP> ("TCP/IP, in full Transmission Control Protocol/Internet Protocol, standard Internet communications protocols that allow digital computers to communicate over long distances.").
[223] See De Filippi and Wright (n 5) 177.
[224] See, e.g., Finck (n 30) 6–7. See De Filippi and Wright (n 5) 13 et seq.
[225] See De Filippi and Wright (n 5) 173. This is true mostly for public, permissionless and proof of work blockchains, such as Bitcoin.
[226] See Kaal and Calcaterra (n 64) 36.
[227] See Narayanan and Clark (n 54) 43. See also Jim Epstein, 'Before the Web: The 1980s Dream of a Free and Borderless Virtual World' <https://reason.com/video/before-the-web-the-1980s-dream-of-a-free-and-borderless-virtual-world/>.
[228] See Epstein (n 227).
[229] See Epstein (n 227).
[230] See Narayanan and Clark (n 54) 41.
[231] See Epstein (n 227).
[232] See Jim Epstein, 'When Encryption Was a Crime: The 1990s Battle for Free Speech in Software' (*Reason - Free Minds and Free Markets*, 2020) <https://reason.com/video/2020/10/21/cryptowars-gilmore-zimmermann-cryptography/>. See also *infra* Chapter 2.4.2.
[233] See Ben Vickers, 'Preface' in Vickers B (ed), *The White Paper by Satoshi Nakamoto* (Ignota Books 2019) i.

that vision seemed to have gone astray due to the centralization by such big tech companies as Twitter, Facebook, and Amazon.[234]

103 Blockchain technology builds on inventions and discoveries made the last few decades by computer scientists, cryptographers, and economists in areas as diverse as digital signatures, hash functions,[235] p2p systems, and game theory.[236] Satoshi Nakamoto,[237] the mysterious and to this date still unknown inventor of Bitcoin and the concept of blockchain,[238] revealed his genius in a technical research paper entitled "Bitcoin: A Peer-to-Peer Electronic Cash System", which is only nine pages long.[239]

104 This paper was posted on the Cryptography online mailing list on 31 October 2008, in which Nakamoto announced that he had "been working on a new electronic cash system that's fully peer-to-peer, with no trusted third party."[240] Nakamoto innovatively merged a number of concepts that had been invented decades earlier to create a p2p electronic cash system without intermediaries.[241] Nakamoto achieved a real breakthrough with the Proof of Work ("PoW") algorithm,[242] solving not only the double-spending problem[243] but also the "Byzantine Generals' Problem".[244]

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[234] See Vickers (n 233) i.
[235] See *infra* Chapter 2.4.2. for an explanation of hash functions.
[236] See Niklas Schmidt, *Kryptowährungen Und Blockchains:Technologie, Praxis, Recht, Steuern* (Linde 2019) 5.
[237] See *supra* (n 51).
[238] However, there is an even older prototype of a blockchain that predates Bitcoin by about 13 years and has been printed weekly in the classified section of *The New York Times*. See Oberhaus (n 52). See also Prof. Gary Gensler talking about it at 'MIT 15.S12 Blockchain and Money, Fall 2018 Prof. Gary Gensler' (n 52).
[239] See Narayanan and Clark (n 54) 36.
[240] See Satoshi Nakamoto, 'Bitcoin P2P e-cash paper' <https://satoshi.nakamotoinstitute.org/emails/cryptography/1/>.
[241] See Antonopoulos, *Mastering Bitcoin: Programming the Open Blockchain* (n 9) 4. See Narayanan and Clark (n 54) 36. See also Zubin Koticha, 'Introduction to Blockchain through Cryptoeconomics — Part 1: Bitcoin' (*Medium*, 2018) <https://medium.com/blockchain-at-berkeley/introduction-to-blockchain-through-cryptoeconomics-part-1-bitcoin-369f245067f9>. See also Joshua Davis, 'The Crypto-Currency Bitcoin and Its Mysterious Inventor' <https://www.newyorker.com/magazine/2011/10/10/the-crypto-currency>.
[242] Proof of Work is a consensus mechanism in a blockchain that requires extensive computational power to find a piece of data to solve so-called "hash puzzles". It's the revolutionary mechanism pioneered in Bitcoin, which is often criticized for its high energy consumption. An alternative consensus mechanism, which requires less energy consumption and is thus seen as more sustainable for the environment, is Proof of Stake ("PoS"), which the Ethereum blockchain is in the process of implementing. See *infra* Chapter 2.4.4.
[243] The fact that a single currency unit can be spent twice, was considered one of the most puzzling problems standing in the way of the success of digital assets.
[244] The Byzantine Generals' Problem is famous in distributed computing. It describes a coordination problem involving a group of military leaders that plan to attack a city but there is a potential traitor among them, so that the strategies are not optimally aligned, and the attack fails. Blockchain offers a solution to this problem. See Antonopoulos, *Mastering Bitcoin: Programming the Open Blockchain* (n 9) 4.

105 There have been several key milestones in the evolution of Bitcoin and, ultimately, blockchain as a technology. Before Bitcoin, there were several failed attempts in electronic cash and decentralized money:[245] David Chaum's DigiCash (eCash) in 1990s,[246] Adam Back's HashCash in 1997,[247] Wei Dai's b-money in 1998,[248] and Nick Szabo's Bit Gold[249] in 2005.[250]

106 Bitcoin's first transaction happened on 3 January 2009, which marked the launch of the Bitcoin blockchain in what is called a "genesis block", creating 50 bitcoins for the first time.[251] Satoshi Nakamoto inserted a phrase from the front-page headline of *The Times* newspaper into the block: "The Times 03/Jan/2009 Chancellor on brink of second bailout for banks".[252] This reference and the fact that Bitcoin was published shortly after the 2008 financial meltdown may indicate Satoshi Nakamoto's motive.[253] Bitcoin emerged from some deep dissatisfaction with the financial system and the prevalent trust model. Nakamoto created scarcity in the online digital world, possible only because of the solution to double-spending and what is now called "cryptoeconomics".[254]

107 The hype surrounding this new technology can be attributed to the 2017 ICO boom and Bitcoin's spectacular rise,[255] when large groups of retail investors discovered Bitcoin and other cryptocurrencies expecting high returns.[256] Bitcoin has often been portrayed

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[245] See Schmidt (n 236) 4.
[246] See David Chaum, 'DigiCash' <https://www.chaum.com/ecash/>.
[247] See Adam Back, 'Email, Subject: [ANNOUNCE] Hash Cash Postage Implementation' <http://www.hashcash.org/papers/announce.txt>.
[248] See Wei Dai, 'B-Money' <http://www.weidai.com/bmoney.txt>.
[249] See Nick Szabo, 'Bit Gold' <https://nakamotoinstitute.org/bit-gold/>.
[250] See Peter McCormack, 'Nick Szabo on Cypherpunks, Money and Bitcoin' <https://www.whatbitcoindid.com/podcast/nick-szabo-on-cypherpunks-money-and-bitcoin#transcription=>. See James Bridle, 'Introduction', in Ben Vickers (ed), *The White Paper by Satoshi Nakamoto* (Ignota Books 2019) x et seq.
[251] Besides being the first block, the genesis block has more special characteristics, see Jamie Redman, 'A Deep Dive Into Satoshi's 11-Year Old Bitcoin Genesis Block' <https://news.bitcoin.com/a-deep-dive-into-satoshis-11-year-old-bitcoin-genesis-block/>.
[252] See 'Genesis Block' <https://en.bitcoin.it/wiki/Genesis_block#cite_note-3>.
[253] See Davis (n 241).
[254] See *infra* Chapter 2.4.1. for more on cryptoeconomics.
[255] As a practice that saw a boom in 2017, ICO stands for "initial coin offering", whereby projects could crowdfund their startups by selling tokens. See 'Ethereum and the ICO Boom' (*Cryptopedia*, 2021) <https://www.gemini.com/cryptopedia/initial-coin-offering-explained-ethereum-ico>.
[256] See Jens Frankenreiter, 'The Limits of Smart Contracts' [2019] Journal of Institutional and Theoretical Economics JITE 149. See Holden Page, '2017's ICO Market Grew Nearly 100x From Q1 To Q4' <https://news.crunchbase.com/news/2017s-ico-market-grew-nearly-100x-q1-q4/>. Even juice beverage companies could simply add "blockchain" to their name and see an increase in their stock, see Evelyn Cheng, '$24 Million Iced Tea Company Says It's Pivoting to the Blockchain, and Its Stock Jumps 200%' (*CNBC*, 2017) <https://www.cnbc.com/2017/12/21/long-island-iced-tea-micro-cap-adds-blockchain-to-

negatively by mainstream media because of its high energy consumption, scams, countless hacks, and connection to criminal and illegal behavior.[257] In 2013, the darknet marketplace called "Silk Road" was shut down. Ross Ulbricht, the site's creator, was taken into custody and sentenced to life in prison in 2015.[258] In 2014, Mt. Gox, the biggest Bitcoin exchange at the time, went bankrupt after it was hacked, which reportedly caused a loss of at least 850,000 bitcoins.[259]

108 Despite these scandals, investment in blockchain technology is growing, and worldwide spending on blockchain solutions is expected to reach 19 billion USD by 2024.[260] The market size of blockchain technology is expected to climb to over 39 billion USD by 2025.[261] More institutional investors (*e.g.*, Microstrategy and Tesla), even academic institutions, such as Harvard, Yale, and Brown, started investing in cryptocurrencies.[262] As of April 2021, Bitcoin's price reached a new all-time high above 63,000 USD, and

name-and-stock-soars.html>. Note that two academics analyzed the possibility of manipulation behind the surge, see John M Griffin and Amin Shams, 'Is Bitcoin Really Untethered?' (2020) 75 The Journal of Finance 1913 et seq. In a Bloomberg interview, one of the authors said: "Years from now, people will be surprised to learn investors handed over billions to people they didn't know and who faced little oversight." See Matthew Leising and Matt Robinson, 'A Lone Bitcoin Whale Likely Fueled 2017 Surge, Study Finds' <https://www.bloomberg.com/news/articles/2019-11-04/lone-bitcoin-whale-likely-fueled-2017-price-surge-study-says>.

[257] An outspoken critic is the US economist Nouriel Roubini, for example, who in 2018 called Bitcoin the "biggest bubble in human history" and referred to cryptocurrencies in general as scams. See Joanna Ossinger, 'Roubini Says Bitcoin Is the Biggest Bubble in Human History' (*Bloomberg*, 2018) <https://www.bloomberg.com/news/articles/2018-02-02/roubini-says-bitcoin-is-the-biggest-bubble-in-human-history>. In 2021, he believes that the future of money are central bank digital currencies (CBDC) but not cryptocurrencies, see Yahoo Finance, 'Cryptocurrencies don't have any fundamental value and are driven by speculation: Nouriel Roubini' (*Youtube*, 2021) <https://www.youtube.com/watch?v=Au_MfQ-r624>.

[258] See Bob Van Voris and Erik Larson, 'Silk Road Mastermind Handed Life in Prison for Drug Bazaar' (*Bloomberg*, 2015) <https://www.bloomberg.com/news/articles/2015-05-29/silk-road-mastermind-sentenced-to-life-in-prison-for-drug-bazaar>.

[259] See MtGox meant Magic the gathering exchange. See Matthew Leising, '"Trillion Dollar" Mt. Gox Demise as Told by a Bitcoin Insider' (*Bloomberg*, 2021) <https://www.bloomberg.com/news/articles/2021-01-31/-trillion-dollar-mt-gox-demise-as-told-by-a-bitcoin-insider>.

[260] See Statista, 'Worldwide Spending on Blockchain Solutions from 2017 to 2024' <https://www.statista.com/statistics/800426/worldwide-blockchain-solutions-spending/>.

[261] See Statista, 'Size of the Blockchain Technology Market Worldwide from 2018 to 2025' <https://www.statista.com/statistics/647231/worldwide-blockchain-technology-market-size/>.

[262] See Kevin Stankiewicz, 'MicroStrategy now owns over 100,000 bitcoins worth more than $3 Billion after latest purchase' (*CNBC*, 2021) <https://www.cnbc.com/2021/06/21/microstrategy-owns-over-3-billion-worth-of-bitcoin-after-new-purchase.html>. See Steve Kovach, 'Tesla buys $1.5 billion in bitcoin, plans to accept it as payment' (*CNBC*, 2021) <https://www.cnbc.com/2021/02/08/tesla-buys-1point5-billion-in-bitcoin.html>. See Ian Allison, 'Harvard, Yale, Brown Endowments Have Been Buying Bitcoin for at Least a Year: Sources' (*Coindesk*, 2021) <https://www.coindesk.com/harvard-yale-brown-endowments-have-been-buying-bitcoin-for-at-least-a-year-sources>.

subsequently lost fifty percent of its value.[263] Such extreme volatility is the basis for continued criticism.

109 However, "[s]peculation is often the engine of technological adoption", more specifically "the boom and the bust", the two "aspects of irrational speculation […] can be very beneficial to technological innovation [because] [t]he boom attracts financial capital through early profits, some of which are reinvested in innovation […] and the bust can actually support the […] long-term adoption of the new technology as prices depress and out-of-the-money stakeholders look to be made whole by promoting and creating value around it."[264] 2021 has seen a boom in NFTs, some of which were sold for millions of dollars in auctions. NFTs are non-fungible tokens, best thought of as unique digital assets authenticated using blockchains.[265] NFTs are widely criticized for their electricity consumption,[266] a criticism that Bitcoin has faced and continues to face due to the Proof of Work ("PoW") consensus algorithm.[267] Bitcoin is often portrayed as having a dramatic carbon footprint. The Bitcoin blockchain's energy consumption is estimated at 71.86 TWh.[268] In comparison, Switzerland in 2020 had an energy consumption of approx. 62 TWh.[269] According to critics mining "is perhaps humanity's most direct way of making money by polluting the planet", "essentially convert[ing] energy into wealth".[270]

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[263] See Charles Bovaird, 'Bitcoin Prices Reached An All-Time High Above $63,000—What's Next?' (*Forbes*, 2021) <https://www.forbes.com/sites/cbovaird/2021/04/13/bitcoin-prices-reached-an-all-time-high-above-63000-whats-next/>.

[264] Joel Monegro, 'Fat Protocols' <https://www.usv.com/writing/2016/08/fat-protocols/>. Footnotes omitted.

[265] See Alejandro de la Garza, 'Digital NFT Art Is Booming—But at What Cost?' (*Time*, 2021) <https://time.com/5947911/nft-environmental-toll/>.

[266] See Justine Calma, 'The Climate Controversy Swirling Around NFTs' (*The Verge*, 2021) <https://www.theverge.com/2021/3/15/22328203/nft-cryptoart-ethereum-blockchain-climate-change>. See De La Garza (n 265).

[267] See *infra* Chapter 2.4.4. for more on Proof of Work. See also Ethan Lou, 'Bitcoin as Big Oil: The next Big Environmental Fight?' (*The Guardian*, 2019) <https://www.theguardian.com/commentisfree/2019/jan/17/bitcoin-big-oil-environment-energy>; see Daniel Shane, 'Bitcoin boom may be a disaster for the environment' (*CNN*, 2017) <https://money.cnn.com/2017/12/07/technology/bitcoin-energy-environment/index.html>. For a discussion on how to possibly tackle this problem, see Jon Truby, 'Decarbonizing Bitcoin: Law and policy choices for reducing the energy consumption of Blockchain technologies and digital currencies' (2018) 44 Energy Research and Social Science 399 <https://doi.org/10.1016/j.erss.2018.06.009>.

[268] See 'Cambridge Bitcoin Electricity Consumption Index' <https://cbeci.org/>. In the comparisons section, Bitcoin is consuming more energy than, for example, Austria or Switzerland. See also, Johannes Sedlmeir and others, 'The Energy Consumption of Blockchain Technology: Beyond Myth' [2020] 62 Business and Information Systems Engineering 599 et seq. <https://doi.org/10.1007/s12599-020-00656-x>. For other estimates and Bitcoin's energy consumption comparisons, see Raffael Huber, 'Bitcoin's Energy Consumption' (*Bitcoin Suisse Decrypt*, 2021) <https://www.bitcoinsuisse.com/research/decrypt/bitcoins-energy-consumption>.

[269] See International Energy Agency (IEA), 'Switzerland Key energy statistics, 2020' <https://www.iea.org/countries/switzerland>.

[270] De La Garza (n 265).

110 Overall, Bitcoin's energy use and related consequences of its PoW mechanism on the environment are complex.[271] However, some investors will want to make sure that the bitcoins they invest in were mined efficiently.[272] Tesla, for example, started accepting bitcoin for vehicle purchases in March 2021 but only two months later suspended accepting bitcoin due to concerns about "rapidly increasing use of fossil fuels for Bitcoin mining and transactions, especially coal".[273]

111 Proponents see blockchain's innovation as groundbreaking as the invention of double-entry bookkeeping.[274] Sandner, for example, refers to Bitcoin as the "first digital commodity" and as a milestone for humanity that will make the history books.[275]

2.4 Functionality and Characteristics of Blockchain Technology and Blockchain Transactions

2.4.1 Cryptoeconomics

112 Nakamoto's breakthrough solution of achieving consensus in a distributed network through PoW[276] opened an entirely new field of research called "cryptoeconomics".[277] According to Vitalik Buterin, "cryptoeconomics […] is the single key fundamentally

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[271] See Huber (n 268).

[272] See Ben Schiller and Marc Hochstein, '"Shark Tank" Star: Wall Street Investors Need to Know How Their BTC Is Mined' (*Coindesk*, 2021) <https://www.coindesk.com/shark-tank-kevin-oleary-bitcoin-mining>.

[273] Elon Musk, '@elonmusk on Twitter Regarding Tesla and Bitcoin' (*Twitter*, 2021) <https://twitter.com/elonmusk/status/1392602041025843203/photo/1>. Katrina Nicholas, 'Tesla Now Accepts Bitcoin as Payment for Cars, Musk Says' (*Bloomberg*, 2021) <https://www.bloomberg.com/news/articles/2021-03-24/you-can-now-buy-a-tesla-with-bitcoin-elon-musk-says>.

[274] See Ryan Hasting, 'Smart Contracts : Implications on Liability and Competence' (2020) 28 University of Miami Business Law Review 358, 360 <https://repository.law.miami.edu/umblr/vol28/iss2/6/>. See also Robert Hackett, 'Why Big Business Is Racing to Build Blockchains' (*Fortune.com*, 2017) 44 <http://fortune.com/2017/08/22/bitcoin-ethereum-blockchain-cryptocurrency/>. For the origins of double-entry bookkeeping see Murphy Smith, 'Luca Pacioli: The Father of Accounting' (2018) <https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2320658>.

[275] See Philipp Sandner, 'What Is Bitcoin? The Discovery Of The First "Digital Commodity"' (*Forbes.com*, 2021) <https://www.forbes.com/sites/philippsandner/2021/03/04/what-is-bitcoin-the-discovery-of-the-first-digital-commodity/?sh=3c00ae6f4759>.

[276] See *infra* Chapter 2.4.4.

[277] Werbach notes that the precise origin of the term is not known but when he asked Vlad Zamfir on twitter, whether he had coined the term, Zamfir responded that he had heard it from Vitalik Buterin; see Vlad Zamfir '@VladZamfir on Twitter on 15 October 2017 (Conversation with Kevin Werbach)' (*Twitter,* 2017) <https://twitter.com/VladZamfir/status/919576004405764096>. See Werbach (n 7) 48, see Footnote 40 wherein Werbach refers to Zamfir's twitter response.

transformative idea that came out of Satoshi's code and whitepaper".[278] Stark suggests that it is "what makes blockchains interesting, what makes them *different* from other technologies".[279] As an interdisciplinary discipline that combines applied cryptography with economics, specifically mechanism design,[280] it studies how cryptography can secure blockchain networks against malicious attacks while incentivizing participants to act in a certain way.[281] The design mechanism is relevant not only on a blockchain-wide level but also for single decentralized applications, especially in the area of dispute resolution.

113 According to Berg, Davidson, and Potts "institutional cryptoeconomics", which studies how blockchains relate to and shape social institutions on many different levels, "adds another institutional form".[282] As such a new institution, this means that blockchains can impact the law and the legal system, including how parties resolve their disputes.

2.4.2 The Breakthrough of Asymmetric Cryptography and Hash Algorithms

114 Cryptography[283] is the science of secure messaging in the presence of third parties (adversaries).[284] This science goes back thousands of years, from the ancient Egyptian hieroglyphics to ancient Rome's "Caesar cipher" and has continuously developed since.[285] Cryptography has played a significant role in history. It has been decisive in the outcome of wars and nowadays makes it possible for anyone with an internet connection and a credit card to shop online securely.[286]

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[278] Vitalik Buterin, 'Blockchain and Smart Contract Mechanism Design Challenges', *1st Workshop on Trusted Smart Contracts in Association with Financial Cryptography 17, Malta* (2017) <http://fc17.ifca.ai/wtsc/Vitalik_Malta.pdf>. See also Werbach (n 7) 155.

[279] Josh Stark, 'Making Sense of Cryptoeconomics' (*Coindesk*, 2017) <https://www.coindesk.com/making-sense-cryptoeconomics>.

[280] See Stark (n 279). See Amy Castor, 'Vitalik Buterin Doubles Down on Ethereum Incentive Strategy' (*Coindesk*, 2017) <https://www.coindesk.com/vitalik-buterin-doubles-ethereum-incentive-strategy>.

[281] See Finck (n 30) 29. During the Disrupt conference, Vitalik Buterin stated that "crypto is really ultimately all about incentives on multiple levels from the community all the way down to […] the security of the consensus protocol", see 'Decentralizing Everything with Ethereum's Vitalik Buterin | Disrupt SF 2017' (n 217).

[282] See Berg, Davidson and Potts (n 17) 1.

[283] Means "hidden/secret writing" in Ancient Greek, see 'Cryptography' <https://www.merriam-webster.com/dictionary/cryptography#note-1>.

[284] See Werbach (n 7) 40. See generally Schneier (n 19) 1, 5. See 'MIT 15.S12 Blockchain and Money, Fall 2018, Prof. Gary Gensler (Lecture 3 Blockchain Basics & Cryptography)' (*Youtube*, 2020) <https://www.youtube.com/watch?v=0UvVOMZqpEA>.

[285] See Christof Paar and Jan Pelzl, *Understanding Cryptography: A Textbook for Students and Practitioners* (Springer 2010) 2.

[286] See Paar and Pelzl (n 285) 2. See also Werbach (n 7) 40.

115 Cryptography in the digital realm achieves high security for individuals and enables them to have strong protections even against state authorities.[287] Cryptography essentially pursues one important goal: protecting data from unauthorized access.[288] It can be seen as the "digital equivalent to door locks [and] [s]imilar to locks […] in the physical world, cryptography also uses keys".[289] Blockchains rely on cryptography to "prove knowledge of a secret without revealing that secret (digital signature)"[290] and to "prove the authenticity of data (digital fingerprint)".[291]

116 In symmetric cryptography, the same key (cipher) is used both to encrypt and decrypt data.[292] The challenge with this type of cryptography is that even if the cipher itself was absolutely secure, it has to be shared through a channel that might be compromised, which in turn may lead to the key becoming useless.[293] For security purposes, one would have to hand the key over in person, which is obviously impractical and not free from security risks.[294] This is known as the key-distribution problem, which was considered unsolvable and has stayed that way for the last 2,000 years: Two parties that want to share a secret need to have already communicated one beforehand, *i.e.,* the key.[295]

117 Singh explains this concept using the example of a corrupt postal system in which unprotected messages can be easily read, and introduces the two protagonists in cryptography literature, Alice and Bob, who want to exchange a message securely but cannot do so unless they meet in person to exchange the secret key.[296]

118 Asymmetric (or public key) cryptography[297] pioneered by Martin Hellman and Whitfield Diffie in the 1970s solved the key-distribution problem, which is considered to be "the

[287] 'Decentralizing Everything with Ethereum's Vitalik Buterin | Disrupt SF 2017' (n 217).
[288] See Drescher (n 6) 100.
[289] Drescher (n 6) 95.
[290] Antonopoulos, *Mastering Bitcoin: Programming the Open Blockchain* (n 9) 55.
[291] Antonopoulos, *Mastering Bitcoin: Programming the Open Blockchain* (n 9) 55.
[292] See Drescher (n 6) 96.
[293] See De Filippi and Wright (n 5) 14–15. See Simon Singh, *The Code Book: How to Make It, Break It, Hack It, Crack It* (Delacorte Press 2002) 186.
[294] See Singh (n 293) 186.
[295] See Singh (n 293) 186–187, 191-192.
[296] See Singh (n 293) 192–193. In cryptography literature, one often encounters the two fictional and famous characters Alice and Bob, who in this case are the sender and receiver of a secret message. In Singh's illustration, he also introduces a third character named Eve.
[297] This revolutionary invention is widely recognized as "public key cryptography", named as such by Diffie and Hellman in their 1976 paper, see Whitfield Diffie and Martin E. Hellman, 'New Directions in Cryptography' (1976) 22 IEEE Transactions on Information Theory 644. However, the term "public-

greatest revolution in twentieth-century cryptography"[298] and became the foundation of modern internet security.[299] Instead of sharing a single key that serves both to encrypt and decrypt, parties generate their own public-private key pair and only need to share their public key to encrypt messages, respectively.[300] The channel's security level is less relevant because parties use their corresponding private key to decrypt the message.[301] This invention was revolutionary and had profound consequences for modern cryptography. In a sense, it also democratized access to strong cryptography, which before the 1970s was exclusively meant to serve state governments.[302]

119 The inventors of Alice and Bob,[303] the MIT cryptographers Ron Rivest, Adi Shamir and Len Adleman, later developed another important milestone in asymmetric cryptography, called the "RSA algorithm",[304] which makes it possible to share one's public key, without running the risk of exposing one's private key.[305] Asymmetric cryptography can be used for (i) secrecy purposes,[306] and for (ii) digital signatures.[307] Bitcoin uses the latter application.[308]

120 To create a public-private key pair, Bitcoin uses a one-way cryptographic function called "elliptic curve multiplication".[309] A party can share their public key to receive payment, and their private key, which does not have to be revealed at any point, gives the party

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private key cryptography" shows up in literature as well. See Martin Hellman, Stanford Online, 'Stanford Seminar - The Evolution of Public Key Cryptography' (2018) <https://www.youtube.com/watch?v=Tev3tVzH91s> (In his Stanford seminar in 2018, Martin Hellman recounts the story of the NSA's attempts to prevent publication of the Diffie/Hellman paper due to concerns to national security. Hellman says that he "pictured them [the NSA] as Darth Vader" and himself as "Luke Skywalker". This became known as the first in the so-called "crypto-wars"). See also Steve Fyffe and Tom Abate, 'Stanford cryptography pioneers Whitfield Diffie and Martin Hellman win ACM 2015 A.M. Turing Award' <https://news.stanford.edu/2016/03/01/turing-hellman-diffie-030116/>.

298 Singh (n 293) 187.

299 See De Filippi and Wright (n 5) 14. See also Fyffe and Abate (n 5).

300 See Drescher (n 6) 98. See also Berentsen and Schär (n 6) 144.

301 See Drescher (n 6) 98. See Singh (n 293) 196.

302 See, e.g., Antonopoulos and Wood (n 28) 60-61. See Epstein (n 232).

303 To learn more about Alice and Bob, see Bob Brown, 'Security's Inseparable Couple: Alice & Bob' (2005) <https://www.networkworld.com/article/2318241/lan-wan-security-s-inseparable-couple.html>.

304 See RL Rivest, A Shamir and L Adleman, 'A Method for Obtaining Digital Signatures and Public-Key Cryptosystems' [1978] 21 Communications of the ACM 120. See also De Filippi and Wright (n 5) 15.

305 See De Filippi and Wright (n 5) 15.

306 See Antonopoulos, *Mastering Bitcoin: Programming the Open Blockchain* (n 9) 56. See Berentsen and Schär (n 6) 145–146.

307 See Antonopoulos, *Mastering Bitcoin: Programming the Open Blockchain* (n 9) 56. See Satoshi Nakamoto, 'Bitcoin: A Peer-to-Peer Electronic Cash System' 2 <https://bitcoin.org/bitcoin.pdf>. ("A payee can verify the signatures to verify the chain of ownership."). See also Berentsen and Schär (n 6) 145–146.

308 See Berentsen and Schär (n 6) 146.

309 See Antonopoulos, *Mastering Bitcoin: Programming the Open Blockchain* (n 9) 56–57.

control over the funds.[310] This is a crucial component of blockchain technology as it enables parties to transact without third party involvement.[311]

121 One-way hash functions[312] are easy to compute in one direction but not in the other, meaning that it is extremely difficult to infer the input from an output.[313] Hash functions have a variety of features, including the perceived randomness of output.[314] One may regard hash functions as digital fingerprints of data.[315] A popular hash function in blockchains is the so-called "Secure Hash Algorithm" ("SHA") with an output size of 256 bits ("SHA-256")".[316] Hash functions transform data into a fixed size output.[317] Only a small change in the input data changes the output in unpredictable ways.[318] The following table serves as an illustration of the concept:

Text	**Hash**
arbitration	e49f5710c8d3e66821f0e0ee1c3ed574 df3f0b48e2a65c4c357b654fa10ef402
arbitration**s**	08a7edbcb0fe5019486b62ab1e63b848 44cbd21fc3089a906f680c793ed3f811

Table 1. SHA-256 function output based on input terms[319]

[310] See Antonopoulos, *Mastering Bitcoin: Programming the Open Blockchain* (n 9) 56.
[311] See 'What Are Public and Private Keys?' (*Cryptopedia*, 2021) <https://www.gemini.com/cryptopedia/public-private-keys-cryptography>.
[312] See Schneier (n 19) 30 for an in-depth explanation.
[313] See Andreas Antonopoulos, 'Explaining Hash Functions' (*Youtube*, 2020) <https://www.youtube.com/watch?v=jBPQuZaiJOg>. See Schneier (n 19) 30.
[314] See Antonopoulos explains some features in his talk about Hash Functions here: Andreas Antonopoulos, 'Explaining Hash Functions' (*Youtube*, 2020) <https://www.youtube.com/watch?v=jBPQuZaiJOg>.
[315] See Schneier (n 19) 31.
[316] Dylan Yaga and others, 'Blockchain Technology Overview, NISTIR 8202' 7 <https://doi.org/10.6028/NIST.IR.8202>.
[317] See Bhushan Kapoor and Pramod Pandya, 'Data Encryption' in John R Vacca (ed), *Cyber Security and IT Infrastructure Protection* (Syngress 2014) 67.
[318] See Yaga and others (n 316) 7.
[319] Own table. SHA-256 value generated using 'Online Tools Hash SHA256' <https://emn178.github.io/online-tools/sha256.html>.

2.4.3 Process of a Blockchain Transaction

122 Taking the example of Bitcoin, this chapter illustrates a blockchain transaction. Although Bitcoin is often thought of as "coins", no coins are really exchanged.[320] Nakamoto clarifies that "an electronic coin [is] a chain of digital signatures."[321] A holder sends a specific number of bitcoins to the recipient (next holder) through public-key cryptography.[322] The term "holder" is used here instead of "owner" so as to not make any property law assumptions.[323] The holder of bitcoins can be equated with the one who knows the private key in control of these bitcoins.[324]

123 A user can create as many public-private key pairs as desired.[325] The public key hash is the means of identification[326] in the Bitcoin network and is often called a Bitcoin address.[327] Participation in the Bitcoin network is thus pseudonymous.[328] A Bitcoin transaction is digitally signed using a private key.[329] Transactions are confirmed by way of "Nakamoto consensus", *i.e.,* "consensus on the blockchain through a decentralized, pseudonymous protocol".[330] Consensus is achieved by way of solving a computationally intensive hash puzzle, also called Proof of Work ("PoW").[331] This innovation is at the heart of Bitcoin's success.[332]

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[320] See Werbach (n 7) 40–41. See also Jaya Klara Brekke, 'The White Paper Guide' in Ben Vickers (ed), *The White Paper by Satoshi Nakamoto* (Ignota Books 2019) 29.
[321] Nakamoto, 'Bitcoin: A Peer-to-Peer Electronic Cash System' (n 52) 2.
[322] See Brekke (n 320) 29.
[323] In the UNCITRAL report on the digital economy the term "owner" is avoided, rather the term "holder" is used for the same reason. See para 52 in UNCITRAL, 'Exploratory Work on Legal Issues Related to the Digital Economy - Reports of Events' (*2020*) <https://undocs.org/A/CN.9/LIII/INF/2>.
[324] See Joseph Bonneau and others, 'SoK: Research Perspectives and Challenges for Bitcoin and Cryptocurrencies' (2015) 2015-July Proceedings - IEEE Symposium on Security and Privacy 104, 106.
[325] See Roger Wattenhofer, *Blockchain Science : Distributed Ledger Technology* (Inverted Forest Publishing 2019) 130.
[326] See Wattenhofer (n 325) 130.
[327] Note that the "Bitcoin address is the hash of the elliptic curve public key, and not the public key itself", Vitalik Buterin, 'Ethereum Whitepaper: A Next-Generation Smart Contract and Decentralized Application Platform' (2013) <https://ethereum.org/en/whitepaper/>. See Wattenhofer (n 325) 130.
[328] See Wattenhofer (n 325) 130. Pseudonymity, however, does not mean anonymity. It is called "pseudonymous" because it is difficult (though not impossible, as local enforcement agencies and specialized analytics firms, for example, have shown) to link a real-world identity to a Bitcoin address.
[329] See Nakamoto, 'Bitcoin: A Peer-to-Peer Electronic Cash System' (n 52) 2.
[330] See Bonneau and others (n 324) 106. See Zubin Koticha, 'Introduction to Blockchain through Cryptoeconomics, Part 2: Proof of Work and Nakamoto Consensus' (*Medium*, 2018) <https://medium.com/mechanism-labs/introduction-to-bitcoin-through-cryptoeconomics-part-2-proof-of-work-and-nakamoto-consensus-1252f6a6c012>.
[331] See Bonneau and others (n 324) 107.
[332] See Bonneau and others (n 324) 106.

124 Transactions are assembled in a series of blocks connected by hashes.[333] In this way, one block always refers to the immediately preceding block.[334] A new block contains the previous block's hash, a timestamp, a nonce,[335] and the recent transaction history.[336] A simplified structure of blocks can be depicted as follows:

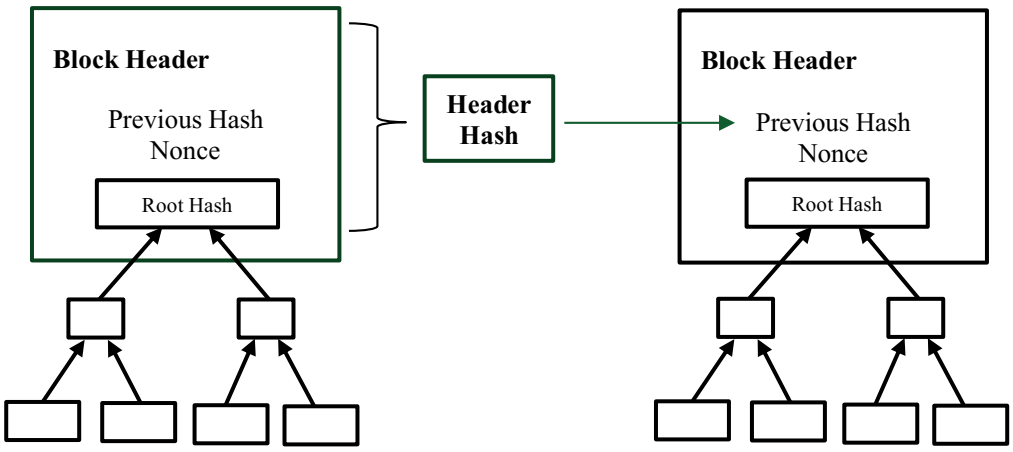

Figure 3. Contents of a Bitcoin Block and the "chaining", simplified[337]

125 The figure shows that each block contains the previous block's hash, thus linking them together in the characteristic way for a blockchain: the "chain of blocks".[338] The timestamp shows the time at which the block was created.[339] A nonce is a random number, which mining nodes try to guess to solve the hash puzzle.[340] It is an important element in the functioning of the proof of work consensus protocol.[341]

126 The Merkle root contains a reference to the list of transactions of a specific block.[342] The hash values for the transactions form a Merkle tree,[343] whose root condenses that tree's

[333] See Bonneau and others (n 324) 106.
[334] See Bonneau and others (n 324) 106.
[335] Nonce stands for "number only used once". See Jake Frankenfield, 'Nonce' (2021) <https://www.investopedia.com/terms/n/nonce.asp#what-is-nonce>.
[336] See Buterin, 'Ethereum Whitepaper: A next-Generation Smart Contract and Decentralized Application Platform' (n 327).
[337] Own adaptation of figure in Nakamoto, 'Bitcoin: A Peer-to-Peer Electronic Cash System' (n 52) 4.
[338] See generally, Nakamoto, 'Bitcoin: A Peer-to-Peer Electronic Cash System' (n 52). On page 3 Nakamoto writes "blocks are chained", on page 7 "chain of blocks". Nakamoto also uses terms such as "chain of hash-based proof-of-work", "proof of work chain", "chain of digital signatures", "chain of ownership".
[339] See Berentsen and Schär (n 6) 197.
[340] See Brekke (n 320) 35. See Berentsen and Schär (n 6) 197.
[341] See Berentsen and Schär (n 6) 197.
[342] See Berentsen and Schär (n 6) 198.
[343] See Berentsen and Schär (n 6) 198

transactions into a single hash value.[344] This system cryptographically secures transactions, such that even a minor change in the structure would ultimately change the root value, which would be easy to detect.[345]

127 The header hash contains all the important block information in a condensed form and can be used as a reference. The fact that the hash of a block only contains the block header's hash is an important feature in terms of scalability.[346] In this way, the network assures a "persistent, ever-growing, 'blockchain' that constantly updates to represent the latest state of the Bitcoin ledger".[347]

2.4.4 Consensus Protocols, Miners, and Nodes

128 Consensus is the technical term used to describe a collective agreement between independent nodes,[348] and distributed consensus is such agreement in a distributed platform.[349] The "consensus protocol" contains all the rules to be followed to reach consensus.[350] Consensus achieves a "shared state"[351] without central control and thereby does away with a single point of failure.[352] Thus, consensus is the glue of blockchain's anatomy keeping all parts together.

129 This concept is important because in a decentralized network there is no central authority to determine which state of the blockchain is correct or the real one.[353] In a peer-to-peer network, each independent participant (called "node") holds its own copy of the ledger.[354] According to Antonopoulos, in Bitcoin, nodes may have four different functions, such as

[344] Wattenhofer (n 325) 146.
[345] See Berentsen and Schär (n 6) 198.
[346] See Buterin, 'Ethereum Whitepaper: A next-Generation Smart Contract and Decentralized Application Platform' (n 327) ("An important scalability feature of Bitcoin is that the block is stored in a multi-level data structure. The "hash" of a block is actually only the hash of the block header, a roughly 200-byte piece of data that contains the timestamp, nonce, previous block hash and the root hash of a data structure called the Merkle tree storing all transactions in the block.").
[347] Buterin, 'Ethereum Whitepaper: A next-Generation Smart Contract and Decentralized Application Platform' (n 327).
[348] See Drescher (n 6) 167.
[349] See Drescher (n 6) 167.
[350] Jean Bacon and others, 'Blockchain Demystified' [2017] Queen Mary University of London, School of Law Legal Studies Research Paper No. 268/2017 5, 13 <https://ssrn.com/abstract=3091218>.
[351] Werbach (n 7) 64.
[352] See Werbach (n 7) 7, 64.
[353] See Berentsen and Schär (n 6) 205.
[354] See Schmidt (n 236) 20. See also Werbach (n 7) 7.

(i) "routing", (ii) "blockchain database", (iii) "mining", and (iv) "wallet services".[355] While all nodes have function (i), a full node incorporates all four functions and keeps a whole copy of the blockchain.[356] In contrast, a light(weight) node only keeps part of the blockchain and uses what is called "simplified payment verification" ("SPV").[357] A full node is thus not necessary to verify transactions.[358]

130 Any alteration to the blockchain, such as the addition of new blocks, requires consensus among the nodes of the network.[359] This is how trust is created in a "trustless" system,[360] or "cryptographic proof instead of trust" in Nakamoto's words.[361] Berentsen and Schär explain that if there was no consensus protocol, each node could generate its own competing version of the blockchain, thereby rendering impossible the creation of value.[362]

131 In the most prominent blockchain examples, Bitcoin and Ethereum, the consensus protocol requires miners to do what is called "Proof of Work" ("PoW")[363] in order for new transactions to be published in a new "block".[364] According to Berentsen and Schär, PoW creates an artificial limitation,[365] which enables the network to agree on a version of the ledger. Buterin explains that its purpose "is to make block creation computationally 'hard', thereby preventing so-called sybil attackers from remaking the entire blockchain in their favor".[366] PoW allows nodes of a blockchain network to synchronize over time.[367]

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[355] See Antonopoulos, *Mastering Bitcoin: Programming the Open Blockchain* (n 9) 172.
[356] See Antonopoulos, *Mastering Bitcoin: Programming the Open Blockchain* (n 9) 172.
[357] See Antonopoulos, *Mastering Bitcoin: Programming the Open Blockchain* (n 9) 172.
[358] See Nakamoto, 'Bitcoin: A Peer-to-Peer Electronic Cash System' (n 52) 5. See Buterin, 'Ethereum Whitepaper: A next-Generation Smart Contract and Decentralized Application Platform' (n 327). ("A protocol known as 'simplified payment verification' (SPV) allows for another class of nodes to exist, called 'light nodes' […] to determine with a strong guarantee of security what the status of any Bitcoin transaction, and their current balance, is while downloading only a very small portion of the entire blockchain.").
[359] See Schmidt (n 236) 20.
[360] See Werbach (n 7) 7, 9, 28 et seq.
[361] Nakamoto, 'Bitcoin: A Peer-to-Peer Electronic Cash System' (n 52) 1.
[362] Berentsen and Schär (n 6) 205.
[363] Narayanan and Clark (n 54) 40 explain that the origins of proof of work come from a paper by Cynthia Dwork and Moni Noar, in which it was used as a defense against spam, see Cynthia Dwork and Moni Naor, 'Pricing via Processing or Combatting Junk Mail' (1993) in E.F. Brickell (Ed.): Advances in Cryptology - CRYPT0 '92, LNCS 740, 139-147 (Springer-Verlag Berlin Heidelberg).
[364] See e.g., Bacon and others (n 350) 14. See also Vitalik Buterin, 'Bitcoin Introduction – General' (*Bitcoin Magazine*, 2012) <https://bitcoinmagazine.com/culture/bitcoin-introduction-general-2-1330732717>.
[365] See Berentsen and Schär (n 6) 60, 207.
[366] Buterin, 'Ethereum Whitepaper: A next-Generation Smart Contract and Decentralized Application Platform' (n 327). For more on Sybil attacks, see 'Sybil Attacks Explained' (*Binance Academy*, 2020) <https://academy.binance.com/en/articles/sybil-attacks-explained>.
[367] See Wattenhofer (n 325) 134.

132 PoW basically means solving hash puzzles.[368] While finding a solution can be hard and cost-intensive, verifying whether the solution is correct is simple.[369] The Bitcoin network adjusts its difficulty (how hard it is to solve the hash puzzle) so that blocks are produced approximately every ten minutes.[370] Miners compete against each other to find a solution to the hash puzzle to then produce the next block. A miner that finds a solution to the hash puzzle, which can be thought of as a lottery,[371] transmits it to the network, where the other nodes - upon verifying the validity of the new block's hash - add the new block to their copy of the distributed ledger, which then gets synchronized.[372]

133 The energy consumption required to perform these intensive computations has been widely criticized. Thus, alternatives have been suggested. Ethereum, for example, will implement "Proof of Stake" ("PoS"). In this environmentally friendly model, no resource-intensive computations are necessary[373] since the model uses the amount of "stake", *i.e.,* the number of native tokens a user locks up in the system in order to maintain the system and create new blocks.[374]

134 It takes miners ten minutes to find a solution in the Bitcoin network.[375] The mining node that solves the hash puzzle and creates a new block receives what is called a "coinbase transaction", which includes the reward.[376] Satoshi Nakamoto wrote: "The steady addition of a constant of amount of new coins is analogous to gold miners expending

[368] See Drescher (n 6) 92. For more on Proof of Work (PoW), see 'What Is Proof of Work (PoW)?' (*Binance Academy*, 2021) <https://academy.binance.com/en/articles/proof-of-work-explained>.
[369] See Yaga and others (n 316) 19.
[370] See Antonopoulos, *Mastering Bitcoin: Programming the Open Blockchain* (n 9) 235 et seq. See Wattenhofer (n 325) 135. See 'Difficulty' (*Binance Academy*) <https://academy.binance.com/en/glossary/difficulty>.
[371] See Brekke (n 320) 35. See making reference to computational puzzles, Buterin, 'Ethereum Whitepaper: A next-Generation Smart Contract and Decentralized Application Platform' (n 327).
[372] See Finck (n 30) 20.
[373] Ethereum has been planning to move to Proof of Stake for some time, this endeavor is part of what is called "Ethereum 2.0" (Eth2) and is currently in development, first steps in testing have already been undertaken, see 'Ethereum 2.0 (Eth2)' <https://ethereum.org/en/eth2/>; see 'Ethereum 2.0 Phases' <https://docs.ethhub.io/ethereum-roadmap/ethereum-2.0/eth-2.0-phases/>; see Sebastian Sinclair, 'Staking on Ethereum 2.0 Takes First Step With Test System for Validators' (*Coindesk*, 2020) <https://www.coindesk.com/staking-on-ethereum-2-0-takes-first-step-with-test-system-for-validators>.
[374] See Yaga and others (n 316) 21. See also Andreas M Antonopoulos, 'Bitcoin Q&A: Proof-of-Work (PoW), Proof-of-Stake (PoS), Delegated Proof-of-Stake (DPoS)' (*Youtube*, 2017) <https://www.youtube.com/watch?v=3W_3AQrQEOM>.
[375] This amount of time is kept nearly constant by what's called "difficulty", a programmed adjustment in the protocol, the exact time can slightly vary though. See Buterin, 'Bitcoin Introduction – General' (n 364).
[376] See Antonopoulos, *Mastering Bitcoin: Programming the Open Blockchain* (n 9) 221 et seq.

resources to add gold to circulation."[377] The difference between a transaction's inputs and outputs constitutes the transaction fees transferred to the winning miner.[378]

135 The total number of bitcoins that can be minted was initially set at 21 million, and the number of bitcoins miners receive for performing PoW decreases over time. At Bitcoin's inception, the block reward amounted to 50 bitcoins. Every 210,000 blocks, the reward is decreased by half.[379] The last "halving" took place in 2020, the reward went down from 12,5 bitcoins to 6,25 bitcoins.[380] This happens approximately every four years until no block reward is issued anymore, and the only compensation miners get are fees generated for transactions, estimated to happen in approximately 2140.[381]

136 According to Moore's law, software and hardware continually improve.[382] While in the early days of Bitcoin anyone with a laptop could become a miner and mine bitcoins, today the mining business has evolved into a sophisticated industry using specialized hardware.[383] Operators invest in expensive equipment and incur considerable electricity costs in so-called "mining farms" or "server farms".[384] Some call it the "modern-day gold rush".[385] Costs associated with mining have increased, such as through application specific integrated circuits ("ASICs"), which is hardware developed specifically and only for mining in the Bitcoin blockchain.[386] Due to the high hurdles for entering the mining business (special hardware, resource-intensive), a tendency towards concentration can be

[377] Nakamoto, 'Bitcoin: A Peer-to-Peer Electronic Cash System' (n 52) 4.
[378] See Buterin, 'Ethereum Whitepaper: A next-Generation Smart Contract and Decentralized Application Platform' (n 327).
[379] See Wattenhofer (n 325) 135.
[380] For an overview and explanation of the mining business and the halving procedure, see 'Cointelegraph Platform: CV-Labs "Bitcoin Halving View From The Crypto Valley"' (*Youtube*, 2020) <https://www.youtube.com/watch?v=pxaFRq9U8-Q>.
[381] See Antonopoulos, *Mastering Bitcoin: Programming the Open Blockchain* (n 9) 214-215.
[382] In his 1965 paper (revised in 1975), Gordon E. Moore outlined what would later be a famous computing term coined by California Institute of Technology professor Carver Mead "Moore's Law". According to Moore's Law, the capacity on silicon chips would double every two years. See Gordon E Moore, 'Cramming More Components onto Integrated Circuits' (1965) 38 Electronics <https://newsroom.intel.com/wp-content/uploads/sites/11/2018/05/moores-law-electronics.pdf>; see Gordon E Moore, 'Progress in Digital Integrated Electronics' [1975] Technical Digest 1975. International Electron Devices Meeting, IEEE; see Rachel Courtland, 'Q&A: Carver Mead - A Longtime Collaborator Recalls the First Time He Met Gordon Moore' (*IEEE Spectrum*, 2015) <https://spectrum.ieee.org/semiconductors/devices/qa-carver-mead>. See 'Gordon Moore' (*Intel*) <https://www.intel.com/content/www/us/en/history/museum-gordon-moore-law.html>.
[383] See Tech Vision (n 32).
[384] See Tech Vision (n 32).
[385] See Tech Vision (n 32).
[386] For a more in-depth look at mining specific hardware, see, e.g., 'Cointelegraph Platform: CV-Labs "Bitcoin Halving View From The Crypto Valley"' (n 380).

observed.[387] Blockchain's public and decentralized features are thus somewhat questionable.[388] Additionally, due to the increasing difficulty and the competition between miners, mining pools have started to form to guarantee a steady income by splitting the computationally intensive work between more nodes and subsequently sharing the rewards.[389]

137 Although such concentration raises concern, Satoshi Nakamoto believed that the incentive mechanism in Bitcoin would "encourage nodes to stay honest" and that even if an attacker were to assemble more computing power for a 51% attack, he would "find it more profitable to play by the rules, such rules that favour him with more new coins than everyone else combined, than to undermine the system and the validity of his own wealth".[390] Although the risk is thus seen as rather low because miners should have a higher incentive to uphold the system, [391] such an attack happened twice within a week for the Ethereum Classic blockchain in August 2020.[392]

2.4.5 Decentralized, Distributed, and Disintermediated

138 Basic terms often get confused and intermingled, such as "decentralized"[393] and "distributed". There is a subtle difference between these two that relate either to control or location.[394] Whereas in a centralized system a central authority has control, in a decentralized system the nodes of the network share control, resulting in no single point of failure.[395] Distributed systems, unlike non-distributed systems, are usually geographically dispersed.[396]

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[387] See Berg, Davidson and Potts (n 17) 42.
[388] See Berg, Davidson and Potts (n 17) 42.
[389] See Yaga and others (n 316) 20–21. The formation of such mining pools has been criticized as running against the philosophy of a decentralized, open and permissionless blockchain because of the concentration of power and the risk of 51% attacks. See, e.g., Finck (n 30) 21. See Buterin, 'Ethereum Whitepaper: A next-Generation Smart Contract and Decentralized Application Platform' (n 327).
[390] Nakamoto, 'Bitcoin: A Peer-to-Peer Electronic Cash System' (n 52) 4.
[391] See Finck (n 30) 21. See Nakamoto, 'Bitcoin: A Peer-to-Peer Electronic Cash System' (n 52) 4.
[392] See Sebastian Sinclair, 'Ethereum Classic Suffers Second 51% Attack in a Week' (*Coindesk*, 2020) <https://www.coindesk.com/ethereum-classic-suffers-second-51-attack-in-a-week>.
[393] See Vitalik Buterin, 'The Meaning of Decentralization' (*Medium*, 2017) <https://medium.com/@VitalikButerin/the-meaning-of-decentralization-a0c92b76a274>.
[394] See Julia Poenitzsch, 'What's the Difference between Decentralized and Distributed? And How Does This Relate to Private vs. Public Blockchains?' (*Medium*, 2018) <https://medium.com/nakamo-to/whats-the-difference-between-decentralized-and-distributed-1b8de5e7f5a4>.
[395] See Poenitzsch (n 394). See also Drescher (n 6) 236.
[396] See Poenitzsch (n 394). See also Finck (n 30) 19.

139 Disintermediation refers to eliminating trusted and traditional intermediaries and is one of blockchain's most prominent promises.[397] Intermediaries are seen as obstacles in a p2p decentralized world because they are usually costly and may compromise security.[398] Nakamoto points out that the "cost of mediation increases transaction costs".[399] A blockchain does not eliminate the mediator,[400] rather it becomes itself the "digital and strictly rule-following middleman."[401] De Filippi and Wright point out that "[p]erhaps most profoundly, blockchains are characterized by their ability to facilitate the deployment of autonomous software that is not under the control of any one party".[402] One of Satoshi Nakamoto's key innovations is that Bitcoin can run in a decentralized manner.[403]

140 There can be varying degrees of decentralization and distribution in any given blockchain system. Blockchains are not automatically decentralized or distributed.[404] A decentralized blockchain using PoW may become centralized when a 51% attack happens.[405] However, public blockchains are more likely to be decentralized than private blockchains controlled by one or a group of entities.[406]

141 Decentralization and distribution come with various advantages, such as no single point of failure, "[h]igher computing power[,] [c]ost reduction[,] [h]igher reliability [and] [a]bility to grow naturally".[407] However, disadvantages and challenges present themselves as well in the form of programming complexity, diminished efficiency, and security concerns.[408] Furthermore, such systems present jurisdictional uncertainty because decentralized public permissionless blockchains have global reach as a p2p network of nodes with no central authority.[409]

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[397] See generally on blockchain's disintermediation, Matthieu Quiniou, *Blockchain: The Advent of Disintermediation* (ISTE Ltd and John Wiley & Sons, Inc 2019). See also Finck (n 30) 18.
[398] See Brekke (n 320) 23.
[399] Nakamoto, 'Bitcoin: A Peer-to-Peer Electronic Cash System' (n 52) 1.
[400] In the Bitcoin Whitepaper, Satoshi Nakamoto uses the term "mediation".
[401] Drescher (n 6) 242. See also Brekke (n 320) 24.
[402] De Filippi and Wright (n 5) 43.
[403] See Schmidt (n 236) 20.
[404] See Finck (n 30) 19. See also for a study on the degree of decentralization in both Bitcoin and Ethereum, Adem Efe Gencer and others, 'Decentralization in Bitcoin and Ethereum Networks' (2018) arXiv preprint arXiv:1801.03998 <https://arxiv.org/abs/1801.03998>.
[405] See Poenitzsch (n 394).
[406] See Poenitzsch (n 394).
[407] Drescher (n 6) 12.
[408] See Drescher (n 6) 13. See also Finck (n 30) 19.
[409] See Finck (n 30) 19.

2.4.6 Types of Blockchains

142 The Bitcoin blockchain is often considered the mother of all blockchains and certainly has given rise to the emergence of a whole new industry. Blockchain technology can broadly be categorized into public and private, permissioned and permissionless systems.

143 The following figure gives an overview:

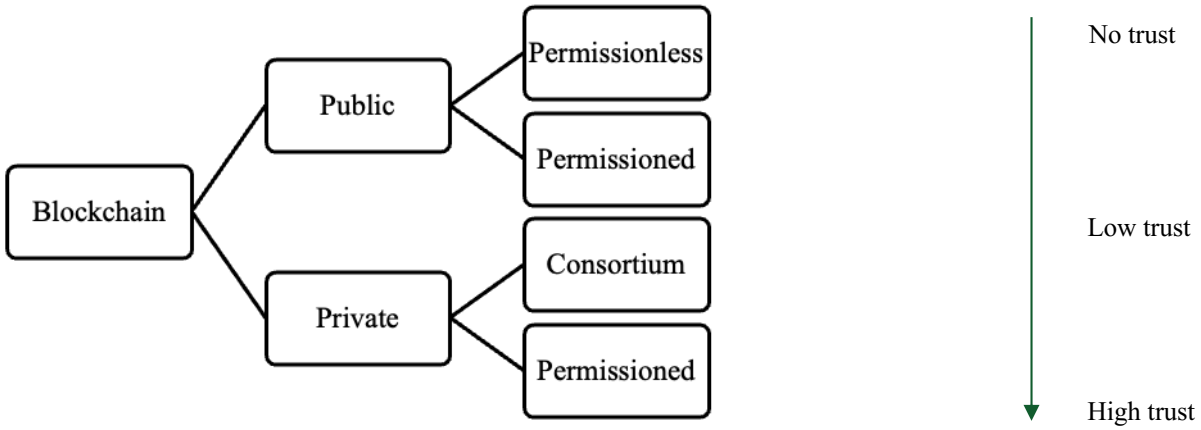

Figure 4. Overview Types of Blockchains[410]

144 The prevailing setups are (i) public and permissionless and (ii) private and permissioned.[411] However, other combinations are also possible.[412] For example, there can be public-permissioned systems.[413] In a public-permissionless blockchain, users who neither know nor trust each other can participate without needing permission by running a node with the appropriate software client.[414] In contrast, private blockchains are limited to select few. A major distinction is transparency: whereas public blockchains are fully

[410] Own figure. Inspired by blockchain taxonomy as in Jesus Ruiz, 'Public-Permissioned Blockchains as Common-Pool Resources' <https://www.linkedin.com/pulse/public-permissioned-blockchains-common-pool-resources-jesus-ruiz/>.
[411] See Finck (n 30) 15.
[412] See Finck (n 30) 15.
[413] See 'How "Public-Permissioned" Blockchains Are Not an Oxymoron' <https://www.r3.com/blog/how-public-permissioned-blockchains-are-not-an-oxymoron-2/>. See Jesus Ruiz, 'Public-Permissioned Blockchains as Common-Pool Resources' <https://www.linkedin.com/pulse/public-permissioned-blockchains-common-pool-resources-jesus-ruiz/>.
[414] See Finck (n 30) 14. In the case of Bitcoin, the most used software client is "Bitcoin Core", which can be downloaded here: 'Download Bitcoin Core' <https://bitcoin.org/de/download>. Ethereum's most used clients for running nodes are Geth and Parity. See 'Download Geth' <https://geth.ethereum.org/downloads/>. See 'GitHub Repository Ethereum Release Notes' <https://github.com/openethereum/openethereum/releases>. See 'Running an Ethereum Node' <https://docs.ethhub.io/using-ethereum/running-an-ethereum-node/>. As of July 2021, the Bitcoin network counts 12352 nodes, spread across the entire globe, with a heightened concentration in Europe and the US, and in parts of China, see 'Bitnodes - Global Bitcoin Nodes Distribution' <https://bitnodes.io>.

transparent, private ones need not be.[415] A disadvantage of public permissionless systems is that they currently cannot attain a high level of transaction speed. While Visa and other settlement solutions can handle thousands of transactions a second,[416] public permissionless blockchains, such as Bitcoin and Ethereum, can only handle anywhere from 3 to 15 transactions per second ("tps").[417]

145 This is often referred to as the "scalability problem" which is directly connected to the blockchain trilemma.[418] At most two of the three properties can be attained in blockchains: (i) decentralization, (ii) scalability, and/or (iii) security.[419] Bitcoin and Ethereum are decentral and secure now, not scalable, however.

146 In permissioned blockchains, participation and access to maintain a node in the network are restricted by a gatekeeper or a central entity,[420] and participants can usually be identified.[421] A variant are consortium blockchains, also referred to as "shared permissioned" blockchains.[422]

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[415] See Werbach (n 7) 96. See Gwyneth Iredale, 'Public Vs Private Blockchain: How Do They Differ?' (*101 Blockchains*, 2021) <https://101blockchains.com/public-vs-private-blockchain/>.

[416] See 'Visa Fact Sheet' <https://www.visa.co.uk/dam/VCOM/download/corporate/media/visanet-technology/aboutvisafactsheet.pdf> ("VisaNet, provides secure and reliable payments around the world, and is capable of handling more than 65,000 transaction messages a second.").

[417] See 'Scalability - Scalability Targets' <https://en.bitcoin.it/wiki/Scalability> ("Today the Bitcoin network is restricted to a sustained rate of 7 tps due to the bitcoin protocol restricting block sizes to 1MB."). Ethereum can handle up to 15 tps at the moment, and the issue of scalability is connected to the scalability trilemma, see 'On Sharding Blockchains FAQs' <https://eth.wiki/sharding/Sharding-FAQs>. Ethereum's founder, Vitalik Buterin, has released a roadmap with the ambitious vision of Ethereum scaling up to 100,000 tps, see Vitalik Buterin, 'A Rollup-Centric Ethereum Roadmap' <https://ethereum-magicians.org/t/a-rollup-centric-ethereum-roadmap/4698>. See also 'Decentralizing Everything with Ethereum's Vitalik Buterin | Disrupt SF 2017' (n 217). See also Felix Irresberger, Kose John, Peter C. Mueller and Fahad Saleh, 'The public blockchain ecosystem: An empirical analysis' [2020] SSRN Electronic Journal 22 et seq. <https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3592849> (Irresberger et al.'s analysis shows that while public blockchains have made progress, they are still much slower at processing transactions than, for example, Visa.) See also 'Bitcoin 101 - Chapter 9 - Can Bitcoin Scale?' <https://www.coindesk.com/learn/bitcoin-101/can-bitcoin-scale>.

[418] See 'On Sharding Blockchains FAQs' (n 417).

[419] See 'On Sharding Blockchains FAQs' (n 417).

[420] See Schmidt (n 236) 26. See also the famous example of 'R3' <https://www.r3.com>.

[421] See Finck (n 30) 15.

[422] Interview #12, Christian Scharr explained that to code and maintain a smart contract an intermediary is needed for the parties, and they need to trust that intermediary. A whole new market has emerged for smart contract audits and certificates, which can be considered an entry barrier. Scharr explained that there is the possibility to "bring together different, interested parties to form a consortium, which can run on an economic basis in a joint venture, or you found a non-profit organization". See also ConsenSys Academy, 'Lesson 2: Public, Private & Consortium Blockchains' (*Coursera Blockchain: Foundations and Use Case*) <https://www.coursera.org/lecture/blockchain-foundations-and-use-cases/lesson-2-public-private-consortium-blockchains-hDSxZ>.

2.4.7 Trust Layer

147 Trust runs deep in all human relationships. It is the fabric that makes and whose loss breaks all human interaction. Werbach explains that trust comes with a certain degree of vulnerability and release of power,[423] and that trusted entities are more powerful than those who are not trusted.[424] In the Bitcoin Whitepaper, Nakamoto highlights the monetary system's reliance on trust.[425]

148 If one considers law from the perspective of trust, law can be seen as serving the function of trust, and dispute resolution allows for means to repair broken trust when mechanisms come into effect in case contractual agreements are not honored.[426] The legal system thus protects parties in their vulnerabilities and places them in a web of assurances that takes effect against exploitation,[427] and other – what computer scientists may call – "malicious attacks".

149 According to Botsman, trust has evolved from local to institutional to its third wave, which society is witnessing now: distributed trust.[428] It "return[s] [society] to the old village model of trust […], except that the community is global in scale".[429] Werbach offers a similar model of how trust evolved in what he calls "trust architectures": from the earliest one, which he terms "peer-to-peer" ("p2p") trust, to state-enabled leviathan[430] trust, and finally trust in intermediaries.[431] According to Werbach, blockchain is a novel trust architecture.[432]

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[423] See Werbach (n 7) 23–25.
[424] See Werbach (n 7) 19.
[425] See Nakamoto, 'Bitcoin: A Peer-to-Peer Electronic Cash System' (n 52) 1. ("Commerce on the Internet has come to rely almost exclusively on financial institutions serving as trusted third parties to process electronic payments. While the system works well enough for most transactions, it still suffers from the inherent weaknesses of the trust based model.").
[426] See Werbach (n 7) 163 et seq.
[427] See Berg, Davidson and Potts (n 17) 2. (The authors cite Williamson: "Oliver Wiliamson pointed out that many of our economic, social and political institutions have evolved in order to safeguard against opportunism – 'self-seeking with guile', as Williamson put it – by providing *ex ante* or *ex post* compensation for the uncertainty that rules will be followed."). Note that Williamson actually uses the term "self-interest seeking with guile", see Oliver E Williamson, *The Economic Institutions of Capitalism* (The Free Press 1985) 30, 47, 65. See also Werbach (n 7) 24.
[428] See Rachel Botsman, *Who Can You Trust?* (PublicAffairs; Illustrated edition 2017) 7.
[429] Botsman (n 428) 10.
[430] Leviathan is Hobbe's representation of an extremely powerful state, see Werbach (n 7) 27.
[431] Werbach (n 7) 25 et seq.
[432] Werbach (n 7) 28 et seq.

150 Satoshi Nakamoto in Bitcoin's whitepaper, remarks that the established and traditional monetary system for transactions "still suffers from the inherent weaknesses of the trust based model"[433] and makes reference to disputes for the first and only time by stating that "[c]ompletely non-reversible transactions are not really possible, since financial institutions cannot avoid mediating disputes".[434] Therefore Nakamoto proposed "an electronic payment system based on cryptographic proof instead of trust, allowing any two willing parties to transact directly with each other without the need for a trusted third party."[435]

151 The Bitcoin blockchain is thus "a system for electronic transactions without relying on trust."[436] Nick Szabo, a computer scientist who later went on to study law and invented smart contracts, refers to trusted third parties as "security holes".[437] A term is often put forth which seems to encapsulate an inherent contradiction: "trustless trust".[438] Since any node in the system could be dishonest, having to trust would constitute a flaw.[439] "Trustlessness" thus leads to a more secure, "transparent and open" system.[440]

152 James Bridle explains, "[t]he concept of trustlessness is at the heart of a vision which seeks to escape from established systems of power by making each individual sovereign to themselves, cryptographically secured, anonymous, untraceable and thus ungovernable."[441] Blockchain enables a transaction between parties who either do not know each other and/or do not trust each other without intermediaries. In a typical transactional setting, parties would only transact if they knew each other and trusted each other. If any of these two elements were not fulfilled, a transaction would not happen without involving a third party. See the table below for a visual representation.

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[433] Nakamoto, 'Bitcoin: A Peer-to-Peer Electronic Cash System' (n 52) 1.
[434] Nakamoto, 'Bitcoin: A Peer-to-Peer Electronic Cash System' (n 52) 1.
[435] Nakamoto, 'Bitcoin: A Peer-to-Peer Electronic Cash System' (n 52) 1.
[436] Nakamoto, 'Bitcoin: A Peer-to-Peer Electronic Cash System' (n 52) 8.
[437] See Nick Szabo, 'Trusted Third Parties Are Security Holes' (2001) <https://nakamotoinstitute.org/trusted-third-parties>. See also Werbach (n 7) 203 et seq.
[438] See Werbach (n 7) 28 et seq. See Bridle (n 250) xxii. See Finck (n 30) 12. See Reid Hoffman, 'The Future of the Bitcoin Ecosystem and "Trustless Trust" – Why I Invested in Blockstream' (*Linkedin*, 2014) <https://www.linkedin.com/pulse/20141117154558-1213-the-future-of-the-bitcoin-ecosystem-and-trustless-trust-why-i-invested-in-blockstream/>.
[439] See Brekke (n 320) 22.
[440] See Brekke (n 320) 22–23.
[441] Bridle (n 250) xxii.

	Place	Anonymity	Trust	p2p or Third party
Traditional	Localized	No	High	p2p
Traditional	Localized	Yes (or No)	Low	Third Party
Traditional	Delocalized	No	High	p2p
Traditional	Delocalized	Yes (or No)	Low	Third Party
Blockchain	**Localized or Delocalized**	**Yes (or No)**	**Low**	**p2p**

Table 2. Comparison of blockchain transactions and traditional transactions[442]

153 Traditionally, parties would transact with each other on a local level and since the last decades, increasingly at a "delocalized" level, meaning that distances are no longer a hindrance to contractual relationships. The table illustrates blockchain's novelty of enabling p2p transactions in an environment of low trust, irrespective of location and level of anonymity (or pseudonymity). A p2p transaction would only take place traditionally if parties were known to each other and trusted each other. If either of these elements were missing, they would need a third party to assist with the transaction, such as an escrow service, irrespective of the location (localized or delocalized). "[E]conomic institutions provide a trust layer to govern complex exchange".[443] Werbach explains that "blockchain tries to replace [trusted elements in transactions] with software code", more specifically "the counterparty, the intermediary, and the dispute resolution mechanism".[444] Werbach further notes that "dispute resolution occurs through 'smart contracts' executing predefined algorithms".[445]

154 Blockchains are sometimes referred to as a "technology of trust".[446] However, as Finck remarks, trust is not eliminated, rather the source of trust is shifted from known and established institutions to the technology itself that powers blockchains.[447] Users,

[442] Own table.
[443] Berg, Davidson and Potts (n 17) 2–3.
[444] See Werbach (n 7) 29. Footnote omitted.
[445] See Werbach (n 7) 29.
[446] See Berg, Davidson and Potts (n 17) 2. See generally, Werbach (n 7).
[447] See Finck (n 30) 12.

therefore, place their trust in the publicly available code. Nick Szabo thus posits that the system is "not trustless" as such but rather "trust minimized".[448]

155 However, more complex systems built on Ethereum, and other smart contract platforms make trust difficult. When technology and (smart contract) code itself become the source of trust, much of the power shifts to the developers of these systems. Decentralized Finance ("DeFi") is a prime example of that. DeFi projects are not regulated like traditional finance projects and bear large risks for users, seeing that there are no proper means of recourse. In general, regulation of blockchain-based systems is still lagging. Companies that identify security vulnerabilities, verify and audit smart contracts and blockchain projects are thus seeing increased demand to heighten trust overall.[449] These kinds of developments show that intermediaries cannot be eliminated entirely because when coders retain so much power that large sums of money flow through their codes and are placed in their smart contracts, users will want assurance that the code is safe, opening the gateway to intermediaries to reenter the space.

2.4.8 Blockchain Tokens

156 Blockchain or crypto tokens are used in a wide variety of blockchain projects, and their purposes can vary substantially, from being a store of value to currency (cryptocurrency),[450] for funding purposes to voting rights, among many others.[451] There is considerable confusion and a *de facto* lack of consistent terminology. While some use "crypto assets" as an umbrella term encompassing cryptocurrencies, tokens, altcoins (or alternative coins),[452] others make a distinction between cryptocurrencies (native assets of

[448] See e.g., McCormack, 'Nick Szabo on Cypherpunks, Money and Bitcoin' (n 250).

[449] See as an example Chainsecurity AG, a spin-off of ETH Zurich, which was acquired by PwC Switzerland in 2021, 'ChainSecurity-Team stösst zu PwC Schweiz –PwC Schweiz wird zum weltweit führenden Smart Contract Assurance Anbieter' (*PwC Switzerland Press Release*, 2020) <https://www.pwc.ch/de/press-room/press-releases/PwC_MM_ChainSecurity_d.pdf>. See 'Chainsecurity' <https://chainsecurity.com/>.

[450] Bitcoin being the first of its kind.

[451] See more generally and for a broad overview and classification of the various types of tokens and their use cases: Luis Oliveira et al., 'To Token or Not to Token: Tools for Understanding Blockchain Tokens' [2018] in International Conference of Information Systems (ICIS 2018), San Francisco, USA, 12 December 2018 - 16 December 2018 <https://doi.org/10.5167/uzh-157908>.

[452] Cryptocurrencies which are not Bitcoin are generally referred to as "altcoins" (alternative coins). The ECB defines cryptoassets as "a new type of asset recorded in digital form and enabled by the use of cryptography that is not and does not represent a financial claim on, or a liability of, any identifiable entity", see ECB Crypto-Assets Task Force, 'Crypto-Assets: Implications for financial stability, monetary policy, and payments and market infrastructures' [2019] ECB Occasional Paper No 223 <https://www.ecb.europa.eu/pub/pdf/scpops/ecb.op223~3ce14e986c.en.pdf>. The Commodities Futures Trading Commission ("CFTC") in the US defines cryptocurrencies such as Bitcoin, as commodities. In

a blockchain) and tokens (built on top of a blockchain that has its separate cryptocurrency) in the category of blockchain-based digital assets.[453] The Swiss Financial Market Supervisory Authority ("FINMA"), for example, classifies tokens into payment, utility, and asset tokens, with the possibility of hybrid tokens.[454]

157 Blockchain tokens represent an entirely new asset class.[455] The ecosystem in late 2020 had over 7,100 publicly traded cryptocurrencies listed on "Coinmarketcap", by mid-2021 there were almost 11,000.[456] The Ethereum main network alone lists over 300,000

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contrast, the CFTC uses the term "virtual currency", and explains that a virtual currency is a "digital representation of value that functions as a medium of exchange, a unit of account, and/or a store of value", see U.S. Commodity Futures Trading Commission, 'Bitcoin Basics' <https://www.cftc.gov/sites/default/files/idc/groups/public/%40customerprotection/documents/file/oceo_bitcoinbasics0218.pdf>. The Internal Revenue Service (IRS) treats them as property for federal tax purposes. See 'Internal Revenue Bulletin: 2014-16 - Section 4, Frequently Asked Questions, Q1, A1' <https://www.irs.gov/irb/2014-16_IRB#NOT-2014-21>.

[453] See 'Digital Assets: Cryptocurrencies vs. Tokens' (*Cryptopedia*, 2021) <https://www.gemini.com/cryptopedia/cryptocurrencies-vs-tokens-difference>. See also Adam Haeems, 'What Is a Crypto-Asset?' (*Medium,* 2018) <https://medium.com/babb/what-is-a-crypto-asset-1f0fcc517887>.

[454] FINMA was one of the first regulatory authorities worldwide to classify blockchain tokens. See 'FINMA Publishes ICO Guidelines' (*finma.ch*, 2018) <https://www.finma.ch/en/news/2018/02/20180216-mm-ico-wegleitung/>. See 'FINMA Guidelines for enquiries for enquiries regarding the regulatory framework for initial coin offerings (ICOs)' (2018) <https://www.finma.ch/en/~/media/finma/dokumente/dokumentencenter/myfinma/1bewilligung/fintech/wegleitung-ico.pdf?la=en>. As opposed to Liechtenstein, where a completely new law was created for blockchains and tokens, Swiss lawmakers opted to adapt existing legislation to the specifics of DLT. See 'Report and Application of the Government to the Parliament of the Principality of Liechtenstein Concerning the Creation of a Law on Tokens and TT Service Providers (Tokens and TT Service Provider Act; TVTG) and the Amendment of Other Laws' <https://www.naegele.law/files/Downloads/2019-07-12_BuA_TVTG_en_full_report.pdf>. See also Philipp Sandner, Thomas Nägele and Jonas Gross, 'Liechtenstein Blockchain Act: How Can Nearly Any Right and Therefore Any Asset Be Tokenized Based on the Token Container Model?' (*Medium*, 2019) <https://philippsandner.medium.com/liechtenstein-blockchain-act-how-can-nearly-any-right-and-therefore-any-asset-be-tokenized-based-389fc9f039b1>. See Ian Allison, 'Switzerland's Tokenized Securities Law Ushers In New Chapter for Digital Assets' (*Coindesk*, 2021) <https://www.coindesk.com/switzerland-tokenized-securities-law-new-chapter-seba-sygnum-six-sdx>. See also 'Federal Council Brings Part of DLT Bill into Force' (*The Federal Council - Press Release,* 2020) <https://www.sif.admin.ch/sif/en/home/dokumentation/medienmitteilungen/medienmitteilungen.msg-id-81563.html>.

[455] See, e.g., para 18 in Secretariat, 'GOVERNING COUNCIL 99th Session (A) Item No. 2 on the agenda: Matters concerning the 2020–2022 Work Programme (b) ii. Work on Artificial Intelligence, Smart Contracts and DLT' (*UNIDROIT*, 2020) <https://www.unidroit.org/english/governments/councildocuments/2020session/cd-99-a-04-e.pdf> ("Until the development of this technology, the danger of double spending had been avoided either by the tangibility of assets (tangible assets only exist in one form) or, in the case of intangible assets, the use of trusted intermediaries (such as registries and banks). Current technology enables a type of asset to exist which was not possible before: an intangible asset which could be transferred without the danger of double spending and without the use of a trusted intermediary. This special type of asset, which in this proposal is called a 'token', is part of a wider category of 'digital assets'.").

[456] See 'Today's Cryptocurrency Prices by Market Cap' <https://coinmarketcap.com/>. Use 'Internet Archive' <https://archive.org> to see snapshots of the webpage from previous years.

Ethereum tokens, reaching more than 400,000 by mid 2021.[457] Only a year before, Coinmarketcap listed approximately 3,000 cryptocurrencies[458] and Ethereum main network listed around 200,000 tokens.[459] There is thus a rapid increase of the number of crypto assets.

158 Blockchain tokens are not restricted to currency and may represent physical or digital goods, rights and services.[460] In the joint UNCITRAL/UNIDROIT workshop on smart contracts, "Professor Gullifer drew a distinction between 'endogenous tokens'[461] (which do not refer to anything existing outside the blockchain) and 'exogenous tokens'[462] (which are tokens which have a necessary connection with assets existing outside the blockchain)".[463] This is often called "tokenization",[464] or "tokenomics".[465] Tokenizing an asset has the benefit of making it more easily movable around the world as its value is represented on the blockchain (on-chain).[466]

2.4.9 Smart Contracts

159 This section gives a primer into what smart contracts are.[467] A simple way to conceptualize smart contracts is to view them as "value flow with rules attached".[468] Instead of Alice simply transferring cryptocurrencies to Bob, they agree that the value will only be transferred once Bob meets certain pre-defined criteria.[469] "Smart contracts"

[457] See 'Etherscan Token Tracker' <https://etherscan.io/tokens>. Use 'Internet Archive' <https://archive.org> to see snapshots of the webpage from previous years.
[458] See 'Internet Archive of Coinmarketcap (September 2019)' <http://web.archive.org/web/20190926225720/https://coinmarketcap.com/>.
[459] See 'Internet Archive of Etherscan Token Tracker (October 2019)' <http://web.archive.org/web/20191015224442/https://etherscan.io//tokens>.
[460] See Werbach (n 7) 86 et seq. See Finck (n 30) 16. See generally, Oliveira et al. (n 451).
[461] Representing "on-chain" assets. See para 48 in UNCITRAL (n 323).
[462] Representing "off-chain" assets. See para 48 in UNCITRAL (n 323). The UNCITRAL report notes that the experts thought it was a real issue on how to tokenize off-chain assets, stating that "the tokenization of warehouse receipts would likely be less problematic than the tokenization of real estate".
[463] 'Joint UNCITRAL/UNIDROIT Workshop 6 and 7 May 2019, Summary of the Discussion and Conclusions' <https://www.unidroit.org/english/news/2019/190506-unidroit-uncitral-workshop/conclusions-e.pdf> para 7.
[464] See Finck (n 30) 17.
[465] See Oliveira et al. (n 451) 14. See William Mougayar, 'Tokenomics — A Business Guide to Token Usage, Utility and Value' (*Medium*, 2017) <https://medium.com/@wmougayar/tokenomics-a-business-guide-to-token-usage-utility-and-value-b19242053416>.
[466] See Finck (n 30) 17–18.
[467] See *infra* Chapter 3.
[468] See Charles Hoskinson, 'A Brief Introduction to Smart Contracts' (*Youtube*, 2015) <https://www.youtube.com/watch?v=3bY66Zgr8Cs>.
[469] See Hoskinson (n 468).

are the "simplest form of decentralized automation",[470] the term is frequently used to describe computer software on a blockchain that once triggered automatically executes terms that have been specified in the code.[471] They are based on an "if"/"then" logic.[472]

160 Once the smart contract is triggered and its preconditions are met, the blockchain is updated accordingly and automatically to reflect the outcome of that transaction, *e.g.,* the transfer of digital assets. With no need for third parties to enforce the contract, the perceived benefits are cheap and speedy transactions. Smart contracts allow for "[c]omplex economic activity on a blockchain" and enable entire ecosystems with marketplaces to form around decentralized organizations and applications.[473]

2.4.10 From Decentralized Applications to Decentralized Autonomous Organizations

161 Decentralized Applications ("DApps"), Decentralized Organizations ("DOs") and Decentralized Autonomous Organizations ("DAOs") are made possible using smart contracts on blockchains, which create decentralized networks where the rules are pre-determined. They are thus expansions to the concept of smart contracts, with each having its own characteristics.

162 DApps usually have a web frontend interface, enabling interactions with smart contracts in a user-friendly way.[474] According to Buterin, in decentralized organizations, humans collaborate on the basis of a protocol enforced by code on the blockchain.[475] According to De Filippi and Wright, collaboration is possible on a p2p basis and reliance on a central authority is diminished as smart contracts steer governance in the form of distributed consensus by combining the decisions of token holders.[476]

[470] Vitalik Buterin, 'DAOs, DACs, DAs and More: An Incomplete Terminology Guide' (*Ethereum Blog*, 2014) <https://blog.ethereum.org/2014/05/06/daos-dacs-das-and-more-an-incomplete-terminology-guide/>.
[471] See Stuart D Levi, 'An Introduction to Smart Contracts and Their Potential and Inherent Limitations' <https://www.skadden.com/insights/publications/2018/05/an-introduction-to-smart-contracts>.
[472] See Finck (n 30) 25.
[473] See Berg, Davidson and Potts (n 17) 46.
[474] See Antonopoulos and Wood (n 28) 10. See also Berg, Davidson and Potts (n 17) 46.
[475] See Buterin, 'DAOs, DACs, DAs and More: An Incomplete Terminology Guide' (n 470).
[476] See De Filippi and Wright (n 5) 136–137.

163 DAOs[477] refer to a new form of programmable organization.[478] A DAO is the "blockchain equivalent of a company" and it includes a governance mechanism through smart contracts.[479] Instead of being largely human-led (as with a DO), smart contracts form the backbone of such blockchain companies.[480] It is the expression of a "complex ecosystem of autonomous agents interacting with one another according to a set of pre-determined, hard-wired, and self-enforcing rules."[481] The concept was first presented by DApp developer Daniel Larimer in 2013, followed up by an article published by Vitalik Buterin in Bitcoin Magazine.[482]

164 Blockchains and more sophisticated AI enable what might have seemed like science fiction, a company owned by no humans and running on its own.[483] It is the combination of blockchain and AI that can be truly disruptive.[484] A DAO structure, which relies on blockchains and smart contracts to organize itself and execute any logic coded into it, can have wide-ranging applications. DAOs are claimed to be "a paradigm shift in the very idea of economic organization. It offers complete transparency, total shareholder control, unprecedented flexibility and autonomous governance."[485] However, if not coded correctly, the consequences can be devastating.[486]

165 There is much legal uncertainty regarding DAOs. There are different definitions and perspectives, such as whether DAOs are autonomous, independent of legal orders or whether compliance with law is required to ensure interoperability with the "off-chain world", whether human or legal entities must run such organizations, and whether DAOs

[477] Note the difference to "The DAO", see *infra* Chapter 5.3.1.1.
[478] See De Filippi and Wright (n 5) 146 et seq.
[479] See Berg, Davidson and Potts (n 17) 46.
[480] See De Filippi and Wright (n 5) 146. See Buterin, 'DAOs, DACs, DAs and More: An Incomplete Terminology Guide' (n 470).
[481] Aaron Wright and Primavera De Filippi, 'Decentralized Blockchain Technology and the Rise of Lex Cryptographia' [2015] Ssrn 17 <https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2580664>. Footnote omitted.
[482] See Larimer called it a "Decentralized Autonomous Corporation (DAC)". See Daniel Larimer, 'Overpaying For Security' <https://letstalkbitcoin.com/is-bitcoin-overpaying-for-false-security>. See also Vitalik Buterin, 'Bootstrapping a Decentralized Autonomous Corporation: Part I' (*Bitcoin Magazine*, 2013) <https://bitcoinmagazine.com/technical/bootstrapping-a-decentralized-autonomous-corporation-part-i-1379644274>. See also Buterin, 'DAOs, DACs, DAs and More: An Incomplete Terminology Guide' (n 470).
[483] See De Filippi and Wright (n 5) 146.
[484] See De Filippi and Wright (n 5) 146 et seq. It is the combination of the two which could lead to a truly autonomous decentralized organization.
[485] Seth Bannon, 'The Tao of "The DAO" or: How the autonomous corporation is already here' (*TechCrunch*, 2016) <https://techcrunch.com/2016/05/16/the-tao-of-the-dao-or-how-the-autonomous-corporation-is-already-here/>.
[486] See *infra* Chapter 5.3.1.1.

may form a legal entity.[487] The uncertainty concerning DAOs' legal status and the fact that only a few jurisdictions recognize them does not prevent them from thriving in the crypto-economy, where users have embraced them enthusiastically, such as in the DeFi space, which has seen considerable growth especially ever since the middle of 2020.

166 Law makers worldwide are looking into DAOs and their potential legal recognition. Malta began the process of recognizing DAOs as legal personalities in 2019.[488] The US state of Vermont's Governor in 2018 reportedly signed a law that recognizes so-called "Blockchain-Based Limited Liability Companies" ("BBLLC").[489] The US state of Wyoming in April 2021 clarified the legal status of DAOs. The Wyoming Governor signed bill 38[490] to recognize DAOs as limited liability companies ("LLCs").[491]

2.4.11 Oracles

167 Oracles help to find and transmit information from real-world events, such as travel data or the price of oil, to smart contracts on blockchains.[492] Oracles can be software systems, they can also be one or several human beings.[493] De Filippi and Wright observe that an oracle can be used for private dispute resolution by delivering decisions rendered by humans to a smart contract, for example.[494] Najera explains that "[a]n oracle is not the datasource itself but the layer that interfaces with data-sources [and] the blockchain".[495]

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[487] Jentzsch lists these concerns in his "The DAO" Whitepaper, see Christoph Jentzsch, 'Decentralized Autonomous Organization To Automate Governance - Final Draft – Under Review' (2016) 1 <https://lawofthelevel.lexblogplatformthree.com/wp-content/uploads/sites/187/2017/07/WhitePaper-1.pdf>.

[488] See Adriana Hamacher, 'Giving Citizenship to Bots' (*Decrypt*, 2019) <https://decrypt.co/6981/civil-rights-for-bots>.

[489] See Stan Higgins, 'Vermont Governor Signs Bill Clearing Way for Blockchain Companies' (*Coindesk*, 2018) <https://www.coindesk.com/vermontdao-state-governor-signs-bill-clearing-way-blockchain-companies>.

[490] See 'State of Wyoming Senate File No. SF0038, Decentralized autonomous organizations' <https://www.wyoleg.gov/2021/Introduced/SF0038.pdf>.

[491] See Nate DiCamillo, 'State Lawmaker Explains Wyoming's Newly Passed DAO LLC Law' (*Coindesk*, 2021) <https://www.coindesk.com/wyoming-dao-llc-law-passed>. See also Adriana Hamacher, 'Wyoming Bill Granting Crypto DAOs Legality Nears Approval' (*Decrypt*, 2021) <https://decrypt.co/60883/wyoming-bill-granting-crypto-daos-legality-nears-approval>.

[492] See Antonopoulos and Wood (n 28) 253–254. See Chainlink, 'What Is a Blockchain Oracle? What Is the Oracle Problem? | Chainlink Engineering Tutorials' (*Youtube*, 2020) <https://www.youtube.com/watch?v=ZJfkNzyO7-U>.

[493] See Finck (n 30) 25. See also De Filippi and Wright (n 5) 75.

[494] See De Filippi and Wright (n 5) 75. ("More experimentally, an oracle can also be made to convey the insights of human beings or support private dispute resolution and private arbitration systems (sometimes referred to as judge-as-a-service or arbitration-as-a-service)." With footnote to Michael del Castillo, 'Lawyers Be DAMNed: Andreas Antonopoulos Takes Aim at Arbitration With DAO Proposal' (*coindesk*, 2016) <https://www.coindesk.com/damned-dao-andreas-antonopoulos-third-key> and Michael Abramowicz, 'Cryptocurrency-Based Law' [2016] 58 Arizona Law Review 359-420).

[495] See Jesus Najera, 'Blockchain Oracles' (*Medium*, 2018) <https://setzeus.medium.com/blockchain-oracles-af3b216bed6b>. Emphasis omitted.

168 As a pathway between the "off-chain" world and blockchains, oracles provide outside data to blockchains and can thereby significantly enhance the usefulness of smart contracts.[496] Oracles are the answer as to how smart contracts can perform based on circumstances happening in the "real world", since blockchains have no access to off-chain data.[497]

2.5 Conclusion

169 This chapter introduced some of blockchain technology's most important concepts, which make up the new field of "cryptoeconomics". A key takeaway is that the technology itself is still in development. There is, however, wide agreement on its disruptive nature for the future digital economy. Blockchains and other exponential technologies will change a lot of the technical infrastructure the world rests on, which will affect arbitration as well. Open and permissionless blockchains are the truly innovative variants among the many different types of blockchains that can exist, although the degree of decentralization is not always clear. The most prominent examples of this type of blockchain are Bitcoin and Ethereum. Blockchains are a new trust layer for economic transactions and have a unique value proposition by introducing novel concepts, such as digital value creation (scarcity), tokenization, and autonomous organizations. Legal systems worldwide are already affected by this development and international arbitration could be touched by all these aspects as well.

Chapter 2: Summary

Blockchain technology's vast potential for innovation has been widely recognized. Blockchains can be considered a "disruptive innovation". Various jurisdictions worldwide have started to enforce legislation to bring more legal certainty to the blockchain space. Trust underlies all human interactions, and the new decentralized systems shift trust in the "old" intermediaries to the technology underlying blockchains and the "new" intermediaries of the blockchain ecosystem. For the first time in human history, it is possible to transfer value between participants who do not know and do not trust each other in an online network without the need for a central authority. A

[496] See Antonopoulos and Wood (n 28) 253–254. See Finck (n 30) 25. See De Filippi and Wright (n 5) 75. See Najera (n 495).
[497] See Najera (n 495).

blockchain is a shared, replicated, immutable, and synchronized digital database secured by a consensus algorithm and replicated across a distributed network of computers (nodes). Blockchain can be considered a disruptive technology because of its unique features. The terminology as the technology itself is developing in real-time. The origin of today's blockchains is Bitcoin. The paper introducing Bitcoin to the world appeared in 2008 after the global financial meltdown in an online mailing list dedicated to Cryptography. To this date, the real-world identity of the author, Satoshi Nakamoto, is unknown. The roots of cryptocurrency can be found in the Cypherpunk movement. The invention of Bitcoin has been regarded as groundbreaking as the invention of double-entry bookkeeping. It has sparked a new field of research termed cryptoeconomics and even entirely new industries, such as DeFi.

Bitcoin also solved one of the most puzzling issues in computer science, the double-spending problem. However, the Bitcoin blockchain consumes a considerable amount of energy, more than a country like Switzerland with more than 8.5 million inhabitants. There are different types of blockchains, which can be categorized as private and permissioned, public and permissionless. The consensus mechanisms on how a blockchain is secured can vary. Bitcoin, for example, runs on the Nakamoto consensus, which is a proof of work consensus mechanism, where nodes in the network participate in a sort of lottery to find new blocks and earn new bitcoins. This lottery system incentivizes participation and enables the network's security but comes at a high cost of energy consumption.

Other blockchains besides Bitcoin have more advanced concepts, which allow for programmable code and so-called smart contracts. Ethereum is the first and prime example of a programmable blockchain and has revived the term smart contract, which Nick Szabo first coined in the 1990s. Smart contracts allow for the establishment of DAOs, organizations that are supposed to run by pre-determined algorithmic rules rather than by humans. Some jurisdictions have started to recognize DAOs as limited liability companies.

3 Chapter 3: Smart Contracts

3.1 Introduction

170 According to Yuval Harari the emergence of writing liberated stories to develop their full potential since people could more accurately share longer and more complex ideas by writing them down on paper rather than keeping them in the "limited capacity of [their] brains".[498] This applies to much more than just stories. Of all technologies, writing had perhaps the most profound impact on humanity. It allows for layers of complexity that were not possible before and allows for the transferal of information in time from generation to generation in a more precise way. Departing from Harari's view on stories, this chapter tells one about the commercial world and its fuel: Contracts. When it comes to contracts, writing is a form of evidence. In a scenario where two parties are contracting with each other, both can see the written contract and negotiate the terms. They can clarify misunderstandings because the written document is there, in black and white. In ordinary speech, errors are more prone to occur, and parties miss out on the opportunity to evidence and verbalize in written form their agreement. If anything, blockchain technology may enable a new form of communication by placing parties' agreements in an immutable ledger, for anyone to witness.

171 The Internet brought about changes so rapid that within the span of a lifetime, one could be born into a world where communication tools were expensive and difficult to access, and then grow up in a world where phones became portable, where personal computers entered homes, and where portable phones became portable supercomputers more powerful than all previous communication technologies combined, and cheaper as well, giving access to endless information in the blink of an eye. When such rapid speed disruption happens, it may be difficult to understand the profound changes that affect society and, ultimately, one's own life. Comparable to sitting in a train, traveling at high speed, one sees the outside world in an ever-changing landscape, this train of technological revolution does not stop while one sits and watches, and there never seems to be enough time to analyze the landscape. The moment one starts analyzing, the landscape has already transformed, and the train has moved on.

[498] Yuval Noah Harari, *Homo Deus - A Brief History of Tomorrow* (Vintage 2017) 186.

172 The landscape seems to have moved from a rudimentary form of writing on paper to a more digital sphere of digital code, exemplified by the figure below.

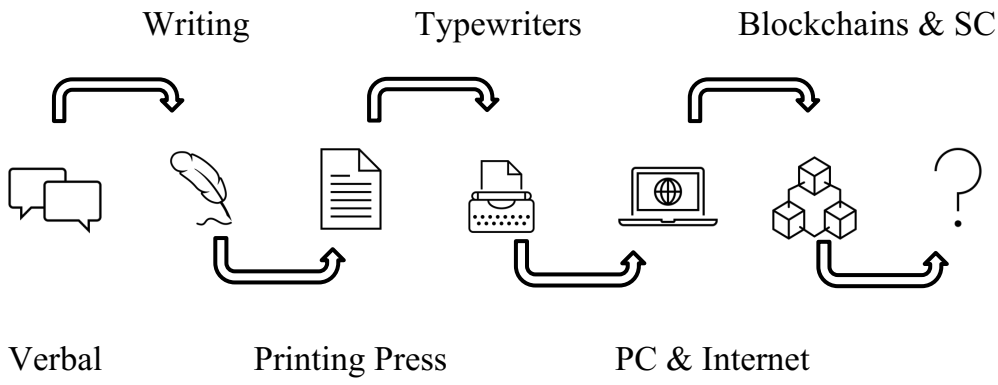

Figure 5. Evolution of information recording and transfer[499]

173 Smart contracts allow communication to be structured to enable future economic transactions based on specific parameters. Much of the legal discussion about smart contracts delves into whether it is possible to recognize smart contracts as legal contracts and under what circumstances that might be the case. What is often overlooked is that besides being mere software code, smart contracts operate on another medium that has not existed before. Just as oral communication may lead to an oral legal contract, so can written communication lead to a written legal contract. Coded contracts are the natural, technological evolution.

174 However, is that so? There seems to be much uncertainty regarding smart contracts and what they can do. Ortolani, for example, claims that "[t]he construction of scripts […] becomes a new form of contract making", referring to "the Bitcoin protocol [which according to him] allows for the creation of contracts, whose contents can be autonomously modified by writing software scripts".[500] When it comes to writing smart contracts, Bitcoin provides a much less powerful platform than does the Turing complete Ethereum blockchain. An interesting perspective is to look at blockchains as "a new evolution of contract-making, where code replaces traditional language".[501]

[499] Own figure created using Microsoft Word icons.
[500] Ortolani, 'Self-Enforcing Online Dispute Resolution: Lessons from Bitcoin' (n 104) 608.
[501] Ortolani, 'The Three Challenges of Stateless Justice' (n 104) 605.

175 Financial and business transactions are the pillars of modern society. The legal system serves as the foundation and enables the formation of contracts as a basis for trusted human interactions. A contract can be defined as an agreement to create legally enforceable obligations between parties.[502] A contract is concluded if one buys coffee in a coffee shop. If one gets sick, and the insurance covers the expenses and medical bills, there was an insurance contract. Contracts are important, and there is no denying it. Aaron Wright describes them as "the dark matter of the commercial world, they exist everywhere, they exist in almost every industry, and for most people they are completely inscrutable just like dark matter is to physicists."[503]

176 Parties enter into agreements "to work together to create and allocate value" in business transactions.[504] A variety of contracting forms are possible, and contractual agreements express human interaction. However, people can have differing interests and contracts can provide the right incentives for the contracting parties to cooperate and benefit from future gains.[505] The legal system provides the necessary basis of trust for parties to enter into deals.[506]

3.2 Smart Contracts on Blockchains

177 The term "smart contract" incites the imagination. It naturally evokes pictures of a marvelous artifact, smart in every sense, perhaps even smarter than the parties and their lawyers negotiating the contract. And who would not want their contract to be smart? Parties negotiating the terms of their agreement can simply narrate their respective wishes and positions. The contract then comes up with an ideal solution which both parties can

[502] See, e.g., Legal Dictionary provided by the Legal Information Institute (LII) of the Cornell Law School, <https://www.law.cornell.edu/wex/contract>. See also Werbach and Cornell (n 75) 338, where a contract is defined as "a promise or an agreement that is legally enforceable" (Footnote omitted). Note there are differences between common law and civil law systems. For example, the concept of consideration is important in common law, whereas in civil law countries it is not. See Caslav Pejovic, 'Pejovic C, 'Civil Law and Common Law: Two Different Paths Leading to the Same Goal' [2001] 32 Victoria University of Wellington Law Review 817, 821–822.

[503] Aaron Wright, 'Legal Infrastructure for DeFI and DAOs' (*The Future Law Virtual Summit (FLVS)*, 2020) <https://www.youtube.com/watch?v=cXO6jAyP4c4>.

[504] See Ronald Gilson and others, 'Building Foundations for a Durable Deal' (*Financial Times*, 2006) <https://on.ft.com/2p94cUs>.

[505] See The Committee for the Prize in Economic Sciences in Memory of Alfred Nobel, 'Oliver Hart and Bengt Holmström: Contract Theory', Scientific Background on the Sveriges Riksbank Prize in Economic Sciences in Memory of Alfred Nobel (2016) <https://www.nobelprize.org/uploads/2018/06/advanced-economicsciences2016.pdf> 1.

[506] See Werbach (n 7) 1, 19. See also Frankenreiter (n 256) 150, also therein Footnote 1.

agree upon, *et voilà* a smart contract or rather science fiction, *for now*. What does it mean then for a contract to be "smart"? How can anything which cannot think for itself be smart, to begin with? Or does it think for itself?

178 Nick Szabo, who in the 1990s coined this term, describes "smart contract[s as] a set of promises, specified in digital form, including protocols within which the parties perform on these promises"[507] and a "computerized transaction protocol that executes the terms of a contract".[508] Szabo wrote that "[t]he general objectives of smart contract design are to satisfy common contractual conditions (such as payment terms, liens, confidentiality, and even enforcement), […] and minimize the need for trusted intermediaries".[509] According to this explanation, the term does not seem justified.

179 That is why - so often - in many legal blockchain conferences, the opening sentence goes like this: "Smart contracts are neither smart nor are they contracts." Szabo, however, "call[s] these new contracts 'smart', because they are far more functional than their inanimate paper-based ancestors",[510] he further points out that "[n]o use of artificial intelligence is implied".[511] In Szabo's mind, smart contracts' "economic goals include lowering fraud loss, arbitration and enforcement costs, and other transaction costs".[512] Note that Szabo was targeting arbitration specifically.

180 When Szabo first conceptualized smart contracts, there was no appropriate infrastructure for their fruition.[513] This changed with the emergence of blockchain technology and especially the Ethereum blockchain in 2015.[514] According to Wright, blockchains enable "peer-to-peer contracting and peer-to-peer asset transfers in a secure way, in which we can authenticate the underlying information related to it".[515] They, therefore, provide fertile ground for smart contracts to blossom. Christian Scharr, a smart contract

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[507] Nick Szabo, 'Smart Contracts: Building Blocks for Digital Markets' (1996) <https://www.fon.hum.uva.nl/rob/Courses/InformationInSpeech/CDROM/Literature/LOTwinterschool2006/szabo.best.vwh.net/smart_contracts_2.html>.
[508] Nick Szabo, 'Smart Contracts' (1994) <https://www.fon.hum.uva.nl/rob/Courses/InformationInSpeech/CDROM/Literature/LOTwinterschool2006/szabo.best.vwh.net/smart.contracts.html>.
[509] Szabo, 'Smart Contract.' (n 508).
[510] Szabo, 'Smart Contracts: Building Blocks for Digital Markets' (n 507).
[511] Szabo, 'Smart Contracts: Building Blocks for Digital Markets' (n 507).
[512] Szabo, 'Smart Contract.' (n 508). Footnote omitted.
[513] See Frankenreiter (n 256) 152. See also Werbach and Cornell (n 75) 330.
[514] See Antonopoulos and Wood (n 28) 127.
[515] See Wright, 'Legal Infrastructure for DeFi and DAOs' (n 503).

developer, explains that "the blockchain layer makes it really interesting" and that "distributed software has been around for ages, that is nothing fundamentally new … but this blockchain layer on top with its cryptographic means and what comes along with it, makes the whole thing attractive … one says that it is so-called 'bleeding edge' technology, which means that it is still in the middle of research, in the middle of development".[516] However, this also represents a risk because it is a "technology that is not yet fully mature and has not been on the market for years",[517] meaning that under certain circumstances it may be necessary to update and change one's approach in as little as a year to adapt to the current development.[518]

181 Some legal treaties on smart contracts prefer to take a technology-neutral approach and not confine the discussion to blockchain technology.[519] This thesis purposely takes a blockchain-specific focus. A blockchain-based definition of smart contracts makes sense because it was the dawn of blockchain technology that has revived the concept of smart contracts into actual practical use cases. According to Scharr, the idea of decentralization, on the one hand, and the cryptographic security advantages of blockchains, on the other, are crucial aspects when discussing smart contracts.[520]

182 Regarding legal reflections concerning smart contracts, the discussion is centered mainly around smart contracts' legal validity, whether they can be considered legal contracts at all, and if so, under what circumstances.[521] Sometimes a distinction is made between smart contracts in their pure form and smart legal contracts, which may be considered contracts in the legal sense.[522]

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[516] Interview #12, Christian Scharr.
[517] Interview #12, Christian Scharr.
[518] Interview #12, Christian Scharr.
[519] See, e.g., Tom Braegelmann and Markus Kaulartz (eds), *Rechtshandbuch Smart Contracts* (CH Beck Vahlen 2019) 9–10. (Only available in German. Braegelmann and Kaulartz in their book on Smart Contracts define these in a technology neutral way, without always making specific reference to blockchain because this technology is not "necessarily required in order to carry out legally relevant acts using code in a digital environment". Own translation. Original: "[…] da es [einer Blockchain] nicht zwingend bedarf, um eine rechtlich wie auch immer relevante Handlung mittels Code in einer digitalen Umgebung durchzuführen.").
[520] Interview #12, Christian Scharr.
[521] See, e.g., Max Raskin, 'The Law and Legality of Smart Contracts' (2017) 1 Geo. L. Tech. Rev 305. See Alexander Savelyev, 'Contract Law 2.0: 'Smart' Contracts as the Beginning of the End of Classic Contract Law' (2017) 26 Information and Communications Technology Law 116. See Werbach and Cornell (n 75).
[522] See, *e.g.*, Alessandro Palombo and Raffaele Battaglini, 'Justice for All: Jur's *Open Layer* as a Case Study, Towards a More Open and Sustainable Approach' in Benedetta Cappiello and Gherardo Carullo (eds), *Blockchain, Law and Governance* (Springer 2021) 260, Footnote 2. ("The legal issue to be discussed is when a smart contract can be considered legally binding, in other words when a smart contract becomes a smart legal contract.").

183 Although it is possible to code smart contracts on the Bitcoin blockchain,[523] these are not as advanced due to Bitcoin's "very limited scripting language".[524] The Ethereum blockchain has made the term "smart contract" *en vogue*.[525] Smart contracts owe their success and revival to the Ethereum blockchain. This chapter, therefore, focuses on Ethereum since it is currently the most advanced smart contracts platform based on blockchain technology.

3.2.1 The Ethereum Blockchain

184 After Bitcoin's appearance in 2008, countless more blockchain networks have emerged.[526] One of them, Ethereum,[527] has quickly gained a widespread following within the Blockchain community and has seen an incredible rise in adoption and developer engagement. According to the Electric Capital Developer Report, 300 new developers are joining Ethereum as developers monthly on average,[528] and nearly 2,300 individuals are active developers on Ethereum per month on average in the third quarter of 2020.[529] In comparison, Bitcoin engages less than 400.[530] This chapter briefly introduces Ethereum, shows some of the most important differences to Bitcoin, and lays the groundwork for further discussion in Chapter 3.

3.2.2 Ethereum Basics

185 Ethereum, "the world's programmable blockchain"[531] started to take shape in November 2013 when Vitalik Buterin, a young Canadian programmer with Russian roots, shared a whitepaper of his idea.[532] Others joined Buterin's vision and together, the early Ethereum

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[523] See Camila Russo, *The Infinite Machine: How an Army of Crypto-Hackers Is Building the next Internet with Ethereum* (HarperBusiness 2020) 43. See also BTC Studios, 'Yes, Bitcoin Can Do Smart Contracts And Particl Demonstrates How' (*Bitcoin Magazine* 2017) <https://bitcoinmagazine.com/articles/yes-bitcoin-can-do-smart-contracts-and-particl-demonstrates-how>.
[524] See Antonopoulos and Wood (n 28) 2.
[525] See Braegelmann and Kaulartz (n 519) 9.
[526] Examples include Ethereum, Cardano, Stellar, EOS.IO, Solana, Tezos, amongst many.
[527] See Ethereum's official website is 'Ethereum' <https://www.ethereum.org>.
[528] See Maria Shen, 'Electric Capital Developer Report (2020)' [2020] Medium <https://medium.com/electric-capital/electric-capital-developer-report-2020-9417165c6444>.
[529] See Brady Dale, 'Ethereum Far Outpaces Bitcoin in Developer Activity in 2020: Electric Capital Report' <https://www.coindesk.com/ethereum-outpaces-bitcoin-developer-activity-2020-electric-capital-report>.
[530] See Dale (n 529).
[531] 'Ethereum 101' <https://ethereum.org/en/what-is-ethereum/>.
[532] See Russo (n 523) 57 et seq. See also Vitalik Buterin, 'A Prehistory of the Ethereum Protocol' (*Vitalik Buterin's Website*, 2017) <https://vitalik.ca/general/2017/09/14/prehistory.html>.

founders built and refined the first general-purpose blockchain.[533] Ethereum, the foundation, was then incorporated in Zug, Switzerland, and in 2015 the first block was mined.[534] "The vision […] to create an unstoppable censorship-resistant self-sustaining decentralised world computer" came into being.[535]

186 Vitalik explains that Ethereum comes from the idea of using cryptoeconomics to create decentralized networks for a wide range of applications.[536] Antonopoulos and Wood describe Ethereum as an "open source, globally decentralized computing infrastructure that executes programs called *smart contracts*. It uses a blockchain to synchronize and store the system's state changes, along with a cryptocurrency called *ether* to meter and constrain execution resource costs."[537]

187 Ethereum can be referred to as a second-generation blockchain, as it enables more programming capabilities than its predecessor, Bitcoin, since on Ethereum, developers can "build powerful decentralized applications with built-in economic functions".[538] Ethereum is an all-purpose blockchain that is programmable and distributed all over the world.[539] Ethereum's programming language is Turing complete.[540] Turing proved the impossibility of predicting whether a program will halt or not (the "halting problem").[541] Ethereum's workaround to this problem is the internal "gas" system.[542] The concept of gas helps prevent network abuse and various types of attacks.[543] Since all calculations are run over the entire network, significant time and energy consumption is required.[544] "Gas" is the price tag for using the Ethereum network.[545]

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[533] See Buterin, 'A Prehistory of the Ethereum Protocol' (n 532). See 'Decentralizing Everything with Ethereum's Vitalik Buterin | Disrupt SF 2017' (n 217).
[534] See for the series of events that led to this, Russo (n 523) 91 et seq.
[535] See Antony Lewis, 'A Gentle Introduction to Ethereum' (*Bits on Blocks - Blog*, 2016) <https://bitsonblocks.net/2016/10/02/gentle-introduction-ethereum/>. See also Antonopoulos and Wood (n 28) 1.
[536] See 'Decentralizing Everything with Ethereum's Vitalik Buterin | Disrupt SF 2017' (n 217).
[537] Antonopoulos and Wood (n 28) 1.
[538] Antonopoulos and Wood (n 28) 1. See Nathan Reiff, 'Blockchain Technology's Three Generations' (*Investopedia*, 2021), <https://www.investopedia.com/tech/blockchain-technologys-three-generations/>.
[539] See Antonopoulos and Wood (n 28) 6.
[540] See Antonopoulos and Wood (n 28) 8.
[541] See Antonopoulos and Wood (n 28) 8.
[542] See Antonopoulos and Wood (n 28) 9 et seq.
[543] See Antonopoulos and Wood (n 28) 9.
[544] See Lewis (n 535).
[545] See Antonopoulos and Wood (n 28) 105 et seq. See 'Ethereum Gas Limit Explained' (2019) <https://ethgasstation.info/blog/gas-limit/>. See also Interview #2, William George ("The metaphor that I've given to lawyers before is that Ethereum is a notary service. When I vote I get my vote notarized …

188 While bitcoins are stored in so-called *addresses* and Bitcoin uses the Unspent Transaction Output ("UTXO") Model, Ethereum uses *accounts*.[546] Two types of accounts can be distinguished: (i) Externally Owned Accounts ("EOAs"), which only store ether and enable payments, and (ii) Contract Accounts, which store ether and smart contract code.[547] Unlike an EOA, a contract account is controlled by smart contract code and has data storage.[548] However, a contract account lacks a private key.[549]

3.2.3 Smart Contracts on Ethereum

189 According to the Ethereum Foundation's developer resources, a smart contract is a software program with a state and specific functions that runs on the Ethereum blockchain and has an Ethereum address.[550] Smart contracts "are deployed on the Ethereum platform using a special *contract creation* transaction".[551] Since they do not have a private key, one can say that "smart contract accounts own themselves".[552] Once deployed on the Ethereum blockchain, a smart contract does not act autonomously, rather an EOA or another smart contract needs to trigger it.[553] A smart contract thus needs an initial trigger event to self-execute.[554]

190 Solidity[555] is the most popular scripting language in use.[556] Any smart contract written in solidity or any other high-level programming language[557] needs to be run through a

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the parties provide their contract and it goes through a scenario where it lives in the blockchain and it's then notarized by Ethereum. And if you have to go through the notary in order to use that dispute resolution service and the notary is charging you know crazy high fees, then it's just a less cost effective dispute resolution service.").

[546] See Gudgeon and others (n 84) 204.
[547] See Lewis (n 535). See Antonopoulos and Wood (n 28) 26, 127.
[548] See Antonopoulos and Wood (n 28) 26, 127.
[549] See Antonopoulos and Wood (n 28) 26, 127.
[550] See 'Introduction to Smart Contracts' (*Ethereum Official Documents*) <https://ethereum.org/en/developers/docs/smart-contracts/>.
[551] Antonopoulos and Wood (n 28) 128.
[552] Antonopoulos and Wood (n 28) 128.
[553] See Antonopoulos and Wood (n 28) 129.
[554] See Antonopoulos and Wood (n 28) 128.
[555] See for latest updates 'Solidity Project Documentation' <https://docs.soliditylang.org/en/latest/>. In Ethereum, common programming languages for writing smart contracts that then get compiled on the EVM are besides Solidity, Vyper, LLL (Lisp Like Language), and others; see Antonopoulos and Wood (n 28) 131. In Interview #13, Philip C. Hanke explained that "Solidity smart contracts live basically on the blockchain but do not have their own interface, frontend". Hanke observes that "it is good to have a website and frontend to interact with the smart contract".
[556] See Lewis (n 535). See Antonopoulos and Wood (n 28) 131.
[557] Regarding the difference between a "high-level language" and "low-level language", see Andrew Butterfield, Gerard Ekembe Ngondi and Anne Kerr, *A Dictionary of Computer Science* (Oxford University Press 2016).

compiler[558] to convert the code into bytecode in order for it to be executed.[559] Once deployed on Ethereum, smart contracts are immutable.[560] The contract will execute as is, notwithstanding any bugs, and may thus result in unimagined circumstances potentially unfavorable to the contracting parties.[561] However, there is a way to circumvent this inherent limitation by programming smart contracts to be "upgradeable".[562] Also, there is a possibility to delete a smart contract; this functionality has to be programmed into the smart contract up-front.[563] However, even if one deletes a smart contract, its history remains unchanged on the Ethereum blockchain.[564] Smart contracts are what powers the crypto economy and its many DApps.[565]

3.3 Capturing Smart Contracts

191 Vitalik Buterin describes smart contracts as a "computer program that directly controls digital assets", emphasizing the "direct control" aspect.[566] The inherently legal connotation attached to the term "contracts" and the feature "smart" seem to be missing from the definition in the Ethereum context.[567] Buterin once tweeted that he regretted adopting the term smart contract for the Ethereum blockchain.[568] However, the term remained, and although often proclaimed as missing, the legal aspect is not entirely out of the picture. Aaron Wright describes "smart contracts […] in a blockchain-based

[558] See "compiler" in Butterfield, Ngondi and Kerr (n 558).
[559] See Antonopoulos and Wood (n 28) 32. A popular Integrated Development Environment ("IDE") is called Remix and can be found here: 'Remix' <https://remix.ethereum.org>.
[560] See Antonopoulos and Wood (n 28) 129.
[561] See Berg, Davidson and Potts (n 17) 8.
[562] See Sylvain Tissier and Nick Adams, 'Upgradable Smart Contracts' (*github ethereum book*) <https://github.com/ethereumbook/ethereumbook/blob/07e5110916b2f06b0cb150e2e01545f5fa11431b/contrib/upgradability-patterns.asciidoc>. See also Mudit Gupta, 'How to Make Smart Contracts Upgradable!' (Hackernoon, 2018) <https://hackernoon.com/how-to-make-smart-contracts-upgradable-2612e771d5a2> . See also Santiago Palladino, 'The State of Smart Contract Upgrades' (2020) <https://blog.openzeppelin.com/the-state-of-smart-contract-upgrades/>. In Interview #3, Clément Lesaege explains that "you can make a smart contract which can be updated in parameters or sometimes completely replaced with upgradeable contracts".
[563] See Antonopoulos and Wood (n 28) 129.
[564] See Antonopoulos and Wood (n 28) 129.
[565] See, *e.g.*, Berg, Davidson and Potts (n 17) 9.
[566] See 'Decentralizing Everything with Ethereum's Vitalik Buterin | Disrupt SF 2017' (n 217).
[567] See Antonopoulos and Wood (n 28) 127.
[568] See Vitalik Buterin, '@VitalikButerin on Twitter 13 October 2018' (*Twitter*, 2018) <https://twitter.com/VitalikButerin/status/1051160932699770882> ("To be clear, at this point I quite regret adopting the term 'smart contracts'. I should have called them something more boring and technical, perhaps something like 'persistent scripts'.").

ecosystem [as tools to] create digital assets, […] define rights and obligations related to those assets, and […] manage an asset's movement".[569]

192 Smart contracts have a rigid set of rules,[570] and they "can only control assets which [they have] explicitly been given control of".[571] In legal discussions, smart contracts are predominantly defined as computer code that enforces rules in an "if /then" - manner.[572] In the context of legal relationships, smart contracts could be useful e.g., for automatic procedures and payments, insurance events, and evidence purposes because of blockchain's immutability.[573]

193 It is difficult to systematically categorize the different types of smart contracts since the terminology and standards applied to smart contracts keep evolving and changing. From a technical viewpoint, smart contracts have no specific legal significance and are not limited to constituting legal contracts. Smart contracts are blind to the law.[574] The many uncertainties regarding smart contracts have not kept certain states from enacting legislation. In the US, for example, several states have passed or have pending legislation to legally recognize smart contracts.[575] Arizona was the first state to pass legislation recognizing smart contracts and defining them as "an event-driven program, with state, that runs on a distributed, decentralized, shared and replicated ledger and that can take custody over and instruct transfer of assets on that ledger."[576] In New York a bill was introduced to allow smart contracts in commerce.[577] A US scholar cautioned that enacting

[569] Wright, 'Legal Infrastructure for DeFi and DAOs' (n 503).
[570] Interview #12, Christian Scharr.
[571] Interview #3, Clément Lesaege.
[572] See, *e.g.,* Finck (n 30) 25. See also Gabriel Jaccard, 'Smart Contracts and the Role of Law' [2017] Weblaw Jusletter IT 3. In Interview #12, Christian Scharr said that on a technical level there is some truth to this definition. He further asserted that smart contracts by themselves without enriching them with data are rather meager, and that there is always an input and output, and a fixed set of rules behind them. See also Interview #3, Clément Lesaege ("A smart contract can only control assets which it has explicitly been given control of."). See also Interview #14, Anonymous (DEX co-founder), ("On the blockchain, things are deterministic for the most part, and so you look at the smart contract and it says if this happens, then this will happen.").
[573] Interview #12, Christian Scharr.
[574] See Flaubert's quote: "Droit (le): On ne sait pas ce que c'est." 'Dictionnaire Des Idées Recues (1913) de Gustave Flaubert' (*Le Monde Citations avec Dico Citations*) <https://dicocitations.lemonde.fr/citations/citation-109351.php>. See also Jaccard (n 572) 7.
[575] See Christopher Adcock, 'An Update on State Smart Contract Legislation' (2020) <https://www.blockchainlegalresource.com/2020/04/an-update-on-state-smart-contract-legislation/>. See also Buchwald (n 113) 1372, Footnote 10.
[576] See 'Arizona House Bill 2417' (n 61). The law was passed in 2017.
[577] See Heather Morton, 'Blockchain 2021 Legislation' (2021) <https://www.ncsl.org/research/financial-services-and-commerce/blockchain-2021-legislation.aspx>.

laws that attempt to define technologies that lack a consistent definition in their technical ecosystems might be counter-productive.[578]

3.3.1 Smart Contracts Token Standards

194 Developers are free "to create absolutely any kind of application without restriction to specific feature types".[579] However, the need for standardization of common use cases has been recognized early on.[580] In Chapter 2 the term "blockchain token" was introduced.[581] This term becomes relevant again when discussing Ethereum Improvement Proposals ("EIPs"), which "describe standards for the Ethereum platform, including core protocol specifications, client APIs, and contract standards".[582] Ethereum Request for Comments ("ERC") standards are particularly interesting since they provide, amongst others, token standards.

195 Standards are important to ensure compatibility.[583] Token standards emerge from the Ethereum developer community, where some developers write libraries of which certain ones are then considered as standards to implement smart contracts.[584] Once a smart contract is written conforming to one of these libraries and gets deployed on Ethereum, where it gets a permanent address, it is then recognized as, for example, an ERC-20 token if it was coded as such.[585] The standardization process is outlined in detail in EIP-1.[586]

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[578] See Mike Orcutt, 'States That Are Passing Laws to Govern "Smart Contracts" Have No Idea What They're Doing' (*MIT Technology Review*, 2018) <https://www.technologyreview.com/2018/03/29/144200/states-that-are-passing-laws-to-govern-smart-contracts-have-no-idea-what-theyre-doing/>, quoting Andrew Hinkes, adjunct professor at NYU's Stern School of Business.

[579] 'Standardized Contract APIs' <https://eth.wiki/en/concepts/standardized-contract-apis>.

[580] See 'Standardized Contract APIs' (n 579).

[581] See *supra* Chapter 2.4.8.

[582] 'Ethereum Improvement Proposals (EIPs)' (*Ethereum Official Documents*) <https://eips.ethereum.org>.

[583] See 'Token Standards' <https://ethereum.org/en/developers/docs/standards/tokens/>.

[584] Thanks to Tejaswi Nadahalli (ETH Zurich, Disco) for this insight. OpenZeppelin's libraries are considered somewhat standardized, see 'OpenZeppelin Token Contracts' <https://github.com/OpenZeppelin/openzeppelin-contracts/tree/master/contracts/token>.

[585] *Ibid*. The two most common standards for smart contract development are the ERC-20 token standard and ERC-721 non fungible token standard. See Antonopoulos and Wood (n 28) 223. See Fabian Vogelsteller and Vitalik Buterin, 'EIP-20: ERC-20 Token Standard' (*Ethereum Improvement Proposals*, 2015) <https://eips.ethereum.org/EIPS/eip-20>. See William Entriken and others, 'EIP-721: ERC-721 Non-Fungible Token Standard' (*Ethereum Improvement Proposals*, 2018) <https://eips.ethereum.org/EIPS/eip-721>.

[586] See 'EIP-1: EIP Purpose and Guidelines' (*Ethereum Improvement Proposals*, 2015) <https://eips.ethereum.org/EIPS/eip-1>.

196 The following figure illustrates the concept:

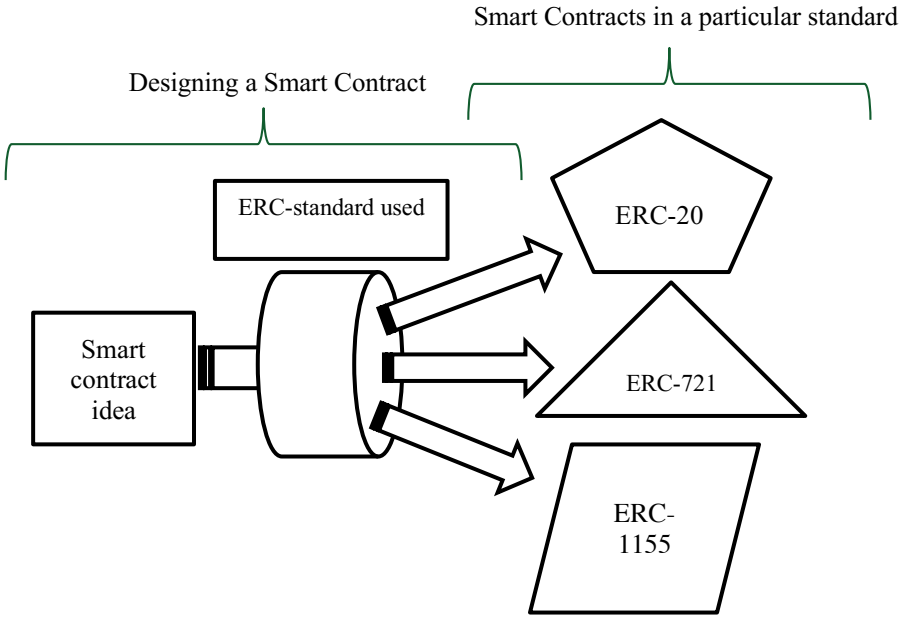

Figure 6. Standards applied in Smart Contracts[587]

197 To conceptualize this, one could imagine that the application of a particular ERC standard in a smart contract changes its "shape" in such a way that it can be easily recognized by other applications that recognize the specific shape, allowing seamless integration, exchange, and further interaction with the token.[588] Not all smart contracts are necessarily blockchain tokens, however.

3.3.2 Szabo's Vision and Smart Contract Taxonomy

198 Nick Szabo's idea of smart contracts as proposed in the 1990s involves in some sense bridging the law and technical code.[589] Szabo calls the vending machine a smart contract's "primitive ancestor".[590] His vision was that "[s]mart contracts [would] go beyond the vending machine in proposing to embed contracts in all sorts of property that is valuable and controlled by digital means".[591] One of Szabo's basic contract design objectives is "*verifiability*, the ability of a principal to prove to an arbitrator that a contract has been

[587] Own figure.
[588] Recognizing that this is a simplistic, non-technical description.
[589] See Werbach (n 7) 204 et seq. See Szabo, 'Smart Contracts: Building Blocks for Digital Markets' (n 507). See Jaccard (n 572) 3.
[590] Szabo, 'Smart Contracts: Building Blocks for Digital Markets' (n 507).
[591] Szabo, 'Smart Contracts: Building Blocks for Digital Markets' (n 507).

performed or breached, or the ability of the arbitrator to find this out by other means."[592] The predominant aim of Szabo's smart contracts is to reduce the involvement of "trusted third parties",[593] he highlights that "[i]n smart contract design we want to get the most out of intermediaries and arbitrators, while minimizing exposure to them."[594]

199 Are smart contracts legal contracts? The answer to this question may very well be that it depends, as is so often in law. Like a piece of paper on which words are written may or may not constitute a legal contract. A useful classification from a legal perspective is to distinguish between smart contracts that are legal contracts and those that are not. Any legal relevance may be exposed by removing a smart contract's inherent blindfold and exposing its legal implications. This depends on the contents and the specifications of the smart contract in question and might only be finally resolved on a case-by-case basis unless standards are created which conform to legal standards and thereby facilitate a legal analysis.[595] See the following illustration of a proposed taxonomy:

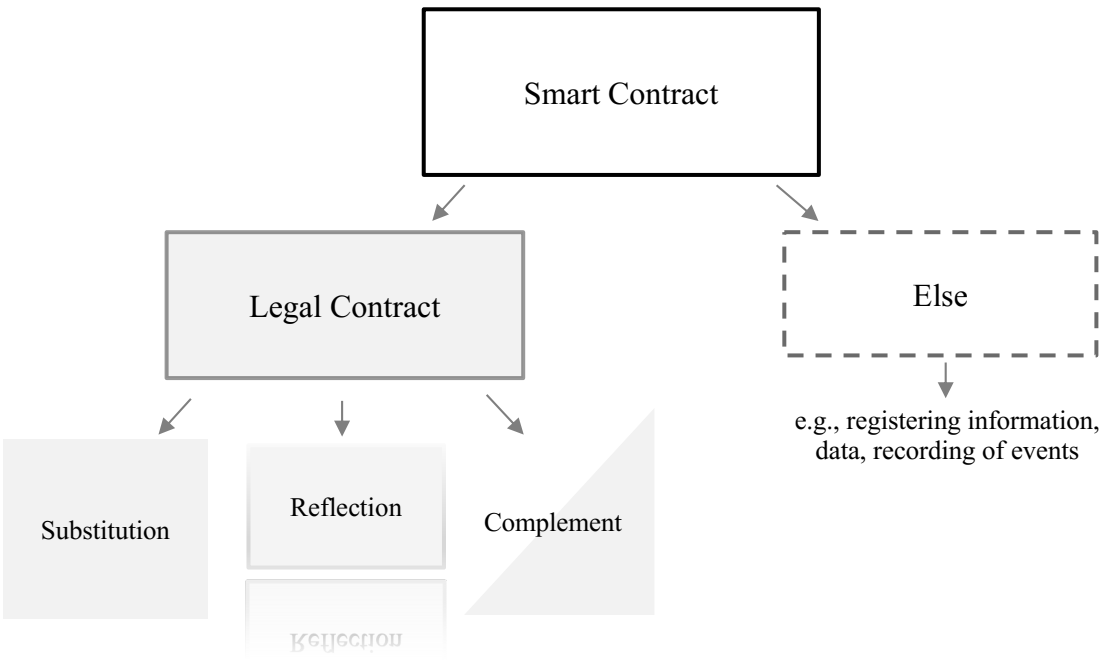

Figure 7. Taxonomy of Smart Contracts[596]

[592] Szabo, 'Smart Contracts: Building Blocks for Digital Markets' (n 507).
[593] Szabo, 'Smart Contracts: Building Blocks for Digital Markets' (n 507). See also Jaccard (n 572) 3.
[594] Szabo, 'Smart Contracts: Building Blocks for Digital Markets' (n 507).
[595] An idea would be to create ERC- type of standards and other smart contract standards that constitute from the outset, legally relevant attributions and therefore make it clear from the start that one is dealing with in fact, a legal contract or rights and/or obligations. It is, however, questionable whether this is feasible.
[596] Own figure. See other approaches at classifying smart contracts, for example, Jaccard (n 572) 13 et seq. Jaccard analyzes the legal relevance of smart contracts adopting and advocating a case-by-case approach, having special regard to data, property, legal contracts, and rights. He focuses on the "representation"

200 On the one hand, smart contracts may not have any legal effects if they only register data, or events for purely informative purposes, and Jaccard gives the example of the smart contract function "greeter", which simply says "hello".[597] Or, if they are used in games for enjoyment. However, even non-legal smart contracts may have legal effects depending on the use case. On the other hand, smart contracts may be legally binding if they contain rights and/or obligations, such as voting rights, or if they represent an asset, whether physical or digital.[598] Smart contracts may also be legal if they, in fact, constitute a legal contract, a category often referred to as "smart legal contracts".[599] In that case, a smart contract may substitute a legal contract altogether, *i.e.,* a contract the parties would have concluded off-chain. A smart contract may also complement a legal contract the parties conclude off-chain, automating certain aspects of the legal contract, such as payment by a certain date.

201 Suppose a smart contract reflects a legal contract. In that case, it acts as its twin, it is its mirror, a direct translation into bytecode of the human-readable language contract. Considerable challenges exist in such a scenario: first, in terms of the feasibility of such an undertaking, and second, in terms of the interpretation and validity in case of inconsistencies in the translation. So, there would be two "tools" that purport to reflect a contract with the same content, one readable by humans, the other readable by machines. This would fit into the notion of so-called "Ricardian contracts" first portrayed by Ian Grigg, which is generally taken to describe a smart contract that is both readable by machines and humans.[600] An interesting project relating to smart contracts is the Accord Project, which describes itself as "a non-profit, collaborative, initiative developing an ecosystem and open source tools for smart legal contracts".[601] Users can design "the

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aspect and calls smart contracts that represent legal contracts "smart legal contracts". See also Palombo and Battaglini (n 522) 260, footnote 2, where they make a distinction between "Solely Code Model", "Internal Model", and "External Model" of smart contracts, where the solely code model can be seen as a substition form as termed in this thesis, the internal and external model seem to be in line with this thesis' complement variant, and a "reflection/twin" variant is not accounted for, or may be close to the "internal model". See also Josh Stark, 'Making Sense of Blockchain Smart Contracts' (*coindesk*, 2016) <https://www.coindesk.com/making-sense-smart-contracts>. Stark distinguishes between "smart contracts as smart contract code" and "smart legal contracts".

[597] Jaccard (n 572) 13.

[598] See Jaccard (n 572) 13 et seq.

[599] See Jaccard (n 572) 15 et seq.

[600] See Grigg (n 36). See also Dmitri Koteshov, 'Smart vs. Ricardian Contracts: What's the Difference?' (*eliNext*, 2018) <https://www.elinext.com/industries/financial/trends/smart-vs-ricardian-contracts/>. In Interview #15, Monique Morrow discussed Ricardian Contracts, the interesting part being that it could incorporate legal prose, discussions were also held on the automation and disintermediation aspect.

[601] 'Accord Project - About' <https://accordproject.org/about/>.

natural language of any type of contract and integrate with smart contract logic developed for expressing and modeling legal concepts, clauses, and obligations."[602] Also, two global leaders in online legal services, LegalZoom and RocketLawyer, have reportedly started testing smart contracts.[603] If a smart contract substitutes a legal contract's natural language, there is no human-readable counterpart, and it stands by itself.

202 Based on the above, this dissertation adopts the following definition of smart contracts:

Smart contracts are computer code stored and executed on blockchains that may or may not be legally binding depending on their specific features and the intention of the parties.

203 In fact, a smart contract is code whose composition determines whether it can be regarded as a legal contract. Determining whether a smart contract constitutes a legal contract is a difficult endeavor because of the considerable differences in how smart contracts are presently understood and/or defined.[604] Contract law can also vary from jurisdiction to jurisdiction.[605] Moreover, establishing jurisdiction is not an easy task in an environment that adheres to the notion of decentralization. Aside from jurisdiction, other aspects pose difficulties, such as considering the formation of contracts and which law should be applied in determining whether a smart contract was validly concluded as a legal contract.[606] There are many more aspects to consider, such as parties that act

[602] 'Accord Project - About' (n 601).

[603] See Tim Fries, 'LegalZoom, Rocket Lawyer Test Blockchain for Smart Contract-Automated Legal Services' (*The Tokenist*, 2021) <https://tokenist.com/legalzoom-rocket-lawyer-test-blockchain-for-smart-contract-automated-legal-services/>.

[604] See Florence Guillaume, 'Aspects of private international law related to blockchain transactions' in Daniel Kraus, Thierry Obrist and Olivier Hari (eds), *Blockchains, Smart Contracts, Decentralised Autonomous Organisations and the Law* (Cheltenham/Northampton, 2019) 57 et seq.

[605] See e.g., Guillaume (n 604) 57 et seq. (Guillaume who states that the question regarding smart contracts "must be settled by each State through the exercise of its sovereignty.").

[606] Likewise, during the joint UNCITRAL/UNIDROIT Workshop on smart contracts, the discussion paper stated that "in order for a smart contract to be deemed a contract and be valid and enforceable at law, it must meet all the standard requirements for a contract in general". See 'Joint UNCITRAL/UNIDROIT Workshop 6 and 7 May 2019, Summary of the Discussion and Conclusions' (n 463) (para 20: "The panel agreed that smart contracts did not exist in a normative vacuum, and that there were many rules and general principles of contract law which equally applied to smart contracts. There were two different types of provisions found in existing international legal texts: enabling provisions (e.g. those found in the UNCITRAL Model Law on E-Commerce), and generally applicable provisions (e.g. the part on contract formation in the UNIDROIT Principles), as well as many applicable domestic laws. […] Hence, it was important to clarify how these existing rules and general principles applied to smart contracts and, where necessary, to propose updated language in existing legal texts.").

pseudonymously without ever revealing their real-world identity[607] and the implications this may have in terms of legal capacity or if one should employ an agent or representative.

204 Although there may not be a conclusive answer to these questions just yet, there is a vibrant discussion regarding the concept of smart legal contracts in various jurisdictions in legal literature. In general, the prevailing opinion is that this new phenomenon is compatible with existing contract law principles.[608] However, even if a smart contract is not deemed a legal contract, it may still self-enforce, which may pose problems, such that legal issues may ensue where previously there may have been none.[609] Parties to a smart contract may face challenges in enforcing their warranty rights, for example. The automatic enforcement of smart contracts may even bring about an illegal result. Because blockchain technology and traditional legal systems do not naturally align, it will be important for states to cooperate in determining the legality of different blockchain-based applications and crypto assets in an international effort to harmonize this new and emerging area of law.[610]

[607] To the UK Jurisdiction Taskforce of the LawtechUK Panel, 'Legal Statement on Cryptoassets & Smart Contracts' (2019) <https://technation.io/lawtech-uk-resources/#cryptoassets>. (Under English law, such contracts can be legally binding, see para 156: "We have no doubt that a smart legal contract between anonymous or pseudonymous parties is capable of giving rise to binding legal obligations. That is because there is no requirement under English law for parties to a contract to know each other's real identity.").

[608] See, *e.g.*, Lukas Müller and Reto Seiler, 'Smart Contracts Aus Sicht Des Vertragsrechts' AJP/PJA 3/2019. See also Christoph Müller, 'Die Smart Contracts Aus Sicht Des Schweizerischen Obligationenrechts' ZBJV 5/2019. See also UK Jurisdiction Taskforce of the LawtechUK Panel (n 607), according to which smart contracts are capable of forming enforceable contracts under English law.

[609] The result may be illegal or lead to unjust enrichment, for example.

[610] See UNCITRAL and UNIDROIT held joint workshops in May 2019 and March 2020. UNIDROIT established a Working Group for Digital Assets and Private Law. See also 'Study LXXXII - Digital Assets and Private Law Project' (*UNIDROIT*, 2021) <https://www.unidroit.org/work-in-progress/digital-assets-and-private-law>. See also UNCITRAL (n 323), (para 18: "It was stated that developing and harmonizing legal frameworks that facilitated the use of the wide array of emerging technologies would be most desirable and one that could be undertaken by UNCITRAL at an intergovernmental level."). See Secretariat, 'GOVERNING COUNCIL 99th Session (A) Item No. 2 on the Agenda: Matters Concerning the 2020–2022 Work Programme (b) Ii. Work on Artificial Intelligence, Smart Contracts and DLT' (n 455). (para 20: "The international nature of the markets, and, in many cases, the fact that the nodes in the distributed ledger can be anywhere in the world, mean that there is great advantage in uniformity in the basic principles of national legal structures. A harmonised approach would favour a level of certainty and predictability in markets necessary for their continued development. Such an approach would offer the benefit of *ex ante* guidance as opposed to a piecemeal approach of waiting for disputes to arise, thus forcing the judiciary to come up with *ad hoc* solutions."). See also *UNCITRAL, HCCH and UNIDROIT Legal Guide to Uniform Instruments in the Area of International Commercial Contracts, with a Focus on Sales* (2021) 2 <https://assets.hcch.net/docs/0571d8ca-8b56-41a2-8443-4fe93e306c17.pdf>.

3.4 Conclusion

205 Smart contracts were invented two decades ago but have only steadily evolved since 2015. They empower the decentralized blockchain economy of DeFi, NFTs, DAOs, and more. On the Turing complete Ethereum blockchain, developers can program anything they dream about in smart contract form. However, much legal uncertainty exists. It is too soon to tell whether smart contracts can replace written and human-readable language contracts used in commercial contracts. However, the speed with which these software codes of immutable, decentralized, and distributed ledgers have accumulated capital and talent is telling.

Chapter 3: Summary

Nick Szabo coined the term "smart contracts" in the early 1990s and its conceptualization has changed ever since. Like blockchain technology in general, smart contracts in specific are very much in development, with novel improvements constantly happening. This is evidenced by the fast-paced evolution of one of the most widely used programming languages for smart contracts, Solidity, whose version changes frequently.[611] Ethereum is the most used programmable blockchain on which smart contracts can be deployed. Smart contracts can be defined as computer code stored and executed on blockchains that may or may not be legally binding depending on their specific features and the intention of the parties. Such code can reflect, complement, or substitute a legal contract. Smart contracts may not have any legal implications if they only record data or store information. Whether a smart contract constitutes a legal contract depends on the position and requirements of the relevant jurisdiction to which such a question is addressed, and there is still much uncertainty regarding smart contracts' definition and legal implications in general.

[611] See 'Solidity Version Releases' <https://github.com/ethereum/solidity/releases>.

4 Chapter 4: International Arbitration

4.1 Introduction

206 Now that the fundamentals of blockchain technology and smart contracts have been demonstrated, this thesis turns its attention to international arbitration and outlines its legal framework. When there were no governments, no rules, no courts, no justice systems, a primitive early manifestation of a society organized itself in a most rudimentary form. Hunter-gatherers, mostly in close relationships and small groups, were scattered over vast areas. If disputes arose that could not be resolved peacefully, violence was the go-to method. With each technological revolution, the agricultural revolution, the modern revolution, groups have become more interconnected while complexity increased, necessitating robust infrastructures and better means of resolving disputes. After a brief historical voyage, this chapter explores the foundational characteristics of international arbitration, its legal framework, and contrasts arbitration to other means of resolving disputes.

4.2 A Brief History

207 Exploring the development of alternative dispute resolution is both a historical as well as a philosophical quest. In his book on political philosophy,[612] Wolff contrasts the outcome of Ballantyne's *Coral Island* story to Golding's *Lord of the Flies*.[613] In both stories the protagonists end up stranded on an island, while one has a happy ending, the other depicts the main characters "fall[ing] first into dispute, and then into desperate tribal warfare […] [in] a world without government".[614] While one society has apparently succeeded in using peaceful methods of dispute resolution, the other has failed miserably.

208 It is almost impossible to imagine life without the institutions that have become so familiar and essential for the functioning of today's modern society. Parts of the world

[612] See Jonathan Wolff, *An Introduction to Political Philosophy* (Oxford University Press 2016) 6.
[613] See William Golding, *Lord of the Flies* (The Berkley Publishing Group 1954). See R. M. Ballantyne, 'The Coral Island - A Tale of the Pacific Ocean' (*Project Gutenberg Ebook #646*, 1996) <https://www.gutenberg.org/files/646/646-h/646-h.htm>, originally published in 1884.
[614] Wolff (n 612) 6.

are at war, while other parts have successfully maintained a peaceful society within their borders and in relation to their neighboring countries.

209 A dispute symbolically stands for something that has fallen apart, and dispute resolution seeks to mend what is broken and keep the wheels of commerce turning. There are few attempts to trace the history of arbitration, though – as Derek Roebuck observes – "[n]o general history of arbitration has yet been written".[615] The precise origins of commercial arbitration are not fully known.[616] However, Julian Lew notes that "[s]ince the beginning of recorded time, arbitration has existed in some form as a dispute resolution mechanism."[617] Some early recounts can be found in the ancient mythology of disputes between the Greek gods.[618] There are also some records from early civilizations in, *e.g.* China and Egypt, as well as evidence from about 3,000 BC in Mesopotamia.[619] Merchants who traveled to different fairs used arbitration to resolve commercial disputes, which can be traced back to "the desert caravans in Marco Polo's time" and between traders of distant towns.[620]

210 It may be an impossible undertaking to trace the history of arbitration with its possibly different paths in evolution from one place and culture to the other,[621] with some commentators claiming "[t]he story is now lost forever"[622] as "[p]rivate dispute resolution has always been resolutely private".[623] Arbitral procedure's earliest manifestation was bound to be rather informal.[624] What seems clear is that arbitration was born out of

[615] Derek Roebuck, 'Sources for the History of Arbitration: A Bibliographical Introduction' (1998) 14 Arbitration International 239, 250.
[616] See Earl S Wolaver, 'The Historical Background of Commercial Arbitration' [1934] University of Pennsylvania Law Review 132 ("The origin of arbitration is lost in obscurity. At what time or place man first decided to submit to his chief or to his friends for a decision and a settlement with his adversary, instead of resorting to violence and self-help, or to the public legal machinery available, is not known; and any inquiry of this sort would belong more properly in the history of social growth and ethics than in either law or economics.").
[617] Julian D.M. Lew QC, 'Achieving the Dream: Autonomous Arbitration' (2006) 22 Arbitration International 179, 180. Footnote omitted.
[618] Gary Born, *International Commercial Arbitration (Third Edition)* (Kluwer Law International 2021) 8.
[619] See Roebuck (n 158) 51. See especially Footnote 2, which makes reference to Lafont (n 163).
[620] See Frank D Emerson, 'History of Arbitration Practice and Law' (1970) 19 Cleveland State Law Review 155, 156.
[621] See Michael Palmer and Simon Roberts, *Dispute Processes: ADR and the Primary Forms of Decision-Making (Law in Context), Kindle Edition* (Cambridge University Press 2020) 192 (In Chapter 8, "Government and Dispute Institutions").
[622] See Michael John Mustill, 'Arbitration: History and Background' (1989) 6 Journal of International Arbitration 43.
[623] Mustill (n 622) 43.
[624] See Blackaby and others (n 70) para 1.13. See also Roebuck (n 158) 14.

necessity and the human condition.[625] Though it may have looked quite different in earlier times, its essence has prevailed. Instead of resorting to self-help or violence, a third party in the form of a neutral, an elder, or a friend is asked to make a binding decision on a dispute between two members of the tribe – at first local and now global – if they cannot reach an agreement.

211 The process is straightforward, more formalized today but its simplicity reigns supreme: Parties in dispute present their dispute to a neutral decision-maker, the "arbitrator", whom they trust and whose ruling they are prepared to comply with.[626] When the first cities emerged, societies became more sophisticated, and commerce started to flourish. Arbitration, able to adapt to the changing circumstances, put on clothes of a new sort of fabric and became a "system of justice, born of merchants".[627] Nappert explains that modern commercial arbitration found its beginnings in commerce, where parties sought a neutral arbitrator who was an industry expert and could therefore render a viable decision fast.[628]

212 Some regard this as hardly surprising, much more surprising is how "such a simple system of resolving disputes has come to be accepted worldwide […] as the established method of resolving disputes in which millions, or even hundreds of millions, of dollars are at stake."[629] That may not be that surprising after all, if arbitration was there likely before any sort of coercive state powers emerged, it must have been the most readily and naturally available tool in the arsenal of peaceful dispute resolution methods. The fact that it is such a simple system is perhaps its most powerful feature.[630]

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[625] See, e.g., Gerard Vanderhaar, professor of peace studies who is quoted as follows: "The story of the human race is characterized by efforts to get along much more than by violent disputes, although it's the latter that makes the history books. Violence is actually exceptional. The human race has survived because of cooperation, not aggression." See Gerard Vanderhaar, 'Quote' in 'History Quotes' <http://www.emilyfund.org/doonething/quotes/history-quotes.htm>.

[626] See Blackaby and others (n 70) para 1.04 et seq.

[627] Blackaby and others (n 70) para 1.15, with further reference, in footnote 11 authors attribute citation to Serge Lazareff, 'L'arbitre singe ou comment assassiner l'arbitrage' in Gerald Aksen et al. (ed), *Global reflections on international law, commerce and dispute resolution: liber amicorum in honour of Robert Briner* (ICC Pub 2005) 478.

[628] See Sophie Nappert, 'Kleros Online Conference - Law & The Future of Arbitration' (*Youtube*, 2020) <https://www.youtube.com/watch?v=TouqkZz_L-Y>.

[629] Blackaby and others (n 70) para 1.05.

[630] This includes its less formalized procedure and adaptability to the needs of the parties. In contrast, the issue of "judicalization" of arbitration, the tendency of arbitration procedures to become more formalized, such that they start to resemble litigation before state courts more and more, is debated and raises concern. See, e.g., Gaillard (n 153) Footnote 108. See also Emmanuel Gaillard and John Savage (eds), *Fouchard, Gaillard, Goldman on International Commercial Arbitration* (Kluwer Law International 1999) para 53.

213 The boundaries between arbitration and litigation are often blurred in the written history.[631] Generally, parties in arbitration enjoy more flexibility, informal procedures, and the freedom to choose suitable arbitrators. Today arbitration is often defined as one of many forms of alternative dispute resolution ("ADR"), meaning that it is an alternative to national courts, as parties to an arbitration agreement specifically exclude the jurisdiction of national courts to resolve disputes between them.[632] At a time when there were no states, no governments, no formal institutions, no legal systems, and no courts, there is nothing to contrast arbitration to besides violence and other forms of brutal enforcement of one's position.

214 Today's modern international commercial arbitration started to evolve in the 1920s.[633] Prior to that, arbitration was mostly national and reflected the values of the society in which it was conducted, which accounts for the differences in domestic arbitrations in different parts of the world.[634] The number of international arbitrations has grown significantly since the 1950s.[635] Before and into the 20th Century, international commerce and arbitration were less relevant and less international.[636]

215 Important milestones for international commercial arbitration were the establishment of the Court of Arbitration of the International Chamber of Commerce in 1923, the Geneva Protocol on Arbitration Clauses of 1923, and the Geneva Convention on the Execution of Foreign Arbitral Awards of 1927.[637] The development over the last century happened gradually, and the international legal frameworks provided the basis of modern arbitration.[638] Catherine Rogers explains that "international commercial arbitration was not the mature, intricate mechanism we find today"[639] and "[e]xpectations about what international arbitration could accomplish were much lower".[640] In the early days, the

[631] See Roebuck (n 615) 242. See Mustill (n 622) 43.
[632] See Blackaby and others (n 70) para 1.137. See also Lew, 'Achieving the Dream: Autonomous Arbitration' (n 617) 181.
[633] See Catherine Rogers, *Ethics in International Arbitration* (Oxford University Press 2014) para 1.12.
[634] See United Nations Conference on Trade and Development (UNCTAD), 'Dispute Settlement International Commercial Arbitration (5.1 Course)' (2005) 19 <https://unctad.org/system/files/official-document/edmmisc232add38_en.pdf>.
[635] See Jan Paulsson, 'Arbitration in Three Dimensions' [2010] LSE Law, Society and Economy Working Papers 2/2010, 9 et seq. <http://ssrn.com/abstract=1536093>.
[636] See Paulsson, 'Arbitration in Three Dimensions' (n 635) 9.
[637] See Rogers (n 633) para 1.13.
[638] See Rogers (n 633) para 1.13. See also UNCTAD (n 634) 19.
[639] Rogers (n 633) para 1.13.
[640] Rogers (n 633) para 1.14.

setup was very flexible, and more reliance was placed on the parties voluntarily complying with arbitral awards.[641]

216 The turning point for arbitration came in the 1950s with the entry into force of the New York Convention.[642] The seeds of a powerful system were planted at that moment, equipping international arbitration with wings to take flight. In 1959, the convention had entered into force in ten contracting states. Sixty years later, that number had grown to 168 states, spanning the entire globe. Paulsson, speaking before an audience, explained the power of this convention in the following terms: "any single person in this room, without holding a judicial office, without having any legal training, simply by virtue of being appointed sole arbitrator, could render an award which has greater international effect than decisions of nine unanimous Justices of the U.S. Supreme Court. Court judgments simply do not travel as well internationally as arbitral awards do."[643] Internationalization continued to advance with the UNCITRAL Arbitration Rules in 1976 and the UNCITRAL Model Law in 1985. With almost no travel restrictions, the way was paved for arbitration to become truly international.[644]

217 Rogers observes that several major trends have accompanied this growth and made arbitration the international powerhouse it is today, the first trend being "diversification", starting out as a mostly "European affair".[645] Americans have been much more involved in the international scene of arbitration since the 1980s and brought their "uniquely adversarial American style of advocacy".[646] Aside a more global participation of attorneys from the Americas and soon thereafter from other parts of the world, in the 1970s and 1980s arbitration started to become more institutionalized, with the emergence of arbitral institutions, even in the most exotic of places.[647] The other major trends, included more formalization, transparency, and competition.[648] By the late 1990s, Yves Dezalay and Bryant Garth report that "[i]t is true that, as we have seen, international

[641] See Rogers (n 633) para 1.19.
[642] See Paulsson, 'Arbitration in Three Dimensions' (n 635) 9–10.
[643] Jan Paulsson, 'Moral Hazard in International Dispute Resolution' (2010) 25 ICSID Review - Foreign Investment Law Journal 340.
[644] See School of International Arbitration- Queen Mary University of London, 'International Arbitration Study: Corporate Attitudes and Practices' (2006) <http://www.arbitration.qmul.ac.uk/research/2006/>. The study shows that a large majority of companies surveyed, *i.e.,* 73% preferred to use arbitration for cross border disputes.
[645] Rogers (n 633) paras 1.28-1.29.
[646] Rogers (n 633) para 1.29.
[647] See Rogers (n 633) para 1.32.
[648] See Rogers (n 633) para 1.35 et seq.

commercial arbitration is now flourishing; it is the accepted method for resolving transnational commercial disputes […] the field of international commercial arbitration continues to gain new territories and to bring new converts into this multi- and transnational legal profession; and the internationalizing process in turn transforms the landscapes of national business dispute resolution."[649] They attribute this success to different factors, among them "the cold war and the interventionism of the welfare state and of third worldism" as arbitration "permitted business conflicts to be handled at a distance from cold-war politics and state interventionism".[650]

218 Today arbitration is characterized as a private form of justice, which relies on the agreement of the parties.[651] Although there is not much involvement from courts of law and the state,[652] arbitration is not left to its own devices.[653] This is reflected in the fact that arbitral procedures must be compatible with *ordre public*[654] and observe the parties' fundamental procedural rights.[655] In addition, some disputes cannot be resolved by arbitration (arbitrability) and are reserved for states.[656]

219 Often the institutions and systems in place today are taken for granted.[657] However, they have gone through major transformations themselves. When entering the digital economies based on blockchain technology, one finds oneself in a new land with no governments, no legal system, no courts, just code, and more code. May one find arbitration there again?

[649] Yves Dezalay and Bryant G Garth, *Dealing in Virtue* (The University of Chicago Press 1996) 311. See also Palmer and Roberts (n 621) 217 (In Chapter 9, "Arbitration – International").
[650] Dezalay and Garth (n 649) 311.
[651] See Blackaby and others (n 70) para 1.04 et seq.
[652] See for a portrayal of some of the tensions in this relationship, see Lew, 'Achieving the Dream: Autonomous Arbitration' (n 617) 181.
[653] See Blackaby and others (n 70) paras 1.14-1.15. National court intervention is limited, such as when an arbitral award is to be enforced, set aside, or refused recognition and enforcement. Other instances include what Lew calls "anti-arbitration injunctions", see Lew, 'Achieving the Dream: Autonomous Arbitration' (n 617) 180.
[654] See Palmer and Roberts (n 621) 214 (In Chapter 9, "Introduction").
[655] These include the right to be heard and equal treatment, which is in line with the arbitral procedure having to observe public policy. See Palmer and Roberts (n 621) 214. See *infra* Chapter 6.5.1.
[656] See Gaillard and Savage (n 630) para 532 et seq.
[657] See Wolff (n 612) 6.

4.3 Capturing Arbitration

220 What is meant by the term "arbitration"? Born highlights that "there are almost as many […] definitions of international arbitration as there are commentators on the subject".[658] The definition adopted here is the following:

> *Arbitration is a private, contractual, and consensual form of binding dispute resolution involving a third-party decision-maker.*[659]

221 Arbitration is thus a voluntary process based entirely on and taking its legitimacy from an agreement between the parties whereby they choose to arbitrate.[660] Party autonomy forms one of the cornerstones of arbitration. By way of an arbitration agreement, courts cannot decide the parties' dispute, as power is bestowed on the arbitrator, whose decision will be final and binding.[661] This means that parties are required to comply with the arbitrators' decision, which otherwise can be enforced against the will of the losing party.[662] By choosing to arbitrate, parties agree not to litigate.[663]

222 Arbitration is thus seen as a form of alternative dispute resolution in the sense that it falls outside of state courts' formal legal procedures, constituting an alternative to litigation.[664] However, arbitration exercises the same function as the judicial process as both the arbitrator and the judge decide on a dispute in a binding fashion.[665] The efficacy of this system is guaranteed by a multifaceted web of international and national laws.[666]

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[658] See Born, *International Commercial Arbitration (Third Edition)* (n 618) 67.
[659] See Gary Born, *International Arbitration: Law and Practice* (Kluwer Law International 2012) 4. See also Marco Stacher, *Einführung in Die Internationale Schiedsgerichtsbarkeit der Schweiz* (Dike 2015) para 10, making reference, among others, to DSFT of 21 November 2003, 130 III 66 reason 3.1.
[660] This is true for contractual-based arbitration, there are also treaty-based arbitrations which will be discussed briefly *infra* under Chapter 4.3.2.3 See also Daniel Girsberger and Nathalie Voser, *International Arbitration: Comparative and Swiss Perspectives* (Nomos Schulthess 2016) para 1 et seq.
[661] See Blackaby and others (n 70) paras 1.04, 1.41. See Girsberger and Voser (n 660) para 4.
[662] See Blackaby and others (n 70) para 1.04. See Born, *International Arbitration: Law and Practice* (n 659) 5.
[663] See Blackaby and others (n 70) para 1.41. See Girsberger and Voser (n 660) para 4. The principle that state courts have no jurisdiction to hear disputes for which an arbitration agreement has been concluded can be found in, for example, Art. II (3) New York Convention, Art. 8 UNCITRAL Model Law, and Art. 7 Swiss Private International Law Act ("Swiss PILA").
[664] See Blackaby and others (n 70) para 1.137.
[665] See Stacher (n 659) paras 1, 2, 11. See Blackaby and others (n 70) para 1.137.
[666] See Blackaby and others (n 70) paras 1.08-1.09.

4.3.1 Contrasting Arbitration to Other Forms of Alternative Dispute Resolution (ADR) and Online Dispute Resolution (ODR)

223 Alternative Dispute Resolution (ADR)[667] refers to either binding or non-binding dispute resolution procedures, which may or may not form part of the formal state judiciary system.[668] It is most widely regarded as an alternative to formal state courts procedures.[669] A range of forms fall under ADR, from negotiation, conciliation, mediation to hybrid procedures, such as med-arb, arb-med and others, incorporating and combining different elements of different processes forming either binding or non-binding decisions.[670]

4.3.1.1 *Alternative Dispute Resolution (ADR)*

224 Arbitration stands out in the ADR realm because of its preferred and widespread use in commercial transactions.[671] What differentiates arbitration from other forms of alternative dispute resolution is its adjudicatory nature.[672] However, it has been suggested that "both arbitration and litigation are […] tools to produce settlements".[673] In mediation, the mediator assists in the negotiations and creates a helpful setting to enable a settlement or amicable agreement.[674]

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[667] In a later chapter, when discussing the nature of arbitration and whether there is an arbitral legal order, one may think of Autonomous Dispute Resolution ("ADR"). However, this would lead to confusion and the term is not used in its abbreviated form. ADR is commonly used to refer to alternative dispute resolution, without any reference to the legal nature of the dispute resolution model in use.

[668] See C Menkel-Meadow, 'Mediation, Arbitration, and Alternative Dispute Resolution (ADR)', *International encyclopedia of the social & behavioral sciences* (Elsevier 2001) 9507.

[669] See Blackaby and others (n 70) para 1.137. See Girsberger and Voser (n 660) para 30 et seq.

[670] See Menkel-Meadow (n 668) 9507. Especially in long-term agreements, the dispute resolution clause will often provide for an attempt to negotiate or mediate a settlement before going to arbitration; see Blackaby and others (n 70) para 1.135 et seq.

[671] See Horst Eidenmüller and Faidon Varesis, 'What Is an Arbitration? Artificial Intelligence and the Vanishing Human Arbitrator' (*SSRN Electronic Journal*, 2020) 3 <https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3629145>. In contrast to most common scholarly assertions, however, the widespread use of arbitration has been questioned in an empirical study, which focuses on the US, see Julian Nyarko, 'We'll See You In… Court! The Lack of Arbitration Clauses in International Commercial Contracts' (2019) 58 International Review of Law and Economics 6, 19 <https://doi.org/10.1016/j.irle.2018.12.004> ("[T]his study shows, the reality is that the impact of arbitration on the commercial environment is often overstated. Neither for domestic nor for international contracts, the rate at which arbitration clauses are included is particularly high").

[672] See Tony Cole and Pietro Ortolani, *Understanding International Arbitration* (Routledge 2020) 3.

[673] Roebuck (n 158) x. See also Richard A. Posner, *Economic Analysis of Law* (Wolters Kluwer 2014) 779.

[674] See Girsberger and Voser (n 660) para 36 et seq. See Cole and Ortolani (n 672) 3.

225 Just like arbitration, mediation[675] and conciliation involve a third party.[676] However, unlike an arbitrator, rather than making a decision, the mediator or conciliator helps to facilitate a settlement.[677] Such proceedings where the parties are assisted by a third person to settle their dispute are non-binding, and may be referred to as conciliation, mediation, and other similar terms.[678]

226 According to Menkel-Meadow, one may distinguish between primary and hybrid processes.[679] The following figure gives an overview:

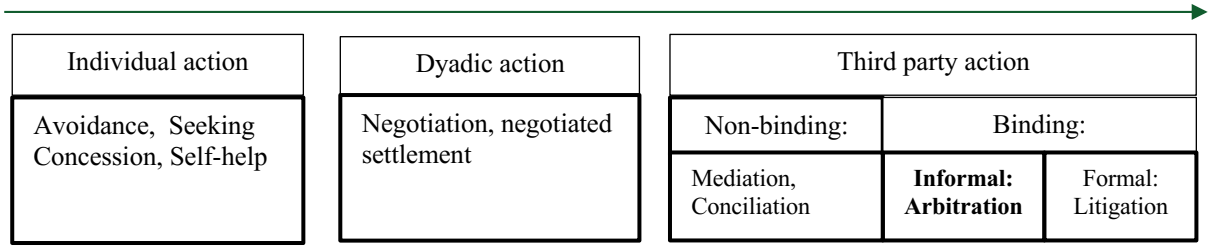

Figure 8. Dispute resolution spectrum from individual to third party action including the types of processes[680]

227 In this escalation spectrum pictured above, a party in a dispute may either do nothing or take individual action, such as resort to self-help. In the next stage the parties may enter negotiation procedures to come to terms in their own capacities. When parties cannot resolve their dispute amicably, they involve a third party to either help them find a settlement or – if things have escalated to a point where parties cannot find a resolution even with the help of a third party – render a binding decision in an informal process, such as arbitration or appointed by the state in a more formal process, such as litigation.

[675] See the United Nations Convention on International Settlement Agreements Resulting from Mediation 2019 (Singapore Convention), which is a new milestone as it enables the free circulation of international settlement agreements much the same way that the New York Convention enabled the circulation of arbitration agreements and the enforcement of arbitral awards.
[676] See Cole and Ortolani (n 672) 3. The two terms "mediation" and "conciliation" are often used interchangeably; see Girsberger and Voser (n 660) para 35.
[677] See Cole and Ortolani (n 672) 3. See Girsberger and Voser (n 660) para 36 et seq.
[678] See Born, *International Arbitration: Law and Practice* (n 659) 7.
[679] See Menkel-Meadow (n 668) 9507–9508.
[680] Own figure, inspired by Roebuck (n 158) 17 and by Menkel-Meadow (n 668) 9507–9508.

4.3.1.2 *Online Dispute Resolution (ODR)*

228 Society is changing fast due to ever-increasing ease of mobility, the use of powerful and ubiquitous technologies, wireless Internet, mobile and smart devices, and social networks, all of which has an impact on dispute resolution.[681] Often, a distinction seems to be made between the online world and the "real world". The validity of this distinction is brought to question as time passes since lines that divide the online world and the offline (or real) world are beginning to disappear.[682] The merger of the online with the offline world has become especially evident since at least the COVID-19 pandemic has started. Much of modern face-to-face interaction was shifted almost exclusively online. It is safe to say that humans in modern societies today live in at least a dual reality. Also, virtual reality worlds are becoming increasingly more realistic, and blockchains have enabled users to "own" land in the digital sphere.[683] In addition, the year 2020, fueled by the COVID-19 pandemic, saw a sharp increase in global retail e-commerce sales, which is only projected to increase further.[684] The assumption is that the increase of global e-commerce transactions will also lead to more disputes.

229 Online Dispute Resolution ("ODR") can be defined as "the use of information and communications technology to help disputants find resolution to their disputes".[685] Similarly, the UNCITRAL Technical Notes define ODR as a "mechanism for resolving disputes through the use of electronic communications and other information and communication technology".[686] It can be regarded as ADR conducted online and enhanced by Information and Communication Technology ("ICT").[687]

230 ODR only appeared more than twenty years after the invention of the Internet because disputes only happened sporadically and were mostly resolved informally in the early

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[681] See e.g., Colin Rule, 'Session 1 - The Evolution of ODR' (*Youtube*, 2020) <https://www.youtube.com/watch?v=IFAg6lZEz7o>.
[682] See Rule (n 681).
[683] See, e.g., 'Decentraland' <https://decentraland.org/>. See 'Cryptovoxels' <https://www.cryptovoxels.com/>.
[684] See eMarketer, 'Retail E-Commerce Sales Worldwide from 2014 to 2024' (*Statista*, 2020) <https://www.statista.com/statistics/379046/worldwide-retail-e-commerce-sales>.
[685] Rule (n 681).
[686] Article 24 of the 'UNCITRAL Technical Notes on Online Dispute Resolution' (2017) <https://uncitral.un.org/sites/uncitral.un.org/files/media-documents/uncitral/en/v1700382_english_technical_notes_on_odr.pdf>.
[687] See 'ICT' <https://techterms.com/definition/ict> ("ICT refers to technologies that provide access to information through telecommunications [which] includes the Internet, wireless networks, cell phones, and other communication mediums.").

days of the Internet.[688] In fact, the Internet itself was not widespread and only very few had access to this network, mostly academics and state authorities, such as the military.[689] All the services taken for granted today, such as search engines, social media, online shopping platforms, did not yet exist.[690] The turning point came in 1991 with the invention of the World Wide Web, after which commercial use ensued.[691] In 1993 there were 7,500 registered domain names, by 1998 there were more than 2 million.[692]

231 The Internet reduced the perceived distance between parties, enabling commercial activity that would not have otherwise occurred. Parties located in different parts of the world were suddenly able to buy and sell from each other. Naturally, courts were not suited to handle international, mostly low-value consumer disputes that were increasing in number.[693] Colin Rule, a pioneer in the ODR space, who led the development of eBay's Dispute Resolution Center, explains that the legal system does not work for the Internet because of issues associated with jurisdiction, the parties' expectations when transacting online and the low value of disputes, which make going to court prohibitive.[694] Rabinovich-Einy, a leading ODR scholar, says that "[t]he introduction of technology may prove to be the single most dramatic transformation of our dispute resolution landscape."[695]

232 In ODR literature, technology is often regarded as the "fourth party", a metaphor widely used,[696] where alongside the disputants (parties one and two), and the third-party neutral, a fourth party joins the scene.[697] The fourth party was still nascent in the last twenty years, accompanying and aiding the third party.[698] Now, the third party cannot imagine life without the fourth party. Soon, maybe not too far in the future, the fourth party, matured and visibly more competent, will have outgrown its human counterpart, thank it for all

[688] See Wing and others (n 131) 50.
[689] See Wing and others (n 131) 50. See National Science Foundation (NSF), 'A Brief History of NSF and the Internet' (2003) <https://www.nsf.gov/news/news_summ.jsp?cntn_id=103050>.
[690] See Wing and others (n 131) 50.
[691] See National Science Foundation (NSF) (n 689). See also Wing and others (n 131) 50.
[692] See National Science Foundation (NSF) (n 689).
[693] See Wing and others (n 131) 51.
[694] See Rule (n 681).
[695] See Orna Rabinovich-Einy, 'The Past, Present and Future of Online Dispute Resolution at UCL Laws' (*Youtube*, 2021) <https://www.youtube.com/watch?v=ae9HFcdca-Q>.
[696] See Wing and others (n 131) 51. First introduced by Ethan Katsh and Janet Rifkin in Ethan Katsh and Janet Rifkin, *Online Dispute Resolution: Resolving Conflicts in Cyberspace* (John Wiley & Sons 2001) 93. Ethan Katsh is often referred to as the "father of ODR".
[697] See Wing and others (n 131) 51.
[698] Similar to a child going through development stages, becoming a teenager and finally an adult.

its services and resume its place as the new third party.[699] What may have seemed like science-fiction has become a real possibility with the advancement of artificial intelligence, machine learning, and deep neural networks.[700]

233 At eBay and PayPal, the fourth party has already become the third-party neutral in most cases due to a streamlined, automatic system that can handle more than 60 million disputes a year, of which 90% are handled without any human intervention.[701] Ultimately, the possibility to redress creates trust in these online environments.[702] Moreover, eBay's resolution center shows how dispute resolution in the context of new online systems could look like, where traditional redress mechanisms are not fit for purpose.[703] While in the early days of ODR it seemed that the industry would simply move traditional face-to-face ADR online, the reality shows the emergence of entirely novel procedures tailored to the parties' needs.[704]

234 ODR can take many forms and combine traditional dispute resolution methods in novel ways.[705] Taking the figure from the previous chapter, ODR can thus be found underlying almost the whole spectrum:[706]

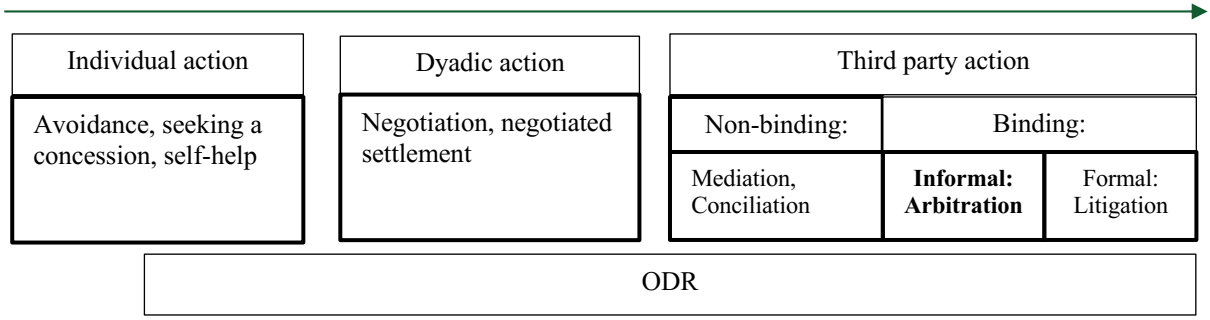

Figure 9. ODR underlying and permeating the dispute resolution spectrum from individual to third party action, including the types of processes[707]

[699] See Wing and others (n 131) 52–53.
[700] See Wing and others (n 131) 52–53. ("The real question is not where the fourth party is today but where it is going. The fourth party is becoming more capable all the time. As computer processors become more powerful and user experience designs more intuitive, the fourth party expands what it is able to provide.")
[701] See Rule (n 681).
[702] See Rabinovich-Einy (n 695).
[703] See Rabinovich-Einy (n 695).
[704] See Rabinovich-Einy (n 695).
[705] See, e.g., 'UNCITRAL Technical Notes on Online Dispute Resolution' (n 686) (Part of Article 2: "ODR encompasses a broad range of approaches and forms (including but not limited to ombudsmen, complaints boards, negotiation, conciliation, mediation, facilitated settlement, arbitration and others), and the potential for hybrid processes comprising both online and offline elements.").
[706] See Besides avoidance and self-help for reasons intrinsic in these modes of action.
[707] See Own figure, inspired by Roebuck (n 158) 17 and also by Menkel-Meadow (n 668) 9507–9508.

235 The Internet Corporation for Assigned Names and Numbers ("ICANN") is another famous example of an efficient ODR mechanism, which deals exclusively with disputes relating to domain names, for which special rules come into play, called the Uniform Domain Name Dispute Resolution Policy ("UDRP").[708] Aside from integrated ODR centers in e-commerce websites and domain-related procedures, the European Union ("EU") also provides an ODR platform under Regulation No. 524/2013,[709] a link to which traders in the EU, Iceland, Liechtenstein, and Norway must provide to any online shoppers.[710] Another framework adopted by the EU is the Directive 2013/11/EU[711] on alternative dispute resolution for consumer disputes. After setting up a working group to address online cross-border transactions in 2010, UNCITRAL adopted the Technical Notes on Online Dispute Resolution as practical non-binding guidelines, incorporating best practice standards.[712] However, with that release, UNCITRAL did not realize its original ambitions of creating a global ODR system.[713] Rule explains that one of the reasons why UNCITRAL failed in its endeavor was that the EU launched its own ODR regulation.[714] In 2018, the European Committee on Legal Co-operation published a technical study, which led to the drafting and adoption of Guidelines on online dispute resolution mechanisms in civil and administrative court proceedings in June 2021.[715]

236 Mass adoption has failed to materialize despite efforts on the EU and international levels until the COVID-19 pandemic started. During the pandemic, courts and arbitral tribunals,

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[708] See 'Uniform Domain-Name Dispute-Resolution Policy (UDRP)' <https://www.icann.org/resources/pages/help/dndr/udrp-en>. See also Ortolani, 'Self-Enforcing Online Dispute Resolution: Lessons from Bitcoin' (n 104) 603.

[709] See 'Regulation (EU) No 524/2013 of the European Parliament and of the Council of 21 May 2013 on Online Dispute Resolution for Consumer Disputes and Amending Regulation (EC) No 2006/2004 and Directive 2009/22/ EC (Regulation on Consumer ODR)' <https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=celex:32013R0524>.

[710] See 'Why the ODR Platform Matters for Traders' <https://ec.europa.eu/consumers/odr/main/?event=main.trader.register>. See also Ortolani, 'Self-Enforcing Online Dispute Resolution: Lessons from Bitcoin' (n 104) 597.

[711] See 'Directive 2013/11/EU of the European Parliament and of the Council of 21 May 2013 on Alternative Dispute Resolution for Consumer Disputes and Amending Regulation (EC) No 2006/2004 and Directive 2009/22/ EC (Directive on Consumer ADR)' <https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX%3A32013L0011>. See also Ortolani, 'Self-Enforcing Online Dispute Resolution: Lessons from Bitcoin' (n 104) 597.

[712] See 'UNCITRAL Online Dispute Resolution' <https://uncitral.un.org/en/texts/onlinedispute>.

[713] See Nadine Lederer, 'The UNCITRAL Technical Notes on Online Dispute Resolution – Paper Tiger or Game Changer?' (*Kluwer Arbitration Blog*, 2018) <http://arbitrationblog.kluwerarbitration.com/2018/01/11/new-found-emphasis-institutional-arbitration-india/>.

[714] See EOS Detroit, 'Second Community Call with Colin Rule' (*Youtube*, 2018) <https://www.youtube.com/watch?v=MBGe7i0z00s>.

[715] See 'Online Dispute Resolution Mechanisms' (European Committee on Legal Co-operation, CDCJ) <https://www.coe.int/en/web/cdcj/online-dispute-resolution-mechanisms>.

previously hesitant to such change, had to integrate videoconferencing and electronic filing to a greater extent into their standard procedures. The CRT British Columbia was one of the pioneers. In 2016, it had already introduced and made ODR mandatory under the law.[716] There are examples of ODR adoption at other courts as well.[717] Since 2020 international commercial arbitration may have come closer to ODR than ever before.

4.3.2 Types of Arbitration

237 There are different types of contemporary arbitrations that one may distinguish. An arbitration may either be international or domestic, *ad hoc*, or institutional, contract or treaty-based.

4.3.2.1 ***International and Domestic Arbitration***

238 A broad distinction can be drawn between international and domestic or national arbitration. Different criteria may apply to distinguish between the two. Arbitration may be international based on characteristics of the parties (nationalities, domicile, or place of business) or the type of the dispute.[718] The Model Law clarifies that it applies to "international commercial arbitration", and many states recognize the difference between national and international arbitrations, including Switzerland, Singapore, and France, which have adopted a separate legal regime for international arbitrations.[719] Some states, however, make no distinction.[720]

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[716] See Rabinovich-Einy (n 695).
[717] See Rabinovich-Einy (n 695).
[718] See Blackaby and others (n 70) para 1.19. See Girsberger and Voser (n 660) para 115 et seq.
[719] See Art. 1(1) of the UNCITRAL Model Law on International Commercial Arbitration (1985), with amendments as adopted in 2006. See Singapore: International Arbitration Act – which already in its name clarifies the distinction to the Arbitration Act for domestic arbitrations – see 'International Arbitration Act' <https://sso.agc.gov.sg/Act/IAA1994>. See Swiss Federal Act on Private International Law (PILA) <https://www.fedlex.admin.ch/eli/cc/1988/1776_1776_1776/en> , Chapter 12 "International Arbitration" – see Art 176(1) whose revisions entered into force in January 2021 – it now clarifies the scope of its application to disputes where at least one party to the arbitration agreement did not have its domicile, habitual residence or seat in Switzerland at the time of conclusion of the arbitration agreement. For a short overview regarding the revisions, see Sebastiano Nessi, 'New Law Maintains Switzerland at the Forefront of International Arbitration' (*Kluwer Arbitration Blog*, 2020) <http://arbitrationblog.kluwerarbitration.com/2020/08/22/new-law-maintains-switzerland-at-the-forefront-of-international-arbitration/>. In France the French Code of Civil Procedure is divided into a section dealing with domestic arbitration (Articles 1442 to 1503) and international arbitrations (Articles 1504 to 1527).
[720] A state which has not made a distinction between national and international arbitration although it adopts the UNCITRAL Model Law is, e.g., Austria, see Austrian Code of Civil Procedure, Sections 577-618.

239 While the Swiss Private International Law Act ("Swiss PILA") focuses on the parties to a dispute to distinguish between an international and a national arbitration,[721] the French Code of Civil Procedure relies on the international nature of the dispute and considers it international if "it implicates international commercial interests".[722] The Model Law follows a combined approach of a series of alternative criteria, either the parties' place of business is in different states, or different from the arbitral seat, the contractual relationship has some connection to a different place, or the parties have expressly agreed that the subject matter of their agreement relates to more than one country.[723] This highlights the Model Law's relatively liberal approach to party autonomy by giving the parties an ultimate choice to elevate their potentially domestic arbitration to an international one by simply declaring it so.[724]

4.3.2.2 *Ad Hoc Arbitration and Institutional Arbitration*

240 In an *ad hoc* arbitration, parties do not refer to an arbitral institution, whereas in an institutional arbitration, they do.[725] Party autonomy is expressed to a greater extent in an *ad hoc* arbitration, where no institution supervises the parties' arbitration, instead the parties hold the procedure in their own hands.[726] There are procedural rules for *ad hoc* arbitrations that parties may rely on rather than draft their own set of rules.[727] Advantages may include a speedier process, greater adaptability, confidentiality, and flexibility.[728] This comes at a potentially higher risk of procedural standstill if parties cannot agree on the arbitrators or in cases where there is a challenge to an arbitrator.[729] If parties cannot find agreement on an appointing authority to designate an arbitrator, in the last instance,

[721] See Art 176(1) PILA, in its revised form.
[722] See Art. 1504 of the French Code of Civil Procedure: "An arbitration is international if it implicates international commercial interests." See Girsberger and Voser (n 660) para 121.
[723] See Art. 1(3) of the UNCITRAL Model Law on International Commercial Arbitration (1985), with amendments as adopted in 2006.
[724] For a critical view, see Gaillard and Savage (n 630) para 103. ("[I]t is not clear why the fact that the place of arbitration is located abroad-a choice made exclusively by the parties-should suffice to render the arbitration international."). See also Girsberger and Voser (n 660) para 124.
[725] See Born, *International Arbitration: Law and Practice* (n 659) 27. See Girsberger and Voser (n 660) para 66 et seq.
[726] See a critique on the "judicialization" of arbitration and institutional arbitration, which has made it rarer for parties to choose their arbitrators and design their own procedures, in Gaillard and Savage (n 630) para 53.
[727] See 'UNCITRAL Arbitration Rules 2013' <https://uncitral.un.org/sites/uncitral.un.org/files/media-documents/uncitral/en/uncitral-arbitration-rules-2013-e.pdf>.
[728] See Born, *International Arbitration: Law and Practice* (n 659) 28. See Blackaby and others (n 70) para 1.143.
[729] See Born, *International Arbitration: Law and Practice* (n 659) 28. However, parties in *ad hoc* arbitrations may select an appointing authority, and the national courts may aid in circumventing such standstills.

a national court, according to national arbitration legislation, may appoint the arbitrators for the parties.[730]

241 Institutions specializing in the resolution of international commercial arbitrations have a long tradition in Europe, in places such as London (the London Court of International Arbitration "LCIA"), Paris (the International Chamber of Commerce, "ICC"), and Geneva or Zurich (the Swiss Arbitration Centre),[731] also in the United States, in New York (American Arbitration Association "AAA" and its International Centre for Dispute Resolution "ICDR"), for example. There is now an increasing number of new institutions entering this competitive market, both regionally and globally.[732] This is a trend that has already been observed in the late 20th century and continues to this date.[733] Arbitral institutions have seen a steady rise worldwide, with new centers opening in Asia, and established ones in these regions gaining increasingly more importance, such as in Singapore (Singapore International Arbitral Centre "SIAC") and China (China International Economic and Trade Arbitration Commission, "CIETAC"), but also in Latin and South America as well as in Africa.[734]

242 Parties may favor the organized nature of institutional arbitration, including all the services these institutions provide.[735] In institutional arbitration, arbitral procedures follow the rules of an arbitral institution and take place under that institution's supervision.[736] The institution normally does not function as an arbitrator; therefore, it

[730] See Born, *International Arbitration: Law and Practice* (n 659) 28.
[731] Formerly known as Swiss Chambers' Arbitration Institution, "SCAI". See 'Swiss Arbitration Centre' <https://www.swissarbitration.org/centre/>.
[732] See Stéphanie Papazoglou, 'The Battle for Survival Among Arbitral Institutions' (*Kluwer Arbitration Blog*, 2020) <http://arbitrationblog.kluwerarbitration.com/2020/06/19/the-battle-for-survival-among-arbitral-institutions/>.
[733] See, e.g., Gaillard and Savage (n 630) para 53.
[734] See, e.g., Mohamed Abdel Raouf, 'Emergence of New Arbitral Centres in Asia and Africa: Competition, Cooperation and Contribution to the Rule of Law' in Stavros Brekoulakis, Julian DM Lew and Loukas Mistelis (eds), *The Evolution and Future of International Arbitration* (Kluwer Law International 2016) 321 et seq.
[735] See Born, *International Arbitration: Law and Practice* (n 659) 28, where Born writes that "most users prefer the more predictable character of institutional arbitration". The statistics of the yearly increasing caseload at arbitral institutions signifies a growing popularity, however, since *ad hoc* arbitrations are more confidential, there is some uncertainty. A growing number in institutional arbitration, may signify a growing number of *ad hoc* arbitrations as well, whose exact numbers lie in the dark. However, it is likely that some of the big global arbitration practices have a good grasp on the balance between *ad hoc* and institutional arbitrations taking place. Because such practices are likely to receive both *ad hoc* and institutional counsel and arbitrator appointments, they would be in a better position to report on what they can observe in terms of market trends.
[736] See Blackaby and others (n 70) para 1.146. See Born, *International Arbitration: Law and Practice* (n 659) 27. See Girsberger and Voser (n 660) para 92.

does not decide on the substance of the dispute.[737] Institutions rather offer an all-round service with specialized and trained employees.[738]

243 The institution's arbitral rules typically specify the framework and main features for the arbitral procedure, from commencing the arbitration with a request for arbitration, the constitution and appointment of the arbitral tribunal, resolving challenges to arbitrators, the conduct of hearings, to rendering awards and stipulating costs.[739]

4.3.2.3 *Contractual and Treaty-Based Arbitration*

244 The foundation of an arbitration is the parties' consent to arbitrate, their arbitration agreement. This can be manifest in the parties' contract as an arbitration clause before a dispute arises or in a submission agreement after a dispute has manifested itself.[740] This is true for contract-based arbitration, which may involve either private parties or a state (entity) when having entered into a contract with a private party.[741] Through contractual arbitration, parties can contract out of the state court system by including an arbitration clause in their agreement. The state thereby delegates its judiciary function to the private sphere. It is not obvious that the state would simply transfer and give up such powers all that easily. There are, of course, limitations in place, and the national jurisdictions remain oversight over the arbitral process.

245 Treaty-based arbitrations are most frequently investor-state arbitrations, where a treaty is entered into between states, and international law governs the dispute between an investor and a state.[742] However, there are also contract-based investment arbitrations where an investor and a state have entered an investment contract containing a dispute resolution clause.[743]

246 According to Brabandere there may even be "multiple levels of legal obligations [that] may result in a 'procedural overlap' [where] the foreign investor will very often have

[737] See Born, *International Arbitration: Law and Practice* (n 659) 27.
[738] See Born, *International Arbitration: Law and Practice* (n 659) 27. See Girsberger and Voser (n 660) para 93.
[739] See this basic framework followed, e.g., by the ICC 2021 Arbitration Rules.
[740] See Blackaby and others (n 70) para 2.02. See Born, *International Arbitration: Law and Practice* (n 659) 34.
[741] See Blackaby and others (n 70) para 1.182. See Born, *International Arbitration: Law and Practice* (n 659) 417.
[742] See Girsberger and Voser (n 660) para 1788.
[743] See Girsberger and Voser (n 660) para 1788.

different available dispute settlement fora in the contract and the BIT [Bilateral Investment Treaty ("BIT")]".[744] However, most investment arbitrations under the ICSID Convention[745] are treaty-based, jurisdiction thus directly stems from the investment treaty.[746] The state's consent to arbitrate can be derived from the investment protection as guaranteed by the treaty once the investor fulfills certain requirements.[747] However, the tribunal's jurisdiction is challenged in almost every investment case.[748]

247 Investment treaty arbitration has a distinct public international law foundation, which a foreign investor can directly access.[749] Besides bilateral, there are also multilateral investment treaties, such as the U.S.-Mexico-Canada Agreement ("USMCA")[750] and the Energy Charter Treaty ("ECT").[751]

4.3.3 International Sources of Arbitration

248 There are no unanimously accepted rules of procedure in international arbitration.[752] Two texts that emerged under the auspices of the United Nations have considerably shaped and influenced international arbitration law: the Convention on the Recognition and Enforcement of Foreign Arbitral Awards of 1958 ("New York Convention"), and the UNCITRAL Model Law on International Commercial Arbitration of 1985 with amendments as adopted in 2006 ("Model Law"). These form the basis of the international

[744] See Eric De Brabandere, *Investment Treaty Arbitration as Public International Law: Procedural Aspects and Implications* (Cambridge University Press 2014) 31. Footnote omitted. As of beginning of 2021, almost 3000 bilateral investment treaties exist worldwide, with almost 2300 in force. See 'UNCTAD Investment Policy Hub, International Investment Agreements Navigator' <https://investmentpolicy.unctad.org/international-investment-agreements>.

[745] See Convention on the Settlement of Investment Disputes between States and Nationals of Other States (ICSID Convention) is a treaty that has been ratified by 155 Contracting States and entered into force in 1966. See 'ICSID Convention' <https://icsid.worldbank.org/resources/rules-and-regulations/convention/overview>. See also 'Arbitration under ICSID' <https://icsid.worldbank.org/services/arbitration>.

[746] See Eric De Brabandere (n 744) 31.

[747] See, generally, M Sornarajah, *The International Law on Foreign Investment* (Cambridge University Press 2010) 306 et seq. See M Sornarajah, 'Summary Chapter 8: Treaty-Based Investment Arbitration: Jurisdictional Issues' <https://www.cambridge.org/core/books/international-law-on-foreign-investment/treatybased-investment-arbitration-jurisdictional-issues/EA1B5E25090DBC3FA12FE133510F0D89>.

[748] See Sornarajah, *The International Law on Foreign Investment* (n 747) 306 et seq. See Sornarajah, 'Summary Chapter 8: Treaty-Based Investment Arbitration: Jurisdictional Issues' (n 747).

[749] See Eric De Brabandere (n 744) 17 et seq., 31.

[750] Formerly the North American Free Trade Agreement ("NAFTA").

[751] Available at 'Energy Charter Treaty' <https://www.energycharter.org/process/energy-charter-treaty-1994/energy-charter-treaty/>.

[752] See Blackaby and others (n 70) para 6.19.

legal structure of international arbitration and will therefore be outlined briefly. Other elements may include international arbitration rules, soft laws, and the practice of arbitrators and counsel.[753]

4.3.3.1 *The New York Convention*

249 The New York Convention is an international convention whose signatories are obligated to recognize and enforce arbitral agreements and foreign arbitral awards.[754] It replaced the Geneva Protocol on Arbitration Clauses in Commercial Matters ("Geneva Protocol 1923") and the Convention on the Execution of Foreign Arbitral Awards, signed in Geneva on 26 September 1927 ("Geneva Convention 1927") for states that are parties to both conventions.[755] Although the title of the New York Convention focuses solely on arbitral awards, arbitration agreements also form part of the convention.[756] Article II on the enforcement of arbitration agreements made it into the text rather unexpectedly and at basically the last possible moment.[757]

250 Initiated by the newly-founded International Chamber of Commerce ("ICC") with support from the League of Nations, the Geneva Protocol 1923 was the first truly international convention.[758] It was an important milestone in developing international arbitration's legal framework globally and enabled the widespread use of arbitration to

[753] See Blackaby and others (n 70) para 6.19.

[754] For a comprehensive guide on all provisions, including case law and more, see 'New York Convention 1958 Guide (UNCITRAL, Shearman & Sterling, Columbia Law School)' <https://newyorkconvention1958.org/?opac_view=-1>.

[755] See Blackaby and others (n 70) para 11.40. See Art. VII(2) of the New York Convention: "The Geneva Protocol on Arbitration Clauses of 1923 and the Geneva Convention on the Execution of Foreign Arbitral Awards of 1927 shall cease to have effect between Contracting States on their becoming bound and to the extent that they become bound, by this Convention."

[756] See Blackaby and others (n 70) para 1.212. See also 'UNCITRAL Secretariat Guide on the Convention on the Recognition and Enforcement of Foreign Arbitral Awards (New York, 1958)' (2016) 39 <https://uncitral.un.org/sites/uncitral.un.org/files/media-documents/uncitral/en/2016_guide_on_the_convention.pdf>.

[757] See Marike Paulsson, *The 1958 New York Convention in Action* (Kluwer Law International 2016) 7. See also 'UNCITRAL Secretariat Guide on the Convention on the Recognition and Enforcement of Foreign Arbitral Awards (New York, 1958)' (2016) 39 <https://uncitral.un.org/sites/uncitral.un.org/files/media-documents/uncitral/en/2016_guide_on_the_convention.pdf>. See Born, *International Commercial Arbitration (Third Edition)* (n 618) 100.

[758] See Blackaby and others (n 70) paras 1.207-1.208.

resolve international commercial disputes.[759] The Geneva Protocol 1923's principles remain the foundation of today's international arbitration framework.[760]

251 The Geneva Protocol 1923 required Contracting States to enforce only awards made in their own territory.[761] The Geneva Convention 1927 developed further and required recognition and enforcement of awards, regardless of whether they were issued in the territory of the enforcing state or in the territory of one of the contracting states.[762] The Geneva Convention 1927 thus liberated awards from an individual state's national law.[763]

252 However, the double exequatur requirement was still an impediment to the ease of enforcing arbitral awards internationally. This dual control mechanism required the winning party to show that the arbitral award had become final at the seat of arbitration.[764] The winning party needed to seek a declaration of enforceability of the award from the seat court first, and only then was it able to seek enforcement of the award from the courts at other places.[765] This notion of double exequatur heavily relied on the territorial approach or localized representation of arbitration.[766]

253 The New York Convention abolished the Geneva Convention's double exequatur requirement and upgraded the international arbitration framework.[767] It entered into force in 1959 and presently counts 168 signatory states.[768] The United Nations' Economic and

[759] See Gary Born, *International Arbitration: Cases and Materials* (Wolters Kluwer 2015) 31.
[760] See Born, *International Arbitration: Cases and Materials* (n 759) 31. Among other principles, Born gives the example of national courts having to refer parties to arbitration.
[761] See Art. III of the 1923 Geneva Protocol: "Each Contracting State undertakes to ensure the execution by its authorities and in accordance with the provisions of its national laws of arbitral awards made in its own territory under the preceding articles."
[762] See Blackaby and others (n 70) para 1.210.
[763] See Born, *International Arbitration: Cases and Materials* (n 759) 32.
[764] Art. 1(d) Geneva Convention of 1927: "[…] To obtain such recognition or enforcement, it shall, further, be necessary: […] That the award has become final in the country in which it has been made, in the sense that it will not be considered as such if it is open to opposition, appel or pourvoi en cassation (in the countries where such forms of procedure exist) or if it is proved that any proceedings for the purpose of contesting the validity of the award are pending". See Born, *International Arbitration: Cases and Materials* (n 759) 32.
[765] See Blackaby and others (n 70) para 1.210.
[766] For more on the territorial approach in arbitration, see *infra* Chapter 7.2.4.
[767] See Born, *International Arbitration: Cases and Materials* (n 759) 36.
[768] For the updated list of signatory states, see 'Authoritative Information on the Status of the New York Convention' <https://uncitral.un.org/en/texts/arbitration/conventions/foreign_arbitral_awards/status2>. The latest addition being Belize.

Social Council ("ECOSOC") received the ICC's first draft of the Convention in 1953,[769] and subsequently formed a committee in 1954,[770] which produced a second draft.[771] These drafts formed the basis for the United Nations Conference on Commercial Arbitration in New York in 1958.[772] The focus lay on the recognition and enforcement of arbitral awards.[773] Only later at the conference was the Dutch delegation's suggestion to include international arbitration agreements adopted.[774]

254 The Convention ensures the effectiveness of arbitration by providing a structure under which arbitral agreements are recognized and arbitral awards enforced.[775] Its overarching goals are to create a consistent and uniform global arbitral framework and encourage international commerce by enhancing trust in international commercial contracts through functioning dispute resolution processes.[776] The New York Convention is unique in many ways.[777] Usually, treaties and conventions are sources in the realm of public international law, signed and invoked by states.[778] However, the New York Convention has effects in the private sphere and parties can benefit regardless of their nationality.[779]

[769] See Born, *International Commercial Arbitration (Third Edition)* (n 618) 99. See 'Enforcement of International Arbitral Awards, Report and Preliminary Draft Convention Adopted by the Committee on International Commercial Arbitration at Its Meeting of 13 March 1953' (*reprinted ICC International Court of Arbitration Bulletin Vol. 9/ No. 1 – May 1998*) <https://www.newyorkconvention.org/11165/web/files/document/1/5/15940.pdf>.

[770] See 'Resolution 520(VII) - Resolution of the Economic and Social Council Establishing the Committee on the Enforcement of International Arbitral Awards' <https://www.newyorkconvention.org/11165/web/files/document/1/5/15941.pdf>. See also Born, *International Commercial Arbitration (Third Edition)* (n 618) 99.

[771] See Gaillard and Savage (n 630) para 247.

[772] See Born, *International Arbitration: Cases and Materials* (n 759) 34. See Born, *International Commercial Arbitration (Third Edition)* (n 618) 100.

[773] See Born, *International Commercial Arbitration (Third Edition)* (n 618) 100. See Paulsson, *The 1958 New York Convention in Action* (n 757) 7 et seq. See UNCITRAL Secretariat Guide (n 757) 39.

[774] See Born, *International Commercial Arbitration (Third Edition)* (n 618) 100. See Paulsson, *The 1958 New York Convention in Action* (n 757) 7. See UNCITRAL Secretariat Guide (n 757) 39.

[775] See Paulsson, *The 1958 New York Convention in Action* (n 757) 1.

[776] See Born, *International Arbitration: Cases and Materials* (n 759) 35. See Paulsson, *The 1958 New York Convention in Action* (n 757) 1. See also Kofi Annan, 'Opening Address Commemorating the Successful Conclusion of the 1958 United Nations Conference on International Commercial Arbitration', *Enforcing arbitration awards under the New York Convention : experience and prospects* (United Nations Publication 1999) 2 ("[T]he New York Convention […] has inspired confidence in the rule of law. And it has helped ensure fair treatment when disputes arise over contractual rights and obligations. As you know, international trade thrives on the rule of law: without it parties are often reluctant to enter into cross-border commercial transactions or make international investments. For all these reasons, the Convention is one of the most successful treaties in the area of commercial law").

[777] See Paulsson, *The 1958 New York Convention in Action* (n 757) xxi.

[778] See Paulsson, *The 1958 New York Convention in Action* (n 757) xxi.

[779] See Paulsson, *The 1958 New York Convention in Action* (n 757) xxi.

255 Most contracting states adopt the New York Convention through their national legislative processes.[780] The Convention's general text allows for applicability in many different states.[781] The contracting states' national courts are tasked to interpret the Convention, which means that a harmonized interpretation of the Convention and the achievement of the overarching goal of the Convention depends on them.[782] Divergencies in interpretation between courts of different states, however, exist. The US courts, for example, have developed the view that the New York Convention makes a distinction between "primary" (*i.e.*, seat of the arbitration) and "secondary" (*i.e.*, place of enforcement) national jurisdictions.[783]

256 Overall, the New York Convention is seen as the foundation of international arbitration and the main reason why international arbitration has been so successful in the last half-century.[784]

4.3.3.2 ***The Model Law***

257 The United Nations Commission on International Trade Law ("UNCITRAL") was established in 1966 by the General Assembly to promote the harmonization and modernization of international trade law.[785] It produced the Model Law on International Commercial Arbitration ("Model Law"), a procedural instrument adopted in 1985 and amended in 2006.[786] It has been adopted by many states with only limited deviations from the text, suggesting widespread acceptance.[787]

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[780] See Born, *International Arbitration: Cases and Materials* (n 759) 38.
[781] See Born, *International Arbitration: Cases and Materials* (n 759) 39.
[782] See Born, *International Arbitration: Cases and Materials* (n 759) 38.
[783] See Paulsson, *The 1958 New York Convention in Action* (n 757) xxiv.
[784] See Blackaby and others (n 70) paras 1.211, 11.40. See Born, *International Arbitration: Cases and Materials* (n 759) 35.
[785] See UNCITRAL, 'A Guide to UNCITRAL: Basic Facts about the United Nations Commission on International Trade Law' (2013) 1 <https://uncitral.un.org/sites/uncitral.un.org/files/media-documents/uncitral/en/12-57491-guide-to-uncitral-e.pdf>.
[786] See 'UNCITRAL Model Law on International Commercial Arbitration (1985), with Amendments as Adopted in 2006' <https://uncitral.un.org/en/texts/arbitration/modellaw/commercial_arbitration>. The modifications in 2006 included the form of arbitration agreements, leaving two options. See also Giuditta Cordero-Moss and Diego P Fernández Arroyo, 'Private International Law and International Commercial Arbitration – A Dialogue about the Usefulness and Awareness of the Former for the Latter' in Verónica Ruiz Abou-Nigm and María Blanca Noodt Taquela (eds), *Diversity and Integration in Private International Law* (Oxford University Press 2019) 320.
[787] See UNCITRAL (n 785) 15. See Blackaby and others (n 70) para 1.219.

258 After the New York Convention in 1958 and the UNCITRAL Arbitration Rules of 1976, the "UNCITRAL Model Law constitutes the third major contribution of the United Nations to the development of a fair and efficient process of resolving disputes in international commercial transactions".[788] These three texts together form the basis and framework for international arbitrations.[789]

259 The Model Law's origins can be traced back to a proposal by the Asian-African Legal Consultative Committee ("AALCC") to improve arbitration, including suggestions to reform the New York Convention.[790] The Model Law, which covers all stages of the arbitration process, from the arbitration agreement to the recognition and enforcement of arbitral awards, was finally adopted by UNCITRAL in Vienna in 1985.[791]

260 UNCITRAL prepared a Model Law rather than a convention for practical reasons.[792] Whereas a convention would have been a lengthy, rigid, and costly process, "a model law is available to guide State legislators as soon as its text is approved by the Commission".[793] A model law can more easily be adopted by a state in its national legal system as it sees fit, while a convention takes much longer because the procedure is more rigid and finding agreement on the exact wording of the text can be difficult.[794] The Model Law is another success story. Legislation based on the Model Law has been adopted in 85 states.[795] Commentators state that "the New York Convention put international arbitration on the world stage, [and] the Model Law […] made it a star".[796]

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[788] Carl-August Fleischhauer, 'Foreword of the Guide to the 1985 UNCITRAL Model Law' in Howard M Holtzmann and Joseph Neuhaus (eds), *A Guide to the UNCITRAL Model Law on International Commercial Arbitration: Legislative History and Commentary* (Kluwer Law International 1989) v.

[789] See Fleischhauer (n 788) v.

[790] See Howard M Holtzmann and Joseph Neuhaus, *A Guide to the UNCITRAL Model Law on International Commercial Arbitration: Legislative History and Commentary* (Kluwer Law International 1989) 9. See Blackaby and others (n 70) paras 1.218-1.219. See also UNCITRAL, 'Report of the Secretary-General: Study on the Application and Interpretation of the Convention on the Recognition and Enforcement of Foreign Arbitral Awards (New York, 1958) (A/CN.9/168)', Yearbook of the United Nations Commission on International Trade Law, 1979 Volume X <https://undocs.org/en/A/CN.9/168>.

[791] See Blackaby and others (n 70) paras 1.218-1.219.

[792] See Holtzmann and Neuhaus (n 790) 11.

[793] Holtzmann and Neuhaus (n 790) 11.

[794] See Holtzmann and Neuhaus (n 790) 11.

[795] See 'Status: UNCITRAL Model Law on International Commercial Arbitration (1985), with Amendments as Adopted in 2006' <https://uncitral.un.org/en/texts/arbitration/modellaw/commercial_arbitration/status>.

[796] Blackaby and others (n 70) para 1.220.

4.3.4 Further Legal Sources

261 Arbitral procedure may touch upon several different legal systems, such that the seat of the arbitration, the law applicable to the merits of the dispute, the parties to the dispute themselves, the arbitrators, and the arbitral institution may each relate to different countries. This richness in diversity of different legal systems is important to keep in mind as the "interplay may take place at almost any phase of the arbitral process".[797] This web of laws has mostly a supportive function that gives effect to the parties' freedom to conduct the proceedings as they wish. Arbitration benefits from the International Bar Association ("IBA") committee's guidelines, such as the IBA Guidelines on the Taking of Evidence in International Arbitration, on Conflicts of Interest, and on Party Representation.[798]

262 Besides the international framework as outlined in the previous chapters, there are thus other sources, which play a role in international arbitrations. Among these are: (i) national sources, such as state laws (*lex arbitri*), (ii) arbitration rules, such as the rules provided by arbitral institutions, and *ad hoc* rules, such as the UNCITRAL Arbitration Rules; (iii) soft laws, such as IBA Guidelines, and (iv) arbitral practice.

4.3.5 International Arbitration and Private International Law

263 International arbitration is closely associated with private international law. Modern arbitration's evolution can be traced back to the time that followed World War II, when private international law played a dominant role.[799] In Switzerland this connection is especially heeded since international arbitration is governed by Chapter 12 of its Private International Law Act.[800]

[797] Blackaby and others (n 70) para 1.199.
[798] See 'IBA Practice Rules and Guidelines' <https://www.ibanet.org/resources>.
[799] See Cordero-Moss and Arroyo (n 786) 312.
[800] Switzerland seems to be one of the few jurisdictions that has provisions on international arbitration in its private international law act. Most other countries have either created separate arbitration acts or the laws governing arbitration are found in civil codes or civil procedure codes. In fact, even in Switzerland, the laws governing domestic arbitration are found in Part 3 of the Swiss Code of Civil Procedure. However, although international arbitration is governed by the Private International Law Act, it is widely considered as being a separate part of the Swiss PILA.

264 In a sense, private international law itself is a science and some even consider "an art" form that solves "disputes involving several legal orders".[801] Cordero-Moss considers it to be a "meta law" because it is a law that determines another law.[802] Domestic legal systems can differ substantially from one jurisdiction to another.[803] When a legal relationship is not confined within a single jurisdiction, but has either one or more foreign elements, the laws of each involved jurisdiction may be applicable in case of a claim or dispute, which presents a conflict.[804] Private international law is thus often appropriately referred to as conflict of laws.

265 When a particular dispute has a connection to more than one jurisdiction, private international law steps in and provides an answer as to which legal system is applicable. The term "private international law" is misleading as it is not international law but is part of national law.[805] Conflict of laws does not deal with the substance of a dispute but provides rules to determine which legal systems and rules shall be applied to a given legal relationship.[806]

266 In the broad sense, private international law encompasses private international law and international procedural law.[807] It answers the following three questions: (i) which court has jurisdiction to render a judgment, (ii) which law can be applied to the case, and (iii) under what conditions, recognition and enforcement of a foreign judgment can be sought.[808] Legal systems may differ considerably in the solutions provided to legal questions or problems, especially if they are from different traditions, such as common-law or civil law.[809]

[801] Cordero-Moss and Arroyo (n 786) 311.
[802] See Cordero-Moss and Arroyo (n 786) 313.
[803] See 'Conflict of Laws' (*Encyclopædia Britannica Online, Britannica Academic*, 2020) <https://academic.eb.com/levels/collegiate/article/conflict-of-laws/109442>.
[804] See 'Conflict of Laws' (n 803).
[805] See Xandra Kramer and others, 'A European Framework for Private International Law: Current Gaps and Future Perspectives - Study' (*European Parliament, Policy Department C: Citizen's rights and constitutional affairs*, 2012) 15 <https://www.europarl.europa.eu/document/activities/cont/201212/20121219ATT58300/20121219ATT58300EN.pdf>. See also 'Conflict of Laws' (n 803).
[806] See Andreas Furrer and others, *Internationales Privatrecht* (Schulthess 2019) 6.
[807] See Furrer and others (n 806) 5.
[808] See Furrer and others (n 806) 5. See 'Conflict of Laws' (n 803).
[809] See 'Conflict of Laws' (n 803).

267 Bermann states that "given arbitration's international character and its core mission of resolving disputes between private parties, arbitration may fairly be regarded as the quintessential private international law endeavour".[810] Indeed, the international arbitration framework is influenced by private international law, specifically the New York Convention, as can be seen in its Article V.[811]

268 However, modern arbitration follows a trend of detaching arbitration from private international law, as Fernández Arroyo notes in "proceedings conducted by arbitral tribunal, the use of classical private international law is exceptional".[812] However, the question of the applicable law is not futile as it may determine the outcome of a dispute and the prevailing party. Even when parties have validly agreed to apply the same law (choice of law clause), experienced parties will exclude conflict of laws in order to avoid any route to the applicability of another law.[813] In contrast to arbitral tribunals, courts assisting an arbitral procedure may resort to private international law.[814] However, generally in instances that relate to arbitration, courts will usually apply arbitration law, abandoning private international law.[815]

4.4 Conclusion

269 International commercial arbitration has evolved over many years. It has developed a complex legal framework, involving state entities and their laws as well as private institutions and is continuously being shaped by the individuals who practice it. When it emerged, states largely took control, but arbitration has become more and more independent over time. Arbitration is a form of ADR and arbitral awards are final and

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[810] George A Bermann, *International Arbitration and Private International Law General Course on Private International Law (Volume 381)* (Koninklijke Brill NV 2016) <https://referenceworks.brillonline.com/entries/the-hague-academy-collected-courses/*A9789004338289_02>.

[811] Article V (1)(a) of the New York Convention: "Recognition and enforcement of the award may be refused, at the request of the party against whom it is invoked, only if that party furnishes to the competent authority where the recognition and enforcement is sought, proof that: (a) The parties to the agreement referred to in article II were, *under the law applicable to them*, under some incapacity, or the said agreement is not valid *under the law to which the parties have subjected it* or, *failing any indication thereon, under the law of the country where the award was made*" (Emphasis added). See Cordero-Moss and Arroyo (n 786) 316. Cordero-Moss notes that the special conflict rule in determining legal capacity of a party is not flawless and assumes application of another conflict rule.

[812] Cordero-Moss and Arroyo (n 786) 312.

[813] See Cole and Ortolani (n 672) 41.

[814] See Cordero-Moss and Arroyo (n 786) 312.

[815] See Cordero-Moss and Arroyo (n 786) 312, 317–318.

binding in 168 countries. To get to this point, arbitration had to go through major transformations: From the establishment of the ICC, UNCITRAL to the adoption of the Geneva Protocol 1923 and Convention 1927 to the New York Convention 1958, which abolished the double exequatur requirement and only in the last-minute included arbitration agreements. This shows how a single proposal can change the course of history. The development which can be traced back and witnessed today was a worldwide effort to support international trade and commerce. The emergence of the Internet can be considered one of humanity's most transformative events, and ODR has steadily risen since commerce became possible on the World Wide Web. The legal frameworks, both of nation states and the collectivity of states, are not adapted for the Internet age. Challenges exist in terms of jurisdiction, data privacy, and more. Adding blockchains to the mix only complicates matters and makes the complex only more complex, which this thesis will explore further in the next chapter.

Chapter 4: Summary

Arbitration has a long history. Although its precise origins are unclear, commentators largely agree that arbitration as an informal procedure involving a third-party neutral must have been part of the advent of modern civilization long before states emerged. Today arbitration is regarded as a private dispute resolution mechanism, which parties can select freely as an alternative to litigation. Modern international commercial arbitration goes back a hundred years. It has a complex and multi-faceted web of private and public international law instruments to aid modern-day businesses resolve their international disputes. The most important pillar of the international arbitral framework is the New York Convention of 1958. Other sources include the UNCITRAL Model Law, lex arbitri, and arbitral institutions rules, soft laws, and arbitral practice. The New York Convention is more than sixty years old, and much has happened since, most notably the widespread use of PCs and the emergence of the Internet. Online dispute resolution has thus seen a steady rise in e-commerce, and due to the COVID-19 pandemic, arbitration today is mostly conducted via videoconferencing and filings are made electronically. International commercial arbitration is a success story that has helped international trade flourish.

5 Chapter 5: Blockchains and Smart Contracts meet International Arbitration

5.1 Introduction

270 Shortly before two characters, young and old, meet by chance in one of Dostoevsky's most famous novels, he writes that "[t]here are chance meetings with strangers that interest us from the first moment, before a word is spoken."[816] This consequential meeting does not take place in the beginning, it is only in chapter two that the seeds are planted for the course of the story to take a significant turn. Similarly, here a new technology meets an old and well-established institution, and it was not obvious from the beginning that the two would ever meet. In fact, blockchains seem to have been birthed from the idea of an immutable and dispute-free world – a world so marvelous that it does not exist. The idea of perfection thus necessarily had to clash with reality at some point.

271 When discussing disputes and dispute resolution in relation to blockchains, one may be referring to a myriad of different aspects at this intersection. The question may be how to handle disputes once they have arisen, whether they concern governance mechanisms of DAOs which affect parts or an entire blockchain, or data sources, which are off-chain and then transferred on-chain: When something goes wrong, what can be done? Yet another possibility concerns smart (legal) contract disputes between parties to that specific contract. Smart contracts, however, by themselves are not subjective, thus the human factor is still needed and should not be underestimated.[817]

272 The ongoing revolution was not started by lawyers, in the blockchain world, coders are trying to reinvent the law and dispute resolution. Dobrauz, who is a renowned leader at the intersection of law and blockchains, asserts that there will likely be disputes related to blockchains, he believes that "some will be on-chain, some will be off-chain", and that he has "no idea what it's going to be, but it's going to happen".[818] This chapter journeys through the still nascent world of blockchain disputes and the ways in which the blockchain communities have sought to resolve them.

[816] Fyodor Dostoevsky, 'Crime and Punishment (Translation by Constance Garnett)' <https://www.gutenberg.org/files/2554/2554-h/2554-h.htm>.
[817] Interview #12, Christian Scharr.
[818] Interview #10, Günther Dobrauz.

273 First, this chapter conceptualizes disputes in a blockchain context (Chapters 5.2 and 5.3). Second, it outlines major approaches and protocols under development (Chapter 5.4), namely Kleros, Aragon, Jur, Mattereum, and some lesser-known approaches for a more comprehensive understanding. The emergence of these projects can be seen as the blockchain community's understanding that dispute resolution is important. Third, this chapter presents select reactions to the developing blockchain dispute resolution field by international organizations, which aim at harmonizing law globally, such as UNCITRAL and UNIDROIT, other bodies, such as arbitral institutions and national taskforces, and the World Economic Forum ("WEF") (Chapter 5.5).

274 Chapter 5 thus equips the reader with the necessary foundation for the analysis in the next chapter. Once equipped with the understanding of disputes in a blockchain context, real disputes that have occurred, and major blockchain dispute resolution approaches, the reader can be guided in Chapter 6 through an analysis of so-called "crypto arbitration", a model first presented in Chapter 5.4.5. (Kleros) and Chapter 5.4.6. (Aragon). The focus of the analysis in Chapter 6 lies primarily on Kleros because, unlike other approaches, Kleros' dispute resolution mechanism has passed its testing phases and is actively being used on the Ethereum main network.

5.2 A New Decentralized World Of Disputes in the Blind Spot of the Law - Necessity for Smart Dispute Resolution?

275 Dispute resolution for blockchains seems like a paradox. The philosophy underpinning blockchains is decentralization, disintermediation, and transparency.[819] Whereas the philosophy underlying blockchains tries to eliminate intermediaries, dispute resolution requires a third-party intermediary to resolve a conflict. There is an inherent contradiction between the crypto economy and legal systems.[820] Blockchains and smart contracts are deterministic, there seems to be little room for disputes when things work well.[821]

[819] See *supra* Chapter 2.
[820] See e.g., Buchwald (n 113) 1372.
[821] Interview #14, Anonymous (DEX co-founder), ("The whole idea is that you can't really blame anybody, if you put money in something and it behaves as you thought from reading the smart contract, then you can't really complain if that money goes to somewhere else. The interesting area is what happens when there is still some scope for randomness obviously, and one area is things like flash loans, so things that are technically possible in the smart contract world but are based in the fringes of what you expect the smart contract to do, so there are extreme forms of arbitrage, very unusual, you did not expect that to happen when putting your money into the smart contract. … We basically as programmers try to think about how

However, the contradiction can even be witnessed in the Bitcoin Whitepaper itself, where Satoshi Nakamoto refers to the possibility of implementing escrow mechanisms to protect buyers in bitcoin transactions.[822] This is an indicator that the pioneer of blockchain technology recognized the need for safety mechanisms, which, however, would introduce a third-party element into a system designed to eliminate these. Centralized and third parties play a vital role in justice systems. Where then does the justice system fit in with blockchains? If one were to assume that users of blockchains have a tendency to be against any traditional forms of adjudication, how can disputes be resolved if not relying on centralized institutions or a third party, for that matter?

276 To illustrate the difficulty and make it more tangible, see the following metaphor: the blind spot. A blind spot is a spot in the eye's retina where there are no light-sensitive cells, and this is precisely the place where the optic nerve connects to the retina.[823]Although these blind spots exist, the brain compensates for the missing information by the overlapping visual fields of both eyes, thereby bridging the gap.[824] Blockchains are in what could be thought of as the blind spot of the law and legal systems.[825]

277 Traditional adjudication forms face various obstacles when it comes to resolving blockchain disputes.[826] First, parties are often anonymous or pseudonymous, making it hard to bring claims before national courts. Second, even if it was possible to bring claims

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to limit the potential for those kinds of things to happen, so keep things as deterministic as possible. If you make the system fully deterministic, then the responsibility is on the user to verify").

[822] See Nakamoto, 'Bitcoin: A Peer-to-Peer Electronic Cash System' (n 52) 1 ("Transactions that are computationally impractical to reverse would protect sellers from fraud, and routine escrow mechanisms could easily be implemented to protect buyers."). See also Ortolani, 'Self-Enforcing Online Dispute Resolution: Lessons from Bitcoin' (n 104) 609 (Based on this, Ortolani concludes that "the paper founding the Bitcoin system expressly delegates the implementation of dispute settlement devices to private autonomy").

[823] See Kara Mayer Robinson, 'How to Find the Blind Spot in Your Eye' (*WebMD*, 2020) <https://www.webmd.com/eye-health/eye-blind-spot>.

[824] See Kendra Cherry, 'Reasons Why You May Have a Blind Spot in Your Eye' (*verywell mind*, 2020) <https://www.verywellmind.com/why-do-you-have-a-blind-spot-2794880>. See Science Buddies, Svenja Lohner, 'Find Your Blind Spot!' (*Scientific American*, 2020) <https://www.scientificamerican.com/article/find-your-blind-spot/>.

[825] Ast considers the market, where Kleros is building its application as some sort of blind spot, because small value claims are usually not addressed in arbitrations. Interview #1, Federico Ast ("… it doesn't make sense to go to arbitration for small claims so there was a market you know, a blind spot where you did not have a solution system that would address small claims at an international level which is basically what the future is going to be about.").

[826] See Ortolani, 'Self-Enforcing Online Dispute Resolution: Lessons from Bitcoin' (n 104) 610–611 (Ortolani explains that in the Bitcoin network, users "operate in a 'hostile environment', without any support from state law and state courts, or any interaction with trust-based payment systems").

before state courts, national judges may not have sufficient knowledge of blockchain technology. Third, especially public and permissionless blockchains are dispersed all over the globe, defining legal jurisdiction becomes thus an arduous task. Fourth, the blockchain ethos of disintermediation goes against centralized institutions. And the list goes on.

278 It seems that disputes on blockchains are not only hard to grasp but impossible for traditional legal systems and the law to "see" as if they were in a blind spot. That blind spot may have started to form with the emergence of the Internet, which challenged conventional territorial connecting factors for determining jurisdiction due to its international character. Blockchains add to the confusion about the transcendent nature of the online world and further highlight its cross-border, international, and dispersed character even more. In this online blockchain world, the law uncomfortably sits by the sidelines with its impaired vision. The legal system is not only blind to online or blockchain disputes but disputes of low value in general since the costs of seeking enforcement far outweigh the value in dispute.[827] Since traditional dispute resolution seems to be unable to resolve blockchain-specific disputes adequately, alternative means of dispute resolution will rise in importance over time, especially once there is massive adoption of blockchain technology in social interactions and commercial transactions.[828]

279 So, how can this gap be bridged? The solution may well be a metaphorical second eye, another legal system connecting to the traditional one. Parties or participants in a blockchain environment operate in the law's blind spot, where they become unrecognizable and thus intangible unless they seek court enforcement, which presents its own hurdles, either because parties in blockchains usually tend to avoid courts or because even if they wanted to litigate, jurisdictional barriers and the pseudonymous nature of transactions stand in their way.

280 The crypto economy is ridden with fraud, hacks, intellectual property infringements, and manipulations. These and other violations inevitably lead to disputes. For example, a project may sell NFTs based on another artist's work without the IP owner's consent,

[827] See also Ortolani, 'Self-Enforcing Online Dispute Resolution: Lessons from Bitcoin' (n 104) 602 ("The costs and complexity of court enforcement proceedings are disproportionate to the values in dispute […] in the context of e-commerce." Footnote omitted.). See also Interview #1, Federico Ast (n 825).

[828] See Buchwald (n 113) 1372 et seq.

which can leave hundreds of people frustrated for having invested by buying said project's collectibles, which are then tainted by fraud and consequently lose their value.[829]

281 Inexperienced retail investors find new projects on subreddits, promising incredible gains and invest in these projects through decentralized exchanges. Oftentimes, investors find themselves as victims in so-called pump and dump schemes, "rug pulls" or "honeypots",[830] without any means of recourse. The amounts invested may seem small, taken separately, but in total can add up to large numbers,[831] leading to a veritable fertile ground for those who lean towards dishonest behavior. In the absence of viable mechanisms to disincentivize such behavior, it will continue and worsen, as large sums of money can be made quickly without facing any adverse consequences, and on top of that, enjoy the benefits of pseudonymity.

282 And that is the two-sided coin of pseudonymity/anonymity: being able to transact on blockchains without revealing one's identity while being vulnerable to breaches of contract and other violations without any means of recourse against the offender. This seems to be the risk that one accepts by participating in public and permissionless blockchains. However, this begs the question of whether simply accepting the risk is the only solution to this dilemma. Legal systems, for example, have developed a sophisticated public and private law enforcement divide depending on the nature of the offense.[832] Posner points out that criminal law enforcement is predominantly a public monopoly, whereas contract law and tort law are not.[833]

[829] See, e.g., a tweet by a collector of a project that gained widespread traction, voicing their frustration and calling for a "crypto court" after it became known that the project was based on another artist's work without any license. 'Tweet by User Voicing Need for Crypto Court' <https://twitter.com/TheLoveHandlz/status/1380945141549002756>.

[830] A "rug pull" is a term used in crypto communities for the action taken by coin issuers who wait until many retail investors have "pumped" the price of their coin only to then drain the liquidity by selling their entire share of coins, dumping the price and leaving the investors with nothing. "Honeypot" is a term used for coin issuances where investors see the value of their investment in a coin rising but have no possibility to sell the coins they have bought. On "pump and dumps" generally and in comparison to crypto, see Matt Levine, 'Pump and Dump and Pull the Rug' (*Bloomberg*, 2021) <https://www.bloomberg.com/opinion/articles/2021-07-01/pump-and-dump-and-pull-the-rug>.

[831] Just in 2020, billions of dollars were hacked in blockchains. See Tom Foremski, 'Billions Were Stolen in Blockchain Hacks Last Year' (*ZDNet*, 2021) <https://www.zdnet.com/article/billions-were-stolen-in-blockchain-hacks-in-2020/>. This is not counting the several "pump and dump" schemes performed on various coins.

[832] See Posner (n 673) 859 et seq.

[833] See Posner (n 673) 862 et seq.

283 Posner explains the difference between public and private enforcement in legal systems as follows: "The relevant difference between crimes, on the one hand, and torts and breaches of contract, on the other, is that with very small resources devoted to apprehension, the probability of apprehension tends to be much less than one in the former case and to approach one in the latter. The victim of a breach of contract knows who the promisor is; the victim of an automobile accident usually knows the identity of the other driver; but the victim of a burglary rarely knows the burglar's identity."[834] In a blockchain, pseudonymity is still the norm, thus it is entirely possible not to know the contracting party's identity. This poses many hurdles to national court systems, among which are determining jurisdiction and the use of conflict of laws.

284 According to Berg, Davidson and Potts, blockchains work like "a common pool resource to secure private goods".[835] Moreover, they conclude that blockchains can in fact "adopt the characteristics of each of the institutions of governance […] – markets, firms, governments, clubs, and commons – depending on how they are configured".[836] This may have significant consequences to the public goods states offer in the form of, *e.g.*, "law, legal systems, regulation, security, and property rights protection".[837]

285 Since public and permissionless blockchains can create a state-like infrastructure in cyberspace,[838] in which parties are pseudonymous and identifying the other is very difficult, one may contemplate whether automatic recourse and enforcement in case of offenses should not be programmed into the blockchain at a foundational layer as a pre-condition. This may create an added layer of trust. A Twitter user asked Vitalik Buterin, "[w]hy if there is a ledger of transfers can people still get hacked, surely if there is consensus about a hack, a transaction could be reversed or the transfer frozen until consensus is found.. solve this problem first",[839] to which Buterin responded that "[t]hat would impose on the governance layer the obligation of running an entire court system…. risky and much less socially scalable".[840]

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[834] Posner (n 673) 862-863. Footnote omitted.
[835] Berg, Davidson and Potts (n 17) 40.
[836] Berg, Davidson and Potts (n 17) 42.
[837] Berg, Davidson and Potts (n 17) 38.
[838] See Berg, Davidson and Potts (n 17) 42.
[839] @__TIM_CRAIG__, '@__TIM_CRAIG__ on Twitter on 20 October 2020' (*Twitter*, 2020) <https://twitter.com/__TIM_CRAIG__/status/1318512016793980928>.
[840] Vitalik Buterin, '@VitalikButerin on Twitter 21 October 2020' (*Twitter*, 2020) <https://twitter.com/VitalikButerin/status/1318778558353821696>.

286 Overly strict rules at a protocol level may indeed pose some risks, but the "less socially scalable" argument does not convince. It might be riskier not to implement such a court layer at an early stage and instead follow the paradigm of "move fast and break things".[841] If it is technically feasible to implement a dispute resolution layer, this thesis submits that it is imperative to explore that possibility. One would have to tackle the difficulties that arise in designing such an enforcement system that encompasses all participants of a blockchain network without being overly burdensome, which can be of much added value in the long run. Blockchain-enabled smart contract transactions with pseudonymous parties present a particular economic and legal challenge. Moreover, blockchains represent a global challenge at their governance level for the lack of democratic voting structures. Once they become global infrastructures for economic activity, this conceptual flaw will become intensely worrisome.

287 Complex questions arise in such contexts, which are not easily resolved. Questions such as, how can consumers be protected in a wild west world of decentralized blockchains? Or how can participants in the network stay pseudonymous and still find justice? How can parties mitigate the risks of hacks and other failures of the system when contracting with each other on decentralized, open and permissionless blockchains? DeFi with their DEXes, NFTs with open marketplaces, and DAOs as an entirely new organizational proposition are only some of the new and innovative use cases of smart contracts.

288 The lack of recourse to a judicial system in the blockchain infrastructure has precarious consequences for the participants involved. Legal systems stand before what seems an insurmountable challenge, to which they presently do not provide a satisfactory answer. Blockchain transactions or one's involvement in a DApp may touch upon various legal orders. However, private international law is insufficient to deal with the complexity of a decentralized, p2p, worldwide system, which belongs everywhere and nowhere at the same time,[842] whose nodes can be found spread across the globe, holding a copy of the entire, or at least a lightweight version of the entire chain of blocks.

[841] "Move fast and break things" was an early motto of Facebook's Mark Zuckerberg. See Hemant Taneja, 'The Era of "Move Fast and Break Things" Is Over' (*Harvard Business Review*, 2019) <https://hbr.org/2019/01/the-era-of-move-fast-and-break-things-is-over>.

[842] See Guillaume (n 604) 70.

289 The complexity is true even when the parties to a legal relationship in a blockchain context are known. However, as seen above, if parties are pseudonymous, this presents an even more challenging situation. The need for dispute resolution on blockchains was thus recognized early on. In early 2016, Vitalik Buterin proposed a "decentralized court"[843] on Reddit and argued on its usefulness but seems to have refrained from adopting the idea of a court system on the Ethereum protocol layer, as can be seen in the Twitter conversation outlined before. Also, Andreas Antonopolous, a pioneer in the blockchain space, presented a proposal for an arbitration and mediation network, which he, however, subsequently abandoned for lack of funding and community interest.[844]

5.3 Blockchain Disputes – A Conceptualization

290 One may encounter different kinds of disputes in the crypto economy, from community-wide disputes involving a large group of people to disputes involving only a few or two parties. Different layers can be looked at from different perspectives, depending on the specific case. The following figure depicts the layers of blockchain disputes:

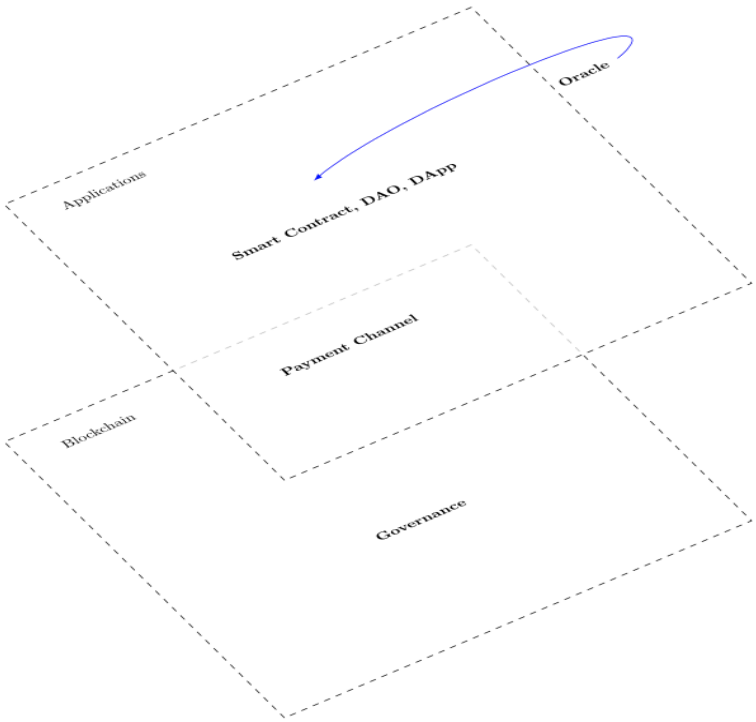

Figure 10. Blockchain Layers of Disputes[845]

[843] See *infra* Chapter 5.4.2.
[844] See *infra* Chapter 5.4.3.
[845] Own figure designed using the tex-template by Pascal Seppecher and Marco Miani, 'Example: Interaction Diagram' <https://texample.net/tikz/examples/interaction-diagram/>.

291 This thesis distinguishes two broad categories: "base layer disputes" and "application layer disputes". Base layer disputes relate mostly to governance issues. Application layer disputes can be anything from smart contracts, DApps, DAOs to payment channels and oracle disputes. The above figure illustrates blockchains as a fundamental layer and the applications layer on top. Governance disputes concern the fundamental layer and may result in a fork. In the case of a hard fork, an entire ecosystem may be affected and split, especially in case of a contentious hard fork. Conceptually, the applications layer entails smart contracts which run on top of blockchains. Smart contracts can be DAOs and/or DApps, which in turn can be made of one or multiple smart contracts. Disputes can arise between parties to a smart contract, members in DAOs or users of DApps. In the applications layer, a subcategory is on/off-chain clashes, which refer to payment channels or oracle disputes. Oracles enable smart contracts to receive off-chain information. Disputes may arise if oracles feed smart contracts wrong information, for example. Payment channels are layer-two solutions, which enable faster transactions. Parties can open a payment channel, where transactions are recorded off-chain. When one party tries to take advantage of the other, an off-chain transaction that did not occur would be reflected on-chain. The following figure offers another visualization of blockchain-related disputes:

Layer	**Description**	**Parties**
Applications	Smart Contracts/DApps/DAOs	Individual, Collective
Base Layer, Governance	Infrastructure (Soft, Hard Forks)	Entire Blockchain
Blockchain		

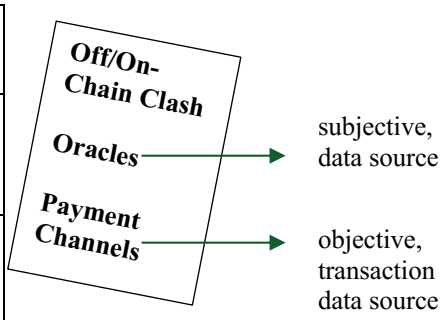

Figure 11. Breakdown of Blockchain Disputes[846]

292 Governance disputes refer to blockchain-wide disputes concerning the direction a specific blockchain should take, implementation of concepts, upgrading the system, and more. In a PoW consensus protocol, such disputes are depended on miners and their willingness to adopt changes to the protocol. These disputes are of wide importance and

[846] Own figure.

concern a large variety of people, developers, and stakeholders. Disagreements and conflicts in the fundamental blockchain layer, may lead to hard forks and – especially if contested – the creation of entirely new parallel blockchains (examples include Ethereum and Ethereum classic, Bitcoin and Bitcoin Cash).

293 Disputes on the application layer may concern few or a multitude of parties. Anyone who participates in a DAO or Dapp could be in dispute with other participants. DAOs can be one or multiple smart contracts, they could run autonomously and may upgrade depending on the votes cast by token holders. If a DApp project wants to become decentralized, it will evolve into a DAO and give its participants power to vote and make decisions on how the project evolves; ultimately, one may thus speak of DAO disputes in general. The Aragon Court, which will be discussed in more detail later, tries to tackle exactly this area. As DAOs grow in importance and become widespread, so does the importance of resolving community-wide disputes concerning token holders with voting rights in DAOs.

294 The self-executing aspect of smart contract does not necessarily result in performance as initially intended.[847] Disputes may arise due to bugs in the code or failure of the smart contract to deliver according to the parties' intent. Many of Ethereum's smart contracts are faulty and may even "lock funds indefinitely or leak funds to unauthorised users".[848]

295 As on-chain assets become widespread, there may be an increased need for resolving disputes in smart contracts. Such disputes may involve parties that live cross-border and are pseudonymous. One may go even further and distinguish two separate phenomena in this category:[849] One relates to any dispute regarding a contractual relationship for which

[847] See Buchwald (n 113) 1371.

[848] Berg, Davidson and Potts (n 17) 8 with reference to Ivica Nikolić et al., 'Finding the Greedy, Prodigal, and Suicidal Contracts at Scale' [2018] 'Finding the Greedy, Prodigal, and Suicidal Contracts at Scale' [2018] Proceedings of the 34th Annual Computer Security Applications Conference (ACSAC '18). Association for Computing Machinery, 653. See also *infra* Chapter 5.3.1.2.

[849] In Interview #4, Alessandro Palombo explained that there are possibly two different phenomena when it comes to blockchain disputes, one regarding a transaction, which is carried out on a blockchain, where the payment mechanics of the blockchain infrastructure are used but these are not proper blockchain disputes, such as when parties agree to enter a contract to design a homepage, or they have some freelancing contract. The other phenomenon regards the execution of an obligation via smart contract, and that is where it gets interesting. He identifies three main elements of the latter example which align the smart contract with dispute resolution: (i) the smart contract itself, (ii) an obligation which gets automated, and (iii) an escrow application. In such a scenario, not only the business relationship could get fully automated but also the dispute resolution side should a dispute arise, leading to automated enforcement.

a smart contract transaction is employed for payments, *e.g.,* some off-chain asset transfer or service for which a blockchain smart contract is used for payment. The other phenomenon regards fully on-chain assets, such as NFTs, cryptocurrencies, and native tokens.

296 NFTs may reflect an off-chain asset in which case it may act as a digital twin, which opens a series of legal issues and questions and leads to hybrid cases. When it comes to purely on-chain assets, the smart contract may deliver, for example, a cryptopunk[850] in exchange for *ether*. This is a transaction for which the transfer of this specific asset happens on the blockchain, and the smart contract executes the transaction, delivers the payment and the asset simultaneously. The distinction of these types of possible disputes is shown in the following table:

Dispute	**Type 1**	**Hybrid 1**	**Hybrid 2**	**Type 2**
Asset Transfer/ Service Delivery	Off-Chain	*Both o*ff-chain (real-world asset) with on-chain twin/reflection	*Only* on-chain while real-world asset held by custodian	On-Chain
Payment	Smart Contract (and/or Ricardian Contract)	Smart Contract (and/or Ricardian Contract)	Smart Contract (and/or Ricardian Contract)	Smart Contract (and/or Ricardian Contract)

Table 3. Smart Contract Dispute Types[851]

297 Many different disputes may arise in the different constellations depicted above. One possible dispute is if an off-chain asset is transferred, but its digital twin (NFT) is not or *vice versa*. One could say that the value of an asset is enhanced by having both the off-chain asset and the on-chain twin. It is conceivable that a myriad of problems may arise if parties fail to deliver one of the two. For example, some artists sell NFTs both in an on-chain and an off-chain version, where buyers may subsequently only sell the on-chain asset and keep the off-chain artwork if parties agree; otherwise, there may be a dispute.

[850] Cryptopunks are considered to be one of the first NFTs on the Ethereum blockchain and can be traded. See 'Cryptopunks' <https://www.larvalabs.com/cryptopunks>. See also CryptoWiener <https://cryptowiener.com/>.

[851] Own table.

298 Disputes may even occur relating to on-chain assets directly, without smart contracts. The Cardano Blockchain is an example where tokens, such as NFTs, exist without smart contracts. While Ethereum struggles with its prohibitively high gas fees, competing blockchains, such as the Binance Smart Chain, Cardano and others, started to take up market share. Community members in such rather small and emerging ecosystems are oftentimes made aware by way of social media to only trade digital assets by using the escrow services provided by verified moderators of certain Discord channels.[852] This is essentially dispute prevention. Should a dispute occur while utilizing the escrow service, the moderator may serve the function of an arbitrator if the parties agree to it. If parties trade p2p on a trust basis without an intermediary or a smart contract and a dispute occurs, finding a resolution may be rather difficult.

299 Besides these different layers of disputes, and the differentiation between base layer disputes and application layer disputes, and the different disputes relating to smart contracts, disputes can also be conceptualized from other perspectives, such as the consumer or user perspective, the developer perspective, the perspective of a solutions provider, and many more. However, the conceptualization this thesis undertakes is sufficient for the present purposes. In the following subchapters, the different types as illustrated above will be examined further, specifically (i) governance disputes, (ii) payment channel and oracle disputes, (iii) smart contract, DAO, and DApp disputes, and (iv) other kinds of disputes.

5.3.1 Governance Disputes

300 The vision of a completely decentralized, distributed system that no one controls and that can maintain peace is utopian. Where humans can be found, power plays are inherent even in the most decentralized of systems. Finck observes that "power structures very much persist in respect of distributed ledgers".[853] Berg, Davidson, and Potts portray

[852] During the NFT boom which started in late 2020 and early 2021, first forms of NFTs emerged on Cardano without the appropriate smart contract infrastructure. The communities assembled in Discord servers and built bot-auction houses and moderators provided escrow services to allow community members to trade the NFTs collected until smart contracts were launched and proper marketplaces emerged. This is interesting from a comparative point of view. Whereas on Ethereum, the infrastructure was set up from the beginning to allow for smart contracts and NFTs to be traded without the need for escrow services, other programmable blockchains still in development may not have advanced as rapidly and had to rely on other online communication methods and third-party escrow services. See, e.g., the Cardano NFT collectibles 'SpaceBudz' <https://spacebudz.io/>.

[853] Finck (n 30) 183.

blockchains as constituting governance orders, more specifically "constitutional order[s], complementing and competing with the other institutions of governance".[854] The market is an institution of governance that people use to coordinate their exchanges,[855] and Adam Smith introduced the concept that these exchanges bring about order naturally.[856] Other institutions of governance include firms, governments, clubs, and commons.[857]

301 Finck defines blockchain governance as "the processes, rules and procedures relied on to maintain the protocol".[858] Introna describes the fundamental "notion of governance [as] the idea of a plurality of actors in which none of the actors has the power or authority to decide and implement solutions or policies unilaterally and directly".[859] To understand the complexity of governance and the problems associated with it, one may draw on concepts from political science. The "ubiquitous modern view of politics"[860] categorizes social entities into groups of the "economy", the "state", and the "society".[861] These are layers of abstractions. For the purposes of this thesis, some other parameters were added in each of the larger categories, the essential ones being "law" and "dispute resolution", forming the following simplistic setup:[862]

[854] See Berg, Davidson and Potts (n 17) 37.
[855] See Berg, Davidson and Potts (n 17) 38.
[856] See Berg, Davidson and Potts (n 17) 38. See Adam Smith, *An Inquiry into the Nature and Causes of the Wealth of Nations* (Project Gutenberg) <https://www.gutenberg.org/ebooks/3300>.
[857] See Berg, Davidson and Potts (n 17) 36, 38.
[858] Finck (n 30) 183.
[859] Lucas D Introna, 'Algorithms, Governance, and Governmentality: On Governing Academic Writing' (2016) 41 Science, Technology and Human Values 27. Footnote omitted.
[860] William Walters, 'Some Critical Notes on "Governance"' (2004) 73 Studies in Political Economy 27, 29–30. ("Hindess has written about the 'ubiquitous modern view of politics which sees 'economy', 'state' and 'society' as distinct but largely coextensive systems of social organization."). Walters thus attributes this statement to Barry Hindess in Barry Hindess, 'Neoliberalism and the National Economy' in Mitchell Dean and Barry Hindess (eds), *Governing Australia; Studies in Contemporary Rationalities of Government* (Cambridge University Press 1998) 211–2.
[861] *Ibid*.
[862] Abstraction is essential for any theory building exercise, see Posner (n 673) 17. ("[…] abstraction is of the essence of scientific inquiry […]. A theory that sought faithfully to reproduce the complexity of the empirical world in its assumptions would not be a theory – an explanation – but a description.") Any simplistic setup of course also has its flaws, as Ian Macduff noted elsewhere regarding reductionism, see Ian Macduff, 'Crowd-Hidden, Whereabouts Unknown' (*Kluwer Mediation Blog*, 2016) <http://mediationblog.kluwerarbitration.com/2016/04/27/crowd-hidden-whereabouts-unknown/>. ("There's a separate and also epistemological discussion to be had on the risks of reductionism – as the late American historian Theodore Roszak commented, the problem with reductionism is that it's both true and incomplete.").

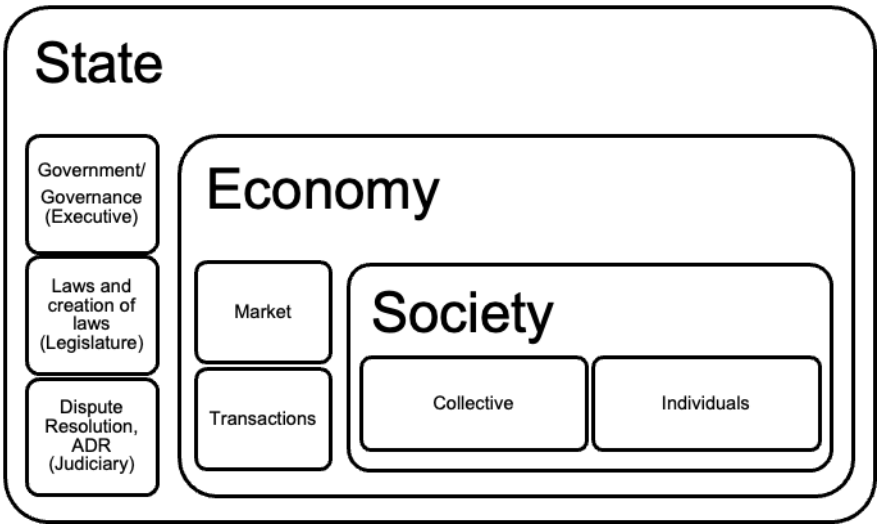

Figure 12. Simple social entities' layers[863]

302 As the foundational layer, the state enables the economy with its market transactions in society and regulates and mediates these by providing different institutional infrastructures. Eugen Ehrlich, an Austrian legal scholar who had an early influence on establishing the field of sociology of law, sees law as "always coming into being".[864] Ziegert explains that to Ehrlich "the state is only one, even if particularly authorised and powerful, association among the many overlapping associations in which individuals are or can become members. They all co-evolve, co-exist and cooperate with the association 'state'".[865] One may think of these associations as layers to the fabric of society or even as forces, interacting and influencing each other, alternatively as an abstract organism of networks, where society splits into different and more specialized functions to keep itself alive and together. What can be observed with blockchain technology is that two layers have become especially intertwined, forming a new model:

[863] Own figure.
[864] Klaus A Ziegert, 'World Society, Nation State and Living Law in the Twenty-first Century' in Marc Hertogh (ed), *Living Law - Reconsidering Eugen Ehrlich* (Hart Publishing 2009) 231.
[865] Ziegert (n 864) 231.

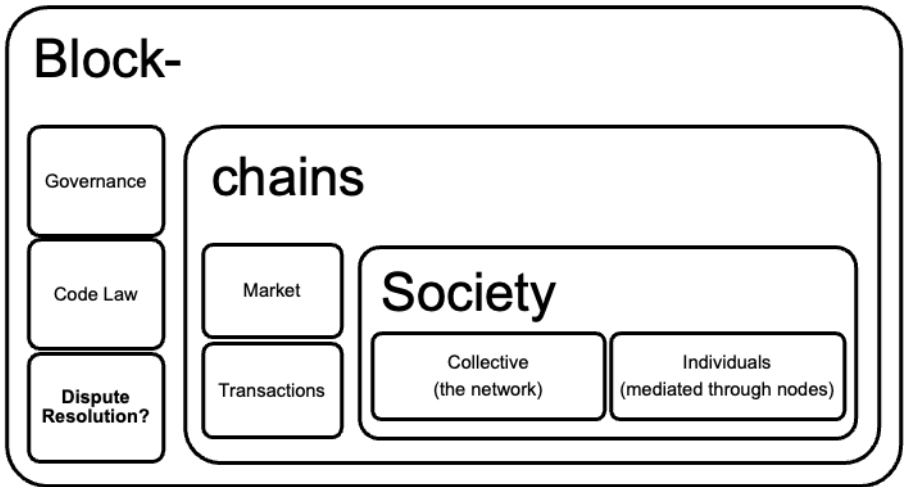

Figure 13. Simple social entities' layers replaced by blockchains[866]

303 Blockchains in this new model have overtaken the foundational layers of the fabric in society, incorporating functions of "the state" and "the economy" in a combined layer of abstraction. This simplistic model attempts to depict the merger of two previously and conceptually separate layers. The boxes have remained the same, aside from the fact that blockchains do not have a government but rather a governance structure. In many cases, governance is underdeveloped and seems even undefined on purpose to keep the pristine image of being completely decentralized intact. Although the blockchain space has its own enforcement mechanism by way of "code law",[867] *i.e.,* the rules of the protocol and smart contract applications, a major difference is that blockchains cannot exert physical violence.[868]

[866] Own figure.
[867] Or what De Filippi and Wright would call "lex cryptographica". See De Filippi and Wright (n 5) 49 et seq.
[868] See Bankless, '64 - Legitimacy | Vitalik Buterin' (*Youtube*, 2021) <https://www.youtube.com/watch?v=mr_Xc_a1mKI>. (Vitalik Buterin stated that "the crypto space controls no guns"). And this distinction is not a trivial one. See, e.g., Max Weber, *On "Politics as a Vocation"* in David Owen and Tracy B Strong (eds), *The Vocation Lectures 'Science as a Vocation' 'Politics as a Vocation'* (Hackett Publishing Company, Inc 2004) 33. ("[T]he state is the form of human community that (successfully) lays claim to the *monopoly of legitimate physical violence* within a particular territory- and this idea of 'territory' is an essential defining feature"). See also Ortolani, 'The Three Challenges of Stateless Justice' (n 104) 602. One may then ask, what is the equivalence of physical violence in the context of blockchains? Anyone can join and leave a public and permissionless blockchain as they wish and if anything, control can only be exerted over digital and not physical assets. Blockchains as state-like entities in cyberspace cannot physically exert any violence. If there was to be a state in cyberspace, and one considers blockchains such a manifestation, exerting physical violence would not be possible. However, even this distinguishing characteristic may change with autonomous devices linked to blockchains, and a more widespread IoT. Over time actors or autonomous agents could exert more and more control on physical objects in the physical space through blockchains.

304 Blockchains' enforcement is thus limited to the network *in abstracto* in cyberspace. Vili Lehdonvirta, an Oxford academic in economic sociology would presumably reject the depiction showcased above as he is "very skeptical of the claims that blockchain will fundamentally transform the economy or government".[869] This is not the claim made here *per se*, though, rather it is argued that blockchains may create independent governance structures and economies in cyberspace that compete with present power structures of government and the economy.[870] This is not about transformation, this is about possible replacement and disruption.[871] If these structures outperform the well-known "off-chain" institutions, they may be prime examples of - what Christensen calls - a "disruptive technology" already discussed in Chapter 2.[872]

305 It would go beyond the scope of this thesis to trace all the intricacies of social entities and sketch the evolution of the state and how each entity relates to the other. However, it is undeniable that laws and dispute resolution have played an important part in this complex dynamic. And that is at the heart of this exploration. Even if one is skeptical, one needs not rush to dismiss the claim that blockchains could represent all these power structures in cyberspace mentioned above. Because the detriment to global society in not tackling such an issue early on - if the claim does, in fact, materialize - could be more significant than the problems currently faced by society due to the lack of foresight years ago in relation to digital platforms, big data, privacy, and the power structures inherent in the centralized systems of the Internet.[873] It could be that blockchains will never truly realize their potential due to the lack, or rather uncertainty as to the translation of the three powers of government (judiciary, legislative, and executive) in cyberspace. Nevertheless, assuming blockchains do represent a state-like entity and provide an infrastructure for a global and online economy in cyberspace, what does this mean for law and dispute resolution?

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[869] Vili Lehdonvirta, 'The blockchain paradox: Why distributed ledger technologies may do little to transform the economy' (*Oxford Internet Institute Blog*, 2016) <https://www.oii.ox.ac.uk/blog/the-blockchain-paradox-why-distributed-ledger-technologies-may-do-little-to-transform-the-economy/>. See also Werbach (n 7) 133.

[870] See making a similar claim: Berg, Davidson and Potts (n 17) 35 et seq.

[871] See *supra* Chapter 2.1. and the ingredients that make a disruptive technology.

[872] See *supra* Chapter 2.1. See Christensen (n 182) xv.

[873] Interview #15, Monique Morrow highlights that although it may sound idealistic, technology should be for good "because the potential for abuse is so high". In his closing speech at the ASA Conference 2018, Elliott Geisinger urged for critical thinking when it comes to blockchains and the associated risks, which reminded him of when social media came about more than a decade ago with all its promises. The speech was recorded and can be watched at Elliott Geisinger, *Closing Remarks* in 'ASA General Meeting & Conference 2018, Blockchain And Dispute Resolution: Current Projects' <https://www.youtube.com/watch?v=TScrd-L8fpE>.

306 In his treatise on *Transnational Legality*, Schultz conveys regarding what constitutes law and a legal order and what does not, that "[l]aw demands to be respected. Instances of law are regimes of effective governance that are to a large extent autonomous and for their greatest part not hierarchically submitted to any other normative system."[874] Can blockchain protocols be considered such "regimes of effective governance"? Following this line of thought, blockchains create their own normative systems, whose governance structures are not yet fully developed. Even if their governance structures may not be fully matured and optimally designed, a given blockchain, when operational, could be considered *de fac*to effective.

307 Aside from not controlling guns, public and permissionless blockchains are also decentralized, which constitutes another distinguishing factor. Blockchains' infrastructure thus becomes the central authority, the network itself, and not a separate institution as such. However, this quality leads to what Werbach calls "Vili's paradox",[875] referring to Vili Lehdonvirta, who is not only skeptical of blockchains' transformative effect – as mentioned above - but who also outlines a critical dilemma that blockchains face.[876] According to Lehdonvirta, governance is rule-making, which he estimates as being as important as the "rule system" and the "rule enforcer".[877] In a talk entitled "The Problem of Governance in Distributed Ledger Technologies",[878] he delves into the prisoner's dilemma[879] and the problem of cooperation.[880] Lehdonvirta outlines the issues that arise with third party enforcement, and highlights that for him the "promise of […] distributed ledger technologies is the idea that the problem of cooperation is solved by having a network-enforced cooperation rather than some central third party".[881] However, the paradox he depicts is that "once you address the problem of governance, you no longer need blockchain; you can just as well use conventional technology that assumes a

[874] Schultz (n 95) 13.
[875] See the Chapter called "Vili's paradox" in Werbach (n 7) 133 et seq.
[876] See Werbach (n 7) 133.
[877] Lehdonvirta (n 869). See also Vili Lehdonvirta, 'The Problem of Governance in Distributed Ledger Technologies - Professor Vili Lehdonvirta, OII', The Alan Turing Institute (*Youtube*, 2016) <https://www.youtube.com/watch?v=eNrzE_UfkTw>.
[878] Lehdonvirta (n 869). See also Lehdonvirta (n 877).
[879] The prisoner's dilemma is a well-known game theory problem, in which two players are faced with the option to either cooperate (cooperation, C) or refuse to cooperate (defection, D). If player A cooperates but player B refuses, A loses, and B has the best individual outcome. The socially most beneficial outcome would be for both players to cooperate but individually, it is not rational for the players to choose that route, that is why in the naturally occurring outcome both players in a prisoner's dilemma would lose.
[880] See Lehdonvirta (n 869). See Lehdonvirta (n 877).
[881] Lehdonvirta (n 869), Lehdonvirta (n 877).

trusted central party to enforce the rules, because you're already trusting somebody (or some organization/process) to make the rules".[882]

308 The World Economic Forum ("WEF") in collaboration with the law firm Latham & Watkins in a report entitled "Bridging the Governance Gap: Dispute resolution for blockchain-based transactions" published late 2020,[883] highlights that for off-chain governance disputes, blockchains need a "specific governance mechanism"[884] and that "decisions regarding the evolution of the blockchain network itself […] should be made through broad majority consensus rather than through an adversarial process".[885] This WEF report thus envisions a majority voting procedure for governance decisions, which are considered to be "more complex than disputes related to network transactions".[886] At the outset, this paradox seems unsolvable. If anything, governance may signify the rise and fall of blockchains, and it was, in fact, a governance issue that almost doomed Ethereum.

5.3.1.1 ***The DAO Hack – Setting a Precedent***

309 "The DAO" project launched in 2016 as a decentralized and supposedly autonomous venture fund on the Ethereum blockchain, in which governance rules were automated and enforced by code.[887] In a TechCrunch article it was described as a mix "between a traditional corporation, a VC fund and a Kickstarter".[888] It appeared as a "paradigm shift in the very idea of economic organization"[889] as it was supposed to offer "complete transparency, total shareholder control, unprecedented flexibility and autonomous

[882] Lehdonvirta (n 869). See There are many initiatives trying to solve this problem and projects conducting research on decentralized governance (dGov). See, e.g., 'Govbase' <https://github.com/thelastjosh/govbase>. See 'Metagov' <https://metagov.org/>.
[883] For more on this report specifically, see *infra* Chapter 5.5.4.
[884] Abdulhakim Alhabib et al., 'Bridging the Governance Gap: Dispute resolution for blockchain-based transactions' (World Economic Forum, Latham& Watkins, 2020) <https://www.weforum.org/whitepapers/bridging-the-governance-gap-dispute-resolution-for-blockchain-xbased-transactions> 7.
[885] Alhabib et al. (n 884) 7.
[886] Alhabib et al. (n 884) 7.
[887] See Russo (n 523) 181. (Russo explains that the project was named "The DAO as a placeholder and the community would vote on another name later"). See Nathaniel Popper, 'A Venture Fund With Plenty of Virtual Capital, but No Capitalist' (*The New York Times*, 2016) <https://www.nytimes.com/2016/05/22/business/dealbook/crypto-ether-bitcoin-currency.html> (The DAO described as a "sort of technology-enabled leaderless collective").
[888] Bannon (n 485).
[889] Bannon (n 485).

governance".[890] Its ambition was to make initial coin offerings ("ICOs") and related crowdfunding something that investors could feel more confident and safe about.[891] As a collective enterprise between all token holders, every token holder would have power to vote on the start-ups to fund.[892]

310 Christoph Jentzsch, founder and CTO of Slock.it then, who authored the Whitepaper,[893] hoped the DAO would become the "center of a decentralized sharing economy".[894] The project attracted far more interest than anyone expected and amassed around USD 150 million (equivalent to 12 million ETH at the price of USD 12,-) at the end of a month-long crowd sale.[895] Later, Jentzsch would regret not setting an upper limit.[896] The DAO held more than 14% of the total supply of ETH and became the largest crowdfunding in history at the time.[897]

311 However, it was experimental code written in the – at the time - new smart contract language Solidity on the still-nascent Ethereum blockchain.[898] These risks were explicitly mentioned in the terms and conditions on the ICO website of the DAO. Aside from security risks, the terms also mentioned "regulatory risks",[899] highlighting that "[b]lockchain technology and Ethereum are allowing new forms of interactions between

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[890] Bannon (n 485).
[891] See Russo (n 523) 180.
[892] See Klint Finley, 'A $50 Million Hack Just Showed That the DAO Was All Too Human' (*Wired*, 2016) <https://www.wired.com/2016/06/50-million-hack-just-showed-dao-human/>.
[893] See Jentzsch (n 487).
[894] See Matthew Leising, 'The Ether Thief' (*Bloomberg*, 2017) <https://www.bloomberg.com/features/2017-the-ether-thief/>, where Leising quotes Jentzsch.
[895] See Russo (n 523) 182.
[896] See Leising (n 894).
[897] See Dino Mark, Vlad Zamfir and Emin Gün Sirer, 'A Call for a Temporary Moratorium on The DAO' (*Hacking, Distributed*, 2016) <https://hackingdistributed.com/2016/05/27/dao-call-for-moratorium/>. Some sources say that the smart contract held 14%, others 16 or 17% ETH. See, e.g., Gavin Wood referring to 14% in Dutch Blockchain Conference, 'Gavin Wood Presentation Hack of the DAO Smart Contract and Options Ethereum Community' (*Youtube*, 2016) <https://www.youtube.com/watch?v=KaOGtH7J0WE>. Whereas Emin Gün Sirer in the full draft, refers to 16%, see Dino Mark, Vlad Zamfir and Emin Gün Sirer, 'A Call for a Temporary Moratorium on "The DAO" DRAFT (v0.3.2)' (2016) <https://docs.google.com/document/d/10kTyCmGPhvZy94F7VWyS-dQ4lsBacR2dUgGTtV98C40/edit#>. See Antonopoulos and Wood (n 28) 326. ("amassing nearly 14%").
[898] See Russo (n 523) 182. The Terms of The DAO token offering explicitly read: "The use of The DAO's smart contract code and the Creation of DAO tokens carries significant financial risk, including using experimental software." It also read under "Risks": "The DAO concept is both experimental in nature and unproven. There is a risk that, as an open source project, any contributor to The DAO's software could introduce weaknesses or bugs into the DAO software, causing the loss of DAO tokens or ETH in one or more or even all of the DAO Token Holder's accounts." See The DAO Community, 'Terms - Explanation of Terms and Disclaimer' <https://web.archive.org/web/20160501124801/https://daohub.org/explainer.html>.
[899] See The DAO Community (n 898).

individuals and/or companies, some of them are still to be imagined and implemented"[900] and that "it is very likely that specific regulations will be set in different jurisdictions targeting blockchain technology and more specifically DAOs [which] may or may not be DAO friendly".[901]

312 The DAO was designed so that token holders could withdraw their funds into a "child DAO" in case they dissented with the majority votes on a proposal.[902] However, the code had a major bug which an anonymous hacker exploited.[903] The bug is often compared to a faulty ATM where the balance is not checked until after the session ends and one can keep requesting to withdraw cash repeatedly.[904] The hacker thus kept draining funds he did not have into a child DAO, ending up with USD 55 million.[905]

313 Due to the DAO smart code's design, funds from child DAOs remained locked up for a 28-day waiting period, thus there was time for the community to decide on how to proceed.[906] This led to heated discussions on the immutability of blockchains and "code is law" during a period of Ethereum history that would later be remembered as the "DAO Wars".[907] Complicated questions arose in this context, such as:[908] Is code law? Are blockchains supposed to be immutable? Who is or can be made responsible for the loss of funds? Did DAO token holders have a contract, and was there an implicit one if there was no explicit contract? If so, with whom? The Ethereum foundation, the DAO project, the coders, or maybe the miners?

314 The Ethereum community was divided. One camp insisted on the notion that code is law and argued that the protocol should remain immutable, free from centralized influences. The arguments did not revolve solely around the "code is law" line. Supporters of this

[900] See The DAO Community (n 898).
[901] See The DAO Community (n 898).
[902] See Max Biederbeck, 'Der DAO-Hack: Ein Blockchain-Krimi aus Sachsen' (*GQ Magazin*, 2016) <https://www.gq-magazin.de/auto-technik/article/wie-aus-dem-hack-des-blockchain-fonds-dao-ein-wirtschaftskrimi-wurde>.
[903] See Daian explains it as a "multi-stage attack", see Phil Daian, 'Analysis of the DAO Exploit' (*Hacking, Distributed*, 2016) <https://hackingdistributed.com/2016/06/18/analysis-of-the-dao-exploit/>. See also 'How the DAO Hack Changed Ethereum' (*coindesk on Youtube,* 2020) <https://www.youtube.com/watch?v=unOp-r4-YrE>.
[904] See Klint Finley (n 892). See also Russo (n 523) 186.
[905] See Leising (n 894). At the time's ether price.
[906] See Biederbeck (n 902).
[907] See Biederbeck (n 902).
[908] Interview #6, Vinay Gupta. Gupta shared that the community contemplated such types of questions during the time of The DAO hack.

idea, for example, compared the DAO hack to Bitcoin's MtGox hack and the fact that Bitcoin did not perform a hard fork.[909] Some saw a moral hazard in taking action in the form of a hard fork, given the fact that there had been and would continue to be other losses made from other smart contracts.[910] In essence, some believed that performing a hard fork would cement a dangerous precedent. The opposing camp argued that the funds should be returned and that the risk to the Ethereum ecosystem if nothing was done was too high, since the DAO had attracted 14% of the total ETH supply. The attacker was holding 5% of the total ETH supply, considering that they could be regarded as a malicious actor, having an entity hold such a large amount of the native token could also impede Ethereum's prospects of moving into a PoS system.[911]

315 The whole situation was contentious. Aside from conflicts of interest, a misalignment of incentives could be observed. Members of the Ethereum foundation were invested in the DAO, even Vitalik Buterin. A hard fork and the possibility of another second blockchain springing to life also meant that every Ethereum holder would have an equal number of tokens on a separate blockchain, doubling the number of tokens they held.

316 Vitalik Buterin made it clear that "the Ethereum Foundation ha[d] no involvement in the DAO. All DAO token holders and curators [were] doing so as private individuals."[912] Furthermore, the terms of the ICO specified an extensive waiver of liability[913] and a disclaimer of warranties.[914] Interestingly, the terms also specify that "[n]othing in this explanation of terms or in any other document or communication may modify or add any additional obligations or guarantees beyond those set forth in The *DAO's code*. Any and all explanatory terms or descriptions are merely offered for educational purposes and do

[909] See, e.g., the thread started by VoiceOfTheEvolution, 'Devil's Advocate: What incentive is there for Ethereum holders who did not participate in The DAO to allow a hard fork' (*Reddit*, 2016) <https://www.reddit.com/r/ethereum/comments/4oz2io/devils_advocate_what_incentive_is_there_for/>. A reddit user named "discoltk", for example, shared that during the Mt Gox hack, "I remember longing for some kind of bailout. Maybe Satoshi himself would come and save the day. But that was a fantasy. The reality was I took a risk, I lost, I moved on, its well in the past. The DAO holders should do the same." See discoltk in VoiceOfTheEvolution 'Devil's Advocate: What incentive is there for Ethereum holders who did not participate in The DAO to allow a hard fork' (*Reddit*, 2016) <https://www.reddit.com/r/ethereum/comments/4oz2io/comment/d4grhkn/?utm_source=share&utm_medium=web2x&context=3>.

[910] See discoltk in VoiceOfTheEvolution (n 909).

[911] See Andreas M Antonopoulos, 'LTB: TheDAO, TheFork, TheFallout' (*Youtube*, 2016) <https://www.youtube.com/watch?v=Swdb-Z_4JmI>.

[912] Vitalik Buterin, '@VitalikButerin on Twitter 27 May 2016' (*Twitter,* 2016) <https://twitter.com/VitalikButerin/status/736357210394112000>.

[913] See The DAO Community (n 898).

[914] See The DAO Community (n 898).

not supercede [sic] or modify the express terms of *The DAO's code* set forth on the blockchain; to the extent you believe there to be any conflict or discrepancy between the descriptions offered here and the functionality of *The DAO's code* at 0xbb9bc244d798123fde783fcc1c72d3bb8c189413, *The DAO's code controls and sets forth all terms of The DAO Creation*."[915]

317 Essentially, the smart contract was to take precedence over all other terms. Gupta mentioned that there was a "running joke" that the hacker had done nothing wrong but had simply used the smart contract code in an unintended way.[916] In fact, the alleged hacker himself pointed to this very fact, citing the above provision and characterized the bug as a "feature" and that he had "rightfully claimed [„„] ether, and would like to thank the DAO for this reward".[917] Moreover, the self-proclaimed "attacker", in his open letter to the Ethereum community, argued that he was the "legitimate and rightful" owner of the ether he "claimed legally through the terms of a smart contract",[918] and warned against any kind of fork as he would otherwise take legal action.[919]

318 The severity of the situation put not only the specific project at risk but the whole Ethereum ecosystem,[920] having amassed more than 14 % of all ETH in circulation, the DAO had become "too big to fail".[921] The Ethereum community, faced with the dilemma, had to decide. A coin voting system was created called "carbonvote", whereby voting could be "conducted […] in a secure web-page fashion with the feature that the voting conducted did not require coins to leave voters' wallets".[922] The majority of voters, *i.e.,*

[915] See The DAO Community (n 898). Emphasis added.
[916] Interview #6, Vinay Gupta ("Now what's particularly ironic is that the DAO hack had a web page, which very specifically said 100% of the law involved in this transaction will be the smart contract, whatever the smart contract does is the law for this transaction, so there was a running joke, that the DAO hacker had simply used the contract in an unanticipated way, but the contract was the law therefore no crime has been committed.").
[917] 'The Attacker' (The Alleged DAO Hacker), 'An Open Letter' (*Pastebin*, 2016) <https://pastebin.com/CcGUBgDG>. Referred to here as the alleged hacker because it is impossible to say whether the source of the letter is truly the hacker or not, since the identity is not disclosed, and the posting of the letter is not linked to the account which created the split child DAO which drained the funds. The letter was not signed by the hacker's address that would allow to connect identities with a higher degree of probability and conclude that it was in fact the attacker who published this letter. However, the letter does portray what could have been the attacker's position in a way that at least serves the purposes of this analysis.
[918] 'The Attacker' (The Alleged DAO Hacker) (n 917).
[919] See 'The Attacker' (The Alleged DAO Hacker) (n 917).
[920] See Russo (n 523) 189.
[921] See Biederbeck (n 902). Staying consistent with the previously specified number of 14%, whereas it could have been anywhere from 14 to 17%. See Russo (n 523) 195 et seq.
[922] 'CarbonVote' <http://carbonvote.com/>.

87% preferred a hard fork to rewrite blockchain history and undo the DAO hack.[923] However, it turned out that the voter participation rate was low, only 5.5% of the total ETH holders participated, and a single account was responsible for 25% of the votes in favor of a DAO fork,[924] thus calling into question the legitimacy of the result.[925] On 20 July 2016, the mission was accomplished and the hard fork was completed.[926] However, some miners voted against the change with their computing power and continued validating blocks in the original version of Ethereum, thereby preserving what is now called "Ethereum Classic".[927]

319 This series of events not only shows the risks of code, even after audits have been conducted, but the extent to which contentious situations can lead to hard forks that divide the community and the blockchain. The two blockchains which now run separately from each other, Ethereum and Ethereum Classic, represent the two very different stances discussed in the DAO hack dilemma – "[to] reverse [or] not reverse".[928]

320 Gupta shared that after the reversal of the DAO hack, there was anticipation on whether the DAO hacker was going to sue, but the lawsuit never came.[929] However, even if the hacker wanted to bring a lawsuit, where would he have taken legal action, which court would have jurisdiction, and who would the claim be made against?[930] Maybe the hacker, aside from having to reveal his identity, did not want to go through the burdensome procedure of what litigation would mean in this context.[931]

321 Aside from the fact that there is no legal certainty as to what DAOs are, the hack also revealed difficult questions about governance that did not remain abstract but had to be dealt with by the Ethereum community in a very real way. Some legal experts explain that DAOs could be seen as legal partnerships, meaning that the members would have a

[923] For the historical vote, see 'Vote: TheDAO Hard Fork' <http://v1.carbonvote.com/>.
[924] See Elaine Ou, 'Stick a Fork in Ethereum' (*Elaine's Idle Mind,* 2016) <https://elaineou.com/2016/07/18/stick-a-fork-in-ethereum/>.
[925] See Vitalik Buterin, 'Notes on Blockchain Governance' (*Vitalik Buterin's Website*, 2017) <https://vitalik.ca/general/2017/12/17/voting.html>.
[926] See Russo (n 523) 205 et seq. The fork was based on Casey Detrio, 'EIP-779: Hardfork Meta: DAO Fork' (*Ethereum Improvement Proposals,* 2017) <https://eips.ethereum.org/EIPS/eip-779>.
[927] See Russo (n 523) 207.
[928] Interview #6, Vinay Gupta ("Right, and you know at this point Ethereum forks in two right, so you have two judicial opinions: we will reverse, we will not reverse.").
[929] Interview #6, Vinay Gupta.
[930] Interview #6, Vinay Gupta. Gupta identified these issues and explained that they were particularly difficult to solve.
[931] Interview #6, Vinay Gupta. Gupta calls this a "legally indeterminate situation".

duty of loyalty towards each other, which also depends on the jurisdiction where a claim is brought.[932] Any of the thousands of investors could go "forum shopping" in order to find a most friendly jurisdiction to establish their case.[933] According to Pamela Morgan, this event exemplifies the need for having a choice of law or arbitration clause in the terms and conditions because without such a clause everyone may be subjected to every jurisdiction.[934]

322 Among the first projects proposed to the DAO, was a Decentralized Arbitration and Mediation Network ("DAMN") by Andreas Antonopoulos and Pamela Morgan.[935] In the proposal, they highlighted the need for a "global, borderless justice system"[936] for the "global, borderless communication and transaction platform[s]"[937] and the now "global, borderless money".[938]

323 The DAO hack led to the realization that the governance mechanism in place for Ethereum was underdeveloped and what resulted was an experiment in *ad hoc* governance. A precedent was set but would it uphold?

5.3.1.2 ***The Parity Freeze – Departing from the Precedent***

324 In November 2017, a flaw in the Parity smart contract's library code caused the freezing of 513,774.16 ETH (at the time USD 160 million worth).[939] In total 587 wallets were affected by the vulnerability.[940] A user named "devops199" took over - presumably accidentally - a specific library contract and activated its "suicide function".[941] The user effectively "deleted" the smart contract in charge of the Parity multi-signature wallet, which means that anyone who had previously stored their tokens in this wallet could not

[932] Pamela Morgan in Antonopoulos, 'LTB: TheDAO, TheFork, TheFallout' (n 911).
[933] Pamela Morgan in Antonopoulos, 'LTB: TheDAO, TheFork, TheFallout' (n 911).
[934] Pamela Morgan in Antonopoulos, 'LTB: TheDAO, TheFork, TheFallout' (n 911). See *infra* Chapter 5.4.3.
[935] Andreas M Antonopoulos and Pamela Morgan, 'Decentralized Arbitration and Mediation Network' (*DAOhub Forum,* 2016) <https://web.archive.org/web/20170905111201if_/https://forum.daohub.org/t/decentralized-arbitration-and-mediation-network/3062>.
[936] Antonopoulos and Morgan (n 935).
[937] Antonopoulos and Morgan (n 935).
[938] Antonopoulos and Morgan (n 935).
[939] Parity Technologies, 'A Postmortem on the Parity Multi-Sig Library Self-Destruct' (*parity.io Blog*, 2017) <https://www.parity.io/a-postmortem-on-the-parity-multi-sig-library-self-destruct/>. Rachel-Rose O'Leary, 'Parity Team Publishes Postmortem on $160 Million Ether Freeze' (*coindesk*, 2017) <https://www.coindesk.com/parity-team-publishes-postmortem-160-million-ether-freeze/>.
[940] Parity Technologies, 'A Postmortem on the Parity Multi-Sig Library Self-Destruct' (n 939).
[941] Parity Technologies, 'A Postmortem on the Parity Multi-Sig Library Self-Destruct' (n 939).

withdraw them anymore.[942] It is worth mentioning that this happened although the contract had been audited by not only the Ethereum Foundation's developer team, but also by Parity Technologies and others.[943] This was the second tragedy for Parity that year, earlier some users' wallets had been affected by a hack.[944]

325 Lost or frozen funds were not something new, but the amount of ETH at stake in this issue was substantial. Some proposals to recover lost funds were made before the Parity incident. EIP 156, for example, proposed by Vitalik Buterin, would allow users to retrieve lost funds in "stuck" accounts.[945] After the Parity freeze, another proposal in the same category was made, EIP 867 suggested putting a process in place called "Standardized Ethereum Recovery Proposals", for retrieving lost funds in general, not limited to the Parity issue.[946]

326 However, no community consensus could be found, and three years later, it remains in a draft stage. Opposers to the protocol change argued that there was no need to create this type of safety mechanism on layer one as there could be insurance systems on layer two.[947] Also, some argued that having such a standardized process may lead to a "lost funds help desk" for Ethereum, which would go against the decentralization ethos and be susceptible to corruption.[948] Another contentious proposal, which was later withdrawn altogether, is EIP 999, geared explicitly towards retrieving the frozen Parity funds.[949]

327 Unlike the DAO incident, this was not presumed a hack or "theft", since the funds had not moved at all, users could still see them in their accounts, but they could not access

[942] Parity Technologies, 'On Classes of Stuck Ether and Potential Solutions' (*parity.io Blog*, 2017) <https://www.parity.io/on-classes-of-stuck-ether-and-potential-solutions/>.
[943] Parity Technologies, 'A Postmortem on the Parity Multi-Sig Library Self-Destruct' (n 939).
[944] See Parity Technologies, 'The Multi-Sig Hack: A Postmortem' (*parity.io Blog*, 2017) <https://www.parity.io/blog/the-multi-sig-hack-a-postmortem>.
[945] Vitalik Buterin, 'EIP 156' (*github,* 2016) <https://github.com/ethereum/EIPs/issues/156>. See Preethi Kasireddy, 'Breaking Down the EIP 999 Debate' (*Youtube*, 2018) <https://www.youtube.com/watch?v=PdngSGkkWJw>.
[946] Dan Phifer, James Levy and Reuben Youngblom, 'EIP-867: Standardized Ethereum Recovery Proposals' (*Ethereum Improvement Proposals,* 2018) <https://eips.ethereum.org/EIPS/eip-867>. See Kasireddy, 'Breaking Down the EIP 999 Debate' (n 945).
[947] See Kasireddy, 'Breaking Down the EIP 999 Debate' (n 945). For an explanation on the difference between layer one and layer two, see Petro Wallace, 'Layer 1 vs Layer 2 : What you need to know about different Blockchain Layer solutions' (*Medium*, 2020) <https://medium.com/the-capital/layer-1-vs-layer-2-what-you-need-to-know-about-different-blockchain-layer-solutions-69f91904ce40>.
[948] See Kasireddy, 'Breaking Down the EIP 999 Debate' (n 945).
[949] Afri Schoedon, 'EIP-999: Restore Contract Code at 0x863DF6BFa4469f3ead0bE8f9F2AAE51c91A907b4' (*Ethereum Improvement Proposals*, 2018) <https://eips.ethereum.org/EIPS/eip-999>.

them.[950] In the DAO hack, the hacker managed to siphon off more than 3 million ETH, almost seven times the amount implicated in the Parity freeze, and it happened when the ecosystem was not as mature. Most funds implicated in the Parity freeze belonged to Parity founder Gavin Wood's Web3 Foundation,[951] who is one of the most outspoken advocates of the "code is law" narrative and held a speech on what he calls "allegality".[952]

328 This was a clear departure from the precedent established in the 2016 hard fork to not proceed with a hard fork in the Parity issue in 2017. Many factors played a role, and the cases were different in nature. However, who decides? This type of inconsistency, the lack of standardized procedures, and clear communication channels for governance decisions create uncertainty. It is not entirely clear what level of community support is required and how this gets measured.[953] The community discusses these issues in a rather dispersed manner, on the Ethereum subreddit,[954] the Bitcoin subreddit,[955] the ethtrader subreddit,[956] different telegram channels,[957] on youtube,[958] on GitHub and different forums, such as the Ethereum Magicians forum[959] and on Twitter.

329 There are no standardized voting procedures for this type of question and no specific quorum that needs to be attained. Media outlets specializing in crypto topics, such as Coindesk or Cointelegraph, then filter this information and condense it and make it accessible to a wider audience. However, the reports can be perceived as distorted and

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[950] See Stan Higgins, 'Parity Floats Fix for $160 Million Ether Fund Freeze' (*coindesk,* 2017) <https://www.coindesk.com/parity-floats-fix-160-million-ether-fund-freeze>.

[951] See Ed Drake, 'Parity rejects Ethereum split proposal to recover lost $320M in ETH' (*coingeek*, 2018) <https://coingeek.com/parity-rejects-ethereum-split-recover-lost-320m-eth/>.

[952] Gavin Wood in 'CoinScrum & Proof of Work Present: Gavin Wood - Allegality, Recorded by IamSatoshi', POW Media (*Youtube*, 2015) <https://www.youtube.com/watch?v=Zh9BxYTSrGU>. See the issue discussed by Brian Fabian Crain, Meher Roy and Sébastien Couture, 'Post DevCon3 Roundtable: State of Ethereum, Cosmos Retreat and Parity Hack' (*Epicenter Podcast Episode 208*) <https://epicenter.tv/episodes/208/>.

[953] Péter Szilágyi, '@peter_szilagyi on Twitter on 25 April 2018' (*Twitter*, 2018) <https://twitter.com/peter_szilagyi/status/989133355571728385?s=20>. A coindesk journalist, for example, asked these questions to Péter Szilágyi.

[954] 'Ethereum's Reddit' (*Reddit*) <https://www.reddit.com/r/ethereum/>.

[955] 'Bitcoin - The Currency of the Internet's Reddit' (*Reddit*) <https://www.reddit.com/r/bitcoin>.

[956] 'The Ethereum Investment Community's Reddit' (*Reddit*) <https://www.reddit.com/r/ethtrader/>.

[957] Each DApp on Ethereum usually has a community telegram chat (and/or discord, slack), where they discuss project related and Ethereum community wide issues as well as crypto in general. In these open and public channels, users discuss events and implications to their projects and investments. Contentious issues that affect the whole ecosystem, such as a controversial hard fork, may be discussed in all these channels, aside all the private channels where smaller groups assemble.

[958] Such as when influencers discuss a topic and voice their opinion on Youtube and members of the community may respond in the comment section. See, e.g., Julian Hosp, 'EN: Will EIP-999 cause another Ethereum hard fork? (English)' Dr. Julian Hosp - Bitcoin, Aktien, Gold und Co. (*Youtube*, 2018) <https://www.youtube.com/watch?v=dD-7eTH1F2Y>.

[959] 'Ethereum Magicians Forum' <https://ethereum-magicians.org/>.

sometimes inaccurate.[960] These kinds of problems are perhaps inevitable for untested new infrastructures in cyberspace, where even regulators seem to have trouble figuring out what they are. Nevertheless, it is unwise to look the other way and think that this will take care of itself. The larger the network grows, the more important viable dispute resolution procedures become.

5.3.2 Payment Channel and Oracle Disputes

330 Off-chain transactions are enabled through so-called "layer-two protocols", which "scale blockchains without changing the layer-one trust assumptions".[961] Some researchers distinguish different blockchain layers: the hardware layer, the network layer (public/private, p2p), and the blockchain layer.[962] On the blockchain layer, "[a] transaction can exchange digital assets between parties or invoke an application (i.e. smart contract)".[963] One may define "[a] layer-two protocol [as being] outside of, but tethered to, a layer-one blockchain".[964] Layer-two protocols aim to solve the scalability problem in blockchains. Of interest to this thesis is the fact that "[a]uthenticated assertions are submitted to the parent-chain only in cases of a dispute, with the parent-chain deciding the outcome of the dispute".[965] The dispute for payment channels is described in the following way: "If an honest party does not receive *n* signatures before a local timeout, it assumes that there has been a disagreement about the proposed state. The honest party may trigger a layer-one *dispute* and enforce a new state transition without the cooperation of the other parties."[966]

331 Parties that only transact once will usually not need a payment channel of their own, as such channels are more suitable for parties that transact often.[967] Since the transactions happen off-chain, the same level of security is not achieved as for on-chain transactions. One party could try to take advantage of the other. There are different attempts in literature that address this issue by incorporating conflict resolution mechanisms. Some

[960] See, e.g., Vitalik Buterin, '@VitalikButerin on Twitter 26 April 2018' (*Twitter*, 2018) <https://twitter.com/VitalikButerin/status/989527277892386816?s=20>.
[961] Gudgeon and others (n 84) 202. Emphasis omitted.
[962] See Gudgeon and others (n 84) 203–204.
[963] Gudgeon and others (n 84) 204.
[964] Gudgeon and others (n 84) 204.
[965] Gudgeon and others (n 84) 204.
[966] Gudgeon and others (n 84) 205.
[967] See Georgia Avarikioti and others, 'Brick: Asynchronous Payment Channels' 1 (*arXiv*, 2019) <http://arxiv.org/abs/1905.11360>.

claim that the layer-one blockchain itself serves as a form of dispute resolution.[968] One solution called "BRICK" incorporates a "conflict resolution process within the channel by introducing a rational committee of external parties, called Wardens".[969] Further technical details will not be discussed here. However, this illustrates that there are blockchain disputes that may occur due to the technical specificities and the design of blockchains that incorporate layer-two solutions. Dispute resolution in the form of "watchtowers" or "wardens" are ways in which security issues and possible attacks may be prevented.[970]

332 Another type of dispute in the applications category is oracle disputes. Oracles feed smart contracts with real-world information.[971] These are conceptually different from payment channels. They do not relate to layer-two transaction data, which are mostly objectively verifiable, but are related to data sources of some real-world events. Such data sources can be subjective, *i.e.,* they are not mathematically verifiable but reflect weather data, price data, location data, and other types of real-world data. Disputes may arise if the data collected in the data source is incorrect or if the transmission of correct data is faulty. Such disputes may arise more frequently in the future with the widespread use of oracles. If such disputes are resolved by crypto arbitration, such as Kleros, which itself could be seen as an oracle, this may lead to the comical situation that one oracle resolves the dispute that occurred due to another oracle.

5.3.3 Smart Contract, DAO, and DApp Disputes

333 In its basic form, smart contracts, which fuel lively decentralized applications and transactions on blockchains, could be regarded as a form of dispute resolution or prevention.[972] Blockchain advocates can portray the image that smart contracts require less dispute resolution, possibly even do away with it altogether. However, that this is not

[968] See Elizabeth Stark, 'Elizabeth Stark of Lightning Labs: "The Importance of Layer Two" | Blockstack Summit 2017' Stacks, (*Youtube*, 2017) <https://www.youtube.com/watch?v=3PcR4HWJnkY>. In Interview #3, Clément Lesaege explained that blockchains can be used as some sort of "computational court" or "computational arbitration" and that mostly in the payment channel no one will try to cheat but if someone does, one goes to the blockchain itself, and because this possibility exists, people will usually not misbehave.

[969] Avarikioti and others (n 967) 1.

[970] See Avarikioti and others (n 967) 1.

[971] See *supra* Chapter 2.4.11.

[972] Palombo and Battaglini (n 522) 261 ("One could argue that smart contracts are in itself a dispute resolution method—or at least a way to prevent proper disputes—since they can gather information and determine the outcome of a certain transaction").

so was described in the Financial Times with the words that there is an "inconvenient truth buried in the promises being made by blockchain advocates",[973] "the promise that blockchain-supported smart-contracts could disintermediate the powers that be and replace them with a self-organising decentralised system".[974] What is that inconvenient truth? That even a system purporting to be self-enforcing and free of inefficiencies cannot avoid disputes, the "fly in the ointment of the smart-contract revolution" as Kaminska writes.[975]

334 Some argue that blockchains are designed in a way to strive for conflict prevention by blocking conflicts from emerging and that the most important techniques to achieve this goal are all the main features of smart contract protocols, namely immutability, self-enforcement, the mining procedure, decentralization, and cryptography.[976] However, even a seamlessly executed smart contract may end up not fulfilling the parties' expectations, and the results may be different from what the parties had intended. A myriad of issues can still occur in many stages of the process, from the design to the execution of a smart contract. And even new types of disputes, difficult to foresee at present, may arise. Smart contracts are software code written by humans, after all.[977]

335 Although the feature of immutability creates trust between parties, in exceptional cases, however, changes may be necessary, such as to prevent or remedy a bug, a faulty or criminal activity or transaction.[978] The consequences of coding errors, in general, can be significant, leading to unexpected outcomes as seen in COVID-19 tracing apps or - as Michaelson and Jeskie note - sometimes even tragic results, as has been shown by Boeing's 737 Max plane crashes.[979] Although such tragedies remain unlikely in most

[973] Izabella Kaminska, 'Decentralised Courts and Blockchains' (*Financial Times*, 2016) <https://www.ft.com/content/b59d19fc-123f-3be1-bdf9-b89d373183a5>.
[974] Kaminska (n 973).
[975] Kaminska (n 973).
[976] Jenni Hakkarainen's Presentation on "Who needs dispute resolution? Conflict prevention in blockchain networks" at the Max Planck Institute Luxembourg on 6 December 2019: Blockchain and Procedural Law: Law and Justice in the Age of Disintermediation, 2nd Seminar: Automating Legal Instruments.
[977] Although even such human involvement is not a given in future. See Khari Johnson, 'AI Could Soon Write Code Based on Ordinary Language' (*Wired*, 2021) <https://www.wired.com/story/ai-write-code-ordinary-language/>. ("'If you can describe what you want to do in natural language, GPT-3 will generate a list of the most relevant formulas for you to choose from,' said Microsoft CEO Satya Nadella in a keynote address at the company's Build developer conference. 'The code writes itself.'").
[978] See Erbguth (n 79).
[979] In Germany a coding error in a Covid-19 tracing app, instead of curtailing the spread, potentially caused a further spread of the virus. See Dominik Lauck, 'Corona-Warn-App: IPhone-Lücke War Seit Wochen Bekannt' (*tagesschau.de,* 2020) <https://www.tagesschau.de/investigativ/corona-warn-app-121.html>. See

smart contract coding error cases, economic losses and disputes can still happen,[980] as has been evidenced by the prominent "The DAO" incident.[981] Thus, a smart contract bug may lead to having wider consequences, affecting an entire blockchain ecosystem. What may start out as a smart contract dispute, could thus lead to a DApp or DAO dispute, and ultimately a governance dispute. The lines separating these different disputes are thus blurry, especially regarding the application layer disputes because DApps and DAOs build directly upon smart contracts.

336 DAOs are company-like structures that run autonomously on blockchains and are enabled through smart contracts.[982] The types of disputes can vary considerably, they may have different constellations and relate, for example, either to members within a DAO, who may want to dispute a proposal or a DAO and another DAO, among other variants. Aside from the prominent The DAO hack,[983] there have been other disputes regarding DAOs. One would assume that when disputes arise between DAOs, these would be resolved through blockchains.

337 However, in 2020 Aragon,[984] a platform for DAOs, took legal action against Autark, a project offering tools for DAOs.[985] The dispute was not resolved using Aragon Court, but rather by way of traditional legal procedures, a claim was filed in Switzerland.[986] Aragon's move faced criticism and the viability of the Aragon Court was put into question if not even Aragon wants to use it.[987]

Peter L Michaelson and Sandra A Jeskie, 'Arbitrating Disputes Involving Blockchains , Smart Contracts , and Smart Legal Contracts' [2020] 74 Dispute Resolution Journal 113–114. The Boeing's 737 Max plane crashes caused 346 deaths, see e.g., Alistair Smout and David Shepardson, 'New 737 MAX software flaw found during tests, Boeing sticks to return timeline' (*Reuters,* 2020) <https://www.reuters.com/article/us-boeing-737max-idUSKBN20026S>. Also in the early 90s, coding errors have led to lethal results; see Michael Barr, 'Lethal Software Defects: Patriot Missile Failure' (*Embedded Gurus - Experts on Embedded Software*, 2014) <https://embeddedgurus.com/barr-code/2014/03/lethal-software-defects-patriot-missile-failure/>.

[980] Michaelson and Jeskie (n 979) 113–114. See also Alex Groce and others, 'What are the Actual Flaws in Important Smart Contracts (and How Can We Find Them)?' (*arXiv*, 2019) <https://arxiv.org/abs/1911.07567> (The article categorizes 246 individual defects in smart contracts, ranging from configuration, logic, data exposure, coding bugs, front-running, cryptography, and code-quality issues, among others.).

[981] See *supra* Chapter 5.3.1.1.

[982] See *supra* Chapter 2.4.10.

[983] See *supra* Chapter 5.3.1.1.

[984] See *infra* Chapter 5.4.6.

[985] Luis Cuende, '@licuende on Twitter on 22 May 2020' (*Twitter*, 2020) <https://twitter.com/licuende/status/1263845843125370880>. See Cooper Turley, 'DAO Legal Battle: Aragon vs Autark Community Grant Dispute' (*DeFi Rate*, 2020) <https://defirate.com/aragon-autark/>.

[986] See Turley (n 985). See also Alhabib et al. (n 884) 8.

[987] See Turley (n 985). See also Eva Beylin, '@evabeylin on Twitter on 22 May 2020' (*Twitter*, 2020) <https://twitter.com/evabeylin/status/1263874348445622274>.

338 In the experimental designs of DAOs – as in the crypto space more generally, – members run the risk of being hacked and suffering significant losses on their investments. In 2021, a hacker "hijacked" the governance mechanism of a DAO, printed tokens before selling it all off and crashing the entire system.[988] Also, it is difficult to imagine that smart contracts will be immune to ambiguous terms that need interpretation. And certain terms are difficult to code, such as "best efforts", for example. Even if the DAO code is secure, unforeseeable disputes may arise, and with more mainstream adoption of DAOs and smart contracts, suitable dispute resolution mechanisms are needed.[989]

5.3.4 Other Types of Disputes

339 What has become evident from the previous chapters outlining the various types of blockchain-related disputes, is that the lines separating these are not clearly drawn, as disputes in one layer may have repercussions in other layers. Within these larger categories, there are many more variants and dispute types. The mechanisms to resolve disputes can either be on- or off-chain, depending on the procedure adopted. Governance disputes, for example, are generally put to the vote and with enough community backing may lead to a change in the layer-one protocol. This procedure may either be on- or off-chain. Payment channel disputes rely on the infrastructure to settle disputes between parties, they thus mostly rely on an on-chain dispute settlement mechanism. Both on- and off-chain procedures are possible for DAOs, DApp disputes as well as smart contract disputes.

340 Some cases have been brought before courts and arbitral tribunals (off-chain).[990] In China, the Shenzhen Court set aside an arbitral award related to Bitcoin on the grounds of public policy.[991] In the award, the exchange between bitcoin and legal tenders was

[988] See DetroitMotorShow, 'Hacker hijacked DAO governance, printed himself 11.8 Billion tokens and sold all of it, crashing the price of TrueSeigniorageDollar to zero' (*Reddit*, 2021) <https://www.reddit.com/r/CryptoCurrency/comments/m54w0t/hacker_hijacked_dao_governance_printed_himself/>.

[989] See writing about the need for dispute resolution for DAOs, Julián Bordet, 'Decentralized Autonomous Organizations: Ethereum Sparks Up Googles of Tomorrow' (*Cointelegraph*, 2016) <https://cointelegraph.com/news/decentralized-autonomous-organizations-ethereum-sparks-up-googles-of-tomorrow>.

[990] See Interview #9, Employee at Arbitral Institution ("We have had cases related to blockchain, but the actual dispute hasn't been related to blockchain, but it's rather been companies working with various blockchain applications getting into disputes with other companies.").

[991] See Arthur Dong, 'Zheyu GAO v. Shenzhen Yun SilkRoad Innovation Development LLP & Bin LI, Intermediate People's Court of Shenzhen, (2018) Yue 03 Minte 719, 26 April 2020' [2021] A contribution by the ITA Board of Reporters (Kluwer Law International).

recognized, although the People's Republic of China does not recognize bitcoin as legal tender, nor does it allow for such exchange.[992] On public policy grounds, another arbitral award that dealt with bitcoin loan agreements was denied enforcement in the Netherlands.[993] The reason was that the respondent did not know of the arbitration against him and was thus not given a fair opportunity to present his case.[994] The arbitral awards also did not indicate any seat of arbitration.[995] In Austria, at least one case - however, not an arbitral award - was brought on appeal before the Supreme Court relating to a bitcoin transaction.[996] The Austrian Supreme Court rejected the jurisdiction of Austrian courts according to private international law, which in its estimation would lead to the competence of courts at the defendant's domicile in Germany.[997] Other types of disputes have occurred concerning ICOs,[998] domain names,[999] and others.

341 In an analysis of 320 litigation cases of the past decade related to blockchains, bitcoin, and cryptoassets, Schrepel discovered that 80% of the cases were civil, followed by 35% in criminal matters.[1000] Besides courts, arbitral tribunals have also had cases related to blockchains, where companies involved in the blockchain industry had their disputes resolved in institutional arbitration.[1001]

[992] See Dong (n 991).
[993] See 'Netherlands No. 67, X v. Y, Gerechtshof, Amsterdam, Case No. 200.234.175/01, 29 January 2019' in Stephan W Schill (ed), *Yearbook Commercial Arbitration 2019 - Volume XLIV* (Kluwer Law International; ICCA 2019).
[994] See 'Netherlands No. 67, X v. Y, Gerechtshof, Amsterdam, Case No. 200.234.175/01, 29 January 2019' (n 993).
[995] See 'Netherlands No. 67, X v. Y, Gerechtshof, Amsterdam, Case No. 200.234.175/01, 29 January 2019' (n 993).
[996] See Austrian Supreme Court (OGH) Judgment, 3 Ob 95/20x.
[997] See Austrian Supreme Court (OGH) Judgment, 3 Ob 95/20x.
[998] E.g., Swiss-based Tezos Foundation's lawsuit concerning its ICO raising $232 million in 2017 as an unregistered securities sale was settled with investors. See Paddy Baker, 'Tezos Investors Win $25M Settlement in Court Case Over $230M ICO' (*Coindesk*, 2020) <https://www.coindesk.com/tezos-investors-win-25m-settlement-in-court-case-over-230m-ico>.
[999] At the WIPO Arbitration and Mediation Center and the National Arbitration Forum. Search results of keywords "blockchain" and "arbitration" in Westlaw show at least 51 domain name disputes.
[1000] See Schrepel (n 101).
[1001] See Interview #9, Employee at Arbitral Institution (n 990). The nature of the cases was not disclosed.

5.4 Blockchain Dispute Resolution Projects and Approaches

342 Certain companies in the crypto economy are tackling how to resolve blockchain disputes. This chapter will outline some of the attempts stemming from crypto communities and the blockchain industry. It is helpful to first distinguish between on-chain and off-chain arbitration, define these phenomena, and contrast them to other forms of dispute resolution. On-chain dispute resolution applications differ from off-chain dispute resolution in significant ways. "On-chain" means occurring on a specific blockchain, whereas "off-chain" means an event that takes place outside of a blockchain, such as traditional arbitration or national court systems, without reliance on any specific DApp.

343 On-chain arbitration services have emerged that combine dispute resolution with the advantages of blockchains. The most advanced working example of an on-chain arbitration,[1002] giving rise to what this thesis terms "crypto arbitration", is Kleros.[1003] Besides Kleros, Aragon Court has a similar prototype,[1004] which has not been launched yet, and Jur's Open Layer is inoperative and still in a testing phase.[1005]

344 All other projects are rather off-chain solutions, for example, Mattereum,[1006] OpenCourt,[1007] or LexDAO.[1008] Some appear to be off-chain solution with unclear stages of development and may have become inactive, such as SmartArb,[1009] Cryptonomica Arbitration,[1010] or RHUbarb.[1011] Others again have either ceased to exist, have pivoted into other areas, appear on standby, have no active community, or are simply

[1002] Since blockchains are used to facilitate crypto arbitration, it will be categorized as an on-chain procedure. However, one could argue that such a procedure is not fully on-chain, especially if a resulting arbitral award is not self-enforceable, humans are involved in the decision-making process, and because Kleros itself can be considered an oracle, and as such connects off-chain and on-chain data.
[1003] See *infra* Chapter 5.4.5.
[1004] See *infra* Chapter 5.4.6.
[1005] See *infra* Chapter 5.4.7.
[1006] See *infra* Chapter 5.4.8.
[1007] See *infra* Chapter 5.4.9.
[1008] See *infra* Chapter 5.4.9.
[1009] 'SmartArb' <https://smartarb.org> The Webpage reads that they are "developing special expertise for disputes arising out of Smart Contracts on the Blockchain".
[1010] GitHub only shows one developer and little activity. See 'Cryptonomica Arbitration: Online Dispute Resolution' <https://cryptonomica.net/#!/arbitration>. See 'Cryptonomica White Paper' <https://github.com/Cryptonomica/cryptonomica/wiki/Cryptonomica-White-Paper>.
[1011] 'RHUbarb' <https://www.rhucoin.com/home.aspx>. Holders of "RHUCoin" get to vote on different polls regarding disputes. However, the whitepaper was not accessible.

inaccessible.[1012] Examples include Jury.Online,[1013] Juris,[1014] DAMN,[1015] SAMBA,[1016] Confideal,[1017] Sagewise,[1018] ECAF,[1019] Oath Protocol,[1020] CodeLegit Blockchain Arbitration,[1021] Jincor,[1022] and many others. Bitrated,[1023] which provides an arbitration marketplace, where anyone can provide dispute resolution services in exchange for fees, seems to have declined in activity. Mechanisms that are similar in design but differ significantly in purpose are prediction markets and oracles such as, *e.g.,* Augur,[1024] Gnosis,[1025] and Polkamarkets.[1026]

345 The following subchapters explore the varied ways in which dispute resolution has and is being attempted on blockchains. Some attempts are only at a prototype stage, others have not yet been tested, still others have been abandoned altogether. The selection was carefully made to give different perspectives and trace the historical development of still nascent blockchain ecosystems' take on dispute resolution. The broad approaches can be

[1012] These projects are either known as abandoned or have pivoted. They may have no, an inaccessible or only an outdated website. Some websites, if still functioning, are redirected, or have changed. There is no community or if there is one, it is not active. They do not provide viable means of communication, or if they do and are contacted, do not respond.

[1013] Website jury.online inaccessible, Jury.Online Token discontinued, see 'Jury.Online Token' (*coinmarketcap*) <https://coinmarketcap.com/de/currencies/jury-online-token/>.

[1014] The website jurisproject.io turned into 'Juris' <getjuris.com>. However, none of these are accessible anymore.

[1015] See *infra* Chapter 5.4.3.

[1016] The Website is down: 'The Smart Arbitration & Mediation Blockchain Application of the Miami Blockchain Group' <http://www.miamiblockchaingroup.com/>. However, an introduction into the SAMBA project and a demo can be watched here at the recorded launch event: Alexander Fischetti, 'BLOCKCHAIN ADR 14 Apr 2018' <https://www.youtube.com/watch?v=X7WQgw_vEwU>.

[1017] They seemed to have pivoted into "an independent marketing website which only acts as an introducer to companies that offer share trading capabilities". See 'Confideal' <https://confideal.io>. See Confideal, 'Why is blockchain-based Arbitration the only future for dispute resolution?' (*Medium*, 2017) <https://medium.com/@confideal/why-is-blockchain-based-arbitration-the-only-future-for-dispute-resolution-93e34d99ec83> .

[1018] See *infra* Chapter 5.4.3.

[1019] See *infra* Chapter 5.4.4.

[1020] See Michael Wurzinger, 'OATH Protocol — The Conflict Resolution System for the Future!' (*Medium*, 2018) <https://medium.com/@michaelwurzinger/oath-protocol-the-conflict-resolution-system-for-the-future-3191fd19412c>.

[1021] See *infra* Chapter 5.4.9.

[1022] Website not updated, no activity on twitter since 2018, last tweet was regarding the possibility to get an ICO refund. See Jincor (@jincor_ico), 'Jincor Regarding ICO Refund Mechanism' (*Twitter,* 2018) <https://twitter.com/jincor_ico/status/969157919999700992>. Jincor seems to have ceased to exist that year. See 'Jincor FAQ: Arbitration System' <http://www.jincor.com/faq> .

[1023] 'Bitrated - About' <https://www.bitrated.com/about>. See also *infra* Chapter 5.4.1.

[1024] 'Augur' <https://augur.net>.

[1025] 'Gnosis' <https://gnosis.io/>.

[1026] See Kiefer Begum, 'Decentralizing Prediction Markets: Augur Vs. Gnosis Vs. Polkamarkets' (*hackernoon*, 2021) <https://hackernoon.com/decentralizing-prediction-markets-augur-vs-gnosis-vs-polkamarkets-cc3v33ef>. For an explanation on the difference between these markets and Kleros, see Clément Lesaege and William George, 'Kleros and Augur — Keeping people honest on the blockchain through game theory' (*Medium*, 2018) <https://medium.com/kleros/kleros-and-augur-keeping-people-honest-on-ethereum-through-game-theory-56210457649c> .

categorized into multisignature wallets, decentralized arbitration and mediation networks, so-called "governed" blockchains, crypto arbitration, and more generally, off-chain arbitration.

5.4.1 From Escrow to Multisignature Addresses

346 As the first blockchain, Bitcoin has no in-built dispute resolution mechanism. Satoshi Nakamoto notes that for financial institutions, "[c]ompletely non-reversible transactions are not really possible, since financial institutions cannot avoid mediating disputes".[1027] In contrast, it seemed, Bitcoin would offer such irreversible transactions that do not need to be disputed. However, in the next paragraph, Nakamoto continues that "[t]ransactions that are computationally impractical to reverse would protect sellers from fraud, and routine escrow mechanisms could easily be implemented to protect buyers."[1028] Nakamoto thus hints at the fact that both sellers and buyers would need some sort of protection. While Bitcoin's design inherently protects sellers, buyers are not protected at all unless escrow mechanisms are used. Nakamoto in the Bitcoin Whitepaper not only proposes a p2p electronic cash system but also makes a concession that escrow would be needed to protect buyers. In later communications, Nakamoto mentions arbitration for the first and only time. On 17 June 2010, Nakamoto stated that "[t]he design [of Bitcoin] supports a tremendous variety of possible transaction types that I designed years ago. Escrow transactions, bonded contracts, third party arbitration, multi-party signature, etc. If Bitcoin catches on in a big way, these are things we'll want to explore in the future, but they all had to be designed at the beginning to make sure they would be possible later."[1029]

347 In a series of Bitcointalk Forum posts from late July to September 2010, Satoshi Nakamoto answered questions regarding escrow and multi-signature transactions.[1030] On 7 August 2010, Nakamoto proposed "an outline of the kind of escrow transaction that's possible in software", which he would not have time to implement.[1031] Nakamoto

[1027] Nakamoto, 'Bitcoin: A Peer-to-Peer Electronic Cash System' (n 52) 1.
[1028] Nakamoto, 'Bitcoin: A Peer-to-Peer Electronic Cash System' (n 52) 1.
[1029] Satoshi Nakamoto, 'Satoshi Nakamoto Referring to Third Party Arbitration' (*Bitcointalk Forum*, 2010) <https://bitcointalk.org/index.php?topic=195.msg1611#msg1611>. This seems to be the one and only time Satoshi Nakamoto uses the term "arbitration". See also Phil Champagne, *The Book of Satoshi - The Collected Writings of Bitcoin Creator Satoshi Nakamoto* (E53 Publishing LLC 2014) 161.
[1030] See Champagne (n 1029) 219 et seq.
[1031] Satoshi Nakamoto, 'Escrow' (*Bitcointalk Forum*, 2010) <https://bitcointalk.org/index.php?topic=750>.

envisioned a buyer paying a seller by putting the money in escrow and the seller not being able to access the funds until the buyer released them:[1032]

> "The buyer can release the payment at any time after that, which could be never. This does not allow the buyer to take the money back, but it does give him the option to burn the money out of spite by never releasing it. The seller has the option to release the money back to the buyer. While this system does not guarantee the parties against loss, it takes the profit out of cheating. If the seller doesn't send the goods, he doesn't get paid. […] The buyer can't benefit by failing to pay. He can't get the escrow money back. He can't fail to pay due to lack of funds."[1033]

348 The reaction was positive, but some saw little utility by having no recourse "except burning the money".[1034] One user, whose pseudonym is aceat64, suggested that "[p]erhaps we could work in a way to do arbitration. If both the buyer and seller agree, the money can be diverted to a 3rd party. That person could then arbitrate and either return the money to the buyer, give it to the seller or steal it (obviously you'd want to choose a trustworthy arbitrator)."[1035] This shows that dispute resolution was discussed early on in the blockchain community. However, even if one implements escrow, there is no viable recourse mechanism if bitcoins are sent to the wrong address or if private keys are lost.

349 Escrow involves a third party on behalf of the transacting parties, who holds the funds until both parties have fulfilled their respective obligations.[1036] An evolution from escrow through middlemen is the implementation of so-called multi-signature ("multisig") addresses.[1037] Ortolani explains that the difference between a multisig system and escrow is that in the former, "the third party cannot unlock the funds autonomously […]. Hence, this system protects users against fraudulent behaviours on the part of escrow service providers."[1038] Multisig technology was first used for Bitcoin addresses in 2012 and serves as a security mechanism, whereby funds can only be accessed using multiple

[1032] See Nakamoto, 'Escrow' (n 1031).
[1033] Nakamoto, 'Escrow' (n 1031).
[1034] See Jeff Garzik's (jgarzik) response in Nakamoto, 'Escrow' (n 1031).
[1035] See user aceat64 response in Nakamoto, 'Escrow' (n 1031). See also Champagne (n 1029) 223.
[1036] See Caroline Banton, 'Escrow' (*Investopedia*, 2021) <https://www.investopedia.com/terms/e/escrow.asp>.
[1037] See Ortolani, 'Self-Enforcing Online Dispute Resolution: Lessons from Bitcoin' (n 104) 610.
[1038] Ortolani, 'The Three Challenges of Stateless Justice' (n 104) 605, Footnote 27.

signatures.[1039] Each party may hold a key in a 2-of-3 multisig address,[1040] for example, Alice has a secret key, so does Bob, and so does Charlie. Funds can then only be accessed or transferred if two keys are used.[1041] If no dispute occurs, the parties can both sign the transfer. However, if a dispute arises, the parties will not cooperate and will thus rely on Charlie holding the additional key to resolve the conflict.[1042] When Charlie resolves the conflict, he will sign the transaction together with the winning party and release the funds.

350 In 2019, Ortolani observed that "adjudication based on multi-signature addresses seems to be a unique form of transnational arbitration, operating outside of the shadow of State law with a high degree of finality and self-sufficiency".[1043] In 2019, as much as 30 percent of bitcoins in circulation were stored in such multisigs and that percentage has remained constant ever since.[1044] Multisig addresses can be considered one of the first and earliest examples of dispute resolution mechanisms implemented on blockchains in individual transactions and have been used in the Bitcoin network.[1045]

[1039] See 'What Is a Multisig Wallet?' (*Binance Academy*) <https://academy.binance.com/en/articles/what-is-a-multisig-wallet>.

[1040] Different combinations are possible, e.g., 2-of-2, 3-of-3, 3-of-4, 4-of-4 etc. See Ortolani, 'Self-Enforcing Online Dispute Resolution: Lessons from Bitcoin' (n 104) 610.

[1041] See Ortolani, 'Self-Enforcing Online Dispute Resolution: Lessons from Bitcoin' (n 104) 610. See also 'What Is a Multisig Wallet?' (n 1039).

[1042] See Ortolani, 'Self-Enforcing Online Dispute Resolution: Lessons from Bitcoin' (n 104) 610. See also 'What Is a Multisig Wallet?' (n 1039).

[1043] Ortolani, 'The Impact of Blockchain Technologies and Smart Contracts on Dispute Resolution: Arbitration and Court Litigation at the Crossroads' (n 99) 435.

[1044] See Ortolani, 'The Impact of Blockchain Technologies and Smart Contracts on Dispute Resolution: Arbitration and Court Litigation at the Crossroads' (n 99) 435. See 'BTC Held in P2SH Addresses' <https://txstats.com/dashboard/db/home-dashboard?orgId=1>. For more, see 'Pay to Script Hash' <https://en.bitcoin.it/wiki/Pay_to_script_hash>.

[1045] See generally, Ortolani, 'Self-Enforcing Online Dispute Resolution: Lessons from Bitcoin' (n 104) 610. See 'What Is a Multisig Wallet?' (n 1039). See Ortolani, 'The Three Challenges of Stateless Justice' (n 104) 604-608. Ortolani also makes reference to 'Bitrated - About' (n 1023). Bitrated is one of the marketplaces offering "trust agents" that sellers and buyers can choose from. The agent will then receive a third key in such multisig transactions. However, the marketplace seems to be rather inactive and it is not clear how successful it is, some of the arbitrators shown as being popular on the webpage only have received few comments in the last months, and many comments seem to be spam rather than feedback on the arbitrator's performance, and actual reviews seem to date back years. It is possible that users have found other means to mediate their transactions, such as through special wallets that offer multsig possibilities. On Ethereum, one could view smart contracts as escrow-agents. Ethereum also has multisig solutions, such as 'Gnosis' (n 1025).

5.4.2 The Idea of a Decentralized Court

351 On 26 April 2016, Vitalik Buterin published a Reddit post, entitled "Decentralized Court" that begins this way:[1046]

> "One crypto-institution that would be very useful for a large set of different applications is a mechanism by which a user could ask a question, expressed in the form of English text, and have a decentralized mechanism, perhaps based on schellingcoin, Martin Koppelmann's ultimate oracle, subjectivocracy (a very similar concept to slock's DAO splitting) or some other scheme with similar properties determine the answer, and then send a callback and a log to the user who asked the question. To achieve scalability, a multi-stage scheme where only a few randomly selected judges look at each question by default, and are incentivized by the threat of a larger "supreme court" contradicting them, is probably optimal."

352 Buterin gave the example of the following four use cases: (i) "[u]sing smart contracts for events that are potentially highly subjective",[1047] (ii) "[a]rbitration in decentralized crowdsourcing and on-demand economy applications",[1048] (iii) "[s]torage or distribution of funds",[1049] and (iv) "[a]s an emergency backstop measure to get funds out of a smart contract if they are stuck for a long time."[1050]

353 Buterin clarifies that "this is not meant to be a full competitor to the traditional court system […] it arguably competes with existing private arbitration more than anything else."[1051] Buterin further explains that the "the power of the decentralized court is limited to what [parties furnish] as a security deposit".[1052] Interestingly, Buterin also compares his idea of a decentralized court to "the function of a decentralized prediction market oracle", but soon outlines the differences between the two: "a prediction market oracle's output is typically relevant to very many parties, and costs of gathering information are

[1046] Vitalik Buterin, 'Decentralized Court' (*Reddit*, 2016) <https://www.reddit.com/r/ethereum/comments/4gigyd/decentralized_court/>.
[1047] Buterin, 'Decentralized Court' (n 1046).
[1048] Buterin, 'Decentralized Court' (n 1046).
[1049] Buterin, 'Decentralized Court' (n 1046).
[1050] Buterin, 'Decentralized Court' (n 1046).
[1051] Buterin, 'Decentralized Court' (n 1046).
[1052] Buterin, 'Decentralized Court' (n 1046).

typically low, whereas the typical decentralized court use case is relevant to only a few parties and the costs of gathering information are higher".[1053] Together with other ideas, this post served as an inspiration to what later became known as Kleros.[1054]

5.4.3 Decentralized Arbitration Mediation Network

354 On 23 May 2016, Andreas Antonopoulos and Pamela Morgan shared a research proposal called Decentralized Arbitration and Mediation Network ("DAMN"),[1055] which they planned to submit to The DAO.[1056] The proposal begins by inquiring why if there is "a global, borderless communication and transaction platform", "global, borderless money", there is not also "a global, borderless justice system?".[1057] The system they envisioned was to be opt-in, community-centric, robust, quick, cheap, able to address simple as well as complex situations.[1058] Most importantly, in contrast to national courts, this novel justice system "offers options, layers of choices, like who will decide […], how long the decision-making process will take, and whether the dispute and the resolution will be made public or remain private".[1059]

355 The proposal then moves on to list the various advantages of ADR, highlighting especially arbitration and the ease of enforcement of arbitral awards due to the New York Convention's many jurisdictions.[1060] It claims that "[i]f smart contracts are to be successful, they must be multi-jurisdictional and in order to be multi-jurisdictional they must include Alternative Dispute Resolution".[1061] One of the key challenges they observed was making sure that national courts would also recognize any decisions rendered in such a borderless mechanism.[1062] Due to the delocalized nature of

[1053] Buterin, 'Decentralized Court' (n 1046).
[1054] Clément Lesaege commented Buterin's post on 22 September 2016, stating that he "proposed the idea to the <hack.ether.camp> hackathon" and later edited the post to reflect that "[p]eople of hackathon and crowd-jury partnered to make it Kleros." See comments section in Buterin, 'Decentralized Court' (n 1046).
[1055] 'Decentralized Arbitration and Mediation Network (DAMN)' <https://github.com/thirdkey-solutions/damn/blob/master/proposal.asciidoc>. The company behind the proposal is called Third Key Solutions LLC, whose founder is Pamela Morgan. See 'Empowered Law - Third Key Solutions' <https://empoweredlaw.com/third-key-solutions/>. The acronym "DAMN" was criticized in the The DAO forum, some users feared that it would hinder the development of the project that seemed to have potential. See Antonopoulos and Morgan (n 935).
[1056] See Antonopoulos and Morgan (n 935).
[1057] 'Decentralized Arbitration and Mediation Network (DAMN)' (n 1055).
[1058] See 'Decentralized Arbitration and Mediation Network (DAMN)' (n 1055).
[1059] 'Decentralized Arbitration and Mediation Network (DAMN)' (n 1055).
[1060] 'Decentralized Arbitration and Mediation Network (DAMN)' (n 1055).
[1061] 'Decentralized Arbitration and Mediation Network (DAMN)' (n 1055).
[1062] See 'Decentralized Arbitration and Mediation Network (DAMN)' (n 1055).

blockchains, the proposal further explains that ADR, in this case, does not bind to a single jurisdiction, it rather "allows [for the] design and implement[ation of] neutral rules".[1063]

356 This arbitration and mediation network has decentralization as its key feature and lists at least five objectives: (i) "[d]esign a suite of simple dispute resolution smart contracts that can be easily and quickly incorporated into other types of smart contracts", (ii) "[b]ridge smart contracts and traditional commercial/contract law relating to dispute resolution"; (iii) "[b]ring the unique capabilities of smart contracts to the broader ADR community"; (iv) "[e]xpand the scope of ADR smart contracts to include and automate more and more of the mediation, arbitration, resolution and award functions"; and (v) "[d]esign decentralized, identity-optional decision-making options for dispute resolution".[1064] It is thus clear that at its core, the network aimed to connect the traditional dispute resolution world with blockchains and smart contracts by enabling these distinct worlds to benefit from each other.

357 However, the proposal also points out the limitations of this design, explaining that the potential of smart contracts can only be fully realized once most commercial transactions take place on blockchains, where funds can be directly accessed.[1065] Alm also held the view that more assets needed to be traded on blockchains first, and once the societal infrastructure is in place, smart contracts and smart awards may be used more widely.[1066] The framework proposed by Antonopoulos and Morgan thus aims at facilitating the transition to this new societal infrastructure in a hybrid form by incorporating elements of smart contracts in traditional commercial contracts and traditional ADR for smart contracts, as well as "technology based options that are otherwise impossible or impractical – such as crowdsourced juries or mediation DAO".[1067]

358 The DAMN project outlines various milestones. The first is the design of a "Dispute Resolution Contract (DRC)" for any type of transaction, whether on- or off-chain, where

[1063] 'Decentralized Arbitration and Mediation Network (DAMN)' (n 1055).
[1064] 'Decentralized Arbitration and Mediation Network (DAMN)' (n 1055).
[1065] See 'Decentralized Arbitration and Mediation Network (DAMN)' (n 1055).
[1066] See Interview #16, Lise Alm ("One of the key pieces of the puzzle for that to really work with an arbitration is that we need to have more assets being traded on blockchain. And when assets are traded on blockchain, then we could move to having something similar to a smart contract, but it being a smart award instead. Something that could automatically enforce the award through blockchain and an automatic transfer. That of course requires that the asset that you are fighting over is tradable on blockchain, and that means a societal infrastructure for this need to be in place first.").
[1067] 'Decentralized Arbitration and Mediation Network (DAMN)' (n 1055).

funds are held in escrow or in a "multi-stage DRC".[1068] Once a dispute arises, parties can choose a suitable ADR mechanism, "such as formal arbitration, voting pool, or some other mechanism".[1069] If no dispute arises, the parties can terminate this special contract which will have an in-built function to "terminate itself after a legally reasonable time".[1070] The proposal notes that third parties would render ADR services in these DRCs.[1071] The grand vision, in the end, was for DAMN to be "a DAO offering a diverse range of DRC[s], an interface for launching them, and a registry of entities providing ADR services."[1072] It seems that they wanted to create a marketplace for the smart contract ecosystem, where DAOs could offer different kinds of DRC services.[1073] Later in June 2016, The DAO was hacked, and the proposal fell into oblivion and did not come to fruition.

359 The idea of arbitration on blockchains, however, as such was not abandoned by the wider community. Sagewise, a company founded in 2017, intended to build a blockchain-agnostic dispute resolution infrastructure for smart contracts. In 2018 the company raised 1.25 million USD to launch its platform, including a software development kit ("SDK") to include a security mechanism in smart contracts, "ensuring that execution of a smart contract reflects its parties' true intent".[1074] It also wanted to offer a dispute vendor marketplace. The now-defunct website sagewise.io previously showed a three-step process: (i) "implement", where a "[s]mart contract creator includes Sagewise SDK in their smart contract", much like a smart contract arbitration clause; (ii) "freeze", where "when something goes wrong, contracting parties can trigger a 'Dispute Resolution Mode', which freezes [the execution of] the smart contract until the dispute is resolved", and (iii) "resolve", where parties would select a vendor from the marketplace, who can "provide unique approaches to dispute resolution using their own fee structure".[1075]

[1068] 'Decentralized Arbitration and Mediation Network (DAMN)' (n 1055).
[1069] 'Decentralized Arbitration and Mediation Network (DAMN)' (n 1055).
[1070] 'Decentralized Arbitration and Mediation Network (DAMN)' (n 1055).
[1071] 'Decentralized Arbitration and Mediation Network (DAMN)' (n 1055).
[1072] 'Decentralized Arbitration and Mediation Network (DAMN)' (n 1055).
[1073] See 'Decentralized Arbitration and Mediation Network (DAMN)' (n 1055).
[1074] 'Sagewise, Leading Smart Contract Dispute Resolution Company, Raises $1.25 Million Seed Funding, Led by Wavemaker Genesis' (*businesswire*, 2018) <https://www.businesswire.com/news/home/20180807005319/en/Sagewise-Leading-Smart-Contract-Dispute-Resolution-Company-Raises-1.25-Million-Seed-Funding-Led-by-Wavemaker-Genesis>.
[1075] 'Sagewise' <https://web.archive.org/web/20181201025359/https://www.sagewise.io/>.

However, since it was reported that the product-market fit was missing, the company pivoted in 2019 into mobile gaming, where players can win bitcoins.[1076]

5.4.4 The "Governed" Blockchains of EOSIO

360 Wan, Sagewise's founder and CEO at the time, was also leading the EOS Alliance Dispute Resolution and Arbitration Working group.[1077] EOS wanted to establish itself as the "first governed blockchain", focusing on small businesses.[1078] EOSIO is an open-source blockchain platform that is adaptable and allows developers to build public, private, permissioned, or permissionless blockchains.[1079] The EOS blockchain was deployed using EOSIO software.[1080] It was argued that a default dispute resolution system at the base layer would best be suited to attract small businesses and consumers, so that users could have confidence that if something goes wrong, recourse is possible.[1081] However, it was also highlighted that if there was no default dispute resolution system, parties had to ensure they would have an arbitration option, which they would have to agree upon separately.[1082] Still, experience has shown that parties do not take that precaution.[1083]

[1076] See 'Amy Wan from Bling on Earning Real Bitcoin by Playing Mobile Games (Episode 105)' (*Crypto Current Podcast*, 2020) <https://crypto-current.co/earn-bitcoin-playing-mobile-games/> (In this interview, Amy Y. Wan, the Founder & CEO of Bling which was formerly known as Sagewise, said that there was no product market fit, that is why they pivoted.).

[1077] In this role, she organized a series of community calls, see, e.g., Amy Wan, 'EOS Alliance — Dispute Resolution & Arbitration Working Group — Aug 27–31 Summary & Plans for Sept 3–7' (*Medium*, 2018) <https://medium.com/@amywan/eos-alliance-dispute-resolution-arbitration-working-group-aug-27-31-summary-plans-for-sept-a535222047c1>. Due to her involvement in Sagewise she was recruited to the EOS working group focusing on dispute resolution, see EOS Detroit, 'EOS Alliance Arbitration & Dispute Resolution Community Call (EMAC)' (*Youtube*, 2018) <https://www.youtube.com/watch?v=_fRthpmD4Wc>.

[1078] Amy Wan in EOS Detroit, 'EOS Alliance Arbitration & Dispute Resolution Community Call (EMAC)' (n 1077). ("[…] the EOS blockchain is trying to be the first governed blockchain and its entire purpose is to be able to become the blockchain for small businesses").

[1079] See 'Eosio' <https://eos.io/>.

[1080] See Jack Tanner, 'The Difference between EOSIO Software and the EOS Blockchain' (*Medium*, 2020) <https://medium.com/coinmonks/difference-between-eosio-software-and-eos-blockchain-13bcc57d1d9d>.

[1081] See Amy Wan in EOS Detroit, 'EOS Alliance Arbitration & Dispute Resolution Community Call (EMAC)' (n 1077). ("[…] when do small businesses do business, when do they transact, when do regular people transact, they transact when they feel confident that they will get what they actually want […] think about it in the sense of if someone is a small business, and are they going to want to do business in an environment where there is no recourse or where there is […] some default level of recourse for them?").

[1082] See jem-BOFH in EOS Detroit, 'EOS Alliance Arbitration & Dispute Resolution Community Call (EMAC)' (n 1077). ("[…] in situations where there is no base layer and it becomes the responsibility of each user to ensure that he has an arbitration option at the time of entering into the contract that most experience tells us that there ends up being no pre-agreed arbitration, that in general without a base layer you end up with nothing".)

[1083] *Ibid*.

361 Dispute resolution was seen as a core value proposition for the EOS ecosystem, which is why an independent arbitration forum called the EOS Core Arbitration Forum ("ECAF"),[1084] designed to be a default base layer system, was created for parties that find themselves in disputes.[1085] The EOS Constitution,[1086] which was a "multi-party contract entered into by the Members by virtue of their use of this blockchain",[1087] in its Article IX entitled "Dispute Resolution", stated as follows: "All disputes arising out of or in connection with this Constitution shall be finally settled under the Rules of Dispute Resolution of the EOS Core Arbitration Forum by one or more arbitrators appointed in accordance with the said Rules."[1088]

362 The ECAF website showed that as of December 2018, 864 cases had been filed and 3,479 actions had been performed.[1089] An early caseload report (status 300 claims) demonstrated that the types of disputes handled by ECAF mostly related to (i) phishing/theft, (ii) issues with keys (*e.g.*, lost keys), (iii) no registration, and (iv) block producers.[1090] On 22 June 2018, an arbitrator issued an "Emergency Measure of Protection Order" to the block producers,[1091] instructing them to freeze 27 accounts, notably not containing any type of reasoning as "[t]he logic and reasoning for this Order [would] be posted at a later date".[1092] This led to heated debates and marked the beginning

[1084] Its website is now inaccessible, see 'EOS Core Arbitration Forum' <https://eoscorearbitration.io>.
[1085] 'ECAF - About Us' <https://web.archive.org/web/20190120062224/https://eoscorearbitration.io/about/>. See Amy Wan in EOS Detroit, 'EOS Alliance Arbitration & Dispute Resolution Community Call (EMAC)' (n 1077), in which she explains that ECAF was set up as a default, but that it was envisioned that parties could opt into another arbitration provider.
[1086] At that time, it still had not been ratified. See Kirill Bryanov, 'Arbitration on a Governed Blockchain: EOS' Crisis of Dispute Resolution' (*Cointelegraph*, 2018) <https://cointelegraph.com/news/arbitration-on-a-governed-blockchain-eos-crisis-of-dispute-resolution>. Today it is called The EOS User Agreement and has no dispute resolution clause, see 'EOS User Agreement' (2019) <https://github.com/EOS-Mainnet/governance/blob/master/eosio.system/eosio.system-clause-constitution-rc.md?>.
[1087] 'EOS Constitution' <https://web.archive.org/web/20181212151732/https://github.com/EOS-Mainnet/governance/blob/master/eosio.system/eosio.system-clause-constitution-rc.md>.
[1088] 'EOS Constitution' (n 1087).
[1089] 'ECAF - Cases' <https://web.archive.org/web/20200419230017/https://www.eoscorearbitration.io/disputes/cases/>. ("actions including e-mails, waivers, emergency arbitration orders and evidence requests"). That number reportedly grew and surpassed 900 in 2019, see Ecaf, 'ECAF: Caseload Announcement' <https://steemit.com/ecaf/@ecaf/ecaf-caseload-announcement>.
[1090] See Amy Wan, 'EOS Dispute Resolution & Arbitration Working Group — Recap Sept 3–7 & Plans for Sept 10–14 & ECAF Update' (*Medium*, 2018) <https://medium.com/@amywan/eos-dispute-resolution-arbitration-working-group-recap-sept-3-7-plans-for-sept-10-14-ecaf-55482c03f36>.
[1091] EOS operates under a different consensus mechanism called Delegated Proof of Stake ("dPoS"), in which block producers maintain the system and validate transactions. See David Floyd, 'EOS' Blockchain Arbitrator Orders Freeze of 27 Accounts' (*coindesk*, 2018) <https://www.coindesk.com/eos-blockchain-arbitrator-orders-freeze-of-27-accounts>.
[1092] Floyd (n 1091).

of ECAF's downfall. In what can be considered the first arbitral award[1093] in the blockchain sphere,[1094] issued on 8 November 2018, dealing with the "ownership" of an EOS account, the arbitrator ruled in favor of the claimant who had allegedly fallen victim to a phishing scam.[1095] The community, however, was split on ECAF and the future of arbitration on EOS.[1096] One blog post by a block producer, for example, stated that ECAF was "an arguably self-appointed and unratified arbitration forum",[1097] which did not conform to the "underlying principles of a decentralized community",[1098] and that there needed to be "free-market solutions that enable the right to autonomously select arbitration forums that enable personalized parameters for third party intervention".[1099]

363 ECAF found itself in a deep legitimacy crisis, which the community was not able to solve. One of the main problems was that ECAF had no system in place to elect members satisfactorily. In fact, the members operating ECAF were not elected at all but had appointed themselves. There were a lot of issues concerning party notification and communication as well.[1100] However, ECAF was one of the distinguishing factors of EOS, by which it wanted to stand out among blockchains as a truly so-called "governed blockchain". Although ECAF was in a preliminary proof-of-concept stage, running on a voluntary basis and a lot of effort was made to enhance the dispute resolution system as such through specialized working groups, much more work than previously anticipated

[1093] There seems to have been a distinction made between arbitral orders and arbitral awards. This distinction in fact is not trivial in traditional arbitrations, see Victoria Clark, 'Decisions, decisions: order or award?' (*Practical Law Arbitration Blog*, 2019) <http://arbitrationblog.practicallaw.com/decisions-decisions-order-or-award/>.

[1094] In comparison, the first Kleros cases were resolved on the Ethereum mainnet starting in March 2019. See 'Kleros Case #0' <https://resolve.kleros.io/cases/0>.

[1095] See Ecaf, 'ECAF makes history today with its first ruling' (*steemit*, 2018) <https://steemit.com/ecaf/@ecaf/ecaf-makes-history-today-with-its-first-ruling>. See EOS42, 'First Arbitral Award & the Future of Arbitration for EOS' (*Medium*, 2018) <https://medium.com/@eos42/first-arbitral-award-the-future-of-arbitration-for-eos-219b05358818>. See the arbitrator's order, which was approved here: 'First ECAF Ruling' (2018) <https://eosauthority.com/approvals/view?scope=libertyblock&name=chngkeyha4ta&lnc=en>.

[1096] See EOS42 (n 1095). See also EOS Detroit, 'EOS Alliance Arbitration & Dispute Resolution Call - August 30th, 2018' (*Youtube*, 2018) <https://www.youtube.com/watch?v=E5TGikZA9E4> (During the call, Amy Wan, for example, asks whether ECAF is not what the community is looking for because it is too centralized. One of the purposes of the call was to understand what the block producers wanted and what the responsibilities were. The general sentiment seemed to be that ECAF needed to be more decentralized. The calls were an effort to explore how to improve the system.).

[1097] EOS42 (n 1095).

[1098] EOS42 (n 1095).

[1099] EOS42 (n 1095).

[1100] Some, for example, argued that communication needed to happen on-chain and there needed to be a way for addresses to be able to send messages to each other.

needed to be done. In the end, no community consensus and support could be found, and ECAF ceased to exist.

364 Another blockchain deployed using EOSIO software called "Telos" followed a different strategy and created its own arbitration mechanism in parallel. Much like EOS and the resulting rationale for ECAF, Telos sees itself as a "governed blockchain".[1101] Telos showcases the following "onchain governance documents": (i) "Arbitrator Minimum Requirements", (ii) "Block Producer Minimum Requirements", (iii) "Data Protection Policy", (iv) "Regarb Agreement", (v) "Regproducer Agreement", (vi) "Telos Blockchain Network Arbitration Rules and Procedures", and (vii) "Telos Blockchain Network Operating Agreement" ("TBNOA").[1102] The TBNOA sets out and explains the intricacies of the Telos blockchain, for example, the consensus mechanism (delegated proof of stake, "dPoS"), when a block becomes irrevocable, the role that block producers play, and more. It specifies that it is valid for all users that participate in the Telos blockchain "in order to establish a secure, stable, and governable blockchain where […] all disputes shall be arbitrated solely using the methods described herein".[1103] The British Virgin Islands is stipulated as the jurisdiction and choice of law.[1104] The agreement also outlines that the "[a]rbitration proceedings may occur via computer network, teleconferencing or video conferencing from any geographic location pending arbitrator approval."[1105]

365 Block producers in the system that are actively validating nodes have broad powers, they "may pause the Telos blockchain, implement new software updates, print new tokens, […], and enforce duly processed arbitration orders by voting for any such action with a majority vote of 2/3+1 Block Producers."[1106] Article 11 of the TBNOA details Telos' "binding arbitrations", whereby "[a]ll Members of the Telos blockchain agree to be bound to binding arbitration by Members elected by the votes of the TLOS token holders to serve this function ("Elected Arbitrators")".[1107] It further specifies that "Members

[1101] See Telos Foundation, 'Telos Blockchain Network Arbitration Rules and Procedures' (*Medium*, 2018) <https://medium.com/telos-foundation/telos-blockchain-network-arbitration-rules-and-procedures-d91d5081dbf8>.
[1102] See 'Telos Governance Documentation' <https://telos.net/governance-documentation/>.
[1103] Article 1, Preamble of the TBNOA, see 'Telos Governance Documentation' (n 1102).
[1104] Article 2, Jurisdiction and Choice of Law of the TBNOA, see 'Telos Governance Documentation' (n 1102).
[1105] Article 2, Jurisdiction and Choice of Law of the TBNOA, see 'Telos Governance Documentation' (n 1102).
[1106] Article 9, Function of Block Producers of the TBNOA, see 'Telos Governance Documentation' (n 1102).
[1107] Article 11, Binding Arbitration of the TBNOA, see 'Telos Governance Documentation' (n 1102).

expressly waive all rights to have matters pertaining to value or information stored on the Telos blockchain decided in a court of any terrestrial jurisdiction".[1108] Parties can choose to select other arbitration forums, however, this does not apply to "dispute[s] questioning the existence, validity, or termination of this Agreement [as these] must be resolved by arbitration by one or more Telos Elected Arbitrators in accordance with the Arbitration Rules of the Telos Blockchain Network Arbitration Rules and Procedures for the time being in force, which rules are deemed to be incorporated by reference in this clause."[1109]

366 Another questionable part of the agreement is Article 12, which states that if one were to waive arbitration, any legal recourse to courts would be excluded: "Waiving of arbitration waives all forms of dispute resolution; it does not invite terrestrial jurisdictions to arbitrate transactions on the Telos blockchain. Neither Elected Arbitrators nor Block Producers are required by this Agreement to fulfill the orders of any terrestrial jurisdictions in the operations of the Telos blockchain."[1110] It is questionable whether users of an open, public, and permissionless blockchain agreement can validly waive their right to legal recourse, considering Article 6 of the European Convention of Human Rights ("ECHR"), which guarantees the right of access to courts.[1111] Also, the TBNOA stipulates a jurisdiction and choice of law clause.

367 Telos' arbitration seems to function as a default base layer dispute resolution mechanism, which Article 13 alludes to by stating that "parties to each transaction on the Telos blockchain may select an arbitration forum when each party freely elects to use the same arbitration forum. If no election for a common alternative forum is so recorded in the transaction, then the arbitration forum shall be the Elected Arbitrators."[1112] However, whether this base layer can substitute court proceedings and traditional arbitration is debatable. Block producers decide the number of elected arbitrators in total and the number of arbitrators assigned to arbitration cases,[1113] which is another indication of their broad powers in this governance system.

[1108] Article 11, Binding Arbitration of the TBNOA, see 'Telos Governance Documentation' (n 1102).
[1109] Article 11, Binding Arbitration of the TBNOA, see 'Telos Governance Documentation' (n 1102).
[1110] Article 12, Arbitration Exclusions of the TBNOA, see 'Telos Governance Documentation' (n 1102).
[1111] However, access to courts may already be technically precluded by the very blockchain infrastructure, the pseudonymity of its users, and other characteristics inherent in open and permissionless blockchains.
[1112] Article 13, Selection of Arbitration Forum of the TBNOA, see 'Telos Governance Documentation' (n 1102).
[1113] Article 14, Elected Arbitrator Nomination, Qualification, and Election of the TBNOA, see 'Telos Governance Documentation' (n 1102).

368 Elected arbitrators serve "a term of […] approximately three years […] and may be re-elected for up to ten terms in total".[1114] Arbitral awards seem not to be automatically enforceable, rather arbitrators need to render their decisions "in the form of a transaction or set of transactions to be appended to the Telos blockchain by the duly elected Block Producers", and arbitrators "shall also provide a public explanation of the rationale for the Decision".[1115] It seems that arbitrators cannot execute these transactions themselves but require block producers to do so. Thus, the wording seems misleading, as the decision will be rendered in a human language format, including certain transactions to be undertaken. A reasoning part will also be incorporated, whereas the rules specify that decisions are made in the form of transactions. Many details of these terms remain unclear and contradictory.

369 What is startling, for example, is the mandatory language employed to instruct arbitrators that "[t]he transactions shall be in the form of a standard value transfer transaction from Respondent to Plaintiff".[1116] However, it cannot be held from the outset, without even knowing the specifics of the case, that decisions rendered will be to the effect of a transfer from the respondent to the claimant. There is an apparent contradiction between Article 9 and Article 18. According to Article 18, "[b]lock producers, having been duly provided with a valid arbitration Decision as defined in the Telos Blockchain Network Arbitration Rules and Procedures document, shall fully enforce the Decision within 180,000 blocks (approximately 24 hours) of receipt".[1117] However, Article 9 states that "Block producers […] may […] enforce duly processed arbitration orders by voting for any such action with a majority vote of 2/3+1 Block Producers".[1118] One article states that block producers must enforce a decision within a specified time span, whereas another article in the same document stipulates that block producers may first vote on specific orders.[1119] Neither is a definition given nor is any specific distinction made between a "decision" and an

[1114] Article 14, Elected Arbitrator Nomination, Qualification, and Election of the TBNOA, see 'Telos Governance Documentation' (n 1102).
[1115] Article 17, Execution of Arbitration Decisions, Qualification, and Election of the TBNOA, see 'Telos Governance Documentation' (n 1102).
[1116] Article 17, Execution of Arbitration Decisions, Qualification, and Election of the TBNOA, see 'Telos Governance Documentation' (n 1102).
[1117] Article 18, Enforcement of Arbitration Decisions of the TBNOA, see 'Telos Governance Documentation' (n 1102).
[1118] Article 9, Function of Block Producers of the TBNOA, see 'Telos Governance Documentation' (n 1102).
[1119] This contradiction can lead to potentially serious consequences, because if block producers do not enforce the decision according to article 18, they "shall be liable for penalty under the 'enforcebpmins' action until the adjudication action is fully enforced". See Article 18, Enforcement of Arbitration Decisions of the TBNOA, see 'Telos Governance Documentation' (n 1102). "enforcebpmins" is a contract to enforce Block Producer minimum requirements, see Article 8 of the TBNOA.

"order" in the context of the document. The assumption is that both refer to the same concept, *i.e.,* the arbitrators' final decision.[1120]

370 The standard for smart contracts is a type of Ricardian contract, according to Article 35, which states that "[e]ach smart contract shall be documented with human-language terms stating the intent of all parties and naming the arbitration forum that will resolve disputes arising from that contract".[1121] If there are multiple human-readable language contracts, one will be chosen as the prevailing one, and if there are ambiguities between the versions, an arbitrator has the authority to select the contract, which will be used in a dispute.[1122] The governance documents are supposed to be recorded on the Telos blockchain.[1123]

371 To be eligible as a Telos arbitrator candidate, minimum requirements need to be fulfilled, such as a "[s]econdary education to Bachelor's degree from a 4-year accredited college or university or equivalent",[1124] "[f]amiliarity with the rules of arbitration",[1125] "[u]nderstanding of mechanics of blockchain and EOSIO".[1126] Note that no legal education is required and arbitrators do not seem to have to apply any law. Arbitrators need to disclose their identities, anonymity is thus not provided.[1127] The "Regarb Agreement" is a human-language contract whereby someone may register as an arbitrator candidate, accepting the conditions, among others, for impartiality, conflict of interest, and disclosure.[1128] The Arbitration Rules outline the envisioned arbitral procedure and determine that arbitrators should take prior decisions into account, establishing precedents.[1129] Parties can remove up to two elected arbitrators from the random five

[1120] The uncertainty in terms of terminology can be observed throughout the document, and is, for example, also present in Article 12, where the document refers to "orders of any terrestrial jurisdiction", presumably referring to court judgments of any nation state worldwide.
[1121] Article 35, Developers of the TBNOA, see 'Telos Governance Documentation' (n 1102).
[1122] See Article 36, Prevailing Language of the TBNOA, see 'Telos Governance Documentation' (n 1102).
[1123] See Article 37, Recording Agreement of the TBNOA, see 'Telos Governance Documentation' (n 1102).
[1124] Phase One, Article 2b of the Arbitrator Minimum Requirements, see 'Telos Governance Documentation' (n 1102).
[1125] Phase One, Article 2c of the Arbitrator Minimum Requirements, see 'Telos Governance Documentation' (n 1102).
[1126] Phase One, Article 2d of the Arbitrator Minimum Requirements, see 'Telos Governance Documentation' (n 1102).
[1127] See Phase One, Article 2a, and Phase Two, Article 1a,b,c and Article 2a,b of the Arbitrator Minimum Requirements, see 'Telos Governance Documentation' (n 1102).
[1128] See Regarb Agreement, see 'Telos Governance Documentation' (n 1102).
[1129] See e.g., Article 27, Inclusion of Precedents of the Telos Blockchain Network Arbitration Rules and Procedures in 'Telos Governance Documentation' (n 1102).

arbitrator panel offered to them.[1130] Article 8 of the Telos Blockchain Network Arbitration Rules and Procedures lists the types of cases, which can be arbitrated as follows:[1131]

para.	Case Type Name	Description	Relief
a.	Lost key replacement	Lost, not stolen keys	Change private keys
b.	Transaction reversal	Erroneous transfers	Return value transferred
c.	Emergency intervention	Account or contract freeze needed to prevent undue loss, or other harm	Halt all transactions from the compromised account until further notice
d.	Contested ownership[1132]	A party claims to own another account, to which it does not have the private keys	Change private keys to grant access
e.	Identification of party from unexecuted adjudication decision	A party in a previous arbitration case that did not comply with the arbitral award is being now identified as the owner of another account	Enact the original decision or some part thereof against the newly identified account
f.	Breach of contract	The computer code execution does not match the parties' intent recorded in the human language contract	Alter the current content of the blockchain to reflect the stated intent
g.	Misappropriation or misuse of information or intellectual property	Respondent misappropriated or misused information or other intellectual property	End the use
h.	A tort	Harm or injury inflicted	Award damages, including punitive damages
i.	Appeal of block producer penalty	Telos Blockchain Network enacted an undue penalty against a block producer	Remove or reduce penalty
j.	Accusation of arbitrator wrongful action	Arbitrator acted wrongfully and willfully deprived a party of a just arbitration	Remove arbitrator, invalidate their services for some time

[1130] See Article 12, Choice of Arbitrator of the Telos Blockchain Network Arbitration Rules and Procedures, see 'Telos Governance Documentation' (n 1102).

[1131] See Article 8, Case Classes of the Telos Blockchain Network Arbitration Rules and Procedures, see 'Telos Governance Documentation' (n 1102). The original alphabetical listing "a" to "o" has been kept, but the content is shortened, language at times modified to only reflect the essential information for each of the types in the table.

[1132] Difference to case type a unclear, could be subsumed under one category.

k.	Core code bug or wrongful action[1133]	The smart contract execution is unintended and does not comply with the terms of the human language contract	Alter the contract as specified
l.	Failure to deliver worker proposal system (WPS) project	At least 15 block producers claim that a WPS was not delivered	Financial restitution
m.	Breach of TBNOA	A party bound by the TBNOA breached it	Rectify the breach
n.	Accused block producer	A block producer claims to have been wrongfully alleged of a breach of the block producer terms	Permission to return to service
o.	Miscellaneous	Cases that do not fit into the previously mentioned categories	Some form of relief

Table 4. Arbitrable Case Types in the Telos Blockchain Network[1134]

372 This shows what users and developers of a blockchain project anticipate the types of disputes that may arise to be. This overview is geared towards the specifics of the Telos blockchain environment, whose consensus mechanism is dPoS and relies on block producers rather than on miners. Although much effort seems to have gone into drafting the governance documents, they are sometimes contradictory, and in many instances, much remains unclear. It is unclear, for example, to whom disclosure is made, where documents are hashed on the blockchain, how – if at all – arbitral awards are enforced, how exactly parties initiate an arbitral process, what the "arbitration" contract entails, and more. In June 2021, when asked in the Telos community forum, Telos members responded that the arbitration system is not live yet and no cases have been arbitrated so far.[1135]

[1133] Seems like this category includes coding bugs and wrongful actions by a respondent, has some overlap with category "f".

[1134] Own table based on Article 8, Case Classes of the Telos Blockchain Network Arbitration Rules and Procedures, see 'Telos Governance Documentation' (n 1102). The original alphabetical listing "a" to "o" has been kept, but the content is shortened, language at times modified to only reflect the essential information for each of the types in the table.

[1135] See 'Telos Community Telegram Chat' <https://t.me/HelloTelos>.

5.4.5 Kleros – The Pioneer of Crypto Arbitration

373 The Kleros Whitepaper states that "Kleros is a decentralized application [("DApp")] built on top of Ethereum that works as a decentralized third party to arbitrate disputes in every kind of contract, from very simple to highly complex ones".[1136] The kind of "crypto arbitration" as termed in this thesis, which has been developed by the Coopérative Kleros will be the focus of the analysis in Chapter 6.

374 The Coopérative Kleros conducts research, supports, and maintains the Kleros protocol.[1137] The DApp can be used on smart contract platforms in general but has been implemented on Ethereum.[1138] At its core, it is a decision protocol, in which - based on game theory - crowdsourced jurors render decisions.[1139] The project is built on the premise of a "not so distant future",[1140] where "most goods, labor and capital will be allocated through decentralized global platforms".[1141] It is the first blockchain arbitration platform to become operational and, at the time of writing, has resolved 885 disputes.[1142] It has received several grants, including from the European Commission to develop its model for social good further.[1143]

375 Inspiration was taken from ancient Greece, not only in naming the project but also in using common people as jurors to decide on disputes.[1144] *Kleros* comes from what the

[1136] Clément Lesaege, Federico Ast and William George, 'Kleros Whitepaper (Short Paper v1.0.7)' (2019) 1 <https://kleros.io/static/whitepaper_en-8bd3a0480b45c39899787e17049ded26.pdf>. See 'Kleros - The Justice Protocol' <https://kleros.io>.

[1137] The Coopérative Kleros is a *Société Coopérative d'Intérêt Collectif* (SCIC) incorporated in France. See Aouidef, Ast and Deffains (n 86) 3.

[1138] See Lesaege, Ast and George (n 1136) 1. See Clément Lesaege, William George and Federico Ast, 'Kleros Yellow Paper (Long Paper v2.0.1)' (2021) 1 <https://kleros.io/yellowpaper.pdf>. See Interview #2, William George ("I mean there are other large smart contract blockchains that don't get as much use, which is, you know the reason we are on Ethereum so far is because most of the apps are there, so this is where most of the disputes are.").

[1139] See Lesaege, George and Ast (n 1138) 1. Interview #2, William George ("If somebody pays them the fee that you know jurors need to be paid in order to make the decision you can ask them anything that sort of conforms with the broad rules for what questions can be posed and they'll answer it.", "You can ask Kleros any question you want.", "The cooperative isn't judging cases, we build software and then we've enabled this peer to peer Community of crowd logic people on the Internet, to make the decisions for themselves.").

[1140] Lesaege, Ast and George (n 1136) 1.

[1141] Lesaege, Ast and George (n 1136) 1.

[1142] See 'Kleros Board' <http://klerosboard.com/>.

[1143] See 'The Commission's European Innovation Council Awards €5 Million to Blockchain Solutions for Social Innovations' (2020) <https://digital-strategy.ec.europa.eu/en/news/commissions-european-innovation-council-awards-eu5-million-blockchain-solutions-social-innovations>.

[1144] See Interview #1, Federico Ast ("This idea of popular trials with different jurors which were drawn from the citizens, so that kind of made me think of justice systems in a way which is different to what we know

ancient Greeks used to call the jury selection done by sortition,[1145] and *pinakion*[1146] was a token inserted by citizens in ancient Greece into a machine for selection for jury trials.[1147] *Pinakion* or "PNK" today is the token used in the Kleros protocol with a dual purpose, on the one hand, to incentivize jurors to vote "honestly" and, on the other hand, to also protect the system against sybil attacks.[1148]

376 Kleros launched in May 2017, when co-founders Federico Ast and Clément Lesaege first met online.[1149] They had similar ideas and had thought about courts on blockchains independently from each other. Aside from working on his PhD, Ast began thinking about collective intelligence and exploring how this concept could be applied to a number of different aspects, including justice systems.[1150] He published a blog post in late 2015, in which he proposed the idea for a "Crowdjury, a framework for court processes of adjudication adapted for the blockchain era".[1151] Lesaege presented a "decentralized arbitration court" at the Hack Ether Camp in 2016,[1152] and a judge later connected Ast with Lesaege.[1153] This encounter marked the beginning of a new blockchain application

today, right so you can use citizens, you can use common people to make decisions just as Wikipedia … the idea of the jurors, of popular jurors, it was very appealing to me."). See Federico Ast and Clément Lesaege, 'Kleros, a Protocol for Decentralized Justice' in Kleros, *Dispute Revolution - The Kleros Handbook of Decentralized Justice – Revised and Augmented Edition* (2020) 32.

[1145] See Ast and Lesaege (n 1144) 32, see Footnote 6 therein.

[1146] See Ast and Lesaege (n 1144) 32.

[1147] See Ast and Lesaege (n 1144) 32–33.

[1148] See Lesaege, Ast and George (n 1136) 4, and see Footnote 2 therein. See also 'Kleros Token PNK' (*coinmarketcap*) <https://coinmarketcap.com/currencies/kleros/>.

[1149] See Interview #1, Federico Ast ("Kleros started in May 2017, so I actually met Clément who is my co-founder."). See also for a visual representation of a timeline of Kleros' journey: '@Kleros_io on Twitter on 14 June 2021' <https://twitter.com/Kleros_io/status/1404461197198508032>.

[1150] See Interview #1, Federico Ast ("I was already as I told you working on decentralized justice things mainly from its theoretical perspective while I was doing my PhD and this was kind of a side project for me … and at some point, I started publishing white-, I wouldn't call it a white paper but like blog posts about how collective intelligence can be used for a number of different aspects and one of those aspects is justice systems.").

[1151] See Federico Ast and Alejandro Sewrjugin, 'The Crowdjury, a Crowdsourced Judicial System for the Collaboration Era' (2015) <https://medium.com/the-crowdjury/the-crowdjury-a-crowdsourced-court-system-for-the-collaboration-era-66da002750d8#.w8w1xmfrb>. See 'Crowdjury' <crowdjury.org>. See Macduff (n 862) for an interesting opinion piece about this project.

[1152] An early presentation pre-Kleros can be seen here: Clément Lesaege, 'Decentralized Arbitration Court' in Meetup Startups Investisseurs - Partie 1 (*Youtube*, 2016) <https://www.youtube.com/watch?v=N3Fn0ZJfY1g>.

[1153] The early team came from different projects: ethercourt and crowdjury. See comment by Clément Lesaege (@clesaege), 'Did Something Come out of This Interesting Discussion? (Thread)' (*Reddit r/ethereum*) <https://www.reddit.com/r/ethereum/comments/6rzkfy/did_something_come_out_of_this_interesting/>. Interview #1, Federico Ast.

enabling an entirely new model, which they termed "decentralized justice",[1154] whose ambition it is to provide faster, cheaper, and more trustworthy dispute resolution.[1155]

377 The original idea behind Kleros was to provide an infrastructure for the digital economy,[1156] especially for low-value cross-border disputes.[1157] State courts and traditional arbitration are expensive and have a high threshold. Traditional arbitration was not the domain Kleros predominantly wanted to tackle; in fact, not a single arbitration expert was part of the core team.[1158] This, in Ast's view, can be an advantage. He says that "the people who transformed how information flows in the world were not librarians, they were Google and software engineers and the kind of people who built uber were not taxi drivers … So, it kind of makes sense from that perspective that the people who started Kleros are not lawyers."[1159]

378 Kleros covers the market for people who are in blockchains and want a decentralized dispute resolution service, but it can also be used for conventional disputes, which are neglected by the traditional legal systems.[1160] Existing arbitration and normative

[1154] For a discussion on "decentralized justice", see Federico Ast, 'Eyal Winter on Game Theory and the Challenge of Decentralized Justice – Interview' in Kleros, *Dispute Revolution – The Handbook of Decentralized Justice – Revised and Augmented Edition* (2020) 124 et seq. See also Sophie Nappert and Federico Ast, 'Decentralised Justice: Reinventing Arbitration for the Digital Age?' (*Global Arbitration Review*, 2020) <https://globalarbitrationreview.com/decentralised-justice-reinventing-arbitration-the-digital-age>. (Nappert and Ast identify three main features of decentralized justice: "(a) alignment with the rule of law (the system is built on blockchain technology which guarantees that neither the evidence, nor the process of decision-maker selection, nor ruling production can be tampered with); (b) crypto-economic incentives (the system uses economic incentives to select jurors and reward them for doing honest work); and (c) the system claims to produce decisions that are fair."). See *infra* Chapter 6.5.6.

[1155] See Lesaege, Ast and George (n 1136) 1.

[1156] See Interview #1, Federico Ast ("So that's kind of what I saw that the world was moving online, moving digital but still we didn't have a proper infrastructure.").

[1157] See Interview #1, Federico Ast ("You have traditional courts which are good for dealing with domestic disputes, sometimes like smaller claims and you also have an ecosystem of ADR solutions for domestic disputes and you have international arbitration for cross-border disputes but it doesn't make sense to go to arbitration for small claims so there was a market you know, a blind spot where you did not have a solution system that would address small claims at an international level which is basically what is going to be the future.") Ast thus considers the Internet to be the natural jurisdiction for such disputes requiring an Internet native dispute resolution mechanism.

[1158] See Interview #1, Federico Ast ("Now we have one lawyer who is a PhD researcher, he is a lawyer in France and he is now doing his PhD in Paris and we have legal advisors who advise us in you know different things related to cryptocurrency law but you know we don't have a core team member who is a lawyer, not the founders and also not the early employees.").

[1159] Interview #1, Federico Ast.

[1160] Interview #2, William George ("So I very much see our sort of potential users as a marriage between two fairly distinct groups: the people who are in blockchains and want a decentralized dispute resolution service because they believe in decentralization for ideological reasons, and there are you know there aren't that many ways to do that, they don't have many options, so they come to us. Even if they have fairly large value disputes. And then people who have conventional disputes, which probably have smaller value

structures have to maintain high standards for the conduct of legal procedures, which all revolve around trust.[1161] In Kleros, trust is placed in the underlying crypto-economic systems, lowering the bar for otherwise rigorously followed standards and for who is able to participate in the system.[1162] This unique combination of incentives, blockchains, and smart contracts is what makes pseudonymous and random people vote on an outcome of a dispute brought before them.

379 The Kleros court,[1163] which is at the heart of its dispute resolution protocol, resolves conflicts that smart contracts cannot resolve.[1164] Smart contracts may self-execute as coded but once there is a dispute to be addressed, a smart contract is unable to provide subjective interpretation.[1165] Ast calls Kleros a "subjective oracle" because human judgment is needed instead of other types of oracles that do not require human intervention as it only feeds data into the blockchain, such as whether it rained in Paris or not on a specific day.[1166] In some sense, every Kleros use case is thus an oracle and an escrow.[1167]

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but … it doesn't make sense taking these to the traditional legal system or traditional arbitration. And it's not really surprising that most of our users so far have been from the first category. Because they're you know they already are involved in blockchains and know how … the tools work, they have the browser extensions to be able to use Kleros without additional friction. Whereas if you hadn't tried to bring in new people from the second category, all that requires a learning curve.").

[1161] Interview #2, William George ("Having philosophized about what exactly is our edge here, what's the secret sauce in Kleros… ultimately it's how I see this is that existing arbitration and existing legal structures have to maintain a really high level of credibility because you know the state wants to be very credible, they are the arbiters … in order to sell themselves as a dispute resolution service that's all about, ultimately about trust, the parties have to trust you to be you know fair, rigorous, carefully look at your arguments …, establish yourself as fair, and be very, very rigorous."). See also *supra* Chapter 2.4.7.

[1162] Interview #2, William George ("In a Kleros like system, you can have a certain amount of confidence, just in the underlying crypto economic mechanisms, you can be like okay I hired basically a bunch of randoms on the Internet and they are sort of qualified, maybe not entirely, I have reason I have sort of economic reasons, to think that they're on average pretty qualified; it's not 100% rigorous. But I can read the code and I can think through the incentives and I have a good reason to believe that they'll be rigorous enough on average to meet my needs. That I have a $300 dispute and maybe they don't have a level of rigor that I would want, if I had a million dollar dispute but they're good enough for my $300 dispute.").

[1163] See 'Kleros Court App' <https://court.kleros.io/>.

[1164] See 'Kleros Gitbook - Court' <https://kleros.gitbook.io/docs/products/court>.

[1165] Interview #1, Federico Ast ("Smart contracts can self-execute as programmed but they cannot solve the case.").

[1166] See Interview #1, Federico Ast ("Another important thing that the smart contracts cannot resolve by themselves are subjective matters or you know interpretation matters where you know the smart contract doesn't know if the website was well done or not according to the agreement we had, so this is what I sometimes call a subjective oracle, so it's a decision of an oracle that it's not completely subjective because there are like agreements … there are rules that we agreed upon which set some objective boundaries but with these subjective boundaries there is room for interpretation which is the work that judges and courts do … It's not always that clear cut if it rained or did not rain as you know oracles solve"; "such a subjective oracle will resolve a huge number of cases that require human judgment to be resolved and which blockchain cannot address.).

[1167] Interview #2, William George ("I would say that every Kleros use case on some level is an oracle and every Kleros use cases on some level is an escrow.").

380 The Kleros Cooperative empirically studied their blockchain protocol under a test pilot called "Doges on Trial" in 2018, where participants were asked to evaluate pictures of the Internet meme Doge and to vote "Doge" or "not Doge".[1168] Images which did not depict a "Doge" were supposed to not appear on the list curated by the jurors.[1169] The study concluded successfully and was able to show the system's resistance to bribes and various other forms of attacks.[1170]

5.4.5.1 *The Incentive Mechanism*

381 The entire dispute resolution process is said to be fully automated,[1171] and Kleros' decentralized design builds on blockchains' strengths. The mechanism behind Kleros was heavily influenced by the Truthcoin[1172] whitepaper and the SchellingCoin[1173] design.[1174] Kleros' incentives structure is built upon Thomas Schelling's work on Schelling Points (or Focal Points), which are points people are naturally drawn to and coordinate their behavior towards, absent communication.[1175] The idea of using Schelling Point game theoretical incentives for dispute resolution on blockchains was first introduced by Vitalik Buterin.[1176] The system is designed so that "agents who do not know or trust each other […] tell the truth".[1177] Schelling observed, for example, that when choosing a meeting point in New York, under the condition of not being able to communicate, the majority of people would choose the information booth at the Grand Central Station at noon.[1178]

[1168] See Kleros (n 89) 171 et seq. Doge is an internet meme which was turned into a cryptocurrency, primarily as a joke.
[1169] See Kleros (n 89) 171 et seq.
[1170] See Kleros (n 89) 212. The smart contract of the Doges on Trial court still exists but it has become a ghost court. One may still interact with it, which is not recommended, see Interview #2, William George ("If you want to use it but … if there's a court with … not very many jurors on it, it won't be very secure so you might want to play around with it, you can but it's probably not a good idea to put real disputes on something unless there's a good community of jurors behind it.").
[1171] See Lesaege, Ast and George (n 1136) 1.
[1172] See Paul Sztorc, 'Truthcoin' (2015) <https://www.truthcoin.info/papers/truthcoin-whitepaper.pdf>.
[1173] See Vitalik Buterin, 'SchellingCoin: A Minimal-Trust Universal Data Feed' (*Ethereum Blog*, 2014) <https://blog.ethereum.org/2014/03/28/schellingcoin-a-minimal-trust-universal-data-feed/>.
[1174] See Lesaege and George (n 1026).
[1175] See Thomas C.Schelling, *The Strategy of Conflict* (Harvard University Press 1960, 1980). See Lesaege, Ast and George (n 1136) 2.
[1176] See Buterin, 'Decentralized Court' (n 1046). See *supra* Chapter 5.4.2. See also Buterin, 'SchellingCoin: A Minimal-Trust Universal Data Feed' (n 1173). See also Vitalik Buterin, 'The P + epsilon Attack' (2015) <https://blog.ethereum.org/2015/01/28/p-epsilon-attack>.
[1177] See Lesaege, Ast and George (n 1136) 2.
[1178] See Lesaege, George and Ast (n 1138) 2. See also Nappert and Ast (n 1154).

382 In deciding cases, jurors are incentivized to side with the majority, thus, to decide the case in accordance with what they expect the majority will decide. When jurors are coherent with the majority, they gain something on top of their stake, if they are incoherent, they lose a portion of their stake.[1179] In most courts, the average coherent rate of jurors is 85-90%, meaning that mostly jurors decide coherently with the majority, but some percentage of the time, jurors will lose.[1180]

383 The search for truth occupies a prominent place in Kleros' incentive mechanism and its whitepaper outlines the court system as "an epistemic engine, a tool for ferreting out the truth about events from a confusing array of clues. An agent (jury) follows a procedure where an input (evidence) is used to produce an output (decision)."[1181] George explains that an important factor in designing incentives in a dispute resolution system is to make sure that jurors put in real effort, instead of "lazy voting" in accordance with statistical data about previous and similar disputes without putting in the work.[1182] Such ill-incentivized systems may be exploitable by bots.[1183] In the future more AI may lead to such bots being capable of actually performing a juror's task of reading and evaluating evidence and the facts of the case, which may lead to a whole different and philosophical discussion.[1184]

[1179] See Lesaege, George and Ast (n 1138) 2. Interview #3, Clément Lesaege also explained that when a juror does not vote, they get de-staked automatically to prevent them from losing more of their stake, such as if they are on holidays or are not online and keeping up with any new notifications. If a juror does not vote, they are regarded as having voted incoherently and lose the portion of the stake that was locked in the dispute.

[1180] See Interview #2, William George ("Most of our courts, the average coherence rate, it's in around 90% …, the average juror is usually coherent around 85 to 90% of time, so some percentage of the time they lose PNK, they don't gain anything. So that's bad that you know, bad luck for them, but the rest of the time, they might gain some PNK from the people who happen to be incoherent on that case.").

[1181] Lesaege, Ast and George (n 1136) 1. Footnote omitted.

[1182] Interview #2, William George ("So one thing that I think about a lot when trying to design the incentives, is that you should design incentives so the jurors put in real effort that allows you to read some truth about it. What you don't want is for jurors to lazy vote. You don't want jurors to be like okay I'm in a court for all disputes between freelancers and small business owners and I can look at the history of the court, and I can say the freelancers win in 70% of cases, so I'm just gonna always vote for the freelancer. That would be really bad because then you wind up with a court that didn't actually do anything. So the parameters of the courts are designed so that if you do something like that you should lose money.").

[1183] Interview #2, William George ("And I got the very bottable strategy, you could totally have a bot do that.").

[1184] Interview #2, William George ("However, it's possible that you had a better bot, you can have some AI that … actually looks at the information on the case and makes a decision that's based on the case but it's still a bot. And then you get into sort of philosophical questions about whether that's actually a problem or not.").

5.4.5.2 *The Voting Procedure*

384 Currently, Kleros uses a plurality vote system in which the party with the most votes prevails.[1185] This voting system is inferior amongst many different voting systems.[1186] In a future version of the court, the team thus wants to implement an incentive structure based on a more refined voting system.[1187]

385 Jurors are only rewarded if they vote according to the majority of jurors. Since it is presumed that jurors have the self-interest to maximize their financial gain, they are incentivized to anticipate the votes of other jurors. Each juror evaluates the evidence submitted independently and tries to vote in accordance with the majority in order to be rewarded in the Kleros incentive design.[1188] If a juror votes in accordance with the majority, they are rewarded with the lost stake by jurors who voted in the minority and with the arbitration fee that is taken from the losing party.[1189]

5.4.5.3 *The Dichotomy of Contracts*

386 Kleros distinguishes between an "arbitrable contract" and the "arbitrator contract" or simply the Kleros court, which can be opted into. The reason for having two contracts is that it allows for separation between ruling on a decision and enforcing a decision.[1190] They are separate smart contracts, which operate independently from each other.[1191] The separation also allows to change between arbitration services so that users can select the services themselves.[1192]

[1185] Interview #2, William George ("So I mean currently on the current version of the Court … its incentive structure uses a plurality vote system where the winner is the one that gets the most votes.").

[1186] Interview #2, William George ("So there is a wide variety of different voting systems you can use that are more intelligent than that. Like basically almost any other voting system is better than that.").

[1187] Interview #2, William George ("So in the in the next version of the Court presumably we will start out with plurality vote for something else, and then you get into interesting questions about … if I'm using this different voting system now, instant run-off … or whatever you know how do I incentivize people, based on this more complicated voting system.").

[1188] See Lesaege, Ast and George (n 1136) 7 et seq. See Nappert and Ast (n 1154).

[1189] See Lesaege, Ast and George (n 1136) 7 et seq. See Nappert and Ast (n 1154).

[1190] See Clément Lesaege, 'ERC 792: Arbitration Standard' (*Github*, 2017) <https://github.com/ethereum/EIPs/issues/792>.

[1191] See Lesaege, 'ERC 792: Arbitration Standard' (n 1190).

[1192] See Lesaege, 'ERC 792: Arbitration Standard' (n 1190). See also Lesaege, George and Ast (n 1138) 5. ("The Kleros team has developed a number of standard contracts using Kleros as a dispute resolution mechanism. Moreover, we have proposed standards that would allow others to develop other contracts in a way that does not require anticipating which dispute resolution mechanism will ultimately be used. This standardization allows parties that regularly require dispute resolution services to easily switching [sic] between dispute resolution providers." Footnotes omitted.).

Arbitrable Contract[1193]	Arbitrator Contract[1194]
○ Designates Kleros as the arbitrator ○ Enforces the decisions rendered by the Arbitrator Contract	○ Is the Kleros Court[1195] ○ Renders decisions ○ Picks jurors, gives them questions and incentivizes the ruling procedure[1196]

Figure 14. Arbitrable and Arbitrator Contract[1197]

387 The dichotomous structure allows for a dynamic process, where anyone can code their own arbitrable contracts according to their own specificities and designate Kleros or any other arbitration oracle as the arbitrator contract.[1198] This means that the standard arbitrable contracts provided by Kleros are just that: standards and models which can be adapted. This allows for flexibility in designing the jurors' impact in case of a dispute and the consequences that result from such rulings.[1199] However, this also puts responsibility on the parties designing their own arbitrable contracts to audit those thoroughly to minimize the risks for bugs. The arbitrable contract provides jurors with options to choose from, and parties need to specify which court a dispute will belong to.[1200] An option that is always present is called "refuse to arbitrate", to enable jurors to

[1193] See Lesaege, 'ERC 792: Arbitration Standard' (n 1190).
[1194] See Lesaege, 'ERC 792: Arbitration Standard' (n 1190).
[1195] See Interview #2, William George ("It's one contract that might use some references and libraries to other Ethereum contracts." Jurors only interact with the arbitrator contract, see same interview: "If you're only a juror and you're never a party to a dispute basically you just interact with the arbitrator contract. You'll stake PNK, that's a call to the arbitrator contract, you'll vote on cases that's a different function on the arbitrator contract. So that would be the contract you would interact with.").
[1196] Interview #2, William George ("The basic idea here is that the arbitrator contract is the Kleros court, it's the smart contract that picks jurors, gives them the question that parties created in the arbitrable contract and incentivizes how they rule on that question and … that's something that we've developed as the Kleros cooperative.").
[1197] Own figure.
[1198] Interview #2, William George ("In theory, any third party that wants to integrate with Kleros doesn't have to ask us or anybody else, they can just create an arbitrable contract that structures what happens depending on different possible ruling outcomes and then they can use that arbitrable contract to ask a question to the court contract, the arbitrator contract, you know the answer comes back in the court contract and the arbitrator contract executes whatever the logic of the contract says. So the rationale for the standards is that we expected lots of different people that are going to be ideally building arbitrable contracts; so far we built several ourselves.").
[1199] *Ibid*.
[1200] See Lesaege, George and Ast (n 1138) 6.

refuse cases which are illegal.[1201] The arbitrable contract also determines what mechanism will be triggered once a decision has been made.[1202]

388 The arbitrator or Kleros court contract can be regarded as a DAO. Although the Kleros Cooperative developed the smart contract, the cooperative released control of it once it is was made available on the blockchain, and the smart contract is updated according to the pre-set parameters, incorporating community votes and more.[1203] Updates to the arbitrator contract can happen based on whether the community agrees to submitted proposals or not.[1204] Kleros uses the platform "Snapshot" for its governance process, which is an "off-chain gasless multi-governance client".[1205] The changes to the court are effected using another smart contract called the "Kleros Governor", which is "a smart contract that is responsible for enforcing decisions in the smart contracts" made by community governance votes.[1206] The community can decide to change the fee structure of the courts, the evidence periods and other parameters.[1207] In essence, the Kleros dispute resolution mechanism oversees its own governance.[1208]

5.4.5.4 ***The Escrow Application***

389 The way Kleros can easily be used as a dispute resolution mechanism by default is through its escrow app.[1209] There the parties define and name their agreement and they

[1201] See Lesaege, George and Ast (n 1138) 6, see Footnote 6 therein.
[1202] See Lesaege, George and Ast (n 1138) 6.
[1203] Interview #2, William George ("That is a DAO the arbitrator contract is not something that is controlled by other cooperatives, you know we developed it. But that once we put it on the Internet, put it on the blockchain you know it has escaped from our control, it follows its own logic and updates itself, changes its parameters according to the way the logic works which involves community votes and such.").
[1204] The proposals can be found here: 'Kleros Proposals' <https://snapshot.org/#/kleros.eth>.
[1205] 'Snapshot Documents' <https://docs.snapshot.org/>. Before voting moved to snapshot, it was done on Aragon, see 'Kleros Voting' <https://client.aragon.org/#/0xaa95B84C444c5FEd9f43ac0045b874Aa95a3040f/0x51f2fceb9011a92b9fad65f673a6ee737c355adb/>. See also Clément Lesaege, 'Voting Has Migrated to Snapshot' (*Kleros Forum,* 2020) <https://forum.kleros.io/t/voting-has-migrated-to-snapshot/485>.
[1206] Sam Vitello, 'Introducing Kleros Governor: A Smart Contract To Rule Them All' (*Kleros Blog*, 2020) <https://blog.kleros.io/introducing-kleros-governor/>.
[1207] See Interview #2, William George ("To give a concrete example I want to change the fees or change the deposits or say that I decided that my three day evidence period is not long enough, I want a five day period. The community can vote on that. And there are very specific function calls when you're updating the arbitrator contract.").
[1208] Interview #2, William George ("People submit to the governor and if somebody says something malicious to the governor then that can be challenged and create Kleros disputes so Kleros is managing its own governance somehow."). See Sam Vitello, 'Introducing Kleros Governor: A Smart Contract To Rule Them All' (*Kleros Blog*, 2020) <https://blog.kleros.io/introducing-kleros-governor/>.
[1209] See 'Kleros Escrow' <https://escrow.kleros.io/>. See also Stuart James, 'Kleros Escrow Explainer - Secure Your Blockchain Transactions Today' (*blog.kleros.io*, 2019) <https://blog.kleros.io/kleros-escrow-secure-your-blockchain-transactions-today/>.

specify an amount and an Ethereum Address as the fund receiver. They have the option to upload documents that describe their agreement in human language in more detail and provide extra details or general service agreements. The party making the payment then gets asked whether the other party has fully complied with the agreement and once the option "yes" is selected, the amount in escrow is released to the other party. However, if the option "no" is selected, the Kleros dispute resolution process comes into play.

390 This is essentially an app to design an agreement whose payment is secured by escrow on the Ethereum blockchain and for which a dispute resolution mechanism is built in. A party to an escrow may ask for dispute resolution and deposit the amount required to start the process. Both parties pay an equal amount and there are a series of email notifications in order to get notified of disputes. If two parties want to enter a business relationship using the Kleros escrow app, one party would create an invoice or a payment inserting all the necessary information, such as the amount a specific Ethereum address is to receive by a certain date, and there is the option to include additional information, such as the contract terms.[1210]

5.4.5.5 *The Jurors and the Courts*

391 Kleros does not call their decision-makers arbitrators but rather jurors. Jurors do not need to provide any personal information, and no specific credentials or verification is needed, anyone who owns an Ethereum address could self-select into any of the "courts" available on the Kleros platform and stake into them.[1211] Jurors do not get training but there is a starter kit for jurors, and each court has its own policies and guidelines of conduct.[1212]

[1210] See 'Kleros Escrow' (n 1209). In Interview #2, William George discussed the possibility of inserting email addresses and getting notified. This functionality, of inserting email addresses and getting notified was not available on the Kovan testnet version the author tried. The test net version is quite different in relation to the time periods as well, for example, there are only a couple of minutes for each party to pay the arbitration fee upfront. E-mail from William George on 4 May 2021, on file with author: "All of the timers on testnet are set to be short (on the order of a few minutes) for the convenience of testing".

[1211] See Interview #1, Federico Ast ("No, there is no screening, anyone can be a juror and the system is engineered for having people self-select into the courts where they have experience, like if you are an expert in financial insurance and you stake your tokens into the website court you are very likely to be wrong lots of times and because of how the majority system works and every other economics incentives work, you're going to lose money and then exit the system because yeah it's not profitable for you.").

[1212] See 'The Kleros Juror Starter Kit' <https://blog.kleros.io/the-kleros-juror-starter-kit/>. See Interview #2, William George ("You inherit policies as you go down the tree, so if I'm in the child court of the General Court, I have inherited all the general court policies. And so that gives me a certain number of instructions on how I'm supposed to think about cases and there are vague sort of examples of things on which one might refuse to arbitrate.").

392 Parties to an arbitrable contract can select a court focused on the type of dispute that may arise out of their legal relationship, such that if parties are concluding, for example, a marketing services contract, they will choose the marketing services court.[1213] While parties may choose a court, they cannot choose their arbitrators on the Kleros system as it now stands.[1214] While parties cannot decide who the jurors are that will adjudicate their case, if they design their smart contract, they can decide on the number of jurors when they bring in their dispute.[1215]

393 The system of Kleros courts has a tree structure, which simplified looks as follows:

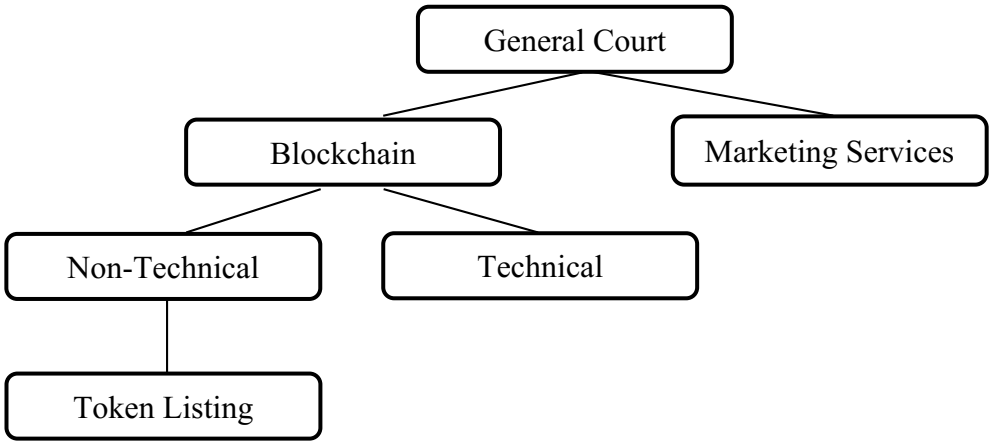

Figure 15. Kleros Court Tree Structure, adapted[1216]

394 There is a general court and sub-courts, depending on the specific use case.[1217] For example, there is a court for technical disputes, one for non-technical disputes, token listings, marketing services, video production, and more.[1218] Jurors in the Kleros system only interact with the arbitrator contract, they need to be able to trust the arbitrator or

[1213] See Lesaege, George and Ast (n 1138) 8.
[1214] Another DApp that allows for arbitrator selection might be feasible, albeit it might also be less trust-minimized. See Interview #2, William George ("If you have a third party that knows who their experts are and can whitelist all the experts and they agree on that ahead of time, then you can get around this issue of not having someone to trust; so you could do that you know, this is an entirely different system, but you know it's like you might adapt other things in accordance with that, but it's possible.").
[1215] See Lesaege, Ast and George (n 1136) 3. See Interview #3, Clément Lesaege ("Some start with one, which is fine because you have appeals, some start with three, and some start with already the maximum number of jurors.").
[1216] Adaptation of Kleros Yellowpaper figure 5 at Lesaege, George and Ast (n 1138) 8. This is just for demonstration purposes, in the live version of the Kleros court there are many more sub-courts, see 'Kleros Board' <http://klerosboard.com>.
[1217] See Interview #3, Clément Lesaege explained that the court including the subcourts is one smart contract. It is possible to add more courts through the governance process, whereby the community decides whether to add new courts or not. In practice the community of token holders hardly say no to adding new courts.
[1218] See 'Kleros Board' (n 1142).

Kleros court contract,[1219] and they do not stake into the disputes that occur themselves, but rather into the "courts".[1220] This is designed this way in order to prevent attacks.[1221]

395 In order to show their interest in resolving disputes, jurors need to deposit the token called *PNK*[1222] into the specific courts.[1223] When a dispute arises, jurors are then randomly selected among the staked users into that particular court, in which a dispute arises. The chances of being selected as a juror in any given dispute is proportional to the amount of *PNK* staked in the respective court, in which the dispute arises.[1224]

396 There is no screening or test to become a juror. If jurors had to be verified first, this would make the system vulnerable to abuse of power, also trust would have to be placed in a central authority which undermines the efficacy and rationale of blockchains' architecture.[1225] However, not verifying jurors enables the same entity to register multiple times as jurors or jurors to be selected more times than once to a dispute.[1226] In fact, presently in Kleros even the same juror with the same Ethereum address can be chosen multiple times for the same dispute.[1227] An alternate system, however, could incentivize

[1219] See Interview #2, William George ("From our perspective, jurors should know and trust the court contract. Before you become a juror you for sure should be confident that the court contract doesn't have any bugs and it's well constructed and has good incentives, whereas you shouldn't necessarily have to be confident in the arbitrable contract. If you are a party and you agree to an arbitrable contract that's on you, you know."). See also Interview #2, William George ("If you're only a juror and you're never a party to a dispute basically you just interact with the arbitrator contract. You'll stake PNK, that's a call to the arbitrator contract, you'll vote on cases that's a different function on the arbitrator contract. So that would be the contract you would interact with.").

[1220] See Interview #1, Federico Ast ("Jurors they don't stake the tokens into specific disputes, they stake the tokens into courts, courts have a lot of different disputes of the same type of topic. So, because if users will be able to stake the tokens into the disputes they like, so this would make the system easier to attack because I can, if I have a dispute with you, I can like bring my friends to study this dispute, right but if we have to stake into the court then it's harder to target the specific dispute where I have an interest, right.").

[1221] *Ibid*.

[1222] See 'Kleros Token PNK' (n 1148).

[1223] See Lesaege, George and Ast (n 1138) 9.

[1224] See Lesaege, George and Ast (n 1138) 9. Also discussed during Interview #3, Clément Lesaege.

[1225] See Interview #2, William George ("The rationale for not verifying the jurors credentials is that if you haven't trusted the party that's verifying the jurors credentials, then you get, you sort of move this problem of who to trust, from putting confidence in the dispute resolution service to the jurors, the dispute resolution resolvers to the person verifying their credentials, so you didn't really solve the problem you still have to have the same level of trust. And you know, instead of having trust in sort of the algorithm in … the broader community, you have to trust in an individual that might commit abuses of power, you might not be totally confident in them."). Since trust needs to be placed somewhere, in this case it would be the architecture or design of the Kleros court smart contract and the fact that the incentive structure enables jurors to deliver coherent decisions.

[1226] See Interview #2, William George ("One of the criticisms of our system is justified, but there's you know, … based on the constraints that we have … is that jurors might be randomly selected for the same case more than once … just because of the way that random draws work.").

[1227] *Ibid*.

jurors to cut up their *PNK* holdings into multiple addresses, which could lead to malicious or dishonest jurors being selected disproportionally more often, which is something to avoid.[1228]

397 There is no certainty whether a human being or a robot is acting on behalf of an Ethereum address.[1229] A new system called Proof of Humanity ("PoH"), which is a new curated list of human beings on the Ethereum blockchain, is designed using the Kleros protocol to draw amongst verified humans of the network to vouch for other humans by way of sortition.[1230] Through PoH, it is possible to create digital and verifiable identities on blockchains in a fully decentralized manner, which opens up the possibility to reliably distinguish between real human and bot actors.[1231] This shows much promise in relation to verifiable identities on blockchains and in cyberspace in general. Moreover, it could enable a more democratic and inclusive system and voting mechanism, where too much influence by large token holders could be reduced.[1232]

[1228] Interview #2, William George ("I won't pick that juror a second time because I see, they have the same address but that runs into issues where it's not … Sybil resistant"; "So if that was our system that would incentivize our jurors to cut up their PNK into multiple addresses because you can have more than one address on Ethereum there and that's just a matter of generating a new address. So we don't do that, specifically because we don't think it's useful and, if anything, might be counterproductive, because the malicious jurors that want to get an edge would cut up their PNK holdings over multiple addresses and then people that are sort of very honest kinds of people wouldn't - so suddenly you'd be picking people that are of a dishonest persuasion more often, disproportionally so - you don't want to do that.").

[1229] Interview #2, William George ("But ultimately this highlights sort of this key annoyance of our system. This key fundamental problem of … being on the Internet or at least being on Ethereum and that is that you never know who's a human being and who's like if you have a crowd of people you never really know if they are not a bunch of bots."). Also, Colin Rule during his Keynote Speech at the University of Leicester Conference 'When Blockchain meets Arbitration: The Birth of Decentralized Justice" on 31 January 2020 showed the famous cartoon from the New Yorker, where one dog looks to the other dog and says "On the internet, nobody knows you are a dog." See for more on the iconic cartoon, Michael Cavna, '"NOBODY KNOWS YOU'RE A DOG": As iconic Internet cartoon turns 20, creator Peter Steiner knows the joke rings as relevant as ever' (*The Washington Post*, 2013) <https://www.washingtonpost.com/blogs/comic-riffs/post/nobody-knows-youre-a-dog-as-iconic-internet-cartoon-turns-20-creator-peter-steiner-knows-the-joke-rings-as-relevant-as-ever/2013/07/31/73372600-f98d-11e2-8e84-c56731a202fb_blog.html>.

[1230] See Damjan Malbasic, 'Humans on the Blockchain' (*Kleros.io*, 2021) <https://blog.kleros.io/kleros-online-conference-report-the-fundamental-importance-of-humans-on-the-blockchain/>.

[1231] See Malbasic (n 1230). See Interview #2, William George ("And that can have broader applications beyond Kleros, for example, you could build a decentralized social media platform or something where on a current social media platform, you never know if someone has like a bunch of sock puppet accounts, but here, you could.").

[1232] Interview #2, William George ("Yes, proof of humanity is a way to sort of … democratize the court a bit to prevent too much influence from large pnk holders.").

398 Jurors in a dispute do not apply law in the ordinary sense, instead they follow specific rules and guidelines as provided by the specific court where a dispute arises.[1233] Jurors also do not need to reason their decisions, but they have the option to provide reasonings in a specific text box on the interface.[1234] By the system design, jurors are incentivized to reason their decisions in view of possible appeals, so that jurors in the appeals process may be persuaded by the arguments given by previous jurors in previous rounds.[1235]

5.4.5.6 ***The Parties***

399 The parties pay the juror fees according to a fixed average, the more jurors are selected, the more parties will have to pay.[1236] Parties may either use applications available, such as the escrow app, to conclude a smart contract which integrates and designates the Kleros court as the dispute resolution mechanism or parties may also build their own arbitrable smart contracts or open a dispute directly.[1237] If parties enter into a new deal, they need to anticipate certain types of disputes that may occur in order to pre-program the options

[1233] Interview #2, William George ("You know when somebody asks me how Kleros works, I wouldn't say that the jurors apply law. They answer questions based on a series of rules, you know they're provided guidelines and then also evidence and policies and things, and they have to think about those guidelines and the evidence and think about the way their incentives work and what they're incentivized to do in accordance with those guidelines, that's not … I wouldn't necessarily say that's the same thing as law, but you know I am not a lawyer.").

[1234] Interview #2, William George ("So we have a box on the interface, where people can type in there …. when you go to vote, there is an opportunity for you to provide reasoning …, so we do not require you put anything in that box. Because if the interface rejected things, we didn't have any type into the reasoning box it would be possible for the jurors to just type gibberish nonsense, we don't have any way to control that because it's decentralized.").

[1235] Interview #2, William George ("However, so our sort of rationale for how this should work is that because there's an appeal process and jurors are incentivized, they lose or gain in ether based on how, what do they do with the ultimate appeal decision, rather than the current decision of their round, then, if that goes to appeal and there are other jurors looking at the case, they will see the evidence that I put in an early round. So, if I have good arguments for why I reason somehow ideally those will be convincing the future jurors and they'll reason with me. And if I don't put anything in the reasoning box then I'm less likely to win the appeal of the journey, so if I have an incentive to put in solid reason I do it.").

[1236] Interview #2, William George ("The way that all of our courts currently work as it's currently implemented is that there's a fixed average commoditization per juror and if you pick twice as many jurors you're going to pay twice as much."). In Interview #3, Clément Lesaege also explained that the parties have to pay the fees upfront and the fees stay locked until the dispute is completely finished, meaning until the last appeal round, if any happened, has closed and a coherent result has emerged. See also Interview #3, Clément Lesaege ("Let's imagine you have to pay 0.1 ETH per juror, you could make a contract which requires parties to pay at least 0.1 ETH but could allow them to pay more if they want to start with more jurors."). Different parameters, such as minimum fees can be changed by the community through governance votes. An example of such a vote to change the fee structure can be found here 'KIP-34 Parameter Updates (December 2020)' (*snapshot*, 2020) <https://snapshot.org/#/kleros.eth/proposal/QmZ8woavWtRXfAMpiozj9JEBUxz1d1RqZrAwVHYh8pP5JC>.

[1237] The escrow app can be found here: 'Kleros Escrow' (n 1209). To create a dispute directly, there is another app 'Kleros Resolve App' <https://resolve.kleros.io/>.

available in case of dispute into the arbitrable contract.[1238] The arbitrable contract, for example, could provide the option to give a contracting party an extension to render its services.[1239] In scenarios where a dispute occurs and parties only later realize that they did not anticipate a particular option, the arbitrable contract could provide for an update if agreed by all involved parties.[1240]

5.4.5.7 *The Procedure and Appeals Process*

400 The time frame for submitting evidence is variable and depends on the court a dispute arises in, it may range from a few days to weeks.[1241] Other steps in the procedure, such as voting and appeal may vary in length of time from court to court.[1242] These fixed procedural time periods cannot be changed by the parties and can only vary if parties decide to move to another court with different time periods.[1243] The reason these parameters are static, not changeable and pre-determined can be attributed to the notion of arbitrable and arbitrator contracts.[1244] Jurors need to have certainty in the procedure and if parties were allowed to choose their own time periods, it could lead to situations,

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[1238] See Interview #2, William George ("So these are exactly the kinds of things that you decide when you build an arbitrable contract, … you have a new business relationship with whoever and you realize that there are certain potential possibilities for disputes. And you have to try to predict in advance, what they might be and what reasonable answers you might give to your dispute resolvers in advance. So I mean you have to make some predictions on what kinds of friction points you have in advance, but then you programmed into your arbitrable contract - what each of the options are and then what they do. If one of your options is to give your freelancer more time to complete a project that … would have a specific meaning when you execute the contract, but you have to pick that option in advance.").

[1239] *Ibid*.

[1240] Interview #2, William George ("You could conceivably have an arbitrable contract that allowed a sort of an unanimous agreement to be updated. That's something that's really possible, and you know that's the next level of complexity. But you can allow the parties to jointly decide to swap out the options and put different options, but they have to agree to that."; "A good smart contract … would either want to have fixed options or have some possibility for unanimous consent to replace those options.").

[1241] Interview #2, William George ("So in some of the courts, maybe the period to submit evidence and arguments is three days, might be a week or five days or whatever. So that period is variable in a way that depends on which court you are in and then there's another period where people have the time to have the opportunity to vote and then there's another period where people can appeal. So, each one of those periods is a parameter that can vary from court to court."). See Interview #3, Clément Lesaege, ("The court can decide how long you have to provide evidence, … to vote, how long you have to appeal, … all of them are court parameters.").

[1242] *Ibid*.

[1243] See Interview #2, William George (Bianca Kremer: "Okay, so this is not something that the parties can change at all? William George: "Only in so far as they pick a different court.").

[1244] Interview #2, William George ("I made this point about the spirit of the arbitrator - arbitrable contract separation … you don't want jurors to have to trust the arbitrable contracts, any weird questions to be asked to them and then they have to sort of do their best maybe refuse to arbitrate a question of illegal … But they do their best to follow the procedure and they should sort of on average come out ahead by doing that. Whereas, if you allow the parties to pick the period, you could conceivably have parties mess with people, … like a five second evidence period, and then the jurors would have to deal with that.").

such as where there may be extremely short evidence periods, which would not allow jurors to look at the evidence completely but still have to arrive at a decision.[1245] Kleros has to balance and accommodate both the interests of the jurors and the parties.

401 The community of jurors chooses these fixed parameters for the courts and the parties pick among the options available to them.[1246] According to Ast, just like one would choose a seat of arbitration, such as Geneva, Stockholm, London, or New York, on blockchains, it will be possible to select a dispute resolution mechanism in the future from a drop-down menu.[1247] Kleros also offers the possibility to open a dispute directly once it arises, even if the escrow service or any of the other services provided by Kleros were not in use before.[1248]

402 Parties may submit their evidence during the evidence period but can also abstain from doing so, which may ultimately have a detrimental effect on their case.[1249] There are Kleros cases which concern listing disputes where not much evidence is submitted, and jurors examine the facts and find the evidence themselves.[1250] Jurors independently analyze the evidence without communicating and deliberating amongst each other and vote on any of the solutions presented to them.[1251]

403 Kleros has an appeals process integrated into it. Disputes are resolved by a small number of randomly selected jurors at first. This makes the design more efficient and saves cost, the balance Kleros wants to achieve is not to have people judge cases superfluously.[1252]

[1245] *Ibid*.

[1246] Interview #2, William George ("The community of jurors picks the parameters for the courts, they pick how long they want to have evidence and how long they want to be able to vote and then parties pick among the options that are available.").

[1247] See Interview #1, Federico Ast ("In the traditional arbitration world you choose a city of arbitration, you could choose like you know Paris, London, Singapore, New York, whatever and so this is the same. You can choose Kleros xyz like from a drop-down menu but like a seat.").

[1248] See 'Kleros Resolve App' (n 1237).

[1249] Interview #2, William George ("If one party didn't submit evidence, they probably hurt their case, but you know, they can do that.").

[1250] Interview #2, William George ("In a lot of our listing disputes over token arguments I think there are many where people haven't really submitted much evidence, you know they just expect the jurors to look at it themselves.").

[1251] See Lesaege, George and Ast (n 1138) 2, see also Footnote 3 therein. However, there is a telegram group where jurors can interact with each other and discuss current cases.

[1252] See Interview #2, William George ("Ultimately, the sort of balance we try to strike is that you don't want to over duplicate peoples' effort, you don't have to pay people to judge your case unnecessarily. So, you want to start with a small group of people", "Because … that is more efficient and it saves more time, it saves money, but if I don't think that I got the right answer I can appeal, I get a larger pool of people that's more likely to be statistically representatives.").

The appeals process also appears to be important in preventing attacks.[1253] The appeals process is presently limited to a panel of 511 arbitrators.[1254] Each new appeal instance includes twice the number of previous decision-makers plus one, resulting in an exponential increase.[1255] The exponential increase also concerns the arbitration fees to be paid as appeal fees.[1256] Once the voting is finished and there is no appeals process, the majority answers go back to the arbitrable contract, which executes according to its pre-programmed logic.[1257]

404 Currently, Kleros is most used for token curated registries ("TCR"), which is something one would not immediately think of as disputes.[1258] DeFi platforms also use the lists curated by Kleros and display them to their users.[1259] Kleros is particularly useful for on-chain assets and on-chain disputes, where assets can be moved without intermediaries in a self-executing logic.[1260] In a way, trusting people to deliver the asset is not necessary, as "the decision respects itself".[1261]

405 Because the dispute resolution process runs on the Ethereum blockchain, anyone can inspect the smart contract and the parameters that underlie the procedure, such as the randomized selection process of jurors. This is an advantage of public blockchains, which

[1253] See Lesaege, George and Ast (n 1138) 28 et seq.
[1254] See Clément Lesaege in 'Likely jury stacking in case 546 & court jump impossible' (Kleros Forum, 2021) <https://forum.kleros.io/t/likely-jury-stacking-in-case-546-court-jump-impossible/532/2>. See Lesaege, George and Ast (n 1138) 28 et seq.
[1255] See Lesaege, George and Ast (n 1138) 28 et seq.
[1256] See Lesaege, George and Ast (n 1138) 28 et seq.
[1257] Interview #2, William George ("It depends on the logic of the arbitrable contract but whatever logic is programmed into the arbitrable contract when it gets the answer back from the Court, it will execute. So, and if the arbitrable contract says if the jurors vote Alice wins, then you know transfer all the ether to this address, then the contract will do that.").
[1258] See Interview #2, William George ("So currently most of our use comes from things that you might not necessarily think of traditionally as being disputes. Like a lot of our users come from things that are called curated lists, where the implicit dispute is. Someone submits some elements to a list and then people argue over whether or not they belong to the list. … So, for example, there are like lists of tokens."). See Interview #3, Clément Lesaege (When asked whether Kleros had turned out to be differently than what he had imagined in the beginning, Lesaege answered: "At the beginning we were imaging more like escrow use cases to be the main use but in practice we saw way more interest in using Kleros for TCRs and for oracles." And regarding the cases, "a lot of curation disputes in terms of quantity, in terms of value that is going to be oracle disputes like what we have here in the presidential election, in these markets you can have millions of dollars' worth of tokens which was linked to the result.").
[1259] See Interview #2, William George ("And there are a couple … of DeFi platforms that pull Kleros lists and say okay we're going to display the list to our users based on the assumption that they satisfy the criteria for the Kleros jurors.").
[1260] See Interview #2, William George ("It's most useful for on-chain things where the self-executing quality of the logic … a contract self-executes itself and then moves the assets around without having to do anything else.").
[1261] See Interview #2, William George ("That's a very powerful thing you know, you don't have to trust people to deliver on your asset, to respect the decision, the decision respects itself.").

allows complete transparency. However, confidentiality is an aspect, which is difficult to implement in this sort of dispute resolution process for reasons that are intrinsic to public blockchains and the crowd-jury mechanism of random pseudonymous individuals on the Internet who need to have access to sufficient information about the parties and their case to make a decision.[1262] Although conceivable in some cases, it is generally difficult to conceal the link between parties' confidential and private data and the data jurors require to rule on a case.[1263]

406 Information is currently stored in so-called interplanetary file system ("IPFS") addresses, which can be thought of as "an extension of a blockchain to […] a decentralized information storage system".[1264] Encryption may be a way to aid in achieving confidentiality so that jurors can only decrypt and access the information with the right public-private key pair.[1265] Even if this information were not publicly available to begin with, jurors could still make it public because they are random strangers whose behavior in this regard cannot be controlled.[1266]

5.4.5.8 ***The Fees***

407 Arbitration fees are paid in *ether* upfront and *PNK* is used for staking. When jurors are coherent, they are awarded *ether* (and some *PNK*), when they are not aligned with the majority, they lose from their staked *PNK*.[1267] The amount of fees to be paid depends on

[1262] See Interview #2, William George ("But the one thing that sort of conventional mechanisms can do that is hard to imagine Kleros being able to do is [confidentiality]. And I mean it's important … like our jurors are sort of by structure random people on the Internet.").

[1263] See Interview #2, William George ("So if you go to other use cases it's conceivable to find other kinds of ways to hide the link between people's confidential information and the information needed by the jurors but it's really, it seems really hard to do that in general.").

[1264] See Interview #2, William George ("So currently information is recorded in what's called an IPFS address, so an interplanetary file system. So it's sort of an extension of a blockchain to information storage, it's a decentralized information storage system.").

[1265] See Interview #2, William George ("And you know, we could have … a sort of mild advancement on this. Like it's totally possible to encrypt the information, for the parties to encrypt their information and they send it to the jurors, the jurors have a public private key pair to encrypt the information, the jurors already have a public private key pair in the form of their name, address. And then they could decrypt information and look at it themselves.").

[1266] See Interview #2, William George ("And then it wouldn't be publicly available unless one of the jurors published it. But because the pool of jurors is random people on the Internet you cannot control people from publishing it.").

[1267] See Interview #2, William George ("There's sort of two amounts floating around there … parties typically will pay arbitration fees in ether. And then the jurors stake PNK and whether you are coherent or incoherent in a case, if you're incoherent, you lose PNK, you don't get anything and if you're coherent you gain some ether, and you might gain some PNK from people who are incoherent."). See also Lesaege, Ast and George (n 1136) 6 et seq.

the court selected and the number of jurors selected and once the dispute goes to court, the fees to ultimately be paid by the parties are known.[1268] Since the fee structure and the arbitrator court protocol may change depending on what the community decides in the governance mechanism that underlies the DAO, once a dispute actually goes to court, the fee structure may have changed in such a way that parties may no longer wish to pay the arbitration fee to resolve their dispute.[1269] This leads to questions regarding the predictability and certainty of the dispute resolution process.

408 In the current escrow system, both parties have to pay fees and if one party asks for dispute resolution and pays the fees, and the other party does not, the party that does not pay the fees, loses the case.[1270] Although the arbitration fees to be paid to jurors are usually in *ether*, regarding the escrow contract, the value in it must not be a monetary value, it could be an NFT, such as a cryptokitty.[1271]

5.4.5.9 ***Interoperability and "Bridges" between Blockchains***

409 Kleros can be used for any smart contract compatible blockchain. The team plans to keep the community of jurors and the court on Ethereum and allow them to resolve disputes on other blockchains through "bridges", which can be thought of as communication channels between Ethereum and other blockchains, where an arbitrable contract from

[1268] Interview #2, William George ("Each court has an average fee per juror … so when you pick a court and you pick a number of jurors, then you know what the fee is going to be … so when you trigger the arbitration, so when this time comes to have a dispute and you click the arbitrate button, you know what the fee is going to be."). See also Lesaege, Ast and George (n 1136) 6 et seq.

[1269] Interview #2, William George ("When you wrote the contract which might have been a few months in the past, it's possible that the fee will have changed between when you wrote the contract and when you click the I want dispute resolution button, in which case it might not make sense for you to pay that fee anymore, but when you actually click please resolve my dispute, you will know what the fee is.")

[1270] Interview #2, William George ("There are different models, you can have for this escrow, so we have an implementation that you know that we have. You could do different things, but the way that the current implementation works you know if you're a party to the escrow and then the other party asks for dispute resolution, and you don't pay, you don't deposit the amount that will cover the juror fees, then you're sort of giving up … you're being like okay, they win - I don't either think I have sufficient chance of winning or I don't care enough, they put in fees and I didn't."). See also Lesaege, Ast and George (n 1136) 7.

[1271] Interview #2, William George ("So the way that our escrow contract works … again, you could create your own arbitrable contract with a slightly different take on the escrow … that could have that model if you wanted. Because you know any third party can create their own arbitrable contract. But the way that our escrow contract currently works is there's an amount in the escrow which might not even be monetary refundable, for example, it could be an NFT, you know you could have an escrow over crypto kitty which is this joke thought experiment we had."). See also 'Cryptokitty' <https://www.cryptokitties.co/>.

another blockchain would access the arbitrator contract on Ethereum and receive the answer back from the jurors.[1272]

5.4.6 Aragon – On-chain Dispute Resolution focused on DAOs

410 The Aragon Association was founded in 2018 by Luis Cuende and Jorge Izquierdo as a non-profit association in Zug, Switzerland.[1273] The Aragon Network's launch was planned for the end of 2019.[1274] It provides an infrastructure for the creation and management of DAOs with a customizable system.[1275] As discussed in Chapter 2.4.10, DAOs are blockchain-enabled organizations relying extensively on smart contracts and minimizing human intervention, a new way of setting up and running companies in a more decentralized way.[1276] According to the whitepaper, smart contracts define the rights and obligations of the DAO's stakeholders.[1277] Since DAOs assemble humans and facilitate their transactions through code, disputes can still occur and need resolution.

411 The Aragon Network provides dispute resolution for DAOs in the form of its Aragon Court, which is defined as being "a decentralized oracle protocol developed and maintained by the Aragon Network", able to handle subjective disputes that cannot be resolved by smart contracts alone.[1278] In the blog post announcing the launch of the Aragon Court, it was portrayed as the "world's first digital jurisdiction".[1279] Similar to the Kleros Court, the Aragon Court offers a crowdsourced on-chain dispute resolution

[1272] Interview #2, William George ("Any smart contract compatible with blockchains, you know, in theory, could use Kleros. And we've had some discussions with other people and other blockchains that have disputes that want them resolved and like currently the sort of model that we've looked into it's keeping the Court on Ethereum to keep it sort of the community of jurors united on Ethereum and then have disputes resolved across "bridges" to other blockchains, so basically there's some kind of communication channel between Ethereum and chain A … where some arbitrable contract on chain A says hi I have a question I need it to be resolved and then that goes over the bridge to Ethereum where jurors see the question, rule on this dispute, and then the answer goes back over the bridge.").

[1273] See 'Aragon Association' (*Aragon Wiki*) <https://wiki.aragon.org/association/overview/>.

[1274] See 'Aragon Network' (*Aragon Wiki*) <https://wiki.aragon.org/network/overview/>.

[1275] See 'Aragon Whitepaper' <https://github.com/aragon/whitepaper>. See Interview #7, Jorge Izquierdo ("It's a very flexible, modular system and people can really customize.").

[1276] See *supra* Chapter 2.4.10. See De Filippi and Wright (n 5) 146 et seq. Jorge Izquierdo, the former CEO of Aragon One and co-founder of Aragon in Interview #7 expressed his conviction in DAOs. He explained that they enable decentralized human coordination and entirely new ways to organize ownership in the digital sphere, enabling people using a platform to own part of that platform instead of the way digital platforms are conventionally structured, such as Facebook.

[1277] See 'Aragon Whitepaper' (n 1275).

[1278] 'Aragon Whitepaper' (n 1275). See Aragon, 'Launching Aragon Court' (2020) <https://blog.aragon.org/launching-aragon-court>. See 'Aragon Court' <https://help.aragon.org/article/41-aragon-court>.

[1279] See 'Launching Aragon Court' (n 1278).

mechanism. Those interested in becoming jurors – or within the Aragon Network termed "guardians" - sign up by activating a special token native to the Aragon Network called "ANT" into the Aragon Court's smart contract.[1280] The more tokens one places there, the higher the likelihood of being chosen.[1281] Aragon's website explicitly states that the "Aragon Court guardians are not asked to rule impartially on disputes but instead are asked to rule the way they expect the plurality of guardians to rule".[1282] This obviously departs from the notion of impartiality or due process that is prevalent in traditional dispute resolution.

412 Aragon incentivizes guardians based on the game theory of Schelling Points. As in the Kleros system, the guardians who vote along with the majority are rewarded with the dispute fees paid by the parties and ANT tokens lost by minority voters. Currently, the court has 164 active jurors,[1283] the number of disputes resolved is not available as the system is not live yet,[1284] but is set to launch in 2021.[1285] Izquierdo anticipates the disputes occurring on the Aragon Network to be mostly about voting proposals in DAOs.[1286] Izquierdo estimates the use of the Aragon Court to be infrequent because the incentives would be aligned in a way for people to coordinate and if disputes occurred, for them to solve these amicably rather than resorting to dispute resolution.[1287]

413 DAOs need dispute resolution as a means to include subjectivity and protect minority stakeholders in decentralized organizations.[1288] Many elements in traditional organizations are not easily replicable for DAOs and need to be reconsidered.[1289] For the

[1280] See 'Aragon Court' (n 1278). Previously, there was a token created only for the court called "ANJ" but was later discontinued.
[1281] See 'Aragon Court' (n 1278).
[1282] 'Aragon Court' (n 1278).
[1283] See 'Aragon Court Dashboard' <https://anj.aragon.org/>. Aragon seemed to have rebranded the jurors as "guardians" but at some parts the term "juror" still appears, such as in the Whitepaper. See 'Aragon Whitepaper' (n 1275).
[1284] Interview #7, Jorge Izquierdo ("The project is like not really live yet. So we haven't seen it on the wild.").
[1285] See Aragon, 'Aragon Project Updates: June 2021' (*Substack*, 2021) <https://aragon.substack.com/p/aragon-project-updates-june-2021>. See Ramon Canales, '@ramonIsTweeting on Twitter on 7 July 2021' (*Twitter,* 2021) <https://twitter.com/ramonIsTweeting/status/1412742065641951234>.
[1286] Interview #7, Jorge Izquierdo.
[1287] Interview #7, Jorge Izquierdo.
[1288] Interview #7, Jorge Izquierdo ("We started working on a court with just the dispute resolution system for the organizations so that they can bring in subjectivity within organizations which is otherwise not possible, and it is also very needed for some basic protections such as minority protections in a company.").
[1289] Interview #7, Jorge Izquierdo ("And if you do see, I have a responsibility to take all these things that we take for granted in human organizations that they're just not possible to replicate … in a way to bring in human judgment.").

well-functioning of DAOs, there needs to be the possibility to include human decision-making in some shape or form.[1290]

414 Izquierdo explains that Aragon is primarily used in the crypto industry by decentralized protocols that need a way to govern their organization by enabling DAO token holders to participate and make decisions "in a completely decentralized way", for example, to update the code.[1291] The way that the Aragon Court is envisioned primarily is for disputes occurring within DAOs, more specifically regarding proposals, so called "proposal agreement disputes".[1292] The Aragon Whitepaper gives the example of allowing treasury funds to be transferred only under certain conditions in a so-called "chain of permissions", the requirements of which are: "1) proposed by a member of the organization, 2) approved by a majority of members, and 3) within a pre-determined budget".[1293] An application within the DAO to effect payments can only be triggered once votes have successfully passed.[1294] Since the majority votes are the ones that effectively execute payments and change parameters within the organization based on successful proposals, minority stakeholders may have a myriad of concerns, such as, for example, the organization being liquidated.[1295]

415 Members in the organization can commence a dispute if a proposal breaches the so-called "proposal agreement terms".[1296] The logic behind this is to mitigate the risk of minority members' interests not being considered. In order to raise a dispute, collateral and fees need to be deposited as specified by the Aragon Court.[1297] This triggers a pause in the voting mechanism until the dispute resolution procedure has ended.[1298] The way that the Aragon network protects organizations is by allowing proposals to be submitted to the voting app only once the proposer has deposited a collateral.[1299] Furthermore, by way of

[1290] See *ibid*.
[1291] Interview #7, Jorge Izquierdo ("Right now Aragon is primarily used within the crypto industry, there are a lot of protocols, decentralized protocols that instead of having a company govern and control the protocol, changing the parameters, being in charge of creating new versions of the code, instead of doing that they have a DAO do that on its own by all the token holders and they can make a decision … in a completely decentralized way, so all the token holders are entitled to control them to participate directly."). More than 1,700 DAOs have been created on Aragon so far.
[1292] See 'Aragon Whitepaper' (n 1275).
[1293] See 'Aragon Whitepaper' (n 1275).
[1294] See 'Aragon Whitepaper' (n 1275).
[1295] See 'Aragon Whitepaper' (n 1275).
[1296] See 'Aragon Whitepaper' (n 1275).
[1297] See 'Aragon Whitepaper' (n 1275).
[1298] See 'Aragon Whitepaper' (n 1275).
[1299] See 'Aragon Whitepaper' (n 1275).

proposal agreements DAOs can define the proposal requirements in human language.[1300] The proposer has the option to concede or enter the dispute, if they concede, they lose their collateral to the party raising the dispute, in which case the voting ends; if they choose to enter the dispute, they will need to pay dispute fees as well and provide evidence backing their case.[1301] Once both sides of the dispute have entered the dispute, the Aragon Court protocol comes into play.

416 In a next step, jurors (guardians), which have been drafted are expected to review the evidence in the case and cast a vote, after which the majority decision is communicated back to the disputants.[1302] If the decision is appealed, a larger set of jurors is chosen to resolve the disputes in an appeals process.[1303] There is a fixed number of times parties may appeal until a final judgment is made and thus there are clear boundaries on when disputes end.[1304] The party challenging the decision needs to commit three times the base amount of the collateral, whereas the party being challenged needs to commit twice the amount.[1305] This system may disadvantage a weaker party that does not have much funds and cannot obtain the required funds through crowdsourcing, as the Whitepaper reads that "[i]f only one side deposits the required collateral, the ruling is immediately finalized in their favor. If both sides deposit the required collateral, then the appeal round is scheduled."[1306]

417 Recognizing the constraints of smart contracts and the need for subjective agreements, the Aragon Network implemented the Aragon Court and sees it as "an equivalent of the legal system, but fully native to [the DAO infrastructure]".[1307] At the moment of writing this thesis, the Aragon Court is not live yet but can be tested on the Rinkeby testnet.

[1300] See 'Aragon Whitepaper' (n 1275).
[1301] See 'Aragon Whitepaper' (n 1275).
[1302] See 'Aragon Whitepaper' (n 1275).
[1303] See 'Aragon Whitepaper' (n 1275).
[1304] See 'Aragon Whitepaper' (n 1275).
[1305] See 'Aragon Whitepaper' (n 1275).
[1306] 'Aragon Whitepaper' (n 1275).
[1307] 'Launching Aragon Court' (n 1278).

5.4.7 Jur – A Digital Justice Platform on the Way to Decentralization

418 Jur AG was founded in 2017 by Alessandro Palombo and Giotto De Filippi as a legal tech company in Zug, Switzerland.[1308] Jur[1309] is working on creating a "decentralized legal ecosystem based on the blockchain technology in order to automate contract creation, formation, execution, enforcement, and dispute resolution".[1310] The aim is to support a contract's whole life cycle.[1311] According to the whitepaper the ecosystem will provide "editable automated contracts with embedded ODR mechanisms, fueled by the use and expenditure of the JUR Token,"[1312] and can be viewed as "wordpress for smart legal contracts".[1313] Unlike Kleros and Aragon, Jur's infrastructure runs on the VeChainThor blockchain and the Jur ecosystem's native token is a VIO-180 token.[1314] The grand vision is to create an "Internet of Jurisdictions", where parties can choose both a jurisdiction and the applicable law.[1315]

419 In its early stages, the company focused on delivering online and blockchain-based dispute resolution in order to resolve up to medium-sized disputes.[1316] It developed a prototype called the "Jur Open Layer", which has been tested by some universities and remains in a research and development stage.[1317] It relies on game-theoretic principles and "wisdom of the crowd".[1318] The "Jur Beta Platform",[1319] whose access is restricted, has performed at least one real-world asset sale.[1320]

[1308] See 'Jur AG Information' <https://business-monitor.ch/en/companies/727481-jur-ag>. See 'Jur White Paper V 3.0.0' (2021) <https://jur.io/wp-content/uploads/2021/03/jur-white-paper-v.3.0.0.pdf>.
[1309] See 'Jur Website' <https://www.jur.io>.
[1310] Palombo and Battaglini (n 522) 263. Footnote omitted.
[1311] See Palombo and Battaglini (n 522) 263.
[1312] 'Jur White Paper V 3.0.0' (n 1308) 11.
[1313] Jur Official, 'Alessandro Palombo, Founder & CEO of JUR on Smart Legal Agreements on the Blockchain _ Short Version' (*Youtube*, 2019) <https://www.youtube.com/watch?v=rjRoTejsxFQ&t=30s>.
[1314] See 'Jur White Paper V 3.0.0' (n 1308) 11. See 'VeChainThor' <https://www.vechain.org/>.
[1315] See 'Jur White Paper V 3.0.0' (n 1308) 6–7. In Interview #4, Alessandro Palombo explains that aside lawyers, technical people are much needed to realize this vision ("There is a need for technical people - non lawyers - contributing in shaping the future of dispute resolution for Web3, at the beginning.").
[1316] See Palombo and Battaglini (n 522) 263.
[1317] See Palombo and Battaglini (n 522) 264 et seq. Interview #4, Alessandro Palombo ("The open layer we tested with some universities, we will keep testing that part, we find these fascinating.").
[1318] See Interview #5, Raffaele Battaglini ("The first solution developed by Jur is called "Open Layer", a fully decentralized platform to solve disputes where the principles of both game theory and wisdom of the crowd should guarantee fairness of the decision-making process. This solution belongs to the research and development area of Jur.").
[1319] See 'Jur Beta Platform' <https://beta.jur.io/>. To test the platform, one needs to download the "Sync browser" and a VeChainThor wallet, available here: 'VeChain Wallets' <https://env.vechain.org/#sync>.
[1320] See Palombo and Battaglini (n 522) 264.

420 Jur's Open Layer tackles "micro-claims" of disputes of up to 500 USD and promises resolution within 72 hours.[1321] Similarly to Kleros, its incentive mechanism is based on Schelling Points.[1322] Palombo and Battaglini give the example of a fictional freelancing contract between two parties, which gets hashed into a smart contract to which an escrow is attached.[1323] In case of a dispute, the claimant uploads a proposal to commence dispute resolution, which includes JUR tokens equaling 1% of the contract value.[1324] JUR token holders can then vote and stake their tokens for either proposal.[1325]

421 After the end of the voting period, the proposal with the most votes wins.[1326] Rewards are given to those who vote according to the majority position, those who do not, lose their stake. The chronological order in which the votes are received matters in determining which voters are rewarded and which are not.[1327] Differently from the Kleros protocol, timing is important when wanting to participate in the voting. What matters is the "lasting majority" and according to the whitepaper the rationale is to incentivize early voting.[1328] This seems to indicate that there is no limit on how many voters can participate in a given dispute.[1329] The Whitepaper points out that in contrast to the standard scenario of the Schelling game, voters in the Jur Open Layer "do not act simultaneously [and] each voter is able to see how prior votes have been allocated".[1330]

422 Note that the term "juror" or "arbitrator" is hardly used in the context of the Jur Open Layer, rather the white paper and other publications refer to the decision-makers as "voters" or "JUR token holders".[1331] In terms of the parties' stake, parties to the dispute are not treated differently from the voting participants, *i.e.,* their stake in the proposal is subject to the same reward/loss mechanism depending on the outcome of the dispute.[1332]

[1321] See 'Jur White Paper V 3.0.0' (n 1308) 9.
[1322] See Palombo and Battaglini (n 522) 268.
[1323] See Palombo and Battaglini (n 522) 267.
[1324] See Palombo and Battaglini (n 522) 267.
[1325] See Palombo and Battaglini (n 522) 267. This is different from the Kleros court design, where tokens are purposely not staked into the specific disputes.
[1326] See Palombo and Battaglini (n 522) 267.
[1327] See 'Jur White Paper V 3.0.0' (n 1308) 9.
[1328] See 'Jur White Paper V 3.0.0' (n 1308) 9.
[1329] See also Palombo and Battaglini (n 522) 270 ("Whatever the case, in the event that an unusually high number of votes are received in the final 30 min of voting, the time limit is extended automatically until volume subsides. If the majority position changes again due to an unusually high number of votes being received in the final hour, the voting will be extended again, repeatedly if necessary, until a majority prevails throughout the final hour of voting.").
[1330] Palombo and Battaglini (n 522) 269.
[1331] See Palombo and Battaglini (n 522) 267.
[1332] See Palombo and Battaglini (n 522) 267.

There is thus no fee to be paid by the parties to the voters directly, rather the losing party is part of the minority vote and loses their stake, whereas the winning party participates in the voter reward mechanism.[1333] Besides voting for proposal A or B, there is also a third possibility, which is to reject the case, for example if voters perceive some type of illegality.[1334]

423 Palombo and Battaglini explain that if tokens staked exceed a certain amount at any point in the procedure, the "Open Layer will automatically refer the dispute to the Court Layer [rebranded as the Online Justice Platform] in order to ensure the recognition and enforceability of issued decisions before national courts."[1335] They further state that "its activation is legitimate provided that the parties to the agreement have expressed their consent to arbitration in a specific arbitration clause."[1336] This mechanism is called the "Safety Clause" as its aim is to disincentivize manipulation and improper conduct by large JUR token holders.[1337] Jur's Community Layer is a variant to the Open Layer, where only trained professionals may participate in voting.[1338] This solution is aimed at commercial business disputes where some expertise is needed and where the value in dispute ranges up to 5,000 USD.[1339] There is a distinction made between the Open Layer, the Community Layer, and the Online Justice Platform.

424 In its most recent and updated Whitepaper, Jur has rebranded its "Court Layer" to the "Online Justice Platform", which aims to provide a remote arbitration service for small-medium enterprises ("SMEs").[1340] This platform aims to provide an infrastructure for the creation of "digital arbitration institutions or private courthouses", which they refer to as "hubs".[1341] Its major aim is to provide an online arbitration, whose arbitral awards will be enforceable under to the New York Convention.[1342] Taking the UNCITRAL Model Law as a model, it also aims at designing an "Online Justice Standard".[1343] In its revised Whitepaper, Jur's main focus lies on the digital arbitration platform, which only utilizes

[1333] See Palombo and Battaglini (n 522) 267.
[1334] See Palombo and Battaglini (n 522) 267.
[1335] Palombo and Battaglini (n 522) 270.
[1336] Palombo and Battaglini (n 522) 270.
[1337] See Palombo and Battaglini (n 522) 270.
[1338] See 'Jur White Paper V 3.0.0' (n 1308) 10.
[1339] See 'Jur White Paper V 3.0.0' (n 1308) 10.
[1340] See 'Jur White Paper V 3.0.0' (n 1308) 5.
[1341] 'Jur White Paper V 3.0.0' (n 1308) 7.
[1342] See 'Jur White Paper V 3.0.0' (n 1308) 7.
[1343] 'Jur White Paper V 3.0.0' (n 1308) 7.

blockchain technology in certain stages of the procedure. Elements Jur wants to implement in its modern online justice platform are "impartiality and fairness, transparency and accountability, and quality of judgement".[1344]

425 The platform aims to provide a "[h]igher quality decision-making process via algorithm, blockchain, and smart contract features, such as (i) random appointment of arbitrators,[1345] (ii) decentralised peer-review mechanism of the preliminary draft decision, (iii) embedded reputation system for Hubs and arbitrators for quality and accountability [and] (iv) higher resilience and corruption resistance thanks to blockchain technology."[1346] It also wants to provide "smart contract-based Hub governance, and […] decentralised legal financing".[1347]

426 Aside from the Jur native token, blockchain technology is not used extensively, for example, for achieving higher resilience and corruption resistance. However, Jur wants to implement a decentralized blind peer review system.[1348] Palombo explains that this system could be more efficient because "smart contracts guarantee that every time there is a decision that judgment is peer reviewed, and everyone can check the logic followed behind it. At the same time, this system doesn't require multiple people to review the same documents and express a vote. It's more efficient."[1349] Jur's focus predominantly lies on viable solutions for the present market conditions, also geared towards the mainstream market, and thus follows a different strategy than Kleros or Aragon. Jur follows a "progressive approach to decentralisation" and only over time wants to merge mainstream with blockchain solutions, in what they call the "road to decentralisation".[1350]

[1344] See 'Jur White Paper V 3.0.0' (n 1308) 13.
[1345] It needs to be distinguished whether this relates to the Jur Open Layer or the Justice Platform. Since it seems to relate primarily to the Justice Platform, a random selection of arbitrators may not be in the parties' interest if the system is not designed as a crowd-based system where random selection is one of the key elements in its game theory design in order to provide security and a sense of neutrality.
[1346] 'Jur White Paper V 3.0.0' (n 1308) 8.
[1347] 'Jur White Paper V 3.0.0' (n 1308) 13.
[1348] Interview #4, Alessandro Palombo ("The award is scrutinized through a blind review so it's like for scientific papers. Then peer reviewers apply the same logic of rewarding that we have analyzed before, so we took that model and we applied it not to the act of judgment per so but on a second layer of quality assessment where game theory reward, in my opinion, makes a lot of sense. The goal is to have an objectively generated rating and review of decisions.").
[1349] Interview #4, Alessandro Palombo.
[1350] Jur Team, 'Road to Decentralisation' (*Jur.io Blog*, 2021) <https://jur.io/blog/announcements/road-to-decentralisation>.

5.4.8 Mattereum – Moving Real-World Assets On-Chain with Off-Chain Arbitration

427 Mattereum was founded in 2017 by Vinay Gupta.[1351] Mattereum provides on-chain tradeable real-world assets and aims to serve as "commercial infrastructure to turn smart contracts into legal contracts that can be efficiently enforced all over the world".[1352] It focuses therefore on the tokenization of real-world assets in order to "give physical matter digital interfaces".[1353] Its approach is to work within the legal framework, without new laws having to be enforced.[1354]

428 When Ethereum launched, Gupta realized that Ricardian contracts were needed to set up real-world assets on the blockchain.[1355] Gupta calls the first phase of the company "Mattereum One", where most of the research was conducted in order to realize his vision, for example, on how to operate a "Ricardian court".[1356] Thus Mattereum's "early work focused on dispute resolution, in the classical Ricardian Contract model".[1357] The challenge the team faced was to find a way to enable proper enforcement of a decision on a dispute.[1358] Reframing the problem, the need for "dispute avoidance over dispute resolution and […] removing the legal obstacles" to enforcing a legal arbitral award, became clear.[1359]

429 Mattereum One was ahead of its time as no significant number of disputes existed in the ecosystem.[1360] This led to the development of the concept of an "automated custodian", which is described as a "legal counterparty to a smart contract".[1361] Such "[a]n automated custodian […] maintain[s] the authoritative register of interests in the asset" by becoming

[1351] See 'Mattereum - About Us' <https://mattereum.com/about-us/>.
[1352] Mattereum, 'Summary Whitepaper: MATTEREUM Protocol, Turning Code into Law' 1 <https://mattereum.com/wp-content/uploads/2020/02/mattereum-summary_white_paper.pdf>. See 'Mattereum' <https://mattereum.com/>.
[1353] Mattereum, 'Summary Whitepaper: MATTEREUM Protocol, Turning Code into Law' (n 1352) 7.
[1354] See Mattereum, 'Summary Whitepaper: MATTEREUM Protocol, Turning Code into Law' (n 1352) 3.
[1355] Interview #6, Vinay Gupta ("So having seen that when Ethereum got started I said hey we need to set up Ricardian contracts so that it is possible to manipulate real world legal value, using the blockchain because without a Ricardian contract gateway it doesn't work, you can't do it.").
[1356] Interview #6, Vinay Gupta ("And so I said okay let's get the Ricardian contracts set up, court set up as an independent company, so all my company did was we spent a couple years in what we call Mattereum One. And Mattereum One was researching how to operate a Ricardian court.").
[1357] Mattereum, 'Summary Whitepaper: MATTEREUM Protocol, Turning Code into Law' (n 1352) 2.
[1358] See Mattereum, 'Summary Whitepaper: MATTEREUM Protocol, Turning Code into Law' (n 1352) 2.
[1359] See Mattereum, 'Summary Whitepaper: MATTEREUM Protocol, Turning Code into Law' (n 1352) 2.
[1360] See Interview #6, Vinay Gupta ("Then we discovered that we were a couple of years ahead of the rest of the field and we had a court, but we had no disputes.").
[1361] Mattereum, 'Summary Whitepaper: MATTEREUM Protocol, Turning Code into Law' (n 1352) 3.

the "asset's legal owner and registrar" and can be thought of as a "legal extension of the blockchain into everyday reality".[1362]

430 Mattereum distinguishes between on-chain assets and physical off-chain assets. Since off-chain assets are not native to the blockchain and cannot be coded directly,[1363] Mattereum proposes to "program […] the registrars", which should then "take legal title to the assets for (at least) the duration of the contract's execution".[1364] Any given asset will have an "asset passport", which is described as a "unique contractual container (legal and smart contracts together) that records and manages the rights and obligations associated with a given asset".[1365] In what is described as an "asset on-boarding process", owners can put objects into the asset passports which "identify property in the same way that URLs identify information."[1366]

431 Mattereum's "Smart Property Register" is the sum of all registrars and their asset passports, containing "definitive records of all related contracts".[1367] Much the same way as official registries for real estate are decisive, the Smart Property Register aims to be authoritative for all asset classes, functioning as a "single source of truth", and preventing double-spending.[1368] The Mattereum summary whitepaper explains that assets which become digitized and embedded in their histories and contexts have more value as they become fully digitally accessible.[1369] The argument goes that many "illiquid assets, such as idle cars and briefly empty flats, found markets through [companies such as] Uber and Airbnb, liberating billions in value".[1370] However, today these platform are centralized and bundle much of the value.[1371]

432 Mattereum will have an initial collection of contracts which parties can enter into, additional contracts can be added subject to prior examination and payment of fees.[1372]

[1362] Mattereum, 'Summary Whitepaper: MATTEREUM Protocol, Turning Code into Law' (n 1352) 3.
[1363] See Mattereum, 'Summary Whitepaper: MATTEREUM Protocol, Turning Code into Law' (n 1352) 3.
[1364] Mattereum, 'Summary Whitepaper: MATTEREUM Protocol, Turning Code into Law' (n 1352) 3.
[1365] Mattereum, 'Summary Whitepaper: MATTEREUM Protocol, Turning Code into Law' (n 1352) 5.
[1366] Mattereum, 'Summary Whitepaper: MATTEREUM Protocol, Turning Code into Law' (n 1352) 5.
[1367] See Mattereum, 'Summary Whitepaper: MATTEREUM Protocol, Turning Code into Law' (n 1352) 5–6.
[1368] See Mattereum, 'Summary Whitepaper: MATTEREUM Protocol, Turning Code into Law' (n 1352) 6.
[1369] See Mattereum, 'Summary Whitepaper: MATTEREUM Protocol, Turning Code into Law' (n 1352) 7–8.
[1370] Mattereum, 'Summary Whitepaper: MATTEREUM Protocol, Turning Code into Law' (n 1352) 7.
[1371] See Mattereum, 'Summary Whitepaper: MATTEREUM Protocol, Turning Code into Law' (n 1352) 7–8.
[1372] See Vinay Gupta et al., 'Mattereum Working Paper', (2020) < https://mattereum.com/wp-content/uploads/2020/02/mattereum_workingpaper.pdf> 38.

Smart contracts on Mattereum need to be audited in order to eliminate possible flaws and to ensure basic functionality, the accompanying human-readable contract needs to express the intentions of the parties clearly.[1373] Review and auditing is done by independent firms on file with Mattereum.[1374] In line with the need identified under Mattereum One, should a dispute arise at a later stage, arbitration will be available. All Ricardian contracts concluded on the Mattereum Protocol include an arbitration agreement to enable any dispute to be resolved by way of off-chain arbitration.[1375] Any documentation is made available on-chain.[1376] Arbitrators may be selected by the parties or appointed by an "Arbitration Association".[1377]

5.4.9 Other Approaches

433 CodeLegit is a compliance and arbitration service provided by Datarella, a company for blockchain-based business applications, headquartered in Munich, Germany.[1378] In its Whitepaper on "Blockchain Arbitration", it provides a "Blockchain Arbitration Library which can be included in the code of a Smart Contract"[1379] and "Blockchain Arbitration Rules".[1380] The Whitepaper outlines the advantage of being able to choose an arbitrator who is both versed in the law and in technical aspects.[1381] The model clause to be included in the legal agreement refers to "Blockchain Arbitration Rules".[1382] They further provide for one arbitrator by default, hearings by video conference, and English as the default language of the proceedings.[1383] No mention is made as regards the seat of arbitration.

[1373] See Gupta et al. (n 1372) 38-39.
[1374] See Gupta et al. (n 1372) 39.
[1375] Interview #6, Vinay Gupta ("Whatever goes wrong, it will be suitable for arbitration because we don't let people sign contracts which are not suitable for arbitration, the required evidence will be recorded on-chain, or in other secure storage. All the documentation will be available for arbitration. … Over time, that will become a more and more complex arbitration agreement as we discover new sources of ambiguity. But all that we can promise is that the dispute will be legally resolved by a competent authority."). A model of a Mattereum contract can be found here: 'Mattereum Contract' <https://passport.mattereum.com/jtkdress.5000247880.62880.1872/10k/0_desc/assets/out/certification-contract.html> (Clause 21 is the arbitration clause and has several subclauses.).
[1376] *Ibid*.
[1377] See Gupta et al. (n 1372) 20.
[1378] See 'Datarella - Blockchain Solutions' <https://datarella.com/blockchain-solutions/>. See 'CodeLegit Imprint' <https://codelegit.com/imprint/>. CodeLegit's approach seems to be modeled after Kaulartz (n 116), and Kaulartz is also mentioned on the webpage.
[1379] 'CodeLegit White Paper on Blockchain Arbitration' <https://docs.google.com/document/d/1v_AdWbMuc2Ei70ghITC1mYX4_5VQsF_28O4PsLckNM4/edit>.
[1380] See 'CodeLegit White Paper on Blockchain Arbitration' (n 1379).
[1381] See 'CodeLegit White Paper on Blockchain Arbitration' (n 1379).
[1382] This clause may be pathological, seeing that it does not specify "CodeLegit's Blockchain Arbitration Rules" but only "Blockchain Arbitration Rules". There is at least one other set of arbitration rules available, namely the one drafted by JAMS. See *infra* Chapter 5.5.2.
[1383] See 'CodeLegit White Paper on Blockchain Arbitration' (n 1379).

434 Aside from the human-readable implementation with a model clause, the Whitepaper outlines the functioning of the Arbitration Library as follows: The parties may insert it in their smart contract code and by calling the function "pauseAndSendToArbitrator ()" during a grace period,[1384] the Arbitration Library gets initiated.[1385] A party may use this function for one of two reasons: (i) either a breach in the legal agreement occurred, or (ii) the smart contract runs incorrectly.[1386] It seems that there are *de facto* two "contracts": "[t]he legal agreement contains the arbitration clause and the Smart Contract includes the Arbitration Library".[1387] Once the function is triggered, the smart contract "pauses its performance"[1388] and "starts the arbitral proceeding".[1389]

435 For evidentiary purposes, CodeLegit recommends hashing any communication, the legal agreement, and the contract code itself onto Bitcoin or Ethereum.[1390] The parties need to disclose their identities to CodeLegit and once the arbitrator is appointed, a hearing in person or via video conference may take place if it is deemed necessary.[1391] The proceedings conclude with an award sent to the parties by postal mail and email, CodeLegit arbitrators then have three options, they either (i) call the function "continueContract ()", or (ii) "endContract ()", another possibility outlined is (iii) the modification of the smart contract code – how this is envisioned, however, remains unclear.[1392] CodeLegit seems to operate independently of any blockchain-based community as there are no social media outlets for community interaction. There is no data freely accessible on whether any cases have been resolved using their Arbitration Library and there have been no news updates since 2017. The assumption is that no significant number of contracts have implemented this specific approach. As was the case for Sagewise, there might not be a product market fit.

[1384] The exact duration of the grace period is not specified.
[1385] See 'CodeLegit White Paper on Blockchain Arbitration' (n 1379).
[1386] See 'CodeLegit White Paper on Blockchain Arbitration' (n 1379).
[1387] CodeLegit states that "[p]arties have concluded a legal agreement and are running a Smart Contract". This seems to indicate that the smart contract does not substitute the legal contract but rather complements it and/or reflects the legal contract. See also *supra* Chapter 3.3.2.
[1388] 'CodeLegit White Paper on Blockchain Arbitration' (n 1379). Note that this is again an indication that the smart contract is seen as a mere performance tool.
[1389] See 'CodeLegit White Paper on Blockchain Arbitration' (n 1379).
[1390] See 'CodeLegit White Paper on Blockchain Arbitration' (n 1379).
[1391] See 'CodeLegit White Paper on Blockchain Arbitration' (n 1379).
[1392] See 'CodeLegit White Paper on Blockchain Arbitration' (n 1379).

436 OpenLaw follows a different approach. In October 2018, OpenLaw, a blockchain protocol for legal agreements,[1393] recognizing the need for dispute resolution "for the blockchain ecosystem to mature into a pervasive global infrastructure", proclaimed the beginning of "the era of decentralized dispute resolution procedures".[1394] OpenLaw's announcement lists the following possible disputes: (i) regarding "the terms governing [the] performance" of smart contracts, (ii) disagreements regarding the contract execution (contradicting the parties' intention), (iii) smart contract bugs, and (iv) problems due to reliance on outside data, such as oracles.[1395]

437 OpenLaw had the grand vision of a blockchain-powered global "online court", accessible to everyone, everywhere.[1396] The crucial factors it identified to accomplish this vision were the following three: (i) smart contracts enabling arbitration, (ii) arbitral awards that are enforceable, and (iii) trustworthy arbitrators by way of a reputation system.[1397] Announcing its "OpenCourt" launch, OpenLaw stated it had made breakthroughs in the areas (i) and (ii).[1398] In the video demonstration of OpenCourt, the presenter shows the arbitration clause, which is the JAMS standard arbitration clause.[1399] When a party uses an OpenLaw smart contract to conclude a legal contract, the funds are deposited into an escrow account and OpenCourt's dispute resolution service can be invoked in case of a dispute.[1400]

438 Once a dispute is created, the amount of ETH that was being held for the transaction will be transferred to the dispute resolution smart contract, to which the arbitrator then has access.[1401] The parties each can nominate an arbitrator by typing in the arbitrator's Ethereum address.[1402] It is unclear what happens if the parties cannot agree on an arbitrator, as the arbitration clause in the contract provides for a sole arbitrator.[1403] The

[1393] See Michael Rice, 'OpenLaw Tutorial: Blockchain-Enabled, Legally Enforceable Smart Contracts' (*Medium*, 2018) <https://medium.com/@OpenLawOfficial/openlaw-tutorial-blockchain-enabled-legally-enforceable-smart-contracts-24d5654050fa>.
[1394] OpenLaw, 'OpenCourt: Legally Enforceable Blockchain-Based Arbitration' (2018) <https://media.consensys.net/opencourt-legally-enforceable-blockchain-based-arbitration-3d7147dbb56f>.
[1395] See OpenLaw (n 1394).
[1396] See OpenLaw (n 1394).
[1397] See OpenLaw (n 1394).
[1398] See OpenLaw (n 1394).
[1399] See Aaron Wright, 'OpenCourt: Legally Enforceable Blockchain-Based Arbitration' (*Youtube*, 2018) <https://www.youtube.com/watch?v=oVfjy43YgnY>.
[1400] See Wright, 'OpenCourt: Legally Enforceable Blockchain-Based Arbitration' (n 1399).
[1401] See Wright, 'OpenCourt: Legally Enforceable Blockchain-Based Arbitration' (n 1399).
[1402] See Wright, 'OpenCourt: Legally Enforceable Blockchain-Based Arbitration' (n 1399).
[1403] See Wright, 'OpenCourt: Legally Enforceable Blockchain-Based Arbitration' (n 1399).

selected arbitrator then has access to the OpenCourt interface, both parties' statements and makes a decision, which can automatically execute.[1404] Though the announcement referred to "decentralized arbitration",[1405] there is little which can be considered decentralized in such an arbitration, which foresees a type of off-chain dispute resolution, besides the underlying blockchain protocol for the smart contract holding the funds. OpenLaw seemed to have put its OpenCourt on standby. However, the company tweeted that "[o]nline dispute resolution will be accelerated with blockchain technology" and linked to another initiative called lexDAO, which started providing its own arbitration protocol.[1406]

439 LexDAO is an initiative for dispute resolution started by a group of legal experts and engineers,[1407] with the following standard arbitration clause: "Any controversy, dispute or claim among the parties arising out of or relating to this agreement, or the breach, termination or validity thereof, shall be finally settled by LexDAO Arbitration in accordance with the rules and procedures recorded on https://github.com/lexDAO/Arbitration/tree/master/rules."[1408] Under the section "LexDAO Arbitration Rules", it is stated that "LexDAO follows UNCITRAL arbitration rules", and a link is provided to the UNCITRAL Arbitration Rules main website.[1409]

440 LexDAO offers two types of arbitration on both Ethereum and xDAI[1410]: One is a tribunal of certified LexDAO legal engineers of up to 10 members ("panel"), and a sole arbitrator option ("individual"), where a legal engineer can be individually selected.[1411] Their objective is to solve binary subjective disputes, which smart contracts cannot resolve.[1412] The native token of LexDAO, needed to participate in resolutions, can only be obtained by LexDAO resolver and its members vote.[1413] Its terms of use designate "the Aragon

[1404] See OpenLaw (n 1394).
[1405] OpenLaw (n 1394).
[1406] OpenLawOfficial, '@OpenLawOfficial on Twitter on 26 February 2020' (*Twitter*, 2020) <https://twitter.com/OpenLawOfficial/status/1232789355816681480>.
[1407] Lex DAO, 'Arbitration Project' (*github*, 2021) <https://github.com/lexDAO/Arbitration>.
[1408] LexDAO, 'Arbitration Project' (n 1407).
[1409] LexDAO, 'Arbitration Project' (n 1407).
[1410] 'XDai' <https://www.xdaichain.com/>.
[1411] See LexDAO, 'Arbitration Project' (n 1407).
[1412] See LexDAO, 'Resolver - Terms of Use' (*github*, 2020) <https://github.com/lexDAO/Arbitration/blob/master/rules/ToU.md>.
[1413] See LexDAO, 'Resolver - Terms of Use' (n 1412). ("DAO is the native token to the LexDAO Resolver required to participate in LexDAO resolutions in accordance with the Terms. DAO may only be obtained after a confirmation vote by LexDAO Resolver and its members."). See also DAO voting shares have been

Court" as the jurisdiction.[1414] LexDAO Resolver has had a demo dispute on the gas-less voting service called snapshot.[1415]

5.5 Global Reactions

441 This section gives a brief overview of the diverse responses by some international organizations and arbitral institutions to the emergence of blockchains and smart contracts related to dispute resolution.

5.5.1 UNCITRAL and UNIDROIT

442 As early as 2015 and 2016, the UNIDROIT Secretariat received proposals to include "distributed ledger (or blockchain) technology and inheritance of digital properties" into its work program.[1416] In 2018 more proposals were received, requesting UNIDROIT to monitor the developments closely, including legal aspects of smart contracts and artificial intelligence.[1417] As a result of these proposals, UNCITRAL and UNIDROIT held a first joint workshop on smart contracts, artificial intelligence, and distributed ledger technology in May 2019, a second joint event was conducted in March 2020.[1418] The objective of these joint workshops was to identify the areas for possible future cooperation regarding emerging technologies.[1419] During one of the panels, "Professor Morishita noted that *lex mercatoria* could be a useful mechanism to address some of these concerns [regarding conflict of laws issues], with the possible need for new dispute resolution mechanisms to correspond with the new technologies".[1420]

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referred to as "COOP", see LexDAO, 'Proof of Judgment - #1' (*snapshot*) <https://snapshot.org/#/lexdao/proposal/QmNreYdZpQTHzHMMsS6RLHCoPZ8eXKtmRubojL79SmBt1R>.

[1414] See LexDAO, 'Resolver - Terms of Use' (n 1412).

[1415] See LexDAO, 'Arbitration Project' (n 1407). See LexDAO, 'Proof of Judgment - #1' (n 1413).

[1416] Secretariat, 'Governing Council 99th Session (B), Item No. 4 on the Agenda: Update and Determination of Scope of Certain Projects on the 2020-2022 Work Programme' (*UNIDROIT*, 2020) <https://www.unidroit.org/english/governments/councildocuments/2020session/cd-99-b/cd-99-b-04-rev-e.pdf> para 2.

[1417] See Secretariat, 'Governing Council 99th Session (B), Item No. 4 on the Agenda: Update and Determination of Scope of Certain Projects on the 2020-2022 Work Programme' (n 1416) para 2-3.

[1418] See 'Joint UNCITRAL/UNIDROIT Workshop Programme 6-7 May 2019' <https://www.unidroit.org/english/news/2019/190506-unidroit-uncitral-workshop/programme-e.pdf>. Secretariat, 'Governing Council 99th Session (B), Item No. 4 on the Agenda: Update and Determination of Scope of Certain Projects on the 2020-2022 Work Programme' (n 1416) para 5 et seq.

[1419] See 'Joint UNCITRAL/UNIDROIT Workshop 6 and 7 May 2019, Summary of the Discussion and Conclusions' (n 463) para 3.

[1420] 'Joint UNCITRAL/UNIDROIT Workshop 6 and 7 May 2019, Summary of the Discussion and Conclusions' (n 463) para 9.

443 An Exploratory Working Group ("EWG") was set up, which convened on multiple occasions in 2020.[1421] The ambition was to prepare a guidance document on digital assets and private law, set to be adopted as a complete draft by May 2022.[1422] UNCITRAL, mandated to investigate legal issues related to the digital economy, held a separate event in late 2019 and published a report on its exploratory work on legal issues related to the digital economy.[1423] In these sessions, it was highlighted that renewed attention to online dispute resolution was necessary due to "the increased use of digital technology since [the release of the UNCITRAL Technical Notes on Online Dispute Resolution in 2016]".[1424] Further, that "[t]he potential of online platforms to settle high-volume, small-value disputes" and "to facilitate deal-making and contract performance, as well as to enhance access to justice for big and small businesses alike" should be explored.[1425]

444 Regarding dispute resolution specifically, the UNCITRAL exploratory work noted that "[a] link was drawn between smart contracts, platforms and dispute resolution. Smart contracts were being deployed on platforms (as demonstrated in the case in Singapore of *B2C2 Ltd. V. Quoine Pte. Ltd*) and encoded with dispute resolution functionalities".[1426] Experts at UNCITRAL also addressed crypto arbitration, bringing the example of "a blockchain-based dispute resolution tool that used crowd-sourced arbitrators which were rewarded on the basis of whether they agreed with a majority of other arbitrators",[1427] and expressing concern over "the implications of these tools for access to justice".[1428] Overall, the role that humans play was emphasized and the need to safeguard human values, possibly requiring new approaches.[1429] The UNIDROIT Governing Council in September 2020 approved the ongoing exploration of legal aspects related to blockchains and digital assets as a high priority project.[1430]

[1421] See Secretariat, 'Governing Council 99th Session (B), Item No. 4 on the Agenda: Update and Determination of Scope of Certain Projects on the 2020-2022 Work Programme' (n 1416) para 15.
[1422] See Secretariat, 'Governing Council 99th Session (B), Item No. 4 on the Agenda: Update and Determination of Scope of Certain Projects on the 2020-2022 Work Programme' (n 1416) paras. 13 et seq, para 25.
[1423] See UNCITRAL (n 323). The "Incheon event".
[1424] UNCITRAL (n 323) para 9.
[1425] UNCITRAL (n 323) para 9.
[1426] UNCITRAL (n 323) para 69.
[1427] UNCITRAL (n 323) para 71.
[1428] UNCITRAL (n 323) para 71.
[1429] See UNCITRAL (n 323) para 71.
[1430] See 'Study LXXXII - Digital Assets and Private Law Project' (n 610).

5.5.2 Arbitral Institutions

445 JAMS was founded in the US in 1979 and is an institutional provider of ADR services with 29 locations worldwide.[1431] It is the first traditional arbitral institution to launch smart contracts, blockchain, and cryptocurrency - specific rules.[1432] So far, no other traditional arbitral institution has offered rules specifically tailored for blockchain disputes. It offers a model dispute resolution clause in natural human language, which can be included in the agreement. Thus, it pre-supposes the existence of at least a portion of the smart contract as a human-readable contract or a separate legal contract. The model clause is construed as a med-arb clause,[1433] providing for mediation prior to arbitration. Only if mediation fails, will the parties proceed to final and binding arbitration. The parties need to specify a seat and the rules foresee English as the language of the arbitral proceedings. According to the Model Clause, the JAMS Smart Contract Rules come into effect in case the parties need to go to arbitration.

446 In total, the "JAMS Rules Governing Disputes Arising out of Smart Contracts" comprise eighteen rules and define the term smart contract as "a computer protocol intended to digitally facilitate, verify or enforce the negotiation or performance of a self-executing contract, when the terms of the agreement between the parties are directly written into lines of computer code that exist across a distributed, decentralized blockchain network."[1434] Since there is no blockchain infrastructure in place, the arbitration is thus modeled after an off-chain, traditional arbitration procedure. However, the arbitration is an expedited one, respondent only has 10 days after receiving the "Demand for Arbitration" to file an "Arbitration Statement", after which the parties have 72 hours to appoint an arbitrator.[1435]

447 The arbitration officially starts once JAMS confirms the appointment of the arbitrator and JAMS has received its fee and the statement of both parties as well as any other documents.[1436] The rules limit discovery to only one competent "individual expert witness

[1431] See 'The JAMS Story' <https://www.jamsadr.com/history>.
[1432] See 'JAMS Smart Contract Clause and Rules (DRAFT)' <https://www.jamsadr.com/rules-smart-contracts>.
[1433] See "Med-arb" stands for mediation-arbitration. Different variants can exist, such as arb-med-arb clauses. Such a clause provides for parties to try and settle their dispute in a mediation before advancing to arbitration.
[1434] Rule 1(d) 'JAMS Smart Contract Clause and Rules (DRAFT)' (n 1432).
[1435] See Rule 5 (a) and (b) 'JAMS Smart Contract Clause and Rules (DRAFT)' (n 1432).
[1436] See Rule 5 (c) 'JAMS Smart Contract Clause and Rules (DRAFT)' (n 1432).

as to the meaning of the Smart Contract coding".[1437] In ascertaining the facts and the law, the arbitrator shall only take regard to the "written contract, the computer code and the witness's testimony".[1438] The rules thus make a distinction between a written contract and the computer code. The question arises as to whether the smart contract includes both the written contract and the computer code as is implied in the definition, specifying that the "the terms of the agreement between the parties are directly written into lines of computer code".[1439] The rules do not have a separate section on hearings,[1440] which is an indication that conducting hearings under these rules is an exception, and that only at certain instances does a hearing seem indicated, such as when a party fails to participate in the process.[1441] Further references to a hearing are made regarding maintenance of confidentiality and privacy and the fees to be paid.[1442] The Rules in general assume the parties to be identifiable, *i.e.,* not pseudonymous.[1443]

448 In the rules regarding interim measures, the rules make an interesting clarification, specifying that "[t]he code will govern interpretation of the Smart Contract, and the terms of the Smart Contract",[1444] and if the terms "are reduced to the English language",[1445] they "shall be considered by the Arbitrator only if there is an ambiguity or logic contradiction in the code".[1446] Finally, the arbitrator needs to render a written award within thirty days after the appointment.[1447] An employee at another arbitral institution shared that they have contemplated whether they should adopt smart contract specific rules and model clauses, but they decided against it because in their view a smart contract clause would "need to

[1437] Rule 12 (b) 'JAMS Smart Contract Clause and Rules (DRAFT)' (n 1432).
[1438] Rule 12 (b) 'JAMS Smart Contract Clause and Rules (DRAFT)' (n 1432).
[1439] Rule 1 (d) 'JAMS Smart Contract Clause and Rules (DRAFT)' (n 1432).
[1440] In contrast to the conventional JAMS arbitration rules, which have multiple provisions dealing with hearings, the main one being rule 22, see 'JAMS Comprehensive Arbitration Rules & Procedures' <https://www.jamsadr.com/rules-comprehensive-arbitration/>.
[1441] See Rule 5 (d) 'JAMS Smart Contract Clause and Rules (DRAFT)' (n 1432).
[1442] See Rule 15 (a), and Rule 18 (b) 'JAMS Smart Contract Clause and Rules (DRAFT)' (n 1432).
[1443] See, e.g., Rule 8 'JAMS Smart Contract Clause and Rules (DRAFT)' (n 1432) regarding representation, where parties need to provide the "name, address, telephone number and email address of [their] representative[s]". This may indirectly require disclosure of the parties' identity as well. A question may arise in this regard, whether a party may stay pseudonymous and only disclose its identity to its representative and neither to JAMS nor the other party. In such a case, however, it may be impossible for the other party to commence or continue proceedings. It further seems counter-intuitive for parties that are pseudonymous (or anonymous) to choose off-chain arbitration to resolve any smart contract disputes. A party that entered a smart contract pseudonymously will hardly reveal its real-world identity once a dispute arises, and it is doubtful whether the notice of the commencement of arbitral proceedings can be reliably sent to a pseudonymous party.
[1444] Rule 13 (c) 'JAMS Smart Contract Clause and Rules (DRAFT)' (n 1432).
[1445] Rule 13 (c) 'JAMS Smart Contract Clause and Rules (DRAFT)' (n 1432).
[1446] Rule 13 (c) 'JAMS Smart Contract Clause and Rules (DRAFT)' (n 1432).
[1447] See Rule 13 (a) 'JAMS Smart Contract Clause and Rules (DRAFT)' (n 1432).

be implemented on whatever that smart contract is, so as opposed to the clauses that we have online that you can just copy and paste, for smart contracts […] it kind of requires the rest of the contract to be written in that same code language with that same structure, just putting a string of code there will only be relevant for those working in that same language."[1448]

449 Indeed, the JAMS's smart contract rules are a form of expedited arbitration rules and are not provided in code form. In the future, one may contemplate offering "arbitrator contracts" as software code. In general, smart contracts are still very much in development and JAMS' institutional rules regarding smart contract remain in a draft stage.

5.5.3 National Taskforces

450 The UK Jurisdiction Taskforce ("UKJT") was established in 2018 to position England and Wales at the forefront of technological revolution and establish the UK as a premier jurisdiction for DLTs, smart contracts, and similar technologies.[1449] The UKJT in 2019 published a legal statement on cryptoassets and smart contracts, clarifying the status of these under English law.[1450] In early 2021, it was the first national taskforce to publish a set of rules for blockchain disputes. The "Digital Dispute Resolution Rules" aim "to facilitate the rapid and cost-effective resolution of commercial disputes, particularly those involving novel digital technology such as cryptoassets, cryptocurrency, smart contracts, distributed ledger technology, and fintech applications".[1451]

451 The rules encompass sixteen articles in total, specify England and Wales as the seat, the laws of England and Wales as applicable,[1452] and are to be read having the English Arbitration Act 1996 in mind.[1453] The document acknowledges that parties transacting in the blockchain environment can be scattered around the world and conflict of laws issues are not easily resolved.[1454] The attached guidance text thus explains that the rules can give parties certainty as to the legal framework that will be applicable to their legal

[1448] Interview #9, Employee at Arbitral institution.
[1449] See 'UK Jurisdiction Taskforce (UKJT) Digital Dispute Resolution Rules' (n 143) 9.
[1450] See 'UK Jurisdiction Taskforce (UKJT) Digital Dispute Resolution Rules' (n 143) 3, 9.
[1451] Article 1 'UK Jurisdiction Taskforce (UKJT) Digital Dispute Resolution Rules' (n 143).
[1452] See Article 16 'UK Jurisdiction Taskforce (UKJT) Digital Dispute Resolution Rules' (n 143).
[1453] See 'UK Jurisdiction Taskforce (UKJT) Digital Dispute Resolution Rules' (n 143) 10.
[1454] See 'UK Jurisdiction Taskforce (UKJT) Digital Dispute Resolution Rules' (n 143) 11.

relationship in case of a dispute.[1455] The rules broadly define the terms "digital asset", "interested party", "automatic dispute resolution process",[1456] "identity details", "appointment body", and "tribunal".[1457] Parties may insert the standard clause provided in Article 3 "into a contract, digital asset or digital asset system by including the text (which may be in electronic or encoded form)".[1458]

452 Parties can submit their dispute to arbitration,[1459] and the proceedings commence by the claimant giving a notice of claim to the respondent and the appointment body.[1460] This notice shall include a variety of information, such as revealing the claimant's identity details, the respondent's contact details, the details of the claim, and more.[1461] Within only three days of receiving the notice of claim, the respondent is required to send an initial response to the claimant and the appointment body, including its own identity details.[1462] Under these rules, the parties do not select the arbitrators themselves, rather these are chosen by the appointment body "as soon as practicable after the time for receipt of the initial responses".[1463] Notably, the appointment body is not bound by any preferences specified by the parties as to the identity or qualifications of arbitrators.[1464] The appointment body is the Society for Computers and Law ("SCL"), which according to the explanatory text is not considered an arbitral institution as its "role is simply to manage the appointment of arbitrators and experts, and to publish anonymised decisions in appropriate cases".[1465]

453 The arbitral tribunal then has "absolute discretion as to what procedure is adopted" and the evidence and arguments it collects.[1466] Emphasis is put on expeditiousness (default of 30 days for the whole procedure),[1467] electronic submissions (award can be in electronic

[1455] See 'UK Jurisdiction Taskforce (UKJT) Digital Dispute Resolution Rules' (n 143) 11.
[1456] Meant here are predominantly p2p and blockchain voting mechanisms, which are considered legally binding according to article 4 of the 'UK Jurisdiction Taskforce (UKJT) Digital Dispute Resolution Rules' (n 143). See also the guidance text, page 12 in the 'UK Jurisdiction Taskforce (UKJT) Digital Dispute Resolution Rules' (n 143).
[1457] Article 2 'UK Jurisdiction Taskforce (UKJT) Digital Dispute Resolution Rules' (n 143).
[1458] Article 3 'UK Jurisdiction Taskforce (UKJT) Digital Dispute Resolution Rules' (n 143).
[1459] See Article 5 'UK Jurisdiction Taskforce (UKJT) Digital Dispute Resolution Rules' (n 143).
[1460] See Article 6 'UK Jurisdiction Taskforce (UKJT) Digital Dispute Resolution Rules' (n 143).
[1461] See Article 6 'UK Jurisdiction Taskforce (UKJT) Digital Dispute Resolution Rules' (n 143).
[1462] See Article 7 'UK Jurisdiction Taskforce (UKJT) Digital Dispute Resolution Rules' (n 143).
[1463] Article 8 'UK Jurisdiction Taskforce (UKJT) Digital Dispute Resolution Rules' (n 143).
[1464] See Article 8 'UK Jurisdiction Taskforce (UKJT) Digital Dispute Resolution Rules' (n 143).
[1465] 'UK Jurisdiction Taskforce (UKJT) Digital Dispute Resolution Rules' (n 143) 12. See Article 2 (e) 'UK Jurisdiction Taskforce (UKJT) Digital Dispute Resolution Rules' (n 143).
[1466] Articles 9, 10 'UK Jurisdiction Taskforce (UKJT) Digital Dispute Resolution Rules' (n 143).
[1467] See Article 12 'UK Jurisdiction Taskforce (UKJT) Digital Dispute Resolution Rules' (n 143).

form and signed digitally),[1468] and written procedures as "[n]o party shall have the right to an oral hearing".[1469] The tribunal is given broad powers relating to digital assets as it can at any time "operate, modify, sign or cancel any digital asset relevant to the dispute [and] direct any interested party to do any of those things".[1470] The means by which it can exercise this power is by the use of a "digital signature, cryptographic key, password or other digital access or control mechanism available to it".[1471]

454 The rules have a clause called "Optional anonymity", according to which claimants and respondents do not need to reveal their identities to each other but can choose to reveal their identities solely to the arbitral tribunal in a confidential manner.[1472] The rules thus give the option for "anonymous arbitration" but clarify that "[t]he tribunal may require details, for example, for the purposes of complying with laws against money laundering or the avoidance of international sanctions".[1473] The accompanying frequently asked questions ("FAQ") section to the rules states that this is "reflecting the fact that [the parties] may have transacted anonymously on a blockchain in the first place".[1474] However, if parties are anonymous to each other from the outset, how are they to submit claims to one another and commence proceedings? A situation that can be envisioned is where one party is anonymous but has been able to identify the respondent and can thus bring a claim, revealing its identity to the tribunal but remaining anonymous to the other party. In any case, a respondent will need to be identified, as a proceeding against an anonymous and unidentifiable party makes little sense.

455 The rules provide for traditional arbitration and the kind of anonymous arbitration the rules foresee hardly enables dispute resolution to take place in anonymous transactions if the parties cannot be identified to begin with. Also, the rules presuppose willing parties. Oftentimes, a respondent will not be willing to participate in an arbitral proceeding, the more so if it can hide in its anonymity. It is commendable that the UKJT has made an effort to tackle this issue. However, it is unclear what advantages these rules have over others. The parties themselves are to propose fees to the appointment body and the arbitral

[1468] See Article 12 'UK Jurisdiction Taskforce (UKJT) Digital Dispute Resolution Rules' (n 143).
[1469] Articles 10 'UK Jurisdiction Taskforce (UKJT) Digital Dispute Resolution Rules' (n 143).
[1470] Article 11 'UK Jurisdiction Taskforce (UKJT) Digital Dispute Resolution Rules' (n 143).
[1471] Article 11 'UK Jurisdiction Taskforce (UKJT) Digital Dispute Resolution Rules' (n 143).
[1472] See Article 13 'UK Jurisdiction Taskforce (UKJT) Digital Dispute Resolution Rules' (n 143).
[1473] 'UK Jurisdiction Taskforce (UKJT) Digital Dispute Resolution Rules' (n 143) 13.
[1474] 'UK Jurisdiction Taskforce (UKJT) Digital Dispute Resolution Rules' (n 143) 13.

tribunal, there is thus no clear fee structure,[1475] the amount parties will pay will thus largely depend on a case-by-case basis and on their negotiation skills. Parties sophisticated enough to incorporate a standard arbitration clause in their contractual relationship, will most likely choose one of the established arbitral institutional rules. The real issues with blockchain transactions are mainly the conflicts of laws issues, the anonymity aspect, and others, which rules on paper cannot resolve, especially if parties need to agree to them before or after a dispute has arisen, the more so if they do not know each other's identity. A promising way to tackle this issue is to start at the base layer, the blockchain layer and incorporate terms from the outset.

5.5.4 World Economic Forum

456 The World Economic Forum ("WEF") published a report specifically tackling dispute resolution in B2B transactions involving blockchains, highlighting the need of enterprise users for suitable dispute resolution mechanisms.[1476] The report states that "enterprise users are more likely to adopt permissioned networks in which the identities of their transactional counterparts are known".[1477] The report thus focuses on permissioned blockchains. It distinguishes between three main types of disputes: (i) non-transactional disputes, (ii) off-chain governance disputes, (iii) on-chain disputes, and focuses on the latter.[1478] Non-transactional disputes relate to off-chain transactions, the example given is a confidentiality provision.[1479] Off-chain governance disputes relate to decisions affecting a blockchain network, such as access criteria.[1480] On-chain disputes relate to on-chain transactions that are "at least partially performed or recorded on a blockchain network", such as supply chain authenticity and payments.[1481] Without going too much in-depth, the WEF report outlines different mechanisms and protocols for dispute resolution, from most private to most public, which would be litigation in courts.[1482] The report explains the difficulties that may arise related to litigation as it seems to adopt a

[1475] See 'UK Jurisdiction Taskforce (UKJT) Digital Dispute Resolution Rules' (n 143) 14.
[1476] See Alhabib et al. (n 884).
[1477] Alhabib et al. (n 884) 7.
[1478] See Alhabib et al. (n 884) 7.
[1479] See Alhabib et al. (n 884) 7.
[1480] See Alhabib et al. (n 884) 7.
[1481] Alhabib et al. (n 884) 7.
[1482] See Alhabib et al. (n 884) 13 et seq.

more general pro-arbitration stance, it also highlights some issues that may arise regarding award enforcement.[1483]

5.6 Conclusion

457 Conceptually, blockchains and dispute resolution are complete opposites. Whereas the former aims to disintermediate transactions, the latter is the epitome of intermediation. However, the truth is that DApps and blockchain networks are not completely decentralized and disintermediated, and disputes can and still do arise. However, much of what happens on open, permissionless blockchains is in "the blind spot of the law". Regulators can only mandate centralized and identifiable entities to enforce their laws, such as exchanges and parties operating in the network within their jurisdictions. Major obstacles are the users' anonymity and the delocalized nature of transactions, which makes filing claims and ascertaining jurisdiction hard, if not impossible.

458 Legal systems cannot keep up with the fast-paced Internet age of digital and near-instant value transfers. This is a serious problem because the crypto economy is ridden with fraud, hacks, breaches of contract, and intellectual property infringements. Like contract negotiations, during which the dispute resolution clause is not usually prioritized, dispute resolution at present is not a high priority concern in the blockchain industry and in crypto communities. However, if it is true that blockchains are powerful state-like infrastructures in cyberspace, the topic of dispute resolution is very important to ensure the protection of parties.

Chapter 5: Summary

Blockchains need dispute resolution because disputes cannot be fully eradicated, not even in the crypto economy. The nature of open, permissionless blockchains results in disputes that are not easily resolved by state judiciaries or private arbitral tribunals, namely due to the anonymity of parties and difficulties in determining jurisdiction.
Disputes can be divided into two broad categories: "base layer" and "application layer" disputes. Each of these can further be broken down into subcategories. Base layer disputes relate to issues of governance, which may impact the entire blockchain

[1483] See Alhabib et al. (n 884) 18 et seq.

infrastructure, and application layer disputes relate to issues resulting from applications, such as smart contracts, DApps, and DAOs, whose legal status remains uncertain in many jurisdictions worldwide. The application layer disputes can have different subcategories. They may refer to issues that can arise in the transfer of off-chain data on-chain, such disputes may arise from payment channels or oracles. Aside from these categories and subcategories, one can go even deeper as there are more specific types of disputes that relate to any of these issues, such as the different types of disputes that may result from a single smart contract, which would be regarded as being part of an application layer dispute. There are a variety of other issues that may occur, such as loss of private keys or the erroneous transfer of funds.

The blockchain community has tried to tackle the topic of disputes in different ways. Many different ideas and approaches have been discussed and proposed by individuals, developers, and legal tech companies. Starting with Satoshi Nakamoto, who recognized the need for escrow on Bitcoin, to ideas of global justice systems in blockchain-based arbitration and mediation networks and "governed" blockchains, to Buterin's idea of a decentralized court on Ethereum and a working model called Kleros, amongst many more approaches. Much like blockchain technology itself, the projects tackling the issue of crypto dispute resolution are still in development. International organizations, arbitral institutions, and jurisdictional taskforces have responded to these new phenomena by organizing workshops and drafting rules and guidelines. Based on Buterin's original idea of a decentralized court, combined with further advancements, Kleros developed a working DApp on the Ethereum mainnet, where pseudonymous arbitrators decide on disputes based on so-called Schelling Points. This game-theoretic concept aligns decisions of individuals who cannot communicate with each other. The system is innovative and stands to represent "crypto arbitration". This system is opt-in. Parties can choose to implement such a dispute resolution mechanism into their smart contract or DAO design. However, participants in blockchains remain without recourse to state courts. What is needed is arbitration at the blockchain base layer as a default.

6 Chapter 6: Dissecting Crypto Arbitration

6.1 Introduction

459 This section breaks down the various elements of crypto arbitration identified in the previous chapters and examines this phenomenon from the perspective of international arbitration law, with special reference to Swiss law. The current applicability of crypto arbitration is limited to low-value, binary disputes,[1484] which stands in contrast to the high-value and/or highly complex cases brought before arbitral tribunals.[1485] However, even in the early days of today's modern arbitration, when the New York Convention was introduced, "the vast majority of international arbitrations involved relatively simple […] disputes."[1486] It is thus only natural that a brand new system would first be used only for simple matters rather than on high-value, complex cases.

460 Sophie Nappert explains that this is "the classic example of disruption", where "you start with a small segment in the market" that is not addressed.[1487] She gives the example of Airbnb, where "people didn't want to pay the high rates for hotels that would change according to the month of the year", instead "you go to someone's empty flat".[1488] She continues that Kleros is "starting with this little segment of decentralized justice", which is "this little bubble of the spectrum".[1489] According to Nappert, once people realize that it works, they will feed it "bigger disputes, see what happens".[1490] Though Nappert cautions that the current system is not there yet, with "the right adjustments, it can be an interesting proposition".[1491]

461 In a world of its own, crypto arbitration, modeled on Buterin's original idea of a decentralized court, operates by way of smart contracts, parties can be pseudonymous, the jurors usually are, due process is mostly replaced by an incentive-mechanism, which

[1484] In the crypto arbitration models that operate today, arbitrators can choose between one outcome or the other, similar to last-offer arbitration also known as baseball arbitration. See Margaret L Moses, *The Principles and Practice of International Commercial Arbitration* (Cambridge University Press 2008, 2012) ch 1.I.6.
[1485] See, e.g., Catherine A Rogers, 'The World Is Not Enough: ethics in arbitration seen through the world of film' (2021) 37 Arbitration International 397, 400. ("International arbitration is increasingly and consistently used to resolve many of the world's most high-stakes, high-drama disputes.").
[1486] Rogers (n 1485) 400.
[1487] Interview #11, Sophie Nappert.
[1488] Interview #11, Sophie Nappert.
[1489] Interview #11, Sophie Nappert.
[1490] Interview #11, Sophie Nappert.
[1491] Interview #11, Sophie Nappert.

tries to produce fair rulings. The procedure is characterized by an in-built inflexibility, direct communication pathways are largely blocked, fairness is generated through mathematical modelling and proponents call this novel kind of arbitration "decentralized justice". As a fully transparent procedure,[1492] which largely operates in the "blind spot of the law",[1493] it produces self-enforcing decisions if so pre-coded. Jerold S. Auerbach once noted that "[u]ltimately the most basic values of society are revealed in its dispute-settlement procedures".[1494] Crypto arbitration may illuminate the values of the blockchain community. In its comparison between traditional and crypto arbitration, this section aids in gaining a better understanding of both. This also allows for the opportunity to look at different parts of traditional arbitration in a renewed way.

462 This chapter will first discuss on-chain arbitral agreements, move to the pseudonymity aspect of parties and the arbitral tribunal in a crypto arbitration, analyze the current incentive mechanisms and see whether due process can indeed be preserved by mathematics. The question of whether justice can be decentralized is raised, and then a brief outlook on "smart arbitral awards" is given. Finally, this chapter concludes with a summary comparison table, comprehensively contrasting traditional international arbitration to the emerging crypto arbitration design.

6.2 Smart Arbitration Agreements

463 The validity of arbitration agreements has been discussed extensively in literature. Note that arbitration agreements can generally and traditionally be categorized as arbitration clauses or submission agreements.[1495] The former is usually a short clause in a contract before any dispute has occurred, whereas the latter is a more elaborate contract dealing exclusively with the arbitration after a dispute has arisen.[1496] In this thesis, "smart arbitration agreements" refer to these two options in a blockchain context.

464 As discussed in Chapter 3, smart contracts are software code on blockchains, which may serve different purposes. A smart contract may be categorized as a legal contract,

[1492] A separate set of issues may arise in relation to the General Data Protection Regulation ("GDPR") in the European Union, for example.
[1493] See *supra* Chapter 5.2.
[1494] Jerold S Auerbach, *Justice Without Law? Resolving Disputes without Lawyers* (Oxford University Press 1983) 3–4.
[1495] See Blackaby and others (n 70) para 2.02 et seq.
[1496] See Blackaby and others (n 70) para 2.02 et seq.

depending on the functions it fulfills. A smart contract may substitute, reflect, or complement legal contracts.[1497] Smart contracts may either be stand-alone legal contracts with no human-language counterpart (substitution), they may be the translation of a legal contract into software code (reflection or mirror), or they may be used to automate certain aspects of a legal contract (complement).[1498] Since there may be different ways in which parties want to conclude an arbitration agreement in the blockchain context, this analysis assumes either a smart contract, which stands to substitute an arbitration clause or an arbitration agreement in its entirety (with no natural language counterpart).

465 Lesaege, Kleros' CTO, proposed an Ethereum standard called "ERC-792".[1499] The standard proposes two contracts, an arbitrable (for enforcement) and an arbitrator contract (for rendering decisions), and there is also an evidence standard, which is a separate contract.[1500] An arbitrable contract could either stand alone or be integrated in another smart contract in crypto arbitration. The arbitrator contract can be thought of in the blockchain context as being the "digital seat" of the crypto arbitration, determining the specific *lex cryptographica arbitri*. Parties in the future may be able to choose between different digital seats, *i.e.*, arbitrator contracts, as they do today in the off-chain world, when parties choose Zurich, Vienna, London, or Paris.[1501]

466 Although still an arbitrable contract, a "smart submission agreement" would be created on the spot, once there already is a dispute.[1502] The problem with an arbitrable contract concluded after a dispute has arisen is that one party may not wish to participate. Any arbitration agreement is only as good as it can compel an unwilling party to its specified dispute resolution mechanism. In the blockchain context, one would refer to a "smart arbitration agreement" or simply the novel term "arbitrable contract", distinguishing

[1497] See *supra* Chapter 3.3.2.
[1498] See *supra* Chapter 3.3.2.
[1499] For Ethereum Smart Contract Standards, see *supra* Chapter 3.3.1. See Lesaege, 'ERC 792: Arbitration Standard' (n 1190).
[1500] See Lesaege, 'ERC 792: Arbitration Standard' (n 1190). See also Ethereum Foundation, 'Kleros: Building a Decentralized Court System to Arbitrate Smart Contracts' (*Youtube*, 2017) <https://www.youtube.com/watch?v=OX4OarfwyaU&list=PLaM7G4Llrb7ynuhOcNMEdx5_nIhUduJRY&index=11>.
[1501] See Interview #1, Federico Ast ("In the traditional arbitration world you choose a city of arbitration, you could choose like you know Paris, London, Singapore, New York, whatever and so this is the same. You can choose Kleros xyz like from a drop-down menu but like a seat.").
[1502] Kleros, for example, has its own interface for that on its 'Kleros Resolve App' (n 1237).

further between an "*ex ante* arbitrable contract", *i.e.*, concluded before a dispute has arisen and an "*ex post* arbitrable contract", *i.e.*, concluded after a dispute has arisen.[1503]

467 From the outset, the separation of smart contracts, distinguishing between an "arbitrable" and an "arbitrator" contract, could pose problems of the likes that are known more traditionally as "pathological arbitration clauses". Similarly, in the blockchain context, there may be a bug in the code, the connection or designation of the arbitrator may not function, the arbitration offering DApp service may have moved to a new (Ethereum) address, may have ceased to exist, or is inoperable due to a lack of sufficient "active" arbitrators.[1504]

468 The overarching question is whether "smart arbitration agreements" fit into the arbitral legal framework. Smart arbitration agreements deployed on open and permissionless blockchains raise the question, whether they can satisfy the international commercial arbitration legal framework's validity and arbitrability requirements. The basic requirements of formal and substantive validity, objective and subjective arbitrability would have to be met for a smart arbitration agreement to be compatible with international commercial arbitration's legal framework. To analyze whether such "smart arbitration agreements" or "arbitrable contracts"[1505] can be validly concluded, this thesis will first explore the validity requirements under the current international arbitration framework with reference to Swiss law. These requirements mostly become relevant when a party contests an arbitration agreement in its entirety or in parts, which may lead to jurisdictional challenges.[1506]

[1503] Alternatively, they may be called "smart arbitration clauses" and "smart submission agreements". However, whether this terminology, in particular "smart arbitration clauses", makes sense, depends on the specific smart contract and the decentralized application.

[1504] Suppose parties concluded an arbitrable contract automatically designating a specific arbitrator contract. What if the parameters of that arbitrator contract, which selects the arbitrators and furnishes the rules of procedure in a coded form, have subsequently changed? What if the parties only agreed to the arbitrator contract in the version in which they concluded the arbitrable contract? Kleros is looking to enhance its smart contract and to offer novel versions with better voting systems. It is unclear whether parties are bound to the newest version automatically or could still interact with an older version. Since Kleros is designed as a DAO, token holders can change many parameters by a majority vote. This is another risk factor.

[1505] There may be other terms one could employ as well, such as "on-chain arbitration agreements", "crypto arbitration agreements".

[1506] A distinction can be made between "partial" and "total" challenges. A total challenge questions the entirety of an arbitral tribunal's jurisdiction and therefore questions whether an arbitration agreement between the parties is valid. See Blackaby and others (n 70) para 5.91 et seq. The competence-competence doctrine, which is accepted widely, enables arbitral tribunal to rule on their own jurisdiction, see Born, *International Commercial Arbitration (Third Edition)* (n 618) 1141 et seq.

6.2.1 Validity Requirements for Arbitration Agreements in International Arbitration

469 The international sources of arbitration are discussed in Chapter 4.3.3. and further sources are discussed in Chapter 4.3.4., together they form the legal framework for international arbitration agreements.[1507] Generally, national legislation and international conventions adopt a pro-arbitration stance (*favor validitatis*).[1508] The arbitration agreement is the basis of international arbitration,[1509] without it, there can be no arbitral procedure and the arbitral tribunal lacks jurisdiction. Arbitration agreements form an integral part of the New York Convention, even if the convention's title suggests otherwise.[1510]

470 Article II (1) of the New York Convention states that "[e]ach Contracting State shall recognize an agreement in writing under which the parties undertake to submit to arbitration all or any differences which have arisen or which may arise between them in respect of a defined legal relationship, whether contractual or not, concerning a subject matter capable of settlement by arbitration." An arbitration agreement is defined by Article 7(1) of the UNCITRAL Model Law in a similar vein as "an agreement by the parties to submit to arbitration all or certain disputes which have arisen or which may arise between them in respect of a defined legal relationship, whether contractual or not."[1511] The Swiss PILA does not include a definition,[1512] but the Swiss Federal Tribunal defines an arbitration agreement as "an agreement by which two or more specific or identifiable parties agree to submit one or more, existing or future disputes to an arbitral

[1507] See also Born, *International Arbitration: Law and Practice* (n 659) 43. Born considers the legal framework for arbitration agreements to consist of mainly the New York Convention, national laws, and institutional arbitration rules. See also Blackaby and others (n 70) para 2.01 et seq.

[1508] See Stacher (n 659) para 58. ("[…] drückt aus, dass der Gesetzgeber die materielle Gültigkeit der Schiedsvereinbarung gegenüber ihrer Ungültigkeit bevorzugt (sog. *favor validitatis*)."). See UNCITRAL Secretariat Guide (n 757) 48. See also Born, *International Arbitration: Law and Practice* (n 659) 45. See also Born, *International Commercial Arbitration (Third Edition)* (n 618) 802 et seq.

[1509] See Blackaby and others (n 70) para 2.01.

[1510] See *supra* Chapter 4.3.3.1. See also UNCITRAL Secretariat Guide (n 757) 39. See Blackaby and others (n 70) para 2.07.

[1511] 118 jurisdictions have adopted legislation based on the UNCITRAL Model Law, their legislation thus have identical or similar provisions defining arbitration agreements. See 'Status: UNCITRAL Model Law on International Commercial Arbitration (1985), with Amendments as Adopted in 2006' (n 795).

[1512] See DSFT of 21 November 2003, 130 III 66, reason 3.1. See Christoph Müller and Olivier Riske, 'Chapter 2, Part II: Commentary on Chapter 12 PILS, Article 178 [Arbitration Agreement]' in Manuel Arroyo (ed), *Arbitration in Switzerland: The Practitioner's Guide (Second Edition)* (Kluwer Law International 2018) 71-72.

tribunal in a binding manner, excluding the original state jurisdiction, in accordance with a directly or indirectly determined legal system".[1513]

471 Article II (2) of the New York Convention refers to the formal validity of an arbitration agreement and states that "[t]he term 'agreement in writing' shall include an arbitral clause in a contract or an arbitration agreement, signed by the parties or contained in an exchange of letters or telegrams."[1514] Article II (3) of the New York Convention relates to the previous subparagraphs and mandates national courts to honor the parties' arbitration agreement and refer these to arbitration.[1515] Arbitral tribunals will rule on their own jurisdiction according to the competence-competence principle.[1516]

472 The requirements under the New York Convention may be summarized as follows:[1517]An arbitration agreement needs to be in writing (formal validity), it needs to relate to differences (disputes) that have arisen or may arise,[1518] these disputes relate to a defined legal relationship, whether contractual or not,[1519] the subject matter is capable of resolution by arbitration (objective arbitrability),[1520] the parties have validly consented to

[1513] Own translation. DSFT of 27 February 2014, 140 III 134, reason 3.1. (German Original: "Unter einer Schiedsvereinbarung ist eine Übereinkunft zu verstehen, mit der sich zwei oder mehrere bestimmte oder bestimmbare Parteien einigen, eine oder mehrere, bestehende oder künftige Streitigkeiten verbindlich unter Ausschluss der ursprünglichen staatlichen Gerichtsbarkeit einem Schiedsgericht nach Massgabe einer unmittelbar oder mittelbar bestimmten rechtlichen Ordnung zu unterstellen"). See also DSFT of 21 November 2003, 130 III 66, reason 3.1.

[1514] UNCITRAL recommends that states interpret these circumstances as non-exhaustive, see 'Recommendation Regarding the Interpretation of Article II Paragraph 2, and Article VII, Paragraph 1, of the Convention on the Recognition and Enforcement of Foreign Arbitral Awards, Done in New York, 10 June 1958, Adopted by the United Nations Commission on International Trade Law on 7 July 2006 at Its Thirty-Ninth Session' <https://uncitral.un.org/sites/uncitral.un.org/files/media-documents/uncitral/en/a2e.pdf>.

[1515] Article II (3) New York Convention reads as follows: "The court of a Contracting State, when seized of an action in a matter in respect of which the parties have made an agreement within the meaning of this article, shall, at the request of one of the parties, refer the parties to arbitration, unless it finds that the said agreement is null and void, inoperative or incapable of being performed." Article 8 of the UNCITRAL Model Law requires the same.

[1516] See UNCITRAL Secretariat Guide (n 757) 41. See also Article 16 UNCITRAL Model Law.

[1517] See Articles II (1) and V(1)(a) of the New York Convention. See Blackaby and others (n 70) paras 2.11-2.12. See Girsberger and Voser (n 660) para 275.

[1518] Generally, there is a broad interpretation of "differences". See UNCITRAL Secretariat Guide (n 757) 48. ("the High Court of Hong Kong has held that the parties should be referred to arbitration even when there is a dispute as to the existence of a dispute" referencing: Guangdong Agriculture Ltd. v. Conagra International Far East Company Ltd., High Court, Supreme Court of Hong Kong, Hong Kong, 24 September 1992, HCA003032/1992).

[1519] See Blackaby and others (n 70) para 2.25 on what "a defined legal relationship" means.

[1520] Article II(1) together with Article V(2)(a) of the New York Convention produce the "non-arbitrability doctrine", *i.e.*, defenses against arbitral agreements and awards if the dispute in question is non-arbitrable. See Born, *International Arbitration: Law and Practice* (n 659) 82.

arbitration (substantive validity),[1521] which requires that the parties have legal capacity under their applicable laws (subjective arbitrability), and the arbitration agreement is valid under the applicable law, alternatively under the law of the seat country.[1522] When it comes to the writing requirement under the New York Convention, courts have not decided consistently and there are divergences between jurisdictions.[1523] However, there is a strong validity and enforcement bias adopted by courts worldwide, supported by the *raison d'être* of the convention, which is to facilitate trade.[1524]

473 Because Article II (2) of the New York Convention only obliges contracting states, it is not directly applicable to an arbitral tribunal.[1525] An arbitral tribunal that is seated in Switzerland would not be bound by the convention but would have to observe the relevant Swiss provisions.[1526] Under Swiss law, the formal validity requirement can be found in Article 178 (1) Swiss PILA, according to which "[t]he arbitration agreement shall be valid if made in writing or in any other manner that can be evidenced by text."[1527] The Swiss legislator wanted parties to conclude arbitration agreements consciously, the purpose of the form requirement (text form) was twofold, (i) to protect parties and (ii) to serve as clarification, since parties waive their right to access the courts.[1528] This is a more favorable provision in comparison to Articles II (1) and (2) of the New York Convention because it does not require the parties to sign the agreement.[1529] However, since parties

[1521] See UNCITRAL Secretariat Guide (n 757) 134. ("[N]ational courts may deny recognition and enforcement of an award pursuant to article V (1)(a) if the consent of the parties is not valid either because the parties lacked the capacity to agree to arbitrate or because the arbitration agreement is invalid under the law applicable to it").

[1522] See Articles II (1) and V(1)(a) of the New York Convention. See Blackaby and others (n 70) paras 2.11-2.12. See Girsberger and Voser (n 660) para 275.

[1523] See UNCITRAL Secretariat Guide (n 757) 53 et seq. In fact, national courts are free to interpret the New York Convention as they please since there is no supreme authority with general interpretative power. There is thus no instance that resembles, for example, the European Court of Justice in relation to European member state courts. The New York Convention does not create a supranational legal order. Although dominant interpretations, adopted by most jurisdictions can be observed, divergencies may still occur.

[1524] See Blackaby and others (n 70) para 2.66. See also Born, *International Commercial Arbitration (Third Edition)* (n 618) 802 et seq.

[1525] See Stacher (n 659) para 75.

[1526] See Stacher (n 659) para 75.

[1527] This version entered into force in 2021, previously the provision included "by telegram, telex, telecopier", but it was seen as outdated, the legislator thus preferred a slimmer version. See 'BBl 2018 7163 - Botschaft Zur Änderung Des Bundesgesetzes Über Das Internationale Privatrecht (12. Kapitel: Internationale Schiedsgerichtsbarkeit)' <https://www.fedlex.admin.ch/eli/fga/2018/2548/de>.

[1528] See Christian Oetiker, 'Art. 178 IPRG', *Zürcher Kommentar zum IPRG - Band II - Art. 108a-200, Kommentar zum Bundesgesetz über das Internationale Privatrecht (IPRG) vom 18. Dezember 1987* (2018).A-D.N 12. See also Blackaby and others (n 70) para 1.47.

[1529] See the more-favorable right provision in Article VII(1) of the New York Convention, which only makes reference to arbitral awards. However, the exclusion of arbitration agreement is said to be unintentional. See also 'Recommendation Regarding the Interpretation of Article II Paragraph 2, and Article VII,

may want to enforce an arbitral award in case of non-voluntary compliance abroad, a closer adherence to the New York Convention has generally been recommended.[1530]

474 Swiss law enshrines a broad validity presumption in Article 178 (2) Swiss PILA[1531] and states that "[a]s regards its substance, the arbitration agreement shall be valid if it conforms to the law chosen by the parties, or to the law applicable to the dispute, in particular the law governing the main contract, or to Swiss law." This provision gives a lot of leeway and accepts validity if the arbitration agreement conforms to any of the three legal systems it may fall under.[1532] An arbitration agreement will generally have to express the parties' mutual intent on the *essentialia negotii*.[1533] The *essentialia negotii* are the minimum requirements for a valid arbitration agreement and it is widely seen that these include the intent of the parties to submit their dispute to arbitration as well as the determination or determinability of the dispute for which arbitration is to take effect.[1534]

475 A valid arbitration clause may be in a rudimentary form, such that it may only state "Arbitration in Geneva".[1535] Words characteristic of arbitration, such as "arbitral procedure", "arbitral tribunal", "arbitration", "award", or comparable are usually enough to indicate the intent of the parties.[1536] Aside the *essentialia negotii* in the required form, it is generally recommended to indicate the seat of arbitration, which will determine the *lex arbitri*, the number of arbitrators, and the substantive law to be adopted.[1537]

476 A case-by-case analysis is needed to determine the validity of an arbitration agreement. In addition, arbitration clauses are often what is called "midnight clauses" because in

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Paragraph 1, of the Convention on the Recognition and Enforcement of Foreign Arbitral Awards, Done in New York, 10 June 1958, Adopted by the United Nations Commission on International Trade Law on 7 July 2006 at Its Thirty-Ninth Session' (n 1514). See Oetiker (n 1528). A-D.N 15. See Stacher (n 659) para 75.

[1530] See Oetiker (n 1528). A. - D. N 18. See Stacher (n 659) para 75.

[1531] See Stacher (n 659) para 58 et seq.

[1532] See Stacher (n 659) para 58 et seq.

[1533] See Müller and Riske (n 1512) 76. DSFT 138 III 29 of 7 November 2011, reason 2.1 ("Nach Art. 1 Abs. 1 sowie Art. 2 Abs. 1 OR komme ein Vertrag zustande, wenn sich die Parteien über alle wesentlichen Punkte geeinigt hätten.").

[1534] See Müller and Riske (n 1512) 76. DSFT 138 III 29 of 7 November 2011, reason 2.1 ("Zu den objektiv wesentlichen Punkten einer Schiedsvereinbarung gehörten einerseits die Absicht der Parteien, ihren Rechtsstreit einem Schiedsgericht zur verbindlichen Entscheidung zu unterbreiten, und andererseits die Bestimmung des Streitgegenstands, der den Schiedsrichtern unterbreitet werden soll."). See Oetiker (n 1528).D.N 48.

[1535] Girsberger and Voser (n 660) para 285. See also Oetiker (n 1528).A-D.N 51.

[1536] Girsberger and Voser (n 660) para 285. See also Oetiker (n 1528).A-D.N 51.

[1537] See Blackaby and others (n 70) para 2.116.

contract negotiations not much consideration is given to them, and they end up being included as a mere formality.[1538] Interpretation is necessary if it is unclear whether there is an arbitration agreement to begin with or if certain aspects of the clause are uncertain. Preliminarily, the law applicable to the arbitration agreement must be determined before any such agreement can be interpreted. An important concept widely recognized in arbitrations is the separability doctrine: arbitration clauses are separable and autonomous from the underlying contract.[1539] This has the effect that even if the underlying contract has a defect or may be void, the arbitration clause can continue intact, and it is possible to apply a different law to the arbitration agreement than the governing law of the underlying contract.[1540]

477 Modern business contracts are increasingly concluded digitally and online.[1541] This has already been the case before the COVID-19 pandemic hit and is especially true ever since. Aside from electronic filings in institutional arbitrations and even the mandatory usage of online platforms, such as the one provided by the Arbitration Institute of the Stockholm Chamber of Commerce ("SCC"),[1542] hearings are nowadays conducted remotely, by videoconferencing and are seen as being in conformity with due process standards.[1543] Arbitration agreements concluded in a way that does not fit the narrative of 1958 may seem to clash with the New York Convention's Article II (2).[1544] UNCITRAL, for

[1538] See Blackaby and others (n 70) para 2.04.

[1539] See Gaillard and Savage (n 630) para 389 et seq. See Stacher (n 659) para 64 et seq. See Blackaby and others (n 70) para 2.101 et seq. See Girsberger and Voser (n 660) para 540 et seq. See Art. 16(1) UNCITRAL Model Law ("For that purpose, an arbitration clause which forms part of a contract shall be treated as an agreement independent of the other terms of the contract. A decision by the arbitral tribunal that the contract is null and void shall not entail *ipso jure* the invalidity of the arbitration clause."), see also implicit Art. 178(3) Swiss PILA.

[1540] See Gaillard and Savage (n 630) para 389 et seq. See Stacher (n 659) para 64 et seq. See Blackaby and others (n 70) para 2.101 et seq. See Girsberger and Voser (n 660) para 540 et seq.

[1541] See Nadine Lederer, 'The Enforcement of Cross-Border Online Arbitral Awards and Online Arbitration Agreements. The New York Convention and the Internet: Friends or Foes?' [2019] Spain Arbitration Review | Revista del Club Español del Arbitraje 63–64. In regards to arbitration agreements, Blackaby et al. assert that in modern times, oral arbitration agreements are also possible, see Blackaby and others (n 70) para 1.48.

[1542] See 'SCC Platform - Simplifying Secure Communication from Request to Award' <https://sccinstitute.com/case-management/>.

[1543] See Lederer (n 1541) 64. See Maxi Scherer and others, 'In a "First" Worldwide, Austrian Supreme Court Confirms Arbitral Tribunal's Power to Hold Remote Hearings Over One Party's Objection and Rejects Due Process Concerns' (*Kluwer Arbitration Blog*, 2020) <http://arbitrationblog.kluwerarbitration.com/2020/10/24/in-a-first-worldwide-austrian-supreme-court-confirms-arbitral-tribunals-power-to-hold-remote-hearings-over-one-partys-objection-and-rejects-due-process-concerns/>. See OGH of 23 July 2020 18 ONc 3/20s. See also Gary Born, Anneliese Day and Hafez Virjee, 'Remote Hearings (2020 Survey): A Spectrum of Preferences' [2021] Journal of International Arbitration 291.

[1544] See Lederer (n 1541) 64–65.

example, issued its own recommendations against a too narrow application of this article in the New York Convention, "[c]onsidering the wide use of electronic commerce".[1545]

478 The New York Convention can be interpreted to fit technological progress, *i.e.*, electronic communication, such as e-mail, as the modern-day equivalent of the 1958 telegram.[1546] Article 7 of the UNCITRAL Model Law, in Option 1 para. (4), states that "[t]he requirement that an arbitration agreement be in writing is met by an electronic communication if the information contained therein is accessible so as to be useable for subsequent reference". Swiss law implicitly makes reference to new communication technologies by stating specifically that the agreement be "in any other manner that can be evidenced by text".[1547] Whether the agreement is in writing or evidenced by text in any other manner, the intent of the parties must be accessible visually or accessible in such a manner as to be embodied visually.[1548] Arbitration agreements concluded via e-mail, for example, fall under Article 178 (1) Swiss PILA and should generally fall under Article II (2) of the New York Convention as well.[1549]

6.2.2 The Competence-Competence Principle

479 Courts will ultimately have to decide when a smart arbitration agreement is presented to them whether they will have to refer parties under Article II (3) of the New York Convention[1550] to crypto arbitration. Because of the pro-arbitration stance generally adopted by national courts, one would assume that a court is more likely to refer parties to crypto arbitration than not. Article II (3) of the New York Convention employs mandatory language and it is generally understood that courts do not have discretion in

[1545] See Lederer (n 1541) 65. See 'Recommendation Regarding the Interpretation of Article II Paragraph 2, and Article VII, Paragraph 1, of the Convention on the Recognition and Enforcement of Foreign Arbitral Awards, Done in New York, 10 June 1958, Adopted by the United Nations Commission on International Trade Law on 7 July 2006 at Its Thirty-Ninth Session' (n 1514). See also Stacher (n 659) para 75.
[1546] See Cole and Ortolani (n 672) 77.
[1547] Article 178 (1) Swiss PILA. See Stacher (n 659) para 74.
[1548] See Stacher (n 659) para 74.
[1549] See Stacher (n 659) para 74. See Lederer (n 1541) 68.
[1550] Article II (3) of the New York Convention reads as follows: "The court of a Contracting State, when seized of an action in a matter in respect of which the parties have made an agreement within the meaning of this article, shall, at the request of one of the parties, refer the parties to arbitration, unless it finds that the said agreement is null and void, inoperative or incapable of being performed."

this regard.[1551] This is also in line with the competence-competence principle, according to which arbitrators will decide on their own jurisdiction.[1552]

480 Courts can review the arbitration agreement to determine whether it is "null and void, inoperative or incapable of being performed".[1553] There is no generally accepted standard of review and courts in different jurisdictions will follow different approaches. For example, courts in Italy and Germany, may more readily conduct a full review, whereas other jurisdictions, such as France will apply a *prima facie* review standard.[1554] The problem with crypto arbitration is that the exercise of competence-competence of arbitrators may be questioned as they cannot decide on their own jurisdiction in the traditional way if they are first, unknown and randomly assigned, second, cannot communicate with each other, and third, may not even know how to apply the law in order to determine their own jurisdiction. However, what they can do, is choose the option to "refuse to arbitrate" which may be considered such a decision to decline jurisdiction.

6.2.3 "Click-Wrap" and "Browse-Wrap Agreements" and Code vs. Text (Formal Validity)

481 When it comes to smart arbitration agreements, one may draw on the discussions relating to so-called "click-wrap" and "browse-wrap agreements".[1555] A user in a click-wrap agreement usually scrolls to the bottom of the webpage and clicks that it agrees to be able to access some content or to complete a transaction.[1556] A browse-wrap agreement provides a link that, when clicked, takes the user to a different source with the terms of

[1551] See UNCITRAL Secretariat Guide (n 757) 58.
[1552] See Blackaby and others (n 70) para 5.105. See also United Kingdom, England and Wales, Court of Appeal, 24 January 2007, Fiona Trust & Holding Corp v Privalov / 2006 2353 A3 QBCMF. See also UNCITRAL Secretariat Guide (n 757) 66 ("In the seminal Fiona Trust decision, the Court of Appeal of England and Wales established that 'it will, in general, be right for the arbitrators to be the first tribunal to consider whether they have jurisdiction to determine the dispute.' However, the court further held that courts maintain within their jurisdiction the right to determine whether an arbitration agreement had come into existence at all." Footnote omitted.).
[1553] Article II (3) of the New York Convention.
[1554] See UNCITRAL Secretariat Guide (n 757) 63–65 (The Secretariat's Guide on the New York Convention at page 65, para 91 also notes that Swiss courts conduct a *prima facie* review, unless the seat is outside of Switzerland, in which case a full review may be conducted.).
[1555] See Lederer (n 1541) 68.
[1556] See Lederer (n 1541) 68–69 Lederer makes reference to Mutasim Ahmad Alqudah, 'Enforceability of Arbitration Clauses in Online Business-to-Consumer Contracts' [2011] 28 Journal of International Arbitration 70. Alqudah further makes reference to Condon Jr William J., 'Electronic Assent to Online Contracts: Do Courts Consistently Enforce Clickwrap Agreements?' (2004) 16 Regent U. L. Rev. 433, 435. William J. explains click-wrap agreements and their difference to browsewrap agreements and makes a further distinction to so-called "shrinkwrap" agreements.

the agreement.[1557] Whether such wrapped arbitration agreements would suffice under Article II (2) of the New York Convention is unclear.[1558] Lederer portrays two opposing camps: (i) one that sees such agreements as barely "a virtual exchange of data than an exchange of documents as is the case with letters, telegrams and emails to which documents are attached"[1559] and as such do not suffice and (ii) the other camp, which regards click-wrap and browse-wrap agreements as modern communication technologies, equivalent to the communication technology available in the late 50s when the New York Convention entered into force, namely telegrams.[1560] Similar arguments can be made when it comes to smart arbitration agreements.

482 The pro-validity argument in terms of click-wrap and browse-wrap agreements in the blockchain use case could fit with the notion of web3 interfaces, through which non-technical parties can interact with smart contracts by connecting their wallets through browser extensions with the web3[1561] enabled web page and perform transactions.[1562] Web3 interfaces will likely become more user-friendly so that non-technical parties can easily create an arbitrable contract, designate a DApp as an arbitrator or create an *ex post* smart arbitration agreement when a dispute arises without having to know how to program smart contracts.

483 If smart arbitration agreements are immutable, transparent, and accessible for anyone to inspect on an open and permissionless blockchain,[1563] one could also argue that they are "accessible so as to be useable for subsequent reference" in accordance with the UNCITRAL Model Law.[1564] Option 2 of Article 7 of the UNCITRAL Model Law eliminates the written form requirement altogether, and certain jurisdictions accept orally concluded arbitration agreements.[1565]

[1557] See Lederer (n 1541) 68–69.
[1558] See Lederer (n 1541) 69. Note that such agreements are more commonly used in consumer e-commerce transactions.
[1559] Lederer (n 1541) 69.
[1560] See Lederer (n 1541) 69.
[1561] See Antonopoulos and Wood (n 28) xxxv ("Web3 – The third version of the web.").
[1562] Smart arbitration agreements as software code will usually only be fully understood by software developers.
[1563] See *supra* Chapter 2.4.6.
[1564] Article 7 Option 1 para. 4 of the UNCITRAL Model Law. Note that the UNCITRAL Model Law in Option 1 of Article 7 (3) specifically refers to the writing requirement being fulfilled if the content "is recorded in any form, whether or not the arbitration agreement or contract has been concluded orally, by conduct, or by other means".
[1565] Sweden, which is not a Model Law country, for example, accepts oral arbitration agreements.

484 The question is whether smart arbitration agreements (as a substitution)[1566] can be seen as "evidenced by text" as required under Swiss law. This analysis assumed a smart arbitration agreement to substitute for an arbitration agreement. Such a substitution in purely code form would pose a significant obstacle to establishing formal validity. Recalling the objectives of the formal validity requirement and the need to have the agreement in writing, according to the Swiss legislator, was to protect parties and clarify to them, that this is an agreement by which parties waive access to state courts.[1567] Thus, although it may be non-trivial to decide on crypto arbitration and set up arbitrable contracts, smart arbitration agreements in code form as substitution for written arbitration agreements have to overcome a major obstacle, *i.e.*, whether one can consider software code to be text.

485 Unlike conventional text, software code does not allow for the determination that parties have opted for arbitration in a manner that state court judges are used to.[1568] Moreover, as opposed to e-mail, smart contracts are not a means of written digital communication between people. However, one could argue that the substitution variant of smart arbitration agreements can fulfill the writing requirement because the case can be made that the intent of the parties can be accessible visually on an open and permissionless blockchain, and that this is all that would be required under Swiss law.[1569]

486 However, it is assumed that software code alone, even if accessible online and in print form, would not suffice unless the code contains comments that make it clear what its functions entail, and that parties had direct access to the code and the comments, preferably through the web3 interface with an option to download the smart arbitration agreement before accepting the terms, including the specific blockchain addresses of the arbitrable contract and the arbitrator contract - in a manner similar to what one would consider either a reflection or complement variant of smart contracts to be.[1570]

[1566] See *supra* Chapter 3.3.2. and *supra* Chapter 6.2.

[1567] See Oetiker (n 1528).A-D.N 12. See also Blackaby and others (n 70) para 1.47.

[1568] An argument could be made that a smart contract code that includes comments in human-readable text, sentences that can be understood by non-developers, could satisfy the requirements of formal validity subject to parties having had the chance to read the smart contract code and the comments included therein. Such a smart arbitration agreement could fall under the reflection/mirror variant of smart contract code.

[1569] See e.g., Stacher (n 659) para 74.

[1570] Meaning smart arbitration agreements which have an accompanying human-readable text. See *supra* Chapter 3.3.2, where a distinction was made between smart contracts that serve to substitute, reflect, or complement a legal contract.

487 Ultimately, for parties that are non-developers and for purposes of fulfilling the writing requirement under the framework of international commercial arbitration, a smart arbitration agreement in purely code form will need some additional adjustments, at least in countries that do not accept orally concluded arbitration agreements, so that the party's intent can be made clear beyond what can be executed as code, such as through a natural language text as a companion, which would preferably be signed by the parties.[1571]

6.2.4 Establishing Parties' Consent (Substantive Validity)

488 If formal validity is merely a means to establish substantive validity, one could also argue that the writing requirement as envisioned by the New York Convention and adopted by states is an old paradigm and that the parties' intent, especially in a blockchain context, can be made visible in other, more convincing ways, such as by way of their interactions with the smart contract itself, *i.e.*, the act of digitally signing transactions with a public-private key pair, which can then be attributed to the parties.[1572] Parties need to consent to every step of the process by signing the transactions, for example, through the use of wallets.[1573] On Ethereum, if one were to create an escrow contract and designate a DApp such as Kleros as an arbitrator, one would have to sign every step of this transaction, authorizing the smart contract to access ones' funds, send funds to some specific address, insert ones' Ethereum address, pay the required amount of gas fees, among others.

489 So many confirmations need to be undertaken consciously by parties, that one would assume such parties must have agreed to arbitration. As all such confirmations and

[1571] One could argue that when developers are parties to the dispute, they can read the code and that for them there was no necessity to specifically translate the smart contract or conclude a separate legal contract in written form which refers to the arbitrable contract. An interesting question which cannot be dealt with in detail here is if a party's subsequent conduct during the crypto arbitration may heal the missing form requirement of a smart arbitration agreement and whether parties would have to object to crypto arbitration in their submissions.

[1572] For example, one could use blockchain explorers, such as 'Ethereum Blockchain Explorer' <https://etherscan.io>. However, whether signatures by way of signing transactions that belong to an arbitrable contract suffices as an e-signature under the Federal Act on Electronic Signatures and the Swiss Code of Obligations is debatable. The ZHAW (Zurich University of Applied Sciences) announced that it had in collaboration with Swisscom created the first application capable of entering a qualified e-signature on the blockchain, see ZHAW, 'Press Release, First-Ever Qualified Electronic Signature for Blockchain' <https://www.zhaw.ch/en/about-us/news/news-releases/news-detail/event-news/first-ever-qualified-electronic-signature-for-blockchain/>. Aside the fact that under Swiss law signing arbitration agreements is not required, it is still advised to conform with the New York Convention in case one wishes to enforce the arbitral award abroad. See Oetiker (n 1528). A. - D. N 18. See e.g., Stacher (n 659) para 75.

[1573] See Antonopoulos and Wood (n 28) xxxv. ("Software that holds secret keys. Used to access and control [crypto] accounts and interact with smart contracts.").

transactions are evidenced on the Ethereum blockchain immutably, a party must show convincing evidence that the actions, which can be verified on the blockchain, were not according to its intentions. Interacting with smart contracts, either via web3 or directly, signing transactions, and other such practices can be considered as "crypto business practice". If the parties are non-merchants, they are at least "crypto-minded" and take part in blockchain and smart contract dealings in a somewhat knowledgeable way.

490 If there is a dispute brought before a Kleros tribunal, the amount of work in the background to get to this stage, should be enough of an indicator that the parties agreed to arbitrate. Generally, there should be no issue regarding consent in this case. However, the case could be different in the future when the sort of technical expertise for transacting and contracting on blockchains becomes less cumbersome and as easy as clicking "I agree" on a click-wrap agreement. The situation may also be different for current DApps that employ Kleros as their dispute resolution venue, if parties interacting in the DApp did not give their consent to such arbitration before a dispute arises, such as if they lacked the knowledge that disputes would be resolved by Kleros to begin with. However, in essence, even today, once one has gone through the initial stages and barriers of downloading a wallet to one's browser, created an Ethereum address, filled that address with *ether*, interactions are as easy as clicking a button called "confirm".[1574]

491 One could assume parties to smart arbitration agreements to have consented to crypto arbitration as it is currently non-trivial to set up such contracts, and that parties have specifically agreed to resolve their disputes in the manner designated in their smart contract, either by referencing to Kleros, Aragon Court, LexDAO, or some other DApp. However, one needs to keep in mind such situations where parties may interact with a DApp on a blockchain they did not themselves create, and for which they lack the knowledge that in case of disputes, crypto arbitration would become relevant, either because they do not have insight into the smart contract code or were not made aware of such details. In such cases, it is important that parties are made aware of the fact that disputes will be resolved by arbitration by some form of notice before interacting with

[1574] Still, issues may arise if parties contest to having agreed to arbitration under a specific DApp, which designates Kleros as the arbitration mechanism, for example. One also needs to distinguish whether parties are using crypto arbitration for on-chain assets or off-chain assets. If parties are using crypto arbitration for on-chain assets, the decision can have direct effect on how the asset moves, whereas off-chain assets may not be directly affected.

the DApp, so that it can be verified that parties did indeed consent to arbitration. For parties transacting with another party that remains pseudonymous or anonymous, such crypto arbitration can generally be deemed as beneficial, since no other recourse mechanism would otherwise be available, which does not necessarily have to be the case for parties whose identities are known.

6.2.5 Parties' Identities and Subjective Arbitrability

492 The pseudonymity aspect of parties in blockchain transactions[1575] - as will be discussed in-depth in the next chapter - raises the question of subjective arbitrability, *i.e.*, whether parties have the legal capacity under their applicable laws to enter an arbitration agreement. Generally, parties will have to expose their real-world identities for a smart arbitration agreement to be deemed valid under the framework of international commercial arbitration. If a party wishes to enforce an arbitral award against its opponent, knowledge of that party's identity is a prerequisite for knowing in which jurisdiction it makes sense to seek enforcement.

493 Aside from the uncertainties that exist regarding the compatibility with international commercial arbitration, parties that decide to opt for crypto arbitration currently run the risk inherent in such a novel technology. Many features of crypto arbitration may be changed or become obsolete within as little as a few months' time. Even if a national court considers the smart arbitration agreement in code form to be sufficient evidence of the parties' consent together with the parties' digitally signed transactions and confirmations relating to the specific smart arbitration agreement on blockchains,[1576] any changes to the protocol, which are not foreseen, may result in the arbitration agreement being defective. Not fulfilling arbitration agreements' validity requirements thus constitutes a barrier to recognizing smart arbitration agreements before state courts.[1577]

[1575] See *infra* Chapter 6.3.

[1576] Together with the blockchain addresses of the parties, wherein it is evidenced that a specific transaction was created, that the dispute was created, the arbitration fees paid, and more. However, this also leads to the question whether one can attribute a signature on a blockchain to a specific party or identity since transacting on blockchains requires one to be barely the holder of a private key to certain funds. This also leads to questions of legal ownership, and it may be that the secret key is shared between multiple parties. There can be various problematic constellations. See Werbach and Cornell (n 75) 372 ("[…] even if a key uniquely belongs to an individual, the person and the key are not the same.").

[1577] At least in their substitution variant. The lines dividing mirror/reflection and complement smart arbitration agreements are not easily drawn because arbitration is a procedure and a method applied by parties to resolve disputes. As such, they are not the same as smart contracts in relation to legal contracts in their

Arguably, these are great obstacles, which only become greater if the opposing party never even reveals their real-world identity.

6.3 Hidden in Pseudonymity

494 As established in the previous section, parties will have to expose their real-world identities for their arbitration agreements to be compatible with the legal framework of international commercial arbitration. However, an issue that arises in on-chain arbitrations is that either parties and/or jurors may be completely anonymous or pseudonymous[1578] and thus unknown. First, this section analyzes the pseudonymity of parties and second, the pseudonymity of the arbitrators.

6.3.1 Pseudonymous Parties

495 Parties do not need to identify themselves.[1579] What is required of parties who want to interact on the Ethereum blockchain is a public address. If a party has not revealed their real-world identity, it is difficult to find out who the person behind an Ethereum address is, the same is true for Bitcoin and most other public and permissionless blockchains.[1580]

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entirety, which reminds of the debate in arbitration concerning the legal nature of arbitration agreements as either substantive, procedural, or both. For the debate on the legal nature of arbitration, see generally, Marco Stacher, *Die Rechtsnatur Der Schiedsvereinbarung* (Dike Verlag Zürich/St Gallen 2007). See also Girsberger and Voser (n 660) para 272. Some, including the Swiss Federal Tribunal, regard them as purely procedural contracts, whilst others regard arbitration agreements as being both substantive and procedural (e.g., Müller and Riske (n 1512) 73). See also Stacher (n 659) paras 55–56, DSFT of 15 March 1990, 116 Ia 56, reason 3a. In the case a smart arbitration agreement mirrors a written arbitration agreement, it is basically its translation into smart contract form. A complement smart arbitration agreement is - as the name suggests - a complement to the arbitration agreement, performing its function in smart contract code. Thus, mirror/reflection and complement smart arbitration agreements may *de facto* be the same, when referring specifically to crypto arbitration. These could be thought of as constituting a reference to crypto arbitration in the arbitration clause of a written contract. Here, it would make sense for parties to include both the smart contract address of the specific arbitrable contract and the arbitrator contract. In addition, parties should refer to the transaction address that pertains to their specific legal relationship (e.g., escrow application that was used).

[1578] See Werbach and Cornell (n 75) 372. Blockchains can allow parties to be pseudonymous, *i.e.*, the real-world identity of the parties may be accessible through inference, or anonymous, *i.e.*, the real-world identity of parties is practically inaccessible. To avoid complicating matters further, this distinction is not observed in-detail in this thesis and the present analysis.

[1579] See, however, new developments, such as the European Commission making new proposals, among which is a requirement to prohibit anonymous crypto wallets. See Jamie Crawley, 'EU Policymakers Propose Tighter Regulation of Crypto Transfers' (*Coindesk*, 2021) <https://www.coindesk.com/eu-policymakers-propose-tighter-regulation-of-crypto-transfers>.

[1580] Bitcoin's transactions, although pseudonymous, do not have strong privacy, i.e., by employing certain tactics more readily available to authorities and specialized firms, identities can be determined. Monero and ZCash are privacy coins, which enable more anonymous transactions through special cryptographic techniques. See Gudgeon and others (n 84) 216.

Even if using the Ethereum Name Service ("ENS"),[1581] which links an Ethereum address to an ENS name chosen by the user (*e.g.*, "name.eth"), the real-world identity might be inaccessible.[1582]

496 Using blockchains and performing smart contract transactions requires some understanding of the infrastructure, the available wallets and applications in use, and the attainment of cryptocurrencies, all of which are not ordinary tasks. This leads to a general presumption of legal capacity for individuals involved in the blockchain space. However, the issue of legal capacity is only a veil that covers another issue, which is that it may be impossible to ascertain the legal capacity of a party, whose identity is unknown and may never be known. Moreover, if parties are pseudonymous, one may not be able to distinguish between whether a human is concluding a specific contract or whether a bot is doing so.

497 This poses a hurdle for national legal systems and international legal frameworks that are naturally built on real-world identities. Besides natural persons, legal systems also recognize legal personhood, such as states or companies.[1583] As a rule, parties to any arbitration agreement and arbitral procedure require legal capacity.[1584] Legal capacity is rarely an issue and carries little weight in international arbitrations because of national courts' general arbitration-friendly stance.[1585] However, if a party lacks legal capacity, the consequences are wide-reaching. Without legal capacity, a party can neither conclude an arbitration agreement nor empower someone else to conclude one in its place.[1586] As a consequence, an arbitration proceeding may not be conducted. This leads to jurisdictional issues because an arbitral tribunal derives its power from the arbitration agreement, which derives its validity from the legal capacity of the parties.[1587]

[1581] See 'ENS - Decentralized Naming for Wallets, Websites, & More' <https://ens.domains/>.
[1582] However, law enforcement agencies may have different strategies to uncover the real-world identity of participants in open and permissionless blockchains.
[1583] See Blackaby and others (n 70) para 2.31 et seq.
[1584] See Stacher (n 659) para 258 et seq. See Blackaby and others (n 70) para 2.31 et seq.
[1585] That it occurs very seldomly also comes across in a statement made by Diego F. Fernández Arroyo in a debate with Giuditta Cordero-Moss; see Cordero-Moss and Arroyo (n 786) 323. ("And, once in a blue moon, we have a problem about capacity. In such a case you need to say, 'Ukrainian law says . . .'. That is indeed very rare; it would be one case out of thousands of cases. That is the reality of the practical use".) See also Blackaby and others (n 70) para 2.33. See Born, *International Commercial Arbitration (Third Edition)* (n 618) 765.
[1586] See Born, *International Commercial Arbitration (Third Edition)* (n 618) 765 et seq.
[1587] See Born, *International Commercial Arbitration (Third Edition)* (n 618) 770 et seq.

498 One of the main problems in not knowing who the other party is, relates to notifications regarding the proceedings and the fact that a pseudonymous party, aside that one is not able to reliably notify them, may as a consequence be absent from the proceedings. The non-participation of parties is something that comes up in traditional arbitration and if an arbitral tribunal proceeds and renders an award may lead to issues, such as the non-participating party alleging violation of the right to be heard and claiming that it was not properly notified of the proceedings.

499 In the case that a party is identifiable, which in international arbitration is mostly the case, and it so happens that a party refuses to participate, this may be a conscious strategy to "boycott the arbitration", *e.g.*, if the respondent considers that the arbitral tribunal lacks jurisdiction.[1588] In such cases, the arbitration proceeds *ex parte*,[1589] whereby the "dynamic between the claimant and the arbitral tribunal" is altered.[1590] The arbitral tribunal will seek to preserve the absent party's fundamental rights.[1591] Awards rendered in such proceedings where respondent does not participate are generally enforceable, "provided that the party has been properly notified of the constitution of the tribunal and of relevant procedural deadlines and hearings".[1592] This is precisely something one would not be able to prove in a crypto arbitration, unless one considers messaging the Ethereum address or some other form of communication on blockchains – if feasible at all – as valid.[1593] However, even if one comments on someone's Ethereum address on etherscan.io, for example, if the party remains pseudonymous, that may not improve the situation. In the Kleros model, if respondent does not participate or pay, they automatically lose, but can appeal and there is a notification system one can sign up for.[1594]

500 Pseudonymity may not pose a problem in executing blockchain transactions as a matter of fact and in conducting crypto arbitration if the transaction and dispute stays within the confines of blockchains and outside state courts. However, pseudonymity poses

[1588] See Blackaby and others (n 70) para 5.120.
[1589] See Blackaby and others (n 70) para 5.120.
[1590] John M Townsend and James H Boykin, 'Advocacy Against an Absent Adversary' (*Global Arbitration Review*, 2019) <https://globalarbitrationreview.com/guide/the-guide-advocacy/fourth-edition/article/advocacy-against-absent-adversary>.
[1591] See Townsend and Boykin (n 1590).
[1592] Blackaby and others (n 70) para 5.120.
[1593] It is possible to leave comments on someone's Ethereum address on etherscan.io.
[1594] Interview #3, Clément Lesaege ("If you don't react, you will tend to lose your case, but you can put on notifications.").

challenges as a matter of law, and it becomes an issue once a party seeks to, for example, enforce a non-self-enforceable award rendered in crypto arbitration before state courts. Presently, pseudonymity is one of the main factors hindering the compatibility of crypto arbitration with the legal framework of international commercial arbitration.

501 In the case that parties were indeed identifiable, there is the fact that in crypto arbitration the arbitral tribunal may not be. One could suppose that once disputes are brought before crypto arbitral tribunals, that if on the one hand, it is possible to identify the parties but on the other hand, it is not possible to identify the decision-makers, this may pose problems when it comes to issues of bias. How does the system guarantee to the parties that the tribunal is not biased then?

6.3.2 Pseudonymous Tribunal

502 In the classic model of crypto arbitration proposed by Kleros, arbitrators are often referred to as jurors. Here again, one can observe software developers' inclination towards using legal terminology to fit preconceived ideas that are only somewhat true. Juries do not form part of the basic design in conventional international commercial arbitrations. Although there have been suggestions to employ juries in investment arbitration cases, such calls had no great effect.[1595] The argument relies on the assumption that in "foreign investment disputes, the decision of a global jury must have greater legitimacy than three arbitrators, two of whom are party-appointees".[1596] Since investment arbitrations involve the participation of states and require a greater level of transparency, the perception of legitimacy may be different than in international commercial arbitrations that occur in a mostly private and confidential setting.

503 In his *Economic Analysis of Law*, Posner explains that having a larger group of jurors reduces the error costs, it also increases the direct costs because jurors will spend time deliberating and have to be paid.[1597] Posner further clarifies that the "difference between arbitrators and jurors is that the former are chosen for their expertise in the area in dispute, and the latter for their lack of expertise!"[1598] In this sense, in the crypto arbitration model

[1595] See Martin Jarrett, 'Juries for Foreign Investment Disputes' (*Kluwer Arbitration Blog*, 2014) <http://arbitrationblog.kluwerarbitration.com/2014/11/10/juries-for-foreign-investment-disputes>.
[1596] See Jarrett (n 1591), in comment section.
[1597] See Posner (n 673) 819-820.
[1598] Posner (n 673) 820.

that Kleros has advanced, jurors self-selection into the "courts" or specific expert pools makes them like arbitrators.

504 One author claims that "[t]he objective of any party facing the selection of a party-appointed arbitrator is to maximize its chances of winning."[1599] This view is hardly contested as the selection of arbitrators is one of the most important decisions in an arbitration aside from the choice of counsel, requiring considerable research and know-how to make a well-founded and strategy-based decision. An experienced counsel has the required expertise and network to find a suitable arbitrator candidate, conduct pre-appointment interviews, and subsequently make an informed decision to the benefit of her client.[1600]

505 An on-chain arbitration mechanism challenges the notion of party-appointed arbitrators. Blockchains by design strive towards disintermediation. The whole procedure of appointing ones' arbitrator, which is common practice, clashes with the strive towards a disintermediated and trust minimized system. However, even in traditional arbitration the practice of appointing one's arbitrator has not been entirely free from criticism. In an Arbitration Academy essay, Ezequiel Vetulli questions the right of parties to appoint "their" arbitrator and explains that the rationale for party-appointed arbitrators is to have an impartial and neutral tribunal.[1601] The question he thus poses initially is whether appointing an arbitrator is at all necessary to achieve the required level of impartiality.[1602]

506 In fact, looking at party-appointed arbitrators from another lens leads to the impression of bias and partiality. The terminology itself implies it: party-appointed *ergo* partial. Jan Paulsson and Albert Jan van den Berg thus criticized this very practice about a decade ago, which started a heated debate.[1603] Charles N. Brower and Charles B. Rosenberg

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[1599] Paul Friedland, 'Selecting the Party Appointed Arbitrator: Key Considerations' (*White & Case Publications*, 2019) <https://www.whitecase.com/publications/alert/selecting-party-appointed-arbitrator-key-considerations>.

[1600] Some also refer to the appointing procedure, which is highly selective and may include telephone or face-to-face interviews as "beauty pageants". See Moses (n 1484) ch 6.A.4.

[1601] See Ezequiel Héctor Vetulli, 'The Parties' Right to Appoint "their" Arbitrator in an International Arbitration Proceeding' (*International Academy for Arbitration Law*, 2013) 1 <https://arbitrationacademy.org/wp-content/uploads/2017/12/Winning-Essay-Ezequiel-Vetulli.pdf>.

[1602] See Vetulli (n 1601) 1. In traditional commercial arbitration with a tribunal of three arbitrators, each party selects their arbitrator, the party-appointed arbitrators then agree on a presiding arbitrator. Parties are generally free to agree on a method for appointing their arbitrators. See Cole and Ortolani (n 672) 103.

[1603] See Paulsson, 'Moral Hazard in International Dispute Resolution' (n 643). See Albert Jan van den Berg, 'Dissenting Opinions by Party-Appointed Arbitrators in Investment Arbitration' in Mahnoush H Arsanjani

called the "Paulsson-van den Berg [p]resumption that [p]arty-[a]ppointed [a]rbitrators are [u]ntrustworthy […] [w]rongheaded".[1604] In the aftermath of the debate, the young practitioner, Vetulli argued he had a solution for a more balanced tribunal, where partisanship was unlikely; he sketched this new model, whereby each party proposes three candidates to the other, from which the opposing party then selects an arbitrator.[1605] This interesting proposal would lead to each party-appointed arbitrator being appointed twice, first in a pre-selection round along with two other candidates by one party and then *de facto* chosen as an arbitrator by the other party. However, that novel approach was lost in oblivion.[1606]

507 One of the benefits often associated with choosing one's arbitrator is that arbitrators can be chosen for their expertise. This is irrelevant in crypto arbitration as jurors must self-identify as experts by staking into the respective pool, for which they assume to have the required expertise. As opposed to party-appointed arbitrators, crypto arbitrators are randomly selected.[1607] Whereas in traditional arbitration, the service providers usually share one trait, *i.e.,* they have studied law,[1608] crypto arbitration is characterized by no such entry barrier as there is no restriction on who can become an arbitrator in the system, all that is required is to stake the native token in a relevant court.[1609] Currently, parties in crypto arbitration also do not seek assistance from lawyers or any legal representation as there are no hearings.[1610] The only form of communication happens in a written form by uploading evidence.

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and others (eds), *Looking to the Future: Essays on International Law in Honor of W. Michael* Reisman (Koninklijke Brill NV 2011) 821 et seq. See Charles N Brower and Charles B Rosenberg, 'The Death of the Two-Headed Nightingale: Why the Paulsson-van Den Berg Presumption That Party-Appointed Arbitrators Are Untrustworthy Is Wrongheaded' (2013) 29 Arbitration International 7.

[1604] Brower and Rosenberg (n 1603) 7.

[1605] See Vetulli (n 1601) 6.

[1606] There are some alternative concepts adopted by the Court for Arbitration for Sport (CAS) and other arbitral institutions. See Paulsson, 'Moral Hazard in International Dispute Resolution' (n 643) 353.

[1607] See Lesaege, Ast and George (n 1136) 5. See also Nappert and Ast (n 1154).

[1608] Although this is a very common characteristic of arbitrators in international commercial arbitration, it need not be the case in every instance. Parties are free to choose anyone an an arbitrator, whether or not they have had legal training. In cases that are highly technical, parties may prefer a technical expert as their arbitrator.

[1609] However, one could argue that this poses a significant entry barrier as well, which is getting higher still. In addition, the chances of being picked as an arbitrator depend directly on one's stake in the system and/or how much one is willing to risk to lose.

[1610] However, it is conceivable that lawyers who have acquired expertise in this domain may start offering services to assist parties.

508 If the randomly selected decision-makers lack the expertise, they may get penalized in case they do not vote with the majority. Therefore, it is in the interest of jurors to honestly determine the courts for which they have expertise. Another aspect to consider is that it is not possible to verify whether the juror is human.[1611] This leads to questions as to jurors' legal capacity. Also, one person can create multiple accounts and be selected as a juror multiple times with different addresses or even with the same address in the exact same case.[1612] Moreover, even a party to a dispute could be drawn as a juror if it had previously followed the requirements of staking tokens into the court.[1613] Such a situation would constitute reasonable doubt as to the arbitrator's impartiality and independence, according to 1.1. of the Non-Waivable Red List of the 2014 IBA Guidelines on Conflicts of Interest in International Arbitration. Thus, this contradicts widespread perceptions of due process,[1614] and leads to serious doubts as to the system's impartiality and viability to create "justice" or fair results.

509 Also, the possibility of conflicts of interest is not accounted for as there is no mechanism in place to object to any juror selection because jurors are pseudonymous. Jurors do not have to disclose their identity, as a result there are no checks for conflicts of interest.[1615] However, it is possible to determine the address of a chosen juror in any given case because the information is publicly accessible on the blockchain. Jurors who have participated many times and have been active in the community, on telegram or discord, for example, may have revealed their identity at some point, or it may be possible to discern and link addresses to real-world identities. In fact, there is even a specialized juror telegram channel,[1616] where anyone can join, and jurors can converse about cases. The pseudonymity aspect is not 100% guaranteed. Thus, the design of the system may not

[1611] At the Max Planck Institute Seminar on 6 December 2019, Professor Jörg Ringe had an interesting comment. He suggested that the logical next step would be for an algorithm to adjudicate. In fact, the algorithm would get rewards just as any human adjudicator would in crypto arbitration and could potentially learn how to maximize its profits. Interview #2 William George, when asked whether there have been any cases where a juror might have been a bot, George responded that "we haven't noticed anything definitive on jurors being bots … it might be hard to tell." George also shared that one of the things that he thinks about a lot in how to design the incentives is how to prevent "bottable" strategies so that jurors put in real effort. Colin Rule during his Keynote Speech at the University of Leicester Conference 'When Blockchain meets Arbitration: The Birth of Decentralized Justice" on 31 January 2020 showed the famous cartoon from the New Yorker, where one dog looks to the other dog and says "On the internet, nobody knows you are a dog." See for more on the iconic cartoon, Cavna (n 1229).

[1612] See for an example: 'Kleros Case 784' <http://www.klerosboard.com/dispute/?id=784>.

[1613] E-Mail from William George on 25 March 2021, on file with author.

[1614] See Nappert and Ast (n 1154). Also, Interview #11, Sophie Nappert.

[1615] See *supra* Chapter 5.4.5.5.

[1616] See 'Kleros Heated Juror Chit-Chat Group' <https://t.me/klerosjuror>.

fully qualify as Schelling point compliant, which will be discussed in the following chapter on the incentive design. The WEF report notes that game theory incentivized juries "may be acceptable for anonymized disputes in low-risk situations, it is unlikely to be adopted by enterprise users because of the inherent uncertainties in a dispute resolution process".[1617]

510 The decision-makers are one of the most important components in a dispute resolution process, if not the most important one. In international commercial arbitration, much care is given to assure arbitrators' expertise, impartiality, and independence. Voser asserts that "[i]n order to maintain the legitimacy of arbitration, the impartiality and independence of arbitrators is of the highest importance".[1618] There are justified doubts about the system's ability to preserve all these notions in the current crypto arbitration design.

511 Pseudonymity raises concern, whether guaranteed or not. On the one hand, if jurors are pseudonymous, the impartiality and independence of jurors cannot be verified. In addition, even parties could be jurors in their own dispute, which cannot be an optimal setup. Moreover, a single party (juror) could be drawn multiple times for the same case, increasing the number of their votes.[1619] On the other hand, if jurors are not pseudonymous, the Schelling Point mechanism is impeded, and jurors that can communicate will tend to coordinate their behavior to maximize their profits, regardless of any "true" or "honest" outcome. These are just some issues the system faces. Thus, the pseudonymity of arbitrators also seems to hinder crypto arbitration from being fully compatible with the legal framework of international commercial arbitration, particularly when it comes to the impartiality and independence of arbitrators.

6.4 Driven by Incentives

512 In economics, every agent is driven by incentives, the world is modeled on that presumption and becomes easier to analyze. Twenty years ago, Jean-Jacques Laffont and David Martimort, two influential French economists on the incentives' theory, observed with surprise that Joseph Schumpeter had not "mention[ed] the word 'incentives' in his

[1617] Alhabib et al (n 884) 13. See also *supra* Chapter 5.5.4.
[1618] Nathalie Voser, 'Has Acting as Arbitrator Become a Risky Business?' (*Kluwer Arbitration Blog*, 2018) <http://arbitrationblog.kluwerarbitration.com/2018/07/18/acting-arbitrator-become-risky-business/>.
[1619] See Lesaege, George and Ast (n 1138) 9.

monumental history of economic thought. Today, for many economists, economics is to a large extent a matter of incentives".[1620] Besides economics, incentives are relevant across disciplines, where human behavior is concerned, including the law.

513 In arbitration, there are different actors with different incentives. A party's incentive may be to win, avoid disruption to its business dealings, or perhaps uphold the business relationship with the counterparty in a long-term contract. The lawyer's incentives may be to serve and lead the client to an optimal outcome and go up the law firm's ranks. The arbitrator's incentives may also be manifold to render justice, deliver an enforceable decision, and build a reputation for possible re-appointments in the future.

514 Although parties' interests in disputes are often opposed, an experienced arbitrator may find common ground for parties to settle their disputes. In fact, arbitrators may even encourage parties to seek mediation if they find that parties have enough common ground to keep the business relationship intact and allow future collaboration. Blockchains' incentive design choices are important.[1621] Bitcoin, for example, is robust because of its consensus mechanism, incentivizing miners to perform proof of work.[1622] This section analyzes the incentives present in crypto arbitration.

515 In crypto arbitration, an arbitrator's experience and skill, which are normally reflected in her reputation in the arbitration community, is replaced by an incentive structure where pseudonymous jurors self-select into courts and get randomly assigned to resolve disputes based on how much they were willing to stake.[1623] The rationale is that jurors will leave courts, for which they do not have sufficient knowledge as they get penalized by losing some of their stake if they do not vote coherently.[1624] Thus, jurors in general

[1620] Jean-Jacques Laffont and David Martimort, The Theory of Incentives: The Principal-Agent Model (Princeton University Press, 2002) 1.

[1621] See Cathy Barrera, 'Blockchain Incentive Structures: What They Are and Why They Matter' (*Medium*, 2018) <https://medium.com/prysmeconomics/blockchain-incentives-101-what-they-are-and-why-they-matter-5127afb56aeb>.

[1622] See Arvind Narayanan, 'Incentives and Proof of Work' (*Coursera Bitcoin and Cryptocurrency Technologies, Princeton University*) <https://www.coursera.org/lecture/cryptocurrency/incentives-and-proof-of-work-XV5nQ>.

[1623] Interview #3, Clément Lesaege explained that the native token *PNK* could be thought of as "transferrable reputation". See also Nappert and Ast (n 1154).

[1624] See Interview #1, Federico Ast ("[…] the system is engineered for having people self-select into the courts where they have experience, like if you are an expert in financial insurance and you stake your tokens into the website court you are very likely to be wrong lots of times and because of how the majority system works and every other economics incentives work, you're going to lose money and then exit the system

will prefer to be honest in this regard and self-select only into such juror pools, for which they do have the required expertise.[1625] Jurors decide based on a financial incentive, seeking to vote coherently with other jurors.[1626] This is another major distinction between traditional arbitration and blockchain-based arbitration. Whereas traditional arbitrators get paid no matter the outcome of the dispute, crypto arbitrators only get paid if they voted according to the majority. One could say that dissenting opinions are penalized.

516 In traditional legal systems, Posner explains that juror duty is compulsory in order to increase the diversity of backgrounds.[1627] He further explains that "if the courts rationed the excess demand by using some criterion of fitness – education, occupation, or whatever – the jury would lose its random-sample character, which is a positive factor in its ability to make correct and predictable factual determinations".[1628] In crypto arbitration, operating by the Schelling mechanism, that randomness sample cannot be accounted for in the same way. However, this feature for jury trials may not be relevant in a blockchain setting, where jurors self-select into the kinds of pools for which they believe they are best suited due to their expertise.

517 It can be assumed that most current jurors are blockchain savvy and that diversity can further be increased to account for multiple backgrounds and eliminate any inherent bias over time. However, different backgrounds may not be in the best interest of the system's game-theoretical design. A major problem is that the focal point theory does not work as efficiently for people from different backgrounds. Basu highlights that "[t]he focal point is a concept that arises from a psychological capacity, prevalent among human beings, *especially those who share a common cultural background*, which enables each to guess what others are likely to do when faced with the problem of choosing one from among many equilibria".[1629]

because yeah it's not profitable for you."). See also Daniel Dimov and Federico Ast, 'Is Kleros Fair?' in Kleros, *Dispute Revolution - The Kleros Handbook of Decentralized Justice – Revised and Augmented Edition* (2020) 268–269.

[1625] See Dimov and Ast (n 1624) 268–269.

[1626] See Interview #3, Clément Lesaege states that jurors may also have an incentive to deliver justice. ("Most of them would have some sense of justice and prefer to give honest rulings compared to just taking bribes, for example").

[1627] See Posner (n 673) 820.

[1628] Posner (n 673) 820.

[1629] Kaushik Basu, *The Republic of Beliefs* (Princeton University Press 2018) 43. Emphasis added.

518 Jurors in the Kleros design, for example, may not share such a common culture, which raises questions as to the design's viability.[1630] The Kleros Yellow Paper refers to Thomas Schelling's work and outlines one of Schelling's famous examples, where people are asked to meet a stranger in New York.[1631] However, they need to pick a place and time without being able to communicate with the stranger.[1632] Most people Schelling asked in this experiment picked the Grand Central Station at noon.[1633] However, whether he would have gotten the same majority response or any majority at all from non-US citizens or non-New York residents is doubtful. Someone who is not from New York but from Berlin, for example, may have picked the Rockefeller Center, the Empire State Building or maybe Times Square.

519 Aside Schelling Points and game theory, social choice theory plays an important role as well since the jurors must vote. Social choice theory studies collective decision-making.[1634] It is an interdisciplinary field spanning economics, philosophy, political science, mathematics, law, and many others.[1635] It started in the late 18th century, around the time of the French Revolution with the mathematicians Jean-Charles de Borda and Nicolas de Condorcet, and continued in the 19th century with Charles Dodgson,[1636] and became more prevalent in the 20th century with such economists as the Nobel laureate Kenneth Arrow.[1637]

520 Here, the branch of social choice theory of interest is called "judgment aggregation".[1638] It considers "how several individuals' judgments on some logically connected propositions can be aggregated into consistent collective judgments".[1639] List and Polak

[1630] As it is an open and permissionless system, anyone from around the world who is willing to buy the native token of a crypto arbitration platform and stake there, can do so. A multitude of backgrounds and cultures is thus almost certain. It is one thing if one considers those participating in blockchain ecosystems to have a common culture, it is something else if parties and jurors are from different backgrounds and the case does not relate to any blockchain-specific issue at all.
[1631] See Lesaege, George and Ast (n 1138) 2.
[1632] See Lesaege, George and Ast (n 1138) 2.
[1633] See Lesaege, George and Ast (n 1138) 2.
[1634] See Federico Ast, 'Eyal Winter on Game Theory and the Challenge of Decentralized Justice – Interview' in Kleros, *Dispute Revolution – The Handbook of Decentralized Justice – Revised and Augmented Edition* (2020) 122. See also 'Social Choice Theory' (*Stanford Encyclopedia of Philosophy*, 2013) <https://plato.stanford.edu/entries/social-choice/>.
[1635] See 'Social Choice Theory' (n 1634).
[1636] Also known as Lewis Carroll, author of Alice in Wonderland. See 'Social Choice Theory' (n 1634).
[1637] See 'Social Choice Theory' (n 1634). See Amartya Sen, 'The Possibility of Social Choice' [1999] 89 The American Economic Review 349, 350–351.
[1638] See 'Social Choice Theory' (n 1634).
[1639] Christian List and Ben Polak, 'Introduction to Judgment Aggregation' [2010] Cowles Foundation Discussion Paper No. 1753, 1 <https://papers.ssrn.com/sol3/papers.cfm?abstract_id=1548413>.

give the example of a court where judges have to decide on a specific case and come to (i) a final judgment (*e.g.*, liable or not liable), (ii) present their findings (*e.g.*, harm was done or not done), and (iii) the law or legal principle they have applied (*e.g.*, the law required a certain action).[1640]

521 The aggregation problem is multi-faceted and faces various constraints.[1641] In a three-panel tribunal, each individual may have diverse preferences, the question then arises whether and how the tribunal can make a choice, which is just.[1642] Judgment aggregation stems from what is called the "doctrinal paradox" portrayed in the 1980s and 1990s by Kornhauser and Sager,[1643] whereby "judges may face a real danger of falling into collective irrationality when trying to reach a common and justified verdict."[1644] This paradox is similar to what is called the Condorcet paradox, according to which among several alternatives compared in pairs, it is impossible to find a winning solution because result *a* may be preferred to *b, b* may be preferred to *c*, *c* in turn may be preferred to *a*, resulting in a cyclic movement.[1645] Kleros is aware of these paradoxes and complexities, which is why they are actively researching to better the current system incentive and voting design to account for these.[1646]

522 Kleros uses Schelling points to incentivize strangers "who do not know or trust each other to tell the truth […] In this simple case, the Schelling Point is honesty".[1647] The use of the term "truth" and "honesty" is somewhat misleading because even if there were a focal point that jurors would naturally be drawn to, that does not constitute any true or honest behavior, it just constitutes a solution to a coordination problem. It seems that what is meant by "honest behavior" is that jurors do not simply vote by employing minimum effort for high rewards but make the real effort of applying their best judgment to rule on a specific case.[1648] The system faces a dilemma: On the one hand, diversity of

[1640] List and Polak (n 1639) 2.
[1641] See generally, List and Polak (n 1639).
[1642] See 'Belief Merging and Judgment Aggregation' (*Stanford Encyclopedia of Philosophy*) <https://plato.stanford.edu/entries/belief-merging/>.
[1643] See 'Belief Merging and Judgment Aggregation' (n 1642).
[1644] 'Belief Merging and Judgment Aggregation' (n 1642).
[1645] 'Belief Merging and Judgment Aggregation' (n 1642).
[1646] See William George, 'Kleros and Social Choice Theory: Research Paths for the Future' (*Kleros Blog*, 2020) <https://blog.kleros.io/kleros-and-social-choice-theory-voting/>.
[1647] See Lesaege, George and Ast (n 1138) 2.
[1648] See Lesaege, George and Ast (n 1138) 27. The authors make the distinction between an "honest" and "lazy" strategy. See also Interview #2, William George ("So one thing that I think about a lot when trying to design the incentives, is that you should design incentives so the jurors put in real effort that allows you to

backgrounds is a goal to be strived for, on the other hand, such diversity may lead to obstacles in finding optimal Focal point outcomes.

523 Jurors are incentivized to participate in order to receive arbitration fees. And the more one stakes, the higher the chances are of being selected. The fact that jurors are financially incentivized to make decisions does not *per se* constitute a hindrance or a due process concern. In traditional arbitration, arbitrators also have monetary incentives to render enforceable arbitral awards as they are not likely to render their services for free. An employee at an arbitral institution with many years of experience shared that there are excellent arbitrators with great expertise in traditional arbitration, whose incentive cannot be financial alone, who seem to be more interested in resolving the dispute the best way possible.[1649] What raises concern in crypto arbitration is the fact that the incentives are aligned with what is anticipated to be a majority outcome. A question that needs to be addressed is whether the majority decision can be considered a just or right decision.[1650] If one affirms this to be the case, then it may be indistinguishable really whether jurors are incentivized not to lose their money or make the right decision. In traditional arbitration it will be the majority decision that makes it into the arbitral award as well. However, the awards are usually reasoned, and the arbitrators apply law.

524 In crypto arbitration, jurors' behavior is driven by the incentive to decide according to what they believe the majority will decide and not so much to decide on a just outcome based on a legal determination of the case at hand.[1651] In fact, jurors do not have to apply

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read some truth about it. What you don't want is for jurors to lazy vote. You don't want jurors to be like okay I'm in a court for all disputes between freelancers and small business owners and I can look at the history of the court, and I can say the freelancers win in 70% of cases, so I'm just gonna always vote for the freelancer. That would be really bad because then you wind up with a court that didn't actually do anything. So the parameters of the courts are designed so that if you do something like that you should lose money.")

[1649] Interview #8, Employee at Arbitral Institution ("I can tell you I've seen excellent, absolutely excellent arbitrators who are barely charging any fees and I can hardly think that their motivation is money. I have seen that and then I've seen those who are okay arbitrators charge a lot, so it's really individual. I mean I've seen absolutely amazing arbitrators who, you can see they are true adjudicators who really care about the disputes who really care about making the right decision, they really dig into the files, into the evidence, really think things through, and you have to beg them to please send an invoice and charge I've seen that. And then you see the other side of it. My point is that you see both and it's really, really individual.").

[1650] See Interview #11, Sophie Nappert ("All deciding in the same direction doesn't mean that it's fair, it means they are all deciding in the same direction, especially if they are paid for it." Nappert also shares that the underlying philosophy is different for Kleros arbitration, and that this reminds her of social media, "the fact that there are many of them deciding in the same way, it's the same idea as social media to me.").

[1651] However, see Interview #3, Clément Lesaege would perhaps not entirely agree because he noted other incentives as well. ("Most of them would have some sense of justice and prefer to give honest rulings compared to just taking bribes, for example"). See also Interview #8, Employee at Arbitral Institution, in which they explained that the incentives in traditional arbitration are individual and not all arbitrators seem to be incentivized by monetary gains alone (n 1649).

any law at all, there are only court policies that serve as guidelines.[1652] Even if parties were to determine an applicable law in their arbitrable contract and draw the jurors' attention to it, there is no guarantee that first, the jurors would have enough legal expertise to do so, second, that they would apply the law even if they had sufficient legal expertise and third, that any of this would make any difference because of the focal point incentive design. In international commercial arbitration, arbitrators usually decide cases by applying law. However, the parties may allow arbitrators to depart from this standard and decide their dispute *ex aequo et bono, i.e.,* according to what the arbitrators consider just and equitable.[1653] This is rare in modern practice, and although arbitrators do not have to take into account applicable laws in such cases, they must nevertheless comply with *ordre public*.[1654]

525 Since crypto arbitration is set up such that if jurors decide against the majority, they lose some of their staked tokens, there is also an increased incentive for jurors to form alliances, try to identify who the other selected and pseudonymous jurors for any given case are, and to communicate to coordinate their behavior to maximize their profits. There is also a clear bias towards majority holders, who will be randomly selected as jurors much more often than others. Also, such majority holders are likely to be active community members who may have already formed alliances as the incentives are much higher for jurors to communicate to align behavior, making a Schelling Point design obsolete.

[1652] Interview #2, William George ("There's a collection of pretty limited and admittedly somewhat vague instructions that define the court policies … And so that gives me as a juror a certain number of instructions on how I'm supposed to think about cases and there are vague sort of examples of like things on which one might refuse to arbitrate", "when somebody asks me how Kleros works, I wouldn't say that the jurors apply law."). The guidelines of the "General Court", for example, includes a portion that states as follows: "Jurors should attempt to interpret disputes according to the "spirit of the dispute" unless the arbitrable contract or the policies of the subcourt state otherwise. Jurors should interpret disputes without assuming the existence of gods, spirits or other supernatural beings unless the arbitrable contract or the policies of the subcourt state otherwise." See 'Kleros Courts and Their Policies' <https://court.kleros.io/courts>.

[1653] See, e.g., Article 28(3) of the UNCITRAL Model Law, Article 35(2) Swiss Rules ("The arbitral tribunal shall decide *ex aequo et bono* or as *amiable compositeur* only if the parties have expressly authorized it to do so.").

[1654] See Blackaby and others (n 70) para 1.10 and Footnote 9 therein. See also Cole and Ortolani (n 672) 42–43.

6.5 Fairness through Mathematics

526 Can crowd-sourced, game theory-based adjudication be fair? Can it preserve the parties' fundamental procedural rights? These are the most pressing questions when it comes to crypto arbitration. There is much reluctance to accept this novel arbitration type for precisely the view that decisions rendered by pseudonymous strangers on the Internet, scattered all over the world, who moreover do not apply any law, rather they only apply their own sense of fairness, and are incentivized based on game theory - that such decisions could simply never be sound judgments. Or could they?

6.5.1 The Origins of Due Process and its Applicability to Arbitration

527 Due process has a long tradition and is expressed in the Latin maxim *audiatur et altera pars* of ancient Roman Law, meaning "the other side shall be heard as well".[1655] In the common law system, the *Magna Carta* of 1215 is an early example of individuals given certain guarantees in light of the king's power.[1656] Due process is generally seen as private individuals' constitutional rights protection before the state.[1657] Since arbitration is a private form of dispute resolution, this type of protection at the outset seems unnecessary.[1658] While an arbitral tribunal's power stems primarily from the parties' freedom of contract, national courts derive their power from state authority.[1659] Moreover, one may assume that justice can be understood differently in arbitration because arbitration is private and confidential, and since there are no precedents that would enable a uniform body of law to emerge in view of being preserved, the decision really only concerns the parties in question.[1660] However, arbitral tribunals are functionally

[1655] Uwe Volkmann, *Staatsrecht II Grundrechte* (CH Beck 2020) 139.

[1656] See Fabricio Fortese and Lotta Hemmi, 'Procedural Fairness and Efficiency in International Arbitration' [2015] Groningen Journal of International Law, vol 3(1): International Arbitration and Procedure 110 <https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2611337>. See also Nathan S Chapman and Michael W McConnell, 'Due Process as Separation of Powers' (2012) 121 The Yale Law Journal 1672 <https://www.yalelawjournal.org/essay/due-process-as-separation-of-powers>.

[1657] See Matti S Kurkela and Santtu Turunen, Due Process in International Commercial Arbitration (Oxford University Press 2010) 1. The excerpts of the Magna Carta, which became due process read as follows: "No freeman shall be taken, imprisoned, disseised, outlawed, banished, or in any way destroyed, nor will We proceed against or prosecute him, except by the lawful judgment of his peers or by the law of the land." and "To no one will We sell, to no one will We deny or delay, right or justice." See 'Magna Carta' (*National Archives*) <https://www.archives.gov/exhibits/featured-documents/magna-carta>.

[1658] See Kurkela and Turunen (n 1657) 1.

[1659] See Kurkela and Turunen (n 1657) 1.

[1660] In contrast to arbitration, see, e.g., Posner (n 673) 33. ("[T]he judge too must consider the future effects of alternative rulings. If judgment is awarded to the defendant on the ground that he is a 'deserving,' albeit careless, person, this will encourage similar people too be careless. Once the frame of reference is expanded beyond the parties to the case at hand, justice and fairness assume broader meanings than what is just or fair as between this plaintiff and this defendant.")

equivalent to state courts, and the state's jurisdictional power can be seen as having been delegated to the private sphere in an arbitration.[1661]

528 Moreover, parties that conclude an arbitration agreement preclude access to state courts, an act that necessarily mandates certain safeguards.[1662] The rationale of arbitration is an enforceable award, which state courts will only enforce if it adheres to the quality standards expected of state court adjudication, most notably due process principles.[1663] Because of the functional equivalence of arbitral procedures and arbitral awards to national procedures and judgments, some authors regard the European Convention on Human Rights ("ECHR") as applicable to arbitration.[1664] Article 6 ECHR does not in principle impede the establishment of an arbitral tribunal, in fact, by setting up an arbitration proceeding, parties can exercise their "right to court" as arbitral tribunals may fall under this provision.[1665]

529 Due process is a procedural foundation of international arbitration and assures the integrity of the arbitral process.[1666] A distinction can be made between substantive and procedural due process.[1667] In arbitrations, substantive due process relates to the content of the arbitration agreement, and it is violated if arbitrators exceed their mandate and exercise powers not granted to them by the parties.[1668] Procedural due process relates to the proceedings as such and directs the tribunal's powers to be exercised in the spirit of

[1661] See Stacher (n 659) para 1. See also Kurkela and Turunen (n 1657) 1.
[1662] See Blackaby and others (n 70) paras 1.41, 1.47. See also Kurkela and Turunen (n 1657) 2.
[1663] See Kurkela and Turunen (n 1657) 1–2.
[1664] See Kurkela and Turunen (n 1657) 1–2. See also Stacher (n 659) paras 1, 266.
[1665] See Council of Europe/European Court of Human Rights, *Guide on Article 6 of the European Convention on Human Rights - Right to a Fair Trial (Civil Limb)* (2020) paras 131 et seq. See also European Court of Human Rights Judgments Deweer v. Belgium 27 February 1980, para. 49 and see also Transado – Transportes Fluviais Do Sado, S.A. v. Portugal 16 December 2003, para. 2, ("The Court notes at the outset that Article 6 does not preclude the setting up of arbitration tribunals in order to settle certain disputes. Indeed, the word 'tribunal' in Article 6 § 1 is not necessarily to be understood as signifying a court of law of the classic kind, integrated within the standard judicial machinery of the country").
[1666] See, e.g., James Menz in Russian Arbitration Center, 'How to Combat 'Due Process Paranoia' in International Arbitration' (*Youtube*, 2018) <https://www.youtube.com/watch?v=AE5ofFRkzPU>.
[1667] See Fortese and Hemmi (n 1656) 111.
[1668] See Kenneth R Davis, 'Due Process Right to Judicial Review of Arbitral Punitive Damages' (1995) 32 American Business Law Journal 622. See Thomas E Carbonneau, 'Defining Arbitral Due Process' (2001) 3 Journal of Alternative Dispute Resolution in Employment 14.

fair proceedings and the equal treatment of the parties.[1669] These principles are enshrined in national arbitration laws, arbitration rules, and soft law.[1670]

530 The New York Convention addresses due process in its Article V(1)(b).[1671] According to this provision, an award may be refused recognition and enforcement, if "[t]he party against whom the award is invoked was not given proper notice of the appointment of the arbitrator or of the arbitration proceedings or was otherwise unable to present his case".[1672] Further procedural fairness provisions can be found in e.g., the Articles 18 and 19 UNCITRAL Model Law (2006),[1673] from which Parties cannot derogate.[1674] Article 18 of the UNCITRAL Model Law states that "[t]he parties shall be treated with equality and each party shall be given a full opportunity of presenting his case."

531 The development in the UNCITRAL Arbitration Rules is interesting to note as compared to the UNCITRAL Model Law. Whereas the UNCITRAL Arbitration Rules in 1976 in Article 15(1) determined that "[s]ubject to these Rules, the arbitral tribunal may conduct the arbitration in such manner as it considers appropriate, provided that the parties are treated with equality and that *at any stage of the proceedings* each party is given a *full opportunity of presenting* his case",[1675] the amended 2013 version in Article 17(1) states that "[s]ubject to these Rules, the arbitral tribunal may conduct the arbitration in such manner as it considers appropriate, provided that the parties are treated with equality and

[1669] See Fortese and Hemmi (n 1656) 111. See also Carbonneau (n 1668) 14.

[1670] See Kurkela and Turunen (n 1657) 11 (Kurkela and Turunen propose the following order of sources for identifying due process in international arbitration: "1) The New York Convention 2) Human rights conventions 3) International soft law concerning arbitration 4) Principles of law formulated from various national procedural laws"). See also Fortese and Hemmi (n 1656) 111, referring to arbitral costs and time efficiency provisions in specific.

[1671] See UNCITRAL Secretariat Guide (n 757) 155.

[1672] Another important provision concerning procedural irregularities is Article V(1)(d) of the New York Convention, according to which recognition and enforcement of an arbitral award may be refused if "[t]he composition of the arbitral authority or the arbitral procedure was not in accordance with the agreement of the parties, or, failing such agreement, was not in accordance with the law of the country where the arbitration took place".

[1673] See Born, *International Commercial Arbitration (Third Edition)* (n 618) 1707.

[1674] See Fortese and Hemmi (n 1656) 113, and see Footnote 20 therein. Arbitral Institution Rules also have due process provisions. See, e.g. Article 22(4) ICC Rules: "In all cases, the arbitral tribunal shall act fairly and impartially and ensure that each party has a reasonable opportunity to present its case." And Article 19(1) Swiss Rules (2021): "Subject to these Rules, the arbitral tribunal may conduct the arbitration in such manner as it considers appropriate, including by adopting measures for the efficiency of the arbitration proceedings, provided that it ensures equal treatment of the parties and their right to be heard."

[1675] 'UNCITRAL Arbitration Rules 1976' <https://uncitral.un.org/sites/uncitral.un.org/files/media-documents/uncitral/en/arb-rules.pdf>. Emphasis added.

that *at an appropriate stage of the proceedings* each party is given a *reasonable opportunity of presenting* its case."[1676]

532 The adapted version gives the impression of a diminished level of due process, instead of a "full opportunity" "at any stage of the proceedings", the requirement has leveled down to "a reasonable opportunity" "at an appropriate stage of the proceedings". A previous draft for the 2010 version of the Rules, simply referred to "an opportunity" as the wording "a full opportunity" was seen as potentially contentious.[1677] Some working group members expressed caution "as to whether this amendment was really necessary given that the Working Group had no information that the current text had led to problems or created undesirable results".[1678] The International Bar Association ("IBA") Arbitration Committee shared its comments on the draft, which were later implemented, stating that although the previous wording referring "to a 'full' opportunity may be seen as too demanding, the current draft may be criticized as providing insufficient protection to the parties' right to be heard."[1679] The IBA thus suggested to amend the sentence to include "a reasonable" opportunity,[1680] a suggestion that is now reflected in the rules.

533 Article 182 (3) Swiss PILA is the due process provision in Swiss law.[1681] Parties have a right to equal treatment[1682] and the parties' right to be heard has been put on par with national court proceedings.[1683] National courts determine from their "own particular national standpoint",[1684] and on a case-by-case basis whether an arbitral proceeding was "fair".[1685] According to Article 190 (2) Swiss PILA, "[a]n arbitral award may be set aside only […] (d) where the principle of equal treatment of the parties or their right to be heard

[1676] 'UNCITRAL Arbitration Rules 2013' (n 727). Emphasis added. This version of Article 17(1) was already implemented in the 2010 Rules.
[1677] 'A/CN.9/614 - Report of Working Group II (Arbitration and Conciliation) on the Work of Its Forty-Fifth Session (Vienna, 11-15 September 2006)' para 77 <https://documents-dds-ny.un.org/doc/UNDOC/GEN/V06/575/26/PDF/V0657526.pdf?OpenElement>.
[1678] 'A/CN.9/614 - Report of Working Group II (Arbitration and Conciliation) on the Work of Its Forty-Fifth Session (Vienna, 11-15 September 2006)' (n 1677) para 77.
[1679] 'A/CN.9/704/Add.2 - Settlement of Commercial Disputes: Revision of the UNCITRAL Arbitration Rules - Compilation of Comments by Governments and International Organizations' (2010) 9 <https://documents-dds-ny.un.org/doc/UNDOC/GEN/V10/535/49/PDF/V1053549.pdf?OpenElement>.
[1680] 'A/CN.9/704/Add.2 - Settlement of Commercial Disputes: Revision of the UNCITRAL Arbitration Rules - Compilation of Comments by Governments and International Organizations' (n 1679) 9.
[1681] Article 182 (3) Swiss PILA states: "[r]egardless of the chosen procedure, the arbitral tribunal shall ensure equal treatment of the parties and their right to be heard in adversarial proceedings."
[1682] See Stacher (n 659) para 268 et seq.
[1683] See Stacher (n 659) para 271. See also further referenced therein, e.g., DSFT of 23 September 2008, 4A_176/2008, reason 4 and others.
[1684] Blackaby and others (n 70) para 10.56.
[1685] See Blackaby and others (n 70) paras 10.54, 10.56.

in an adversary procedure were violated; (e) where the award is incompatible with public policy."

6.5.2 Due Process Paranoia

534 Some suggest that due process is one of the most frequently cited grounds for setting aside and refusing to enforce arbitral awards in international arbitrations.[1686] It can generally be said that parties want to be heard, present their case, present their evidence, and that all of this will be taken into account, and that if there is evidence against them, that the party can submit counter-evidence.[1687] However, there is no internationally recognized standard for due process and national laws provide little guidance.[1688] This may be one of the causes that has led to - what is often referred to as - "due process paranoia", which according to the Queen Mary University of London and White & Case International Arbitration survey in 2015 is "a perceived reluctance by tribunals to act decisively in certain situations for fear of the award being challenged on the basis of a party not having had the chance to present its case fully ('due process paranoia')."[1689]

[1686] See Mohammed S. Abdel Wahab in Russian Arbitration Center in Russian Arbitration Center, 'How to Combat 'Due Process Paranoia' in International Arbitration' (*Youtube*, 2018) <https://www.youtube.com/watch?v=AE5ofFRkzPU>. Wahab also asserts that it is often referred to as the "procedural dimension of public policy", which according to him is the most frequently invoked, but also the least successful. See also Blackaby and others (n 70) para 10.54.

[1687] Interview #8, Employee at Arbitral Institution. An interesting question is also to think about what parties actually and really want, whether parties are more interested in the outcome or in the process. Colin Rule during his Keynote Speech at the University of Leicester Conference 'When Blockchain meets Arbitration: The Birth of Decentralized Justice" on 31 January 2020, for example, said that at ebay, people were happier with a dispute that they lost on the first day than a dispute that took a long time even if they won in the end. So if a resolution took longer than 12 days, even if the party had gotten all the money back, they would be more dissatisfied than if they had lost. See also, Interview #16, Lise Alm ("I think parties generally are more okay with that than lawyers think because we're so focused on due process, privacy issues and so forth, and we need to be. As an institution we are the safeguards of that. But if I'm a party and I have a dispute, I might prefer to get it 70% right now, rather than getting it 90% right in a year from now, with all the due process concerns and the bills from lawyers that comes with that extra year. This means that I think there is a market for these kinds of tools [such as SCC Express]. I think we built the castle slightly too shiny sometimes, we built all these processes to be a 100% safe, even though of course they're not because we are still all humans acting in it. Arbitration has gone over the last hundred years from being that quick and easy version, and it is still quicker and easier than courts. But I am not sure anyone today would say, let's go to arbitration because it's so easy and so quick and so painless. Hopefully they would say we are easier, quicker, and more painless than other options, but is that enough? ... We need to always remember … we are there when people have landed in problems, we come in and help. Nobody craves disputes … everybody wants to not get into it in the first place, and get out of it as soon as possible. Maybe the values we think are core are not core for our users, at least not for all users and all disputes.").

[1688] See Blackaby and others (n 70) para 10.54.

[1689] School of International Arbitration - Queen Mary University of London, '2015 International Arbitration Survey: Improvements and Innovations in International Arbitration' (*Queen Mary University of London, School of International Arbitration*, 2015) 2 <http://www.arbitration.qmul.ac.uk/media/arbitration/docs/2015_International_Arbitration_Survey.pdf>. See also Remy Gerbay, 'Due Process Paranoia' (*Kluwer Arbitration Blog*, 2016) <http://arbitrationblog.kluwerarbitration.com/2016/06/06/due-process-paranoia/>.

This has become more worrisome in international arbitration,[1690] and the COVID-19 pandemic has further heightened this concern.[1691]

535 A lack of decisiveness from the side of an arbitral tribunal can be a problem, because parties may strategically make unreasonable claims of due process violation and intensify the pressure on the arbitral tribunal by repeating the claims, which according to Reed "cheapens, if not threatens, this foundational principle".[1692] Peter Berger and Jensen state that the delicate question here is whether "this [is] a legitimate exercise of the party's procedural rights, or an unreasonable move, leading to an unnecessary delay of the proceedings",[1693] to which they advocate a tribunal to adopt a proactive style that while preserving fairness, still shows firmness to navigate the procedure in the interest of all parties involved, helping to save time and costs.[1694]

536 Due process, already a delicate balancing act in traditional international arbitration, leaves crypto arbitration with what seems an unsurmountable obstacle, *i.e.,* whether due process can be preserved at all. Sophie Nappert, who regularly sits as an arbitrator in international arbitrations, when asked whether she would employ crypto arbitration, responded that one of her biggest concerns is due process and she remarked that in the Kleros model, there is no due process.[1695] She further stated that "everybody can submit evidence, even the jurors can appeal their own decision, the parties lose complete control of their dispute".[1696]

[1690] See School of International Arbitration- Queen Mary University of London (n 1689) 5.

[1691] See e.g., the decision by the Swiss Federal Tribunal on 6 July 2020 (DSFT of 6 July 2020, 146 III 194), according to which it held that the COVID-19 pandemic was not sufficient grounds to impose virtual hearings in state court proceedings against a party's consent. Zaugg and Sharifi argue that the decision does not apply in international arbitration as the decision was made based on state court related assumptions. For a full elaboration, see Nikolaus Zaugg and Roxana Sharifi, 'Imposing Virtual Arbitration Hearings in Times of COVID-19: The Swiss Perspective' (*Kluwer Arbitration Blog,* 2021) <http://arbitrationblog.kluwerarbitration.com/2021/01/14/imposing-virtual-arbitration-hearings-in-times-of-covid-19-the-swiss-perspective/>. The Austrian Supreme Court on 23 July 2020 (18 ONc 3/20s), held that conducting arbitration hearings via videoconference over the objection of a party did not constitute a due process violation. It is seen as the first state court decision worldwide during the COVID-19 pandemic on this issue in arbitration. See Scherer and others (n 1543).

[1692] Lucy Reed, 'Ab(use) of Due Process: Sword vs Shield' (2017) 33 Arbitration International 361.

[1693] Klaus Peter Berger and J Ole Jensen, 'Due Process Paranoia and the Procedural Judgment Rule: A Safe Harbour for Procedural Management Decisions by International Arbitrators' (2016) 32 Arbitration International 415.

[1694] See Berger and Jensen (n 1693) 434–435, who make further references.

[1695] Interview #11, Sophie Nappert.

[1696] Interview #11, Sophie Nappert.

6.5.3 Document Production – The Civil Law and Common Law Divide

537 Buchwald points out that discovery is completely voluntary for parties in crypto arbitration, which deviates considerably from US style discovery.[1697] Discovery or document production is a debated topic in international arbitration.[1698] There is a large divide on this issue between civil law and common law jurisdictions.[1699] While in the civil law system, parties freely present documents to support their case without having to present any that would harm them, in common law countries both sides are required to present as many documents as possible, even such material that could potentially harm their case, and the argument is that this is essential for fair proceedings.[1700]

538 Parties may agree that an arbitral tribunal can use the International Bar Association Rules on the Taking of Evidence in International Arbitration ("IBA Rules") as guidelines,[1701] which have been drafted in order to align common and civil law systems.[1702] Critics of the IBA Rules claim that these rules are closer to the common law than the civil law system and lead to much higher costs due to document production, which is why the Prague Rules on the Efficient Conduct of Proceedings in International Arbitration ("Prague Rules") where released as an alternative.[1703]

[1697] Buchwald (n 113) 1388. Buchwald analyzes the issue of discovery in crypto arbitration thoroughly from a US perspective and thus finds many of the things which in civil law jurisdictions would be considered proper adjudication, not to be so. See Buchwald (n 113) 1395 ("The total absence of discovery compulsion mechanisms is therefore the first great flaw of on-chain arbitration"). See for more on this "culture clash" in international arbitration, Blackaby and others (n 70) para 6.92 et seq.

[1698] See, e.g., Pelin Baysal and Bilge Kağan Çevik, 'Document Production in International Arbitration: The Good or the Evil?' (*Kluwer Arbitration Blog*, 2018) <http://arbitrationblog.kluwerarbitration.com/2018/12/09/document-production-in-international-arbitration-the-good-or-the-evil/>.

[1699] See, e.g., Baysal and Çevik (n 1698).

[1700] See, e.g., Baysal and Çevik (n 1698). For example, if the case depends on documents which are in the possession of the opposing party, some may argue that document production could equal the playing field. See Pawel Halwa and Jakub Kaczmarek, 'Efficient Arbitration – Part 4: Document Production in International Arbitration' (*Kluwer Arbitration Blog*, 2018) <http://arbitrationblog.kluwerarbitration.com/2018/10/13/efficient-arbitration-part-4-document-production-international-arbitration/>.

[1701] The rules have been revised in 2020, see for the rules, comparison with the 2010 version and commentary on the latest version, 'IBA Practice Rules and Guidelines' (n 798). See also Blackaby and others (n 70) para 1.238.

[1702] See, e.g., Baysal and Çevik (n 1698). Parties often use the so-called Redfern Schedule, see for an example of this schedule Blackaby and others (n 70) para 1.238. See also Halwa and Kaczmarek (n 1700).

[1703] See 'Prague Rules' <https://praguerules.com/prague_rules/>. See Baysal and Çevik (n 1698). See Sol Argerich, 'A Comparison of the IBA and Prague Rules: Comparing Two of the Same' (*Kluwer Arbitration Blog*, 2019) <http://arbitrationblog.kluwerarbitration.com/2019/03/02/a-comparison-of-the-iba-and-prague-rules-comparing-two-of-the-same/>.

539 Thus, in general, this issue remains controversial and arbitral tribunals do not have the same power as court judges when it comes to compelling a party to produce documents; in the end, even discovery depends on the prior agreement of the parties.[1704] Aside from the fact that document production may not hinder, at least from a civil law perspective, proper adjudication of a dispute, Buchwald does highlight severe flaws of the present crypto arbitration design by stating that there is a risk of "an endless flood of useless, misleading, unorganized, or false documents. Again, the root of this problem stems from a complete lack of established procedure for synthesizing or paring back the influx of documents."[1705] A flood of documents that prevent meaningful comments would raise due process concerns since under Swiss case law there is minimum duty for the arbitral tribunal to examine and deal with the relevant issues.[1706]

6.5.4 Crypto Arbitration's Appeals Process

540 These are evident shortcomings of this newborn concept, unfit to play in the league of international arbitrations. However, the model is adopted for the ecosystem, for which it was primarily designed, which is blockchains.[1707] To respond to such deficiencies, the Kleros model offers appeal procedures, which do not exist in the same way in international arbitrations. As regards appeals, Posner explains that "[t]he right of appeal serves two social purposes. It reduces the costs of legal error and it enables uniform rules of law to be created and maintained."[1708] In Kleros, the appeal mechanism does not seem to address either of such general purposes (perhaps the former), rather the rationale is to primarily discourage system attacks because with every appeal, the number of jurors is doubled plus one, and arbitration fees have to be paid accordingly, making an attack

[1704] However, arbitral tribunals may draw "adverse inferences" from parties that do not comply with a document production request that may be material to the outcome of the case. See Blackaby and others (n 70) para 6.113. See also Articles 9(6)-(7) IBA Rules on the Taking of Evidence in International Arbitration.

[1705] Buchwald (n 113) 1416.

[1706] See DSFT of 26 April 2016, 4A_342/2015, reason 4.1.1 with further references. ("Toutefois, la jurisprudence en a également déduit un devoir minimum pour le tribunal arbitral d'examiner et de traiter les problèmes pertinents. Ce devoir est violé lorsque, par inadvertance ou malentendu, le tribunal arbitral ne prend pas en considération des allégués, arguments, preuves et offres de preuve présentés par l'une des parties et importants pour la sentence à rendre.")

[1707] Blockchains are still developing in a fast moving and changing landscape, where even the ones shaping the technology are themselves still learning about it. Further, even the underlying blockchains may change (un)expectedly, such as in the case of Ethereum, which is changing its consensus design from PoW to PoS. Blockchains operate in a legal grey area with a certain degree of uncertainty when it comes to the regulatory environment, there are limitations of a technical nature as well with unforeseen consequences on a DApp level and a wider blockchain level, since the technology is still evolving. The Kleros model itself has plans to introduce a new and updated version of its decentralized court. All of this may impact a parties' due process considerations in a crypto dispute resolution procedure.

[1708] Posner (n 673) 823.

considerably costly.[1709] Jurors do not get paid until a final decision is rendered, *i.e.*, until parties have exhausted all rounds of appeal they were willing to pay for.[1710]

541 However, what has to be borne in mind is that if it is required to appeal decisions potentially multiple times in order to safeguard procedural rights and "honest" outcomes, what may have been a cheap alternative to court procedures or traditional arbitration, may turn out to be the opposite instead. It can thus not be in the interest of access to justice that attacks, bribes of jurors, and juror alliances can only be firmly avoided by going through multiple costly rounds of appeal. Besides, one of the advantages of arbitration is that by being final, delays that may occur in litigation can be prevented, which may not hold true in the same way for crypto arbitration.[1711]

6.5.5 Can Parties Waive Their Right to Due Process?

542 Whether parties can simply waive their procedural rights needs to be considered. Judge Richard Posner once highlighted the considerable amount of freedom parties have in arbitration by stating that "[i]ndeed, short of authorizing trial by battle or ordeal or, more doubtfully, by a panel of three monkeys, parties can stipulate to whatever procedures they want to govern the arbitration of their disputes; parties are as free to specify idiosyncratic terms of arbitration as they are to specify any other terms in their contract. […] For that matter, parties to adjudication have considerable power to vary the normal procedures".[1712]

543 In some cases, parties during arbitral proceedings can be deemed to have waived their right to challenge an award, such as if they do not raise an objection during the proceedings although they could have.[1713] In some jurisdictions, parties may waive setting

[1709] See Lesaege, George and Ast (n 1138) 28. And see *supra* Chapter 5.4.5.7.
[1710] Although appealing is possible multiple times, there is a limit set to when the number of jurors has reached 511. Also, the costs increase exponentially. See Clément Lesaege in 'Likely jury stacking in case 546 & court jump impossible' (Kleros Forum, 2021) < https://forum.kleros.io/t/likely-jury-stacking-in-case-546-court-jump-impossible/532/2>.
[1711] See Cole and Ortolani (n 672) 19.
[1712] Baravati v. Josephthal, Lyon Ross, Inc., 28 F.3d 704, 709 (United States Court of Appeals, 7th Cir. 1994).
[1713] Parties can waive their right to object if they do not behave consistently or if a party has knowledge that a privison during the proceedings has not been complied with but for strategic purposes does not object during the proceedings, but rather waits until after the award has been issued in order to start setting aside procedures if the award has been issued against it. See, e.g. ICC Rules Art 40 ("A party which proceeds with the arbitration without raising its objection to a failure to comply with any provision of the Rules, or of any other rules applicable to the proceedings, any direction given by the arbitral tribunal, or any

aside procedures altogether. In Belgium, setting aside was excluded by law in 1985, if none of the parties to the arbitration had its place of business or some other link to Belgium, which had as an effect that parties in international arbitration refrained from choosing Belgium as a seat and the law was subsequently revised.[1714] This seems to indicate that parties value the right to set awards aside at the seat of arbitration in case of procedural irregularities.

544 Switzerland is among the jurisdictions that allow parties to waive challenges in advance. Article 192(1) Swiss PILA states that:[1715]

> "If none of the parties has their domicile, habitual residence, or seat in Switzerland, they may, by a declaration in the arbitration agreement or by subsequent agreement, wholly or partly exclude all appeals against arbitral awards; they may limit such proceedings to one or several of the grounds listed in Article 190 paragraph 2; the right to a review under Article 190a paragraph 1 letter b may not be waived. The agreement requires the form specified in Article 178 paragraph 1."

545 This provision has come under scrutiny. It was examined for the first time for its compatibility with Article 6(1) ECHR on 1 March 2016 in *Tabbane v. Switzerland* (application no. 41069/12).[1716] In this case, Mr Tabbane entered an agreement with the company Colgate, which contained an arbitration clause. Colgate filed a request for arbitration at the ICC and proceedings were held in Geneva. A three arbitrator tribunal issued an arbitral award in favour of Colgate. Mr Tabbane subsequently sought to have the award set aside. However, the appeal was held as inadmissable because Mr Tabbane had waived his right to set aside procedures according to Article 192(1) Swiss PILA. The

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requirement under the arbitration agreement relating to the constitution of the arbitral tribunal or the conduct of the proceedings, shall be deemed to have waived its right to object."). See also Section 73(1) of the English Arbitration Act 1996.

[1714] See Blackaby and others (n 70) para 3.83.

[1715] See also French Code of Civil Procedure Art. 1522 ("By way of a specific agreement the parties may, at any time, expressly waive their right to bring an action to set aside.").

[1716] See 'Tabbane v. Switzerland (Application No. 41069/12)' <https://hudoc.echr.coe.int/eng#%7B%22itemid%22:[%22001-161870%22]%7D>. See Sebastiano Nessi, 'Arbitration, Human Rights and Due Process: Recent Developments in Switzerland' (*Practical Law Arbitration Blog*, 2016) <http://arbitrationblog.practicallaw.com/arbitration-human-rights-and-due-process-recent-developments-in-switzerland/>. See ECHR Press Release, The impossibility of appealing against a verdict issued by the International Court of Arbitration was not in breach of the Convention (2016) <https://www.humanrights.ch/cms/upload/pdf/160324_Entscheid_Tabbane_v._Switzerland_-_challenge_to_the_resolution_of_a_dispute_by_the_International_Court_of_Arbitration.pdf>.

controversial question was whether one can validly waive recourse against a future arbitral award without violating Article 6(1) ECHR.[1717]

546 The provision in the contract between the parties stipulated that "[t]he decision of the arbitration shall be final and binding and neither party shall have any right to appeal such decision to any court of law," and the court held that it was compatible with Article 6(1) ECHR.[1718] The following circumstances of the case were important in determining whether the waiver was in compliance with Article 6(1) ECHR: (i) Mr Tabbane had expressly waived his right, (ii) both parties waived their right (it was not a unilateral waiver), (iii) the waiver was made voluntarily, and (iv) arbitration is a private dispute resolution method, in which parties can choose their arbtirators.[1719]

547 The European Court of Human Rights ("ECtHR") also recalled that the right under Article 6(1) ECHR cannot be considered absolute and is subject to accepted limitations and it stated that the right of access to a court does not necessarily imply a right to have recourse to a court of the conventional type, integrated into the ordinary judicial structures of the country,[1720] which means that parties can generally validly agree to arbitration. The ECtHR noted that Article 192(1) Swiss PILA reflects a particular legislative policy of the Swiss lawmaker and follows two aims: (i) increase the attractiveness and effectiveness of international arbitration in Switzerland by avoiding dual review of arbitral awards, and (ii) to relieve the Swiss Federal Tribunal.[1721] The court did not see any harm to an important public interest by an early waiver of recourse and therefore held that Article 192(1) Swiss PILA was in conformity with Article 6(1) ECHR.[1722]

548 Another case, which informs the present discussion is the decision 4A_342/2015 of 26 April 2016,[1723] in which the Swiss Federal Tribunal analyzed the conditions under which

[1717] See Tabbane v. Switzerland (application no. 41069/12).
[1718] Tabbane v. Switzerland (application no. 41069/12) para 5b.
[1719] See Tabbane v. Switzerland (application no. 41069/12) para 11 (citing 3.2.).
[1720] See Tabbane v. Switzerland (application no. 41069/12) para 25.
[1721] See Tabbane v. Switzerland (application no. 41069/12) para 33.
[1722] See Tabbane v. Switzerland (application no. 41069/12) paras. 11, 36.
[1723] DSFT of 26 April 2016, 4A_342/2015. See also Nessi (n 1716).

parties could validly agree on limiting their submission rounds.[1724] The parties in this case agreed to only a single round of submissions. However, the claimant applied to commence another round of submissions, which the arbitral tribunal rejected in a partial award, and the claimant subsequently filed an appeal to have the partial award set aside based on a violation of its right to be heard and equal treatment, even a violation of public policy (procedurally and substantively).[1725] The Swiss Federal Tribunal rejected the petition and held that the right to be heard does not include the right to oral arguments.[1726] Further, it held that the right to be heard does not require the arbitral award to be reasoned,[1727] and that the parties are free to agree on the arbitration procedure as they see fit, in particular by reference to arbitration rules, provided that the arbitral tribunal guarantees the parties' equality and their right to be heard.[1728] Ultimately, the Swiss Federal Tribunal held that *ex ante* waivers to the right to be heard are permissible insofar as parties are taking this decision with full knowledge of the facts.[1729]

549 The above decisions are revealing for what crypto arbitration may mean in international arbitration and in Switzerland. Parties can generally voluntarily agree to waive challenges to the award. However, even if parties exclude challenge procedures, they may resist enforcement of an arbitrable award at the place of enforcement.[1730] Thus one could argue that parties have not waived their due process rights altogether because of the dual review nature of arbitral awards, whereby even if parties waive the setting aside procedure at the seat, review at the place of enforcement would still be possible.[1731] If parties have agreed to only written procedures without a hearing, that is generally permissible since the right

[1724] See Philippe Bärtsch, 'Enforcing Parties' Agreement to One Round of Written Submissions Does Not Violate Right to Be Heard (Swiss Supreme Court)' (*Practical Law*, 2016) <http://uk.practicallaw.com/3-630-3438>. See Nessi (n 1716).
[1725] See DSFT of 26 April 2016, 4A_342/2015. See also Nessi (n 1716). See Bärtsch (n 1724).
[1726] See DSFT of 26 April 2016, 4A_342/2015 reason 4.1.1.
[1727] See DSFT of 26 April 2016, 4A_342/2015 reason 4.1.1.
[1728] See DSFT of 26 April 2016, 4A_342/2015 reason 4.1.2. Article 182(1) Swiss PILA: "The parties may determine the arbitral procedure, either themselves or by reference to arbitration rules; they may also make the procedure subject to a procedural law of their choice."
[1729] See DSFT of 26 April 2016, 4A_342/2015 reason 4.1.2.
[1730] See Blackaby and others (n 70) para 10.05.
[1731] Note that according to Article 192(2) Swiss PILA even if recourse against the award was waived, court review will still be possible if enforcement of the award is sought in Switzerland, in which case the New York Convention applies by analogy.

to be heard does not include a right to express oneself orally.[1732] In fact, hearings are not a given, which can be seen in most arbitral institutional rules for expedited arbitrations.[1733]

550 Parties have great freedom in designing their arbitration and can limit submission rounds and other aspects of the procedure by agreement. Crypto arbitration represents a special process, whereby parties submit to a smart contract to automatically choose arbitrators who will then render a decision. Parties to crypto arbitration are free to submit evidence and arbitrators cannot limit their right in this regard. Indeed, parties can even appeal decisions as often as they are willing to pay for it. However, what raises concern is that anyone can appeal and the case is not completely in the parties' hands. Based on the parties' freedom of contract, one could argue that they can choose any such procedures as they want, subject to them doing so in full knowledge of the circumstances. However, can party autonomy extend to the point where parties can depart from traditional arbitration and validly adopt experimental methods such as crypto arbitration, which may not conform to conventional notions of due process?[1734]

551 From a constitutional perspective, the question arises whether there is a non-waivable minimum standard of procedural fairness that must be preserved. The right to be heard in arbitration, guaranteed by Article 182(3) and Article 190(2)(d) of the Swiss PILA, is considered to be the same as the one enshrined in Article 29 of the Swiss Federal Constitution.[1735] A crucial aspect of arbitration already discussed in Chapter 6.2., is that parties waive their right to access state courts. Such an act requires certain safeguards, which is why the Swiss legislator adopted a writing requirement for arbitration agreements.[1736] Article 182(1) Swiss PILA gives parties ample freedom in choosing their arbitral procedure, but the mandatory Article 182(3) Swiss PILA states that "[r]egardless of the procedure chosen, the arbitral tribunal shall guarantee equal treatment of the parties

[1732] See DSFT of 26 April 2016, 4A_342/2015 reason 4.1.1.

[1733] See, e.g., Article 33(1) SCC Rules for Expedited Arbitrations ("A hearing shall be held only at the request of a party and if the Arbitrator considers the reasons for the request to be compelling."); see Article 3(5) of the ICC Expedited Procedure Rules. In Interview #8, Employee at Arbitral Institution ("You can perfectly waive your right to a hearing, sole arbitrators are very much allowed to make decisions based only on the documents because for the parties it's a bargain, and you don't have the hearing, you have the documentary evidence still but you give away that hearing and therefore you lower costs and the decision is quicker, because you value that, getting to a result more quickly rather than doing the whole hearing … it's a bargain, it depends what the parties are able to agree and what's the method, they feel comfortable with.").

[1734] For the principles of due process in arbitration, see *supra* Chapter 6.5.1.

[1735] See DSFT of 26 April 2016, 4A_342/2015, reason 4.1.1. ("Le droit d'être entendu, tel qu'il est garanti par les art. 182 al. 3 et 190 al. 2 let. d LDIP, n'a en principe pas un contenu différent de celui consacré en droit constitutionnel".)

[1736] See *supra* Chapter 6.2.1.

and their right to be heard in adversarial proceedings." If the same procedural fairness standard applies to both arbitration and state court procedures, why is there a need to protect parties with an added writing requirement? The most readily available answer is that decisions by arbitrators are final and binding.[1737] Although crypto arbitration adopts an appeals process, the end of such process, would also constitute a final and binding award.

552 One commentator states that the decision of the Swiss Federal Tribunal of 26 April 2016, essentially shows that parties can effectively agree on limiting their right to be heard as long as the principle of equal treatment is respected and both disputing parties can present their position to the same extent and within the same timeframe.[1738] Similarly, it could be argued that the parties in crypto arbitration have mutually limited their right to be heard but since both consented and are treated equally under the inflexible design, this is permissble.

553 Crypto arbitration can be considered an extreme form of expedited or fast-track arbitration. Expedited arbitration also faces criticism that it may not sufficiently guarantee due process.[1739] However, national state courts have enforced awards which were the result of expedited arbitration procedures.[1740] In contrast to expedited arbitration, the crypto arbitration model is based on an experimental incentive design structure (game theory, focal points) and the pseudonymity of arbitrators. Just like expedited arbitration, crypto arbitration must strike the right balance between speed, efficiency, and due process.

554 The question arises whether parties who wish to submit their dispute to crypto arbitration are simultaneously waiving their fundamental procedural rights. And if they are, whether parties can legally do so under party autonomy. These questions touch upon constitutional law, waiver of fundamental rights, procedural law, and freedom of contract. It can be argued that parties do not waive their fundamental procedural rights in crypto arbitration

[1737] See Blackaby and others (n 70) para 10.01 et seq. See also Kurkela and Turunen (n 1657) 1.
[1738] Simon Gabriel, 'Minimalgarantie versus Verfahrensvereinbarung' (*dRSK*, 2016) para 25 <https://www.gabriel-arbitration.ch/de/publikationen-und-vortraege/minimalgarantie-versus-verfahrensvereinbarung>. See DSFT of 26 April 2016, 4A_342/2015.
[1739] See Domitille Baizeau, 'Award under Expedited Arbitration Rules Examined by the Swiss Supreme Court' (*Kluwer Arbitration Blog*, 2009) <http://arbitrationblog.kluwerarbitration.com/2009/04/06/award-under-expedited-arbitration-rules-examined-by-the-swiss-supreme-court/>.
[1740] The Swiss Federal Tribunal ruled for the first time on an expedited procedure in DSFT of 28 October 2008, 4A_294/2008, and rejected the challenge to the arbitral award. See Baizeau (n 1739).

completely since it is possible for them to submit documents and written testimony to defend their positions, and that each is given the same treatment. In contrast, if one considers crypto arbitration to be a waiver of procedural rights, one would have to examine whether party autonomy reaches so far.

555 In general, party autonomy can only go as far as fundamental rights become effective, a minimum standard of the rule of law and procedural fairness principles must be preserved.[1741] Article 182(3) Swiss PILA is a mandatory provision.[1742] Nevertheless, the right to be heard can be waived *ex ante* in certain aspects, provided the parties are aware of the implications.[1743] One commentator lists as an example the waiver of hearings and the conduct of arbitral proceedings based solely on written documents.[1744] That parties can expressly or tacitly waive certain procedural rights was affirmed by the Swiss Federal Tribunal.[1745] It was also affirmed that parties can waive their right to an impartial and unbiased judge.[1746] However, a prerequisite to such waiver is that a party does so voluntarily and to no detriment of public or third-party interests.[1747]

6.5.6 Can Justice be Decentralized?

556 Courts and arbitral tribunals are expensive. If parties cannot afford to pay court fees, arbitration fees and lawyer fees, obtaining justice becomes difficult. National legal orders may aid parties who have little or no income as they can request court fee waivers and states provide legal assistance in court proceedings. However, justice cannot be obtained entirely for free. Access to justice is a major concern. Alm, for example, states that "there is a long trail of disputes that never even get to the point of being looked at by a lawyer".[1748] And even if disputes get to a court, Paulsson observes that "[m]ost human beings living on this planet today do not have the remotest chance of obtaining decent

[1741] See Michel Schenk, *Schiedsfreiheit Und Staatliche Schutzpflichten: Schiedsgerichtsbarkeit Als Ausübung Grundrechtlicher Privatautonomie - Unter Berücksichtigung Einer Schiedsgerichtsbarkeit Mit Staatlicher Beteiligung* (Springer 2020) 134–135. Even if one assumes that party autonomy can go as far as lowering the standard of the right to be heard, any resulting crypto award would face several obstacles if a party seeks to enforce it under the New York Convention, which will be discussed *infra* Chapter 6.6.

[1742] See Jolanta Kren Kostkiewicz, 'Art. 182 VI. Verfahren 1. Grundsatz', *OFK Kommentar - IPRG/LugÜ Kommentar* (2019) para 9.

[1743] See Kren Kostkiewicz (n 1742) para 10.

[1744] See Kren Kostkiewicz (n 1742) para 10.

[1745] See DSFT of 26 May 1993, 119 Ia 221, reason 5a. See also David Rüetschi, 'Vorbemerkungen Zu Art. 47–51', Zivilprozessordnung, *BK - Berner Kommentar* (2012) para 9.

[1746] See Rüetschi (n 1745) para 9. See DSFT of 28 April 2000, 126 III 249, reason 4c.

[1747] See Rüetschi (n 1745) para 9.

[1748] Interview #16, Lise Alm.

justice from their courts. […] These observations about the state of public justice are neither gratuitous nor anecdotal. Vast resources have been expended studying matters of governance throughout the world, first and foremost legal systems. [The reports] are generally disheartening."[1749] He also states that "[o]ne cannot fail to reflect that the thirst for decent methods for solving disputes will in these circumstances generate alternatives".[1750]

557 Blockchain arbitration projects see themselves as such alternatives. Aouidef, Ast and Deffains describe justice systems as "marketplaces which coordinate the supply and demand of resolution services",[1751] where "[p]arties [form] the demand side [while] [j]urors are the supply side".[1752] They argue that in traditional legal systems and in arbitration, the supply of adjudication is limited because lawyers tend to dominate legal services, which results in a high equilibrium price.[1753] In order for the price to decrease, the supply side needs to increase. Network effects aid in achieving cheaper dispute resolution.[1754] That is the promise of the emerging crypto arbitration platforms, which want to empower individuals to employ their abilities and skills to act as jurors for cases often neglected by legal systems and for which the entry barriers are traditionally much higher.[1755]

558 Kleros thus advocates for a new notion, referred to as "decentralized justice", with the following features: (i) decentralization on a peer-to-peer basis enabled through blockchains and compliance with the rule of law, (ii) use of cryptoeconomics, and (iii) output of fair decisions.[1756] Whether "decentralized justice" really encompasses all these points is debatable, and point (iii) is critical and needs to be considered carefully. Decentralized justice systems are said to be inexpensive and much faster than

[1749] Paulsson, 'Arbitration in Three Dimensions' (n 635) 19.
[1750] Paulsson, 'Arbitration in Three Dimensions' (n 635) 19.
[1751] Aouidef, Ast and Deffains (n 86) 6.
[1752] Aouidef, Ast and Deffains (n 86) 6.
[1753] See Aouidef, Ast and Deffains (n 86) 6.
[1754] See Aouidef, Ast and Deffains (n 86) 6.
[1755] See Aouidef, Ast and Deffains (n 86) 6. See also Interview #1, Federico Ast ("You have traditional courts which are good for dealing with domestic disputes, sometimes like smaller claims and you also have an ecosystem of ADR solutions for domestic disputes and you have international arbitration for cross-border disputes but it doesn't make sense to go to arbitration for small claims so there was a market you know, a blind spot where you did not have a solution system that would address small claims at an international level which is basically what is going to be the future.").
[1756] See Nappert and Ast (n 1154).

conventional alternative dispute resolution and therefore especially apt for the digital and crypto economy.[1757]

559 However, the term "decentralized justice" seems to want to combine two ideals that are neither met off- nor on-chain. It can hardly be Kleros's aim to decentralize justice *per se*, rather to offer decentralized alternatives to achieve justice. The term "decentralized justice" may just be a form of terminological vagueness used for the purposes of arousing certain reactions. From its conceptualization, it is hard to imagine what decentralized justice means. That is because justice is an ideal and ideals have little to gain by being decentralized, as ideals span every spectrum from centralization to decentralization, and may even lie above any such notions, contrary to tangible artifacts or organizations, which assemble people.[1758]

560 What can be decentralized are rather the mechanisms by which justice may be attained or the platforms through which justice is sought. Moreover, justice should not differ by how it is obtained, *i.e.,* whether by decentralized or by centralized means, rather justice as a result, should remain pristine from any mechanisms which underly it, even if in reality, the practiced justice may never live up to its perceived image. The real question is whether crypto arbitration can in fact close the justice gap or at least minimize it, and this remains to be seen. It will largely depend on whether it can prove itself to be a faster, cheaper, and a more efficient alternative to existing alternative dispute resolution in a future digital economy.

6.6 A Self-Enforcing Award?

561 The fruits of arbitration are the resulting awards, it can be considered arbitration's *raison d'être*.[1759] The ease of enforceability that the New York Convention introduced is one of the main reasons for the success of international arbitration in the last decades.[1760]

[1757] See Nappert and Ast (n 1154).

[1758] Much has been written about justice and justice as an idea or ideal. See, e.g., John Oberdiek, 'The Ideal of Justice' (2014) 5 Jurisprudence 363 <https://doi.org/10.5235/20403313.5.2.363>.

[1759] See Eric A Schwartz and Yves Derains, *A Guide to the ICC Rules of Arbitration 2nd Edition* (Kluwer Law International 2005) 385.

[1760] See School of International Arbitration – Queen Mary University London, '2018 International Arbitration Survey: The Evolution of International Arbitration' (*Queen Mary University of London, School of International Arbitration*, 2018) 7 <http://www.arbitration.qmul.ac.uk/media/arbitration/docs/2018-International-Arbitration-Survey---The-Evolution-of-International-Arbitration-(2).PDF> ("What are the three most valuable characteristics of international arbitration?", 64% answered the "[e]nforceability of

Empirical evidence shows that the enforceability of arbitral awards is the main consideration for parties in choosing arbitration for the resolution of their dispute.[1761] After comparing different ODR mechanisms, Ortolani highlights an important flaw that haunts most ODR systems, which is the lack of efficient enforceability.[1762] Without enforceability, dispute resolution loses its force.[1763] ODR's value is diminished if court proceedings must be commenced in case the losing party does not voluntarily comply with the resulting ODR decision.[1764] In e-commerce platforms compliance with ODR decisions is incentivized by way of trust marks,[1765] or other means, such as ratings.[1766] Negative ratings affect a seller's reputation, leading to a considerable decrease in sales, the incentives for complying with ODR decisions is thus high.[1767] Mechanisms for self-enforcement are, *e.g.,* "chargebacks", where payment is reimbursed to the buyer.[1768] The mechanisms for enforcement can be distinguished between direct (chargebacks, escrow) and indirect systems (ratings, trustmarks).[1769]

562 One of the notable innovations would be the self-enforceability of awards rendered in crypto arbitration, meaning that resorting to state courts would become unnecessary. A losing party would not be given the choice to not comply, compliance would become automatic. However, this cannot be generalized as it depends on how specifically the arbitrable contract was coded and on how any decision rendered by the arbitrator contract subsequently takes effect.[1770] Although crypto awards, if pre-coded to that effect, can be

awards", putting this specific characteristic in first place, followed by 60% selecting "[a]voiding specific legal systems/national courts", 40% chose "[f]lexibility".).

[1761] See School of International Arbitration – Queen Mary University London, '2018 International Arbitration Survey: The Evolution of International Arbitration' (n 1760) 7. See also Horst Eidenmüller, 'Competition between State Courts and Private Tribunals' (Oxford Legal Studies Research Paper No. 3/2020) 13-14 <https://ssrn.com/abstract=3534025>. (Survey results from 2015 based on 357 completed answers: "approximately 50% of the respondents […] considered the enforceability of awards to be a very important factor when deciding whether to arbitrate a case instead of litigating.").

[1762] Ortolani, 'Self-Enforcing Online Dispute Resolution: Lessons from Bitcoin' (n 104) 602. ("However, one common flaw can be identified in all of the above attempts: after the end of the ODR procedure, the systems do not provide for any device of self-enforcement.").

[1763] See, e.g., Ortolani, 'Self-Enforcing Online Dispute Resolution: Lessons from Bitcoin' (n 104) 595.

[1764] See Ortolani, 'Self-Enforcing Online Dispute Resolution: Lessons from Bitcoin' (n 104) 602.

[1765] See Ortolani, 'Self-Enforcing Online Dispute Resolution: Lessons from Bitcoin' (n 104) 605. (Ortolani describes trustmarks as "labels of quality, which certify a specific quality of a merchant").

[1766] See Ortolani, 'Self-Enforcing Online Dispute Resolution: Lessons from Bitcoin' (n 104) 605.

[1767] See Ortolani, 'Self-Enforcing Online Dispute Resolution: Lessons from Bitcoin' (n 104) 605.

[1768] See Ortolani, 'Self-Enforcing Online Dispute Resolution: Lessons from Bitcoin' (n 104) 606.

[1769] See Ortolani, 'Self-Enforcing Online Dispute Resolution: Lessons from Bitcoin' (n 104) 617. With further reference to the UNCITRAL Working Group III on Online Dispute Resolution's document on Online dispute resolution for cross-border electronic commerce transactions: overview of private enforcement mechanisms 'A/CN.9/WG.III/WP.124' <https://documents-dds-ny.un.org/doc/UNDOC/LTD/V13/863/44/PDF/V1386344.pdf?OpenElement>.

[1770] It also depends on whether the asset over which a dispute is being conducted is held on-chain or off-chain.

self-enforcing, that does not always necessarily have to be the case. If a crypto award is not self-enforcing, parties may want to enforce the award by seeking assistance from national courts under the New York Convention. The party against whom the award is made, may resist enforcement under Article V of the New York Convention, for example, by alleging the invalidity of the arbitration agreement, due process violations, or alleging that the composition of the arbitral tribunal was not in accordance with some *lex arbitri* the party invokes.

563 An obstacle the party seeking enforcement could face is to provide a "duly authenticated original award or a duly certified copy thereof" according to Article IV(1)(a) of the New York Convention as well as the original arbitration agreement or a certified copy thereof according to Article IV(1)(b) New York Convention. Does the translation from smart contract code into an official language of the state in which enforcement is sought satisfy these requirements? Article IV(2) of the New York Convention provides that the translation into such official language "shall be certified by an official or sworn translator or by a diplomatic or consular agent". Naturally, what is meant here is the translation of official state languages, such as the translation from German into English, and not the translation of software code into natural language text.

564 If there is no comment section in their smart contract or parties have not separately concluded a human-readable arbitration agreement that can satisfy the formal validity requirement, a state court may refuse enforcement from the outset because a state court judge will hardly analyze smart contract code. However, even in such a setting one could think about an analogous case where parties have concluded a contract in writing in a language that is so seldomly used that no translators can be found. If there is no translation and the court cannot read the documents, it follows that no decision can be made in either direction. This analogous thought experiment would be different than having a contract as smart contract code, since although it may not fall under what is considered translation from natural language into some other natural written language, it would come close in the sense that smart contract developers could as "translators" and explain the specific features of what each line of code entails. This leads back to the previous discussion in chapter 6.2.1. on formal validity.

565 Thus, for any crypto arbitral award to have a chance of being enforceable in state courts, the parties must have had international commercial arbitration in mind when they decided to engage in crypto arbitration. Alternatively, they will need to cooperate after the conclusion of the crypto arbitration, such as to agree to the natural language version of the smart arbitration agreement, with which the winning party can subsequently try to seek enforcement. However, that disputing parties would collaborate in this regard is rather unlikely. In addition, the identity of the parties must be revealed.

566 Suppose that stage is passed, and the party can present both a valid arbitration agreement and the arbitral award.[1771] In that case, the hurdle is whether the crypto arbitration method was in accordance with fair proceedings and that each party was able to present its case according to Article V(1)(b) of the New York Convention. Although awards resulting from expedited arbitrations get enforced, crypto arbitration challenges traditional perceptions. Thus, although there are good arguments to be made that crypto arbitration is an expedited arbitration with at least a minimum standard of due process, a generalization is not possible, and it will depend on the specific case brought before state courts. Especially in cases where the party opposing enforcement, among many other objections, can show that it was never notified of the arbitration, never participated in the procedure or if it did participate, in its submission to the crypto arbitrators, made the objection that it never even consented to arbitration,[1772] or that there was a flood of documents, which made it impossible to decide on the case, or that one of the parties was an arbitrator to the dispute, or one arbitrator was chosen multiple times in the same dispute, then state courts may refuse to recognize such a procedure as procedurally fair and thus refuse enforcement based on violation of its public policy according to Article V(2)(b) of the New York Convention.[1773]

[1771] Fulfilling the requirements as discussed *supra* Chapter 6.2. The parties then must also have revealed their real-world identity, see *supra* Chapter 6.3.

[1772] One could ask whether a party's conduct during the procedure does not heal any shortcomings in formal validity of the arbitration agreement later on. If the party against whom an arbitral award is to be enforced, participated in crypto arbitration, i.e., paid the arbitration fees, and submitted documents to the arbitrators defending its position, without ever objecting to the arbitration, this could be seen as consent to arbitrate. See, e.g., the Brazilian case of 17 May 2006, in which the Superior Tribunal de Justiça noted the participation of a party in the arbitral proceedings would demonstrate consent to the arbitration agreement, if no objections were raised as to its validity. See 'Superior Tribunal de Justiça (Brazil) of 17 May 2006 / Oleaginosa Moreno Hermanos Sociedad Anónima Comercial Industrial Financeira Imobiliaria y Agropecuaria (Argentina) v Moinho Paulista Ltd (Brazil) / SEC 866' <https://newyorkconvention1958.org/index.php?lvl=notice_display&id=13&opac_view=6>.

[1773] Article V(2)(b) of the New York Convention states: "[…] The recognition or enforcement of the award would be contrary to the public policy of that country."

567 In the end, whether a crypto award will be enforced in the "real world" depends on national courts. Even if the outcome of crypto arbitration did qualify as an arbitral award according to the New York Convention, it is uncertain whether national courts would give it any effect, *i.e.,* recognize and enforce it due to the issues outlined above, and even if a court in one jurisdiction does enforce a crypto award, another national court in another jurisdiction may not.[1774] Should a crypto award not be self-enforceable, and the winning party wants to seek enforcement under the New York Convention, it will have the obstacles discussed in Chapter 6 to overcome.

6.7 Comparison Tables

568 Stone Sweet and Grisel describe the differences between international commercial arbitration and investor-state arbitration "as a matter of degree, not kind".[1775] When it comes to characterizing crypto arbitration as opposed to international commercial arbitration, the differences could perhaps not be more profound. The question arises, whether the differences are such that the procedure constitutes a different kind of dispute resolution altogether. The following tables compare modern international arbitration to crypto arbitration on the basis of thirty-two points in five overarching themes: (i) base concept, (ii) parties, (iii) third party authority and decision, (iv) trusted intermediaries, and (v) legitimacy and perception. Starting from the same basis, party autonomy, two opposing systems are built, trying to attain the same goal: the resolution of a dispute by an enforceable arbitral award.

[1774] Setting aside procedures and enforcement procedures are complex in international arbitrations, a definitive or universal answer cannot be given. See e.g., Albert Jan van den Berg, 'Should the Setting aside of the Arbitral Award Be Abolished?' (2014) 29 ICSID Review 263 et seq.

[1775] Alec Stone Sweet and Florian Grisel, *The Evolution of International Arbitration* (Oxford University Press 2017) 6.

	Topic	Modern Arbitration	Crypto Arbitration
	Base Concept		
1	**Foundation**	Party Autonomy	Party Autonomy
2	**Manifestation**	Arbitration Agreement, Arbitration Clause, Submission agreement	Smart Arbitration Agreement, Arbitrable Contract
3	**Theory**	Territorial, Transnational, Autonomous, and others	Crypto Autonomous
4	**Infrastructure**	Institutional or ad-hoc	Decentralized, DApp, DAO
5	**Principle**	Confidentiality	Transparency
6	**Fairness**	Due Process, Rule of Law, ensured by setting aside procedure and resisting enforcement	Game Theory, Incentive Design, "Decentralized Justice", ensured by appeals process
7	**Design**	Flexible	Inflexible, flexible to a pre-defined degree
8	**Location**	Seat	Cyberspace, alternatively "digital" seat (arbitrator contract)
9	**Legal Framework**	International Convention Arbitration Rules National Laws *Lex arbitri*	Blockchain Infrastructure Guidelines Smart Contract Code Code Law *Lex cryptographica arbitri*
10	**Procedure (online)**	Web2, Video conferencing, Electronic filing, email	Web3, DApp interaction, DAO infrastructure
11	**Hearings**	Mostly yes	Mostly no

Table 5. Comparison Table: Base Concept, Elements 1-11[1776]

569 Both modern and crypto arbitration have the same basis but lead to completely different designs. This can be attributed to the different infrastructures and mediums, in which these dispute resolution mechanisms operate. While one is blockchain-native and

[1776] Own table.

operates in cyberspace, the other is an off-chain world construct. The manifestation of the parties' will to arbitrate is the arbitration agreement in modern arbitration (either as an arbitration clause or a submission agreement), whereas in crypto arbitration the arbitration agreement needs to be coded, such that an arbitrable contract refers to an arbitrator contract. The theoretical concept will be discussed in the next chapter. Modern arbitration knows *ad hoc* procedures and institutional procedures. In crypto arbitration, one could make the comparison to an arbitrator contract[1777] in the form of a DAO being equivalent to an arbitral institution, where arbitrators from a list are randomly selected via an algorithm.

570 The underlying principle of international arbitration is confidentiality. This can be seen as one of the major advantages that commercial parties are drawn to in such private procedural settings. This way, negative press and media coverage can be kept to a minimum, for example. In crypto arbitration the opposite is true for the moment. Transparency is the key ingredient in an open, permissionless blockchain, where anyone can participate and hold the other accountable. The fundamental principles of due process and equal treatment of parties is ensured by the possibility to start setting aside procedures and/or resist enforcement of the arbitral award. The same is true in the game-theoretic model of crypto arbitration, where an appeals process tries to ensure attack resistance, impartiality of the arbitrators and fairness in the outcome. The procedure in modern arbitration is very flexible and can be changed on the spot by arbitrators in consultation with the parties. In crypto arbitration the flexibility is not the same. In fact, the procedure, once commenced is inflexible and needs to follow the pre-coded protocol. In theory, parties also do not have direct communication access to arbitrators and *vice versa*.

571 An interesting question concerns the seat.[1778] In crypto arbitration, one may plausibly argue that the seat is in cyberspace and by referring to a particular arbitrator contract, the parties have designated the inherent "*lex cryptographica arbitri*" to be the laws and rules that govern their proceedings.[1779] This is part of a quasi-legal framework in crypto arbitration, which further encompasses the blockchain infrastructure, guidelines of the

[1777] See the distinction in crypto arbitration between arbitrable and arbitrator contract *supra* Chapter 5.4.5.3.
[1778] Note that although most arbitrations have a seat, delocalized arbitrations are regarded as a possibility. See *infra* Chapter 7.2.4.
[1779] Different concepts converge in crypto arbitration when the "arbitrator contract" incorporates aspects of the seat, the *lex arbitri*, the arbitration rules, the appointing authority, and the arbitral institution.

specific arbitrator contract, the smart contract code, and the code law principle. Modern arbitration's *lex arbitri* can be anywhere the parties choose, whereupon the laws of the nation state chosen as the seat become prevalent for the procedure.

572 Today, arbitration proceedings can be conducted online. In fact, this has been the norm ever since the COVID-19 pandemic started. Documents are filed electronically, and hearings are conducted via video conferencing. In crypto arbitration, a web3 interface allows parties to interact with a smart contract directly. In fact, both parties and arbitrators must have a crypto wallet to connect to the web3 interface. While in modern arbitration hearings are the norm, in crypto arbitration hearings are not envisioned, at least not for now if disputes are low in value.

	Topic	**Modern Arbitration**	**Crypto Arbitration**
		Parties and Cases	
12	**Parties**	Mostly international medium to large corporations	Mostly international crypto businesses and individuals from the crypto community
13	**Party Identity**	Known	Pseudonymous or Known
14	**Party Industry**	Very diverse, from telecommunications to oil and gas	Predominantly parties within the crypto industry
15	**Barriers to Entry for Parties, Levels of sophistication**	Medium to high	Medium
16	**Cases**	Simple to highly complex	Simple (Complexity in works)

Table 6. Comparison Table: Parties and Cases, Elements 12-16[1780]

573 One would expect the parties of these two systems to be very different. Indeed, while modern arbitration is used by medium-sized companies and large enterprises, involved

[1780] Own table.

in international trade, from a wide variety of industries, the parties in crypto arbitration stem directly from the crypto industry and are deeply involved in blockchains and tend to be pro-decentralization. Parties can be developers who have built or are building decentralized applications or who have created a token they want listed on a decentralized exchange.

574 The identities of the parties in modern arbitration are known because at the level of international commercial transactions, parties may be reluctant to enter contracts with pseudonymous counterparties. In crypto arbitration, knowing the counterparty is not necessarily required. The costs in traditional arbitration are high, parties need to be able to afford counsel to represent them and pay the arbitral tribunal, the arbitral institution, and other intermediaries. In crypto arbitration the barriers to entry may be lower but still require some technical understanding. While cases resolved in international arbitration can range from simple to complex, for now, cases in crypto arbitration are binary and tend to be simple. However, research and development are underway to be able to handle more complex cases.

	Topic	Modern Arbitration	Crypto Arbitration
Third Party Authority and Decision			
17	**Deciding Body**	Sole arbitrator, Often a three-member tribunal	Sole arbitrator, panel, crowd
18	**Party-appointed Arbitrator**	Yes (except if other arrangements are made)	No, parties select the smart contract which randomly assigns jurors
19	**Identity of Arbitrators**	Known	Pseudonymous In some instances, can be known
20	**Expertise of Arbitrators**	Yes	Yes (otherwise gets penalized)
21	**Deliberation**	Yes	No (but may happen in jury social media groups)

22	**Decision**	Award	("Smart") Award (can be self-enforceable)
23	**Decision Effect**	Direct (if voluntarily complied with) or Delayed Effect	Direct (but could be delayed) - Effect according to arbitrable contract code or design choice

Table 7. Comparison Table: Third Party Authority and Decision, Elements 17-23[1781]

575 The decision-makers are at the heart of both systems. Choosing an arbitrator in international arbitration is an important part of the process and may mean winning or losing a case. Arbitrators in crypto arbitration are pseudonymous and cannot be selected by the parties. In fact, parties have delegated their right to choose an arbitrator to the so-called "arbitrator contract", which will randomly assign arbitrators for them.[1782]

576 Expertise is ensured by the incentive design. If arbitrators place themselves in pools, for which they do not have the required expertise, they may get penalized by losing their stake. Arbitral tribunals with more than one arbitrator need to deliberate to come to a decision. For sole arbitrators, the question of deliberations does not arise. In crypto arbitration, deliberations are not part of the design, but may happen regardless, such as if arbitrators can identify each other by way of the Ethereum address selected or by other means.

577 There are also social media discussion groups, where arbitrators can meet. This may impact the design and incentive structure of the present system, which relies on the lack of communication between decision-makers. While arbitral awards are mostly voluntarily complied with in international arbitration, if they are not, the effect will be delayed, and the winning party will have to seek enforcement in the places where the losing party has assets. In crypto arbitration, the effects depend on how the arbitrable contract has been coded and the type of decision rendered. For example, if arbitrators decide that one party should get a refund, the arbitral award may result in the direct enforcement of this decision, without any outside influence and without having to rely on the losing party's voluntary compliance.

[1781] Own table.
[1782] This reminds of the concept of an appointing authority.

	Topic	Modern Arbitration	Crypto Arbitration
	Trusted Intermediaries		
24	**Intermediaries**	Counsel, arbitral institution, arbitrators, national courts	Arbitrators/ "Jurors" (as oracle), blockchain, coders, code auditors
25	**Courts**	Court assistance (before, during, after the proceedings)	No court involvement, generally
26	**Appeal – re substance**	No, r*évision au fond* prohibition	Yes (safety measure)
	Appeal – re procedure	Yes, *e.g.*, annulment of the award	Yes, but procedure is inherent in the design
27	**Barriers to Entry for Service Providers**	High to very high (law firms, arbitrators, arbitral institutions), legal expertise usually required	Medium (understanding of blockchains, early adopter advantage), no legal expertise required

Table 8. Comparison Table: Trusted Intermediaries, Elements 24-27[1783]

578 Intermediaries play a role in both modern and crypto arbitration, even if the intermediaries could not be more different from one another. Lawyers rule in the world of modern arbitration, in advising clients, maneuvering the procedure, deciding cases as arbitrators, and managing cases in arbitral institutions. One interview participant who works at an arbitral institution shared that they sometimes wonder when seeing "the costs the parties have to pay for the decision makers and for counsel, and all the filings, and all the paperwork whether all this was worth the effort" and that one could argue that "it is a modest amount compared to what is at stake, but it is still a lot of money, [they] have seen several millions of dollars in counsel fees. And that makes it of course a dispute system that not everyone can have access to."[1784]

[1783] Own table.

[1784] Interview #8, Employee at Arbitral Institution. They also shared that for low amounts in dispute (up to, for example, 25,000 USD), in many cases it is not worth it to go to institutional arbitration because of the fees and one has to engage counsel and more.

579 The barrier entries to crypto arbitration are lower but still require technical affinity. In international commercial contracts, legal expertise is required not only when a dispute arises – however, in such cases the need is more urgently felt – but long before, such as when parties are negotiating their contract terms. While modern arbitration could not exist without legal professionals, and it is hard to imagine the system to work without legal expertise, crypto arbitration seems to be entirely disconnected from the legal realm, where not even the decision makers need to apply any law, and parties do not seek any legal assistance but rather rely on coders and code auditors in their transactions. Some see the possibility that blockchains could make arbitration accessible to small-sized companies.[1785]

580 Further, court involvement is not foreseen, whereas national courts play an important role in international commercial arbitration. Parties that choose arbitration have decided against litigation, they derogate from the default norm. Parties in crypto transactions, opting into crypto arbitration may not have a default to choose from, in particular if they are pseudonymous. Crypto arbitration may be one of the only viable means for parties to find resolution to their dispute in a blockchain setting. That is why it is argued that crypto arbitration should be considered at the blockchain base layer, so that parties have a means of recourse as a default and may then choose among different providers, in the way parties in international arbitration select a seat of arbitration. Arbitral awards in international arbitration are final and binding and there is no *révision au fond*,[1786] whereas the procedure may be challenged in setting aside procedures and/or in challenges to the enforcement of an award. In crypto arbitration, appeals are possible on any grounds.

		Legitimacy and Perception	
28	**Cost**	Expensive	Relatively inexpensive (but highly volatile, paid with cryptocurrency)
29	**Time**	Relatively speedy (in comparison to litigation)	Fast

[1785] Interview #8, Employee at Arbitral Institution.
[1786] The prohibition of *révision au fond* means that state courts are precluded from reviewing on the substance of international arbitral awards.

30	**Legitimacy** **Reasons**	Proven concept, long history, *status quo*, supported by states, active, widespread acceptance	Proof of concept, active R&D, active community, ongoing adoption, network effects
31	**Legitimacy** **Basis** **& Enforcement**	Worldwide: New York Convention State-enforced	Worldwide public and Permissionless blockchains, *e.g.*, Ethereum the DAO/ DApp infrastructure
32	**Established**	1958	2016

Table 9. Comparison Table: Legitimacy and Perception, Elements 28-32[1787]

581 While arbitration was for a long time considered a best alternative to litigation, for which parties to international commercial contracts were willing to pay the high prices, arbitration's perceived move toward more formalized procedures ("judicialization") has seen a new trend develop, where international commercial courts start to compete more and more with international arbitration, trying to attract parties that would usually have chosen arbitration.[1788]

582 International commercial arbitration is a proven concept with a long history, attracting worldwide talent, excellent legal expertise, and is supported in its entirety by the traditional legal frameworks of 168 states. In terms of reputation and appeal, crypto arbitration cannot currently compete in the same kind of market. However, blockchains are new, barely a decade old, so is crypto arbitration. The idea of a decentralized court was voiced less than a decade ago, in 2016, and a proof of concept has only started to emerge in 2019. If one briefly recalls what was stated in Chapter 2 about innovation and Bacon's assertion that "[a]s the births of living creatures at first are ill-shapen, so are all

[1787] Own table.

[1788] See Fortese and Hemmi (n 1656) 111. See also Georgia Antonopoulou, 'The Arbitralization of Courts (2 July 2021)', *ERC "EU Civil Justice" - Seminar Series* (2021). Antonopoulou during her seminar talk referred to the 'Singapore International Commercial Court' <https://www.sicc.gov.sg/about-the-sicc/establishment-of-the-sicc> (On the website of the SICC it states: "While parties may be able to pursue their claims in international arbitration, they may prefer to resolve their disputes in the SICC to take advantage of a well-designed court-based mechanism which will enable parties to avoid one or more of the following problems often encountered in international arbitration: 1. over-formalisation of, delay in, and rising costs of arbitration; 2. concerns about the legitimacy of and ethical issues in arbitration; 3. the lack of consistency of decisions and absence of developed jurisprudence; 4. the absence of appeals; and 5. the inability to join third parties to the arbitration.").

innovations, which are the births of time. […].”[1789] Crypto arbitration is no match for the kind of market in which international commercial arbitration operates, whether it can ever be, only time will tell.

6.8 Conclusion

583 After dissecting crypto arbitration, it needs to be determined whether one can call this procedure an arbitration at all. After explaining the procedure to an interview participant who works at an arbitral institution and asking them whether they would consider crypto arbitration as a type of arbitration, they answered that they would because “even though you do not get to choose the decision-makers, you get to choose the method”.[1790] And if parties are free to choose their method and they know the risks associated with choosing a specific method, then this can be considered an arbitration.[1791] Indeed, the comparison tables contrasting both types or methods of arbitration have the same foundational element, which is the principle of party autonomy. Crypto arbitration is a novel form of expedited arbitration enabled through blockchain technology.

584 In a humorous article, Brower, Pulos, and Rosenberg highlight the inventiveness that exists in international arbitration, and mention that although it is a century old institution, it does not fail to follow trends and remain current.[1792] They suggest that “[a]ttempts to alter the basic elements of a successful vehicle, in this case international arbitration, are doomed, and if universally adopted would spell the ruin of the vehicle; whereas genuine improvements, inventiveness that builds on the essential features of the vehicle, may – also may not – but *may* be beneficial to it.”[1793] They identify the following elements as the main and successful ingredients of arbitration: (i) party autonomy, “including the right freely to select, individually and collectively, the members of the tribunal”, (ii) free from intricacies of foreign judicial systems, and (iii) an enforceable award.[1794]

[1789] Bacon (n 172). See also Interview #16, Lise Alm (“I mean when you talk about blockchain it’s so easy to get caught up in bitcoin and cryptocurrencies and base the analysis of the technology on that. Which is a bit like saying, this is an ugly webpage, I don’t think the internet is going to take on.”).
[1790] Interview #8, Employee at Arbitral Institution.
[1791] Interview #8, Employee at Arbitral Institution.
[1792] Charles N Brower, Michael Pulos and Charles B Rosenberg, ‘So Is There Anything Really Wrong with International Arbitration As We Know It?’ in Arthur W Rovine (ed), *Contemporary Issues in International Arbitration and Mediation: The Fordham Papers (2012)* (Brill Nijhoff 2013) 3 et seq.
[1793] Brower, Pulos and Rosenberg (n 1792) 7.
[1794] Brower, Pulos and Rosenberg (n 1792) 7–8.

585 Analyzing these essential elements in the crypto arbitration context, one concludes that in fact, all these elements are met. Parties that choose crypto arbitration, delegate the power to choose an arbitrator to a smart contract, which automatically and randomly chooses an arbitrator, thus satisfying (i) the party autonomy requirement. There is considerably less to the point of there being no involvement of any judicial system, thus satisfying criterium (ii) as well, and (iii), the decision is enforceable within the confines of the system, which presumably the parties intended. Interestingly, crypto arbitration, although its difference to international commercial arbitration may be considered one in kind and not barely degree, still satisfies Brower, Pulos, and Rosenberg's essential requirements. Brower, Pulos, and Rosenberg further remarked that "any proposal that would alter any of the fundamental elements of international arbitration constitutes an unacceptable assault on the very institution of international arbitration".[1795] However, if one were to consider a new system like crypto arbitration, despite its perceived shortcomings, as an assault on international arbitration, this would further strengthen its position as a disruptive innovation.

Chapter 6: Summary

Crypto arbitration takes international arbitration and turns it upside down. Instead of party-appointed expert arbitrators, arbitrators self-select into expert pools and are then randomly drawn to matching cases as if in a lottery. The parties can be pseudonymous, and the arbitrators usually are. However, there are still some loopholes in the system. Crypto arbitration faces numerous challenges in making it compatible with the framework of international commercial arbitration, from the arbitration agreement to the arbitral award. The idea of employing Schelling Points to incentivize arbitrators to decide coherently is radical and has shown to be quite effective, although it needs some more readjustments as the development continues. Crypto arbitration can be regarded as a blockchain-enabled type of expedited arbitration, which also faces challenges with respect to due process. An important concept in international arbitration is the parties' freedom to adjust the arbitral procedure to their specific needs. The question is whether such a dispute resolution mechanism can provide a fair process and take regard to fundamental procedural principles, the parties' right to be heard, and equal treatment. In general, fundamental procedural rights are

[1795] Brower, Pulos and Rosenberg (n 1792) 8.

mandatory. However, parties can waive certain aspects, if they do so voluntarily, deliberately, and without prejudice to the interests of third parties or the public. If these conditions are met, it is assumed that parties can validly agree to crypto arbitration respecting their freedom of contract and party autonomy as this institution represents only one among many other alternatives and can be considered voluntary arbitration. The situation may be different if crypto arbitration is adopted at the base layer of blockchains as a default. Since parties on blockchains do not have viable recourse to state courts if they opt for pseudonymity, such a default would represent an improvement to their position and should thus be further explored. Crypto arbitration is designed for the blockchain ecosystem and seems to work fine for the cases it resolves.

7 Chapter 7: A Crypto Autonomous Legal Order

7.1 Introduction

586 What might Francis A. Mann, the foremost proponent of localized arbitration, who in an article published nearly 40 years ago, stated that "[i]t is difficult to imagine a more dangerous, more undesirable and more ill-founded view which denies any measure of predictability and certainty and confers upon parties to an international commercial contract or their arbitrators powers that no system of law permits and no court could exercise"[1796] – think today about crypto arbitration? Perhaps he would not be amused, but then again, he did not have the same kind of dream as Julian Lew did.[1797]

587 The prototypes trying to create arbitration services on blockchains are not fully developed, they are still in a proof-of-concept stage, the technology itself and the blockchain ecosystem is in its infancy, taking its first steps. So where does arbitration fit in? From the outset it seems premature to even ask the question. Arbitration and dispute resolution seem even to negate the ethos of blockchains. By exploring these two worlds, one is presented with an inherent contradiction, and that is precisely where the topic becomes interesting. This is especially true, if when looking more closely, common underlying principles can be observed, although perceived differences exist at first glance.

588 In his book on *Legal Theory of International Arbitration*, Gaillard states that the "fundamentally philosophical notions of autonomy and freedom are at the heart of this field of study".[1798] The same could be said about blockchain technology and its first inception: Bitcoin. Ortolani rejects the use of arbitration in this context as he observes that "Bitcoin adjudication cannot be encompassed within any of the traditional narratives of international arbitration and must, therefore, be seen as an entirely new and autonomous paradigm of dispute resolution."[1799] It would make sense that something entirely new cannot fit established narratives. In fact, de Filippi and Wright observe that

[1796] See Francis A Mann, 'England Rejects "Delocalised" Contracts and Arbitration' [1984] 33 International and Comparative Law Quarterly 197.
[1797] See Lew, 'Achieving the Dream: Autonomous Arbitration' (n 617). See *infra* Chapter 7.2.5.
[1798] Gaillard (n 153) 2. See also Paulsson, 'Arbitration in Three Dimensions' (n 635) 22.
[1799] Ortolani, 'Self-Enforcing Online Dispute Resolution: Lessons from Bitcoin' (n 104) 611.

blockchain systems may even replace state judicial enforcement and give rise to "decentralized judiciaries [that are able to] expand dispute resolution procedures, narrowing the role of centralized judicial bodies".[1800]

589 Arbitration is a creature of great adaptability, able to change according to the parties' wishes. For example, there are no restrictions on the parties to use technology in their arbitral procedures.[1801] Because of arbitration's consensual nature and the wide autonomy given to parties in designing their own arbitration processes, arbitration seems well adaptable and suitable enough to merge with any technology in place, be it blockchain, artificial intelligence, or any other. In the previous chapter, crypto arbitration was identified as a type of fast-track arbitration. But what *is* arbitration really? Why is it necessary to ask this question now after the analysis was already done and a basic definition of arbitration was already given in Chapter 4.3? That definition was a practical one, it served as a means to later identify crypto arbitration as potentially fitting the framework of international commercial arbitration, subject to the parties paying close attention to the various validity requirements for arbitration agreements and arbitral awards. However, parties that transact on blockchains may in the future not even need to align crypto arbitration with the international legal framework in place. That is, if the technical blockchain infrastructure itself becomes a self-sufficient legal order. Because cryptography is used to achieve this type of autonomy, it is termed here as a crypto autonomous legal order.

590 Thus, in this chapter the dive is deeper, the quest concerns the very nature of arbitration. This chapter sketches the theoretical thoughts relating to this institution over time, traces new developments, and finally contributes with a novel perspective, challenging contemporary wisdom. It serves to demonstrate how arbitration fits into the notion of a legal order and why blockchains with the help of a functioning dispute resolution mechanism can become autonomous from state legal orders.

591 The exercise this chapter undertakes is one of analytical jurisprudence, which is "an effort to understand *the nature of a social institution and its products*".[1802] Legal theory provides

[1800] Wright and De Filippi (n 481) 50–51.
[1801] Winston Maxwell and Gauthier Vannieuwenhuyse, 'Robots Replacing Arbitrators: Smart Contract Arbitration' [2018] 1 ICC Dispute Resolution Bulletin 24.
[1802] Shapiro (n 151) 7.

a "tool for the observation and critical assessment of the technical solutions adopted" and "aims to bring to light the postulates that underpin the institutions it studies".[1803] As opposed to normative jurisprudence, which primarily treats moral questions in law, analytical jurisprudence "deals with questions of epistemology, that is the study of knowledge" and asks questions such as what law or a legal order is.[1804] If one is a pragmatist, one may validly ask the question, why undertake such an exercise? Or as Judge Richard Posner rather harshly expressed that "[he has] nothing against philosophical speculation. But one would like it to have some pay-off; […] the central task of analytic jurisprudence is, or at least ought to be, not to answer the question 'What is law?' but to show that it should not be asked, because it only confuses matters."[1805]

592 It may be true that the answer to such a fundamental question may lead to confusion. However, this should not prevent someone from asking the question. It is precisely because questions are asked that discoveries can be made, to reject asking a question because it may have a philosophical component or because its practical relevance is not obvious from the start, - and if one were to follow that stance persistently – would lead to a halt in human innovation. And maybe it is no coincidence that one of the greatest minds of the 20th century said this about curiosity: "The important thing is not to stop questioning. Curiosity has its own reason for existing. One cannot help but be in awe when one contemplates the mysteries of eternity, of life, of the marvellous structure of reality. It is enough if one tries to comprehend only a little of this mystery every day."[1806]

593 Natural science has the advantage of being observable and examinable with mathematical precision as lying outside human social complexity. Moreover, "natural laws" are oftentimes constant, universal, and provable. Naturally, non-natural law and other inherently social institutions need interpretation and methods differ considerably. However, a trend towards computational and mathematical legal analysis can be

[1803] Gaillard (n 153) 151.
[1804] Schultz (n 95) 8–9.
[1805] Richard A Posner, *Law and Legal Theory in England and America* (Oxford University Press 1997) 3. See Shapiro reading this quote in Càtedra de Cultura Jurídica, 'Scott Shapiro: What Is Law (and Why Should We Care)?' (*Youtube*, 2017) <https://www.youtube.com/watch?v=RWj9_F7AOj4>.
[1806] Charlotte Edmond, '10 of Albert Einstein's Best Quotes' (*World Economic Forum*, 2019) <https://www.weforum.org/agenda/2019/08/albert-einstein-quotes-inspiring-clever-funny-famous/>.

observed, especially in the United States.[1807] This trend seems to be fueled by the desire to extend the methodological toolbox for legal scientists to enable a more tangible and verifiable analysis. Generation after generation society incessantly builds on discoveries made from past societies, from the questions asked and the answers delivered. Any progress is done by "sitting on the shoulders of giants".[1808] While in Chapter 4 this thesis captured arbitration and then looked for it in the blockchain sphere, in this chapter it attempts to uncover it.

7.2 In Search for Arbitration's Essence

594 Schultz states that calling something law matters and that it is not "an innocent pastime for legal scholars, philosophers, and sociologists"[1809] but that it has serious consequences, such as "on the power relations of the various actors involved in a given social field".[1810] The same holds true for calling something arbitration. And the search for what the term represents has had some heated moments of ebb and flow in the international commercial arbitration literature. Starting with the *lex mercatoria* debates in the late 1950s and 1960s, to the delocalization debates in the 1970s and 1980s, to the autonomy debates ever since the 2000s,[1811] the debates to-date are not settled and are not of purely theoretical nature either, but have practical relevance, for example, depending on the view national states adopt, its courts may come to entirely different interpretations of the same provision in the New York Convention.[1812]

595 Nowadays, technology has taken a prominent place in these debates. In a more recent publication entitled "What is an arbitration?", Eidenmüller and Varesis distill the

[1807] See, e.g., Jens Frankenreiter and Michael A Livermore, 'Computational Methods in Legal Analysis' (2020) 16 Annual Review of Law and Social Science 39. See also Julian Nyarko and Sarath Sanga, 'A Statistical Test for Legal Interpretation: Theory and Applications' (2021) <https://juliannyarko.com/wp-content/uploads/other/nyarko_sanga_legal_interpretation.pdf>.

[1808] 'John of Salisbury Quote, Metalogicon Of John Salisbury' (*Goodreads*) <https://www.goodreads.com/quotes/7831472-we-are-like-dwarfs-sitting-on-the-shoulders-of-giants>.

[1809] Schultz (n 95) 4.

[1810] Schultz (n 95) 4, 13.

[1811] See Marc Robert Fauvrelle, 'Beyond the Dream: Theorising Autonomy in International Arbitration', *Scandinavian Studies in Law Volume 63: Arbitration* (2017) 46 et seq. See also Julian DM Lew, 'Is There a "Global Free-Standing Body of Substantive Arbitration Law"?' in Albert Jan Van den Berg (ed), *International Arbitration: The Coming of a New Age?, ICCA Congress Series, Volume 17* (Kluwer Law International 2013) 53.

[1812] Such as when courts enforce an award annulled at the seat of arbitration, which would be contrary to a territorial approach. See Gaillard (n 153) 67 et seq.

"anatomy of an arbitration" in order "to assess whether a 'fully AI-powered arbitration' is feasible".[1813] Although they ask these fundamental questions, they do not discuss arbitration's legal theories. Moreover, they deliberately do not address blockchain technology as they consider it "much less relevant to [their] inquiry than AI applications"[1814] because blockchain aims "to efficiently execute (human) decisions",[1815] whereas AI applications "seek to assist humans in decision-making or even replace humans as decision-makers altogether".[1816] In contrast, this dissertation has placed particular focus on blockchain technology because it enables decision-making in ways and forms not feasible before by offering novel arbitration procedures. Blockchains are also a new medium that enables digital value transfer and as such can have impact on different layers of society.

596 Can it be held that there is - as Eidenmüller und Varesis claim - "no such thing as the essence of an arbitration in *abstracto* or existing in a legal vacuum"?[1817] What if there in fact is arbitration existing in a legal vacuum? Or rather, not a legal vacuum *per se* but a legal reality different from a state legal system? What then is the essence of arbitration and arbitration law?

7.2.1 Ubi Societas, Ibi Ius[1818]

597 The phrase "where there is a society, there is law" is often portrayed as neither providing context nor answering the question of what law is satisfactorily.[1819] When asking about the nature of arbitration, it is helpful to understand how the inquiry into the nature of law is exercised. When one asks "what is law?", one soon arrives at the question whether law is necessarily linked to the human being, *i.e.*, whether humans simply by virtue of being humans find themselves in the sphere of the law.[1820] This is a valid question, seeing that

[1813] Eidenmüller and Varesis (n 671) 18 et seq.
[1814] Eidenmüller and Varesis (n 671) 6.
[1815] Eidenmüller and Varesis (n 671) 6.
[1816] Eidenmüller and Varesis (n 671) 6. See also Finck (n 30) 183.
[1817] Eidenmüller and Varesis (n 671) 18.
[1818] Where there is a society, there is law, often attributed to Hugo Grotius (1583-1645), but see here for a refutation: David Heith-Stade, 'Ubi societas, ibi ius' (David Heith-Stade's Blog, 2012) <https://davidheithstade.wordpress.com/2012/06/02/ubi-societas-ibi-ius/>.
[1819] See Gerhard Luf, *Grundfragen der Rechtsphilosophie und der Rechtsethik - Einführung in die Rechtswissenschaften und ihre Methoden Teil III* (Manz 2006) 9. See also Ortolani, 'The Three Challenges of Stateless Justice' (n 104) 599 (Therein, see Footnote 12. Pietro Ortolani argues that " the maxim *ubi societas, ibi ius* does not seem to provide the legal observer with any insight as to what law is". He thus rather prefers to start his analysis by asserting that "not every social structure constitutes a legal order").
[1820] Luf (n 1819) 8.

animals have not developed a similar sophisticated legal reality as opposed to human beings, although animal communication enables complex social interactions.[1821] The mystery seems to be directly interwoven with the human language and the ability to transfer and record information into the future. Through the invention of writing, complex architectures and linguistic constructions could be formed, resulting in a web of connected individual realities, where software code has extended the realm of possibilities further. The phrase "*ubi societas, ibi ius*" thus gives more context than its critics are prepared to admit, and answers at least where law is more naturally found.

598 Inquiring into the nature of law concerns ultimately its identity.[1822] Scott Shapiro in his book *Legality*, takes the example of the study of epistemology, whose standard response is that "knowledge is true and justified belief".[1823] The study into the nature of arbitration then asks what makes arbitration what it is and not something else; this Shapiro calls the "Identity Question".[1824] And once one understands the nature of something, one is interested in learning what consequences follow.[1825] An example of implications in the arbitration context may be the enforcement of annulled awards, which fits well into the narrative of an autonomous legal order. However, what if arbitration turns out not be an autonomous legal order, how is it possible then that an award, which does not exist, can still be enforced?

599 Luf in his book on *Basic Questions of Legal Philosophy and Legal Ethics*,[1826] explains that the "conflict between different human interests is the reason for the necessity of the law".[1827] He thus states that conflict is at the center of the development of law.[1828] First, Luf introduces Aristotle's concept of "*zoón politikón*", where human beings naturally

[1821] See, e.g., Dr. Stephanie King's work on acoustic communication and social cognition in bottlenose dolphins, Martina Advaney, 'Meet Dr. Stephanie King An Illustrious Figure In The Study Of Dolphins' (*YouthTime Magazine*, 2020) <https://youth-time.eu/meet-dr-stephanie-king-an-illustrious-figure-in-the-study-of-dolphins/>.
[1822] Shapiro (n 151) 8.
[1823] Shapiro (n 151) 8.
[1824] Shapiro (n 151) 8. If one strips something of its necessary properties, it stops being what it is or was and turns into something else. In a sense, one wants to understand exactly what the properties are that make arbitration arbitration and failing which, arbitration is no more.
[1825] Shapiro (n 151) 31. See also 'Scott Shapiro: What Is Law (and Why Should We Care)?' (n 1805).
[1826] Own translation of title, Luf (n 1819). Students of Vienna's Juridicum will be familiar with the threefold introduction into the legal science, one pertaining particularly to legal philosophy.
[1827] Luf (n 1819) 9. (Own translation. Original German version: "Der Konflikt unterschiedlicher menschlicher Interessen sei somit der Grund für die Notwendigkeit des Rechts.").
[1828] See Luf (n 1819) 9.

strive for society or some sort of community.[1829] Then he moves on to explain Thomas Hobbes' "*bellum omnium contra omnes*", the war of all against all, where Hobbes – in contrast to Aristotle - creates the necessity of law and the state from the conflict between human beings, and the inherent risk of harm from others.[1830] Then the treatise introduces Kant, who considers law as an enabler of human freedom, whereafter Luf continues to introduce more philosophers and concepts.[1831]

600 Ideas about the nature of law were first expressed in Ancient Greece, and began to take shape in Rome, where Cicero "articulated the first, and some would say definitive, conception of what is called 'natural law'",[1832] to then diversify in the early modern period with command theories of law, from which the common-law theories departed, by focusing on courts rather than statue.[1833] Leiter and Sevel explain that "[t]he judge is the 'living oracle' of the law but only as its mouthpiece and not as its source".[1834] Legal positivism started to gain ground as the prevailing legal theory ever since the 1600s, whose main idea is "that law is essentially a matter of social fact and that it bears at most a contingent connection with moral norms".[1835] The 20th century is finally marked by legal positivism, where "the basis of all law lies in the sovereign state",[1836] with the influential legal theorists Hans Kelsen, H.L.A. Hart, and Joseph Raz, whose critics were Ronald Dworkin and Thomist John Finnis.[1837] According to Leiter and Sevel, Scandinavian and American realism later became influential with Alf Ross and Karl Llewellyn, and that Ross concluded that norms in the form of "obligations, duties, rights, or justice […] do not really exist".[1838]

601 Delving into the idea of law itself, its fundament, it seems that arbitration is more than meets the eye. It is a means for the resolution of conflicts in the private sphere, and if conflicts are that which necessitates the law - what is arbitration's relationship to the law then? To any arbitration practitioner or to parties to a dispute, the importance of this

[1829] See Luf (n 1819) 9.
[1830] See Luf (n 1819) 12.
[1831] See Luf (n 1819) 14 et seq.
[1832] Brian Leiter and Michael Sevel, 'Philosophy of Law' (*Britannica*) <https://www.britannica.com/topic/philosophy-of-law>.
[1833] See Leiter and Sevel (n 1832).
[1834] Leiter and Sevel (n 1832).
[1835] Leiter and Sevel (n 1832).
[1836] Ralf Michaels, 'Dreaming Law Without a State: Scholarship on Autonomous International Arbitration as Utopian Literature' [2013] 1 London Review of International Law 35, 55.
[1837] See Leiter and Sevel (n 1832).
[1838] Leiter and Sevel (n 1832).

institution and that of the judiciary architecture of states in general, is obvious. The nature of human beings leads them to enter conflicts, which necessitates the law and which in turn necessitates conflict resolution. Is law only law if there is dispute resolution to attend to its breaches?

602 There are heated scholarly debates regarding the nature of law, questions still largely unresolved spin around notions as to whether law must necessarily be linked to the state or whether it can be stateless and thus set free from the constraints of national legislation. Some sort of legal system is present wherever there are humans, just like the water humans need to survive, humans living in a society need law, which is just one component in this complex social architecture of life.

603 The Internet, cyberspace, and blockchain have heightened this discussion's complexity. By venturing into how international arbitration has been theorized, this thesis seeks to embed this new kind of arbitration observed on blockchains into a theoretical discussion.

7.2.2 Lex Mercatoria

604 Although Emmanuel Gaillard in his treatise on the *Legal Theory of International Arbitration*, explains that "[t]he question of the existence of an arbitral legal order does not amount to reviving the debate over *lex mercatoria* [because this *lex* is] mainly focused on the law applicable to the merits of a dispute or to the arbitral procedure",[1839] the roots of the intellectual confrontation with arbitration's nature are still to be found there, in the 1950s to 1970s.[1840] Moreover, *lex mercatoria* is not as - often portrayed - only concerned with substantive law. Klaus Peter Berger asserts that in the late thirteenth century, the notion of the ancient *lex mercatoria* was formulated by an anonymous author in what is

[1839] Gaillard (n 153) 37.

[1840] And possibly and very likely even before, see Geo Gordon Battle, 'The Two Fundamental Concepts of Arbitration and Their Relation to Rules of Law' (1930) 16 Virginia Law Review 255. See also Lew, 'Is There a "Global Free-Standing Body of Substantive Arbitration Law"?' (n 1811) 53. ("The concept of a separate substantive body of legal rules or law to be applied in international arbitration was widely discussed in the 1950s-1970s by the early pioneers and practitioners of this subject, described by the AG as "the 'grand old men' of yesteryear".''). One could say that these are the roots of the modern debates, there are much older treaties and the literature on *lex mercatoria* is vast. Further, a differentiation is often made between the so-called "old" and the rediscovered "new" *lex mercatoria*, see Klaus Peter Berger, 'The Lex Mercatoria (Old and New) and the TransLex-Principles' <https://www.trans-lex.org/the-lex-mercatoria-and-the-translex-principles_ID8>.

called the "Little Red Book of Bristol".[1841] In particular, Peter Berger states that "the treatise on the Lex Mercatoria in the Little Red Book was not concerned with the search for substantive principles and rules for mercantile transactions. Instead, it focused exclusively on ways to evade inconvenient common law rules in mercantile disputes. Its main focus was on the question as to how one could improve and expedite the procedure in specialized mercantile courts with merchants as judges, including the enforcement of judgements in order to reach a fair and equitable resolution of disputes between merchants."[1842] Contrary to Gaillard's earlier assertion, a brief revival seems thus appropriate. *Lex mercatoria* or "law merchant", a body of rules specific to merchants, was the basis for any theoretical thought relating to modern arbitration.[1843]

605 It is often told that in medieval times, *lex mercatoria* came about naturally as a body of customs from the transactions between European merchants traveling to trade fairs and other places, seeking to create trust by viable means of resolving any potentially arising disputes.[1844] Some works on this subject also ventured into notions of a "*lex meractoria* legal order".[1845] The debate can be traced back to the early 1960s with influential writings by Goldman and Schmitthoff, the two "founding fathers" of the debate.[1846] Both authors "proposed definitions of the customary law that relates to transnational commercial contracts",[1847] and revived the concept of the medieval law merchant.[1848] According to de

[1841] See Berger (n 1840). See Francis B Bickley (ed), 'The Little Red Book of Bristol' <https://archive.org/details/littleredbookbr02enggoog/page/n8/mode/2up>.

[1842] Berger (n 1840). Footnote omitted.

[1843] See Gaillard (n 153) 3, 37 (Gaillard gives *lex mercatoria* credit in "stimulating the thinking concerning the very notion of a legal order.").

[1844] See de Ruysscher (n 161) 469, with futher references. See also Wright and De Filippi (n 481) 44 et seq. See Primavera de Filippi, 'From Lex Mercatoria to Lex Criptographia' in Kleros, *Dispute Revolution - The Kleros Handbook of Decentralized Justice* (2020) 23. See Joel R Reidenberg, 'Lex Informatica: The Formulation of Information Policy Rules through Technology' (1997) 76 Texas Law Review 553. See Fabrizio Marrella and Christopher S Yoo, 'Is Open Source Software the New Lex Mercatoria?' (2007) 47 Virginia Journal of International Law 807, 811.

[1845] See Gaillard (n 153) 37 with further references to Filali Osman, *Les Principes Généraux de La Lex Mercatoria: Contribution À l'étude d'un Ordre* Juridique *Anational* (Libre générale de droit et de jurisprudence 1992) op. cit footnote 10; Eric Loquin, 'L'application de Règles Anationales Dans l'arbitrage Commercial International in L'apport de La Jurisprudence Arbitrale' [1986] ICC Publication No. 440/1, 67, 119 et seq.

[1846] See J Mustill, 'The New Lex Mercatoria: The First Twenty-Five Years' (1988) 4 Arbitration International 86 et seq. Mustill makes reference to both Goldman and Schmitthoff as having been influential when the debate emerged. See Orsolya Toth, *The Lex* Mercatoria *in Theory and Practice* (Oxford University Press 2017) 31. These texts are the ones often referred to as the starting points of the debate: Berthold Goldman, 'Frontières Du Droit et "Lex Mercatoria"' [1964] Archives de Philosophie du Droit 177 et seq; Clive M Schmitthoff, 'Das Neue Recht Des Welthandels' (1964) 1 The Rabel Journal of Comparative and International Private Law 47 et seq.

[1847] de Ruysscher (n 161) 465–466. Footnote omitted.

[1848] Toth (n 1846) 31. In Footnote 2, Toth identifies and names other influential contributors, such as Aleksandar Goldstajn or Philippe Kahn.

Ruysscher, both Goldman and Schmitthoff viewed contemporary cross-border commercial custom as a renewed form of the medieval *lex mercatoria*.[1849] After World War II international trade expanded together with transnational commerce, which led to adaptions that would fit the needs of business parties.[1850] Schmitthoff called it the emergence of a "new *lex mercatoria*".[1851]

606 There are two opposing views regarding the *lex mercatoria* debate.[1852] Proponents submit that "a body of law is emerging beyond the boundaries of nation-states which may govern cross-border commercial transactions without geographical restrictions",[1853] while opponents refuse to accept the idea of laws set free from the state.[1854] Toth compares this heated legal academic debate to the debate amongst cosmologists on "dark matter" as *lex mercatoria* seems just as mysterious.[1855] Trakman highlights that medieval *lex mercatoria* and international commercial arbitration have much in common and that "[l]ike dispute resolution under the medieval Law Merchant, international commercial arbitration, by its nature, is designed in part to reflect the customs, usages, and practices of the parties".[1856]

607 In arbitration, the *lex mercatoria* debate mainly focused on the law applicable to the merits of a dispute or to the arbitral procedure and it resulted in "modern laws on arbitration […] freeing arbitrators from the constraints of the choice of law rules of the seat [of arbitration, allowing for] 'rules of law' rather than 'a law'".[1857] In relation to arbitration, Gaillard notes that the "reflection on *lex mercatoria* overlooked the fundamental question regarding the source of the arbitrators' power to adjudicate".[1858] He also states that party autonomy alone does not suffice in answering this question.[1859]

[1849] de Ruysscher (n 161) 468.
[1850] Toth (n 1846) 31.
[1851] Schmitthoff (n 1846) 47. („Der internationale, mehr noch: der universale Charakter des Welthandelsrechts tritt mehr und mehr in den Vordergrund und berechtigt uns, von dem Entstehen einer neuen lex mercatoria zu sprechen." Own translation: "The international, and even more so: the universal character of world trade law comes more and more to the foreground and allows us to speak of the emergence of a new lex mercatoria."). Schmitthoff also explains that *lex mercatoria* had three phases of development.
[1852] See Toth (n 1846) 1.
[1853] Toth (n 1846) 1.
[1854] Toth (n 1846) 1.
[1855] Toth (n 1846) 3.
[1856] Leon E. Trakman, 'From the Medieval Law Merchant to E-Merchant Law' (2003) 53 The University of Toronto Law Journal 266.
[1857] Gaillard (n 153) 38.
[1858] Gaillard (n 153) 38.
[1859] See Gaillard (n 153) 38.

608 The definition, legal origins as well as the entire story of *lex mercatoria* to-date still remain unsettled.[1860] Herber argues that the term *lex mercatoria* "drifts through the international commercial law discussion like a ghost ship – dissolving into nothingness if you want to look at it closely".[1861] Thus increasing scholarship considers the whole concept of *lex mercatoria* to be a myth,[1862] highlighting that trade usages, if any, were localized, states exercised considerable influence over commercial parties and could impose their own laws on commercial activity and that parties preferred their own local courts instead of private merchant arbitrators.[1863]

609 Still, this theory has played a pivotal role not only in the institutional economics scholarship on private ordering but has also influenced codified commercial codes, which reference to trade usages and arbitral procedure when such usages are invoked.[1864] Not only is the theory itself highly contested, there is no widespread agreement on the views even if one accepts the *lex mercatoria* to be true.[1865] This serves to show that the ensuing autonomy debate has its origins in what seems unstable grounds.

7.2.3 The Principle of Party Autonomy

610 In private law, party autonomy is the right of individuals to shape their legal relationships according to their own wishes, free from state intervention.[1866] In international commercial arbitration, party autonomy refers to the freedom of parties to conclude an arbitration agreement, to choose the applicable law, and to design their arbitral procedure

[1860] See e.g., Nikitas E Hatzimihail, 'The Many Lives-and Faces-of Lex Mercatoria: History as Genealogy in International Business Law' (2008) 71 Law and Contemporary Problems 171. Disputed is also whether lex mercatoria was substantive rather than procedural; see Robert D Cooter, 'Decentralized Law for a Complex Economy: The Structural Approach to Adjudicating the New Law Merchant' (1996) 144 The University of Pennsylvania Law Review 1643, 1647–1648.

[1861] Own translation of Rolf Herber, '„Lex Mercatoria" und „Principles" – Gefährliche Irrlichter Im Internationalen Kaufrecht' [2003] Internationales Handelsrecht (IHR) -Zeitschrift für das Recht des internationalen Warenkaufs und -vertriebs 1, 5. (German original: "Wie ein Geisterschiff treibt dieser Begriff durch die internationale handelsrechtliche Diskussion – sich in Nichts auflösend, wenn man ihn genau betrachten will.").

[1862] See Michaels (n 1836) 49, who makes reference to Emily Kadens, 'The Myth of the Customary Law Merchant' (2012) 90 Texas Law Review 1153. See also Lisa Bernstein, 'The Medieval Law Merchant' – Learn IOE (*Youtube, 2019*) <https://www.youtube.com/watch?v=GDev5WOzezs>.

[1863] See Bernstein (n 1862).

[1864] See Bernstein (n 1862). See also Lisa Bernstein, 'The Modern Law Merchant' – Learn IOE (*Youtube*, 2019) <https://www.youtube.com/watch?v=EXN3EFgYa0M>.

[1865] See Bernstein (n 1862).

[1866] See Helmut Koziol and Rudolf Welser, *Bürgerliches Recht Band I: Kletečka* (Manz 2006) 94. See also Louisa Specht, *Diktat der Technik - Regulierungskonzepte technischer Vertragsinhaltsgestaltung am Beispiel von Bürgerlichem Recht und Urheberrecht* (Nomos Verlagsgesellschaft 2019) 23.

as they wish.[1867] This widely accepted doctrine can be seen as "the result of separate, contemporaneous and pragmatic evolutions within the various national systems of conflict of laws"[1868] which "has come about independently in every country and without any concerted effort by the nations of the world".[1869] Party autonomy is apparently a sort of natural force, sprung from the minds of many different societies in a sort of evolutionary manner, at differing times.

611 The principle of party autonomy can be found in national laws, arbitration rules, the New York Convention (Article V(1)(d)) and the Model Law (Article 19(1)).[1870] In terms of arbitration rules, the ICC, for example, refers to party autonomy both in its Article 21(1) on applicable rules of law as well as in its Article 19 on the rules governing the proceedings.[1871]

612 Some national courts even hold the view that "arbitration is a creature that owes its existence to the will of the parties alone."[1872] The parties can even "choose cyberspace and establish their own rules."[1873] However, the exercise of this autonomy is limited by certain requirements, such as due process, public policy, and mandatory provisions in arbitration rules.[1874]

[1867] See Blackaby and others (n 70) paras 3.97, 6.07.

[1868] Blackaby and others (n 70) para 3.97, with reference to Julian Lew, *Applicable Law in International Commercial Arbitration: A Study in Commercial Arbitration Awards* (Oceana Publications 1978) 75.

[1869] Blackaby and others (n 70) para 3.97, with further reference to Lew, *Applicable Law in International Commercial Arbitration: A Study in Commercial Arbitration Awards* (n 1868) 75.

[1870] See Blackaby and others (n 70) para 6.07, see also footnote 7. The principle of party autonomy is recognized as one of the most important ones upon which the Model Law is based, see: UN Doc., 'UNCITRAL Report of the Secretary-General: Possible Features of a Model Law on International Commercial Arbitration (A/CN.9/207)' para 17. ("Probably the most important principle on which the model law should be based is the freedom of the parties in order to facilitate the proper functioning of international commercial arbitration according to their expectations. This would allow them to freely submit their disputes to arbitration and to tailor the 'rules of the game' to their specific needs. It would also enable them to take full advantage of rules and policies geared to modern international arbitration practice as, for example, embodied in the UNCITRAL Arbitration Rules.").

[1871] See Blackaby and others (n 70) para 6.07. Article 21 of the 2021 ICC Arbitration Rules: "The parties shall be free to agree upon the rules of law to be applied by the arbitral tribunal to the merits of the dispute. In the absence of any such agreement, the arbitral tribunal shall apply the rules of law which it determines to be appropriate." Article 19 of the 2021 ICC Arbitration Rules: "The proceedings before the arbitral tribunal shall be governed by the Rules and, where the Rules are silent, by any rules which the parties or, failing them, the arbitral tribunal may settle on, whether or not reference is thereby made to the rules of procedure of a national law to be applied to the arbitration."

[1872] Canadian Supreme Court, 'Dell Computer Corporation v. Union Des Consommateurs and Olivier Dumoulin' (2007) para 51.

[1873] Canadian Supreme Court, 'Dell Computer Corporation v. Union Des Consommateurs and Olivier Dumoulin' (n 1872) para 52.

[1874] See Blackaby and others (n 70) para 6.09 et seq.

613 When it comes to understanding the institution of international arbitration, party autonomy thus plays a pivotal role. Gaillard sees the inquiry into "the rule that founds the principle of party autonomy" as the central question when discussing the possibility of an arbitral legal order.[1875] However, how important is party autonomy really? And is it fair to say that party autonomy should constitute the foundation of arbitration? Parties to commercial contracts in a B2B relationship have either in-house legal departments or external lawyers and law firms drafting and negotiating their agreements, thus parties will more likely than not employ legal professionals to advise on the terms of any contract. The arbitration clause is oftentimes "the last paragraph of the last page of a contract", basically an "afterthought",[1876] its perceived importance at the contracting stage may be close to null.[1877] Of course, this notion drastically changes when a dispute occurs, the clause then suddenly rises in prominence, and becomes the all-important element. Taking this fact into account, the general discussion on party autonomy may benefit from a slightly modified conceptualization, seeing that many contracts go through intermediaries, especially in commercial transactions. The entry into arbitration is not seamless, it requires legal professionals, and one better choose wisely to prevent uncomfortable situations, such as pathological arbitration clauses.

614 Party autonomy could thus be seen as mediated or rather delegated, from the stage of drafting the contract to performance, and should a conflict arise at any stage, the door is opened to a parallel world of private adjudication, not by the party alone, but by a helpful legal hand. The world of international commercial arbitration is complex, and choices made are non-trivial, starting with the (model) arbitration clause, to possible different seats and *lex arbitri*, to then choosing ones' arbitrators. A party, especially when encountering its very first arbitration, - understandably discontent by the fact that it finds itself there to begin with, - needs help to navigate this unknown territory.

615 Entering the discussion on the nature of arbitration, one may then enquire whether it is important to know when an arbitration begins to even contemplate its nature. Johannes

[1875] See Gaillard (n 153) 38.
[1876] Interview #16, Lise Alm ("We are the prenup at the marriage. We are not what they envision when they take their vows, when they enter into the agreement. They envision the house that they are going to live in and all their grandchildren. They don't focus on the prenup. But we are it. We are literally the last paragraph of the last page of a contract."). See Patrick G Jones, 'The Midnight Clause: From Darkness to Daylight' <https://www.henningmediation.com/n/PGJ/cle_seminar.pdf>.
[1877] Oftentimes referred to as the "midnight clause". See Blackaby and others (n 70) para 2.04.

Landbrecht, who recently published an article proposing a new theory of a "*lex transactionis* order",[1878] claims that "parties, when discussing their rights and obligations under the transaction, will always 'come back' to the fact that they would have to ultimately debate these rights and obligations in front of a tribunal, and not in front of such and such state court".[1879] However, it is doubtful that parties embed their discussion at the contracting stage in a possible future legal lawsuit.[1880] And even if they did, a differentiation between state courts and tribunals does not seem likely to be of relevance to parties unless the discussion revolves around the dispute resolution clause *per se*.

616 To support his claim, Landbrecht states that "[i]f parties anticipate that English courts will decide their dispute, they will comply with relevant pre-action protocols. If the discussion takes place under the umbrella of a standard […] arbitration clause, there is no reason to observe pre-action protocols – which gives the exact same parties' legal communication context a different content".[1881] Pre-action protocols according to the official UK's Ministry of Justice's website "explain the conduct and set out the steps the court would normally expect parties to take before commencing proceedings for particular types of civil claims".[1882] These are thus steps parties need to take once a dispute has already arisen, which tells little about the emergence of a separate legal order between parties at the contracting or transaction stage.

617 Parties are more likely to be primarily concerned with their business dealings.[1883] And the legal order supports such transactions and establishes trust by giving parties a protective

[1878] Johannes Landbrecht, 'The Autonomy of Arbitration: Autonomy À Géométrie Variable' (2021) 14 Contemporary Asia Arbitration Journal 39 <https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3855986>.

[1879] Landbrecht (n 1878) 59.

[1880] See Interview #16, Lise Alm ("The first thought of parties isn't 'how do I handle disputes'.", "We are the prenup at the marriage, we are not what they envision their house that they are going to live in and all their grandchildren, they don't think about the prenup as the main thing, and we are it. We are literally the last paragraph of the last page of a contract.").

[1881] Landbrecht (n 1878) 59. Footnote omitted.

[1882] UK Ministry of Justice, 'Practice Direction - Pre-Action Conduct and Protocols' <https://www.justice.gov.uk/courts/procedure-rules/civil/rules/pd_pre-action_conduct>.

[1883] See Ruth Stackpool-Moore, 'Institutional Appointment of Arbitrators' in Jean Engelmayer Kalicki and Mohamed Abdel Raouf (eds), *Evolution and Adaptation: The Future of International Arbitration, ICCA Congress Series, Volume 20* (Kluwer Law International, 2019) 429. ("As much as arbitration practitioners would like to think otherwise, dispute resolution provisions remain a midnight clause. […] As a consequence, aside from sophisticated and/or repeat users of arbitration, often little attention is paid to the institution or the rules selected, or, if they are considered, they are often seen as an easy give vis-à-vis other more 'important' commercial terms."). See Jones (n 1876). ("During my first 16-1/2 years in private practice I worked on quite a few M&A and other significant transactions, and I know from personal experience that the term "midnight clause" is well deserved. This refers to the dispute resolution clause, and

mechanism through its judiciary.[1884] The entire construct of arbitration is to allow parties an alternative to state courts in their cross-border business transactions. As such, states have collectively signed the New York Convention to promote global trade and offer the kind of trust basis, which a state by itself cannot offer, *i.e.,* enforcement in (possibly) multiple jurisdictions. Arbitration is thus best seen as a best alternative that states can collectively offer to cross-border commercial parties instead of their territorial based judiciaries. Arbitration is the foundational layer to international commerce, building bridges between parties in different countries, solving a trust problem. And at the same time as it is the bridge, when it catches fire, it provides the fire extinguisher. As such, it does not constitute a separate legal order, it can logically not be more than what its function entails, it cannot itself be a legal order because it is part of one (or rather the sum of the New York Convention's signatories), and finally represents an alternative to state judiciary. However, even if this seems obvious at first glance, debates endure and are far from settled.

618 Parties seated in different states can resort to arbitration, which functions as a bridged judiciary between them. The bridge is created by the parties' arbitration clause, thus party autonomy. The design of each arbitration is individual and depends on the specific case, a generalization is thus not possible, only the notion that a particular arbitration will manifest at some arbitral seat, adopting the *lex arbitri*, incorporating the parties' freedom of choices. Landbrecht advances the notion of a "*lex transactionis* order" through the lense of Niklas Luhmann's systems theory to explain the phenomenon of arbitration and its autonomy, which may in turn explain Landbrecht's focus on communication contexts, such as that parties would negotiate under some sort of shadow of an arbitration clause,

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in particular the arbitration clause, because all too often it is addressed at the end of the contract negotiations (and many times after midnight) as more or less an "afterthought," with very little consideration given to the consequences." Footnote and Emphasis omitted). If it is assumed generally that more effectiveness can be obtained in arbitration, parties would benefit from generally including an arbitration clause in their commercial contracts. However, a 2019 study (see Nyarko (n 671)) which analyzed over half a million contracts filed with the U.S. Securities and Exchange Commission (SEC) found that arbitration clauses are less frequently used than widely held. This study, however, was focused on specific contracts which must be filed with the SEC and is US-focused. Its general validity can thus be questioned. In support of Landbrecht, one could look at some law and economics literature, which lists benefits parties may encounter by adopting an arbitration clause, including that such a clause may improve the performance of parties – and if that is the case, one could argue that an arbitration clause may change the setting of a negotiation; see, e.g., Steven Shavell, 'Alternative Dispute Resolution: An Economic Analysis' (1995) 24 The Journal of Legal Studies 1.

[1884] Similarly, Ortolani, 'The Three Challenges of Stateless Justice' (n 104) 618 ("The possibility of contract enforcement through a system of justice plays a fundamental role in enhancing trust."). See *supra* Chapter 2.4.7.

as "[t]he theory of social systems then focuses on observing communications, not structures".[1885] His argument, in its essence, however, ultimately leads to party autonomy, which he clothes in original garment and leaves open the question, which this thesis has identified as particularly difficult, which is what the nature of arbitration is (and what the source of said party autonomy is).[1886] His approach, however, deserves a closer look. In the following this thesis - mindful of its limited scope and thus refraining from going in-depth - will briefly highlight some novelties Landbrecht introduces to the discussion.

619 Landbrecht identifies flaws in the legal theory discussion concerning the nature of arbitration, which he largely blames on a lack of clear definition of both the notions of "autonomy" and "arbitration".[1887] He further states that "arbitration scholarship has so far looked for legal theory answers that, it is submitted, legal theory cannot provide – for structural reasons."[1888] The reasons being that a multitude of legal theories exist, and that jurisprudence is "based on differing ideas of 'law', 'legal system', or 'legal order'".[1889] However, it is unclear why it should follow from such reasoning that jurisprudence cannot deliver answers. He sees it as a flaw that "there is no *one* legal theory or *one* approach to jurisprudence that commands a worldwide consensus".[1890] His argument that just because there are different or a multitude of legal theories, jurisprudence cannot provide any answers to arbitration, because "[i]t is equally unlikely that a single *arbitral* legal theory will emerge",[1891] is not satisfying. In fact, it seems that such a statement only reinforces the fact that jurisprudence can indeed provide an answer, and even more than one.

620 Abandoning jurisprudence for its perceived lack of capacity, Landbrecht thus turns to sociology and in specific Luhmann's systems theory for answers. The foundation for his analysis then becomes somewhat curiously that "arbitral tribunals *must* –autonomously

[1885] Landbrecht (n 1878) 46. Emphasis omitted.
[1886] See e.g., Gaillard (n 153) 2.
[1887] Landbrecht (n 1878) 41.
[1888] Landbrecht (n 1878) 41. Emphasis omitted.
[1889] Landbrecht (n 1878) 41. It seems jurisprudence has quite a bad reputation. Paulsson also calls for a more practical approach, see Paulsson, 'Arbitration in Three Dimensions' (n 635) 3 ("The prospect of taking the full step to the first principle – the definition of a legal order – is not certain to make any audience rejoice. After all, this is a domain to which swarms of exceptionally erudite and disputatious scholars have devoted pages as countless as the stars, destined to be read, it seems, chiefly by others intending to add to the production. Perhaps it is possible to keep it simple and practical.").
[1890] Landbrecht (n 1878) 41.
[1891] Landbrecht (n 1878) 41.

– *make their own decisions*. They cannot rely on someone else deciding for them".[1892] However, the same is true for court judges, unless some internal court procedure allows judges to delegate specific cases, which were assigned to them, to other judges, who in turn will have to make their own decisions as well. A distinguishing factor in the autonomy of decision-making is that in arbitration there is no appeal and that an arbitral award's enforceable reach is global, which suggests that the private arbitrator's decision power is much broader than that of a state court judge.

621 Essentially, what Landbrecht identifies as a major shortcoming in the whole autonomy debate is that the theories "do not do justice to the phenomenon of arbitration overall, do not account for the diversity of the phenomenon globally. Or, in other words, their notion of 'arbitration' is undercomplex".[1893] In this sense, Posner - although not much of a proponent of jurisprudence himself[1894] - would likely disagree, as "abstraction is of the essence of scientific inquiry. […] [A] theory of law will not capture the full complexity, richness, and confusion of the phenomena […] that it seeks to illuminate. But its lack of realism in the sense of descriptive completeness, far from invalidating the theory, is a precondition of theory. A theory that sought faithfully to reproduce the complexity of the empirical world in its assumptions would not be a theory – an explanation – but a description".[1895] In contrast to Landbrecht's assertion, "undercomplexity" should be the aim.[1896]

622 The novelty Landbrecht introduces into the debate about the nature of arbitration is Luhmann's systems theory. Joining the chorus of legal theory critics, Luhmann sees systems theory much better suited to analyze law, since "no other currently available theory can deal as adequately with the issue of complexity".[1897] Already in the beginning of Chapter One of Luhmann's *Law as a Social System*, one comes to the realization that Luhmann will not attempt to answer the question this thesis wants answered either, rather based on the fact that he cannot identify a shared consent in legal theories discussion, Luhmann concludes that "[p]erhaps one can agree, at least, on the point that there is

[1892] Landbrecht (n 1878) 41.
[1893] Landbrecht (n 1878) 43.
[1894] See Posner, *Law and Legal Theory in England and America* (n 1805) 3.
[1895] Posner (n 673) 17.
[1896] The question then is whether the "undercomplex" theory is able to explain the complex, *i.e.,* reality. See Posner (n 673) 18.
[1897] Richard Nobles and David Schiff, 'Introduction' in Niklas Luhmann, *Law as a Social System* (Oxford University Press 2008) 4.

nothing to be gained from arguing over a 'nature' or 'essence' of law, and that the worthwhile question that should be asked is: what are the boundaries of law?".[1898] What may seem like a type of deflection is a practice employed in other disciplines as well.[1899]

623 The question of "what is the nature of arbitration?" is ultimately a question about its meaning, one is trying to make sense of it and direct one's efforts accordingly. Luhmann's and Landbrecht's approach is thus valuable, because by answering the question as to the boundaries of law or arbitration, respectively, one at least has gained some more insight into a more complex problem. Discussing systems theory and Landbrecht's approach to it in detail would go beyond the scope of this thesis. Suffice it to say that Landbrecht eloquently takes systems theory to come to the result that an arbitral legal order does not exist "at the macro-level".[1900] On the basis of systems theory he thus "propose[s] to further refine the analysis [by including] an additional layer, namely that of individual transactions. Irrespective of whether individual proceedings are ever commenced, the fact that parties anticipate that they could be, instead of domestic court proceedings, will change their legal discourse".[1901] This order then serves as the basis for an arbitral award's effectiveness (and existence even after being set aside)[1902] and the arbitral tribunal's power.[1903] Landbrecht asserts that this order is autonomous from domestic legal orders in a "systems-theoretical sense".[1904]

624 However, Landbrecht's theory does not consider the other side of the dispute resolution coin, namely state courts. Instead, the theory is based entirely on party communication at a contracting stage in expectation of future disputes resolved by arbitration alone. If parties were indeed to create a separate and autonomous legal order on a p2p level, such order, tentatively termed here as a "*movens*" order, would be created whenever parties enter contracts, irrespective of whether arbitration was chosen or not. The order then barely changes its flavor or condition, depending on whether an arbitration clause was inserted or not. In such cases, if parties have not chosen arbitration but were to default on

[1898] Luhmann (n 1897) 57. Footnote omitted.
[1899] See e.g., Terence Tao, 'Don't Prematurely Obsess on a Single "Big Problem" or "Big Theory"' <https://terrytao.wordpress.com/career-advice/dont-prematurely-obsess-on-a-single-big-problem-or-big-theory/>.
[1900] Landbrecht (n 1878) 66.
[1901] Landbrecht (n 1878) 53. Emphasis omitted.
[1902] See Landbrecht (n 1878) 73.
[1903] See Landbrecht (n 1878) 74.
[1904] Landbrecht (n 1878) 53.

state courts, the condition would be "solid", much like the territory of states. If parties chose arbitration, their legal order would be "liquid", in a sense like water that changes its condition depending on whether heat is applied or not.

625 The orders in their essence remain the same, whether liquid or solid, just as H2O's molecules are the same, and only the perception and conditions change when they move together in a larger system.[1905] Parties that consciously "move" and exercise their party autonomy to contract out of state courts and into arbitration, thus enter a liquid legal system, movable, adaptable, and anything but fixed in its dispute resolution process, where arbitral awards float like wooden pieces on a vast legal ocean occasionally drifting ashore, and where annulment simply means throwing such awards back into the ocean. However, what is the difference between such p2p orders and party autonomy? And where does Landbrecht's "*lex transactionis* order" fit in? When looking closely, one gets to the same dead end: party autonomy. It is finally still unclear what the nature of arbitration is. However, Landbrecht's approach shows that the debate not only concerns arbitrators and courts, but parties as well and legal orders do not necessarily need to be higher-level orders but could be lower-level orders as well.

626 What rule founds party autonomy, then? It seems unwise to ask the question, as many so far have cautioned against it. However, a thesis about blockchains and arbitration cannot help itself and rather defiantly attempts to at least try. If it is party autonomy that is the basis of arbitration, what is the foundation of its foundation? Before this thesis attempts to explore this question further, an essential detour must be made to the debates that ultimately led Gaillard to first articulate this question in his groundbreaking *Legal Theory of International Arbitration*.

7.2.4 Lex Arbitri and the Strive to Delocalize

627 The question whether arbitration is localized or delocalized ultimately revolves around the tension between state courts and arbitral tribunals as well as on the principle of

[1905] Water seems to be a recurrent theme in legal theory discussions. See Schultz (n 95) vii. (Schultz describes in his book on "Transnational Legality" that after a talk he gave, someone told him that before the talk, they thought of arbitration as a glass, "just a glass with a drink in it. Now I actually discern the molecules in the drink, and recognize the glass itself is liquid".) See also 'Scott Shapiro: What Is Law (and Why Should We Care)?' (n 1805) (Shapiro takes the example of water to explain that its identity is H2O and that this is "what makes water water", referring to the "Identity question").

territoriality and party autonomy.[1906] The idea of localized arbitration was the predominant view until the beginning of the 1980s.[1907] The *lex loci arbitri* or the "seat" of international arbitration is prominent in all these discussions and forms the basis of the territorial view. Francis A. Mann, who in 1967 published an article entitled "*Lex Facit Arbitrum*", coined the term "*lex arbitri*".[1908] Mann states that "arbitration, like any other institution of municipal law, requires a firm legal basis which can only be found in the recognition and implementation of the idea of *lex facit arbitrum*".[1909] He further calls international arbitration a "misnomer", and says that "[i]n the legal sense no international commercial arbitration exists. Just as […] every system of private international law is a system of national law, every arbitration is a national arbitration, that is to say, subject to a specific system of national law."[1910]

628 According to F.A. Mann there is "similarity between the national judge and the arbitrator in that both of them are subject to the local sovereign".[1911] In a sense, arbitration would then just be one of many dispute resolution mechanisms available in a legal order.[1912] The idea of linking arbitration to a state, Gaillard explains, is built on positivism, more specifically the ideas of Kelsen (*Grundnorm*) and Hart (rule of recognition).[1913]

629 The seat of an "arbitration is not merely a matter of geography", rather it embeds an arbitration into a legally relevant and territorial context.[1914] Mann proclaims that the choice of a seat by the parties "is usually far from fortuitous, but made for good and well-understood reasons and purposes."[1915] Localists will argue that the choice of a seat means that parties intended to be subjected to a state's national legal order, even if the choice is

[1906] See Roy Goode, 'The Role of the Lex Loci Arbitri in International Commercial Arbitration' (2001) 17 Arbitration International 19, 24. See Bianca Kremer, 'The Enforcement of Nullified Arbitral Awards in Light of the European Union's Principle of Mutual Trust' in Stina Bratt, Kelly Chen and Mårten Schultz (eds), *Stockholm Centre for Commercial Law årsbok IX* (Stockholm Centre for Commercial Law 2018) 178.
[1907] See Otto Sandrock, 'To Continue Nationalizing or to De-Nationalize? That Is Now the Question in International Arbitration' (2001) 12 Am. Rev. Int'l Arb. 301, 305.
[1908] See Gaillard (n 153) 15. Originally F. A. Mann's article appeared in *International Arbitration, Liber Amicorum for Martin Domke* (P. Sanders ed) in 1967, reprinted: Francis A Mann, 'The UNCITRAL Model Law - Lex Facit Arbitrum (Reprinted Version)' (1986) 2 Arbitration International <https://academic.oup.com/arbitration/article/2/3/241/235643>.
[1909] Mann (n 1908) 244.
[1910] Mann (n 1908) 244. Footnote omitted.
[1911] Mann (n 1908) 246. See Gaillard (n 153) 16.
[1912] See Gaillard (n 153) 16.
[1913] See Gaillard (n 153) 21.
[1914] See Blackaby and others (n 70) para 3.56.
[1915] Mann (n 1908) 247. Footnote omitted.

not made by the parties' themselves but by the arbitrators, for example.[1916] Brazil-David highlights that parties may not even realize that by selecting a particular seat of arbitration, they are subjecting themselves to the laws of that state.[1917] Gaillard asserts that a choice of a seat can hardly be taken to mean that parties intended their dispute to be ultimately resolved under the seat's legal order.[1918] What conclusion might be more readily drawn is that parties wanted to have their dispute resolved by arbitrators rather than by national court judges.[1919]

630 Jan Paulsson explains that proponents of the localized thesis, in the style of Francis A. Mann, argue based on greater predictability by recognizing the authority of the *lex arbitri*, which he, however, considers moot because parties have a choice as to the seat of arbitration,[1920] which oftentimes happens to be a neutral jurisdiction, with no link to the dispute.[1921] Paulsson further explains that this model is the creation of "attitudes prevalent until the middle of the 20th Century [which] simply does not fit the realities of an international society no longer constrained within national units".[1922]

631 Since there is no "universal *lex arbitri*" but rather each country can have its own *lex arbitri*, some have started theorizing "an escape route".[1923] The delocalization theory frees arbitration from the seat country,[1924] from which "the award [takes] off and disappear[s] into the firmament, landing only in those places where enforcement [is] sought."[1925] It therefore all depends on how far up one climbs the delocalization ladder, the *lex arbitri* losing significance the higher one gets until reaching perfect delocalization, where arbitral awards suddenly grow wings, becoming "floating awards".[1926]

[1916] See Gaillard (n 153) 19. See Blackaby and others (n 70) para 3.40. See, e.g., Article 18 (1) UNCITRAL Arbitration Rules: "If the parties have not previously agreed on the place of arbitration, the place of arbitration shall be determined by the arbitral tribunal having regard to the circumstances of the case. The award shall be deemed to have been made at the place of arbitration."

[1917] See Renata Brazil-David, 'Harmonization and Delocalization of International Commercial Arbitration' (2011) 28 Journal of International Arbitration 445, 455.

[1918] See Gaillard (n 153) 20.

[1919] See Gaillard (n 153) 20.

[1920] See Paulsson, 'Arbitration in Three Dimensions' (n 635) 6.

[1921] See Paulsson, 'Arbitration in Three Dimensions' (n 635) 8.

[1922] Paulsson, 'Arbitration in Three Dimensions' (n 635) 7.

[1923] Blackaby and others (n 70) para 3.74.

[1924] See Blackaby and others (n 70) para 3.76.

[1925] Goode (n 1906) 21. See also Blackaby and others (n 70) para 3.76.

[1926] See also Blackaby and others (n 70) para 3.76. See also Jan Paulsson, 'Delocalisation of International Commercial Arbitration: When and Why It Matters' (1983) 32 The International and Comparative Law Quarterly 53, 61. See also Jan Paulsson, 'Arbitration Unbound: Award Detached from the Law of Its Country of Origin' (1981) 30 International and Comparative Law Quarterly 358.

632 The New York Convention aids in this endeavor as, in contrast to the Geneva Protocol 1923 and Geneva Convention 1927, it seems to give the seat much less importance,[1927] seeing that Article V (1)(d) states as follows:

> "Recognition and enforcement of the award may be refused, at the request of the party against whom it is invoked, only if that party furnishes to the competent authority where the recognition and enforcement is sought, proof that: (d) The composition of the arbitral authority or the arbitral procedure was not in accordance with the agreement of the parties, or, failing such agreement, was not in accordance with the law of the country where the arbitration took place [...]"

633 This provision clearly prioritizes the agreement of the parties over the seat of the arbitration.[1928] The New York Convention, which replaced the Geneva Convention 1927 and the 1923 Geneva Protocol,[1929] relinquishes the idea that the seat's legal order is the "only source of the award's legal force",[1930] and thus departs from the importance attributed to the seat of arbitration by the Geneva Convention.[1931] However, at other parts of the New York Convention, *i.e.,* Article V(1)(a) and (e), a reference to the seat of arbitration is made.[1932] Also, one should be cautious to deny the *lex arbitri* its importance because it clearly exists.[1933] Among the legal implications derived from this *lex* are, for example, access to the courts at the seat during and after an arbitral procedure and the need to comply with mandatory provisions of the seat country.[1934]

634 Mann and his followers proclaim that "nothing can come from nothing".[1935] There are, however, some judicial decisions that hold otherwise, some courts resuscitate awards that presumably have ceased to exist.[1936] In the *Putrabali* decision, for example, the French *Cour de Cassation* held that "[a]n international arbitral award, which is not anchored in any national legal order, is a decision of international justice whose validity must be

[1927] See Gaillard and Savage (n 630) paras 1182–1183.
[1928] See UNCITRAL Secretariat Guide (n 757) 189.
[1929] See Art. VII (2) of the New York Convention.
[1930] Gaillard (n 153) 30.
[1931] See Gaillard (n 153) 29–30.
[1932] See Blackaby and others (n 70) para 3.81, Footnote 95.
[1933] See Blackaby and others (n 70) para 3.80.
[1934] See Gaillard and Savage (n 630) para 1239. See also Blackaby and others (n 70) para 3.46.
[1935] See Paulsson, 'Arbitration in Three Dimensions' (n 635) 33. See also van den Berg, 'Should the Setting aside of the Arbitral Award Be Abolished?' (n 1774) 279.
[1936] See Blackaby and others (n 70) para 3.77.

ascertained with regard to the rules applicable in the country where its recognition and enforcement are sought".[1937] The delocalization movement leads to the realization that there seems to be an inherent paradox.

7.2.5 Arbitration's Great Paradox in Dreams, Representations, and Dimensions

635 Jan Paulsson highlights arbitration's great paradox: "arbitration […] seeks the cooperation of the very public authorities from which it wants to free itself".[1938] He refers to the fact that arbitration is depended on the judiciary to assist and validate it but at the same time, it operates independently. Paulsson points out that arbitration is so independent, that it may even go from beginning to end without any public authority ever knowing about the process at all.[1939] This great paradox is what fuels the debate on arbitration's autonomy.[1940]

636 In "Achieving the Dream: Autonomous Arbitration", Julian Lew explains that "[t]he ideal and expectation is for international arbitration to be established and conducted according to internationally accepted practices, free from the controls of parochial national laws, and without the interference or review of national courts. Arbitration agreements and awards should be recognised and given effect, with little or no complication or review, by national courts".[1941] Anything but such a laissez-faire attitude in international arbitration, ends up being a "nightmare scenario".[1942] He proposes that arbitration should

[1937] Albert Jan van den Berg (ed), 'France No. 42, PT Putrabali Adyamulia (Indonesia) v. Rena Holding, et al., Cour de Cassation [Supreme Court], First Civil Chamber, Not Indicated, 29 June 2007', *Yearbook Commercial Arbitration 2007 - Volume XXXII* (2007) 302. See also Blackaby and others (n 70) para 3.77. Another notable case is *Hilmarton*, where an award annulled in Switzerland was later enforced in France. See Albert Jan van den Berg (ed), 'Hilmarton Ltd. v. Omnium de Traitement et de Valorisation - OTV, Tribunal de Grande Instance [Court of First Instance], Nanterre, Not Indicated, 22 September 1993', *Yearbook Commercial Arbitration 1995 - Volume XX* (1995).

[1938] Paulsson, 'Arbitration in Three Dimensions' (n 635) 2.

[1939] See Paulsson, 'Arbitration in Three Dimensions' (n 635) 3, 10–11.

[1940] For an excellent analysis of this paradox, see Fauvrelle (n 1811). He sees the tension in autonomy debates as originating from a flaw in the theory employed by advocates of autonomy. Fauvrelle suggests that Brekoulakis' legal pluralist analysis is more fitting and encourages further development. To learn more about Brekoulakis' approach, see Stavros L Brekoulakis, 'International Arbitration Scholarship and the Concept of Arbitration Law' (2013) 36 Fordham International Law Journal 745.

[1941] Lew, 'Achieving the Dream: Autonomous Arbitration' (n 617) 179.

[1942] Lew, 'Achieving the Dream: Autonomous Arbitration' (n 617) 179.

thus be seen as completely independent from nation states, existing "in its own space",[1943] and as such constituting "a *sui juris* or autonomous dispute resolution process".[1944]

637 Lew traces the historical evolution of modern international arbitration in three separate time periods, where in each "a different attitude towards international arbitration" was prevalent.[1945] According to Lew, in the first period,[1946] arbitration was free from national laws and users were operating in an unregulated space, where *lex mercatoria* flourished.[1947] It was during the second period,[1948] Lew explains, "that arbitration became more formalised with the development and adoption of specific arbitration legislation."[1949] This period was marked, among other things, by what Lew calls "judicial jealousy", which led nation states to exercise tight control over arbitration.[1950] In the third and final period,[1951] which has seen tectonic shifts in the world's political, economic and legal landscape, followed by rapid technological development, arbitration became internationalized and nation states began to loosen their firm grip.[1952]

638 In total, there are eight arguments Lew brings forth to determine that arbitration has become autonomous:[1953] (i) parties and arbitrators may come from different jurisdictions and the seat is usually at a neutral place; (ii) the parties' domestic laws and the *lex arbitri* only have diminished relevance; (iii) arbitral procedure is liberated from national jurisdictions, (iv) parties detach themselves from national state courts through exercising their party autonomy, (v) arbitration procedure is determined by a web of different international and soft laws, practice, and the parties' agreement, (vi) the international arbitral process is generally recognized (and mandated to be recognized) by nation states, (vii) touch points with nation states happen occasionally and require the recognition and enforcement of arbitral agreements, arbitral awards, and the arbitral procedure, and (viii)

[1943] Lew, 'Achieving the Dream: Autonomous Arbitration' (n 617) 181.
[1944] Lew, 'Achieving the Dream: Autonomous Arbitration' (n 617) 181.
[1945] Lew, 'Achieving the Dream: Autonomous Arbitration' (n 617) 182 et seq.
[1946] According to Lew: From the Middle Ages to the 18th century. See Lew, 'Achieving the Dream: Autonomous Arbitration' (n 617) 182.
[1947] Lew, 'Achieving the Dream: Autonomous Arbitration' (n 617) 182–183.
[1948] According to Lew: 18th century to the 1950s. See Lew, 'Achieving the Dream: Autonomous Arbitration' (n 617) 183.
[1949] Lew, 'Achieving the Dream: Autonomous Arbitration' (n 617) 183.
[1950] Lew, 'Achieving the Dream: Autonomous Arbitration' (n 617) 183.
[1951] According to Lew: From the 1950s to date (thus 2006, when the article was published). See Lew, 'Achieving the Dream: Autonomous Arbitration' (n 617) 184.
[1952] See Lew, 'Achieving the Dream: Autonomous Arbitration' (n 617) 184 et seq.
[1953] See Lew, 'Achieving the Dream: Autonomous Arbitration' (n 617) 202–203.

arbitration creates its own standards, which are overseen on a national level.[1954] Although these points describe arbitration's perceived independence, the last two points, in particular, favor the opposite assertion as they refer to national law as overseeing the procedure.[1955]

639 Although Lew lists different accounts of the legal nature of arbitration, which he terms the "jurisdictional", the "contractual", the "mixed or hybrid", and finally the "autonomous" theory of arbitration,[1956] he does not go in-depth in explaining what, for example, Gaillard has identified as lacking in previous discussions, *i.e.,* that which founds party autonomy. Lew outlines some of the shortcomings of other views on the nature of arbitration by stating that "[t]he problem in theoretical terms is that neither the jurisdictional nor the contractual theories of arbitration encapsulate the fundamental and real nature of arbitration. Accordingly, it was suggested that arbitration had a mixed or hybrid nature".[1957]

640 This hybrid nature did not suffice either, as according to Lew "it ignored the various other factors that are inherent in arbitration, such as the arbitrator."[1958] Lew then takes the leap from the mixed theory to the autonomous theory, which acknowledges "that arbitration is a stand-alone mechanism" characterized by its "independent and unique nature" supported by not only party autonomy, but also national and international laws.[1959] Fauvrelle calls this "Lew's most intriguing assertion" and that "[i]t seems that Lew wants international arbitration to have its cake and eat it too".[1960] Here arbitration's great paradox becomes apparent again, Fauvrelle asserts that "[i]t appears that international arbitration emerges from, but somehow transcends, state and international law."[1961]

[1954] See Lew, 'Achieving the Dream: Autonomous Arbitration' (n 617) 202–203.
[1955] See also Fauvrelle (n 1811) 51 (He notes that "[Lew] does not provide any theoretical analysis that would explain this interaction or, more importantly, how it is that autonomous arbitration is created by the very state and international legal orders it is said to transcend.").
[1956] See Lew, 'Achieving the Dream: Autonomous Arbitration' (n 617) 186 et seq.
[1957] Lew, 'Achieving the Dream: Autonomous Arbitration' (n 617) 186.
[1958] Lew, 'Achieving the Dream: Autonomous Arbitration' (n 617) 186.
[1959] Lew, 'Achieving the Dream: Autonomous Arbitration' (n 617) 186–187.
[1960] Fauvrelle (n 1811) 50 ("This thought leads to Lew's most intriguing assertion: that autonomy is generated not only by the principle of party autonomy and the use of non-national arbitration rules, but by state laws and international instruments." Footnote omitted). See also Lew, 'Achieving the Dream: Autonomous Arbitration' (n 617) 186–187.
[1961] Fauvrelle (n 1811) 50–51.

641 Ralf Michaels observes that "Lew is not the only dreamer […] once you look, you realise: the literature on law without a state is replete with dreams, visions and faith."[1962] To Michaels, arbitration appears to be actually "based […] entirely in cool economic rationality",[1963] while "completely denationalised law is of course a utopia".[1964] Towards the end of his criticism, however, he recognizes the strength in utopias,[1965] and encourages to join in as "we need more, not fewer, utopias of international commercial law. We need more creativity, more imagination. We need more willingness to depict alternative worlds".[1966]

642 Emmanuel Gaillard was certainly willing to portray his own account of the world of arbitration. Gaillard examines international arbitration "from the angle of the visions, philosophies or, more accurately, mental representations that underlie the discipline".[1967] He introduces his representations of international arbitration by first making reference to legal scholars whose works have made significant contributions and laid the foundation for his own legal theory.[1968] Among them, he cites Berthold Goldman, who in the 1960s "proposed the powerful idea that 'arbitrators do not have a forum', or if one were to attribute one to them, it would be the entire world".[1969] Gaillard structures the idea of international arbitration into three distinct forms.[1970] The first representation links arbitration to the seat,[1971] and the second embeds arbitration in a multitude of legal orders.[1972] The third representation sees arbitration as a system of its own, the so-called "arbitral legal order".[1973] Gaillard also introduces the term "juridicity", which he refers to as the "source of [the arbitrators'] power and the legal nature of the process and of the ensuing decision".[1974] According to Gaillard, "the question of the sources – if not *the* source, the 'basic norm' for some, the 'rule of recognition' for others – is one of the most

[1962] Michaels (n 1836) 36. Footnote omitted.
[1963] Michaels (n 1836) 40.
[1964] Michaels (n 1836) 39.
[1965] Michaels (n 1836) 62.
[1966] Michaels (n 1836) 62.
[1967] Gaillard (n 153) 10.
[1968] See Gaillard (n 153) 1 et seq. He pays tribute to, e.g., Henri Batiffol, Berthold Goldman and Phocion Francescakis.
[1969] See Gaillard (n 153) 1. Footnote omitted.
[1970] See Gaillard (n 153) 15 et seq.
[1971] See Gaillard (n 153) 15 et seq.
[1972] See Gaillard (n 153) 24 et seq.
[1973] See Gaillard (n 153) 35 et seq.
[1974] Gaillard (n 153) 2.

complex in legal theory, international arbitration should be considered a privileged field of interest for legal theorists".[1975]

643 The first of Gaillard's representation equals the arbitrator to a national judge and derives the award's legal validity from the arbitration's seat.[1976] The Geneva Convention 1927 is based on this first representation, which Gaillard calls "outdated".[1977] This representation adopts the view that an award's legitimacy stems from the nation state in which the arbitration is conducted.[1978]

644 The second representation anchors arbitration in many different national legal orders.[1979] The so-called "multilocal representation" takes the award as the point of departure.[1980] Gaillard calls this a "Copernican revolution".[1981] The plurality of legal orders is made up of all states that can be involved in any given arbitration.[1982] Like the first representation, the second one is based on legal positivism but takes on a "Westphalian" perspective.[1983] This conception acknowledges that each state can decide on its own what effects to give an arbitral award,[1984] which is the underlying attitude of the New York Convention as well.[1985] The Westphalian representation derives "juridicity of arbitration" from the legal order of those states where parties seek to enforce their arbitral awards.[1986] By agreeing to arbitration, parties expect an enforceable award once the arbitral procedure concludes,[1987] which is "the *raison d'être* of the arbitration process".[1988] Even if most arbitral awards are voluntarily followed,[1989] sometimes enforcement actions may become necessary. According to Gaillard, the Westphalian model is inadequate because arbitrators cannot possibly observe all imaginable state positions for the enforcement of

[1975] Gaillard (n 153) 2. Footnotes omitted.
[1976] See Gaillard (n 153) 15.
[1977] See Gaillard (n 153) 30.
[1978] See Gaillard (n 153) 30.
[1979] See Gaillard (n 153) 24 et seq.
[1980] See Gaillard (n 153) 25.
[1981] Gaillard (n 153) 25.
[1982] See Gaillard (n 153) 24–25. See also Paulsson, 'Arbitration in Three Dimensions' (n 635) 10.
[1983] See Gaillard (n 153) 26 et seq.
[1984] See Gaillard (n 153) 28.
[1985] See Gaillard (n 153) 29.
[1986] See Gaillard (n 153) 31.
[1987] See Martin Platte, 'An Arbitrator's Duty to Render Enforceable Awards' (2003) 20 Journal of International Arbitration 307, 308.
[1988] Schwartz and Derains (n 1759) 385. See also Article 42 of the 2021 ICC Arbitration Rules: "In all matters not expressly provided for in the Rules, the Court and the arbitral tribunal shall act in the spirit of the Rules and shall make every effort to make sure that the award is enforceable at law."
[1989] See Born, *International Commercial Arbitration (Third Edition)* (n 618) 3144. See Platte (n 1987) 307.

the award.[1990] Paulsson also criticizes this view as "[a]rbitrators do not examine the validity of the arbitration clause, or of their appointment, under the laws of every country that might conceivably be approached as an enforcement forum".[1991]

645 Gaillard's third representation sees "juridicity of arbitration" as originating from the autonomous legal order or the "arbitral legal order".[1992] Gaillard considers this legal order to be a "transnational" representation which takes regard to the "community of States".[1993] Gaillard observes that French legal scholars started using the term "arbitral legal order" in the 1990s,[1994] and the case law Gaillard uses to support arbitration's claim to autonomy are mostly French.[1995] Gaillard claims that arbitration has become truly autonomous because states recognize "the result of the arbitral process, *i.e.* the award, without reviewing the merits of the dispute".[1996] He claims that "arbitrators can today be considered to be the organs of a distinct legal order. In performing this function, international arbitrators produce norms which, although based on the States' normative activity, do not belong exclusively, as transnational rules, to any State specifically."[1997] Here the great paradox once more sneaks into the debate.[1998]

646 Paulsson criticizes Gaillard and asserts that the existence of an autonomous arbitral legal order cannot be demonstrated by referring to French court judgments, and he claims that French case law only proves that "the French legal order is willing to give effect to arbitral awards when enforcement is sought in France without concerning itself with the views of the courts of the seat".[1999] He further states that this "is but the reaction of a single national legal order of the multiplicity of orders which may have the occasion to play a

[1990] See Gaillard (n 153) 36.
[1991] Paulsson, 'Arbitration in Three Dimensions' (n 635) 11.
[1992] Gaillard (n 153) 35 et seq.
[1993] Gaillard (n 153) 37.
[1994] See Gaillard (n 153) 38–39.
[1995] See Gaillard (n 153) 60 et seq. See also Paulsson's critique: Paulsson, 'Arbitration in Three Dimensions' (n 635) 13.
[1996] Gaillard (n 153) 59.
[1997] Gaillard (n 153) 59. Footnote omitted.
[1998] See Paulsson, 'Arbitration in Three Dimensions' (n 635) 16. ("[…] the manner of the Parisian thesis, to the somewhat dreamy and self-contradictory premise of an 'autonomous' order *recognised* by the very state orders from which is purports to be free."). See also Ortolani, 'Self-Enforcing Online Dispute Resolution: Lessons from Bitcoin' (n 104) 612–613. See also Fauvrelle (n 1811) 53.
[1999] Paulsson, 'Arbitration in Three Dimensions' (n 635) 13. Emphasis omitted.

role in the life of an arbitration",[2000] and that "French law cannot will into existence something which is larger than itself".[2001]

647 Paulsson identifies three competing propositions, which largely overlap with Gaillard's representations, while later claiming that "[r]eality […] ignores them":[2002] (i) the "territorial thesis", according to which solely the seat gives arbitration legitimacy, which he rejects,[2003] (ii) the "pluralistic thesis", according to which arbitration derives its power from a multitude of legal orders, and (iii) the "autonomous legal order".[2004] Paulsson considers the latter as "extravagant claims", which can be disregarded as this notion "is no more than pluralism, masquerading as something more grand".[2005]

648 According to Paulsson, the notion of a legal order was only developed recently and although one could "undoubtedly survive without it",[2006] it is still helpful in sharing views about the law.[2007] Paulsson defines "a legal order [as] a set of norms acknowledged by a social group as authoritative".[2008] In a dualistic view, Paulsson distinguishes between international and state legal orders.[2009] National legal orders are formed by sovereign states, whose legal authority is undisputed in their respective territories.[2010] Through the international legal order, sovereign states can regulate the relations between them.[2011] The applicability of international law depends on whether a specific state agrees to be bound by it or not.[2012]

649 According to Paulsson, however, these two orderly legal concepts do not depict the multitude of international and national legal orders that exist today, which may include hybrid forms.[2013] Finally, Paulsson introduces a revised pluralistic model or legal

[2000] Paulsson, 'Arbitration in Three Dimensions' (n 635) 13.
[2001] Paulsson, 'Arbitration in Three Dimensions' (n 635) 15.
[2002] Paulsson, 'Arbitration in Three Dimensions' (n 635) 15.
[2003] See Paulsson, 'Arbitration in Three Dimensions' (n 635) 3. Emphasis omitted.
[2004] See Paulsson, 'Arbitration in Three Dimensions' (n 635) 3. Emphasis omitted. At first Paulsson includes a fourth proposition, which he then merges with the second proposition.
[2005] Paulsson, 'Arbitration in Three Dimensions' (n 635) 15.
[2006] Paulsson, 'Arbitration in Three Dimensions' (n 635) 28.
[2007] See Paulsson, 'Arbitration in Three Dimensions' (n 635) 28.
[2008] Paulsson, 'Arbitration in Three Dimensions' (n 635) 28.
[2009] See Paulsson, 'Arbitration in Three Dimensions' (n 635) 29.
[2010] See Paulsson, 'Arbitration in Three Dimensions' (n 635) 29.
[2011] See Paulsson, 'Arbitration in Three Dimensions' (n 635) 29.
[2012] See Paulsson, 'Arbitration in Three Dimensions' (n 635) 29.
[2013] See Paulsson, 'Arbitration in Three Dimensions' (n 635) 29–30.

pluralism in three dimensions, which includes non-state legal orders.[2014] On a "*horizontal*" axis, "it envisages the cooperation of a multiplicity of territorial sovereign legal systems", and on a "*vertical*" axis, "more than one legal order occupies the same space".[2015] In addition, it includes the dimension of "*depth*".[2016] These dimensions seem to be in a sort of balancing act. Any attempts by private orders to strive for too much autonomy may "be perceived as threats to the legitimate role of the larger order".[2017] Arbitration's great paradox is thus only present, when advocates of the autonomy theory defend it. Otherwise, arbitration is not seeking to free itself at all. One could say that Paulsson promotes dissolving the paradox by employing a moderate, pluralistic view akin to his notion of a "fluid reality".[2018]

7.2.6 The Foundational Question

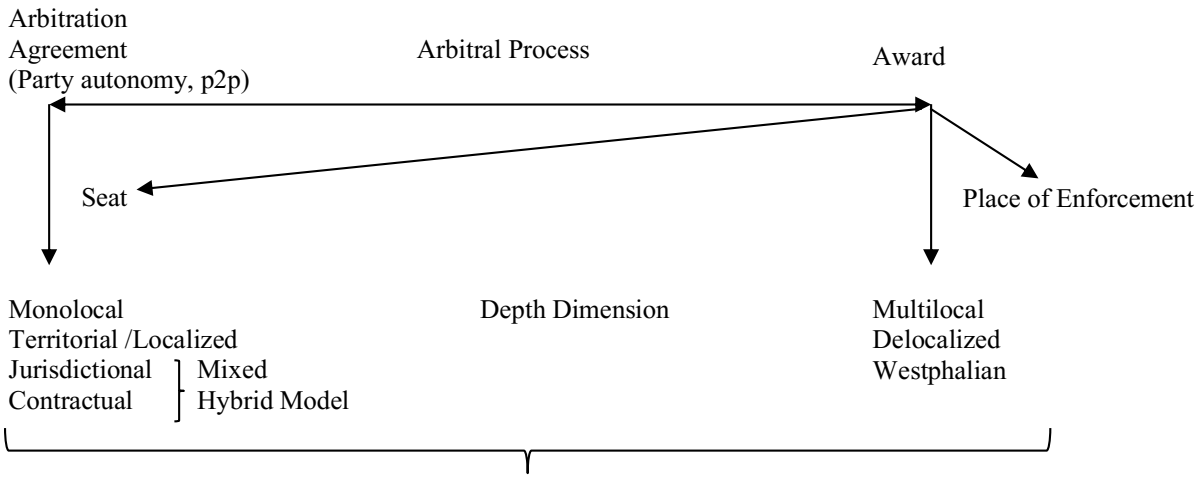


Figure 16. Spectrum of Autonomy[2019]

650 The above figure depicts some of the main approaches to the autonomy debate in arbitration. The arbitration agreement, the arbitral process, and the arbitral award are the cornerstones of an arbitration. Monolocal, territorial, localized, and jurisdictional arbitration share the notion of arbitration that is attached to the seat country. An award is

[2014] See Paulsson, 'Arbitration in Three Dimensions' (n 635) 30-32. Paulsson gives the examples of ICANN and CAS.
[2015] Paulsson, 'Arbitration in Three Dimensions' (n 635) 30.
[2016] Paulsson, 'Arbitration in Three Dimensions' (n 635) 32.
[2017] Paulsson, 'Arbitration in Three Dimensions' (n 635) 32.
[2018] Paulsson, 'Arbitration in Three Dimensions' (n 635) 15.
[2019] Own figure.

distinctly Swiss, French, English, American and so forth. The contractual theory focuses on party autonomy but does not yet detach arbitration entirely from the seat. Hybrid or mixed models combine the jurisdictional notion and the contractual notion, taking regard to both the seat of arbitration and the role that party autonomy plays. The depth dimension accounts for the dual nature of arbitration, which can be either entirely private if no state court support is needed, or public and private if national courts are asked to interfere based on an international treaty. Multilocal and Westphalian approaches focus on the arbitral award and the place of enforcement more so than on the seat of the arbitration. Delocalization is best thought of as being on a spectrum, varying in degrees of delocalization,[2020] depending on how much one balances the relationship between party autonomy and territoriality. A completely delocalized arbitration is possible if the notion of an arbitral legal order is adopted, in which case, arbitration has become entirely independent of any nation state, including from both the seat and enforcement courts. However, this has been criticized as it does not reflect reality.

651 Some enforcement courts have given effect to previously annulled awards, which has resulted in controversy. While some see this as giving effect to the New York Convention's non-mandatory language in Article V(1)(e)[2021] and preserving a state's sovereignty, others have been more critical of this practice because it leads to legal uncertainty. Newer approaches account for legal orders which arise on a p2p level between the parties. To the question from where an arbitrator derives her power, the answer is always: from the contract of the parties, thus party autonomy. Both the arbitrators and the parties are limited in their freedom, which leads to arbitral procedures having to observe public policy and parties' fundamental rights.

652 Although there are such differences in perception, and one can entertain one notion or the other, these approaches show the versatility and complexity that is international commercial arbitration. Dezalay and Garth state that "despite the networks and relationships associated with international commercial arbitration […] there is no

[2020] Roy Goode, 'The Role of the Lex Loci Arbitri in International Commercial Arbitration' (2001) 17 Arbitration International 24.

[2021] Article V(1)(e) of the New York Convention states: "1. Recognition and enforcement of the award may be refused, at the request of the party against whom it is invoked, only if that party furnishes to the competent authority where the recognition and enforcement is sought, proof that: (e) The award has not yet become binding on the parties, or has been set aside or suspended by a competent authority of the country in which, or under the law of which, that award was made."

objective thing called 'international commercial arbitration'".[2022] The field is subjective, made up of many different cultures with different legal backgrounds, and is spread globally. There is perhaps no legal field as versatile as this one, progressing through changing times and adapting to the needs of the parties in global commerce. If there is any dispute resolution mechanism that can be of guidance to an emerging global internet society, where trade will mostly be executed on blockchains, it is this one.

653 The New York Convention is the central puzzle piece in the autonomy debate discussions. Paulsson asserts that when the Geneva Convention 1927 entered into force "an award could not even begin to have obligatory force outside its country of origin until that country had positively declared the award to have executory force under its law. Plainly, there was no question what legal order gave controlling effect to the award".[2023] The New York Convention changed this as it "radically reengineered the mechanism of the 1927 Geneva Convention […] abandoning the requirement of […] double exequaturs (a technical term for orders that an award shall have executory force)".[2024]

654 Thus, three main notions emerged that see arbitration as either (i) localized due to the *lex arbitri*, (ii) delocalized because of party autonomy, or (iii) as an entirely autonomous legal order. Gaillard presented these three "representations" in a comprehensive manner, explaining the origins of each and the impact they have. He, however, refrained from suggesting a definitive model as "these are mental representations, visions of international arbitration that, as such, are a matter of belief – if not of faith – and not of scientific truth. A mental representation is never right or wrong; it can only be coherent or incoherent, efficient or inefficient."[2025] Michaels calls "[t]his […] quite remarkable. After all, faith is used here to establish nothing less than the very foundations of the whole theory - the autonomy of arbitration."[2026] Michaels then continues:

> "Precisely at the point, at which arbitration must be legitimised (and therefore at precisely the point at which philosophy of law should furnish answers), we find, instead of an argument, a genuinely Kierkegaardian leap from rationality to faith.

[2022] Yves Dezalay and Bryant Garth, 'Merchants of Law as Moral Entrepreneurs: Constructing International Justice from the Competition for Transnational Business Disputes' (1995) 29 Law & Society Review 31.
[2023] Paulsson, 'Arbitration in Three Dimensions' (n 635) 9.
[2024] Paulsson, 'Arbitration in Three Dimensions' (n 635) 10. Emphasis omitted.
[2025] Gaillard (n 153) 152.
[2026] Michaels (n 1836) 46.

> The legitimacy of arbitration itself, and thus the core of its identity, cannot be accessed by reason alone. What is achieved is thus not an ultimate justification, but instead the formulation of a credo, on which the epistemic community is based and which holds it together. The epistemic community of delocalised law, it appears, is a community of faith."[2027]

655 In Gaillard's conclusion and Michaels's critique, there are some profound insights that together bring this thesis closer to the essence of arbitration. First, one notes Gaillard's equation of the representations with belief "and not of scientific truth".[2028] Louis Girifalco explains that "[s]cientific truth is based on facts. […] Only facts matter. Verified, reproducible facts are the bedrock of scientific truth."[2029] Facts, backed by evidence, can be proven true or false, and that is why Gaillard concluded that his theories do not provide scientific truth. However, Girifalco is a professor of Materials Science and Engineering, his assertions thus pertain to the natural science field.

656 What is scientific truth in legal scholarship? What are the facts? What is the evidence? Michaels took this as a conceptual flaw in Gaillard's analysis, as his expectation of encountering a sort of "ultimate justification" was not met.[2030] The question then is, what different justification Michaels could have expected or why a different reasoning would be required to answer the – to use Shapiro's terminology - "identity question".[2031] Can the essence of arbitration not be a belief? What would make the statement "arbitration is a shared belief" true or false and unattainable by scientific truth? It seems there is an underlying misunderstanding that has gone unaddressed. Otherwise, there would not be a discussion on some scientific truth or ultimate justification. Law is not a natural science, or is it?

657 Geoffrey Samuel explains that "the problem facing law in the quest for this status [as a natural science] is that the theories produced by academic lawyers cannot be falsified, this falsification method being one of the key tests, according to Karl Popper, for

[2027] Michaels (n 1836) 46. Footnotes omitted.
[2028] Gaillard (n 153) 152.
[2029] Louis Girifalco, *The Universal Force: Gravity - Creator of Worlds* (Oxford University Press 2007) 267.
[2030] See Michaels (n 1836) 46.
[2031] See *supra* Chapter 7.2.1.

qualifying a theory as scientific."[2032] This is where Samuel continues that "[t]he only alternative epistemological test is to associate law with the non-empirical science of mathematics where the test is one of coherence rather than correspondence".[2033] Gaillard seemed to have intuitively made the same distinction as to his scientific method by claiming that "[a] mental representation is never right or wrong; it can only be coherent or incoherent".[2034]

658 Samuel explains that "[l]aw does not […] take as its object social reality – or at least an aspect of social reality – so as to produce a model that increases our knowledge of this reality. Law has as its object only itself"?[2035] However, law is a social phenomenon that coordinates human behavior. Does law pertain to the social sciences? While some object to law as being a social science,[2036] others see law as an essential social science thought.[2037] And the answer a jurist usually learns to give in the early semesters of studying law is: It depends. Samuel concludes as such, saying it depends much on the paradigm one adopts.[2038] This is outlined here to raise awareness to the fact that law and discussions about law and the different legal institutions are multifaceted and depend largely on paradigms.[2039] Further, it can be said that law is very similar to mathematics: while in nature, the dynamics of reality are discovered and captured mathematically, in society, new dynamics are also "discovered" and captured in laws and new regulations are passed.

659 Coming back to Michaels's critique of Gaillard: The fact that based on Gaillard's assertions, Michaels concludes that "[t]he epistemic community of delocalised law, it appears, is a community of faith",[2040] is significant. This is what legitimizes arbitration, or any other "social game" for that matter, and that is where game theory comes in, which this thesis will elaborate further on in the next chapter. Michaels not only observes that the "current paradigm of law, that of national positivism, the paradigm that transnational

[2032] Geoffrey Samuel, 'Is Law Really a Social Science? A View From Comparative Law' (2008) 67 The Cambridge Law Journal 288, 294. Footnote omitted.
[2033] Samuel (n 2032) 294. Footnote omitted.
[2034] Gaillard (n 153) 152.
[2035] Samuel (n 2032) 295. Footnote omitted.
[2036] See Samuel (n 2032) 289 et seq.
[2037] See Samuel (n 2032) 297.
[2038] See Samuel (n 2032) 321.
[2039] The concept of "paradigms" was introduced by Thomas Kuhn when he attempted to understand the difference between social and natural sciences. See Thomas S Kuhn, *The Structure of Scientific Revolutions* (The University of Chicago Press 2012) xlii.
[2040] Michaels (n 1836) 46. Footnote omitted.

law tries to overcome is also built, ultimately, on faith",[2041] but also that "HLA Hart's suggestion that the normative bindingness of positive law rests on the socially observable fact that people in fact recognise the rulemaking power of the sovereign. Not only is this recognition itself, quite possibly, a myth (just as Kelsen's *grundnorm* is a fiction)."[2042] Michaels further criticizes arbitration scholarship as "zealous advocacy", which "frequently masks a poverty of theoretical foundations".[2043] However, it is unclear what Michaels considers to be a sound theoretical foundation if he considers two of the most important legal theoretical foundations of the 20th century to be myths themselves. And there it is again, the recurring theme: beliefs, myths, fiction, faith.

660 At this stage, this thesis needs to borrow a figure from a previous chapter and modify it slightly to account for the new assumption or paradigm that arbitration, arbitration procedure, and its governing substantive and procedural laws are part of a belief system, and so are states as the larger legal orders in their entirety:

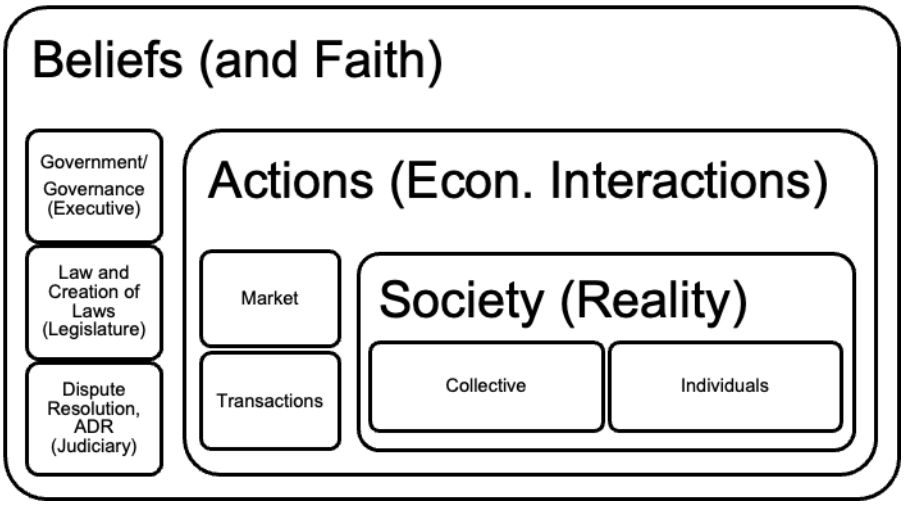


Figure 17. Simple social entities' layers, adapted[2044]

661 Breaking down the layers, what was formerly the state becomes the beliefs and faith of a society, which includes the government, laws, and - of particular importance for this thesis - dispute resolution. What was formerly the market become actions, tangible economic interactions of a society.[2045] And the society itself is the reality that continues

[2041] Michaels (n 1836) 54. Footnote omitted.
[2042] Michaels (n 1836) 55. Footnotes omitted.
[2043] Michaels (n 1836) 37.
[2044] Own figure.
[2045] This thesis deliberately leaves out actions of non-economic nature, since the main departing point of analysis is the subject of international commercial arbitration, which occurs after some economic transactions.

undisturbed, as individuals in a collective and does not seem to require any adaptation. The common denominator of this figure throughout the chapters is society. Since an individual alone is not in need of a market or a state, it is the collective that leads to actions within the society, thus between individuals and the necessity for order or maintenance of the belief system. This leads back to the notion of *ubi societas, ibi ius*.[2046] However, even the undisturbed parts of the model might shift, seeing that society itself can be seen as communication and the structure of society is made up of different functions of communication.[2047] This is also a significant realization because much of what occurs on the Internet is communication. Through blockchains, communication can be combined with value, shifting reality even more into the online realm.

662 Since the hypothesis is that arbitration forms part of the larger machinery of a society's/community's belief system, in which - for simplicity – there are three distinct pillars, of which arbitration pertains to one, the question arises as to what role it plays. Luhmann has an interesting perspective on this as, according to him, "law solves a problem in relation to time".[2048] Expectations are communicated, but since "social operations take time",[2049] and the future is uncertain, it is unclear whether expectations will be met or not, law thus serves as a means to cope with possible disappointments.[2050] According to Harari, the world's entire economies work because of societies' "trust in the future" or rather "trust in an imaginary future".[2051] Thus, law ensures stability in this trust at every level, including between two parties entering into a contract.

663 Dispute resolution is consequential to law, it functions as a means to align present reality with one's expectations made in the past about the present reality, when there is a misalignment, and is, in essence, societal approval or disapproval on a given unmet

[2046] See *supra* Chapter 7.2.1.
[2047] See Dietrich Schwanitz, *Bildung - Alles, Was Man Wissen Muss* (Eichborn Verlag 1999) 376–377. (Own translation: "What is society made of? It is made of communication (and not of thoughts or feelings or of the metabolism of organisms). What are communications? Fleeting and passing events. What is the structure of society made of then? Of those facilities that can combine volatile and transient events such as communications. In modern society, groups of people are no longer differentiated, but the types of communications are."). See also Landbrecht (n 1878) 43. (Landbrecht explains that "[s]ystems-theoretical analyses in the tradition of Niklas Luhmann and Gunther Teubner focus on communication contexts. If a communication context is stable enough to keep itself coherent, i.e. to develop its own and unique rationality, it is labelled a 'system'." Emphasis omitted.).
[2048] See Luhmann (n 1897) 142. See also Landbrecht (n 1878) 49.
[2049] Luhmann (n 1897) 143. See also Landbrecht (n 1878) 49.
[2050] See Luhmann (n 1897) 142–143, 146. See also Landbrecht (n 1878) 49.
[2051] Yuval Noah Harari, *Sapiens* (Vintage 2015) 343.

expectation. It supports the disappointed party who rightly believed in its expectation and thereby allows for society's continued trust in its shared beliefs. In other words, dispute resolution sews together tears in the trust fabric of society. If dispute resolution breaks down, so does society. International commercial arbitration rectifies unmet expectations in international, cross-border trade. If arbitration breaks down, so does international trade. Of course, there would be a back-up, which are the national judiciaries. However, it is hard to imagine sustained and thriving international cross-border trade without this special form of private adjudication. In a sense, arbitration is the legal institution of a global society where it is difficult to stabilize the shared beliefs (trust) by enforcement mechanisms of expectations in a single nation state (national courts) and thus requires cooperation on a global scale to meet business needs. And it has been a success, largely attributed to an international treaty, which 168 states have signed so far. It is remarkable that it works. How come it does?

7.2.7 A Game Theoretical Focal Point Perspective

664 This question leads the focus to shift briefly to game theory as it gives an interesting perspective on the phenomenon of arbitration and is thus valuable for the present analysis. This thesis earlier introduced Schelling's theory of focal points in connection with Kleros's decentralized court design.[2052] There, focal points are used to coordinate strangers to make coherent decisions. Game theory, founded by John von Neumann and Oskar Morgenstern in 1944, helps explain interactive situations.[2053] It can be defined as "attempts to mathematically capture behavior in strategic situations, in which an individual's success depends on the choices of others."[2054]

665 To illustrate:[2055] imagine a military leader with an army of soldiers who wants to conquer an island. The battle on the island happens between the soldiers who came by boat, called the blue army and the islanders, called the green army. A soldier of the blue army standing in the front lines may think that if they win, his single contribution will not be a decisive

[2052] See *supra* Chapters 5.4.5.1. and 6.4.
[2053] See 'Game Theory' (*Stanford Encyclopedia of Philosophy*) <https://plato.stanford.edu/entries/game-theory/>.
[2054] Wattenhofer (n 325) 217.
[2055] This is an adaptation and merger of two stories retold in the Stanford Encyclopedia of Philosophy, see 'Game Theory' (n 2053). The first one originally attributed to Plato (Laches, Symposium) referring to Socrates who tells the story of the Battle of Delium and the other story of the Spanish conqueror Cortez on his mission in Mexico.

factor and he is more likely to die even if his side wins because he is standing in the front lines. If they lose, however, his chances of surviving are smaller still. He is thus inclined to run away, which is true for all the other soldiers of the blue army as well. The battle is lost before it even begins. The strategic military leader thus burns the boats, the blue army is left with no other choice but to stay and fight. However, the green army witnesses the burning, which makes them think that for a leader to burn every boat, he must be sure of his victory, they thus retreat, and the blue army ends up winning.

666 This example illustrates how one's expectations of the expectations of others influence one's own behavior. One's actions are influenced by one's beliefs about what others believe. Basu explains that "[t]he might of the law, even though it may be backed by handcuffs, jails, and guns, is, in its elemental form, rooted in nothing but a configuration of beliefs carried in the heads of people in society".[2056] This idea, which can be traced back to David Hume,[2057] is closely linked to the law and economics scholarship on the so-called "expressive function of law", developed in the mid-1990s.[2058] The origins of these expressive theories of law are to be found in the Chicago School,[2059] and a subset of these theories does not specifically ask "why do people obey the law?", instead it asks "why people obey courts", and is called the "expressive power of adjudication".[2060] Another type is called the "focal point theory of expressive law", according to which law provides focal points that drive individuals to coordinate in a certain way.[2061] The concept of focal points was introduced by Nobel Laureate Thomas Schelling, who asserts:

> "People *can* often concert their intentions or expectations with others if each knows that the other is trying to do the same. Most situations […] provide some clue for coordinating behavior, some focal point for each person's expectation of what the other expects him to expect to be expected to do. Finding the key, or

[2056] Basu (n 1629) 40.
[2057] See Basu (n 1629) 40.
[2058] See e.g., Thomas A.J. McGinn, 'The Expressive Function of Law and the Lex Imperfecta' [2015] 11 Roman Legal Tradition 1-3.
[2059] Approaches developed at the University of Chicago, referred to as the Old and the New Chicago School, see Lawrence Lessig, 'The New Chicago School' (1998) 27 The Journal of Legal Studies 661, 662. See McGinn (n 2058) 3.
[2060] See Richard H. McAdams, 'The Expressive Power of Adjudication' [2005] University of Illinois Law Review 1043 et seq.
[2061] See Richard H. McAdams, 'Focal Point Theory of Expressive Law' [2000] 86 Virginia Law Review 1649 et seq.

rather finding *a* key – any key that is mutually recognized as the key becomes *the* key".[2062]

667 Focal points seem to be a psychological feature of humans, said to be closely linked to evolution.[2063] If ten random people were asked to pick the same door among twenty identical doors but had to decide independently from each other, each not knowing what door the others would choose, which one would they pick? Since all doors look the same, it would be difficult for them to coordinate and come to a common conclusion absent communication. Maybe the majority would go for the first door on the left or the second door on the right, maybe the tenth. However, if one door in the middle had a shining arrow pointed towards it, it would be easy to coordinate, as now there was something different about one door. It had become "the key". Basu explains that once people are convinced, something will happen, and believe that others assume the same, "they are locked in".[2064] Thus, by virtue of a contract, for example, parties can create a unique focal point in their relationship, believing that the other will act in a certain way and *vice versa*.[2065] And "the enforcement machinery – the police, the judges, the courts"[2066] are "[a] critical counterpart of modern law".[2067]

668 Arbitration as an alternative to litigation has the function to solve disputes or, in other words, to restore past belief in a certain outcome or expectation, which was not fulfilled. The New York Convention serves as a focal point for international trade and commerce, in the sense that if disputes arise, states recognize and enforce both arbitration agreements and awards because they expect that other states will do the same. Arbitration is thus a phenomenon of multiple societies that cooperate to establish a form of an alternative international judiciary for commercial trade. One of the major reasons arbitration has become so successful is the New York Convention, which has enabled awards to become enforceable virtually worldwide. An interesting question is whether blockchains can replace the New York Convention as an enforcement mechanism in the future, when most

[2062] Thomas C. Schelling (n 1175) 57.
[2063] See Basu (n 1629) 43 with futher references.
[2064] See Basu (n 1629) 52.
[2065] See e.g., Richard H. McAdams and Janice Nadler, 'Coordinating in the Shadow of the Law: Two Contextualized Tests of the Focal Point Theory of Legal Compliance' [2008] 42 Law & Society Review <https://doi.org/10.1111/j.1540-5893.2008.00361.x>.
[2066] Basu (n 1629) 7.
[2067] Basu (n 1629) 7.

of the real-world assets and digital assets are traded on blockchains.[2068] An intriguing question in this regard would be, what it means for focal points in general, if enforcement is guaranteed by the blockchain infrastructure and the mechanism design and "a shared belief" is not that relevant anymore. Or at least, that shared belief at one point was important but then has been coded into the blockchain.

669 Dezalay and Garth note that "it is relatively easy to imagine the development of international commercial arbitration as an aspect of a growing 'international legal field' – and indeed, a growing international legal order – with its own form of private justice detached from the national justice of states."[2069] However, what makes up an international legal order are international institutions and these "can change quite dramatically in response to transformations in the international legal field. The institutions can move *toward* or *away* from states. International does not mean a necessary decline of the role of states".[2070] Thus, even if one were to determine that arbitration belongs to an international legal order detached from the state, the relationship of such an order to states is still susceptible to different tides, like waves of attachment and detachment.

670 The essence of today's international commercial arbitration is thus the globally shared belief in international trade and the ability modern societies have developed to cooperate over vast distances to exchange goods and services beyond any nation state alone. If modern arbitration can be considered birthed in the late 1950s, it has had a wonderful childhood, followed by splendid teenage and adult years. If blockchains are now added to the mix, where does it lead to?

[2068] Interview #16, Lise Alm, voiced a concern. ("One of the big benefits of the New York Convention is that it provides enforceability. If you play by the book, the award will be enforceable. If you uphold due process, if you do it in this and that way, if the country agrees to so and so – then the award will be enforceable in all Convention states. Now, if you don't need that anymore because you have a built-in automatic enforcement, then it lessens the need to play by the (NY Convention) book. You lose the carrot in the carrot and the stick. The New York Convention and the Model Law being the stick, and the access to enforcement being the carrot. If you don't need it to get enforcement, is there a risk that we no longer need to play by the book to the same extent? If so, what would that mean? Do we need to take a renewed and closer look at how we safeguard our legal principles in the future if we no longer have the same fences as we have today through the New York Convention?").

[2069] Dezalay and Garth (n 649) 316.

[2070] Dezalay and Garth (n 649) 316.

7.3 Arbitration Unchained: The Emergence of a Crypto Autonomous Legal Order

7.3.1 Lex Cryptographica Arbitri

671 In the 1990s influential US scholars like Reidenberg coined the term *lex informatica* and Lessig wrote *Code and Other Laws of Cyberspace*.[2071] Reidenberg drew parallels between "merchants traveling across [medieval] Europe" with the emergence of *lex mercatoria*[2072] and users of the Internet "traveling on information infrastructures" which led him to coin the term *lex informatica*.[2073] Reidenberg reasons that "default ground rules are just as essential for participants in the Information Society as Lex Mercatoria was to merchants hundreds of years ago".[2074] Today, *lex informatica* operates cross-border, and is shaped and applied by the relevant global Internet communities.[2075]

672 Lessig argues that cyberspace requires a rethinking of how regulation works. He describes four major regulators for his "pathetic dot", *i.e.*, "the law, social norms, the market and architecture," that create a profound impact on society.[2076] While Easterbrook argued against the creation of a separate cyberlaw by comparing the law of cyberspace with the "law of the horse", which he considered a futile enterprise,[2077] Lessig, in contemplating the differences between cyberspace and the physical "real-world" space, recognized a distinct law.[2078] William Mitchell held that "[o]ut there on the electronic frontier, code is the law",[2079] an idea which Lessig fleshes out prominently in his book.[2080] Lessig makes "the software and hardware (i.e., the 'code' of cyberspace)" the central tool in his analysis and argues that it makes "cyberspace what it is" but "also regulates

[2071] See Reidenberg (n 1844). See Lawrence Lessig, *Code and Other Laws of Cyberspace* (Basic Books 1999). The second edition came out in 2006: Lawrence Lessig, *Code Version 2.0* (Basic Books 2006).
[2072] For a contrary view that the law merchant is a myth, see Bernstein (n 1862). See *supra* Chapter 7.2.2.
[2073] See Reidenberg (n 1844) 553 et seq. See Joseph Cannataci, 'Lex Personalitatis & Technology-Driven Law' (2008) 5 SCRIPT-ed 1, 3.
[2074] Reidenberg (n 1844) 553–554. Footnote omitted.
[2075] See Wright and De Filippi (n 481) 46–47. See also '3 Questions To... Primavera de Filippi' (*Coup Data*, 2019) <https://www.coupdata.fr/post/3-questions-to-primavera-de-filippi>.
[2076] Lessig, *Code Version 2.0* (n 2071) 123.
[2077] Frank Easterbrook, 'Cyberspace and the Law of the Horse' [1996] University of Chicago Legal Forum 207 et seq.
[2078] See discussion on this here: Wright and De Filippi (n 481) 47–48. See Lessig's challenge of Eastbrook here Lawrence Lessig, 'The Law of the Horse: What Cyber Law Might Teach' (1999) 113 Harvard Law Review 501.
[2079] William Mitchell, *City of Bits: Space, Place, and the Infobahn* (MIT Press 1995) 111.
[2080] See Lessig, *Code Version 2.0* (n 2071) 5. See Mitchell (n 2079) 111.

cyberspace as it is".[2081] Schultz also asserts that "the paradigm that law is perforce state law is less and less convincing. As a consequence, broader accounts of what law may be are being pushed. These competing accounts are candidates to become, sometime in the future, the new paradigm of what we collectively recognize and treat as law."[2082]

673 De Filippi discerns that whereas *lex mercatoria* was developed out of need "by and for an international community of merchants", *lex informatica* is forced onto users of online platforms.[2083] De Filippi and Wright observe that society "might be facing a similar inflection point in the history of the Internet" as in the 1990s.[2084] And parallels are drawn to *lex mercatoria*: Just like the needs of international merchants in the Middle Ages were not met by the infrastructures in place and the national courts of the time, so are the needs of those interacting in the crypto economy not met by national legal orders today because DApps, DAOs, protocols, and services based on blockchain technology that may operate autonomously can implement their own rules and normative systems, which De Filippi and Wright term "*lex cryptographica"*.[2085]

674 The authors first coined this *lex* in 2015 as "a set of rules administered through self-executing smart contracts and decentralized (and potentially autonomous) organizations".[2086] De Filippi and Wright argue that "mainstream adoption of [blockchain] technology may require a shift in the way we perceive the role of law".[2087] They argue that blockchain technology enables the emergence of powerful code-based and self-enforceable systems which "create order without law and implement what can be thought of as private regulatory frameworks", which they refer to again as *lex cryptographica*.[2088] This may enable a novel form of jurisdiction built on blockchains and by way of blockchains. And this is where a *lex cryptographica arbitri* to adjudicate disputes in a private manner becomes important.

[2081] Lessig, *Code Version 2.0* (n 2071) 5.
[2082] Schultz (n 95) 5.
[2083] De Filippi (n 1844) 24.
[2084] Wright and De Filippi (n 481) 48.
[2085] See De Filippi and Wright (n 5) 49 et seq. Note that the authors changed it slightly from "lex cryptographia" in their 2015 article to "lex cryptographica" in their book. See also Wright and De Filippi (n 481) 44 et seq. See also De Filippi (n 1844) 23 et seq.
[2086] Wright and De Filippi (n 481) 48.
[2087] Wright and De Filippi (n 481) 44.
[2088] De Filippi and Wright (n 5) 5.

675 It seemed like the Internet would break down even more barriers for the individual and bring about more freedom. However, modern Internet giants show a different reality, one in which platforms are more powerful than entire states and regulate the behavior of their consumers or members outside of state law. Blockchains and *lex cryptographica* enable individuals to participate in platforms and ecosystem built by and owned by the community. It breaks with old paradigms and moves the focus from the centralized multicorporate to decentralized "multi-cooperations". This digital decentralized economy is creating a parallel legal order by way of smart contracts and code, the rules are being established in weekly community calls on zoom, twitter, in telegram discussions, slack, and discord channels.

676 Aside nation states, international organizations, large corporations and centralized Internet platforms and services, such as Amazon, Google, Facebook, and Twitter, there is a new power structure emerging enabled by blockchain ecosystems that seem to be creating their own quasi-state entities in cyberspace or "cyberstates", while amassing power and capital in unprecedented ways. Ortolani rightly points out as regards "Bitcoin adjudication [that it] cannot be encompassed within any of [Gaillard's] representations as it constitutes an entirely 'floating' form of private adjudication, where the enforcement of dispute resolution agreements and the recognition and enforcement of decisions do not rely on any form of cooperation with national legal systems, but mechanically derive from the way the Bitcoin protocol operates."[2089]

677 If *lex cryptographica* are the laws of these nascent cyberstates, they have their own *lex cryptographica arbitri* in DApps parties can choose from, crypto arbitration then becomes the pure autonomous arbitration, entirely state-detached, as envisioned by Gaillard and dreamed by Lew, and others. Indeed, it is arbitration on blockchains, which in turn can elevate blockchains to themselves become crypto autonomous legal orders.

678 A "crypto autonomous legal order" is a legal order that uses cryptography and blockchains to achieve autonomy from state legal orders. In contrast to a state legal order, the architecture has its home not in the territory of a state but rather in cyberspace. Public, permissionless blockchains have their own governance mechanisms in place, which can be independent from states. Blockchain communities are experimenting with different

[2089] Ortolani, 'Self-Enforcing Online Dispute Resolution: Lessons from Bitcoin' (n 104) 612. Footnote omitted.

approaches to governing these powerful state-like entities in cyberspace. Programmable blockchains allow for smart contracts and economic transactions between users according to pre-defined logic.

679 Instead of requiring state adjudication, blockchains were supposed to be able to settle disputes through the technology itself.[2090] However, that is only part of the story and does not reflect present reality. The economy layer of the social entities' layers model presented in earlier chapters seems easily absorbed by blockchains, while other aspects are in an experimentation phase, such as on- and off-chain governance structures.[2091] Thus, blockchains are not fully autonomous legal orders yet because certain ingredients in the social entities' layer model[2092] are still in development, and especially dispute resolution is not fully operational on a blockchain-wide level.[2093] When dispute resolution on blockchains become crypto autonomous, *i.e.*, independent from the reliance on state courts, blockchains themselves can emerge as fully crypto autonomous legal orders. Such orders would be characterized by the diminished relevance of the New York Convention because blockchains and crypto arbitration together would have replaced the need to have awards enforced by state courts either because arbitral awards are voluntarily complied with or in cases they are not, they become self-enforceable.

7.3.2 Ultramodern Society

680 Since many of the concepts discussed in this thesis so far are still largely under development and concern the unknown future, it may be ripe for this thesis to offer some predictions. This thesis suggests that blockchains enable a global on-chain and online economy and the emergence of a crypto autonomous legal order, an entirely novel construct of the likes of states, albeit in cyberspace. In this section, this thesis embeds the previous discussions on arbitration on blockchains and its nature in a wider framework. Modern society may eventually develop into what this thesis terms an "ultramodern society", where humans are largely mediated through technology. Today, participation in the digital on-chain economy is mediated by smart phones, PCs and requires Internet

[2090] See *supra* Chapter 2.4.7., see *supra* Chapter 5.1.
[2091] See *supra* Chapter 5.3.1.
[2092] See *supra* figures 12, 13, and 17.
[2093] See *supra* Chapter 5.3.1 for the depiction of the social entities' layers, figures 12 and 13.

connection. In the future, these and novel devices will enable a highly immersive experience through Virtual Reality (VR) and Augmented Reality (AR).

681 The similarity between state entities in the off-chain world and blockchains in the on-chain world is depicted below:

Global Off-Chain World	**Global On-Chain World**
A state is an ordered form of a collective of human beings, in which power is **centralized**.	A blockchain is an ordered form of a collective of nodes (and subsequently mediated humans), in which power is **decentralized**.[2094]
Laws are rules for the collective of human beings.	Code laws are rules for the collective of nodes (and subsequently mediated humans).
States and laws order the relationships and interactions between human beings and provide a trust layer for economic transactions.	Blockchains and code laws order the relationships and interactions between nodes (and subsequently mediated humans) and provide a trust layer for economic transactions.
Human beings	Humans via nodes (mediated human)
Computers	Computers (Nodes)
State	Blockchain
Law	Code Law

Table 10. Comparison of offline vs online global economy[2095]

682 Code law is software code which emulates the function of law as an organizing mechanism in a society, which is transitioning to an ultramodern society. The importance of law in any modern society can hardly be overstated. Laws can be the means to enable freedom. An early legal code from as far back as approximately 2,360 BC had the first

[2094] Note that there are blockchains, which are not decentralized, and that the notion of decentralization lacks a clear definition and widespread agreement. Even blockchains, which are portrayed as being decentralized, upon closer inspection, may turn out not to be so. See *supra* Chapter 2.4.5.

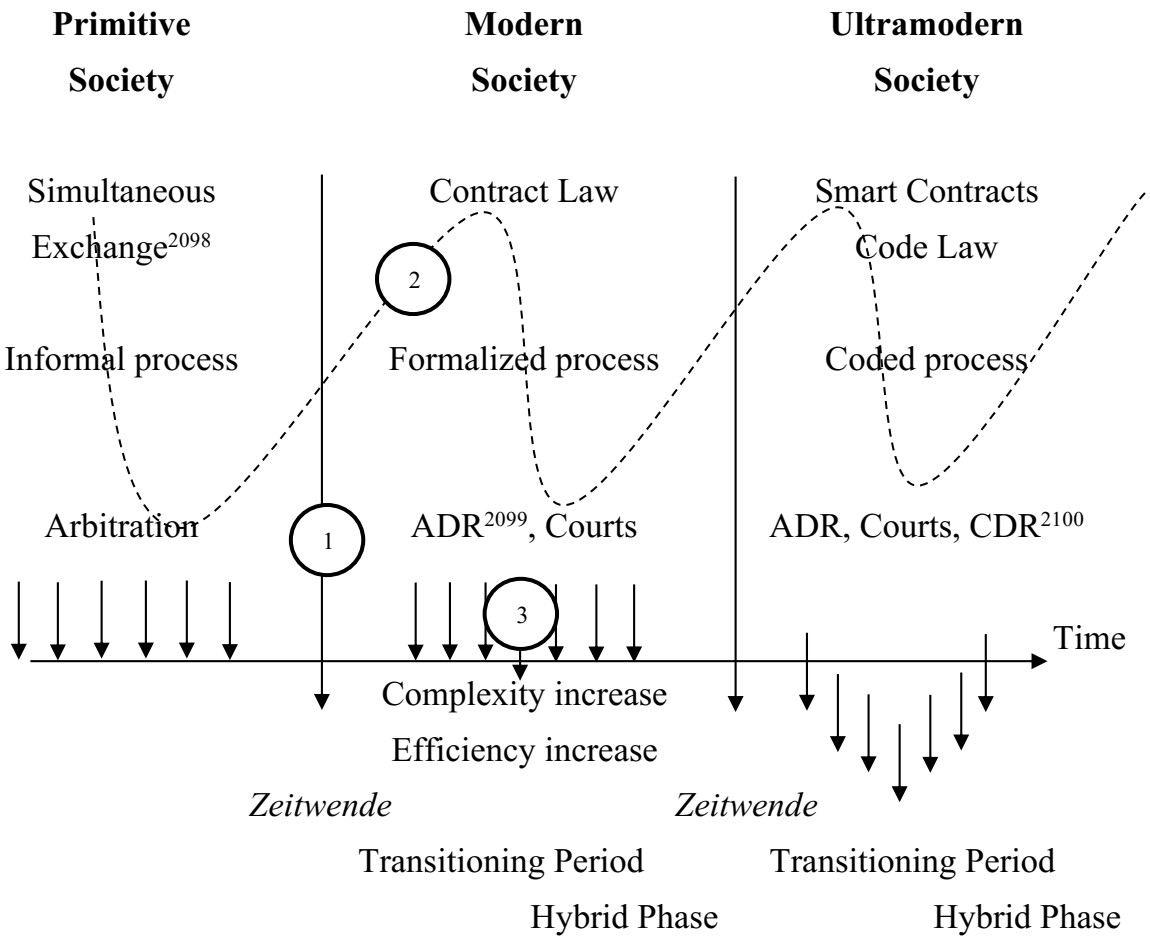
[2095] Own table.

known recorded instance of the word "freedom" in it.[2096] The question of course is whether humans can remain free in a world that will become more coded and artificially intelligent. Blockchains emulate the function of the state as they provide an infrastructural layer for the interaction between humans at an economic level in cyberspace. Humans cannot directly access the online global economy; thus, humans are mediated via nodes. Nodes are the access points for humans to enter the on-chain global economy. However, in the off-chain world humans are also mediated, though the architectures are different, mediation happens through laws and the state. The fabric that runs through and allows for every mediation is trust. Trust can be minimized in an on-chain global society and economy by way of public and permissionless blockchains, where transactions and protocols can be audited by everyone in a fully transparent manner.

683 At another level of abstraction, nodes enable humans to interact with each other on-chain. Blockchains are a consequence of that evolution and that interaction, which reflect human institutions and power structures. Berg, Davidson, and Potts observe that "blockchains both complement institutions and compete with them".[2097] This evolution, however, does not happen from one day to the other. The following figure depicts this thesis' assumption of the future development to an ultramodern society:

[2096] See Renita Murimi, 'When Humans Judge Other Humans Using Machines' (*MIT Computational Law Report*, 2021) <https://law.mit.edu/pub/whenhumansjudgeotherhumansusingmachines/release/1>. The "Code of Urukagina". See also Urukagina, <https://en-academic.com/dic.nsf/enwiki/175293>.

[2097] Berg, Davidson and Potts (n 17) 35.



1 ***Zeitwende*** – Widespread adoption of a new paradigm, a new age begins. Technological advancement continues in increments - **Transitioning Period.**

2 **Waves of progress**, increased trade activity, change happens at the level of economic interactions, which gets reflected in institutions, processes, and the law.

3 **Infrastructural breakthrough** occurs after multiple advancements. The technological innovation is so profound that it starts to revolutionize the fabric of society at the level of institutions, processes, and the law. Transitioning Period intensives, begin of **Hybrid Phase.**

Figure 18. Predominant Commercial Fabric of Society[2101]

[2098] See Posner (n 673) 859. ("Criminal (as well as virtually all other) law enforcement is almost entirely private in primitive and ancient societies." Footnote omitted.). See also Richard A Posner, *The Economics of Justice* (Harvard University Press 1981) 183. ("The economic activity of primitive societies is simple, so if the transactions governed by the law of contracts usually involve simultaneous (or virtually simultaneous) performance, the scope for that law is reduced to assigning liability for defects that show up later.").

[2099] Including ODR.

[2100] Crypto Dispute Resolution (CDR).

[2101] Own figure.

684 After breaking down society's evolution into waves of progress and different stages of transitions, this thesis suggests that Bitcoin marks the entry into a hybrid phase, in which the old technology and the new technology live side by side and once - in Clayton's terminology - the predominant design takes over and becomes the way in which society mostly operates, a *Zeitwende* occurs.

685 This thesis observed blockchains through the lens of the international arbitration's framework and suggests the emergence of a crypto autonomous legal order. In its effort to structurally map the societal shift, this thesis argues that blockchains mark a technological breakthrough or in Clayton's terminology "a disruptive innovation", an entirely new technology enabling society to do something it was not able to do before. Once such a breakthrough occurs, society enters the "hybrid period", where the new starts finding applicability and taking market share of the established infrastructure. In terms of the law, regulation and processes are put in place to reflect the changes, as advancements continue to happen in waves of progress until the shift is complete and society adapts the new standard in its entirety.

686 The transition from a primitive society to the present modern society is characterized by more formalized procedures and increased complexity. In primitive societies exchange was largely simultaneous and procedures were informal, the focus was on the present and dispute resolution, if any, was a violent enterprise or an entirely private and informal process of arbitration. As major advancements in technology occurred and societies started to build nation states, laws, and institutions to support their economic infrastructures, processes became more formalized, exchange could be deferred to the future, contract law became the epitome of commerce and courts with their alternatives provided the necessary trust layer.

687 Society finds itself in a transitioning period, which is its natural state of constantly changing. However, a transitioning and hybrid period is characterized by competing technologies of an infrastructural design that influences society on many levels, from belief systems that hold the infrastructure together to processes and institutions. Blockchains enable cooperation and economic value exchange online without traditional intermediaries. Although the narrative is that blockchains are decentralized, that is not entirely the case because the protocol needs to be maintained by various entities, who

have become more centralized and elitist, such as core developer groups and miners in PoW blockchains or stakers in PoS blockchains. Society could become even more formalized due to an even more significant increase in the degree of complexity, enhanced by more rapid and novel innovations in areas such as computer science, engineering, physics, biotechnology, and others. Language itself may have to change to adapt to this development.

688 Smart contracts enable a future, where much of the commercial processes will be coded, verifiable and evidenced, which reduces uncertainty in the future and leads to higher compliance with formerly negotiated expectations. If such a development were to happen, it could also be counter beneficial, depending on how strict and formalized compliance with pre-agreed terms become. Risks of contracting and participating in commerce for the individual could be passed on to individual DAOs or other new, yet unknown constructs that may represent humans in an on-chain economy.

689 However, enforcement to the letter can bear high social costs according to Posner.[2102] Therefore, deterministically operating smart contracts may pose problems, which is why redress mechanisms will become more relevant. The arrows depicted in the figure represent innovation in the ultramodern society, which goes much deeper, as disruptive innovation is likely to happen much more frequently.[2103]

690 Centralization and dominion of these economies by unknown, pseudonymous entities is present and poses great risk. Viable redress mechanisms in public, permissionless blockchains seem to be sacrificed to support the narrative of decentralization and attract developers who believe in "code is law". In the long run, however, some redress mechanisms to adapt the necessity of humans, will need to be implemented. This thesis therefore suggests that the (technical) viability and implementation of a default dispute resolution layer on public, permissionless blockchains, where blockchain-related disputes can be resolved, should be further explored. This is controversial as it may lead to what some may regard as centralization of power, such as if only select few decide on the

[2102] See Posner (n 673) 864.

[2103] See e.g., Yuval Noah Harari, 'Why Technology Favors Tyranny' (The Atlantic 2018) <https://www.theatlantic.com/magazine/archive/2018/10/yuval-noah-harari-technology-tyranny/568330/>. (Harari observes that "economic growth may not solve social problems that are now being created by technological disruption, because such growth is increasingly predicated on the invention of more and more disruptive technologies.").

outcome of disputes. There is of course much work ahead and oftentimes decentralization in blockchains is but a pretense. Safeguards need to be put in place where the legal systems of nation states largely remain blind, arbitration can serve as a bridge.

691 Some scholars make the case of arbitration being the default option in international commercial transactions.[2104] The argument is that since arbitration is deemed to be the preferred option in international commercial transactions, arbitration should be regarded as the standard procedure,[2105] even without the parties' consent.[2106] Such proposals in international commercial arbitration have not borne any fruit so far and parties are not put in an inferior position because in any case, they still have access to courts, should their arbitration agreement be invalid. This is true for B2B transactions. When it comes to B2C transactions, the US generally accepts arbitration clauses in such contracts, binding consumers to arbitration, whereas in the EU consumer arbitration is considered an unfair term.[2107]

692 On blockchains it may be indistinguishable whether a business or a consumer is transacting in any given situation if they have chosen not to reveal their identity. The situation on blockchains is rather alarming and there is clear need for a base layer type of recourse mechanism. Proponents of the "code is law" narrative, would not be inclined to accept such a dispute resolution layer. And the priority of the blockchain community presently largely lies elsewhere, such as in building applications in DeFi and NFTs. After all, blockchains are still a "bleeding-edge technology", if someone gets wounded, it was to be expected. If the dispute resolution clause remains an "afterthought" in the blockchain community's and industry's conscience, that may come to haunt the future digital economy.

[2104] See Jack Graves, 'Court Litigation over Arbitration Agreements: Is It Time for a New Default Rule?' (2012) 23 The American Review of International Arbitration 127–128.
[2105] See Graves (n 2104) 128 et seq.
[2106] See Gilles Cuniberti, 'Beyond Contract – The Case for Default Arbitration in International Commercial Disputes' (2008) 32 Fordham International Law Journal 487 et seq.
[2107] See, e.g., Justinas Jarusevicius, 'Consumer Arbitration – Will The Two Different Worlds Across The Ocean Converge?' (*Kluwer Arbitration Blog*, 2016) <http://arbitrationblog.kluwerarbitration.com/2016/02/25/consumer-arbitration-will-the-two-different-worlds-across-the-ocean-converge/>.

7.3.3 The Certainty of Change

693 Blockchains can only have emerged in a world where there is the Internet, they are native to the Internet and extend the cyberspace's possibilities to include a digitally native economy, whose reach may perhaps never be fully understood or captured in advance. The world is defined by change, or rather the world *is* change. This thesis main assumption is that blockchains will change international trade, which will ultimately influence any of its supporting institutions, including arbitration. This thesis thus suggests a "fourth dimension" for arbitration.[2108] Paulsson in his *Arbitration in Three Dimensions* explains that the world has changed in radical ways since the mid-20th Century, "a period of imperial dismantlement" happened after World War II and a "phenomenal expansion of international economic exchanges" ensued, the adoption of the New York Convention then accelerated this development.[2109] He also notes:

> "With dizzying speed, a world in which a majority of people were not citizens of their own countries, but of colonies, was turned right side up. It is an astonishing fact that a majority of States established by 1970 had not even existed 25 years before. The single year 1960 saw the accession to independence of the greatest number of states ever seen. Each was now in a position to create its own legal order. Each now had borders that defined international trade."[2110]

694 He later only briefly refers to the Internet,[2111] which, however, is arguably an even more radical change and he does not mention blockchains at all, which is only natural because by the year 2010, when Paulsson published the article, only few were interested in blockchains, and among those who were one ended up buying two pizzas worth 10.000 bitcoins.[2112] What is surprising, however, is how fast perceptions can change. From being worthless, bitcoins became highly valuable, not because they in fact are valuable but because people believe in their value. It is a shared belief or "fiction". This ability to

[2108] Following Jan Paulsson's example "Arbitration in Three Dimensions", see Paulsson, 'Arbitration in Three Dimensions' (n 635).
[2109] See Paulsson, 'Arbitration in Three Dimensions' (n 635) 9–10.
[2110] Paulsson, 'Arbitration in Three Dimensions' (n 635) 10. Emphasis omitted.
[2111] See Paulsson, 'Arbitration in Three Dimensions' (n 635) 23 (Paulsson makes reference to "a single global Internet", referring to the ICANN mechanism and the Domain Name System (DNS)).
[2112] Laszlo Hanyecz bought two pizzas on 22 May 2010 for 10,000 bitcoins, an event considered to be the first time bitcoins were exchanged for real goods. See Ambrose Leung, 'The Infamous Bitcoin Pizza Would Be Worth $470 Million USD If Ordered Today' (*hypebeast*, 2021) <https://hypebeast.com/2021/2/laszlo-hanyecz-bitcoin-pizza-money-470-million-usd-price?amp=1>.

create shared fictions is what according to Yuval Harari in his book *Sapiens*, has made humankind so successful compared to other species and has enabled the exhilarating progress that can be witnessed today.[2113]

695 Harari also calls the legal fiction of the "limited liability company" as being "among humanity's most ingenious inventions".[2114] Blockchains enable the emergence of DAOs, a new type of digitally native company structure, which does not need to be owned by or controlled by humans but could be owned and controlled by themselves, *i.e.,* code.[2115] Wright explains that "DAOs operate with different assumptions than many of today's traditional legal entities and other business associations. DAOs are not run by boards or managers, but rather aim to be governed by democratic or highly participatory processes or algorithms. Instead of operating in one or a handful of jurisdictions, DAOs seek to stretch across the globe, stitching together thousands—if not tens or hundreds of thousands—of members regardless of their physical location, background, or creed."[2116]

696 DAOs are a radical new idea that can completely change the landscape of economies. According to Wright "[l]arge blockchain-based ecosystems and projects point to a future where online groups coordinate at arms-length and potentially pseudonymously, relying exclusively or entirely on software."[2117] This means that online groups, whose interactions could not be viably monetized before, have a new vehicle to enable such cooperation, since DAOs enable easy, transparent, and efficient coordination of actions.[2118] The implications of this new collaborative design should not be underestimated, such online groups can gather much influence, as has been witnessed by

[2113] See John Reed, 'Yuval Noah Harari' (*Financial Times*, 2014) <https://www.ft.com/content/aee05cca-3416-11e4-b81c-00144feabdc0>. See Harari, *Sapiens* (n 2051).

[2114] Harari, *Sapiens* (n 2051) 32. During the ASA Conference in 2018 in Berne on Blockchains, Smart Contracts and Arbitration, Elliott Geisinger told the audience that the conference reminded him of what he read in Harari's book *Sapiens* and he agreed with Harari's observation that limited liability companies were one of the most important human fictions. He said that blockchains may create such a special event in human fiction-making, a tipping point for new wealth creation. The speeches were recorded, see Geisinger, *Closing Remarks* (n 873).

[2115] See *supra* Chapter 2.4.10.

[2116] Aaron Wright, 'The Rise of Decentralized Autonomous Organizations: Opportunities and Challenges' (2021) 4.2 Stanford Journal of Blockchain Law & Policy 152 <https://stanford-jblp.pubpub.org/pub/rise-of-daos/release/1>.

[2117] Wright, 'The Rise of Decentralized Autonomous Organizations: Opportunities and Challenges' (n 2116) 152.

[2118] Interview #7, Jorge Izquierdo explained that he has seen Aragon used for groups of people that gather and form around an idea or a meme and want to create a DAO and give each other tokens in order to form a reputation system in the community and enable the idea to take on a particular form by way of being able to monetize it.

the actions of an online forum (subreddit) group in early 2021.[2119] However, there are also many risks, DAOs operate in a legal grey area, many jurisdictions do not legally recognize DAOs, there is yet no optimal design structure for DAOs and a myriad of open governance challenges remain critical and unaddressed.[2120] Research and development across the blockchain ecosystem is tackling these unsolved problems, however, and with time DAOs may become more streamlined to the needs of modern digital economies.[2121]

697 DAOs represent a new paradigm of business entities and could constitute the predominant actors in the future digital economy. They enable collaboration between disparate groups, scattered across the globe on new infrastructural layers for economic transaction, *i.e.,* blockchains. Open-source, permissionless blockchain ecosystems have shown the ability to amass large amounts of capital.[2122] Harari explains that before the invention of limited liability companies, people were discouraged to open an enterprise.[2123] DAOs are arguably an invention at least as ingenious as limited liability companies and are the Internet's response to modern day off-chain companies. Smart contracts, the technology behind DAOs, enable anyone with an Internet connection and the required technical abilities to fund-raise their ideas, gather like-minded people to invest, support, collaborate, and benefit from the idea. The momentum is further fueled by more and more developers leaving centralized tech giants and building their own decentralized applications on blockchains.[2124]

698 If in the future digital economy, such DAOs and other types of digitally native companies become the new major players in international trade, and thus the new parties of arbitrations, the question is, will they resort to traditional means of international commercial arbitration or resort to crypto arbitration instead? The purpose of arbitration or adjudication historically was not to simply settle disputes, it was a means of power and

[2119] See, e.g., Pierre-Yann Dolbec, 'WallStreetBets Is Disrupting Financial Markets — Possibly Permanently' (*The Conversation*, 2021) <https://theconversation.com/wallstreetbets-is-disrupting-financial-markets-possibly-permanently-154355>.

[2120] See Wright, 'The Rise of Decentralized Autonomous Organizations: Opportunities and Challenges' (n 2116) 164 et seq.

[2121] See for example research and development funding platforms, such as 'Gitcoin Grants' <https://gitcoin.co/grants/>. And dGov (decentralized governance) initiatives, such as 'Metagov' (n 882).

[2122] See Vitalik Buterin, 'The Most Important Scarce Resource Is Legitimacy' (Vitalik Buterin's Website, 2021) <https://vitalik.ca/general/2021/03/23/legitimacy.html> (Buterin rightly observes "that the organisms that are the Bitcoin and Ethereum ecosystems are capable of summoning up billions of dollars of capital").

[2123] Harari, *Sapiens* (n 2051) 33.

[2124] See Robert Hackett, 'Bitcoin and Ethereum Are Now, Decentralized Apps Are the Future' (*Fortune.com*, 2021) <https://fortune.com/2021/05/27/bitcoin-ethereum-crypto-decentralized-apps-daos-coinbase-olaf-carlson-wee/>.

control, and judges were the extensions of a monarch to reach all areas of his kingdom.[2125] The emergence of blockchains is rooted in a deep suspicion towards the state, state entities and centralized forces in general. It is thus understandable why decentralized ecosystems prefer not to adopt an "arbitration layer" or "court layer" in their blockchain protocols, although the necessity is there. Arbitration as a private alternative institution to the state judiciary, however, should not arouse large apprehension. In fact, the concept of arbitration is seen largely in a positive light by blockchain communities. Decentralized applications, such as Kleros, are thus building opt-in arbitration solutions for parties to smart contracts, for whom there presently are no default redress mechanisms, so they can resolve their disputes in a decentralized manner. Although the present designs are far from optimal, they are allowing a glimpse into a future, which strives to be decentralized.

7.4 Conclusion

699 An MIT study found that more than 60% of jobs performed in 2018 had not even been conceived of in 1940.[2126] Similarly, at that time, the New York Convention, the most important pillar for modern international arbitration,[2127] was still two decades away. To preserve their sovereignty and territoriality, states are battling an ever growing strive towards a borderless world, and maybe they are losing the battle. Tech giants already practically govern more people than entire states and have gained considerable power in just two decades. However, they also act as gatekeepers and do not provide the same constitutional guarantees one enjoys from states. Blockchain ecosystems are sensing an opportunity to provide alternatives. Just within the last century vast changes occurred. The world is not the same it was a hundred years ago, when arbitration first showed its promise. What if people in the future placed more importance on their "citizenship", not that of territorial states, but of on-chain cyberstates? Or what some consider the evolving metaverse? States emerged in a pre-Internet era, and states' borders do not align with the borderless reality of cyberspace. Even now, there are already multiple realities, where

[2125] See Palmer and Roberts (n 621) 194 (Kindle version, Chapter "Government and Dispute Institutions").
[2126] David Autor, David Mindell and Elisabeth Reynolds, 'The Work of The Future: Building Better Jobs in an Age of Intelligent Machines' 10 et seq. (*MIT Task Force on the Work of the Future*, 2020) <https://workofthefuture.mit.edu/wp-content/uploads/2021/01/2020-Final-Report4.pdf>.
[2127] See, e.g., Paulsson, 'Moral Hazard in International Dispute Resolution' (n 643) 340. ("[W]e have a powerful instrument, namely the New York Convention on the Recognition and Enforcement of Arbitral Awards, often referred to as the most important legal instrument in the history of international economic exchanges".)

people are citizens of nation states and online quasi-states, whether it be DAOs or social networks.

700 Cyberspace has continued to evolve ever since the advent of the personal computer and the Internet. Mobile phones with Internet access allow modern society to be connected to cyberspace, which transcends any single state, virtually 24/7. Blockchains offer the ability to transfer value without relying on traditional institutions, including the state monetary system. This can have profound consequences, one of which is the emergence of a legal order that is autonomous from state legal orders. Figure 13 in Chapter 5.3.1, demonstrated that blockchains merge two separate social entities layers (as they exist off-chain) into one, the state and the market, transposed into cyberspace. As explained in Chapter 5.1, blockchains were built with the strive towards an immutable and dispute-free world, a utopia that does not exist.

701 The benefits of Online Dispute Resolution, which has been used for disputes in e-commerce platforms, are starting to be realized, especially due to the COVID-19 pandemic and the increased use of videoconferencing and remote hearings. Although the crypto arbitration model is a new phenomenon, its rationale is the same as with any dispute resolution mechanism: resolving disputes. In case an increasing number of assets becomes tradeable on blockchains in the future, including assets that are typically thought of as being off-chain because they cannot be easily moved, such as real estate, the significance of blockchains in general and crypto arbitration, in particular, will likely grow. It is the combination of blockchains with viable dispute resolution mechanisms, which can lead to the emergence of what this thesis calls a "crypto autonomous legal order".

702 The "arbitral legal order" as suggested by Gaillard and others, which is the theoretical concept of autonomous arbitration in relation to nation states is, in fact, no legal order at all. Ortolani rightly states that "a legal order only exists in the presence of autonomous powers to adjudicate, prescribe and enforce. As a consequence, not all instances of adjudication taking place in a private context demonstrate the existence of a private legal order".[2128] A legal order offers protective mechanisms to the breaches of its order. The concept of the arbitral legal order is not self-sufficient as it is a mechanism to attend to

[2128] Ortolani, 'The Three Challenges of Stateless Justice' (n 104) 610.

breaches. Instead of being a legal order itself, what international arbitration does is slightly change the effect of a national legal order for parties from being "solid" as a single nation state to becoming "liquid" legal systems in the multitude of states, between which decisions can move easily. This aligns with Paulsson's notion of pluralism. As such, by opting into international commercial arbitration, parties can transcend a single state and move enforcement beyond a single state's boundaries. What further speaks against arbitration being its own legal order is that it heavily relies on the New York Convention and the enforcement apparatus of national courts.

703 Likewise, crypto arbitration would not be self-sufficient as it would rely on the blockchain infrastructure and any decentralized application that underlies it. However, crypto arbitration could be crypto autonomous from state legal orders if enforcement can be confined within the blockchain infrastructure without relying on national courts. It would be the mechanism to attend to disputes that may result from transactions on blockchains. Blockchains could become crypto autonomous legal orders in cyberspace when they fulfill the three characteristics as described by Ortolani, "to adjudicate, prescribe and enforce".[2129]

704 Twenty-five years ago, Dezalay and Garth noted that "the history of business disputing shows that change is typically made through the creation of new models and institutions rather than simply modifications of the existing institutions."[2130] They also observe that "[t]he field may certainly be transformed, but in the absence of major unsettling events like wars or political upheavals, the change takes place according to social logic and even a rhythm of generations".[2131]

705 Blockchains and crypto arbitration would fit Dezalay and Garth's description of such entirely new models and institutions as engines of change. Moreover, the newer generations are digitally savvy, mobile first, and are dancing to a rhythm, whose beats are much faster.

[2129] See Ortolani, 'The Three Challenges of Stateless Justice' (n 104) 610. Thus one may doubt the characterization of the arbitral legal order as a separate legal order. Dispute resolution is one of the pillars that make up a legal order and does not itself represent its own legal order.
[2130] Dezalay and Garth (n 649) 315.
[2131] Dezalay and Garth (n 649) 316.

Chapter 7: Summary

Legal scholars and philosophers have debated the nature of law and legal institutions for centuries. Early philosophical notions lead to the discovery that disputes may be considered the very birthplace of law. In international commercial law and arbitration law, the theoretical debates concern the essence of arbitration. Various types of views and theories have emerged, from the territorial and localized, to the transnational and finally the autonomous views of arbitration. Scholars from other legal fields sometimes read arbitration scholarship with bewilderment, criticizing the daring "dreams", "representations", and "dimensions". However, even critics come to the realization that the institution of international arbitration is intriguing from both a practical and theoretical point of view and that it aligns with one of human being's most fundamental strives, the one towards freedom. Arbitration's paradox lies at the center of the debate, in the interaction of its founding principle and the *lex arbitri.* And arbitration's essence, hidden in the paradox, is uncovered as a shared collective belief. The focal point game theory explains the notion of shared beliefs and gives a compelling reason as to why the New York Convention works. Finally, arbitration in the blockchain context may be considered the necessary ingredient to elevate blockchains to create their own crypto autonomous legal orders, where an ultramodern society can do business in the future digital economy. Although the future is uncertain, there is certainty in change.

8 Chapter 8: Conclusion and Future Outlook

8.1 Introduction

706 This thesis has contributed to the nascent field of blockchains and the law. And within this nascent field, it has devoted its attention to a largely neglected area, whose importance is usually only felt once disputes arise, *i.e.,* when the damage is done. Similar to contract negotiations, where parties are not keen on discussing the dispute resolution clause, which ends up being an "afterthought" or a "midnight clause", this should not happen when it comes to such important infrastructural layers of the future that are being built today. This thesis analyzed a set of open questions at the intersection of blockchains and international dispute resolution, focusing on arbitration.

707 Blockchain technology allows for new ways in which parties can collaborate without traditional trusted intermediaries. There is widespread consensus that blockchain technology is a disruptive force, which will find its way into most areas of the global economy. The first example of a functioning blockchain is Bitcoin, which may be termed a first generation blockchain. Second generation blockchains allow for more leeway in terms of structuring economic transactions by enabling the design of smart contracts, powering DApps, DAOs, and NFTs. Ethereum is the first and most prominent example of this type of blockchain. Smart contracts are software code deployed on a blockchain that can enforce terms of a contract according to pre-programmed logic. The technology is developing rapidly, and no viable default redress mechanisms exist. This thesis advocates for continued discussions on this important topic. Parties that transact on blockchains find themselves in an area that can be described as a "blind spot of the law". In the following the research questions are answered in a summary fashion, drawing upon the previous chapters.

8.2 The Research Questions and Summary of Outcomes

8.2.1 Research Question 1

What are the approaches to dispute resolution on blockchains? *Sub questions: How does crypto arbitration differ from traditional international commercial arbitration? How can blockchain disputes generally be conceptualized?*

8.2.1.1 *Approaches to Dispute Resolution on Blockchains*

708 Already in the Bitcoin Whitepaper, Nakamoto hinted at the necessity for dispute resolution. It is possible to trace the development of dispute resolution discussions relating to public and permissionless blockchains back to the early days of Bitcoin, where Nakamoto discussed escrow-based mechanisms with other users on Bitcointalk. Aside escrow, multisig addresses were found to be a blockchain-native early way to resolve conflicts, where an arbitrator holds a key in a three-key address. The critical moment in blockchain dispute resolution history is the emergence of Ethereum as a programmable blockchain, enabling the use of smart contracts. Ethereum can be considered the catalyst to even more blockchain innovation and disruption, where radical ideas have been experimented with in a sandbox-like style.

709 One year after the launch of Ethereum, Buterin shared his idea for a decentralized court and Antonopoulos and Morgan proposed the creation of a global borderless jurisdiction powered by blockchain technology. A competing programmable blockchain called EOS, which wanted to establish itself as a "governed" blockchain, brought forth the EOS Core Arbitration Forum ("ECAF"). The initial success of the forum was short-lived as the community perceived the arbitrators as lacking legitimacy. Another "governed" blockchain changed the structure of ECAF to increase the perception of legitimacy of arbitrators on its blockchain but has not had a single case decided yet. Kleros is the poster child for crypto arbitration and has developed Buterin's idea of a decentralized court further. With a working product, ongoing development, and continuous community support, it can be considered an early success story. Aragon is developing its Aragon Court based on a similar philosophy and design to Kleros and focuses on DAOs. Jur has a Kleros-like app, which is not live yet as their focus is on providing a digital platform for mainstream arbitration cases. Mattereum links on-chain real world assets with off-

chain arbitration, CodeLegit introduced the idea of an Arbitration Library, OpenCourt showcased a prototype of an arbitrator interface to decide on disputes between parties that have used smart contracts for payments and LexDAO is providing parties with the ability to integrate their dispute resolution service into smart contracts.

8.2.1.2 *Major Differences between Traditional and Crypto Arbitration*

710 Among the various identified approaches, crypto arbitration is to be highlighted as a radical new way of how disputes can be resolved using blockchains. The differences to mainstream international arbitration are manifold, starting with the parties, arbitrators, and the procedure itself. The most striking differences relate to how the decision-makers are chosen and the underlying incentives in decision-making. Whereas in conventional arbitration, parties usually appoint their arbitrators, in crypto arbitration, arbitrators self-select into expert pools, from which they are randomly drawn in case of a dispute. Arbitrators do not know the other arbitrators who are deciding the same case and are incentivized to decide according to how they think the majority will decide, *i.e.,* based on so-called Schelling Points. Although very different from mainstream arbitration, the phenomenon of crypto arbitration can be considered an expedited arbitral procedure (extreme fast-track). It is built on the same fundamental principle, *i.e.*, party autonomy. Party autonomy is the foundation of international arbitration and can be transposed to blockchains.

8.2.1.3 *Classifying Crypto Disputes*

711 When it comes to conceptualizing blockchain-related disputes, one can broadly distinguish between “base layer” disputes and “application layer” disputes. Base layer disputes relate to issues of governance, which may impact the entire blockchain infrastructure, and application layer disputes relate to issues resulting from applications, such as smart contracts, DApps, and DAOs. A governance dispute can be the consequence of an issue on the application layer, as was the case when The DAO hack happened, where a hacker was able to exploit a weakness in a smart contract code. A subcategory in the applications layer, are on/off-chain clashes, which refer to issues that may arise in discrepancies between the data stored on-chain and off-chain. Such disputes may arise from payment channels or oracles. Other issues that may arise are not disputes

per se but rather relate to, for example, users losing their keys or sending funds to wrong addresses and do not belong to the two broadly defined above categories. One of the most difficult problems to solve are governance disputes, they need careful consideration, and many research projects are trying to optimally design on- and off-chain governance systems. A major governance dispute that in 2016 led to Ethereum splitting into Ethereum and Ethereum classic via a hard fork can be seen as the catalyst for the emergence of dispute resolution systems on Ethereum and on-going discussions. There are other governance disputes that have occurred on Bitcoin and other blockchains. The topic of governance will become more important as will the need for parties to have viable means of recourse on blockchains.

8.2.2 Research Question 2

What are the legal effects of an arbitration agreement as smart contract code? *Sub question: Can such an agreement be entered into validly?*

8.2.2.1 *Smart Arbitration Agreements*

712 There is much legal uncertainty concerning crypto arbitration. If the arbitration agreement is deemed to be invalid, all subsequent actions, the arbitral procedure and the resulting arbitral award are invalid as well. Understanding whether an arbitration agreement in form of code can be entered into validly is thus important from the outset. That is the case, if parties want to make use of the powerful international arbitral legal framework that the New York Convention represents, where awards are enforceable virtually worldwide. However, parties may not need to make use of this powerful instrument when blockchains themselves can represent such powerful infrastructures, where arbitral awards could be coded smartly so as to be directly enforceable. Whether such questions will be relevant to parties that opt for crypto arbitration remains to be seen.

713 In crypto arbitration the design foresees two different smart contracts, one that parties can design and the other that is not directly accessible to them but can only be changed by the governance mechanism at the DApp infrastructure level. This means that such an arbitrator contract will be ruled by a DAO, where the majority of token holders, *i.e.*, the community of arbitrators, can decide on different parameters of the arbitral procedure, including the fee structures, and more. The arbitrator contract can be thought of as the

mechanism that is attached to a pool of arbitrators that once it is triggered, meaning once a dispute is sent to it, will choose appropriate candidates to resolve any upcoming disputes. The contract accessible to parties is the "arbitrable contract", which would be the blockchain equivalent of an arbitration agreement. There, the parties can choose which arbitrator contract any dispute should be sent to. The arbitrator contract in crypto arbitration would be the replacement of what one would consider traditionally as a seat of arbitration, thus becoming a digital seat and it would determine the *lex cryptographica arbitri*.

8.2.2.2 *Validity of Smart Arbitration Agreements*

714 The international arbitral framework generally adopts a pro-arbitration stance, meaning that if arbitration agreements are to be interpreted, there is a bias towards validity. The minimum requirements for an arbitration agreement are the *essentiala negotii,* which are the identifiability of a dispute and the intent of the parties to submit their dispute to arbitration. However, aside these there is also the formal validity, objective and subjective arbitrability requirements.

715 In drawing on the discussion concerning "click-wrap" and "browse-wrap" agreements, smart arbitration agreements, may also lead to the formation of at least two camps, who either see them as not fulfilling the requirements of Article II (2) of the New York Convention, since an agreement in code cannot be considered an "agreement in writing". Further, interacting with a smart contract by way of a wallet in a web3 interface or otherwise does not constitute a party's signature, and the exchange of data on blockchains does not constitute an "exchange of letters or telegrams".

716 The other camp may see smart arbitration agreements as being new communication technology, and modern-day equivalents to telegrams. Thus, arbitrable contracts or smart arbitration agreements should be able to satisfy the requirements of the New York Convention. The UNCITRAL Model Law recommends states to adopt a liberal approach and offers an option of abandoning the writing requirement altogether. There are some jurisdictions which allow for arbitration agreements to be concluded orally.

717 Article 178 (1) Swiss PILA requires arbitration agreements to be evidenced in text. The rationale was to protect parties since they waive their access to state courts. The writing

requirement is fulfilled if the agreement is accessible in any manner that can be evidenced by text, and commentators also refer to the intent being accessible visually, which may not require a traditional text-form. Here again, there can be debates as to whether code can be regarded as text or not. The better view is that software code alone will not fulfill this requirement, although it can be accessed online and printed. Although software developers may understand the code, it cannot be assumed that the public, general users of blockchains, or that court judges do. Initially, this thesis drew a distinction between smart contracts that can substitute legal contracts in their entirety, those that reflect the terms of a legal contract (either a written contract or an orally concluded legal contract, which could lead to problems in translation), those that are embedded in legal contracts to automate certain aspects (complement variant), and smart contracts that have no legal relevance at all. The substitution variant is the most ambitious one, its true realization uncertain.

718 Considering the Swiss legislator's objective of protecting parties who are waiving access to state courts, parties will have to either attach comments to the code which is in natural language text-form or present a written agreement, either of which should preferably be signed by the parties. In addition, if parties want to use crypto arbitration as a method in their conventional contracts, the clause in a written agreement should refer to the specific blockchain addresses of the arbitrable and arbitrator contracts so as to avoid misunderstandings. However, even these precautions will not eliminate the risk of pathological smart arbitration agreements. As with any bleeding-edge technology, different features may change unexpectedly. Even if parties make sure to fulfill the requirements today, parameters outside their reach may invalidate their agreement, such as if the decentralized application ceases to be operative due to insufficient community support and active arbitrators.

719 Although one could argue for a general presumption of a party's legal capacity when interacting on blockchains, besides natural or legal persons, bots or even other smart contracts could be interacting with a smart contract, which leads to questions regarding novel forms of personhood. Pseudonymity poses a challenge in this regard. Parties will have to expose their real-world identities if they wish to seek support from national state courts. A general presumption of consent could be argued for if the parties' confirmations of the specific transactions belonging to an arbitrable contract can be verified on

blockchains. However, if crypto arbitration is set up not separately by parties in their individual transaction but is instead used as a dispute resolution mechanism embedded in another decentralized application, missing consent can become an issue.

8.2.3 Research Question 3

Do the rules that govern crypto arbitration comply with international due process and fairness standards? *Sub questions: What are the basic principles of fair procedure that need to be maintained? Can these fundamental standards be transposed to and safeguarded within the blockchain context? Does a game theoretical approach to decision-making in arbitration, as proposed in Kleros' blockchain dispute resolution process, constitute a fair process?*

8.2.3.1 *Basic Principles of Fair Procedure in International Commercial Arbitration*

720 Arbitration relies on the use of an impartial third party who observes due process. Due process ensures the integrity of the arbitral process. It encompasses the parties' equal treatment and right to be heard. Provisions relating to these fundamental principles are ubiquitous. They can be found, for example, in Article V(1)(b) of the New York Convention, Articles 1(2), 18, and 19 of the UNCITRAL Model Law, and Article 17 of the UNCITRAL Arbitration Rules. These fundamental principles can be found in Swiss law in Article 182 (3) and Article 190 (2)(d) of the Swiss PILA, whose standard is considered to be the same as the one enshrined in Article 29 of the Swiss Federal Constitution. As one of the most frequently invoked grounds for setting aside procedures, making sure that parties are heard and treated equally is perceived as so important, that a trend towards "due process paranoia" can be observed, meaning that arbitral tribunals can be reluctant to act decisively in certain situations for fear of violating any of these fundamental procedural rights.

8.2.3.2 *Due Process in Crypto Arbitration*

721 Crypto arbitration uses crypto economics to incentivize decision-makers and randomly assign them to disputes. There is general reluctance to perceive this system equally as fair as traditional arbitration. However, different elements of traditional arbitration are also criticized, among them, the party-appointment of arbitrators. It could be argued that randomly assigning specialized and pseudonymous arbitrators to disputes puts parties at

an equal playing field and saves considerable time and costs because choosing an arbitrator is one of the most time consuming and crucial parts in an arbitration. There can be value in a system where specialists self-select into expert pools and are then randomly assigned to cases, for which they have expertise. There is also value in the pseudonymity of arbitrators, if it can indeed be guaranteed, such that it may even enhance the perception of impartiality. However, at the same time, there can be doubts as to the arbitrators' independence and whether conflicts of interest can be ruled out. Especially in a dispute, where the parties are unknown to each other, the concept becomes problematic.

722 One of the elements of crypto arbitration met with high suspicion is the game theory aspect. Arbitrators, if they are pseudonymous and do not know each other, need to come to a coherent decision although they cannot communicate with each other. If each arbitrator selects a different outcome, no decision is made. Crypto arbitration thus uses Schelling Points to gear arbitrators to largely decide on the same outcome. This means that whenever crypto arbitrators need to decide, they will try to anticipate how the others will adjudicate the dispute and select the same outcome they believe the others will choose. The system is designed in a way that arbitrators are penalized if they do not decide with the majority, so there is a high incentive to decide coherently with the majority, even if that majority is unknown at the start. This can be perceived as problematic from a due process standpoint. However, parties have great freedom in designing their arbitration. Parties can agree to only written procedures without a hearing because the right to be heard does not include a right to express oneself orally, they can also limit submission rounds and other aspects of the procedure by agreement.

723 When parties choose crypto arbitration, they submit to a smart contract to automatically choose arbirators who will then render a decision. The process allows for the submission of evidence without much limitation and parties can appeal decisions on grounds of substance as well. However, the system is not perfect, what may raise concern is that parties can themselves be chosen as arbitrators, anyone can appeal, and the case may not be completely in the parties' hands.

724 The general sentiment is that crypto arbitration will have to evolve and improve many of its current features to become more attractive to commercial parties. One of the crucial points is due process. Still, one could argue that parties can agree to crypto arbitration

and validly so if they do so voluntarily, in full knowledge of the conditions of such an arbitral procedure, and to no detriment of third-party or public interests. The freedom of parties to contract should thus include for them to choose any such arbitral procedure as they wish, besides *ad hoc*, institutional, they could now submit to crypto arbitration as an even speedier form of fast-track arbitration. On blockchains, where parties can be anonymous and where it may be impossible to have access to courts, such as provided by national state systems, such an arbitration may be the only viable means for parties to find a resolution to a dispute if no default redress mechanisms exist.

8.2.4 Research Question 4

Which legal theory of international arbitration can be applied to crypto arbitration? *Sub questions: What are the legal theories of international commercial arbitration? Does resolving disputes on a blockchain create a separate, autonomous legal order?*

8.2.4.1 *International Arbitration's Legal Theories and Arbitration as Part of a Liquid Legal System*

725 The degree to which arbitration can be seen as distinct from national legal orders depends on the model of arbitration one adopts, such as territorial, transnational, or autonomous, among others. The origins of the debates regarding the legal theory of arbitration are to be found in the *lex mercatoria* discussions, which increasing scholarship considers to be a myth. Arbitration's founding principle, party autonomy, plays a significant role in these discussions as does the relationship between courts and arbitral tribunals. Arbitration cannot be considered a separate legal order because of the function it entails as a dispute resolution mechanism. A dispute resolution mechanism is but a pillar of a legal order or a multitude of legal orders. However, the debate is ongoing, and a paradox is often found in autonomy discussions: arbitration seems to want to break free from the very source that enables its existence. This thesis considers arbitration as pertaining to a global "liquid" legal system that parties can opt into, such that decisions *move* much more easily cross-border, as they do not stay contained within a "solid" legal system of a nation state alone. The notion of legal systems and of their dispute resolution mechanisms, whether litigation or arbitration, are part of a shared belief of society. Furthermore, game theory and expressive functions of law scholarship may provide new insights into the nature of arbitration and its legal frameworks.

8.2.4.2 *Crypto Autonomous Arbitration as Part of Crypto Autonomous Legal Orders*

726 Since crypto arbitration can operate without interference or support from state courts, one may theorize it as truly autonomous arbitration. However, like international commercial arbitration, crypto arbitration does not become an arbitral legal order by the degree of autonomy it achieves from nation states. Presently, crypto arbitration can be considered an experimental method to achieve a type of judiciary for emergent blockchain ecosystems. It can be considered crypto autonomous because it can be independent from national state courts through the use of cryptography and design incentives. This thesis views blockchains with the help of crypto arbitration as allowing for the emergence of crypto autonomous legal orders. Such legal orders based on cryptography and crypto economics are Internet-native and can be highly independent from nation states and national court systems. Therefore, continued research regarding viable dispute resolution mechanisms is important.

8.3 Future Research Avenues and Suggestions

727 The present study is situated in a wider research field encompassing blockchains and the law and is thus interdisciplinary. The intersection of blockchains and dispute resolution as well as the notion of justice and justice systems, presents novel and exciting research opportunities, which teams can undertake made up of such diverse disciplines as, for example, psychology, law, philosophy, political science, ethics, (behavioral) economics, mathematics, computer science, cryptography, and computational social choice. Further, combining legal research with blockchains and artificial intelligence opens research avenues, whose paths are only limited by ones' imagination. In preparation for this thesis, many more research avenues were identified and drafted, whose design, timeframe, and ambition far exceeded the scope of the present study. Some of these will be briefly described below.

728 In preparation for this thesis and in deciding upon the methodology, two more surveys were drafted to gather quantitative empirical data. One survey aimed to capture the perspective of arbitral institutions on blockchains and the crypto industry and to enquire their general sentiment towards these industries. The objective was to uncover whether any cases related to blockchains have occurred so far, whether arbitral institutions offered

blockchain-based arbitration services and whether they accepted cryptocurrencies as payment. The second survey aimed at collecting counsel and the arbitrators' perspective on the topic of blockchains within the arbitration industry. Such surveys may present a base for future academic empirical research in this field. The perspectives of both arbitral institutions and practitioners provide deeper insight into the current practice regarding these technologies in the established arbitration industry. The results of periodic surveys with a three-to-five-year gap may give a continuous account of the developments to directly grasp any convergence of the blockchain and arbitration industry when it occurs. Other possible surveys may be addressed to regular users of blockchain arbitration protocols, DAO services, DeFi, and more. Combining different approaches in gathering empirical data, both qualitative and quantitative, addressing multiple stakeholders, allows for future academic research possibilities.

729 Valuable further academic research would entail testing the Kleros Court in the main net version of Ethereum, by presenting the jurors with real-world arbitration cases in a condensed form and comparing the decisions derived at by Kleros jurors to the awards made by arbitral tribunals. Court cases more readily available may also be tested in a blockchain protocol. This may lead to the employment of such protocols at national courts. In a pilot study one could start implementing the protocol in a sub-section of a national court.

730 One may even go one step further, taking the example of on-chain decision making protocols, implement the code at the University's Behavioral Lab with a new set of tokens to undertake a larger study within the field of law and behavioral economics, starting with students and then expanding the study to include random participants from the wider population to act as jurors. One may then employ, different incentive mechanism designs and perform experiments during the participants' decision-making process. Another perspective would be to compare the decisions rendered in a lab environment to the decisions rendered in the original court on the Ethereum main net for the same set of factual cases. Such studies would further enlighten the current understanding of blockchain decision-making protocols and the employability of these in national legal systems for the benefit of the public.

731 Under controlled circumstances in a lab, all the metrics of the court and protocol are open to one's modification. In fact, that would constitute one of the more interesting research

avenues to advance the research field. Experiments, which have been and are regularly undertaken within the field of law and behavioral economics, could be reproduced using blockchain decision-making protocols to compare the advantages and disadvantages with tangible data. In collaboration with the computer science department, the next step could be to design algorithms that may perform the task of jurors in a decentralized court protocol and compare these to human juror performance.

732 Legal research that employs methodologically rigorous designs, encompassing statistical, data, and computational analysis, will become more important due to increasing digitization. Blockchain technology is a novel institutional layer that enables individuals - who may even have conflicting goals to the detriment of each other, - to work together based on incentive design choices. It offers vast opportunities for further discoveries, which should not be left unexplored. Much more work remains to be done in the intersection of novel technologies with international dispute resolution, the dynamics between and the evolution of public and private adjudication, international governance, and civil procedure.

733 The emerging literature, largely stemming from the US, on the expressive function of law and adjudication could be extended by questions pertaining to private adjudication and specifically arbitration. Combining the expressive function of the law literature with international commercial law and notions of international private ordering may further enhance the understanding of how game theory may have a pivotal role to play in legal systems.

734 As the technology becomes more widely understood and adopted to a greater extent, blockchains may become critical public infrastructures with diverse and multifaceted applications, such as DeFi, DApps, DAOs, and IoT services. Given that such a development is likely to happen and that widespread use will only increase over time, it is paramount to follow the development closely, test different incentive designs of crypto dispute resolution on a continuous basis, and challenge any observed flaws early on. This thesis offered only one possible way to analyze dispute resolution in its interplay with disruptive technologies. There is much work ahead.

8.4 Closing Remarks

735 Dezalay and Garth in their groundbreaking book on international commercial arbitration *Dealing in Virtue*, state that "[h]owever powerful, an idea, like any new invention or technology, still requires carriers to promote it in a new context."[2132] Paulsson observes that "[i]deas move the world".[2133] Bitcoin was conceived more than a decade ago by a mysterious Satoshi Nakamoto. At first adopted by a small group of people in the spirit of the cypherpunk movement, the network has grown beyond anyone's expectations. The message ingrained in the first block of the first blockchain was one of freedom and new beginnings. Today's world is different from the one encountered at the beginning of this research endeavor, the years 2020 and 2021 have seen a rate of crypto adoption unmatched so far. More private, as well as public institutional investors, have started adopting bitcoin, even nation states.

736 Bitcoin gave rise to other blockchains, one of them thriving with a sandbox-like attitude is Ethereum, the first and most used smart contract blockchain to date. Some of the thought leaders of the blockchain space, such as Antonopoulos and Buterin, recognized the need for dispute resolution for these emerging, still nascent, technical, mostly mysterious institutional layers to the fabric of society early on. What if these layers become the foundation of most of the world's economic interactions in the future? The signs are there. Some companies are leading the way, recycling ideas of societies long gone, placing them in a new context, innovating in what seems a parallel world that obeys different laws, those of code and algorithms.

737 The future is uncertain like a faraway island one has never visited before. It is distant and unknown. What novelties may await society on that island, what costumes and cultures? Is there a satisfying answer to "what is law"? How has society changed, how has the legal system changed? Is there a legal system? Are disputes prevented and resolved more efficiently? Is the world more peaceful, is it fairer, is it just? Or has the crowd become an irrational digital mob? Has international arbitration reinvented itself, has it transcended borders and moved completely online? Has it gone so far as to replace national court

[2132] Dezalay and Garth (n 649) 3. Yuval Harari has an interesting remark in this regard, see Harari, *Sapiens* (n 2051) 35.
[2133] See Paulsson, 'Arbitration in Three Dimensions' (n 635) 2.

systems entirely, and has it thus become the world's default dispute resolution layer, powered by blocks and more chains of blocks?

738 In German, one would say that this is all *Zukunftsmusik*. In the end, any curious explorer is constraint by the here and now. But at moments when observing the reality carefully, combining one's observations with those of others from the present and the past, the music of the future becomes a little bit clearer, and the faraway island a little less far.

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Interview List

Interview #	Name	Affiliation
#1	Federico Ast, PhD	Co-Founder and President at Cooperative Kleros
#2	Dr. William George	Director of Research at Cooperative Kleros
#3	Clément Lesaege	Co-Founder and CTO at Cooperative Kleros
#4	Dr. Alessandro Palombo	Co-Founder and CEO of Jur
#5	Raffaele Battaglini	Jur Legal Advisor
#6	Vinay Gupta	Mattereum Founder and CEO
#7	Jorge Izquierdo	Co-Founder of Aragon and former CEO of Aragon One
#8	Anonymous	Employee at Arbitral Institution
#9	Anonymous	Employee at Arbitral Institution
#10	Dr. Günther Dobrauz	Partner & Leader at PwC Legal Switzerland
#11	Sophie Nappert	International Arbitrator in independent practice and Co-Founder of ArbTech
#12	Christian Scharr	Software Engineer at CSS Insurance, Graduate in Business Information Systems (UCE) and in Data Science (UAS)
#13	Dr. Philip C. Hanke	Weblaw Publishing Director, Lecturer in LegalTech at Zurich University of Applied Sciences
#14	Anonymous	Co-Founder of a Decentralized Exchange
#15	Monique Morrow	Senior Distinguished Architect Emerging Technologies at Syniverse
#16	Lise Alm	CSO at Worldfavor, previous Head of Business Development at the Arbitration Institute of the Stockholm Chamber of Commerce

Curriculum Vitae

Bianca Kremer

ACADEMIC POSITIONS

The Wharton School of the University of Pennsylvania, Philadelphia, United States
Research Fellow, Wharton Blockchain and Digital Asset Project, 2021 - Present

ETH Zurich, Swiss Federal Institute of Technology, Zurich, Switzerland
Academic Guest, Distributed Computing Group, Spring & Summer 2021

University of Oxford, Oxford, United Kingdom
Junior Academic Visitor, Harris Manchester College & CLC, Trinity 2019
Research Affiliate, Deep Tech Dispute Resolution Lab

Stockholm University, Stockholm, Sweden
Visiting Doctoral Candidate, School of Law, 2019
Guest Lecturer, School of Law, 2018 - 2019

University of St. Gallen (HSG), St. Gallen, Switzerland
Doctoral Candidate, Swiss Government Excellence Scholar, Law School, 2018 - 2021
Research Associate, Institute of Public Finance, Fiscal Law, Law & Economics, 2018

EDUCATION

University of St. Gallen (HSG), Law School, St. Gallen, Switzerland
Ph.D. in Law, expected 2022

Dissertation: "Blockchains, Smart Contracts, and International Arbitration – The Emergence of a Crypto Autonomous Legal Order"
Gerzensee Law & Economics Doctoral Courses (Stanford University, NYU)
Committee: Prof. Dr. Markus Müller-Chen and PD Dr. Marco Stacher

Stockholm University, School of Law, Stockholm, Sweden
LL.M. International Commercial Arbitration Law, 2016

Master Thesis: "Judgments Relating to Arbitral Awards and The European Union's Principle of Mutual Trust – A reflection on the enforcement of nullified arbitral awards and the delocalization theory of international arbitration from a European perspective", Prizes: *SCCL-Priset and YAS Award*
Supervisor: Prof. Dr. Christina Ramberg, Examiner: Prof. Dr. Patricia Shaughnessy

University of Vienna, School of Law, Vienna, Austria
Mag. iur., 2013

Additional Diploma in International Private Commercial Law and Comparative Law; in addition, some courses taken at WU Vienna University of Economics and Business

University of Geneva, School of Law, Geneva, Switzerland
CDT, 2012

Certificat de Droit Transnational
Erasmus Exchange

ACADEMIC HONORS & AWARDS (SELECTION)

DLT Talents Frankfurt School Blockchain Center 2021

Swiss Government Excellence Scholarship 2018, 2019, 2020, 2021

HSG's Law & Digitization Initiative Grant 2018, 2019, 2020, 2021

Winner ICC YAF Call for Ideas in Arbitration 2017

Young Arbitrators Sweden Award (YAS Uppsatspris) for Best Master's Thesis in Arbitration 2016

The Stockholm Centre for Commercial Law Prize (SCCL Priset), Best Master's Thesis at Swedish Universities 2016

Willem C. Vis Moot Werner Melis Award, Honorable Mention for Best Memorandum for Respondent 2016

Willem C. Vis Moot Pieter Sanders Award, Honorable Mention for Best Memorandum for Claimant 2016

Vis East Moot Eric Bergsten Award, Honorable Mention for Best Memorandum for Claimant 2016

Fürst Dietrichstein'sche Stiftung Scholarship 2015, 2016

Julius Raab Scholarship 2015

Scholarship for European Forum Alpbach 2013

Willem C. Vis Moot Werner Melis Award, Third Place for Best Memorandum for Respondent 2013

Willem C. Vis Moot Martin Domke Award, Honorable Mention for Best Individual Oralist 2013

Media Summit Scholarship awarded by Members of the European Parliament 2013

LAW PRACTICE

08/2017 – 12/2017	**District of the Higher Regional Court,** Vienna, Austria (Judicial Law Clerkship)
11/2016 – 06/2017	**Mannheimer Swartling Advokatbyrå AB**, Stockholm, Sweden (Traineeship, Dispute Resolution Practice Group)
06/2015 – 08/2015	**German Institution of Arbitration (DIS)**, Cologne, Germany (Traineeship, Editorial Work, Research)
05/2015	**Vienna International Arbitral Centre (VIAC)**, Vienna, Austria (Internship, Research)
01/2015 – 04/2015	**Schellenberg Wittmer Ltd**, Zurich, Switzerland (Traineeship, Arbitration Practice Group)
03/2014 – 08/2014	**LALIVE**, Geneva, Switzerland (Traineeship, Arbitration Practice Group)

LANGUAGE SKILLS

German (native), Portuguese (native), English (fluent), Swedish (fluent), French (advanced), Spanish (intermediate), Mandarin (basic), Latin (written)