RESULT PAPER

Digital Platforms in Manufacturing Industries

In collaboration with

rri **Robot Revolution &**
Industrial IoT Initiative

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1 Executive Summary

Currently, there are 7 platform companies among the 10 companies with the largest market capitalization. The business of these companies is based on the operation of a digital platform orchestrating a digital ecosystem to increase their usage and thus also of the platform operator. The result is a "the winner takes it all" phenomenon. The underlying self-reinforcing network effects have been examined and discussed in many ways, for example in the book "Platform Revolution" by G. Parker, M. Van Alstyne and S. Choudary.

The large platform companies mentioned have so far addressed Business-to-Consumer (B2C) markets, but the ideas and concepts have already been used in various ways in Business-to-Business (B2B) markets, too, even if the "winner takes it all" phenomenon has not yet been observed there. Especially in manufacturing industries self-reinforcing network effects are more difficult to achieve with platforms – or take more time to be achieved with impact on both pace and cost of growth.

Nevertheless, efforts by new platform companies can increasingly be observed in the manufacturing industry. These aspects are discussed by Japanese and German experts. They analyzed concrete examples, scenarios and use cases from Japan and Germany, which are observable in the market, in order to reach a common understanding of the specific mechanisms and impact and to provide guidance in these complex discussions especially to enterprises, politics and research.

2 Introduction

2.1 Objectives

The Robot Revolution & Industrial IoT Initiative in Japan and the Plattform Industrie 4.0 in Germany have agreed to work together in the field of "digital business models". The overall objective of this cooperation is to illustrate the economic importance of digitization for the manufacturing industry, driven by the analysis of selected examples, scenarios and use cases.

There are many theses and ideas from a technical perspective (e.g. security, communication, artificial intelligence, etc.), there are many claims from an economic perspective (e.g. platform economy, new intermediaries, etc.) and often facts in Business-to-Consumer (B2C) are directly transferred to Business-to-Business (B2B), but the discussions typically stay on an abstract level and generally do not reach the business level in the manufacturing industry.

Therefore, the results of this cooperation will be based on concrete examples, scenarios and use cases that can be observed in the market. Japan and Germany both benefit from such a joint discussion because they have a similar understanding of the importance of digitization for the future of the manufacturing industry.

Addressed stakeholder of this cooperation is primarily the manufacturing industry, to provide guidance in the complex discussions, but also politics and research will be addressed.

2.2 Scope

The focus of the discussion will be on so called "platforms".

Currently, there are seven platform companies among the ten companies with the largest market capitalization worldwide. The business of these companies is based on the operation of a digital platform via which an ecosystem is orchestrated to enable strong growth of the ecosystem and thus also of the platform operator. The result is a "the

winner takes it all" phenomenon. The underlying self-reinforcing network effects have been examined and discussed in many ways, see for example [1].

The large platform companies mentioned have so far addressed B2C markets, but the ideas and concepts have already been used in various ways in B2B markets, too, even if the "winner takes it all" phenomenon has not yet been observed there. Especially in manufacturing industries self-reinforcing network effects are more difficult to achieve with platforms – or take more time to be achieved with impact on both pace and cost of growth. Nevertheless, efforts by new platform companies can increasingly be observed in the manufacturing industry.

2.3 Brief Introduction to Platforms

The term "platform" is used in many ways and is also discussed in the individual communities with different objectives. Basically, a distinction should be made between a *technical* and a *business* perspective (see Figure 1).

- Technical perspective: Here, a platform comprises technological concepts that support companies in the development of modular products, services, or technologies. An example of a digital platform in this sense is Linux or an example of a non-digital platform is a kit of mechatronic components for the development and production of automobiles. In this context digital platforms are often described in the form of a layered architecture.

- Business perspective: Here, platforms are understood as intermediaries that connect two or more market participants with the help of a technology and enable business interactions. Examples of digital platforms in this sense are eBay or AirBnB, an example of a non-digital platform is a classic marketplace. In this context platforms are often described in the form of a value network.

Both perspectives are justified, but it is not very effective to always change and mix between these two perspectives in the discussion. In addition, the discussion should differentiate between digital and non-digital platforms.

The focus of the cooperation between Japan and Germany is on the *business perspective of digital platforms*. The discussion of the business perspective of digital platforms is of interest to companies because it promises great potential for growth and scaling.

2.4 Overview of the Document

Based on these considerations, a total of eight examples of platforms that can be observed in the market were documented by Japanese and German experts, see chapter 2 and chapter 3. The description is based on an extension of the tried and tested methodology developed by the "Digital Business Models" working group of the Plattform Industrie 4.0, see [2].

Chapter 4 summarizes the results of the analysis of the experts from Japan and Germany and chapter 5 describes an outlook on further work.

Figure 1: Different perspectives on platforms

technical perspective

artifacts

design & engineering

application

■ other artifacts
■ artifacts of platform

business perspective

intermediary

←→ value chain

Source: Plattform Industrie 4.0
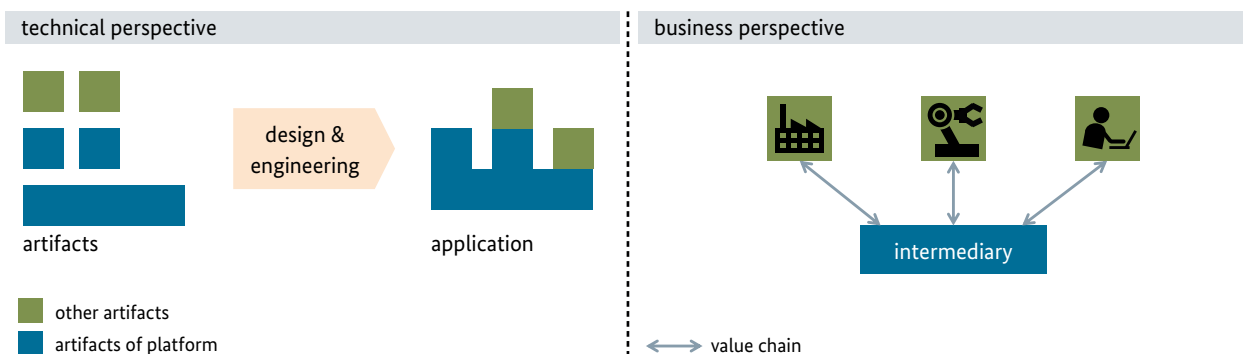
3 Examples from Japan

3.1 CADDI – Manufacturing platform for sheet metal bending

This example is based on the information published at https://caddi.jp/.

CADDI is a manufacturing platform offering an online shop for the procurement of bended sheet metal components. An interested party provides a CAD design data for the bended sheet metal component to be produced and requests a quote. Based on it, CADDI produces a quote in an extremely short time, so that the component can be ordered immediately at a desired delivery date. CADDI determines the price and delivery date based on its system for monitoring the states of its suppliers' production lines, which are provided by them.

The requested components can be ordered through the online shop with a few mouse clicks. CAADI guarantees the fastest way to procure the bended sheet metal parts at fair prices, in high quality and on time delivery.

CADDI's suppliers are manufacturing service providers with different specialization in terms of part size, quantity, materials, and area of application. Each company is audited before being included in the supplier network. In addition, CADDI monitors the quality of the executed orders regard-ing delivery, quality, and customer satisfaction. The registration and use of CADDI is free of charge for the manufacturing partners.

There is no auction mechanism on CADDI, but CADDI arranges the orders, where the manufacturing partner can accept or reject an order. After the delivery of the components, the manufacturing partner issues an invoice to CADDI, which is then paid by CADDI. CADDI takes the risk of a payment default.

3.1.1 Value Network

See Figure 2: Value network of CADDI

3.1.2 Value Proposition

Because pricing is done by an automated algorithm, the operator of the platform is able to respond almost immediately to a request for quote from potential buyers of a component. CADDI claims that the market prices are quoted. During the onboarding of a manufacturing service provider, the operator of the platform clarifies that the production processes and production capabilities of a manufacturing service provider should be prepared for potential inquiries

Figure 2: Value network of CADDI

CADDI (operator online shop)

buyers of metal sheet components

01 request a quote with 3D CAD
02 quotation is done by algorithm within 2 hours
03 purchase order
04 order acknowledgement
08 deliver component

06 forwards order without any sales effort
05 order confirmation with clarification of production process and capability
07 delivers component

price information
operation status
quality and experience

provider A of manufacturing services
provider B of manufacturing services
provider C of manufacturing services

→ physical value stream
→ service value stream

Source: Plattform Industrie 4.0

so that brokered contracts for the manufacturing service provider are economical. The buyer requests a component needed using the online shop. He benefits from the fast offering of the online shop and – in the case of an order – a takeover of the complete transaction through the platform.

The provider of manufacturing services receives orders via the platform and thereby benefits from additional orders without any sales effort.

3.1.3 Revenue Mechanism

The operator of the platform is paid for the production and delivery of the produced component. He does not receive any fees for brokering or providing an offer. The strategy of enhancing over the critical mass is necessary.

The buyer of a component pays to the operator of the platform for production and delivery of the component.

The provider of manufacturing services is paid by the operator of the platform for production of the component.

3.1.4 Business Model Contract

The operator of the platform takes over the full technical and business risk regarding compliance to the requirements of potential buyers of a component. When the provider is different from the original candidate in the offer because of any reason on the candidate, the cost difference for CADDI is covered by CADDI.

The fixed asset for processing at providers is managed by themselves.

If CADDI obtains a better margin by the selection of providers, it will stay with CADDI.

3.1.5 Business Model Innovation

The business model changes of the companies considered in this example can be summarized as follows (see Figure 3).

The operator of the platform is a new player with a new business model in the value network of manufacturing industries.

The business model of a buyer of a sheet metal component is not innovated: The buyer assembles the same components with the same value proposition to the same customers and applies the same revenue mechanism. However, the buyer can source the components faster and more efficiently than before, which is a major benefit especially when sourcing individual parts in small batches. The buyer is enabled to speed up prototyping and development as well as providing customer specific products/solutions. Because of the use of this manufacturing platform, the value chain of the sheet metal component buyer changes structurally.

The business model of the provider of bending service is innovated: The company provides the same value proposition and does not change the revenue mechanism, but the company has the operator of the platform as an additional

Figure 3: Business model innovations of CADDI

○ No significant change   ● Significant change

Source: Plattform Industrie 4.0
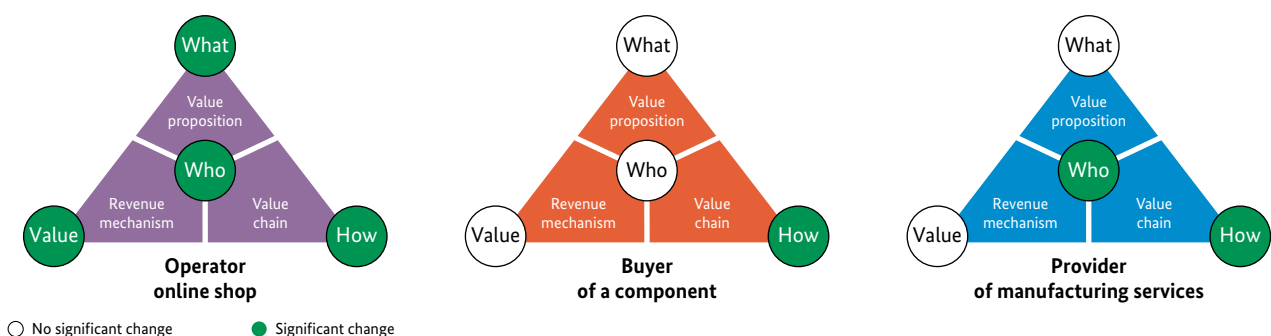
customer channel and changes the value network because of the connection to the platform.

3.1.6 Information Sharing and Value of Information

The production status of providers is monitored by CADDI. The production know-how of providers will be gathered to CADDI, because CADDI takes all the responsibility of quality.

3.2 sitateru – An organizer of supply chain for apparel companies

This example is based on the information published at https://sitateru.com/.

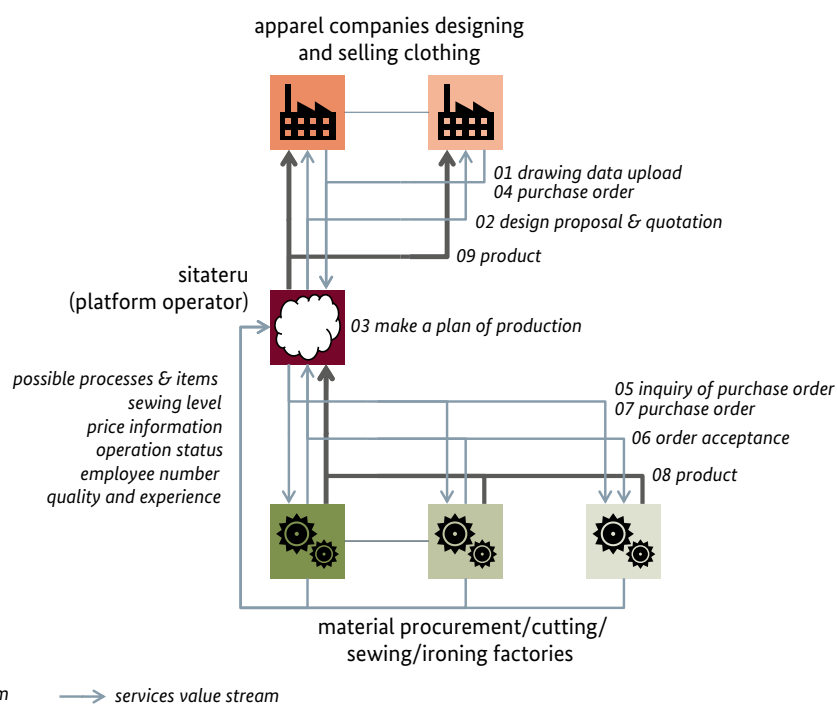sitateru is an organizer of supply chains for apparel companies. An interested party provides CAD design data or specification of apparel products to be made and requests a quote. When the party is not capable to provide such specifications, they can request sitateru to arrange a third-party

apparel pattern maker who provides a specification for their desired products. A staff of sitateru produces a quote based on the provided specifications so that the apparel product can be ordered immediately at an agreeable delivery date. sitateru designs the whole production processes by arranging the various types of suppliers to make the apparel product. They provide price quotes and delivery dates based on their in-house system for monitoring the status of suppliers' production lines.

Apparel products can be ordered through their online shop with a few mouse clicks and several online discussions. sitateru guarantees the optimal way to procure assembled apparel products at fair prices, in high quality and on-time delivery.

sitateru cooperates with manufacturing service suppliers with different specialization such as material procurement, cutting, sewing, ironing, and so on. Each company is audited before being included in the sitateru supplier network. Also, sitateru monitors the quality of the executed orders related to each special area. The registration and use of sitateru is free of charge for partnered suppliers.

Figure 4: Value network of sitateru

apparel companies designing and selling clothing

01 drawing data upload
04 purchase order
02 design proposal & quotation
09 product

sitateru (platform operator)

03 make a plan of production

possible processes & items
sewing level
price information
operation status
employee number
quality and experience

05 inquiry of purchase order
07 purchase order
06 order acceptance
08 product

material procurement/cutting/ sewing/ironing factories

→ physical value stream   → services value stream

Source: Plattform Industrie 4.0

There is no auction mechanism on sitateru, but sitateru arranges the orders, where the manufacturing supplier can accept or reject an order. After the delivery of the apparel products, the manufacturing supplier issues an invoice to sitateru, which is then paid by sitateru. sitateru takes the responsibility of payment.

3.2.1 Value Network

See Figure 4: Value network of sitateru

3.2.2 Value Proposition

The apparel companies that do only design and marketing/sales, can delegate the entire manufacturing process to the one-stop online shop. They can benefit from the ease and speed of all the processes being arranged through the online shop and in case of an order, the platform can take over the complete transaction.

The suppliers of manufacturing service receive orders via the platform and thereby benefit from additional orders without any sales effort.

3.2.3 Revenue Mechanism

The platform owner is paid for the process arrangement, the production management, and the delivery of the pro-

duced apparel products. The strategy of enhancing the critical mass is necessary.

Each supplier of manufacturing service is paid by the platform owner for the delivery of its part in the manufacture of the apparel product.

3.2.4 Business Model Contract

The operator of the platform takes over the full technical and business risk regarding compliance to the requirements of potential buyers of apparel products. In case of payment from apparel companies is not done as expected, sitateru takes the responsibility to pay to its providers.

3.2.5 Business Model Innovation

The business model changes of the companies considered in this example can be summarized as follows (see Figure 5).

The platform owner is a new player with a new business model in the value network of apparel industries.

The business model of apparel companies is not innovated: The apparel companies sell the same clothes and so on with the same value proposition to the same customers and apply the same revenue mechanism. However, the apparel companies can outsource the processes faster and more efficiently, which is a major benefit, especially when

Figure 5: Business model innovations of sitateru
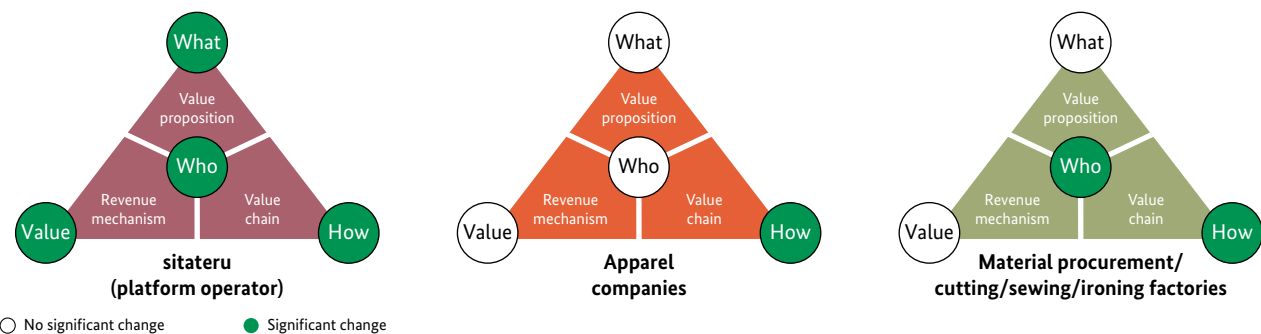
Source: Plattform Industrie 4.0

sourcing individual process in small batches. The apparel companies are enabled to speed up prototyping and development as well as providing customer-specific products/ solutions. Because of the use of this platform, the value chain of the apparel companies changes structurally.

The business model of the provider of processes is innovated: The company provides the same value proposition and does not change the revenue mechanism, but the company has the operator of the platform as an additional customer and changes the value network because of the connection to the platform.

3.2.6 Information Sharing and Value of Information

The information who can do what is gathered in the platform from the process providers. These data are used for selecting suppliers in the supply chain. The production know-how of suppliers will be gathered to sitateru, because sitateru takes all the responsibility of quality. The production status of providers is also monitored by sitateru.

3.3 Landlog – An IIoT platform for monitoring and managing daily construction activities

This example is based on information published at https://www.landlog.info/.

Landlog is an open innovation platform where about 60 partners are collaborating to develop and sell jointly new solutions together for construction. Right now, 10 solutions and several devices to make the job visible are available for construction business. Landlog is, at the same time, a construction platform offering supporting software applications to enable efficient construction jobs. An interested construction company can get an appropriate software on the platform with low cost.

Some construction machineries can measure the mass of sediment that has been lifted, but using this function, it is possible to measure the total amount of sediment movement. In addition, it is possible to know whether the soil was piled up on site or discharged to the outside. On the other hand, the details of the movement of earth and sand carried out to the outside can be clarified from the load capacity of the truck, the moving place and the carrying out. Measurements with a drone will also show the

Figure 6: Value network of Landlog
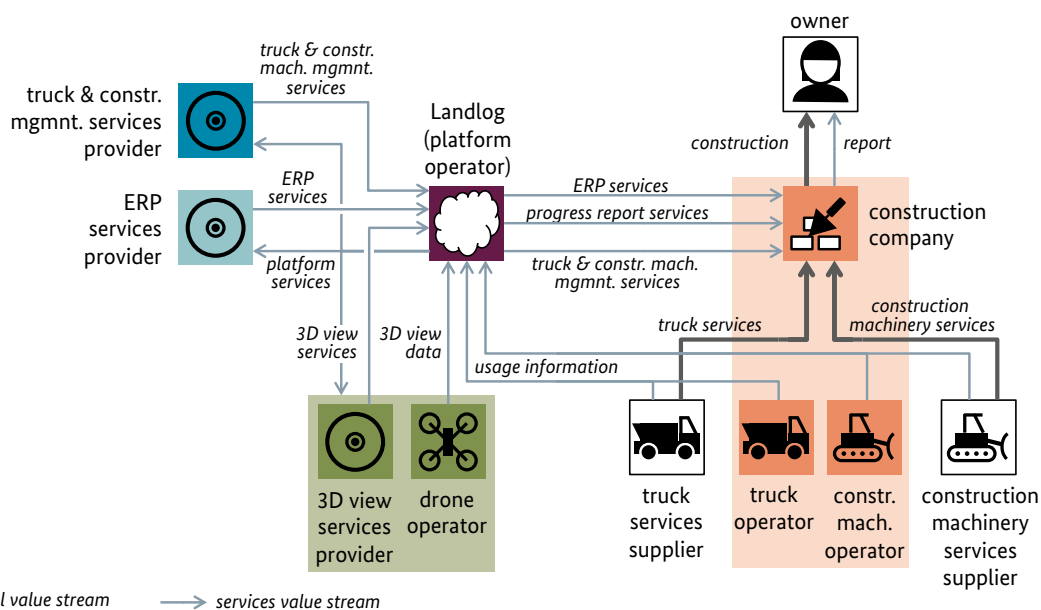
Source: Plattform Industrie 4.0

Figure 7: Revenue mechanisms of Landlog

- - -> revenue stream

Source: Plattform Industrie 4.0
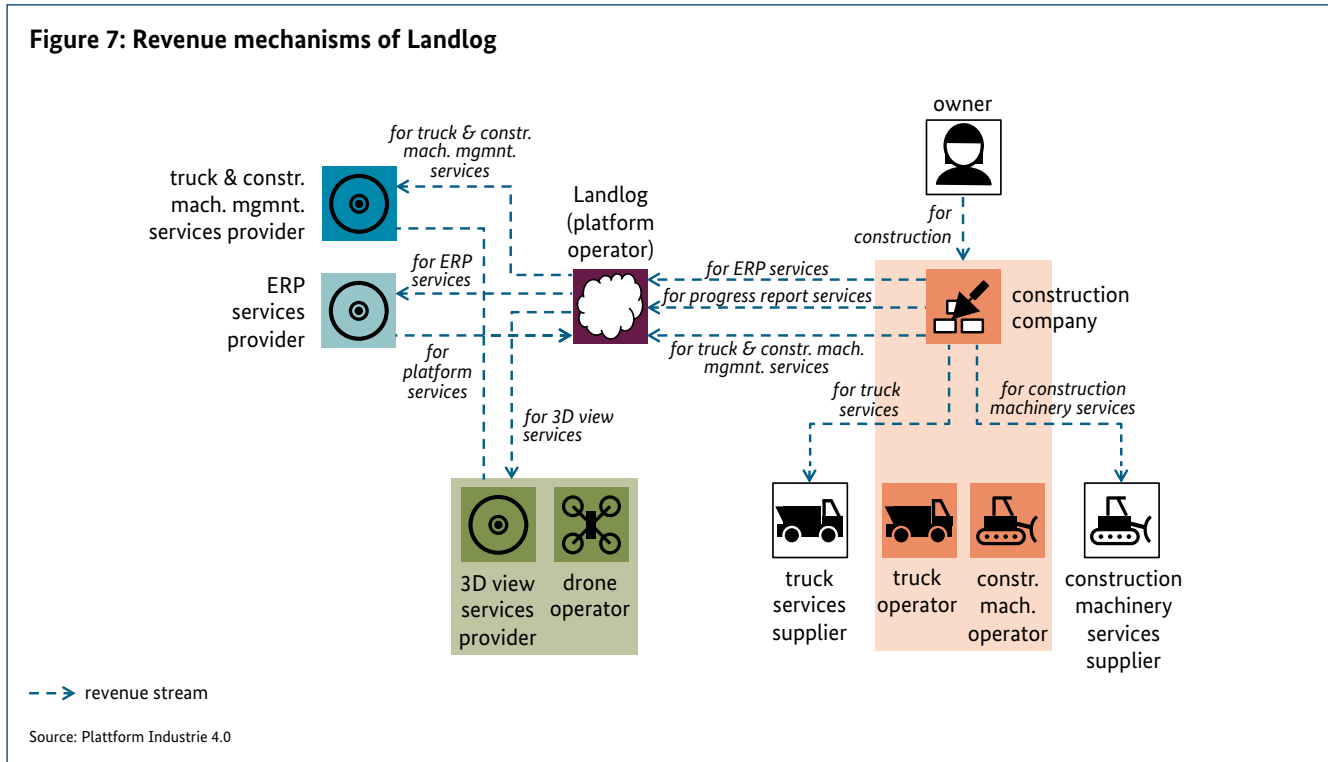
final topography of the resulting molded location. Truck management seems to be able to manage the number of vehicles on the road, optimize travel time, etc. in addition to the load capacity. An ERP application is also planned to be provided, and materials, vendor procurement, cost management, delivery date management, etc. can be performed efficiently. It seems that Landlog aims to be a platform specialized in civil engineering and construction and intends to accumulate data that can improve the accuracy and ability of each application.

3.3.1 Value Network

See Figure 6: Value network of Landlog.

3.3.2 Value Proposition

The platform operator can help a construction company to run its civil engineering operations efficiently using construction machinery services, truck services, and 3D view services. Truck and construction machinery management service application constantly monitors the usage information of trucks and construction machineries and provides

information for the construction company to make efficient work instructions and maintenance management.

The construction company uses the third-party truck and construction machinery service for the physical construction job. The platform operator provides an application software to connect to the platform.

The platform operator will provide an ERP service, which is provided by an ERP service provider, to the construction company.

- Truck and construction machinery management service application manages the location, loading weight, movement, and waiting time of trucks. It also monitors the operation and condition data, such as vibration and fuel level, of construction machineries.

- 3D view service makes the 3D drawings to see the current land shape from the view data of drones.

3.3.3 Revenue Mechanism

See Figure 7: Revenue mechanisms of Landlog.

The construction company pays for progress report services, and truck and construction machinery management services and ERP for future. Since Landlog claims that it is a platform for civil engineering and construction, it will charge a usage fee for know-how such as data accumulation. Civil engineering and construction companies are expected to pay for truck services and construction machinery services for their measured result instead of working period, which reduce construction costs, and receive orders for more construction because of their grown reputation of the business.

3.3.4 Business Model Contract

Since the difference between the estimate and the actual result can be analyzed reasonably, it can be expected that the length of construction period and cost will be reduced. With the help of visualization, it helps the owners and construction companies to track the bottlenecks and optimize their labor and machinery.

3.3.5 Business Model Innovation

The business model changes of the companies considered in this example can be summarized as follows (see Figure 8).

- Landlog (platform operator): The platform operator offer a infrastructure where construction companies receive new service to improve its productivity and reputation. It also provide connectivity to truck service suppliers and construction machinery suppliers for their maintenance opportunity.

- Construction company: It is able to minimize cost and shorten leadtime by converting some of the tasks that were previously performed visually on site into efficient operations using applications provided by truck and contruction machinery management service provider, 3D view service provider, and ERP service provider.

- 3D view service provider: The 3D view service provider provides 3D drawings of the land that is daily changed by construction machineries.

Figure 8: Business model innovations of Landlog
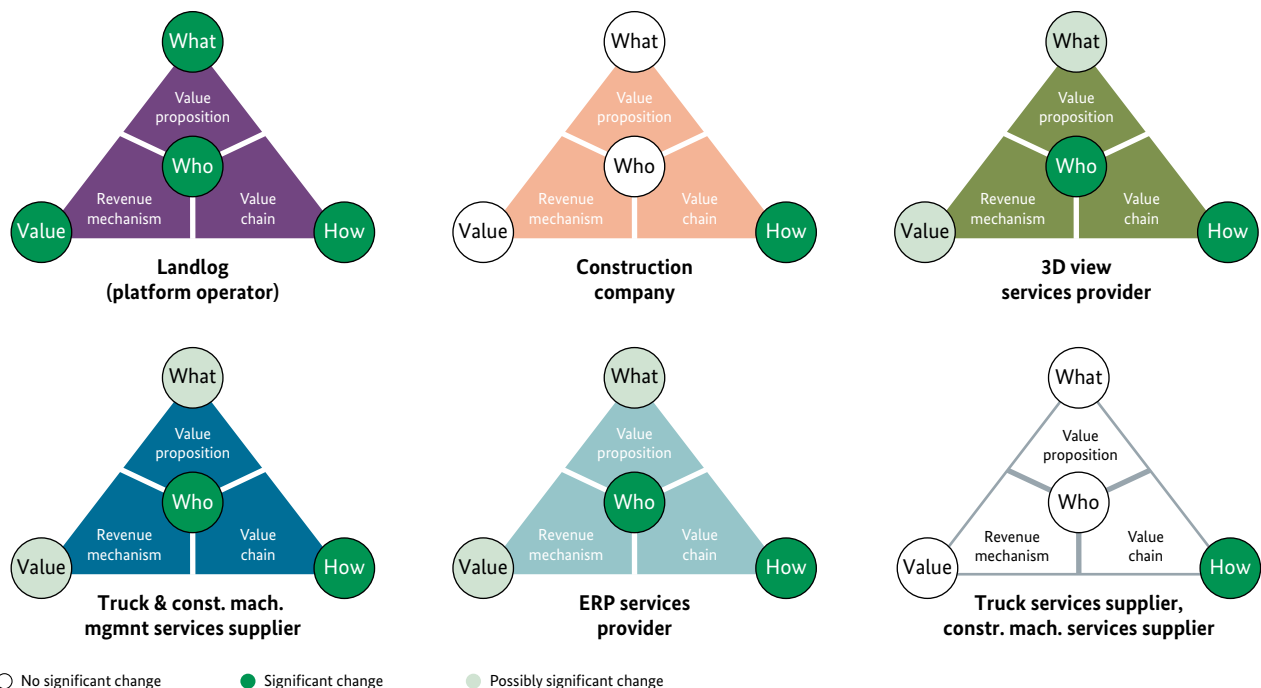
Source: Plattform Industrie 4.0

- Truck and construction machinery management service: This service provide usage information of trucks and constrution machineries for the construction company to make en effective sediment movement.

- ERP service provider: The ERP service provider will help the construction comapny for achiving effective resource management.

- Truck service supplier and construction machinery supplier: These suppliers provide their service to the construction company and get information for maintenance from the management service providers.

3.3.6 Information Sharing and Value of Information

The operation performance of construction machines and trucks is measured automatically. It helps manufactures of construction machines and trucks to improve their products.

Since the progress is reported daily to the owner, the quality and reliability of the construction company's work can be evaluated real-time. Thus, the construction companies that do not perform the promised work can be excluded. Appropriate reports to the owner even in regions with different commercial customs around the world can respond to changes in the quality of the contractor.

Landlog has improved its security system with own WAF in addition to the firewall service on the cloud. Additionally, it can protect against the illegal login on the application layer by OAuth2 and 2-step verification.

3.4 FANUC FIELD system – An IIoT platform for monitoring usage data of robots and machine tools

This example is based on the information published at https://www.fanuc.co.jp/en/product/field/index.html.

FANUC FIELD system is a platform offering software applications to monitor usage status of production asset such as robots and machine tools. An interested manufacturing company can select an appropriate software on the platform to see the running status of machines and get information related for maintenance. For this purpose, FANUC Intelligent Edge Link & Drive system (FANUC FIELD system) connects all production devices at the manufacturing site to consolidate information for better productivity and nonstop production in the factory.

From a technical perspective FANUC FIELD system is structured according to the following technical layers:

- Machine layer: This layer addresses the machines to be connected to an edge layer.

- Connectivity layer: This layer provides the ability to connect not only the latest FANUC products, but also existing machinery in the factory. General communication standards, OPC UA and MTConnect are supported.

- Edge layer: This layer comprises interconnected FIELD system box units according to the number of connected machines. The applications offered by the management layer can be deployed on the FIELD system box units.

- Application layer: In this layer not only FANUC applications like "PMA (Production Monitoring & Analysis)" or "ZDT (Zero Down Time)" can be used, but also applications of a manufacturing company or applications from 3rd parties.

- Management layer: A FIELD system manager, located in FANUC, manages whether the FIELD system box units in the factories are operating normally. Applications can be purchased in an online FIELD system store and downloaded into the FIELD system box units. The FIELD system is configured with a multilayer defense system that employs multiple security technologies on all layers.

3.4.1 Value Network

See Figure 9: Value network of FANUC FIELD system.

FANUC as platform provider provides applications – for example "PMA (Production Monitoring & Analysis)" or "ZDT (Zero Down Time)" –, computing devices (FIELD system box units), monitoring services and support.

Applications can also be supplied by 3rd party app developer.

FIELD system box units will be installed onsite at the machine user. The FIELD system box units can be supplied by FANUC (small scale systems) or Cisco (large scale systems). The installation and integration of the FIELD system box units is executed by some system integrator; the role of the system integrator can be assumed by the machine user. The provided applications from FANUC or 3rd party app developer will be deployed on the FIELD system box units.

The service provider can be assumed by FANUC, an app developer, the machine user, or a 3rd party service provider.

3.4.2 Value Proposition

FANUC offers the following value propositions:

- FANUC provides FIELD system box units to be installed at customer's site. This can be hardware devices supplied by FANUC or Cisco.

- FANUC provides connectivity capabilities for machines. The ability to connect machines is not only restricted to the latest FANUC products, but also existing machinery in the factory.

- FANUC operates a FIELD system store, where – after a review process conducted by FANUC – applications are made available. Afterwards applications can be downloaded and installed from there on the FIELD system box units.

- FANUC operates a FIELD system manager, located in FANUC, which monitors whether the FIELD system box units in the factories are operating normally. However, this function must be enabled by the machine user if required.

- FANUC operates a support call center.

Figure 9: Value network of FANUC FIELD system
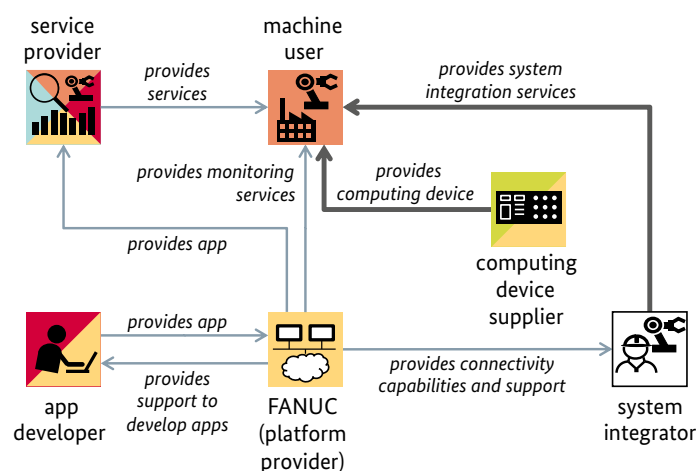
Source: Plattform Industrie 4.0

An app developer provides an application via the FIELD system store.

A service provider offers services to a machine user based on usage information collected locally in a FIELD system box, typically combined with the usage of applications provided via the FIELD system store. These services help a machine user to run its machines more efficiently.

Cisco provides as a business partner of FANUC FIELD system box units for large scale systems.

A system integrator provides integration services to install the FIELD system box units onsite including the connection of the machines and the necessary integration services.

3.4.3 Revenue Mechanism

See Figure 10: Revenue mechanisms of FANUC FIELD system.

The machine user pays for the computing device, integration services and the services (provided by a 3rd party service provider or by an app provided by an app developer or FANUC).

FANUC as platform provider retains a commissioning fee if an application of a 3rd party app developer is purchased from the FIELD system store.

3.4.4 Business Model Contract

FANUC assumes responsibility for technical properties of the FIELD system box units provided, such as security or monitoring of system properties.

The responsibility for increasing the productivity of a machine user must be regulated in a contract between the machine user and the service provider.

3.4.5 Business Model Innovation

The business model changes of the companies considered in this example can be summarized as follows: see Figure 11: Business model innovations of FANUC FIELD system

● FANUC as platform provider has a significantly new business model. Especially FANUC has new customers in form of app developer and new revenue streams from the provision of apps.

Figure 10: Revenue mechanisms of FANUC FIELD system
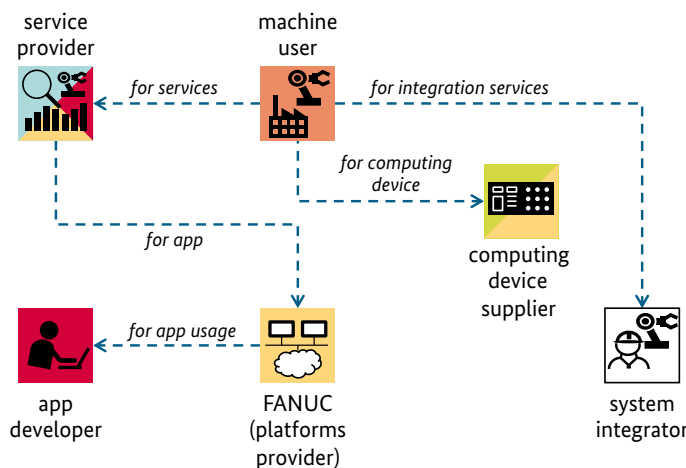
Source: Plattform Industrie 4.0

Figure 11: Business model innovations of FANUC FIELD system

FANUC (platform provider)

Cisco (computing device supplier)

Service provider

App developer

Machine user

System integrator

○ No significant change ● Significant change

Source: Plattform Industrie 4.0
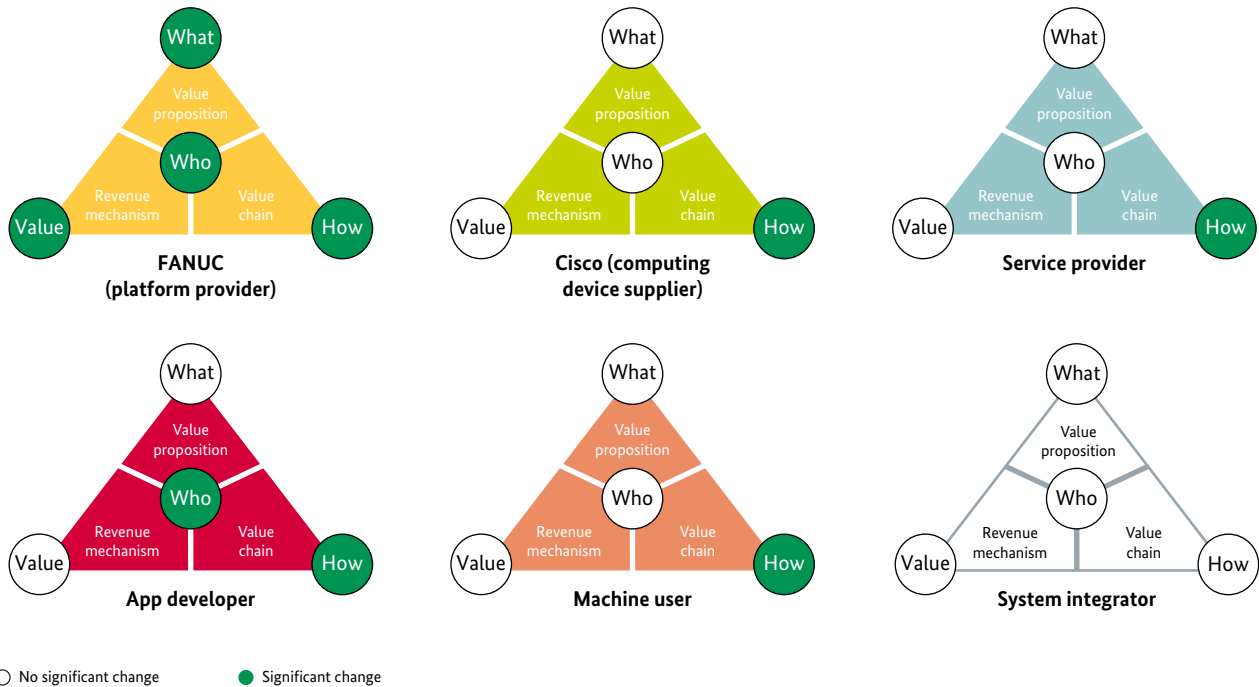
- Cisco as computing device supplier has a partnership with FANUC, therefore the value chain changes significantly.

- The business model of a 3rd party service provider and machine user does not change significantly. Their value chain changes due to the involvement of FANUC as platform operator.

- The app developer uses the FANUC platform as additional sales channel.

- The business model of the system integrator does not change.

3.4.6 Information Sharing and Value of Information

The FIELD system is configured with a multilayer defense system that employs multiple security technologies on all layers. Especially FANUC as platform operator needs to log in the FIELD system box units installed locally at the machine user using an ID and password, for example to monitor whether the FIELD system box units in the factories are operating normally. The log in must be enabled by the machine user.

The operation performance of machines is measured automatically. It helps a machine user to improve its productivity and uptime by the help of an service provider. Usage information is provided to the service provider for the service purpose, too, but the machine user will define – typically based on a legal contract – for which purpose the service provider may use this information. FANUC as platform operator has no right to use this usage information.

4 Examples from Germany

4.1 V-Industry – Brokerage of machine resources

The example is based on published information at https://v-industry.com/.

For companies to be able to place production orders with manufacturing companies at short term and in small quantities, a high administrative effort was previously necessary. The search for suitable manufacturing companies, the request for quotations, price negotiations, contract design and the transmission of order data requires a lot of time and personnel effort. V-Industry operates a platform that mediates orders between requesters with demand for manufactured goods and providers with available production capacities. The current focus is primarily on providers with metalworking machines (lathes, milling or cutting machines).

In order to determine the current capacity utilization of these machines, V-Industry offers the integration of a hardware component to machines that performs a pre-evaluation of operating data of the machines and enables the transfer of operating data for internal analysis by V Industry. V-Industry uses data analysis to determine the machine utilization to identify free production resources. On the one hand, the results are used for an optimized matching with request for manufacturing capacity on the brokerage platform. On the other hand, the results are provided to the manufacturing company via web-based dashboards. Based on these utilization data further data-based services will be offered in the future.

A requester can upload a 3D model of a required product on the platform and specify the manufacturing process and further requirements. V-Industry uses a matching algorithm to select potential providers that currently have the required manufacturing capacities and capabilities. These selected companies will then receive the order information (including the contact details of the requester) and will be invited by V-Industry to submit an offer. The requester can now choose between several offers and will place the order via the platform. Compared to other brokerage platforms, the requester always knows who will manufacture his order.

4.1.1 Value Network

See Figure 12: Value network of V-Industry.

Figure 12: Value network of V-Industry

delivers product

V-Industry

system integrator

provides connectivity services

provides connectivity box

submit order
forwards offer

forwards order
provides offer

makes a request for services
and transmits order data

requester

brokerage platform operator

provides suitable order requests

provides identified free machine capacities

provides evaluation of machine utilization

provider

computing infrastructure provider

provides infrastructure as basis

data-driven service

provides machine data

→ physical value stream   → data/services value stream

Source: Plattform Industrie 4.0

4.1.2 Value Proposition

The platform operator (V-Industry) offers the following value proposition to the business partners involved in the value network:

- The platform operator provides an infrastructure that simplifies interactions between two independent parties regarding a service request and a service offering. Through its brokerage service, it offers support and simplifies processes in the search, awarding and billing of production orders. Additionally, the platform operator offers the connectivity of production machines and the transmission of their usage data as basis for the provision of evaluations of machine usage.

The business partners benefit from the offer of the platform operator as follows:

- Requester: The requester saves time and personnel effort for many requests to many companies. In addition, through a single access point, they receive several offers for the required product, between which they can choose their preferred offer and order it directly and without any high effort. The ordering and payment process is less time-consuming because the requester orders and pays directly via V-Industry. Therefore, the requester does not have to enter every new supplier into his ordering system. This enables the requester to place also short-term even small order quantities with many different providers with low administrative effort.

- Provider: The provider benefits from the platform by receiving an evaluation of his machine operating data and thus a feedback on the utilization of his machines. In addition, the provider is given the opportunity to be assigned order requests in case of free production capacities and thus to receive additional orders.

- Infrastructure provider: The infrastructure provider enables the platform operator to offer his platform services based on a corresponding IT infrastructure.

4.1.3 Revenue Mechanism

See Figure 13: Revenue mechanisms of V-Industry.

- Platform operator (V-Industry): The platform operator receives its income through a commission in the event of successful order placement. This commission is calculated based on the total amount of the order and is paid in equal parts by the requester and the provider. Furthermore, the platform operator receives (a monthly paid) fee for the connectivity box and evaluation of the machine usage from the manufacturing provider.

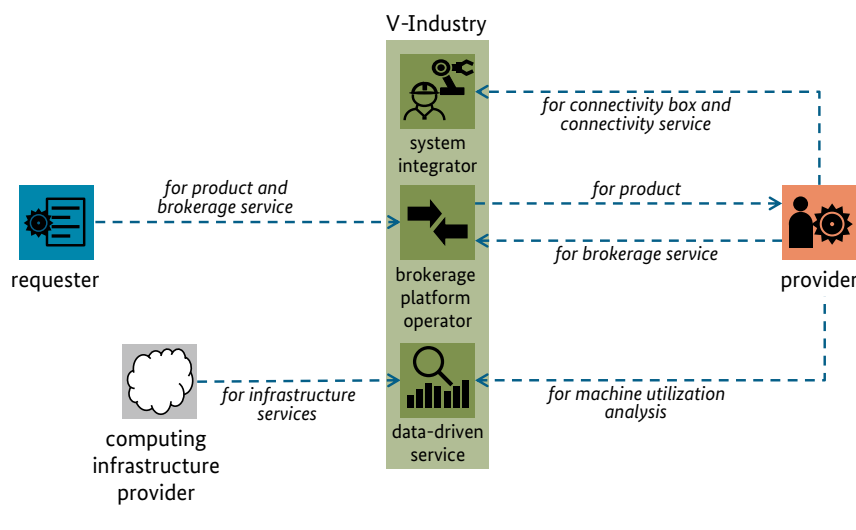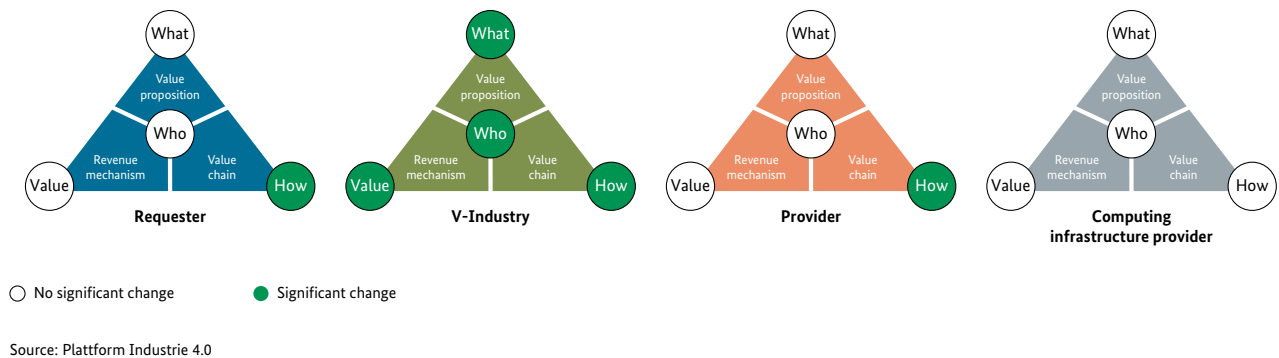**Figure 13: Revenue mechanisms of V-Industry**

Source: Plattform Industrie 4.0

Figure 14: Business model innovations of V-Industry

Source: Plattform Industrie 4.0

- Requester: The requester pays for the delivered product and a percentage commission for the brokerage service. In this business model, the platform provider handles the payment of the ordered product to the manufacturer.

- Provider: The provider receives payment for its service from V-Industry. The provider must pay a percentage brokerage fee and must pay additionally a fee for the connectivity box, connectivity services and the machine usage analysis to the platform operator.

- Computing infrastructure provider: The computing infrastructure provider receives payment for its infrastructure service from the platform operator.

4.1.4 Business Model Contract

The operator of the platform takes over the full technical and business risk regarding compliance to the requirements of the requester. In case of payment from the requester is not done as expected, V-Industry takes the responsibility to pay to its providers. For both the requester and the provider, V-Industry is the direct business and contract partner and therefore the direct responsible for quality aspects or payment. There is no direct trade or contract between the Requester and the Provider.

4.1.5 Business Model Innovation

The business model changes of the companies considered in this example can be summarized as follows (see Figure 14: Business model innovations of V-Industry).

- The platform operator V-Industry has a significantly new business model.

- For the requester, the business model does not change significantly. He continues to produce the same products for the same type of customers with the same revenue mechanism. However, the platform allows him to expand his customer base with additional orders. His value network is expanded by the addition of the platform provider.

- For the provider, the business model does not change significantly either. The provider continues to manufacture products and sells them to existing customers to manufacture their products and sell them to existing customers with the same revenue mechanism. The platform enables him to optimise his order placement and administrative processes. His value network is expanded by the addition of the platform provider.

- For the computing infrastructure provider, the business model does not change.

4.1.6 Information Sharing and Value of Information

V-Industry collects usage data from the machines connected via the connectivity box. This information helps to select possible provider and enables data-driven services to improve machine utilization.

4.2 Railigent – Application suite for intelligent asset management

The Railigent platform of Siemens Mobility supports owners and operators of trains, infrastructure and signaling to achieve added value. The applications in Railigent allow customers to increase the availability of their trains, infrastructure or signaling, improve maintenance and operation, and reduce costs. For this, Railigent not only uses Siemens' own application and data analytics, but also integrates an ecosystem of partners to offer customers even greater added value.

Railigent is a cloud-based platform that can record, interpret, process, and analyze large amounts of data from the railway environment. Many applications not only generate relevant insights (for example, that a door is noticeable), but also generate recommendations for the customer. Railigent uses advanced and sometimes proprietary methods of machine learning and artificial intelligence. The data and these algorithms are also made available to the partners to enable them to create even more and better applications.

4.2.1 Value Network

The following value network of Railigent focuses on the train provider and train operator but does not consider the rail infrastructure and signaling.

See Figure 15: Value network of Railigent.

4.2.2 Value Proposition

The platform operator (Railigent) offers the following value proposition to the business partners involved in the value network:

● Railigent enables the collection and analysis of usage information of the trains including the components of the trains. The concrete value proposition depends on the respective business case, see section 3.2.4.

The business partners benefit from the offer of the platform operator as follows:

Figure 15: Value network of Railigent

Source: Plattform Industrie 4.0

Figure 16: Revenue mechanisms of Railigent

- - ► *revenue stream*

Source: Plattform Industrie 4.0

- The asset operator, who provides train services, benefits from an increased availability of the trains, more reliable operations, or improved business processes. The asset operator may pass this on as a value proposition to the asset services user, i.e. the passenger using the train, for example that passengers are compensated for delays resulting from technical defects of the trains.

- The asset provider delivers the train to the asset operator. Based on insights from the collection and analysis of usage information of the train, the asset provider may offer for example an availability guarantee covering delays resulting from technical defects of the trains.

- The component supplier provides a component of the train. Based on insights from the collection and analysis of usage information of the component, the component supplier may offer an improved value proposition, for example an improved reliability of the component.

- The asset maintainer provides maintenance services for the asset operator. Based on insights from the collection and analysis of usage information of the trains, the asset

maintainer may improve the internal service processes, for example by switching from time-based maintenance to condition-based maintenance.

4.2.3 Revenue Mechanism

See Figure 16: Revenue mechanisms of Railigent.

There are the "classical" revenue streams, where the asset services user pays for the train services, the asset operator pays for the train and the maintenance services, the asset provider pays for the component, and Railigent pays for the IT infrastructure.

Railigent is paid for the enablement of collection and analysis of usage information of the trains including the components of the trains, or for the insights delivered, or for the guaranteed outcome. There also may be revenue streams, where Railigent forwards revenues from a customer to an asset provider, component supplier or asset maintainer. The concrete revenue stream depends on the respective business case, see section 2.5.4.

4.2.4 Business Model Contract

Railigent orchestrates an ecosystem in the "rail" industry and assumes the role of a value integrator. This means that the business model contract depends on the consortium on which a specific business case is based. Basically, Railigent can offer the following different business model contracts:
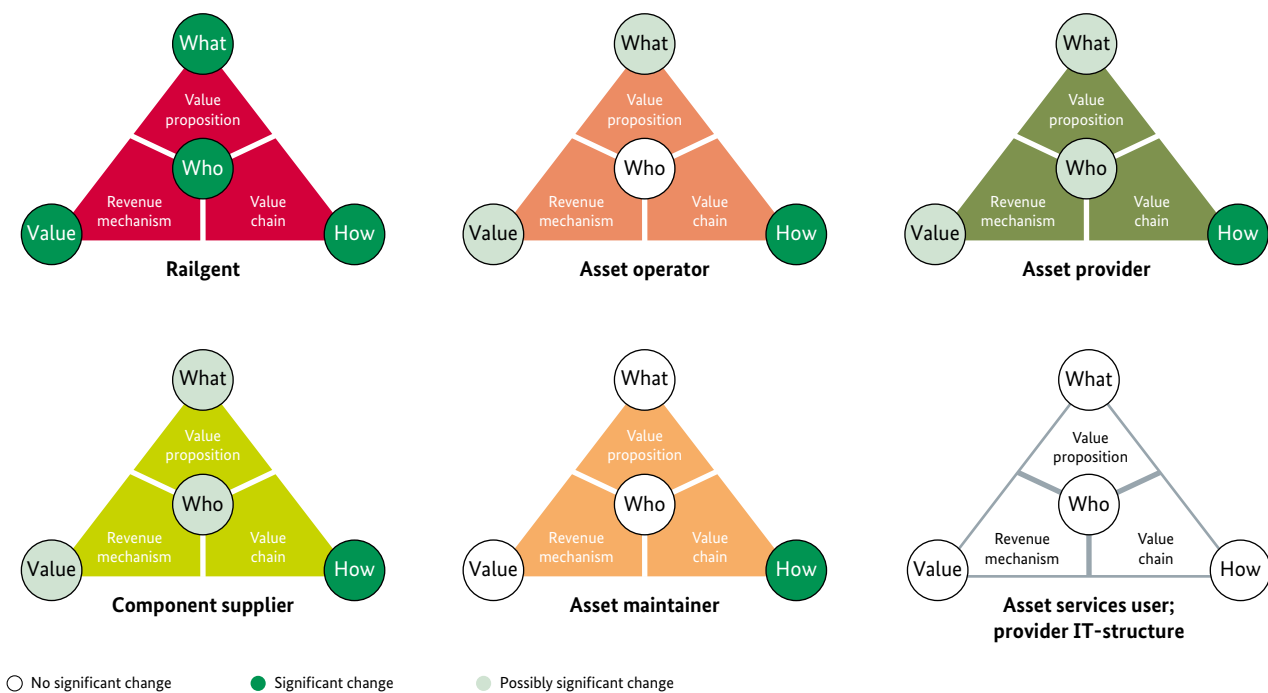
- Managed services: Railigent acts as an IT service provider, which takes responsibility for the provision of a defined range of services with a focus on the "rail" industry for its customers.

- Software as a service: Railigent offers its customers the use of software applications with a focus on the "rail" industry.

- Insights as a service: Railigent provides its customers with the use of analytics solutions with a focus on the "rail" industry.

- Outcome as a service: Railigent takes responsibility for a contractually agreed outcome regarding its customer, such as the technical availability of a train.

4.2.5 Business Model Innovation

The business model changes of the companies considered in this example can be summarized as follows. It must be mentioned that there may be different setup for the individual companies (see Figure 17: Business model innovations of Railigent).

The business model of Siemens Mobility – the business owner of Railigent – will be innovated: The customer changes, because today the asset provider – these are typically competitors of Siemens Mobility –, component supplier and asset maintainer typically are not customers of Siemens Mobility. The value proposition is extended by operating the Railigent platform and offering platform services to the user of the platform, even based on Railigent Siemens Mobility can offer outcome-as-a-service. This also implies a change of the revenue model due to additional revenue streams generated by the platform services. The value chain is changed due to the additional partner (especially the new role asset maintainer). Even existing partners are integrated differently into the value network through the platform.

Figure 17: Business model innovations of Railigent

Railgent

Asset operator

Asset provider

Component supplier

Asset maintainer

Asset services user; provider IT-structure

○ No significant change   ● Significant change   ● Possibly significant change

Source: Plattform Industrie 4.0

The business model of the asset operator could be innovated: The customer typically does not change. The value chain changes in a structural way, because Railgent is integrated as a new partner in the value chains. The value proposition and possibly also the revenue model may change significantly since the asset operator could guarantee its customers punctuality and pay compensation to the customer in the event of delays.

The business model of the asset provider, component supplier und asset maintainer could be innovated: The value chain changes in a structural way, because Railigent is integrated as a new partner in the value chains. Depending on the concrete business case Railgent could be their customer, whereas in the past Siemens Mobility may not has been their customer. The value proposition and possibly also the revenue model may also change significantly:

- The asset provider or the component supplier could guarantee technical availability and compensate the asset operator accordingly in the event of violations.

- In addition to optimizing its internal service processes, the asset maintainer could also guarantee technical availability and compensate the asset operator accordingly in the event of violation.

For the asset services user business model considerations are not applicable; for the provider of the IT infrastructure the business model does not change.

4.2.6 Information Sharing and Value of Information

Railigent has data on the usage behavior of trains, from business cases in which Siemens offers trains to a customer based on an outcome-as-a-service contract. Thanks to Railigent's focus on the "rail" industry, the data, the analysis methods, and the resulting insights can be transferred to other business cases, for example if the assets are supplied by other asset providers.

The usage data on the trains also contain usage data on the components installed in the trains. Usually the suppliers of these components do not have access to this data. Such data are of value to suppliers of components because they can use it to improve their components. Since Railigent has this data, Railigent can establish a business relationship with component suppliers. These business relationships are application specific.

4.3 GrabCAD – Community-supported collaborative 3D-printing platform

This example was analyzed by German experts; however, it is not a platform developed in Germany. The example was chosen to illustrate the aspect of a community, which is not expressed in the other examples.

The example is based on published information at https://grabcad.com/.

Stratasys, a company that manufactures 3D printers extends its existing hardware product to provide an additional platform, including software tools for the users of its printers. At the same time, a developer community is being established and supported. Stratasys acquires GrabCAD with its developer community and Workbench tool and began to offer the additional Print and Shop tools:

- GrabCAD Workbench is a CAD software collaboration tool, which enables developers to work together in teams (also with external members) on a single data basis. Developers can upload their files from different CAD systems and receive a uniform CAD model in the cloud-based collaboration tool. The collaboration environment provides standard functions (e.g. revision management, version comparison, web-based view of the models and cloud synchronization). Other functions, such as commenting on components or web-based exploded views, also support cross-departmental collaboration even for users without CAD access.

- GrabCAD Print is a software suite that allows to optimize, prepare, and send the designed model directly from the CAD system to the 3D printer. In addition, it allows to organize different print jobs in a simplified way and to analyze the printing process, for example regarding material consumption. The software is currently limited to Stratasys printers.

- GrabCAD Shop is a work order management software for in-house orders especially for operators of 3D printers or other production machines. As a web-based software, it offers a coordination of print orders and simple transfer of CAD files from the developers to the printer operator. In addition to Stratasys printers, printers from other manufacturers are also included.

A special feature is the large developer community (7.5 million developers). This community provides self-

developed CAD-models (4.27 million files) for free access for other developers to view and download from a library. In groups and tutorials, the community offers other users support for questions concerning the development of products and the use of GrabCAD tools. The members of the community offer their services without any financial compensation – the prospect of being recognized in the community and symbolic awards for their personal profile are in prospect. Via challenges, companies can submit design tasks to the developer community, who can then submit their designed 3D models in competition with each other. Finally, the challenger determines the winners and awards them with prizes.

4.3.1 Value Network

See Figure 18: Value network of GrabCAD.

4.3.2 Value Proposition

The platform operator offers the following value proposition to the business partners involved in the value network:

- Stratasys as operator of the platform and at the same time printer manufacturer offers software tools ranging from collaborative product development to an optimized 3D print model and the organization of print jobs. Thus, a seamless workflow and data exchange for communication and collaboration between product designer, process designers and 3D printer operators are offered. In addition to the basic hardware product (3D printer), Stratasys also provides collaborative tools for an optimal product development process up to all tasks of a 3D printer operator. Stratasys also operates and supports a large developer community. Through the worldwide community exchange (for example providing user knowledge, discussions about tools, discussion about product design), the Stratasys offers an additional value for the users of its printers.

The business partners benefit from the offer of the platform operator as follows:

- Product Designer: The product designer benefits from the collaborative workbench tool with a standardized data basis within design projects, which also allows the
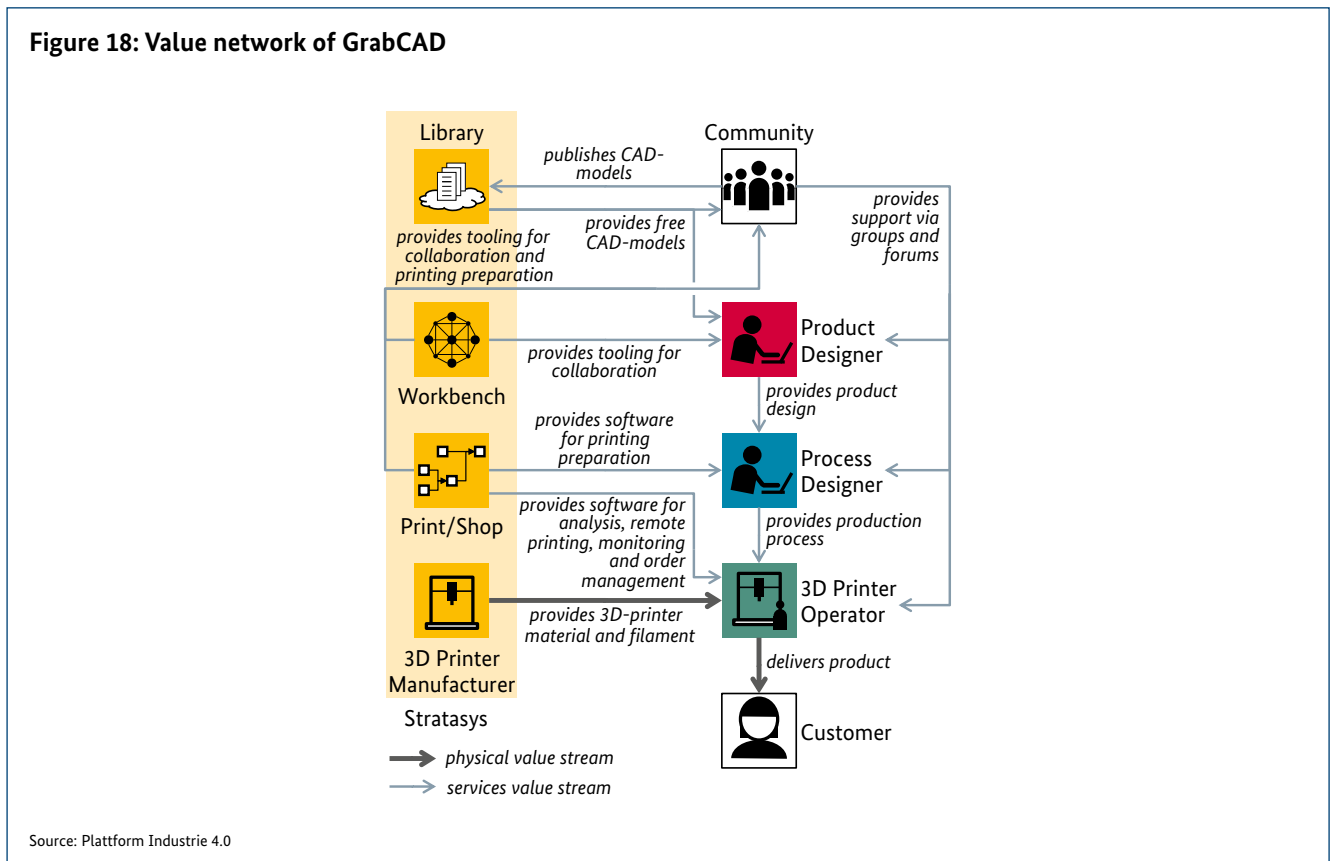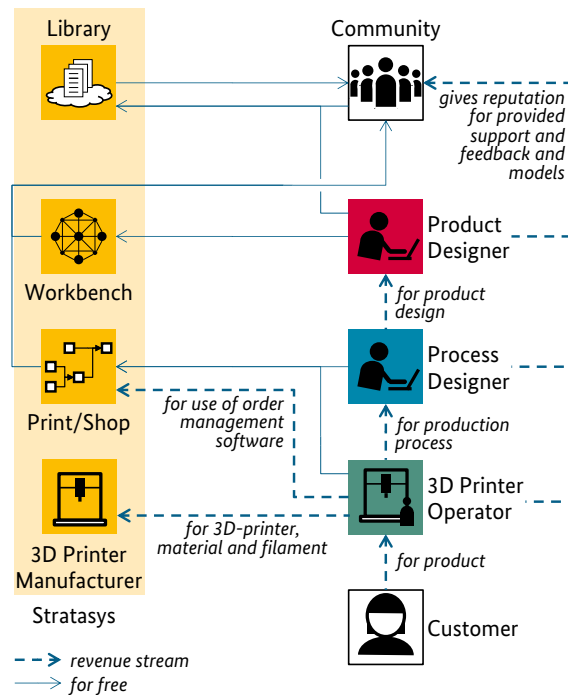

Figure 18: Value network of GrabCAD

Source: Plattform Industrie 4.0

Figure 19: Revenue mechanisms of GrabCAD

Source: Plattform Industrie 4.0

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use of different proprietary modelling tools. This enables internal and external collaboration that is more efficient. Using the shop tool, the product designer benefits from optimized transfer of information (including 3D models) to the 3D printer operator. The product designer also benefits from the CAD models, forums, discussions, and tutorials provided by the developer community. The knowledge sharing with the community may leads to more creative solutions.

- Process Designer: The process designer benefits by using the print software to prepare 3D models directly for the printing process and to transmit them to the 3D printers. He also receives support from the developer community.

- 3D Printer Operator: The 3D printer operator benefits from the platform by being able to optimize the operation of his printers with the tools offered. This includes a better organization and monitoring of his print orders. In addition, he receives the order data directly and standardized via the shop tool, thus reducing his administrative workload. By using the print software, the 3D

printer operator can manage, analyze, and monitor his printers remotely. He also receives support from the developer community.

- Community: The community benefits by using the provided infrastructure and software tools for designing and exchanging CAD models. In addition, the community benefits from the exchange of experiences, feedback, or usage hints.

- Customer: The customer is not related to the platform. He benefits from a faster and more efficient production and development of his purchased product.

4.3.3 Revenue Mechanism

See Figure 19: Revenue mechanisms of GrabCAD.

- Platform operator and 3D printer manufacturer: The printer manufacturer receives its revenues from the one-time sale of the 3D printers and the continuous sale of required resources such as materials and filament.

For the tools offered, only a fee is charged for the use of the GrabCAD Shop software for order management. The use of the print software, the workbench collaboration tools and the 3D models in the library are offered free of charge.

- Product Designer and Process Designer: The product designer receives revenues from the process designer for the delivered product designs and the process designer receives revenues from the 3D printer operator for the delivered production process.

- 3D Printer Operator: The 3D printer operator receives revenue from the customer for the delivery of the manufactured products. The 3D printer operator has expenses for the shop software for order management, for the 3D printer and for materials and filament to the 3D printer manufacturer.

- Community: The community receives no monetary compensation for their activities (for example creating tutorials or providing 3D models). However, everyone can gain reputation in the developer community by

receiving virtual awards for a profile or by getting more "followers" for a profile.

- Customer: The customer pays the 3D printing operator for the delivered product.

4.3.4 Business Model Contract

There are no changes in the business model contracts of the legal entities involved in the value network. Although the community provides services on the platform, there is no contract with the platform provider. Stratasys provides and operates the platform to lock a community to its own products and thereby improve the market penetration of these products.

4.3.5 Business Model Innovation

The business model changes of the companies considered in this example can be summarized as follows (see Figure 20: Business model innovations of GrabCAD).

Figure 20: Business model innovations of GrabCAD
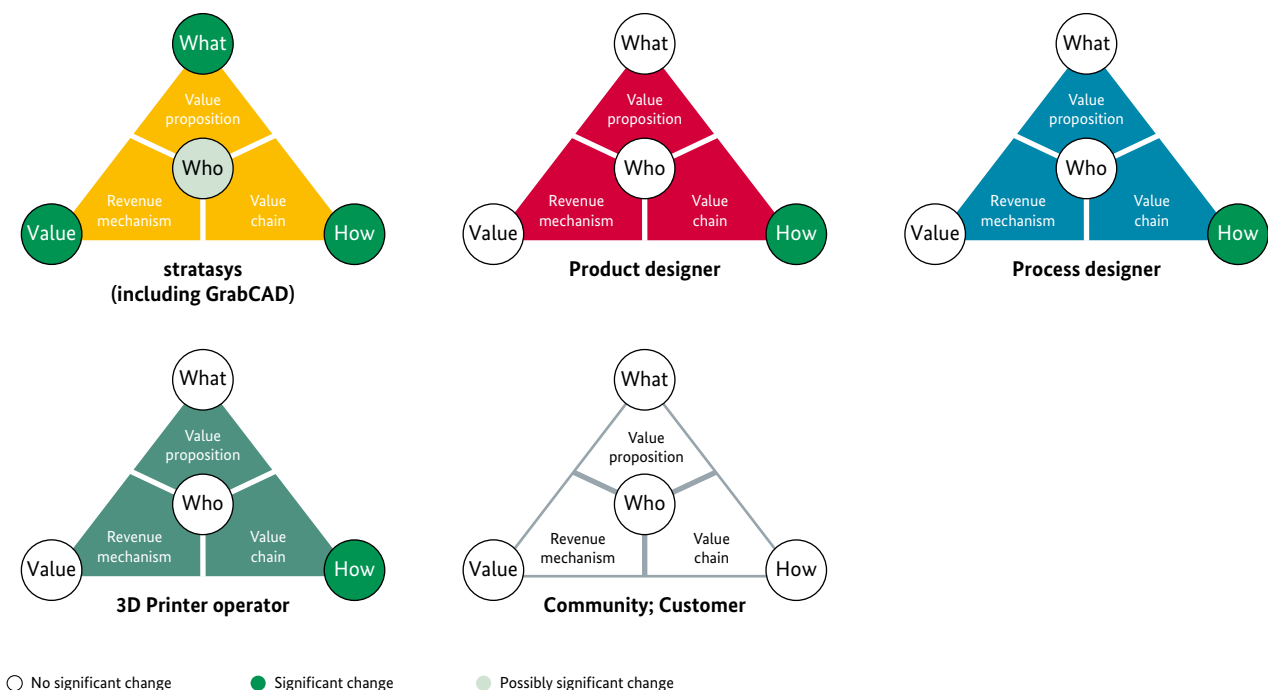
Source: Plattform Industrie 4.0

- Stratasys (including GrabCAD): Stratasys offers additional software products and operates a platform for its existing customers and thus changes its value proposition. Stratasys also changes the revenue mechanism by the fee for software use instead of one-time product sales. The platform also changes the value chain by integrating product designer, process designer and a community into the value network. The platform may also attract new 3D printer operators and thereby change the customer base of Stratasys in a significant way.

- Product Designer, Process Designer and 3D Printer Operator: The business model of the 3D printer operator does not change significantly, except that they optimize their processes by using the tools and platform offered by Stratasys and the services offered by the community.

- Customer: For the customer, the business model does not change.

- Community: The community is no legal entity with focus on a business model. The individuals in the community initially do not pursue business interests but seek for non-monetary reputation. The fact that an individual can in turn pursue a business purpose on this basis is not considered here.

4.3.6 Information Sharing and Value of Information

By operating the platform and thereby orchestrating a community Stratasys gets a lot of insights in the value chains in the context of the usage of their 3D printers. These insights can be used by Stratasys to improve their 3D printer in a sustainable way. In addition, the product models available on the platform have a value, as the published 3D models contain specific engineering knowledge.

4.4 MIP – Manufacturing Integration Platform

Manufacturing companies need a wide range of IT applications to plan and produce efficiently. In contrast to mainly monolithic systems, MPDV Mikrolab GmbH, with the open platform approach of MIP, makes it possible to combine applications from different suppliers. Manufacturing companies as well as developers, system integrators and machine manufacturers benefit from the resulting ecosystem.

How does MIP work?

MIP forms the technological and semantic basis for an ecosystem of users, vendors, and integrators. It serves as a central information and data hub for manufacturing and all related processes. All applications communicate via web services with a common and open information model, thus enabling comprehensive interoperability. Manufacturing companies can use exactly the applications they need – regardless of the supplier. Developers can focus on the application logic while using MIP's basic services. System integrators can combine the applications available on the market in a targeted manner and create individual standard solutions from them. Machine manufacturers can integrate their systems more easily into the world of manufacturing IT.

4.4.1 Value Network

See Figure 21: Value network of MIP.

The stakeholder in the value network are characterized as follows:

- The MIP platform provider offers a MIP runtime[1]. This software provides an open information model of a factory from the perspective of manufacturing execution systems including open interfaces for managing this information model, for example changing attributes, creating resp. deleting objects or associations between objects. A user of the MIP runtime must deploy the MIP runtime somewhere on a computing infrastructure. Applications that use the provided open interfaces are called mApps.

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1   A runtime provides an environment for execution of software programs.

Figure 21: Value network of MIP
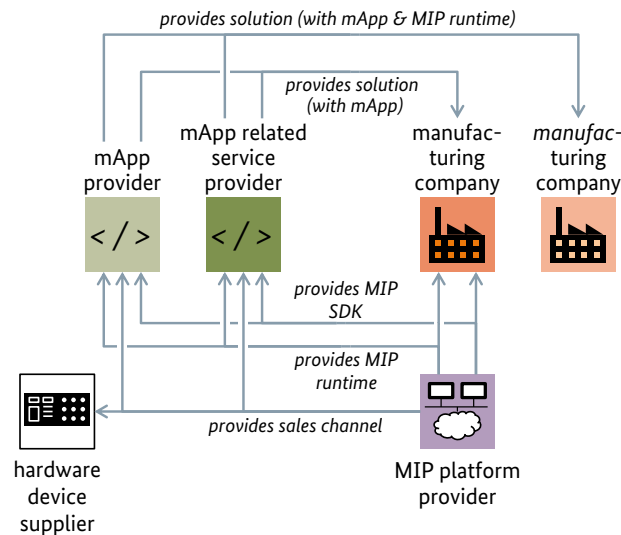
- The mApp provider offers a standardized mApp, which is priced with a list price, including additional integration services to integrate the standardized mApp in the overall system of a manufacturing company. If the manufacturing company has not yet installed a MIP runtime, the delivery and installation of a MIP runtime can be included in the offering.

- The mApp related service provider offers services to create customer specific mApps and to integrate such a specific mApp in the overall system of a manufacturing company. As for the mApp provider, the offering of the mApp related service provider may include the delivery and installation of a MIP runtime.

- The manufacturing company (shown in orange in the figure illustrating the value network) uses the MIP platform provided by the MIP platform provider specially to optimize the internal processes and workflows. For this purpose, the manufacturing company develops and integrates its own mApps and thus also acts in the role of an internal mApp related service provider. Typically, the manufacturing company has no interest in making its own mApps available to other companies. The manu-

facturing company can also use external mApp providers or mApp related service providers for development and integration.

- The manufacturing company (shown in light orange in the figure illustrating the value network) is interested in a solution to optimize the internal processes and workflows. The manufacturing company commissions mApp provider or mApp related service provider to create such a solution without necessarily entering into a contractual relationship with the MIP platform provider.

- The hardware device supplier offers MIP compatible products and thereby serves as technical enabler. The value streams, how these products are used and integrated by the other stakeholders, are not shown in the figure illustrating the value network.

4.4.2 Value Proposition

The MIP platform provider offers the following value proposition to the business partners involved in the value network:

- The MIP platform provider offers a MIP runtime. By the common and open information model mApps are prepared for comprehensive interoperability. The common and open information model provided by this software also leads to a reduction of engineering and especially integration efforts for mApps.

- The MIP platform provider offers a so-called MIP Software Development Kit (SDK), which includes mainly manuals and descriptions, that supports users to create an mApp and connect it to the MIP runtime.

- MPDV as MIP platform provider offers marketing services for developed mApps, mApp related services, and MIP compatible products, for example hardware components, over its sales channel.

- In summary, the MIP platform makes it easier for manufacturing companies to combine the offerings of different mApp providers. As a result, a user can select the best offers on the market and can use them in combination with low integration and customization efforts. At the same time, the MIP platform reduces the costs compared to investing in a new solution.

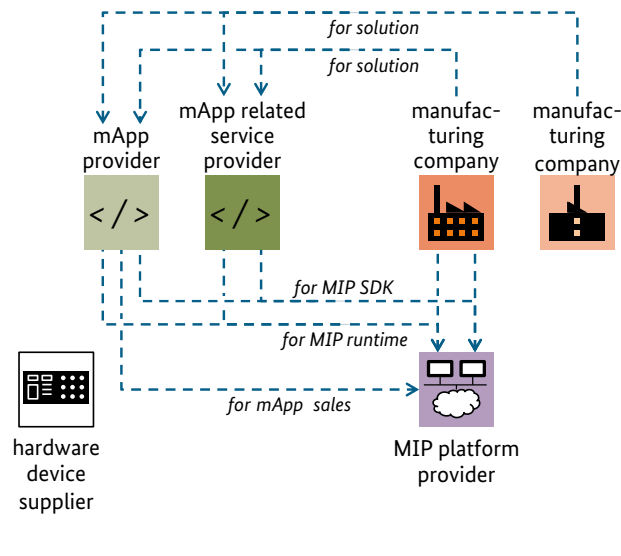The business partners benefit from the offerings of the MIP platform provider as follows:

- mApp provider: The mApp provider benefits from the MIP platform by the enablement to offer an mApp being prepared for comprehensive interoperability with other mApps. Thus, the engineering and especially integration efforts of the mApp will be reduced and the customer of the mApp can easily combine the provided mApp with other mApps offered to the market to create the best solution for its own purpose. The mApp provider can offer the mApp and customization and integration services regardless of whether the customer has a contractual relationship with the MIP platform provider or whether the customer already has installed a MIP platform. However, the effort and costs for customization and integration will depend on the customer's configuration. If necessary, the mApp provider can install a MIP platform for the customer without the customer having to conclude a contract with the MIP platform provider. In addition, the mApp provider benefits from the marketing and sales activities of MPDV as MIP platform provider.

- mApp related service provider: An mApp related service provider offers customer-specific services that are not based on a standardized mApp with a price tag, but the benefits for an mApp related service provider are the same as for an mApp provider.

- Manufacturing company (shown in orange in the figure illustrating the value network): The manufacturing company benefits from low development and integration efforts and reduced time expenditure for a solution to optimize the internal processes and workflows. By using the MIP SDK, the manufacturing company can focus on its own process know-how when developing applications to optimize internal processes and integrate them into its IT-systems. In addition, the solution is prepared to be enhanced easily by other mApps offered on the market or developed and integrated by the manufacturing company itself, thus enhancing the flexibility of the manufacturing company and reducing maintenance costs over the lifecycle of the solution.

- Manufacturing company (shown in light orange in the figure illustrating the value network): The manufacturing company has the same benefits as the manufacturing company shown in orange, however, the manufacturing company buys the development and integration services for the required solution exclusively on the market and does not enter into a contractual relationship with the MIP platform provider.

- Hardware device supplier: The hardware device supplier benefits from the additional sales channel of MPDV as MIP platform provider.

4.4.3 Revenue Mechanism

See Figure 22: Revenue mechanisms of MIP.

- MIP platform provider: MPDV as MIP platform provider receives a one-time fee for the MIP SDK per user. Further revenues are generated by the MIP runtime licenses. As one option, the MIP runtime license is sold with a one-time fee for software distribution with recurrent fees for an additional maintenance contract especially for software updates, etc. As another option, the MIP runtime including maintenance is sold with a recurrent rental fee. The fees are usage-based in dependence on

Figure 22: Revenue mechanisms of MIP

for solution

for solution

mApp provider

mApp related service provider

manufacturing company

manufacturing company

for MIP SDK

for MIP runtime

for mApp sales

hardware device supplier

MIP platform provider

- - - - ▶ *revenue stream*

the number of processor kernels required for deployment of the MIP runtime. As an additional revenue a percentage fee of the list price of a standardized mApp is collected as a commission fee from the mApp provider. This fee is independent of the project turnover that the mApp provider charges for customizing and integration services. MPDV as MIP platform provider negotiates the amount of the percentage individually with the mApp provider.

- mApp provider and mApp related service provider: Both, the mApp provider and mApp related service provider receive revenues for the provided customer specific solution from the manufacturing company, which is typically a one-time sales fee, but can also be a recurring usage fee. When calculating the project costs, the mApp provider or mApp related service provider will consider whether the manufacturing company is already in a contractual relationship with MPDV as a MIP platform provider, or whether the manufacturing company has already installed a MIP platform, or whether – in the case an mApp provider – a percentage fee must be forwarded to MPDV.

- Hardware device supplier: The revenue streams of a hardware device supplier are not discussed here.

4.4.4 Business Model Contract

The mApp provider respectively the mApp related service provider conclude a contract with each manufacturing company for the solution. Accordingly, the providers are fully responsible for ensuring the quality of their solutions and cover the entire business risk.

Further contracts are concluded between the users of the MIP runtime and the MIP SDK (mApp provider, mApp related service provider, manufacturing company shown in orange) and MPDV as MIP platform provider. This is a classical software license agreement which is negotiated individually between the companies.

In addition, there is a contractual relationship between a mApp provider and MPDV as MIP platform provider regarding the percentage of the list price of the mApp that the mApp provider pays to MPDV for every mApp connected to the MIP.

4.4.5 Business Model Innovation

The business model changes of the companies considered in this example can be summarized as follows:

See Figure 23: Business model innovations of MIP.

- The business model of MPDV as MIP platform provider is changing significantly. The MIP platform provider offers a new value proposition to a new customer segment in form of mApp provider and mApp related service provider. This also changes the participants in the value network and the principal revenue mechanism.

- The business model of the mApp related service provider as well as the mApp provider change with respect to the following aspects. The mApp related service provider and mApp provider may address new customers by using the MIP platform provider as additional sales channel and integrate the MIP platform provider as new participant in their value network.

- The business model of the manufacturing company shown in orange is just changing in the aspect that the MIP platform operator is integrated in the value network. The manufacturing company continues to offer the same value proposition for the same customer group following the same revenue mechanisms.

- The business model of the manufacturing company shown in light orange is not changing. The manufacturing company continues to offer the same value proposition for the same customer group following the same revenue mechanisms. Even the value network is not changing since the manufacturing company only keeps the supplier relationship to a solution provider (mApp provider or mApp related service provider) as in its previous value network and has no contractual agreement with MPDV as MIP platform provider.

- The business model of the hardware device supplier may change with respect to attracting additional customer groups through the MIP platform provider's sales channel. However, the hardware device supplier offers the same value with the same revenue mechanisms.

Figure 23: Business model innovations of MIP
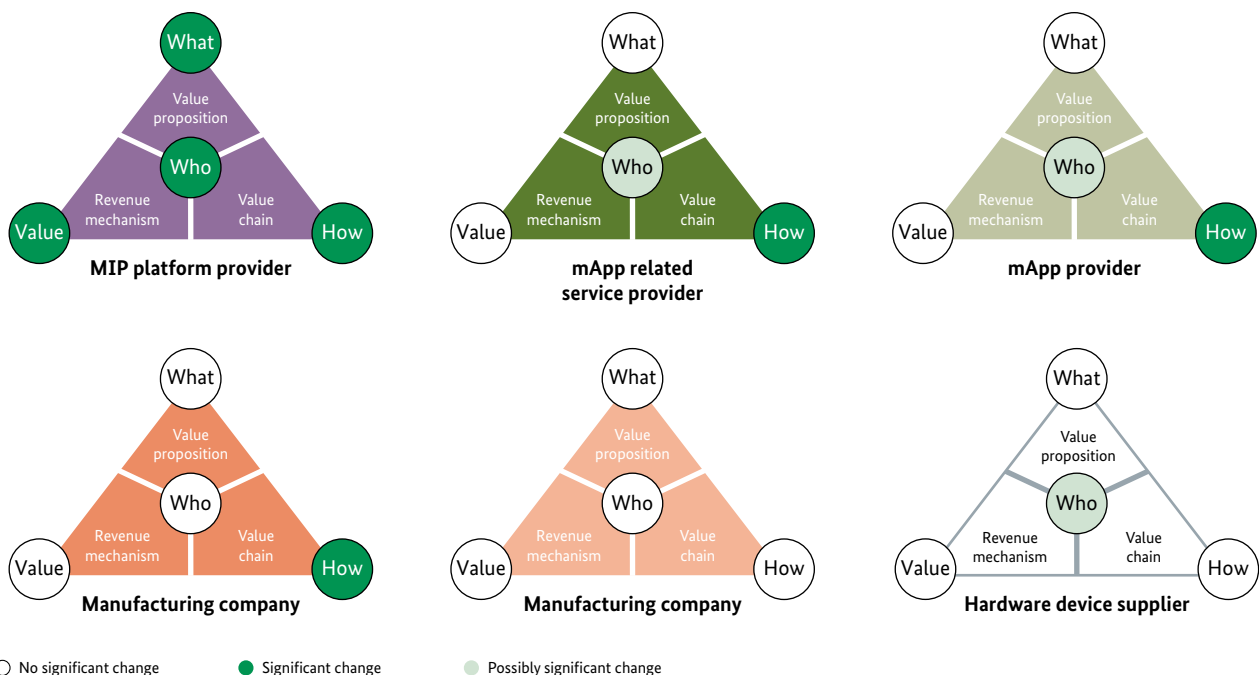
Source: Plattform Industrie 4.0

4.4.6 Information Sharing and Value of Information

This example does not address any information sharing between different cross-company business roles.

The core of this example is to provide an open semantically prepared information model from the perspective of manufacturing execution systems. This enables users develop and integrate applications with less efforts and to combine different applications and therefore also information quickly and easily.

In addition, the MIP platform offers further capabilities to ease system integration, for example rights administration or user management. So that the app developer can concentrate even more on the application logic in the future, the MIP platform will also offer a standardized app management to simplify the deployment of apps.

5 Analysis of the Examples

This chapter describes the first results of the joint analysis of the examples considered. This is an interim status, as the analyzes are to be continued, see also chapter 5.

5.1 Pattern of B2B-platforms

The analysis of the examples has shown that the platform operators pursue different business goals in the individual examples. This purpose of a platform has an impact on the design of the value and revenue streams. Even so, some examples have certain similarities. These similarities are described in this chapter in the form of platform patterns and the examples described in chapters 2 and 3 are assigned to these patterns.

A platform pattern is described by the structure of the underlying value and revenue streams, see also [3]. If an example is assigned to a specific pattern, the revenue and value stream of the example follow the structure as described in the specific pattern. These patterns are selective in the sense that a conscious business decision is required as to according which pattern one would like to develop. Note that patterns can also be combined.

5.1.1 Cloud-based IIoT platform

Using a cloud-based IIoT platform so called things, for example machines or factories, are connected to the Internet and provide information for applications in such a way that the applications can be deployed in the cloud.

The core of the platform pattern "cloud-based IIoT platform" is a IIoT platform operator offering the enablement that assets like machines, factories, products, devices, or other items transfer data to the IIoT platform. These assets could be physically installed in widely distributed different locations. Regardless of the location information from the usage of the assets can be collected, processed, and analyzed on the IIoT platform, which is based on a cloud-based infrastructure of a computing infrastructure provider. For this purpose, an IIoT platform operator provides to app developers the capabilities to create applications and offer them via the IIoT platform, for example in an app-store. A service provider can then offer data-based services to the asset user by using such apps and deploying the apps on the IIoT platform. The asset user thus provides usage information of the asset and ultimately receives services that improve its internal performance. The usage rights of the provided usage information can vary in concrete examples and need to be contractually regulated.

Figure 24: Value and revenue streams of cloud-based IIoT platform pattern
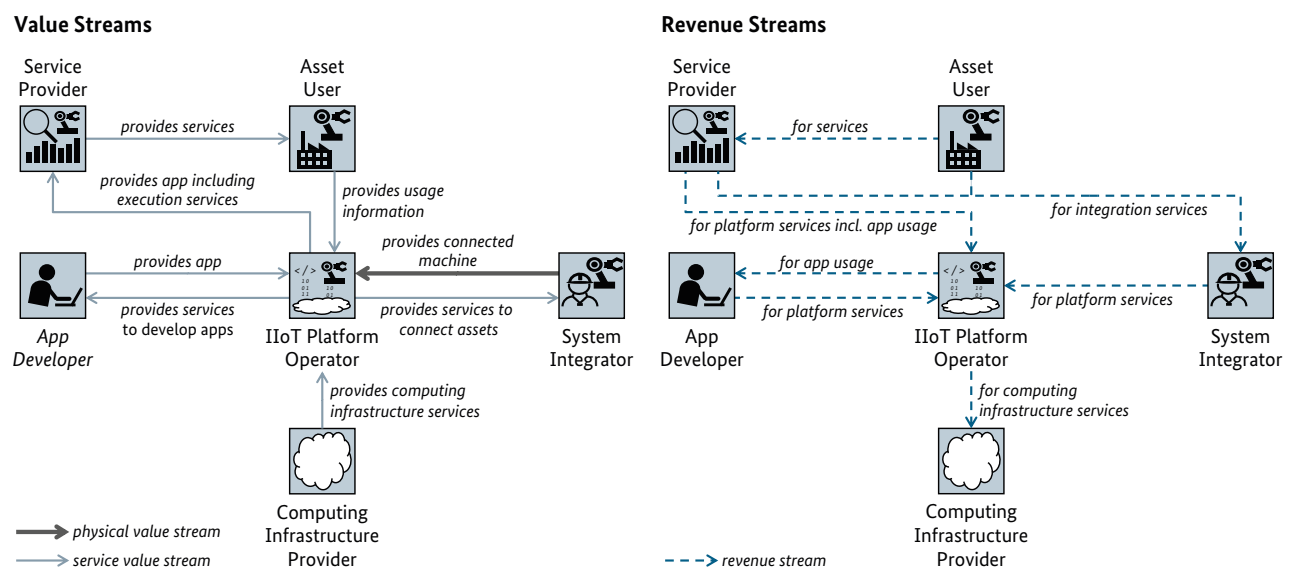
Source: Plattform Industrie 4.0

Figure 25: Value and revenue streams of edge-deployable platform pattern
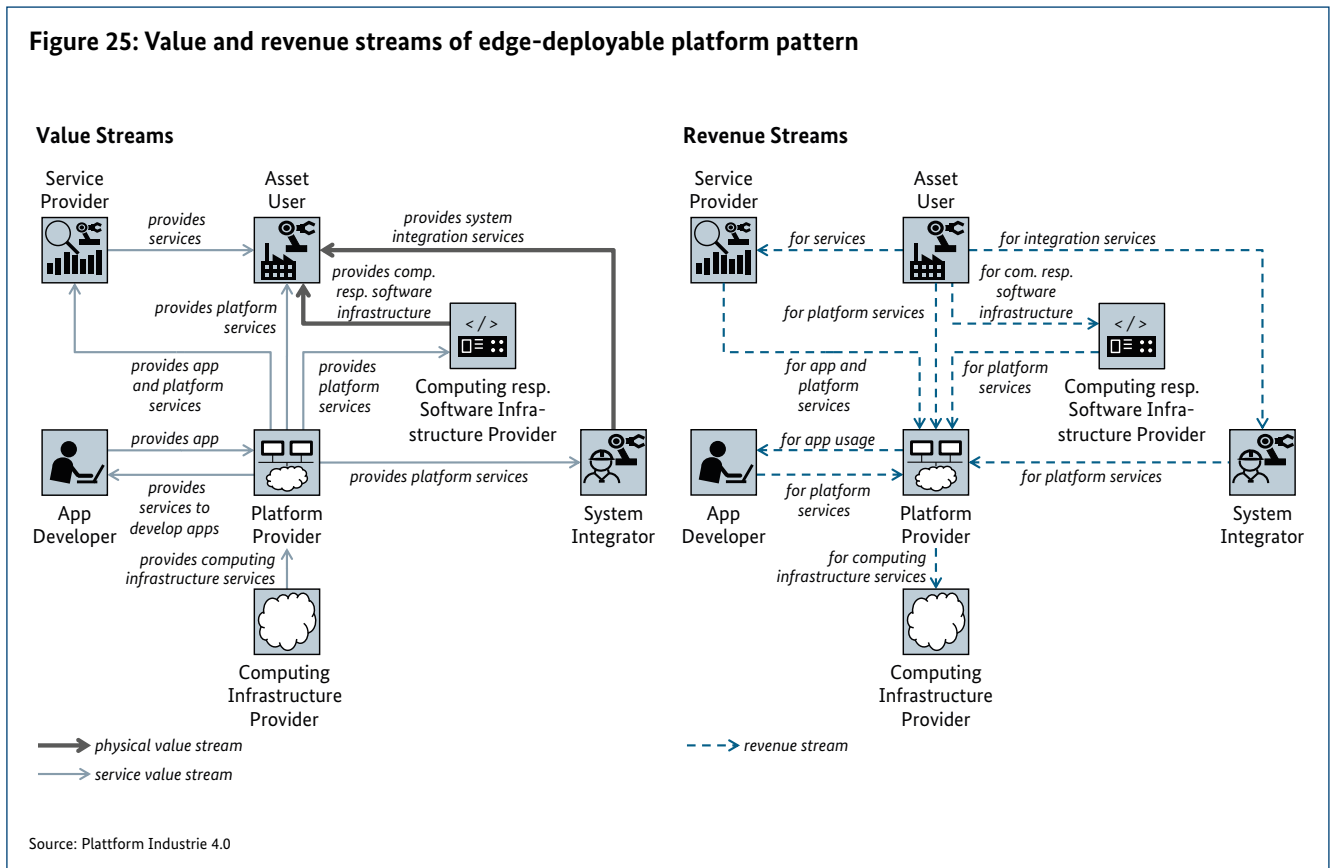
Source: Plattform Industrie 4.0

The IIoT platform operator receives revenue streams from various stakeholder for the offered platform services as well as from the service provider for the provision of apps. Typically, the system integrator is paid by the service provider, may be sometimes by the asset user. The IIoT platform operator pays the app developer depending on the app usage and the computing infrastructure provider for the computing infrastructure services.

Figure 24 illustrates the value and revenue streams of the pattern.

According to this pattern, the two examples Landlog (see chapter 2.3) and Siemens Mobility as provider of Railigent (see chapter 3.2) show similar characteristics and represent concrete examples of the cloud-based IIoT platform pattern:

- Landlog acts as IIoT platform operator and the construction company as asset user. The assets in this example are trucks and construction machinery, which are operated by the construction company or 3rd parties offering services to the construction company based on their own assets. Also, the drones are assets. In addition, Landlog acts as service provider, whereas the truck & construction machinery management services provider, the

ERP services provider, and the 3D view services provider act as app developer. Finally, Landlog and the construction company act in this example as system integrator.

- Siemens Mobility acts as IIoT platform operator and as asset operator providing trains services for the asset user. The assets in this example are trains and the integrated components. In addition, Siemens Mobility acts as service provider as well as the asset maintainer acts as service provider by basing its maintenance services on services provided by Railigent. The asset provider acts as system integrator, but in this example also as customer for services provided by Railigent. The component supplier acts as app developer, but in this example also as customer for services provided by Railigent.

5.1.2 Edge-deployable platform

An edge-deployable platform provides a computing resp. software infrastructure, which is installed resp. deployed close to the things, for example machines or a factory, in the so-called edge. Applications can be deployed on the provided computing resp. software infrastructure and consequently these applications can then process information

provided by the things. The applications may be managed and monitored centrally.

The core of the platform pattern "edge-deployable platform" is a platform provider offering the enablement that assets like machines, products, or devices transfer data to some computing infrastructure operated by the asset user. The platform provider offers such a computing infrastructure, which may be restricted to a software infrastructure, to be installed at the asset user so that information from the usage of the assets can be collected, processed, and analyzed on this computing infrastructure. For this purpose, the platform provider provides to app developers the capabilities to create applications and offer them via the platform, for example in an app-store. A service provider can then offer data-based services to the asset user by using such apps and deploying the apps on the computing infrastructure operated by the asset user with means of the platform.

The platform provider receives revenue streams from various stakeholder for the offered platform services as well as from the service provider for the provision of apps. The system integrator and the computing resp. software infrastructure provider are paid by the asset user. The platform provider pays the app developer depending on the app usage.

Figure 25 illustrates the value and revenue streams of the pattern.

According to this pattern, the two examples FANUC (see chapter 2.4) and mdpv as provider of MIP (see chapter 3.4) show similar characteristics and represent concrete examples of the edge-deployable platform pattern:

- FANUC acts as platform provider and the machine user as asset user. In this example a computing infrastructure including hardware and software is provided. The terms "service provider", "app developer" and "system integrator" are already used according to Figure 25 in the example.

- mpdv acts as platform provider and the manufacturing company as asset user. In this example a software infrastructure is provided by mpdv. The mApp provider acts as app developer, system integrator, and – depending on the concrete business model – possibly also as service

provider. The mApp related service provider acts as system integrator and – depending on the concrete business model – may be also as service provider.

Nevertheless, the business (and technical) characteristics of this platform pattern are very diverse and therefore require an even more detailed analysis based on additional examples.

5.1.3 Brokerage platform

A brokerage platform mediates between a requester and a provider with the objective that the requester and provider enter a contractual relationship.

The core of the platform pattern "brokerage platform" is a brokerage platform operator offering the assigning a specific demand for a product or service from a requester to a corresponding offer of a provider. This assignment is done actively by the brokerage platform operator, often based on automatic processes and matching algorithms. The assignment is characterized by the fact that the offering and price structure offered by some requester is not fixed at the beginning of the request. Therefore, it is necessary that the brokerage platform operator manages the brokerage processes of creating an inquiry, an offer, and an agreed price in several steps between the requester and provider.
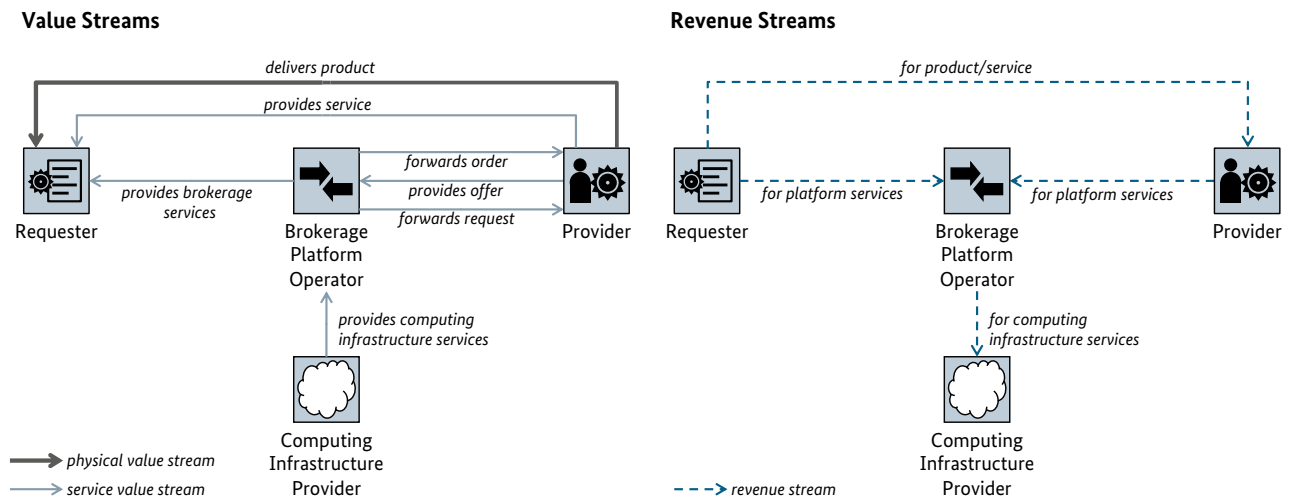
The brokerage platform operator typically receives revenue streams in form of brokerage fees depending on the price of the offering. The payments from the requester to the provider may vary in several examples and can be made either directly or via the brokerage platform operator.

Figure 26 illustrates the value and revenue streams of the pattern.

According to this pattern, the three examples CADDI (see chapter 2.1), SITATERU (see chapter 2.2) and V-Industry (see chapter 3.1) show similar characteristics and represent concrete examples of the brokerage platform pattern:

- CADDI acts as brokerage platform operator, the buyers of metal sheet components as requester, and the provider of manufacturing services as provider.

Figure 26: Value and revenue streams of brokerage platform pattern

Source: Plattform Industrie 4.0

- SITATERU acts as brokerage platform operator, the apparel companies designing and selling clothing as requester, and the material procurement/cutting/sewing/ironing factories as provider.

- V-Industry acts as brokerage platform operator and the terms "requester" and "provider" are already used according to Figure 26 in the example. Note that V-Industry also acts in the role of a service provider and computing infrastructure provider according to the platform pattern "edge-deployable platform".

5.1.4 Additional pattern

The GrabCAD example shows that the examples analyzed so far are not yet complete or representative for B2B platforms. This applies in particular to the aspect of collaboration between different stakeholders and the aspect of a community in connection with a platform.

It is therefore recommended to consider and analyze further examples. It should also be noted that further examples were analyzed in the context of other activities and further platform patterns were identified, see for example [3].

5.2 Summary

The various characteristics of the examples from Japan and Germany are summarized in the following table (see Table 1: Summary of characteristics of the analyzed examples from Japan and Germany).

An overall conclusion can be summarized by the following key messages:

- The key to understanding the business perspective of platforms is the value network describing the value-added relationships between all partners involved.

- In the discussion of platforms there should be strictly separated between a technical and a business perspective. Both perspectives have their justification, but they should not be mixed up in the discussion.

- There can be distinguished different forms of platforms from a business perspective. Based on the purpose a conscious business decision is required regarding which type of platform should be offered on the market.

Table 1: Summary of characteristics of the analyzed examples from Japan and Germany

	Description	Purpose of platform	Platform pattern	Value proposition of platform operator	Revenue stream of platform operator
CADDI	Manufacturing platform for metal sheet bending	Matching demand and supply	Brokerage platform	Provision of metal sheet bending services	For delivered bended metal sheet
SITATERU	Organizer of supply chain for apparel companies	Matching demand and supply	Brokerage platform	Provision of manufacturing services for apparel products	For manufactured apparel product
Landlog	Platform for monitoring and managing daily construction activities	Improvement of value-chains of a customer	Cloud-based IIoT platform	Data-driven services	For platform services (consumption based)
FANUC	Edge-based platform offering software applications	Connecting all production devices at the manufacturing site to improve productivity	Edge-deployable platform	Provision of computing devices, apps, related services, and marketplace	For computing devices, apps, and app brokerage
V-INDUSTRY	Digital procurement of components	Matching demand and supply	Brokerage platform	Operation of platform Data-driven services	For successful transaction For data-driven services (time based)
Railigent	Application suite for intelligent asset management	Improvement of value-chains of a customer	Cloud-based IIoT platform	Performance improvement Operation of platform	For services and data (outcome or consumption based)
GrabCAD	3D printing & CAD collaboration software	Provision of technical infrastructure to lock a community to a product	open	Support of current business model (improve market penetration of current products)	No revenues from platform operation
mpdv	Manufacturing integration platform	Integration platform for manufacturing applications	Edge-deployable platform	Provision of technical platform and marketplace	For technical platform and app brokerage

6 Outlook: Platform Business Model Mechanism

From a business perspective, digital platforms are interesting because the related business often grows very quickly and strongly and scales well. The good scaling is certain since the added value is essentially based on digital assets. In the relevant literature, see for example [1], the enormous growth potential is attributed to so-called network effects.

In general, network effects address the topic of value adding and defensibility of products. A network effect occurs when every customer of a product adds incremental value to all the other customers of a product so that it becomes difficult for customers to find any alternative product which gives them as much value, see [4].

We started to analyze network effects with respect to the examples described in chapters 2 and 3 by distinguishing two perspectives:

- Types of network effects, which are briefly sketched in chapter 5.1.

- Dynamics of network effects, which are briefly sketched in chapter 5.2.

We would like to emphasize that these are only initial considerations that we want to deepen in the context of further cooperation.

6.1 Types of Network Effects

There can be distinguished different types of network effects with diverse characteristics. These types can also be subdivided into more specific types, which is briefly explained in the following, further details can be found in [4].

- The first type is designated as *direct network effects.* Direct network effects occur when a higher usage of a product has a direct impact on the value of the product to the users. This type can be divided into subtypes:

  - *Physical network effects* can arise at physical nodes (e.g. telephone boxes) or physical links (e.g. pipelines) and tend to be very strong. Since they are usually related to high effort and costs, they often lead to monopolies.

  - *Protocol network effects* occur when a single standard is used across different products, such as a communication standard. With this standard protocol, additional devices can be connected to a network easily and the benefit for other products increases. As a result, the distribution and the whole network increases (e.g. Ethernet).

  - *Personal network effects* include the influence of personal contacts and relationships. By joining the network, additional nodes are created and thus all previous participants have further contact possibilities. In most cases, personal relationships and personal reputation play an important role (e.g. LinkedIn).

- *Two-sided network effects* arise in two-sided or multi-sided markets. As the number of participants grows on one side of the market, a complementary value is created for the participants of the other side of the market and vice versa. It is important to distinguish between two subtypes:

  - *2-sided marketplace network effects* occur when offers are distributed via a marketplace. The existence of a network of participants at both sides of the market creates the main value. In a marketplace, for instance, the value for the sellers increases when additional buyers join the marketplace. At the same time the value for the buyers rises if more sellers and thus more offerings on the marketplace are involved. The offerings are usually independent of the technical platform (e.g. eBay).

  - With the *2-sided platform network effects*, there are as well two sides of a market. In contrast to the 2-sided marketplace, the offers depend on the platform used. The services use specific features or characteristics of the underlying platform and partly must be adapted for the platform (e.g. Microsoft Operating System).

- *Data network effects* are a third type of network effects. This network effect can occur in networks with products that produce additional data when they are used. In this case, additional data must increase the user's benefit. Thus, an increase in the use of the product leads to a higher user' value. In a data network, each user adds additional data to the central database and thus increases the overall value for all participants in the network (e.g. Google).

- Another type is described as *tech performance network effects*. The tech performance network effects arise when the technical performance of a product improves directly with the number of users. An improvement for users might be that the product works faster or cheaper. Every additional participant of the network contributes to this improvement (e.g. BitTorrent with Peer-to-Peer communication).

- The fifth type of network effects addresses *social network effects*. These network effects involve psychological aspects in decisions or feelings of a group of people. For example, social pressure or the feeling of wanting to be part of a network can motivate people to join. As the network grows, this pull respectively push of the network to join becomes increasingly stronger (e.g. Apple).

In the examples considered in chapter 2 and 3 these five different types of network effects can be observed, see Table 2. However, the intensity of these effects is varying, which is indicated by different colors. A green color indicates a strong intensity, and a yellow color indicates a weak intensity. However, it should be noted that this is only a rough statement of tendencies. It is planned to refine this characterization at a later point in time.

Two statements can be derived as a first interim conclusion from the analysis of the types of network effects:

- The types of network effects should be sharpened especially with respect to the application in manufacturing industries to better apply the concepts especially in the industrial B2B sector. To develop more precise characteristics additional examples should be analyzed.

- Typically, a specific platform addresses several different network effects albeit possibly to different degrees. Therefore, when designing a platform, conscious design decisions with respect to the different types of network effects are necessary.

Table 2: Mapping the types of network effects to the examples

Type of network effect	Subtype of network effect	CADDI	SITATERU	Landlog	FANUC	V-Industry	Railigent	GrabCAD	MIP
Direct	Physical								
	Protocol				green			green	green
	Personal							green	
2-sided	2-sided marketplace	green	green		green	green		yellow	
	2-sided platform			green	green		green		green
Data	-			yellow		green	green		green
Tech performance	-						yellow		
Social	-							green	

Figure 27: Illustration of dynamics of network effects by Jeff Bezos
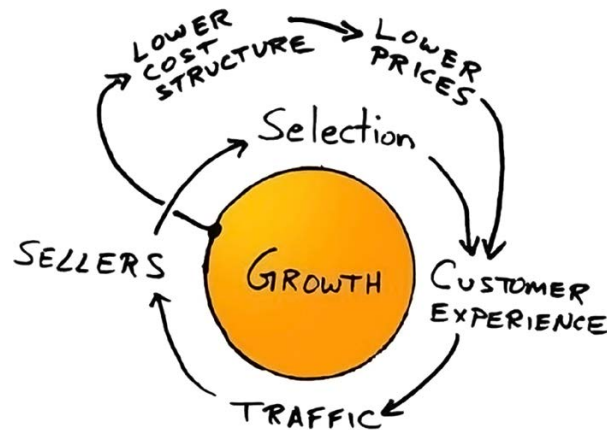
Source: www.amazon.jobs/de/landing_pages/about-amazon

6.2 Dynamics of Network Effects

Dynamic network effects are often discussed in the advancement and interaction of same-side effects and cross-sides effects, where acceptance on one side of the market will result in an increase of acceptance on the other side of the market so that the two sides influence each other and dynamically expand over the time. This effect was illustrated by Jeff Bezos on a paper napkin, see [5]. It is based on the considerations of the so called flywheel effect, where the success of a company is compared to a spinning flywheel, which, through various impulses, becomes an increasingly swinging instrument spinning faster and faster so that a momentum like a self-reinforcing cycle is developed in the company, see [6].

Note that the self-reinforcing effect not necessarily results in growth but can also result in collapse. Therefore, it is important to design a dependency cycle in which an improved customer experience creates more traffic and thereby increases the number of sellers. By these new sell-

ers the offered product lineup and new combinations grow and thereby improve customer experience by additional selection opportunities. Expansion can be created through this evolving cycle, but also efficiency and cost reduction are important for that purpose. It is necessary to optimize the entire lifecycle of the offered products based on information and data managed by the underlying technical platform. For this purpose a technical foundation such as an architecture, interfaces and applications must be developed so that such an optimization is enabled for example by incorporation of engineering functions that streamline conventional procedures with applications. This will create an additional evolving circular mechanism to encourage new sellers to serve and attract new customers by improving their experience.

The described dynamics of network effects can be observed using numerous B2C examples. However, the B2B examples considered as part of this cooperation have not been on the market long enough to also demonstrate these dynamics.

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AUTHORS AND CONTRIBUTORS

Prof. Dr. Ulrich Löwen (Siemens AG) | Prof. Dr. Nils Madeja (Technische Hochschule Mittelhessen) |
Dr. Sicco Lehmann-Brauns (ZVEI e.V.) | Mr. Fabian Hartner (Friedrich-Alexander University Erlangen-Nürnberg) |
Mr. Steffen Münch (MPDV) | Mr. Thorsten Eller (V-Industry) | Prof. Dr. Masanori Yasumoto (Yokohama National
University) | Prof. Dr. Hirofumi Matsuo (Kobe University) | Mr. Naoaki Fujino (NRI) | Mr. Kiyoshi Mizukami (Hitachi) |
Mr. Kazuo Nakashima (RRI) | Mr. Kazuo Hariki (RRI)

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