



Multivendor Installed Base Service Management in the Heavy Equipment Industry – A Value Proposition

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Table of Contents

1	The market for heavy equipment industry is changing rapidly and demands players to adopt new business models & technologies.....	6
1.1	The economic perspective has changed	6
1.2	Embedded systems drive an upcoming industrial upheaval.....	6
1.3	Information systems remain to be explored	7
1.4	Existing CRM systems focus on the consumer product business	7
1.5	Why does installed base management matter for the heavy equipment goods industry?.....	8
1.6	Enterprise systems can enable efficient collaboration between the OEM, the subsidiary and local subcontractors	8
2	A smart approach that fosters customer integration.....	10
2.1	Processes supporting the installed base are well-known.....	10
2.2	What is the potential for improvement that makes the installed base management smart?	11
2.3	Combining analytical processing and supply chain data management into a multivendor installed base service management.....	12
2.3.1	Back stage perspective	13
2.3.2	Front stage perspective	14
2.4	Key data issues for the installed equipment service management when applying extant IT architectures.....	15
2.5	Applying cross-enterprise installed base service management for competitive advantage	17
3	Putting the cross-enterprise installed base management into realization	19
3.1	Plan the roll out in appropriate transformation phases.....	19
3.2	How might the new SAP Business Suite on HANA-base contribute?	24
4	Get on board & next steps.....	27
5	Appendix.....	30

List of Abbreviations

CAD	Computer Aided Design
CIO	Chief Information Officer
CRM	Customer Relationship Management
CRUD	Create Read Update Delete
EAM	Enterprise Asset Management
ERP	Enterprise Resource Planning
HANA	High Performance Analytic Appliance
IS	Information Systems
IT	Information Technology
IWI	Institute of Information Management
OECD	Organisation for Economic Growth Co-operation and Development
OEM	Original Equipment Manufacturer
OLAP	Online Analytical Processing
OLTP	Online Transaction Processing
SDL	Service-Dominant Logic
SOA	Service Oriented Architecture
SSME	Service Science, Management, and Engineering

Abstract

The manufacturing industry is subject to structural economic change. The paradigm shift from a product-dominant to a service-dominant logic can hardly be refuted. The shift in focus to services is a shift from the product and manufacturing perspective to the utilization and customer perspective. Being confronted with the strategic challenge of reducing operating costs while at the same time meeting ever-increasing service demands, manufacturing firms struggle to find the appropriate information systems solution for planning and operations.

The Institute of Information Management (IWI) at the University of St. Gallen aims to address this issue from an information systems perspective. Starting the analysis with the customer relationship management (CRM) seems reasonable, since the system is designed for sales and service planning. However, information on the installed base is limited in the technical level of detail. Serialized descriptions about sold assets incorporate information on maintenance, contracts, and warranty, but lack deep technical information. Heavy equipment goods are hence not adequately modeled in the CRM system. The equipment goods that are produced by this industry are characterized as long-living and highly productive. Consequently, maintenance, repair and change operations are particularly important capabilities of the heavy equipment manufacturers for achieving and maintaining high profit margins. Traditional mobile CRM solutions obtain replication-based information on the installed equipment and consequently, service technicians have very limited access to “back stage” information. Heavy equipment goods manufacturers are well known for operating internationally with strong exports. Delivering excellent services to customers who are distributed around the globe states another key capability in achieving competitive advantages.

Since business customers show enormous interest in the condition of the installed heavy equipment, large manufacturers have built large-scale proprietary systems for service support which combine detailed knowledge of the heavy equipment [bill of material] with the customer knowledge which is buried in the CRM. The installed base describes the equipment installed at the customer. Installed base data comprise the bill of material, customer master data, and transactions performed on the equipment that is owned by the customer. Accordingly, the installed base, in its core definition, has to be considered as collaborative. However, delivering excellent service worldwide by a singular manufacturer becomes physically very hard to realize. The necessary workforce would be too large, while education remains an unsolved issue. Moreover, it is often not profitable to set up service locations and the corresponding infrastructure in small markets. Collaboration with partners that know the local market is hence a necessary precondition.

The service processes enabling installed base management for heavy equipment goods are known but the implementation falls short in collaboration, scalability and consistency. Addressing these shortcomings, the IWI proposes a smart multivendor installed base management. Smart is the combination of the as-is bill of material [from production planning systems] with as-is maintenance data and sensor data [from the machinery equipment] to achieve a deeper customer integration. Big data management allows the aggregation and con-

solidation of all installed base data across enterprise boundaries without suffering information losses. Real-time processing of mass data opens new sources of revenue in terms of performance-based contracts and condition-based maintenance and recovery services. Equipped with this comprehensive source of information, business analytics are able to perform extensive analyses that generate deep insights about the customer usage of their productive machinery equipment.

1 The market for heavy equipment industry is changing rapidly and demands players to adopt new business models & technologies

1.1 The economic perspective has changed

The service sector is on the rise; employees working in business services in Germany account for 42% of the total workforce compared with 27% in the 1970s (Wölfl 2005). Furthermore, the fraction of industrial product-related services is increasing for all Organisation for Economic Co-operation and Development (OECD) countries except Luxembourg (OECD 2011). According to a recent study of Bain & Company, services generate about 20% of revenues for many European heavy equipment manufacturers but they account for half of the sector's profits and are growing steadily at 5% per year (Strähle et al. 2012).

The paradigm shift from a product-dominant to a service-dominant logic (SDL) can hardly be refuted (Vargo & Lusch 2008). The largest part of economic exchange is not based on products anymore but on services (Vargo & Lusch 2004). Over the last thirty years, academics as well as practitioners have begun to investigate services as a distinct phenomenon with its own body of knowledge and rules of practice (Spohrer & Kwan 2009). Their approaches are revitalized under the emergent discipline of service science, management, and engineering (SSME).

In spite of this impressive growth of services business, services remain an underexploited opportunity for most original equipment manufacturers (OEMs). Their service initiatives are typically halfhearted. When considering the full-service potential of their installed base, companies typically reach only 10% to 25% of potential revenue – and often companies don't even know where they stand with their service potential. OEMs' engineering roots have let them to focus their attention and investments on technical innovation and new product sales. This paradigm is beginning to change, however, in the wake of the financial crisis, as the industry has been confronted with slower growth (Strähle et al. 2012).

1.2 Embedded systems drive an upcoming industrial upheaval

The automation of production processes applying advanced information and computing technology has announced the third industrial upheaval. Besides a stronger automation, the industry 4.0 initiative fosters the development of smart monitoring and autonomous decision making processes which allow for real-time control and for optimization of enterprises and value networks. In other words, the digital refinement of production plants, industrial equipment, radio sensors, embedded actuators, and smart software systems bridges and synchronizes the virtual world (digital model) and objects in the physical reality (Kagermann et al. 2011). Equipment controls the production process itself, monitors relevant environmental parameters through embedded sensors and triggers counter-measures when incidents occur.

Industry 4.0 refers to the vertical integration of embedded systems and enterprise resource planning software for achieving optimization potentials in logistics and production. Local autonomy of digital equipment memories allows shorter reaction times for incidents and fosters resource efficiency in all process phases. The equipment obtains immediate access to higher layered process data and is capable to make accurate decisions (Kagermann et al. 2011).

However, the synergy potential is not limited to process optimization but also lies in the enabling function for new business models of industrial services. Connected in the internet of things, smart equipment provides its capabilities as intelligent services, which is able to automatically trigger service tasks and enable new ways of service collaboration (Kagermann et al. 2011). The technological change puts the OEMs in the position to integrate customer needs at a high detail level with efficient means.

1.3 Information systems remain to be explored

Being confronted with the strategic challenge of reducing operating costs while at the same time meeting ever-increasing manufacturing-related service demands, manufacturing firms struggle to find the appropriate information systems solution for planning and operations (Dietrich 2006). For the service component, expensive proprietary systems and highly customized standard solutions must be maintained (Günther et al. 2009; Thomas et al. 2008), while legacy systems need to be replaced. In particular, firms encounter problems in supporting managerial accounting (Dietrich et al. 2008) and the maintenance function of product-service systems (Thomas et al. 2008).

By now, information systems' support for service business has hardly been addressed as a dedicated research stream. The IWI at the University of St. Gallen claims a leading business engineering role helping information systems to catch up with marketing and management research on service science. The availability of service oriented architectures (SOA), cloud technology, big data and mobility constitutes the technological aid to address the increased service demands in manufacturing industry.

1.4 Existing CRM systems focus on the consumer product business

The IWI at the University of St. Gallen aims to focus on the information systems perspective. Starting the analysis with the CRM system seems reasonable, since the system is designed for sales and service planning.

The CRM system is well-suited to perform operations for the consumer product business. The system models the installed base of a product company at their sold-to-customers. Operational services performed for these customers are kept in the CRM customer database. Supported processes are:

- Requirements management
- Contracts & entitlements

- Knowledge management
- Rudimentary installed based management
- Return material
- Proactive services
- Workforce management

Serial numbers of sold products are associated with the respective customer. However, information on the installed base is limited in its technical level of detail. Serialized descriptions of sold products incorporate information on maintenance, contracts, and warranty, but lack deep technical information. Heavy equipment goods are hence not adequately modeled in most CRM systems. Rather, the CRM provides high level as-maintained information that aim at supporting after-sales service processes.

1.5 Why does installed base management matter for the heavy equipment goods industry?

Still obtaining global leadership in the international market, the German heavy equipment goods industry is one of the key enablers of growth and wealth in the German society (BDI 2012; Strähle et al. 2012). The equipment goods sold by this industry are characterized as long-living and highly productive. Consequently, service operation activities on the installed customer equipment (such as maintenance, repair and change transactions) are particularly important capabilities of the heavy equipment manufacturer for succeeding in the market (Drucker 1991). The typical heavy equipment manufacturer is further characterized by a strong export focus. Delivering high quality services to customers who are distributed around the globe presents hence another key capability for achieving competitive advantages.

Predominant enterprise systems are not adequately modeling the specific needs of the heavy equipment goods industry. While CRM systems lack detailed technical specifications, enterprise asset management (EAM) systems are accountable for the operational maintenance services performed on enterprise owned equipment that is used for production. Mobile devices usually obtain their information on a replication base and consequently service technicians have only limited access to “back stage” information. Since business customers shows enormous interest in the condition of the installed heavy equipment, large manufacturers have built large-scale proprietary systems for service support that combine detailed knowledge of the heavy equipment [bill of material] with the customer knowledge which is buried in the CRM.

1.6 Enterprise systems can enable efficient collaboration between the OEM, the subsidiary and local subcontractors

The installed base describes all the equipment installed at the OEM’s customer. Installed base data comprise the bill of material, customer master data, and transactions performed on the equipment that operates at the customer’s site. Accordingly, the installed base, in its core

definition, has to be considered as collaborative information for the OEM and their customers. The OEM produces very specific equipment that is highly customized in its deployment for productive usage. Delivering excellent service worldwide by one OEM becomes physically very difficult to realize. The workforce necessary would be enormous, while continuous knowledge transfer remains challenge.

Moreover, it is often not profitable to set up service locations and the corresponding infrastructure in small markets. Collaboration with partners who are familiar with the local market is hence a necessary precondition. Service processes have to be executed across organizational borders involving customers, subsidiaries, subcontractors, service centers and external service providers. Small enterprises position themselves also for other customers.

Achieving productivity in collaborative service operations on the installed equipment presents a key challenge in order to realize competitive advantages in the heavy equipment business (Drucker 1991). Service operation activities on the installed equipment (such as maintenance, repair and change transactions) refer to very complex and knowledge intensive tasks. The provisioning of serialized descriptions on sold assets in combination with deep technical information [bill of material] to all involved partners along the value chain presents a key lever to increase productivity for these tasks. Once available, the digital equipment memory allows shorter reaction times for incidents and fosters resource efficiency in all process phases. Based on accurate and consistent equipment data, a collaborative installed base management enables more sophisticated service processes (service quality, spare parts originality control) and business models (performance contracting). However, the collaborative installed base management remains a technically unresolved issue. For that reason, a smart approach becomes necessary to achieve cost synergies through efficiency in the operations and value synergies through collaboration.

2 A smart approach that fosters customer integration

Smart is the combination of the as-is bill of material [from production planning system] with as-is maintenance data [from proprietary system] and sensor data [from the machinery equipment] to achieve a comprehensive view on the equipment installed and operating in the customer's production environment. Connected in the internet of things, smart equipment that controls the production process itself and monitors relevant environmental parameters through embedded sensors ensures consistency and accuracy in the as-is maintained list of the installed equipment. Big data management and particularly in-memory databases contribute to real-time processing of mass equipment data. Once aggregated and consolidated, this data of the installed equipment can serve as decision support on strategic and operative level. While strategic level refers to the support of supplier selection, R&D insights and equipment usage, operative decision support is accountable for immediate service activities such as the selection of appropriate counter-measures for the incident management. Local autonomy of digital [smart] equipment memories allows shorter reaction times for incidents and fosters resource efficiency in all process phases. The synergy potential is not limited to process optimization but is also generated in the enabling function for new business models of industrial services in terms of performance-based contracts and condition-based maintenance and recovery services.

2.1 Processes supporting the installed base are well-known

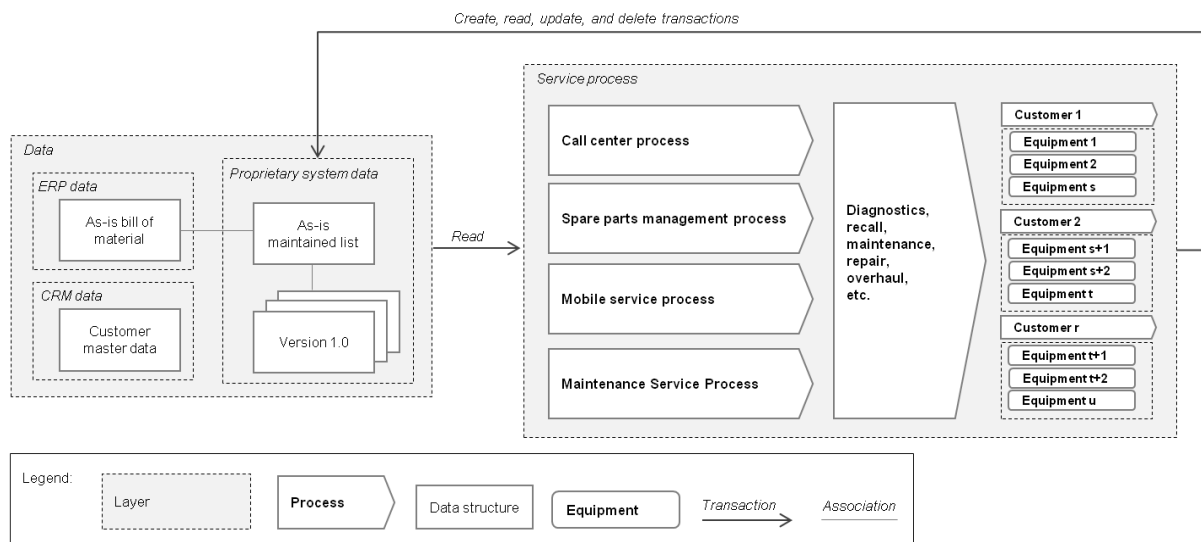


Figure 1: Installed base supported service processes

The enterprise resource planning (ERP) system concludes with the as-is manufactured bill of material that, in turn, serves as the “level 0” as-is maintained list for service planning (see Figure 1). After each transaction or modification on the installed base, the as-is maintained list is updated. A versioning allows a “service memory” on the equipment along the entire life cycle.

Call center receives a failure report. When conducting diagnostics in cooperation with the customer, the service staff gains access to the concrete instance of the equipment good. Then service technicians can be equipped with the appropriate spare parts before the customer visit. The reliability and efficiency in spare part management can be optimized. During the visit at the customer's site, a mobile application guides the service technician with the detailed and accurate equipment information. When closing the transaction, all installed spare parts are reported to the proprietary service planning system that ensures validity of the as-is maintained list. Beyond the service processes, the as-is maintained list obtains a key enabling function for any efficient realization of performance contracting. The list provides information necessary to remotely monitor all equipment at the customers' plants, not only ensuring an immediate replacement of the correct equipment part in the case of failure, but even providing accurate estimations on how long a certain equipment good can run before it will break down. Doing so, downtimes of production facilities can be reduced immensely.

Leading manufacturers have built large-scale proprietary systems for service support that enrich detailed knowledge of the heavy equipment [bill of material] with the customer knowledge which is buried in the CRM (see *Figure 1*). Most heavy equipment goods are customized to the customer's need resulting in n-versions of the bill of material. The relation of customer to the sold asset is modeled in the CRM. Key functionality of the service processes is allowed by a proprietary system. It enables a service memory by updating the as-is maintained list of the equipment after each transaction.

Although these operational processes, i.e. service operation processes on the install base, present a significant advancement in service operations in the heavy equipment industry, the propriety solutions fall short in collaboration, scalability and consistency. While some manufacturers have built their own systems, other manufacturing firms and service providers diverted ERP or CRM from its intended use to bring adequate support to service operations. The result is a mixture of diverted and proprietary enterprise systems that are far away from being a smart approach. Even information sharing, e.g. in terms of a "service history", between manufacturer and local service entity entails a costly and resource-consuming IT project; a comprehensive service collaboration, scalability and consistency not to mention.

2.2 What is the potential for improvement that makes the installed base management smart?

The service processes enabling installed base management for heavy equipment goods are known, but the implementations falls short in operational efficiency and effectiveness. In most cases, the implementations are limited in their scalability and consistency, while the full potential of collaborative services is not tapped. Heavy equipment goods industry has pointed out the following potentials:

- *Automation:* Inefficient call center-based service processes should be replaced by smart equipment that reports on usage, abrasion, alerts and prediction about the remaining life time. Connected in the internet of things, smart equipment controls cus-

customer production process and monitors relevant environmental parameters through embedded sensors.

- *Collaboration*: Access to knowledge for small and medium-sized service providers that complement service offering in particular countries and markets.
- *Consistency*: Use of an integrated database ensures consistency and mitigates redundancy.
- *Mobility*: Since service operation activities on the installed equipment (such as maintenance, repair and change transactions) refer to very complex and knowledge-intensive tasks, service technicians need mobile access to master equipment data, service history and 3-D CAD (Computer Aided Design) documentation.
- *Precision*: Equipment specific master data and 3-D CAD documents improve the documentation quality.
- *Scalability*: Big data management presents a technical aid for achieving scalability. Technical details and accurate information become accessible in real-time.
- *Standardisation*: Standardising installed base data and interfaces of the involved enterprise systems allows information sharing of the service history between manufacturer, service providers and customers.
- *Usability*: Enterprise search allows service technicians in the front and back stage to improve efficiency and effectiveness in the knowledge access.

2.3 Combining analytical processing and supply chain data management into a multivendor installed base service management

After understanding that heavy equipment manufacturers have made large investments into enterprise systems that already include valuable data, a smart approach should be grounded on the existing infrastructure. For the vision of the multivendor installed base management, the authors build on the typical value chain that can be found in the heavy equipment goods industry (see *Figure 2*). The number of involved entities and the resulting complexity in the enterprise information systems with multiple data sources make a distinction into back stage and front stage processes quite reasonable (Sampson & Froehle 2006; Teboul 2006). Front stage processes in services business are customer-centric processes of interaction and collaboration where a shared consistent information view is indispensable. The subsequent chapter (2.3.1) is concerned with the back stage perspective of the vision that explains the IT system landscape between component manufacturer and equipment manufacturer. The front stage perspective is outlined in chapter (2.3.2) and comprises the interaction between manufacturer, service provider and the customer.

The IWI proclaims a data architecture for all back and front stage service processes that is openly integrated with existing enterprise systems and data resources. Our vision is described in the subsequent sections and in *Figure 3*.

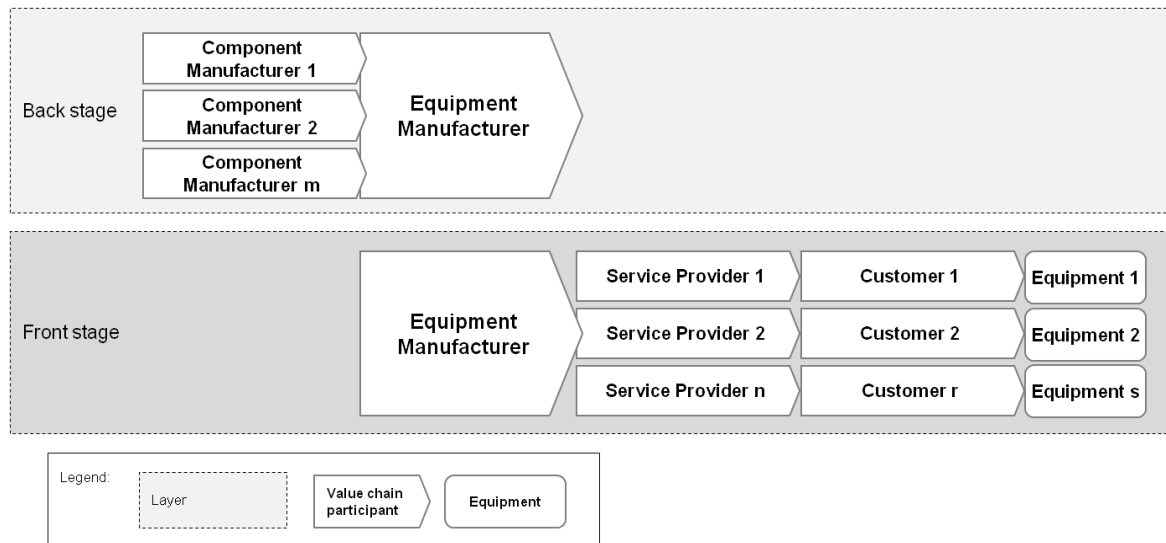


Figure 2: Value chain in the heavy equipment industry

2.3.1 Back stage perspective

Allowing for efficient operations of innovative business models, the smart approach incorporates pieces of data from a number of enterprise systems and instances, i.e. ERP and CRM. Service processes are usually rendered across organizational borders resulting in the need for a cross-enterprise solution. The installed base is technically modeled as a $N:M$ relationship of a multiple vendor installed base allowing business customers to enjoy comprehensive view on their critical assets in use. Information exchange happens on various levels of the IT system landscape as depicted in Figure 3.

Enterprise systems: The component manufacturer supplies the equipment manufacturer with integral components. The equipment manufacturer, in turn, assembles the items of equipment and offers those to the business customer who in turn uses the equipment for production. Both players apply ERP and CRM systems for business planning and execution. Based on the large scale systems, business intelligence applications are used to give managerial and operational decision support for product and service business, while sales force automation solutions help the sales division to offer and deliver products efficiently and effectively.

Meta repository: In order to provide a single version of the truth of all the installed base information, a shared and cross-enterprise cross-system database becomes an essential need. Heterogeneous data from multiple enterprise systems need to be aggregated and consolidated at a high quality level. Being the connection between the enterprise systems and a shared database, the meta repository obtains the role of middleware that knows the database schema of standard enterprise systems. It includes physical repository type libraries that contain object instance data and tables that manage object relationships. When transactions are performed, the meta repository applies business rules (which are based on the libraries and relationships) to ensure data validity.

Database: Enormous amounts of data must be processed, while heterogeneous data from multiple enterprise systems need to be aggregated and consolidated at a high quality level. In this light, in-memory technology becomes inevitable for efficient processing. The multivendor installed base builds on a shared and cross-enterprise database that is informed by the local installed base databases. Standardized interfaces ensure the exchange of critical asset data, while data quality and accuracy is organized through High Performance Analytic Appliance (HANA) stored procedures. As a result, the HANA database serves as one single version of truth for all installed base data that enable collaborative service processes. For example, analysis and detection of fraud parts and flexible spare part management substantially increase their value by involving more players. The collaboration across organizational boundaries thus helps to increase customer satisfaction.

2.3.2 Front stage perspective

Customer centric processes of the service front stage depend on the consistent real time installed base information provided by the service information infrastructure. This includes the services history, the actual as maintained equipment state as well as equipment embedded intelligence data.

Condition monitoring: Being smart further implies the inclusion of local intelligence of equipments that are deployed at the customers' plants (see *Figure 3*). On the one hand, customers itself can access the detailed and accurate information about the equipment installed without having an own enterprise system maintaining these data manually. On the other hand, the machinery equipment can alert issues to the equipment interface and transmit sensor data via Internet to the HANA database that updates the as-is maintained list with run time condition information. Building on real-time sensory data, condition monitoring technology allows the fulfillment of real time and reliable information needs in performance-based contracts. Environmental data further help to increase accuracy for the analyzed information and hence for the derived implications. For product improvement, business analytics can identify patterns of best practices in the usage and component assembling.

Service provider: Small and medium sized service providers usually do not use ERP, but rely on more flexible CRM solutions instead. Nonetheless, there is a clear need to read, update and process deep technical information of the heavy equipment. When a service incident is reported through the condition monitoring, the service provider coordinates the service operations. As a first step, the service staff is automatically informed by a detailed report including the incident message and installed base data. For a more detailed diagnosis, the service staff can remotely call and communicate with the affected equipment.

Frontend client: If necessary, a service technician is sent out to the customer. Equipped with the failure report and access to the service history [the versions of the as-is maintained list of the affected equipment], the service technician can adequately prepare his customer visit. After performing repair and maintenance activities, he can immediately prompt the change transactions so that the as-is maintained list remains consistent and accurate.

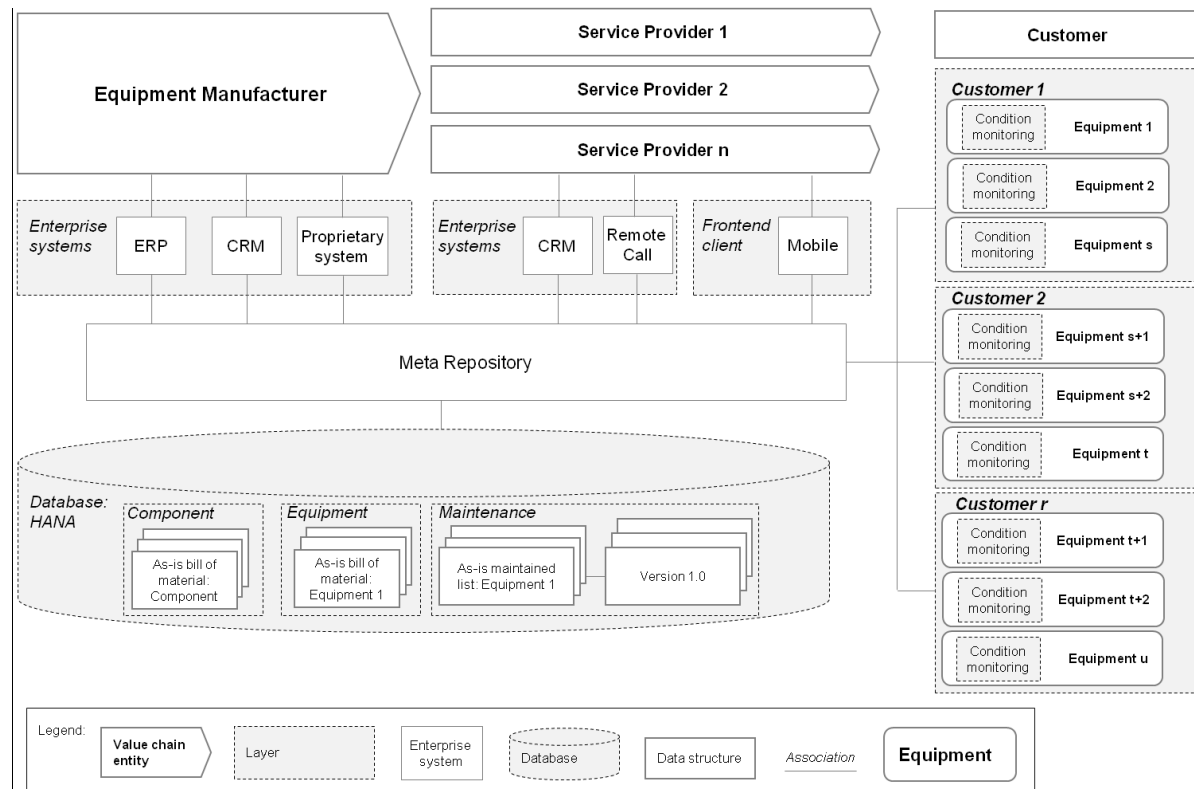


Figure 3: IT system landscape for cross-enterprise installed base management

2.4 Key data issues for the installed equipment service management when applying extant IT architectures

To identify the needs and challenges of installed equipment service management, the authors want to build on existing scenarios that they found during the problem analysis in the heavy equipment industry. Company ALPHA and BETA are two case companies which we have intensively studied during the initial research phase.

ALPHA is an international manufacturing enterprise in the construction and equipment industry (see Figure 4). They offer equipment for mining, plant and large scale transportation. ALPHA is a well-known brand that enjoys high reputation among its customers. The organizational setting consists of a few production facilities and over 200 local sales and service entities. After selling the product, customers enjoy a 5 year warranty. The first customer usually deploys the product for 6 years and then resells it to a service provider. The service provider overhauls the product and offers it on the renewal market. In that position the service provider takes over the maintenance and repair service business which after 6 years becomes relevant. Since ALPHA only holds the data of the first customer, retention for the renewal customer becomes very expensive or even impossible. However, economically it is the renewal customer that is relevant for the service business.

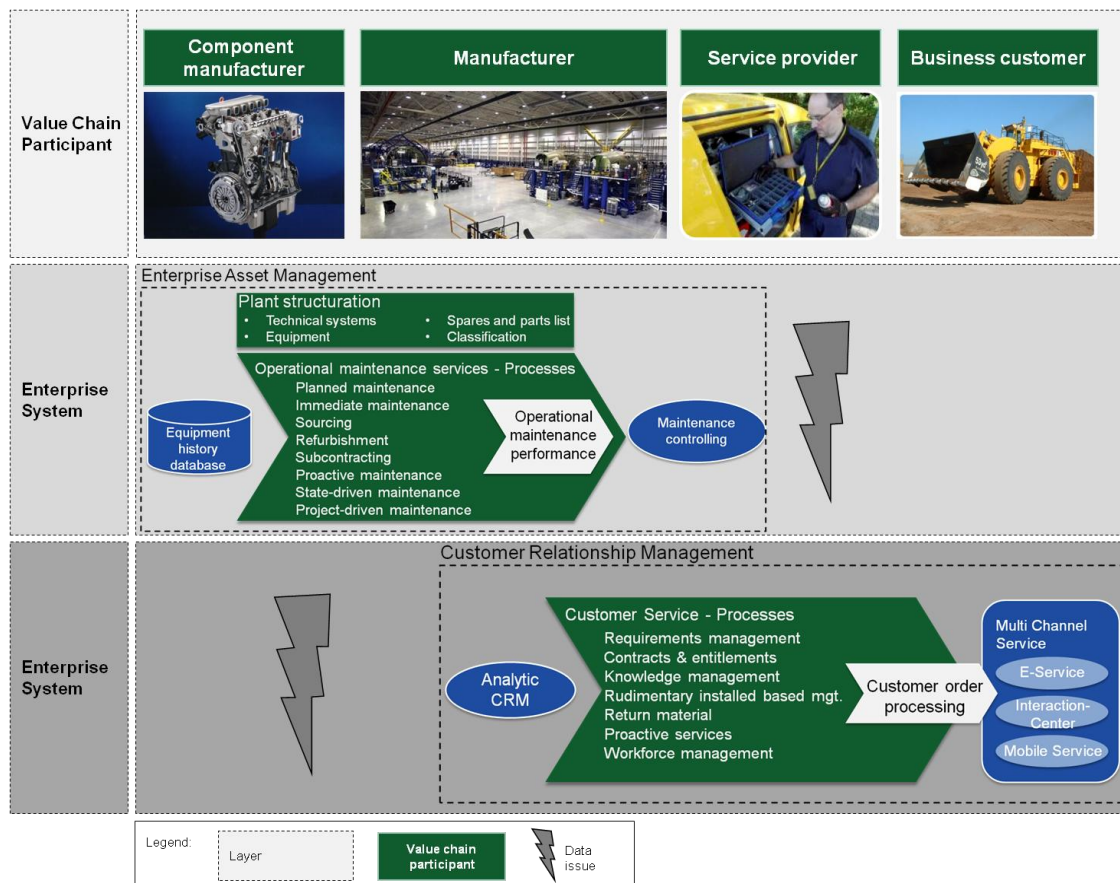


Figure 4: Supply chain and system landscape of ALPHA

The second case company (BETA) is a component manufacturer. BETA's business customers deploy the equipment in huge production plants. In total, thousands of products are distributed all over the facilities and business customers report a lack of information necessary to maintain operations. Picking up this need, BETA has developed a condition monitoring prototype that provides relevant status information about the products deployed in the customer's plants. The customer is warned when e.g. the equipment exceeds predefined parameters in temperature in order to prevent any downtimes of the production plant that could cause enormous costs. The service employees are informed about the concrete failure and will be prepared for the customer visit. The compiled information can contribute to the development of new products and services. IT is directly involved in the generation of sales and provides a competitive advantage for customer retention. However, the project was never rolled out, since the BETA's products only represent components of the machinery used by the customer and the status information relevant for the customer must address the entire machinery equipment. Sensor input data of the component are misinterpreted as events that have never occurred, since a complete picture - based on environmental and component data - is missing.

In addition to the presented problem scenarios, the multivendor installed base management approach can help to overcome the following challenges:

- *Spreadsheet usage*: The usage of decentralized and highly individualized data formats prevents efficient information processing and automation.
- *Information silos*: Aggregating data from multiple sources [instances of enterprise systems] leads to redundancy and can result in inconsistency issues.
- *Complex & customized on-premise software*: On-premise enterprise systems and legacy systems are characterized by a significant amount of customization.
- *Static cost structure*: Software licenses are static over the period that has been specified in the contract. Cloud solutions apply a pay-per use cost model.
- *Scalability*: On-premises enterprise systems and data bases are limited in their capability to scale up. Economic growth in developing countries requires the decentralized service entities to scale up their enterprise systems very quickly.
- *Update procedure*: The roll-out of new releases und software updates bind valuable human resources.
- *Competing situation*: Inefficient and uncoordinated service handling of the manufacturers forces the customers to reconsider their service contracts. Competing service providers enter the market and replace the manufacturer's service business.
- *Accessibility to data*: Customization of enterprise systems leads to the need to customize the corresponding interfaces for mobile devices as well. In this light, accessibility becomes an issue.

2.5 Applying cross-enterprise installed base service management for competitive advantage

The processes of the smart service management approach were explained the previous sections. However, the capability of transforming valuable customer-centric and product-related data resources into a competitive advantage is decisive to strengthen the market position. Given this comprehensive view on the equipment sold to the customer and using the technical aids of big data management and smart equipment, leaves the question of what the implications on service processes and business models are. Big data management and particularly in-memory databases contribute to real-time processing of mass equipment data. Once aggregated and consolidated, the data of the installed equipment can serve as decision support on both strategic and operative levels.

On the operative level, sensory data and installed base data serve as valuable tools to control the originality of the deployed spare parts. Inefficient call center-based service processes can be replaced by a smart incident management approach, in which the equipment reports independently on usage, abrasion, alerts and prediction about the remaining life time. Connected in the internet of things, smart equipment controls customer production processes and monitors relevant environmental parameters through embedded sensors. When conducting diagnostics in cooperation with the customer, the service staff gains access to the concrete

instance of the equipment good including the service history. Then service technicians can be equipped with the appropriate spare parts before the customer visit.

On the strategic level, the comprehensive view on customer equipment and the usage data statistics can be applied for strategic decision support. Knowledge on the customer usage is a valuable input resource for the design of new machinery equipment solutions. The procurement function is capable to select component suppliers based on their actual performance and fit to the equipment. The knowledge of customer practice helps to give guidance and best practices to more recently acquired customers. The insights about customers, their equipment and the production environment provide the opportunity to answer customer needs and hence to build sustainable relationships.

Beyond decision support functionality, the as-is maintained list obtains a key enabling function for any efficient realization of performance contracting. The list provides information necessary to remotely monitor all equipment at the customer's plants, not only ensuring an immediate replacement of the correct equipment part in the case of failure, but also providing accurate estimations on how long a certain equipment good can run before it will break down. Doing so, downtimes of production facilities can be reduced immensely which is in accordance to the customer interest.

3 Putting the cross-enterprise installed base management into realization

Most industrial companies have seen service initiatives starting and failing. They massively underestimate the effort needed to turn a product-focused company into a customer service-centric organization (Strähle et al. 2012) and build up the information systems infrastructure needed in parallel. To deal with that complexity the presented approach can be implemented in a phased approach where each phase delivers customer value and competitive advantages on its own. The transition through these phases allows organizational learning while targeting the business transition to competitive customer satisfaction and profitability based on services excellence.

3.1 Plan the roll out in appropriate transformation phases

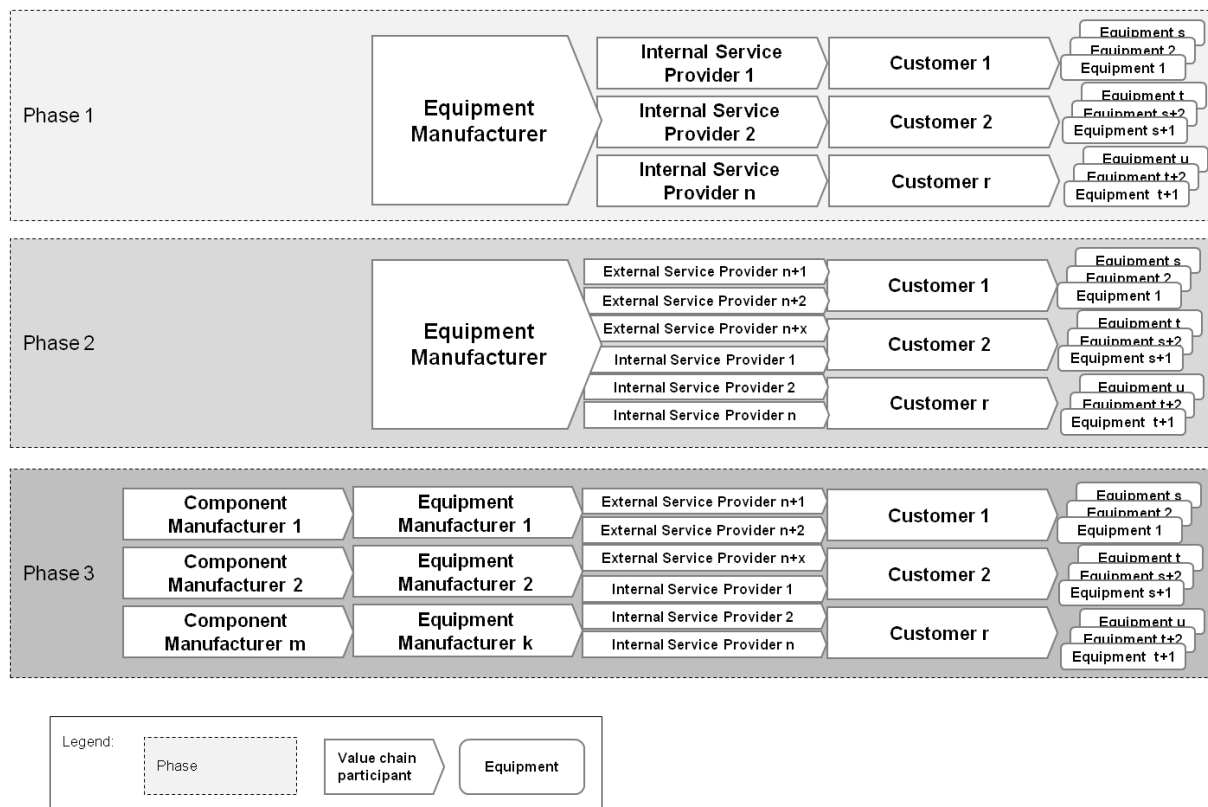
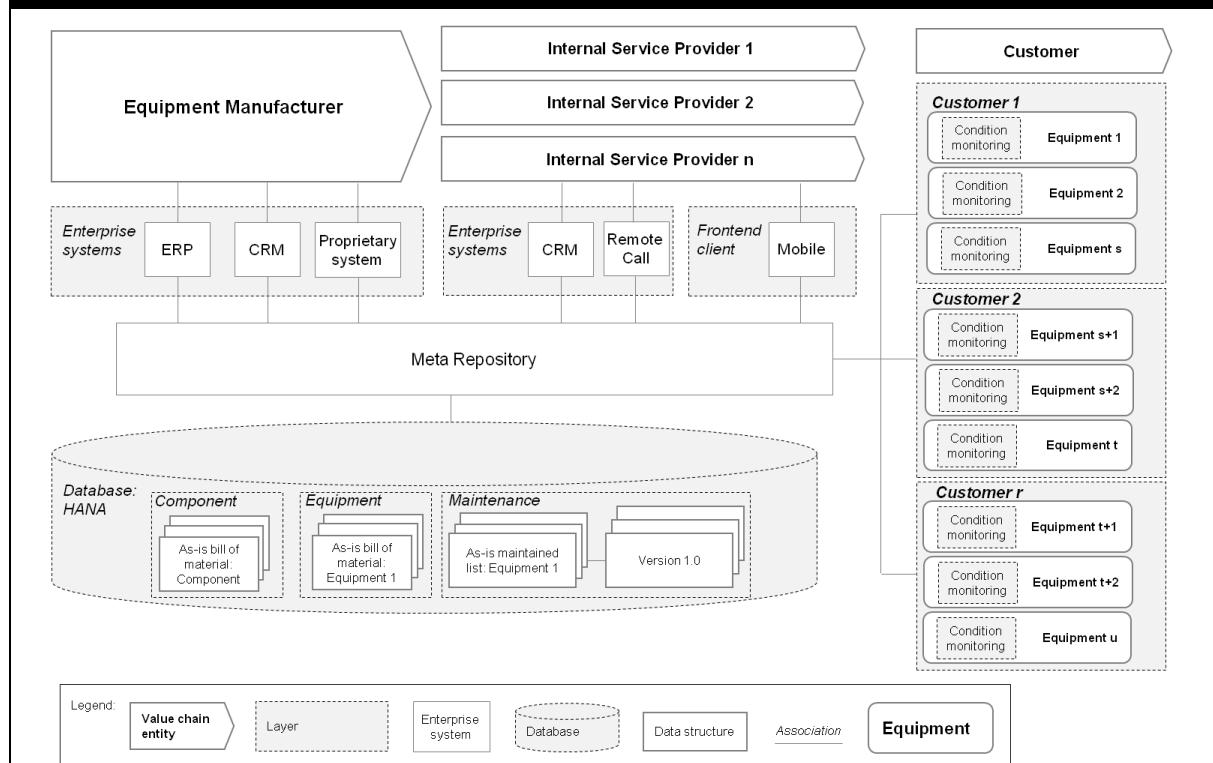


Figure 5: Phases of Transformation

As motivated in Chapter 1, the provisioning of serialized descriptions on sold assets in combination with deep technical information [bill of material] to all involved partners along the value chain presents a key lever to increase service productivity. The digital equipment memory presents the key data source of any sophisticated service process (service quality, spare parts originality control) and business model (performance contracting). However, the implementation of the targeted stage as outlined in Chapter 2 is often underestimated. For that reason, the authors recommend a three step transformation approach (see Figure 5). Each

of the phases provides already concrete competitive advantages in terms of synergy potential for cost and value that can be achieved successively. The first phase is concerned with the internal aggregation and the *internal consolidation* of the installed base data.

Phase I: Internal Consolidation



Description

The first phase is concerned with the internal consolidation of installed equipment data that is aggregated from multiple sources. The manufacturer provides deep technical information with the bill of material [ERP], while the CRM yields the association of sold products with the global customers. Numerous internal service providers [i.e. globally distributed sales and service entities] contribute to the association of sold products with the local customer. Proprietary systems enable sophisticated service processes such as remote calls or mobile support for the service technicians.

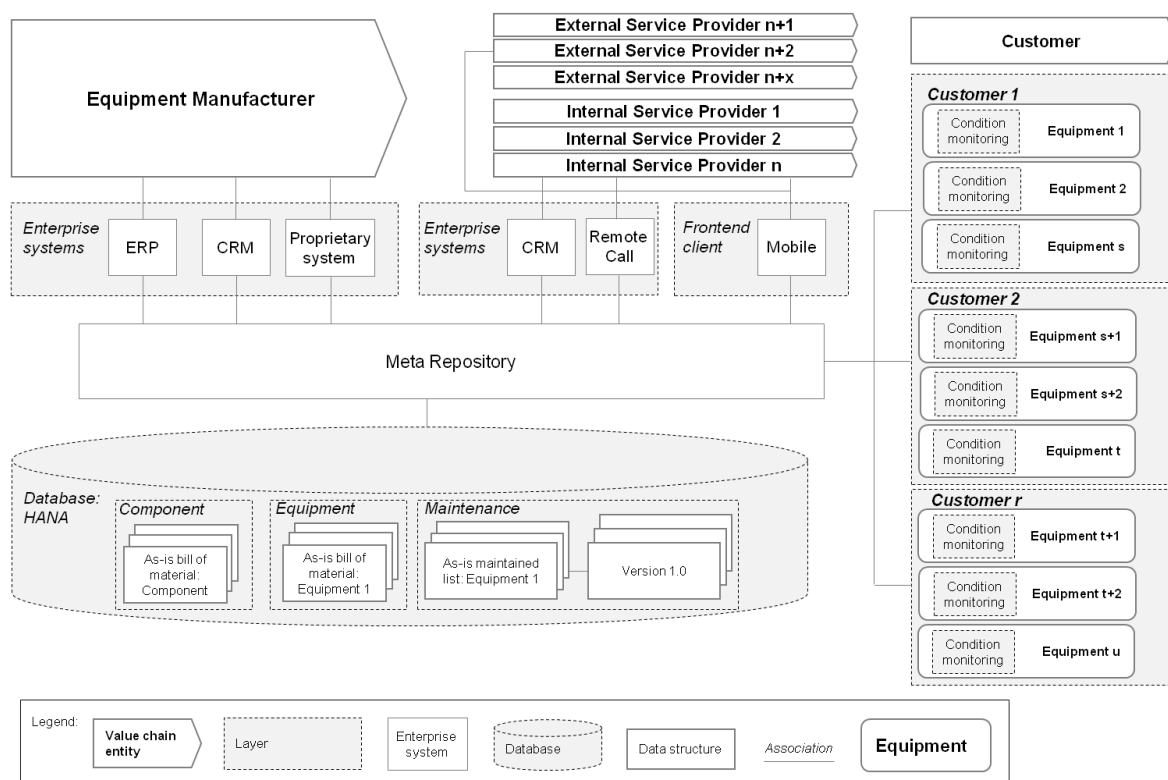
The machinery equipment reports issues to the equipment interface and transmit sensor data via internet to the centralized database that updates the as-is maintained list with status information. Building on real-time sensory data, condition monitoring technology allows the fulfillment of reliability and velocity needs in performance-based contracts. Environmental data further help to increase accuracy for the analyzed information and hence for the derived implications. The centralized database stores the service history [the versions of the as-is maintained list of the affected equipment] and supplies one version of the truth to support service processes of all involved value chain entities.

Objectives

- Strategic objectives
 - Use of maintenance and operations data for product improvement
 - Use of maintenance and operations data for supplier selection
 - Gain knowledge about the appropriate usage of the equipment
 - Keep control on customer data
 - Analytics based on “one version of the truth”
- Operational objectives
 - Automation
 - Analysis & detection of fraud parts (e.g. origin-one)
 - Selection of appropriate counter-measures in the incident management

Table 1: Roll-out Phase I – Internal consolidation

Phase II: Service Provider Integration



Description

Although phase I presents a significant advancement for service operations in the heavy equipment industry, those proprietary solutions fall short in collaboration and scalability. On a global scale, it is often not profitable to set up service locations and the corresponding infrastructure in small markets. Service processes have to be executed across organizational borders involving subsidiaries, subcontractors, service centers and external service providers. Nonetheless the OEM has to ensure the same quality level as the service is executed with internal resources. To efficiently execute the service processes, the knowledge transfer to service partners has to be enabled by the shared installed base services management system.

Hence, the second phase continues the roll-out process through the integration of external service providers. Besides the extension of the synergy potential for analytics, the major capability lies in a more scalable and collaborative approach.

Objectives

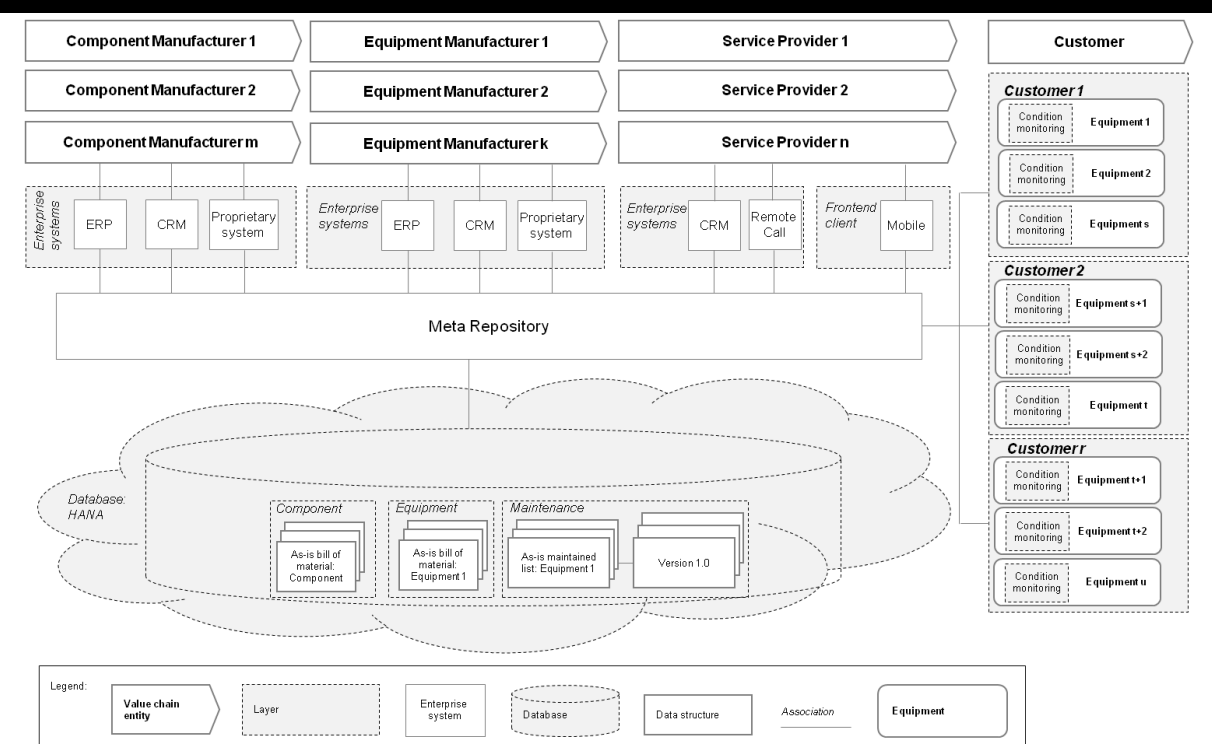
- Strategic objectives
 - Access to new customer segments (rebuyers)
 - Customer retention
 - Knowledge sharing with external service providers
- Operational objectives

- Flexible spare parts management
- Analytics are based on a large number of customer equipment data
- Enterprise and cross-enterprise version of the truth

Table 2: Roll-out Phase II – Service provider integration

In the third phase, the cross-enterprise installed base constitutes openness towards business customers, external service providers, and suppliers in order to maximize customer satisfaction. Cloud technology allows an efficient data exchange among the involved players.

Phase III: Multivendor Customer Equipment Integration



Description

The aforementioned advantages [see phase I and phase II] are strengthened through a growing number of participants sharing installed base-related data. After integrating internal and external providers in the front stage, the focus is now placed on the supplying component manufacturers and cooperating OEMs. The OEM does not have the resources to interpret all sensors that are embedded in the equipment, while the component manufacturer requires context-specific information from other components, the equipment itself or the production facility. The OEM aims to exchange installed base data with the important component manufacturers. Both players can take advantage of such collaboration.

The collaboration of the value chain members can ensure the respective market position, since the value of the data heavily depends on completeness. Only the combination of in-

stalled base data from all component and equipment manufacturers can provide a profound base for delivering high quality services. The quality aspect and the synchronization with the business model of the customers help the OEM to build sustainable customer relationships.

Due to the organizational diversity in size, function and management of service entities and a clear need for seamless integration, the authors recommend the implementation of a cloud-based IT architecture. Being flexible in scale and accessibility, the cloud helps to overcome diversities in the present enterprise systems (legacy, proprietary and standard systems) and to consolidate and aggregate equipment master data. In addition, smaller service entities can focus resources on the sales and service operation, since they do not have to hold IT resources available.

Objectives

- Strategic objectives
 - Service collaboration
 - Integrated solution offering including the service operations for competing brands
 - Protect the market position
 - Increase service productivity through cloud technology
- Operational objectives
 - Scalability: On-premises enterprise systems and data bases are limited in their capability to scale up. Economic growth in developing countries requires the decentralized service entities to scale up their enterprise systems very quickly.
 - Pay as you go: Software licenses are static over the period that has been specified in the contract. Cloud solutions apply a pay-per use cost model.
 - Maintenance and update procedure: The roll-out of new releases und software updates binds valuable human resources.
 - Web-based access for customers: Customization of enterprise systems leads to the need to customize the corresponding interfaces for mobile devices as well.

Table 3: Roll-out Phase III – Multivendor Customer Equipment Integration

3.2 How might the new SAP Business Suite on HANA-base contribute?

The obvious benefits are associated with an increase in speed. Typical examples refer to less time spent for creating data aggregations and database administration tasks. The dedicated IT administration staff can be reallocated to higher value-added activities, since there is a reduced maintenance effort compared to disk based database systems. Self-service access to granular data makes the service staff perform analysis without the involvement of the IT department. Processing of more information with fewer computing resources requires lower capital outlay compared with traditional, disk-based approaches.

In order to justify the implementation costs, the OEM must present benefits that are not only associated with an increase in speed and reaction times. The introduction of SAP HANA creates not only license and set up costs, but delivers substantial business benefits of the SAP Business Suite infrastructure already in use by most of the European heavy equipment manufacturers. The SAP Business Suite on HANA presents a modern business suite solution for integrated analytics and real-time processing with existing and new business processes without disruption. In contrast to traditional analytical systems (i.e. data warehouse and business intelligence) for management information, the HANA approach offers analytical intelligence to the operational users based on an integrated view on multiple transactional enterprise systems (e.g. ERP and CRM) in use. New business processes especially addressing the needs of field people can be added with modern mobile solutions having real time access to all operational data needed to solve customer issues. A multivendor installed base service management can be implemented on top of existing data structures in use of one or more business suite components protecting the customers' SAP investments and delivering new value added processes on top with fast returns.

Technical opportunities	Value Proposition
More planning iterations, scenarios, and variables can be taken into account when planning. Adjustments can be made as actual performance is updated	Improve planning accuracy
More granular data is available for analysis, with the system performing aggregation when requested	Reduction in time spent by business staff on data preparation, cleansing, aggregation
Speed of analysis leads to quicker insight. It enables embedding of analytics within key business processes.	Reduction in analysis turnaround time
In-memory technology removes the barrier to investigating and finding meaning in organizational performance data	Ability to analyze more granular data rather than pre-aggregated information
Applications combine benefits of in-memory technology with business context through an interactive interface	More flexible and more interactive user interface
Speed of analysis enables more scenarios to be done in a given day than with traditional planning solutions	Ability to run through more planning or scenarios
Users are free to perform ad hoc queries not limited by predefined data sets	Answers to questions we could never ask before
Speed of analysis means business users can question assumptions, re-evaluate potential outcomes, and repeat with rapidity	Increase frequency of re-evaluation of analytic models, plans, forecasts

Table 4: Technical opportunities and business value of in-memory technology based on Vesset et al. (2011)

Table 7 presents technical opportunities and business value that can arise from both analytical and transaction processing. Analytical synergy potential can range from the improved planning accuracy, over the reduction of analysis turnaround time towards the ability to run through more planning scenarios. Synergies arising from the transactional potential refer to the ability to process more granular data to answer questions that have never been asked before. Transactional applications can process more detailed data, while the business user is able to perform ad-hoc queries. In-memory technology removes the barrier between transactional and analytical systems.

Data can be multi-structured and multi-sourced. It can be structured, semi-structured, or unstructured; it can come from enterprise applications, point of sale systems, clickstream from online commercial and social networking activity, call detail records, mobile devices, or sensors (Vesset et al. 2011). Some of the data, such as call detail records, mobile device activity, or vehicle traffic data, can be considered part of the big data trend that emphasizes high-volume or high-velocity data of various types (Vesset et al. 2011). While in-memory database system alone cannot solve the multisource and multi-structured data integration issue, a new meta repository on top of existing data structures can open up the formerly closed enterprise systems for open access from outside as well as for standardized open services feeding the new environment with content out of multiple legacy enterprise systems.

The HANA database fits into the requirements list of the smart approach, since it represents the technical aid that is able to manage structured and unstructured data from multiple resources. As outlined in *Chapter 2*, an increase in service productivity is substantially dependent on the capability to combine customer data [CRM], technical descriptions of the machinery equipment [ERP], sensor data [connected things], and mobile device activity data [from the service technicians]. The new HANA-based SAP Business Suite can help to overcome most of the discussed challenges (see *Chapter 2.4*). In fact, HANA and the meta-repository contribute the integration and big data management aspect to the multivendor installed base management approach. Plausibility checks and business rules do not anymore involve resources of the transaction systems, but can be handled by the meta-repository. The need for data warehouses and the online analytical processing (OLAP) become obsolete, since HANA incorporates in-memory technology that is capable to process data from the transaction systems. The enterprise search enables to search and access all pieces of data across the SAP Business Suite in real-time. The use of HANA stored procedures ensures high data quality through instant data and business rule checks. A unified data interface supports the full integration of mobile devices and sensor data.

4 Get on board & next steps

By now, information systems support for service business has hardly been addressed as a dedicated research stream. The IWI at the University of St. Gallen claims a leading business engineering role helping information systems research to catch up with marketing and management research on service science. The availability of SOA, cloud technology, big data and mobility constitutes the technological aid to provide adequate answers to the increased service demands in the manufacturing industry. The IWI aims to address the multivendor installed base service management focus. In order to achieve consumable results that are highly relevant, the IWI relies on the consortium research approach. This collaborative research program will comprise numerous heavy equipment enterprises, a limited number of software vendors and consulting firms. Results are based on scientific state of the art knowledge, in order to be discussed, improved and tested in cooperation with global acting companies.

While CRM systems lacks in technical granularity, EAM holds accountable for the operational maintenances performed on enterprise owned equipment. Since the customer shows enormous interest in the condition of the installed heavy equipment, leading OEMs have obtained a first mover role in the design of proprietary systems that adequately support service processes which are closely linked business models. As a first step, we want to analyze the installed base related service processes and data structures of those OEMs in the heavy equipment industry. The objective is to derive requirements on data and process level for the multivendor installed base service management [AP.1].

Equipped with a detailed conception of the installed base management requirements, it is possible to use proprietary implementations as a reference design for the development of a functional prototype in the second phase [AP.2].

The third phase [AP.3] is concerned with the implementation of the software prototype. The objective is to achieve a comprehensive view on the sold equipment and track the service transactions in a versioning. The equipment data are stored in the HANA database as the combination of the as-is bill of material [from production planning system], the as-is maintenance data [from proprietary system] and sensor data [from the machinery equipment].

The fourth phase explores the synergy potential of in-memory databases that ranges from improved planning accuracy, over reduced analysis turnaround time, to the ability to process more granular data to answer questions that have never been asked before [AP.4]. The objective is to take advantage of the removed barrier between transactional and analytical systems for multivendor install base service management.

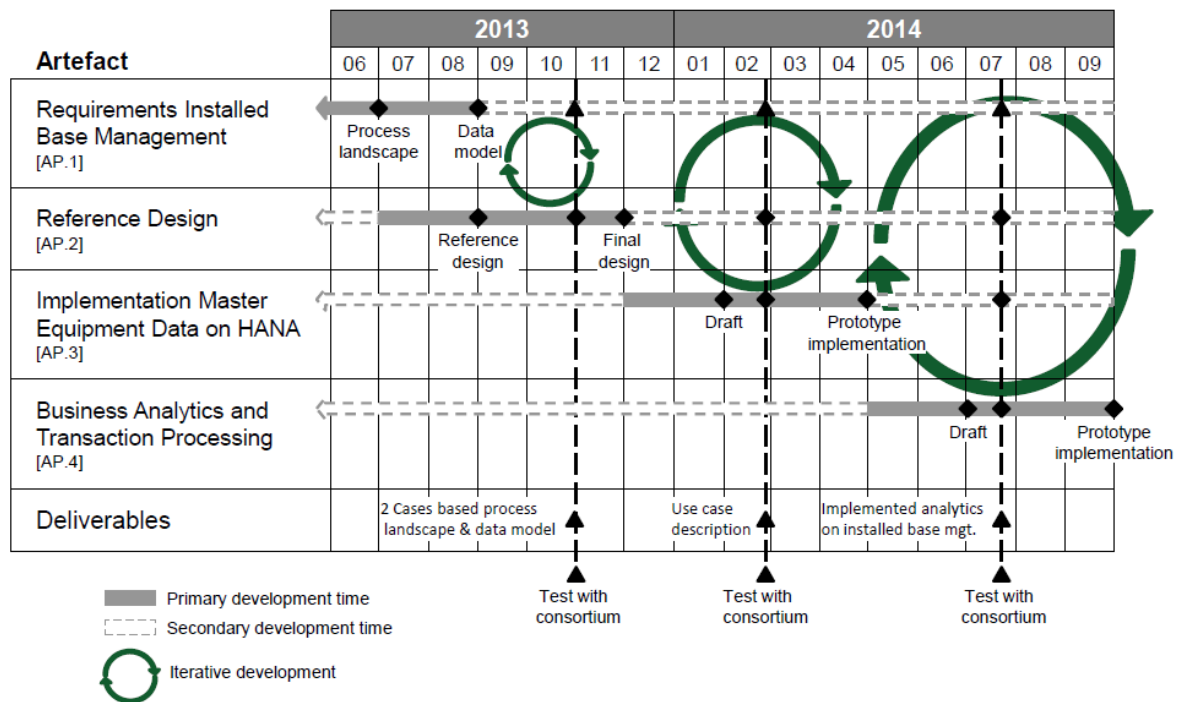


Figure 6: Project Schedule

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Appendix: Methodological approach and performed research activities

For the specification of the focus on multivendor installed base service management and the conception of this document, the IWI research team conducted several interviews with OEMs that use SAP enterprise systems for service planning and operations (*see Table 5*). In October 2012 a workshop has been carried out to identify the current state in global acting heavy equipment manufacturers.

Case company	Industry sector	Employees > 10k	Turnover 2011 € > 10 Billion	Interview partner	Number of interviews
ALPHA	Industrial	✓	✓	Process Automation Division IS Manager	3
BETA	Industrial	✓	-	Vice President, Service Division	2
GAMMA	Construction	-	-	CIO & Head of Processes	2
DELTA	Industrial	-	-	CIO	1
EPSILON	Industrial	✓	-	Head of IT Strategy & Transformation	1
ZETA	Industrial	✓	✓	Head of Corporate Solutions & Technology	1
ETA	Industrial	✓	-	Head of Customer Service	2

Table 5: Profile of the case companies

The IWI aims to address research questions around the service business in a holistic approach. As depicted in *Figure 7*, *Consumer Services* and *IT Services* are already subject to collaborative research programs at the IWI. The upcoming program on *Industrial Services* can benefit from the existing frameworks, methodologies and experiences regarding the research within the service business.

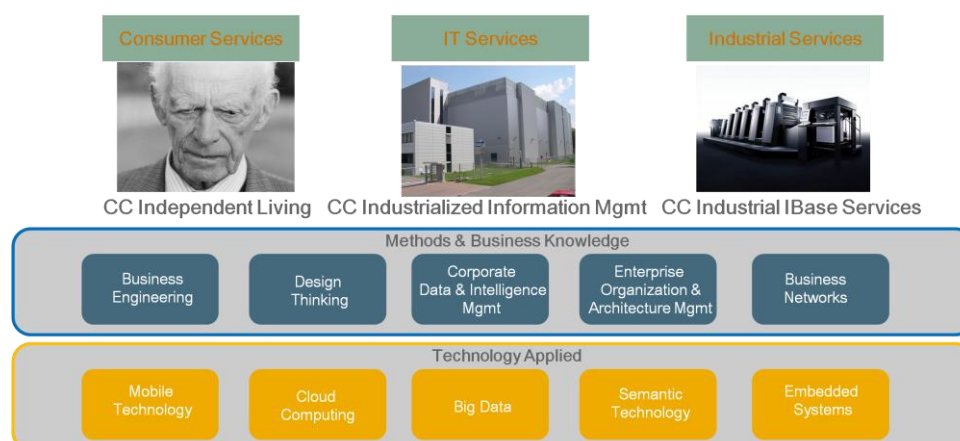


Figure 7: Collaborative research programs in service business at IWI based on Zencke (2013)

This collaborative research program will comprise numerous heavy equipment enterprises, a limited number of software vendors and consulting firms. Results are based on scientific state of the art knowledge, in order to be discussed, improved and tested in cooperation with global acting companies. As a first result, the research team was able to derive a draft version of requirements for an integrated information systems solution. In order to holistically support such a broad transformation task, the IWI-HSG applies the business engineering framework (see *Figure 8*) that comprises the dimensions *strategy, process and systems*.

The *service strategy* informs the business model and defines respective controlling objectives. Since the value of industrial services arises when the business customer applies it, the service quality has to be ensured along the entire value chain, including external vendors.

On the *process* level, engineering and operations processes need to be addressed. Managing the installed base is salient as it presents valuable customer knowledge and creates critical insights about the equipment in operation. There is a clear need for supporting service technicians during the customer visit. The main purpose is to provide master data, historical data, service catalogues, access to the knowledge base, and to trigger the billing and accounting processes.

On the *systems* level, architecture and data requirements have to be addressed. Larger production entities, smaller service entities and local subcontractors form a comprehensive service network that requires appropriate architectural solutions. The resulting complexity provides additional challenges to the IT architecture. Ensuring high efficiency in the service processes requires substantial investment in corporate data quality to establish standards. A set of profound and reliable master data is crucial for automated service processes.

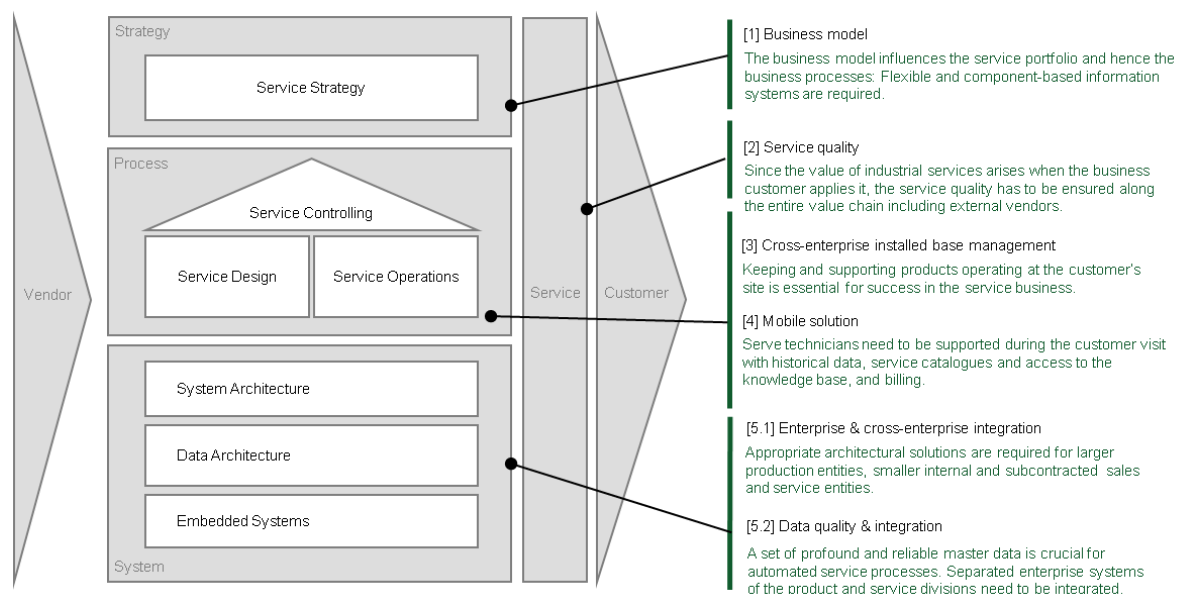


Figure 8: Business Engineering Framework based on Österle (2010)

Appendix: Existing enterprise software fails in adequately supporting this strategic shift into the service business

The first step in expanding product-related services is to develop a complete picture of the equipment to be serviced. Identifying the relevant equipment types, numbers and technologies in use at the customer site is a time-consuming task, but the effort pays off. In Bain's experience, increasing identification of installed equipment to 80% to 90% can help double service possibilities (Strähle et al. 2012). However, existing enterprise systems are designed for completely different purposes and are hence not capable in adequately supporting a cross-enterprise installed base management (see Figure 9).

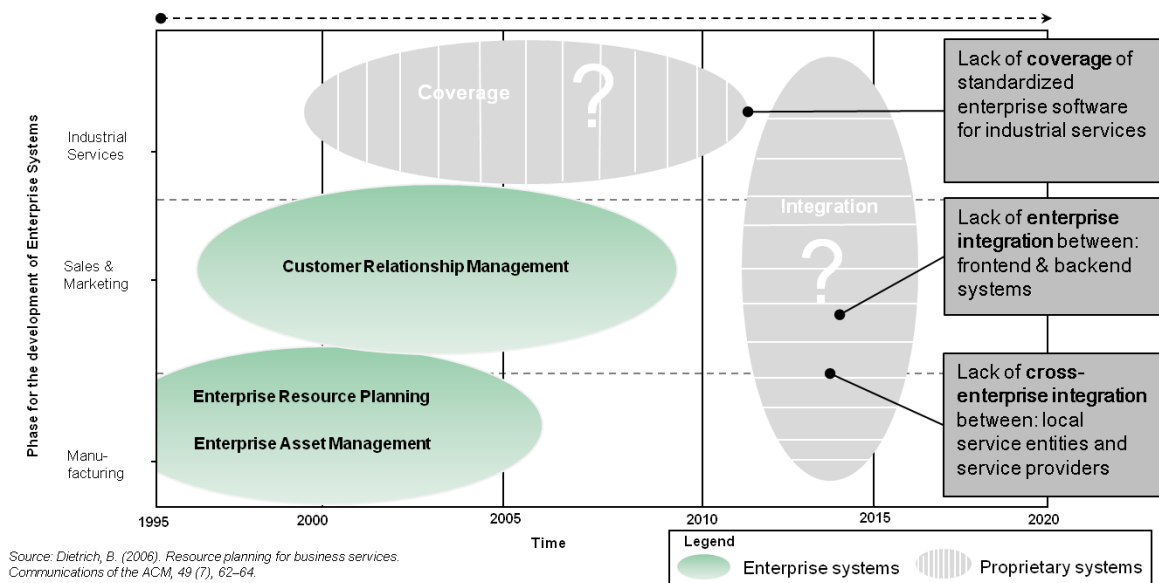


Figure 9: Phases for the Development of Enterprise Systems

EAM possesses a single enterprise technical view on owned production assets (see Figure 10). Purpose: the installed base (e.g. equipment master data) models the technical view on the enterprise owned assets with its installations from multiple vendors. Operational maintenance services performed on equipment are kept in the equipment history database. Supported processes are:

- Planned maintenance
- Immediate maintenance
- Sourcing
- Refurbishment
- Subcontracting
- Proactive maintenance
- State-driven maintenance

- Project-driven maintenance

Enterprise Asset Management

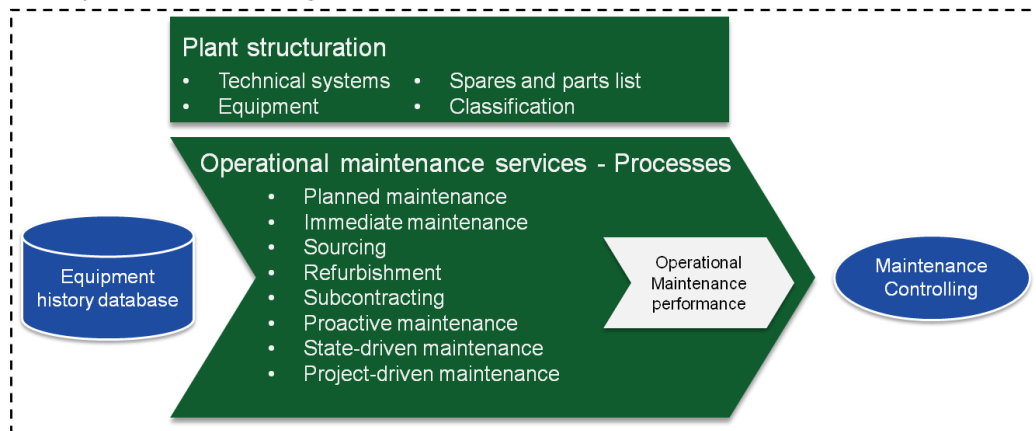


Figure 10: Enterprise Asset Management Services

CRM models sold products of a single enterprise at multiple customers (see *Figure 11*). Purpose: The installed base models the installed base of a single vendor at multiple customers [sold to customers]. Operational services for these customers are kept in the CRM customer database. Supported processes are:

- Requirements management
- Contracts & entitlements
- Knowledge management
- Rudimentary installed based management
- Return material
- Proactive services
- Workforce management

Customer Relationship Management

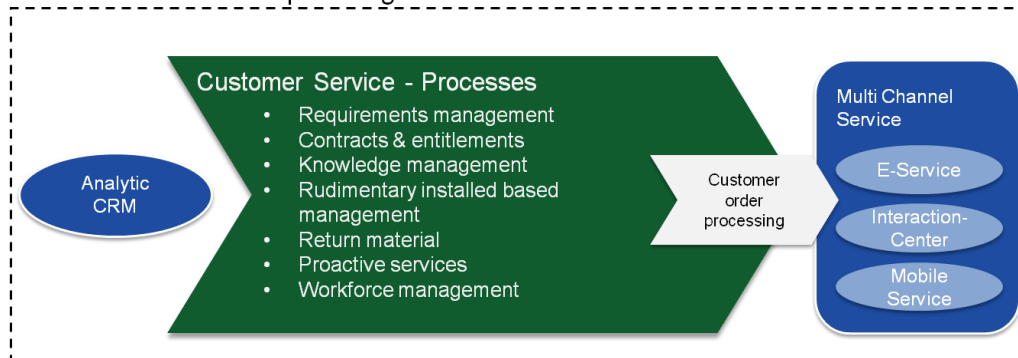


Figure 11: Customer Relationship Management Services