



University of St.Gallen

Institute of Computer Science

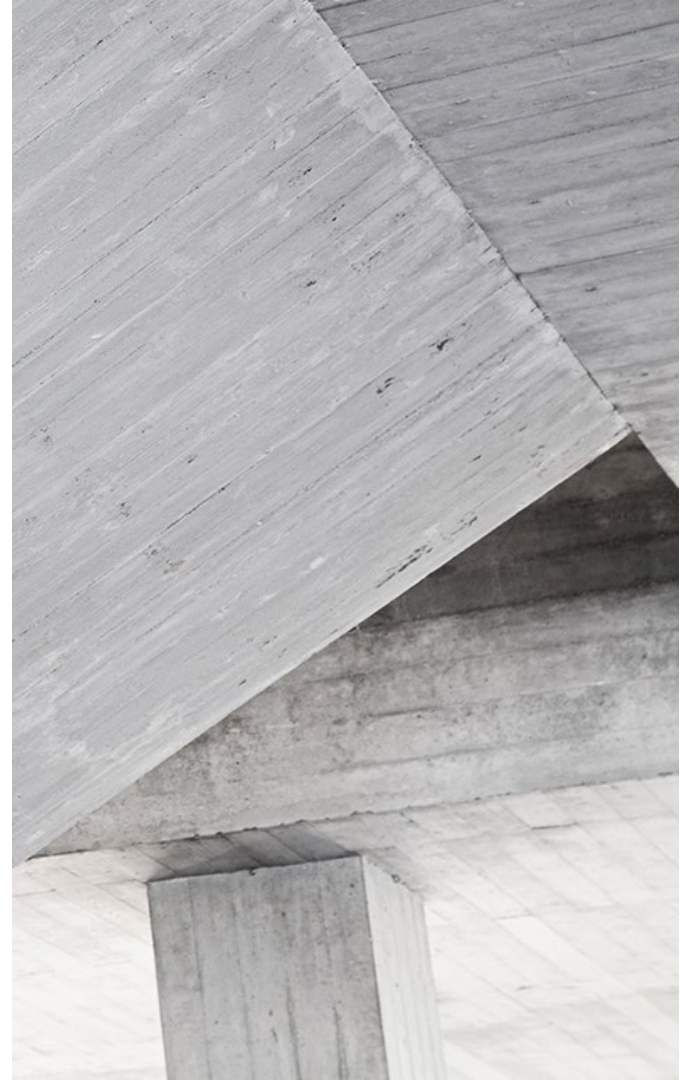
Integrating Process Management and Event Processing in Smart Factories: A Systems Architecture and Use Cases*

*Originally published in: [Journal of Manufacturing Systems](#) (2022)

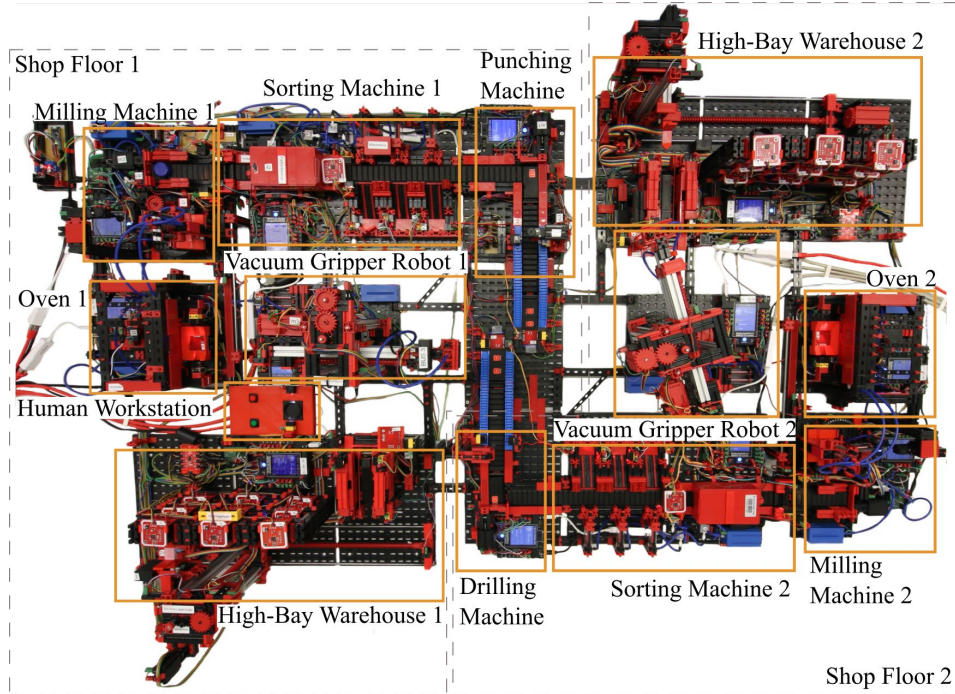
CAiSE@Zaragoza, 14 June 2023

[Ronny Seiger](#), Lukas Malburg, Barbara Weber, Ralph Bergmann

From insight to impact.



Smart Factory @ Uni Trier / UniSG



– Sensors

- Light barriers
- Switches
- Color
- NFC
- Environment

– Actuators

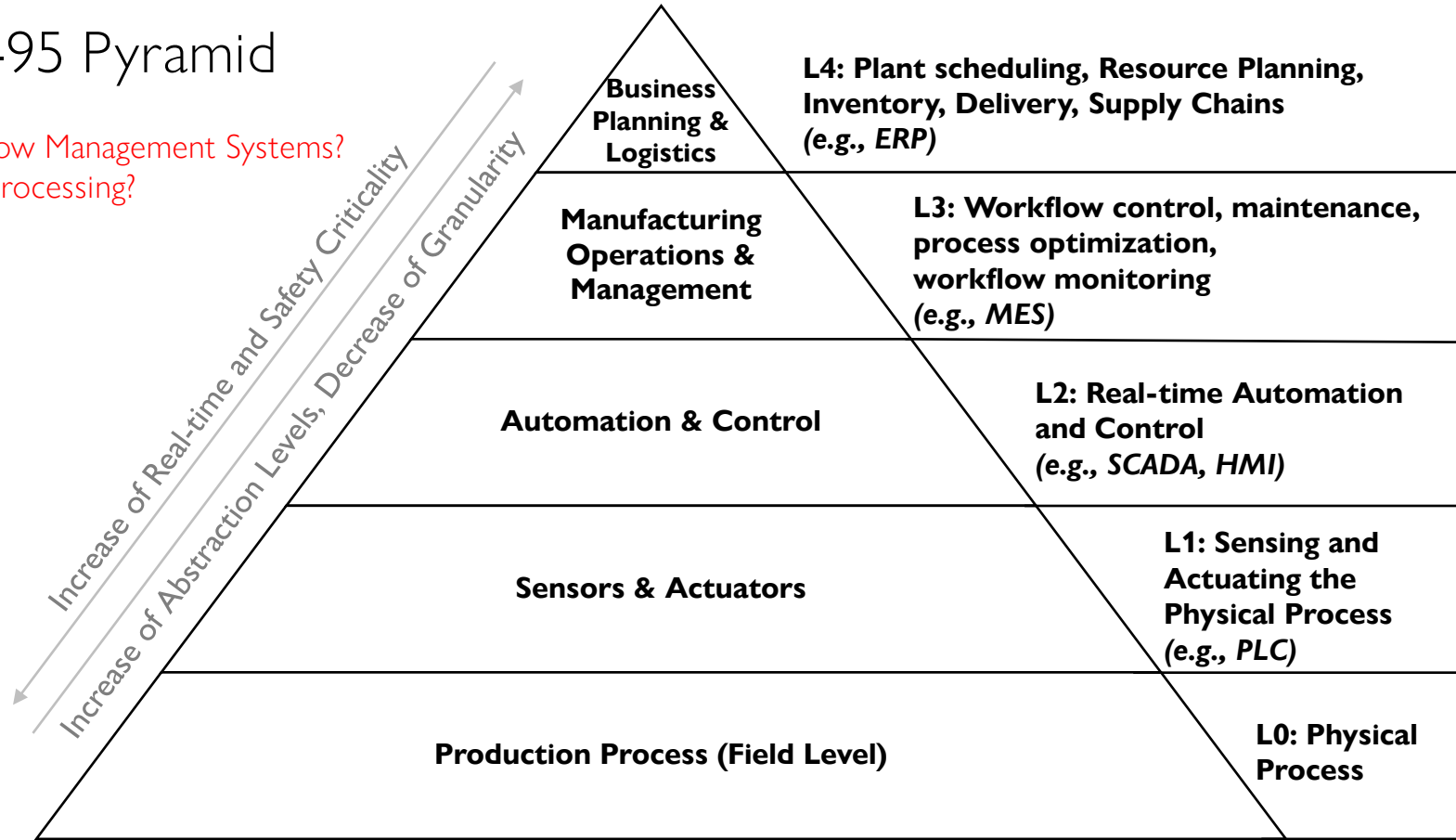
- Motors
- Valves
- Compressors

→ Processes

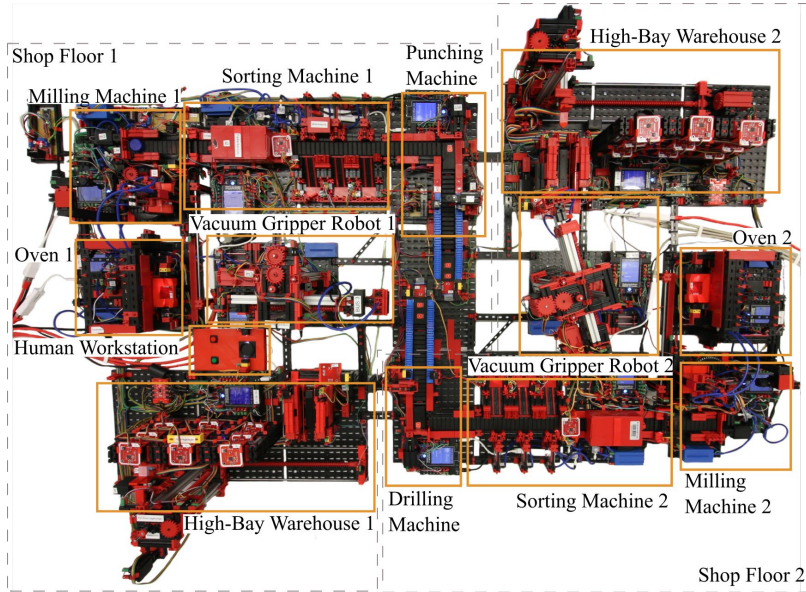
→ Event Streams

ISA-95 Pyramid

Workflow Management Systems?
Event Processing?



Extending the Setup



– Sensors

– Actuators

→ Processes

→ Event Streams



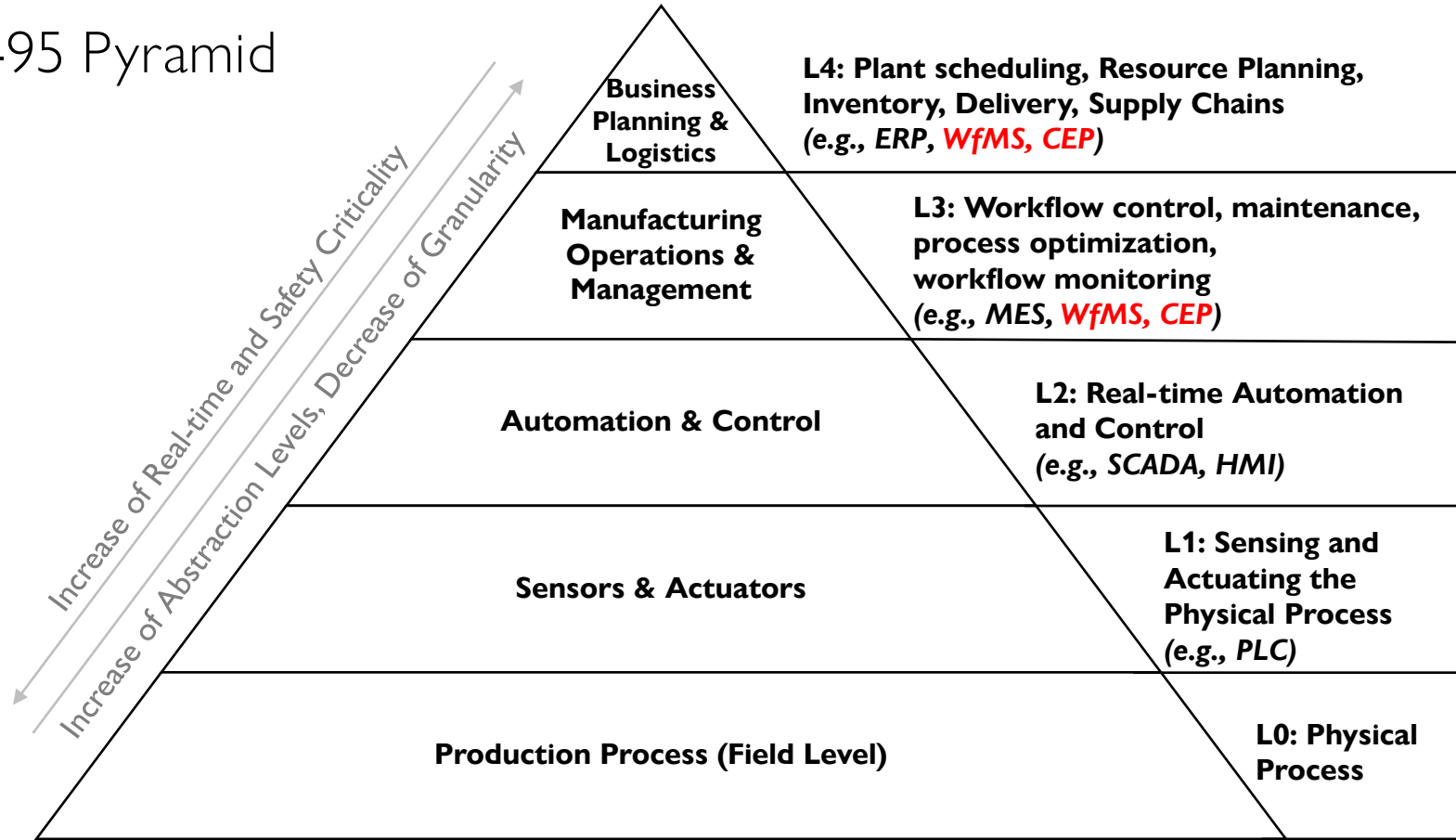
Workflow Management Systems (WfMS)
for coordination



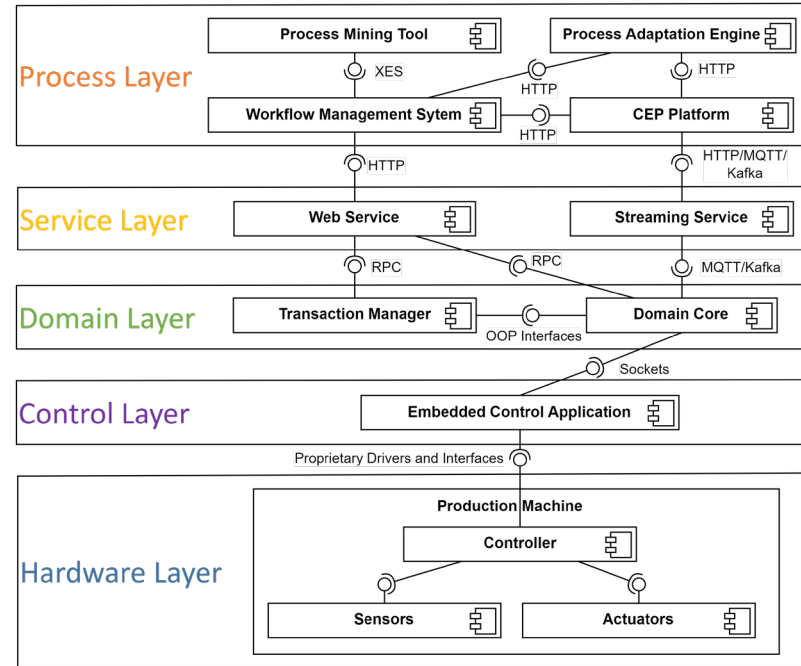
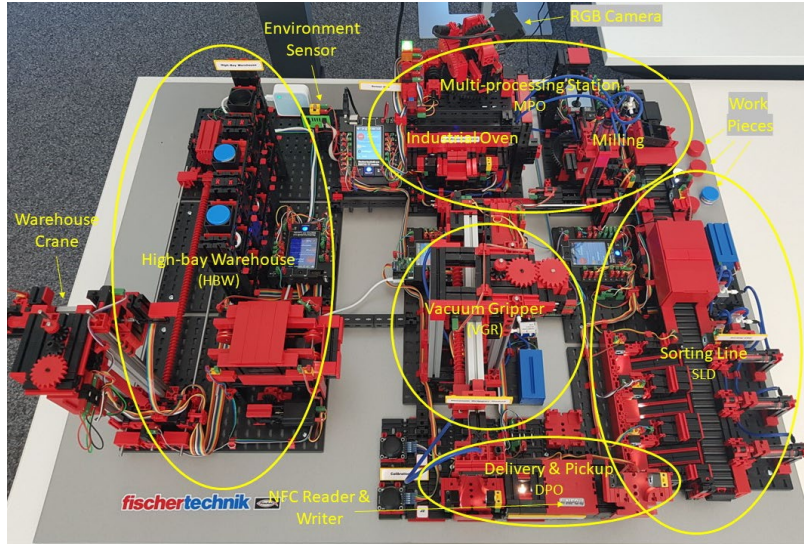
Complex Event Processing (CEP)
for event processing at runtime



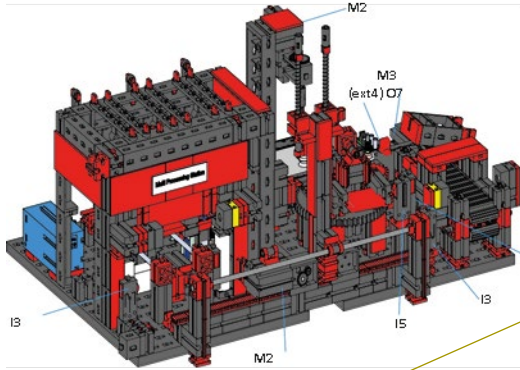
ISA-95 Pyramid



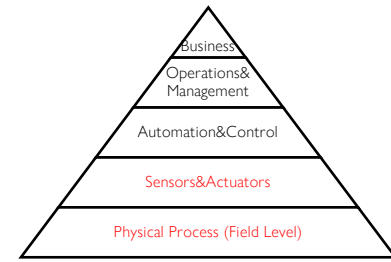
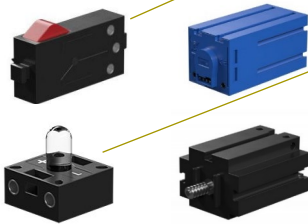
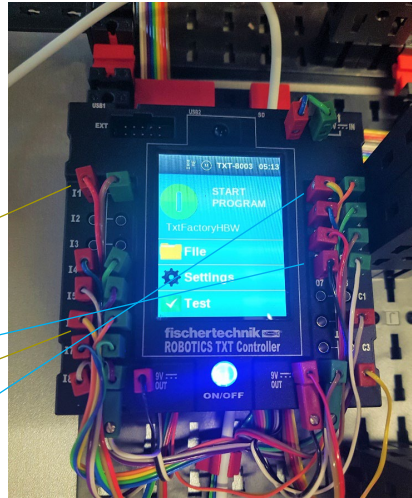
Systems Architecture: Overview



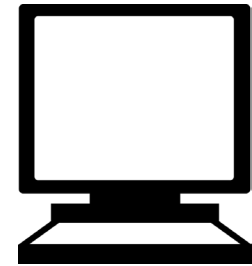
Hardware and Controllers



RoboTXT Controller (PLCs)



Client Computer



Get Sensor Data

TCP Socket

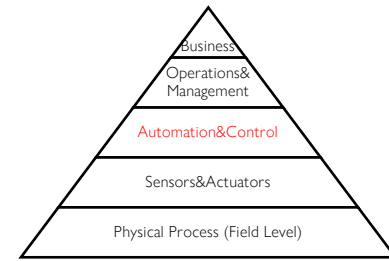
Activate Actuators

Control Programs

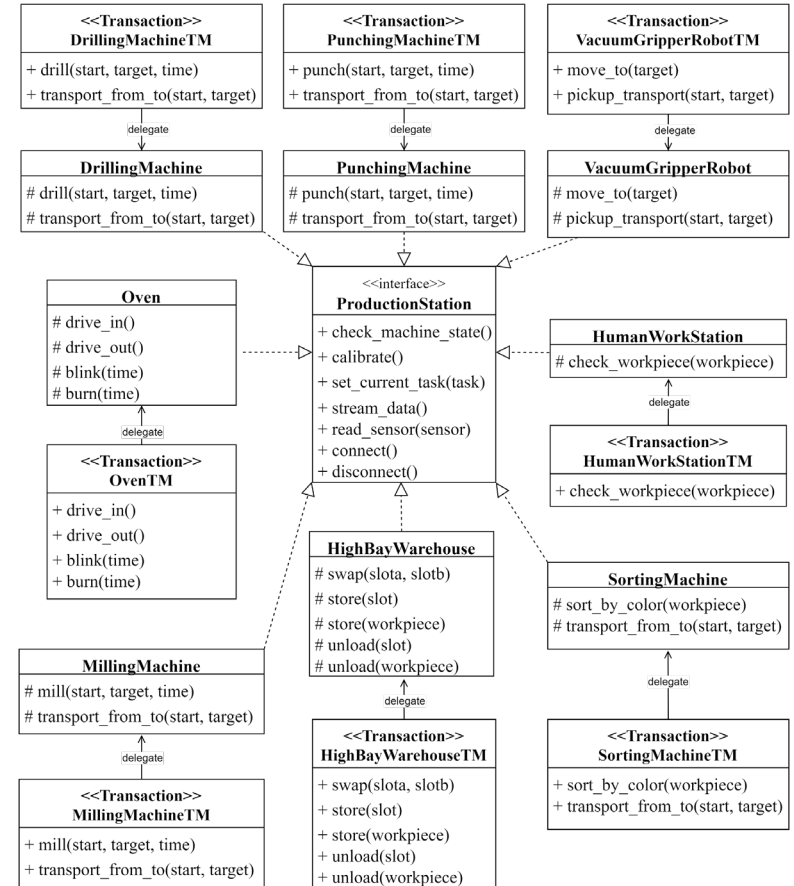
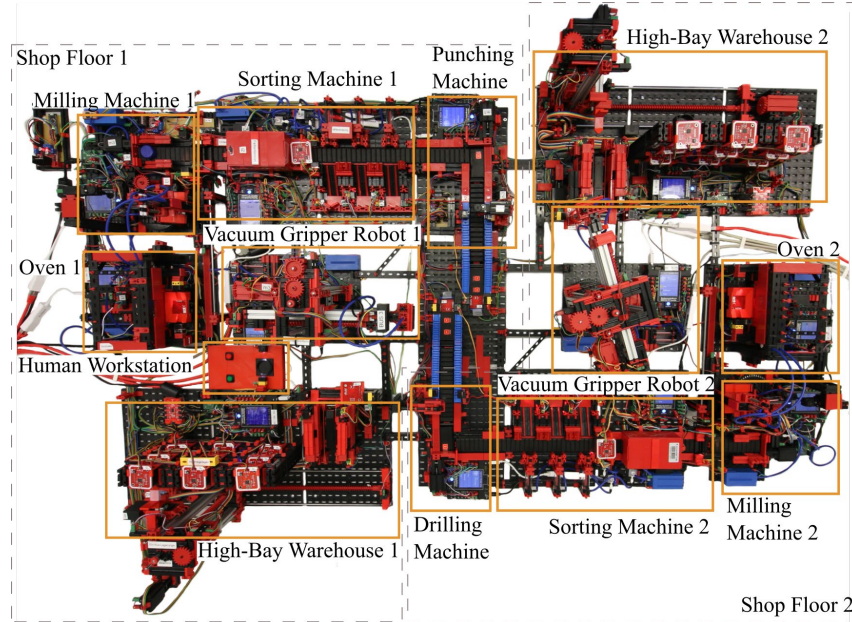
Client Computer



```
File Edit View Navigate Code Refactor Run Tools Git Window Help smart-factory-pythr
smart-factory-python hardware burn_slide_example Git Run 'burn_slide_example' Umschalt+F10
Project Structure Pull Requests
1 import fttrobopy
2
3 oven_txt = fttrobopy.fttrobopy(host=f"192.168.0.14",
4                               port=65000, update_interval=0.01)
5
6 o7 = oven_txt.output(7)
7 m1 = oven_txt.motor(1)
8 i1 = oven_txt.input(1)
9
10 # Open Oven door
11 o7.setLevel(512)
12
13 # Drive in slide
14 m1.setSpeed(-512)
15 while i1.state() == 0:
16     pass
17 m1.stop()
18
19 # Close Oven door
20 o7.setLevel(0)
21
Run: burn_slide_example Event Log
Update...
Run Problems Python Packages Git Terminal Python Console TODO Event Log
Run selected configuration 20:1 CRLF UTF-8 4 spac... Python 3.8 (smart-factory-python) master
```

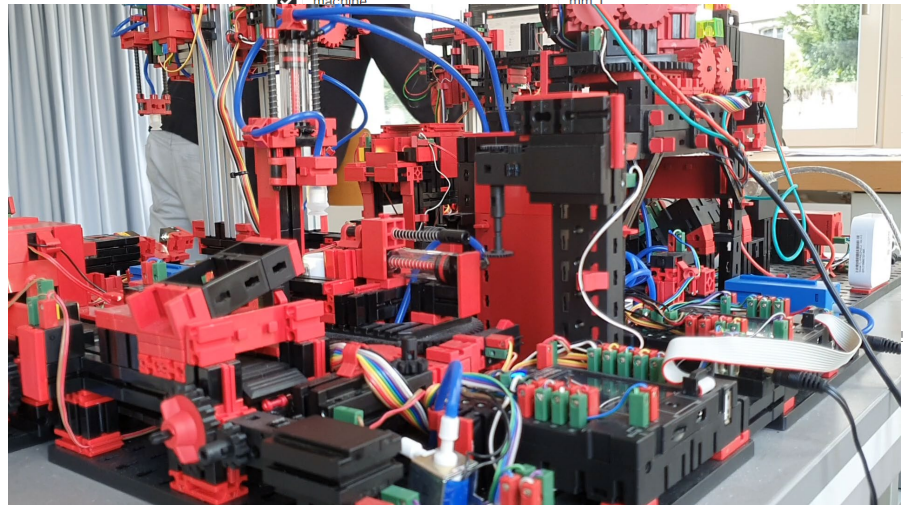
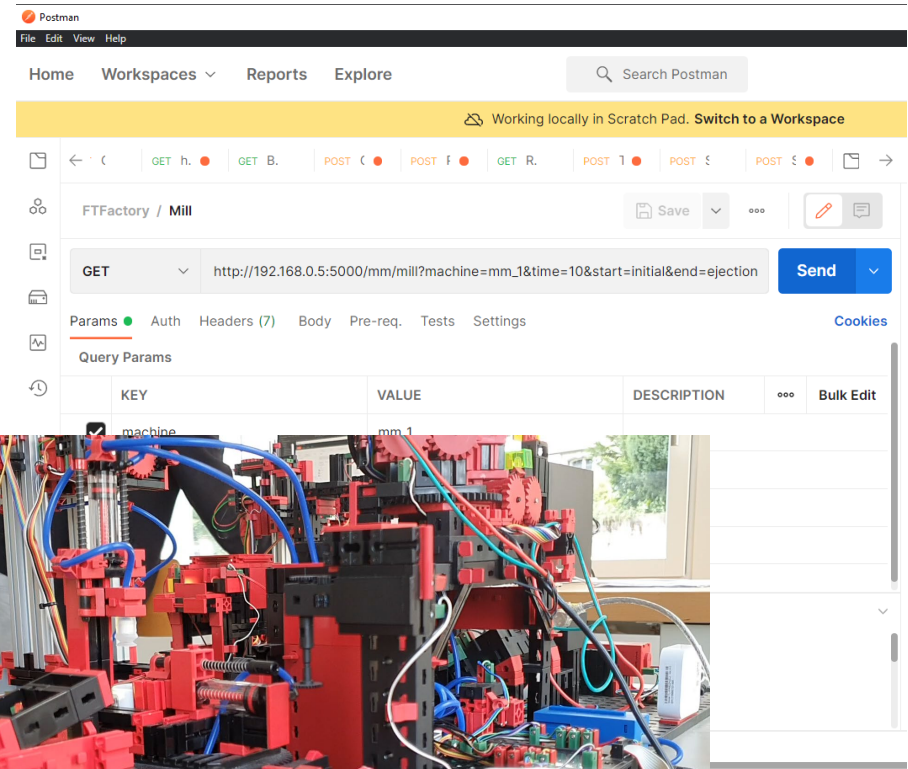


Object-oriented Domain Core

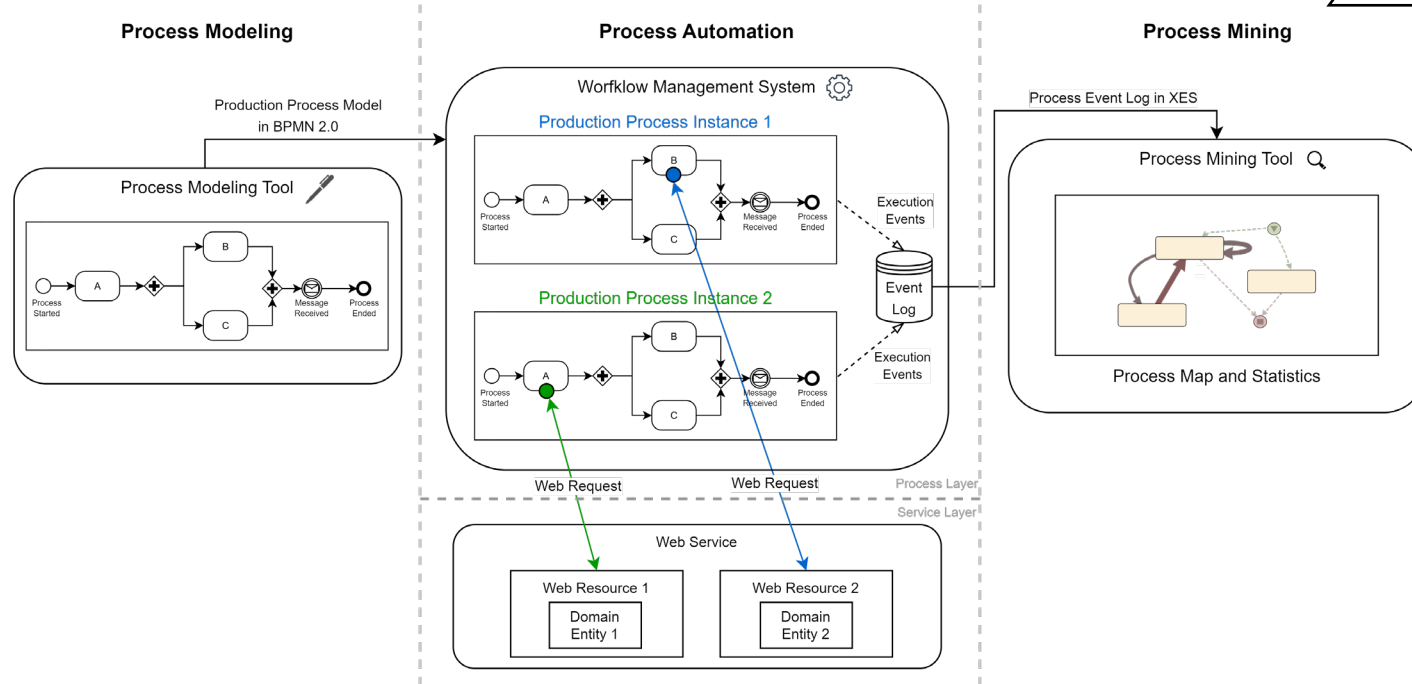
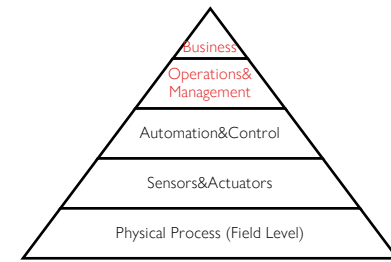


Web Services

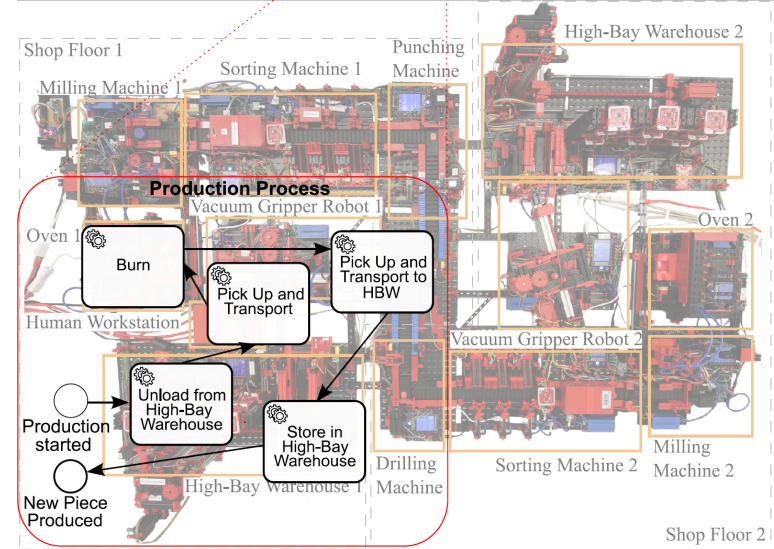
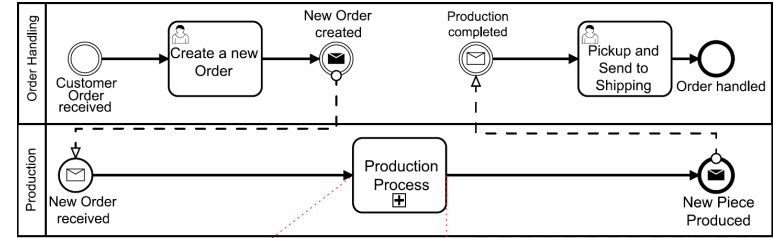
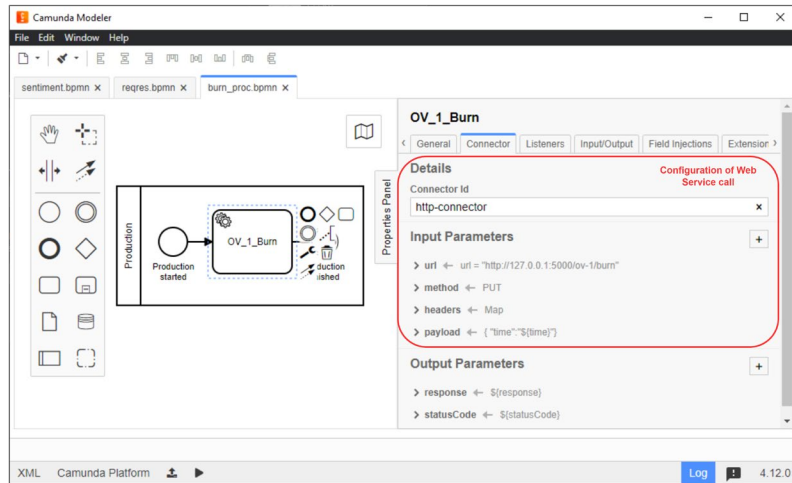
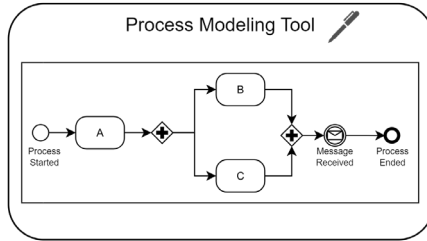
- Expose high-level methods of OOP model 1:1 via RESTful web service
- HTTP GET / PUT
- Calls handled by Transaction Managers (blocking, queues for parallel activity calls)



It's Time for BPM



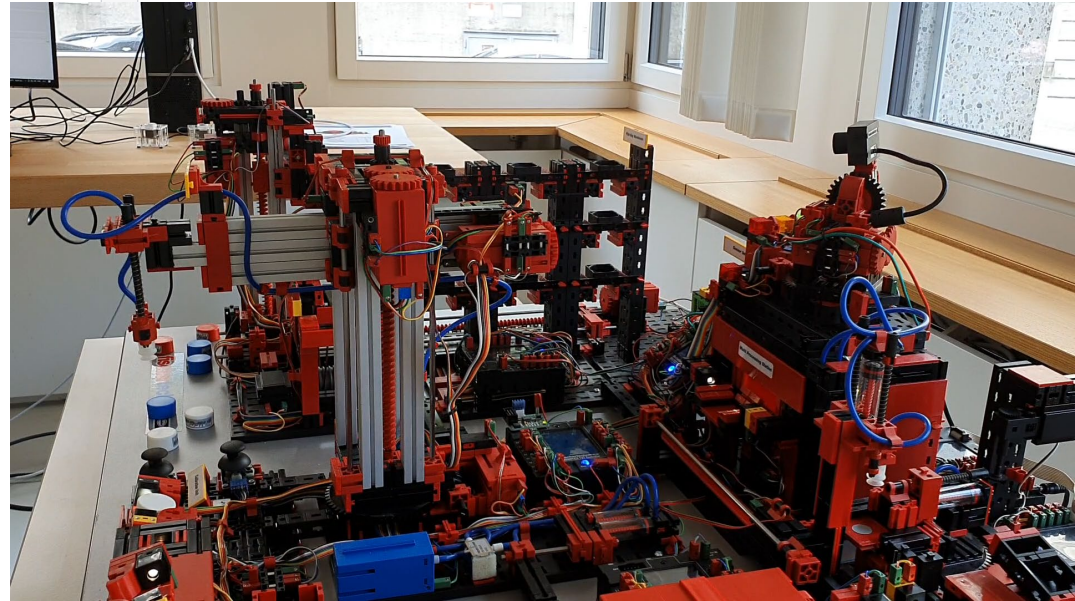
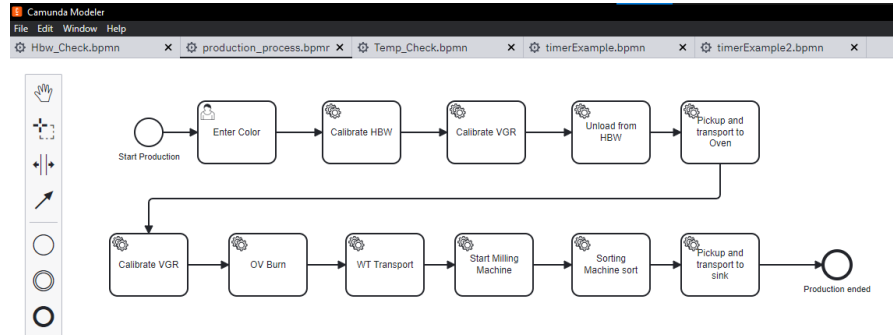
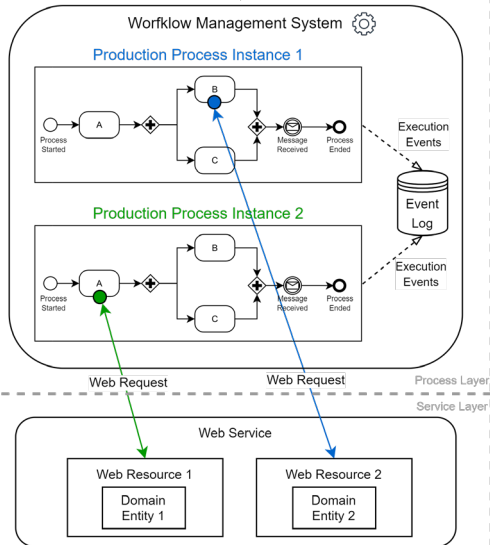
Process Modeling



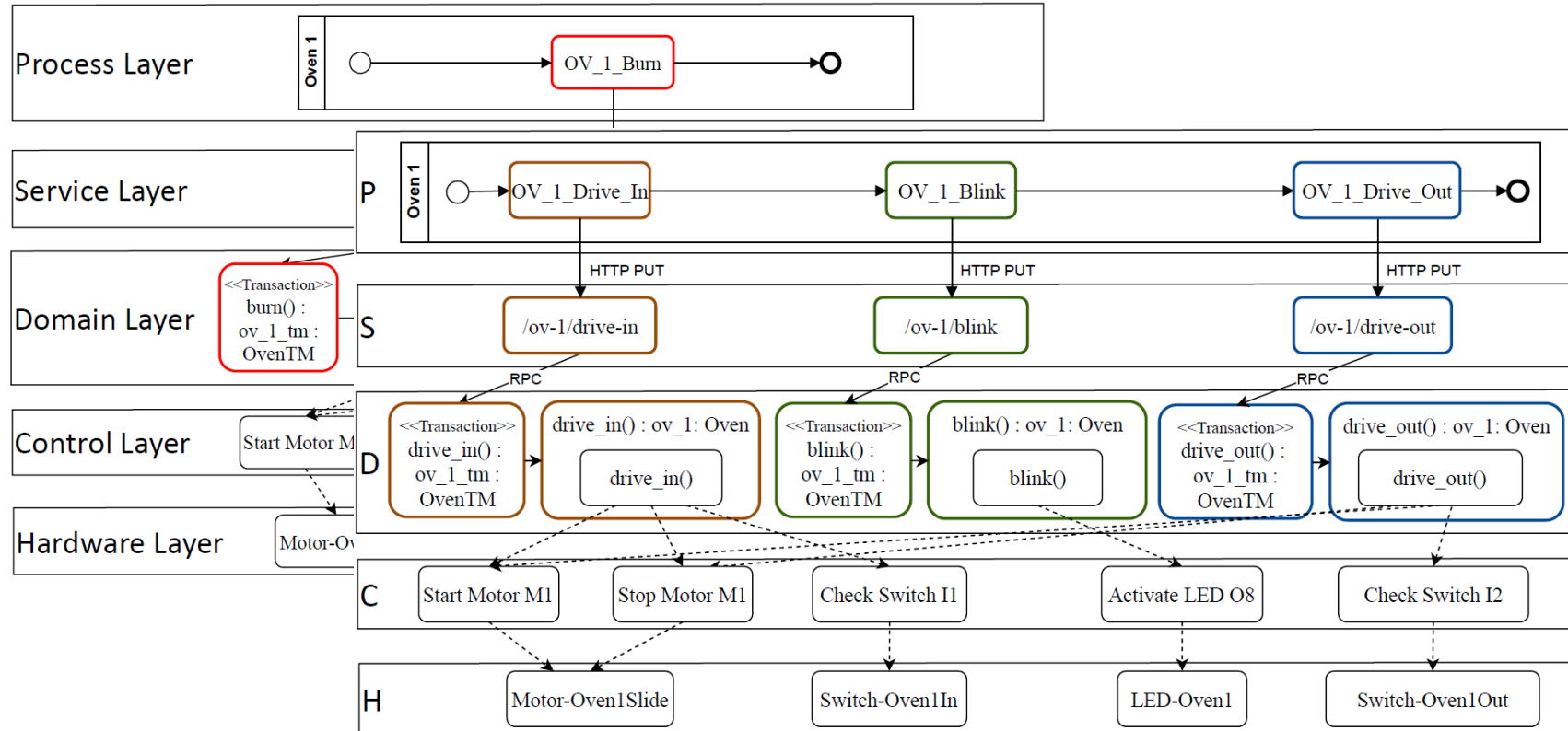
Process Automation

Production Process
Model in BPMN 2.0

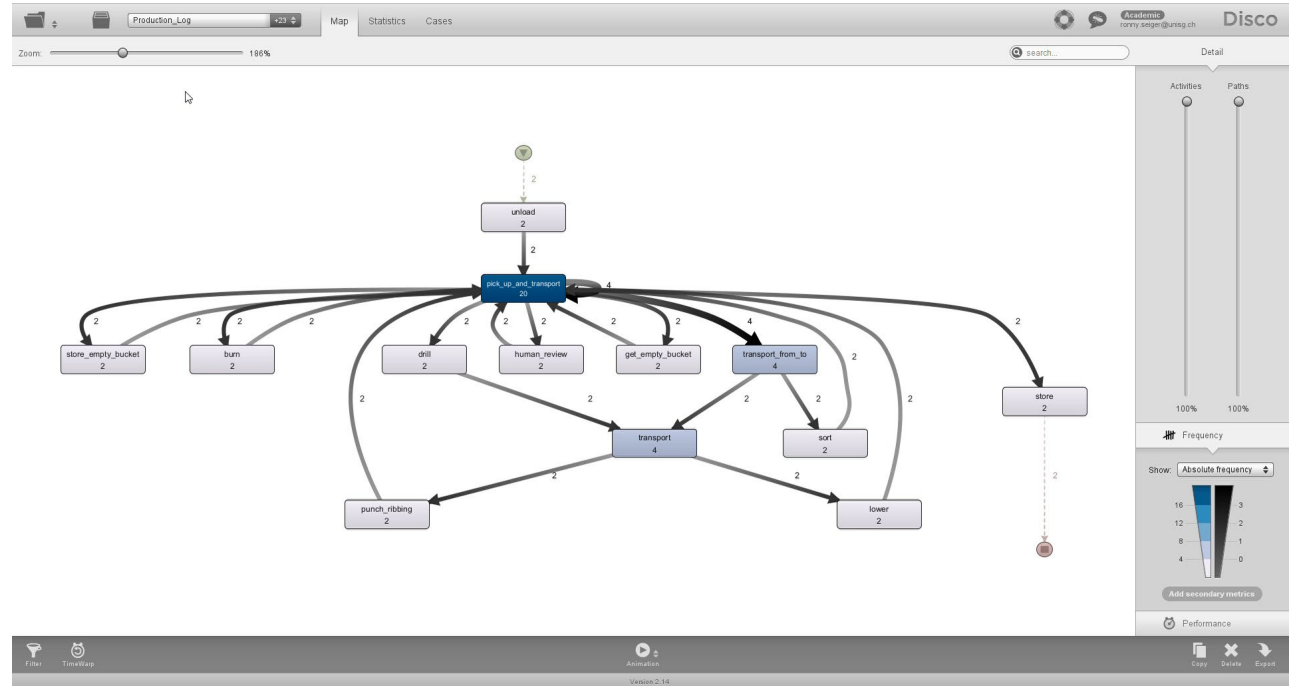
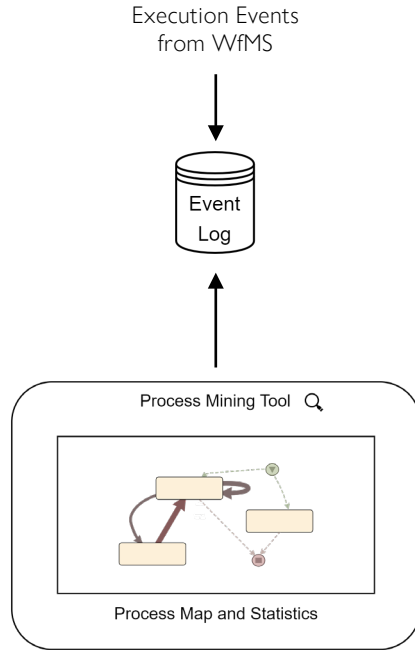
Process Automation



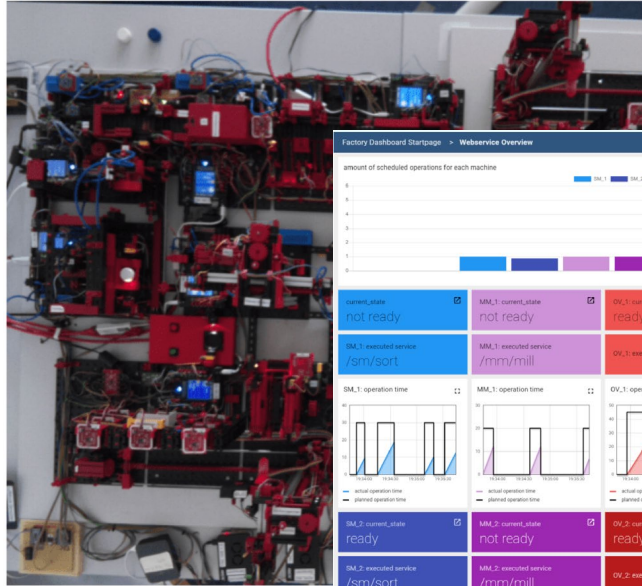
How “Big” should an Activity be?



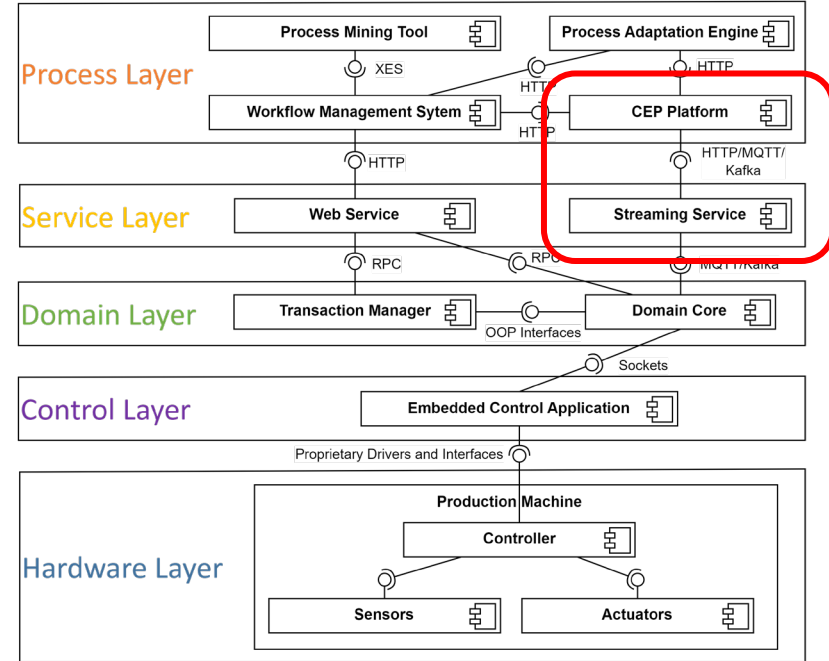
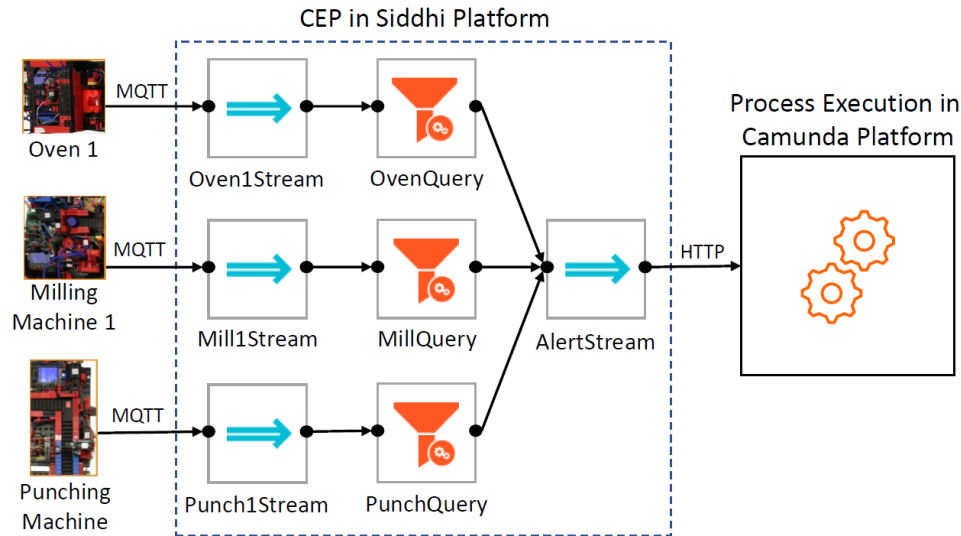
Process Mining



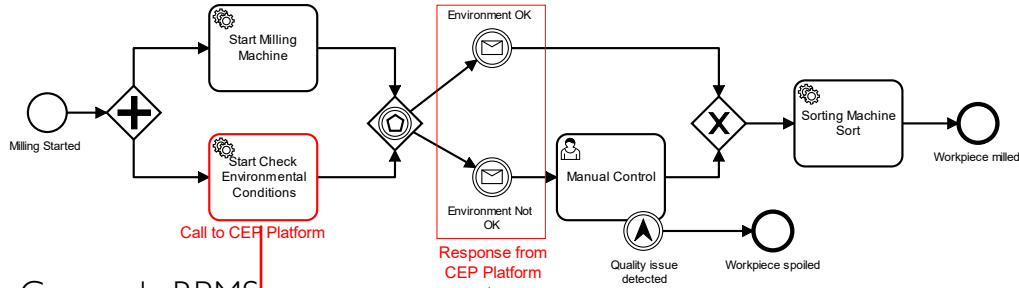
IoT Data Streams



Complex Event Processing (CEP)



CEP Example



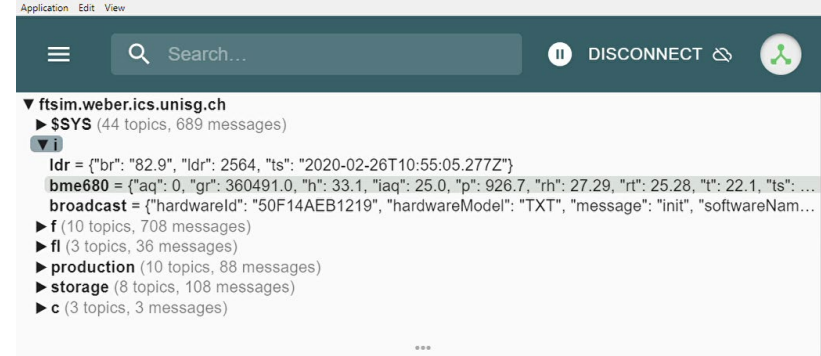
Call to CEP Platform

Response from
CEP Platform

HTTP POST

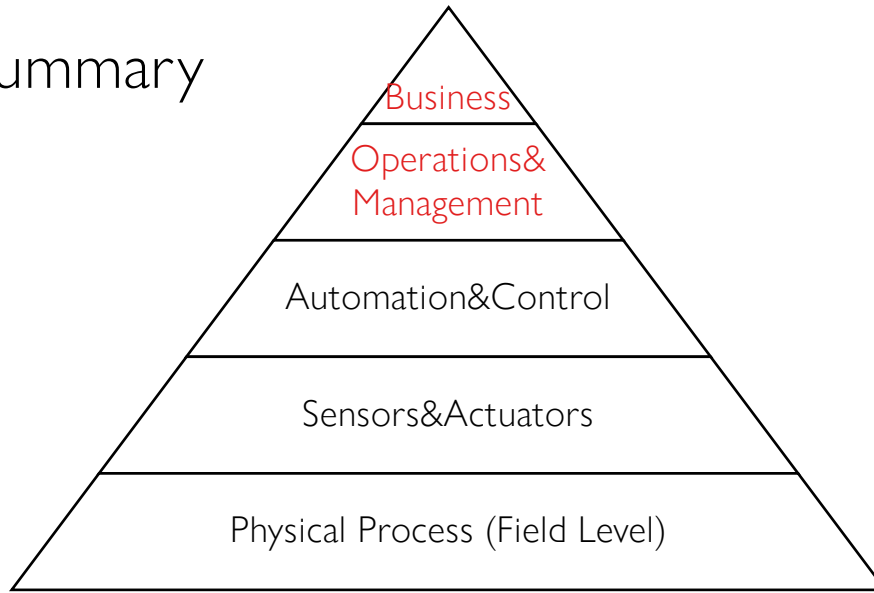
HTTP POST

MQTT Streaming



```
@info(name='EnvCheckOk')
from EnvAnalysisStream#window.timeBatch(10sec)
select "env_ok" as msgname, avg(t) as avgtemp,
      avg(br) as avglight
having (avgtemp >= 22 and avgtemp <= 25) and
      (avglight >= 80 and avglight <= 85)
insert into EnvCheckStream;
```

Summary



 Workflow Management Systems (WfMS) for coordination

 Complex Event Processing (CEP) for event processing at runtime

