IIP-Ecosphere

WORKSHOP DOCUMENTATION - II o T PLATFORM

Version 0.1

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Executive summary

Here are the results of the workshop for the development of an IIoT platform documented. The workshop takes an ecosystem approach to the roles within this Analyze the ecosystem around the IIoT platform.

Based on the Ecosystem Pie Model (Talmar *et al.* , 2020), 7 core roles were assigned in two workshops identified and based on their resources, activities, value contributions, as well as dependencies and risks analyzed. The core roles are:

- Role 0: system integrator
- Role 1: machine operator
- Role 2: Machine component supplier
- Role 3: machine manufacturer
- Role 4: application provider
- Role 5: Service provider
- Role 6: platform operator

Actors on the platform can assume or fulfill several of these roles at the same time. However, this poses further challenges to the design of the platform and it emerging Ecosystem. On the one hand, the interests of the respective (individual) roles are taken into account, as well as those of actors who have multiple roles fill in at the same time. This is particularly relevant at the beginning (in the incubation phase) of the platform, in of a critical mass of participants on the platform must be reached in order to be appropriate Initiate network effects (penguin effect).

A more detailed elaboration will take place as part of the Business View development, for which this Workshop forms the basis.

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Glossary and Abbreviations

term	meaning
IIRA	Industrial Internet Architecture Viewpoints: The "Industrial Internet Architecture Viewpoints" model is a Framework of the “industrial internet consortium”. It represents a Architecture with which, for example, IIoT platforms are structured can.
IIoT	Industrial Internet of Things: Industry 4.0, that internationally under the term Industrial Internet of Things (IIoT) denotes a paradigm of digitized and connected industrial value creation (eg Kagermann, Wahlster and Helbig, 2013; Arnold, Kiel and Voigt, 2016)
IIoT platform and digital platform	A platform encompasses technological concepts, the organizations in the development of modular products, services or Support technologies. An example of a digital platform would be the Linux system; A. An example of a non-digital platform would be Das VW- Modular system. In this context, digital platforms Also viewed as architecture with different levels. (Platform Industry 4.0, 2021)
Servitization	Servitization refers to the trend in which Manufacturing companies from product providers to Switching to a solution provider (Kohtamäki *et al.* , 2018).
service	A service is a singular, distributable, functional unit that fulfills a specific function. A service can do this on Edge / Cloud / Server systems can be configured and installed (Stichweh, Sauer and Eichelberger, 2021). eg cloud storage, model calculation, etc.
application	An application is an executable software solution that consists of consists of several orchestrated and combined services (cf.

Figure 1) .
eg predictive maintenance, anomaly detection

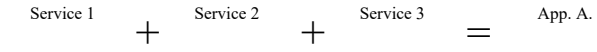

Figure 1: Services and applications

1 Introduction

1.1 Motivation

Platforms are one of the most influential concepts in recent years (Parker, Van Alstyne and Choudary, 2016). The platform economy is both in practice (Platform Industry 4.0, 2021) and Research one of the most discussed topics (Kenney and Zysman, 2016).

(Technological) industrial platforms play a very important role, as they are an essential Play part of the fourth industrial revolution (Plattform Industrie 4.0, 2021). Common with these Platforms mean those that arose from the "servitization" movement (Baines *et al.* , 2018). In contrast, the term is also used for so-called collaborative platforms, But they have nothing to do with the technological platforms in the context of servitization and Industry 4.0 have to do.

The trend of platforming (Gawer, 2009) has increased in recent years due to the development of digital Initiated technologies such as artificial intelligence, augmented reality, digital twins and others (Nambisan *et al.* , 2017). IIoT platforms are of particular interest, as over Such services are offered by different providers on the basis of certain standards can (Bullinger *et al.* , 2017). Ie an IIoT platform ensures that services work with each other, however are also compatible with the various technical components of a machine. So here is the use of the term platform diffuse. On the one hand, an IIoT platform consists of technological View from a technological component that we call a platform and from a economic or business component, which also includes the term Uses platform, but understands completely different aspects by it. In Section 2.1 this topic becomes brief understood.

1.2 Goals

The workshop takes a business perspective on an industrial IIoT platform and develops a value-based overview by using different role models that are relevant for the platform, identified and analyzed. These role models are thereby created on different levels described (see chapter 3) .

The ecosystem that is formed by the respective actors who take on these roles (cf. Figure 4) thus provides the basis for the development of (collaborative) business models for the involved actors (Platform Industry 4.0, 2020).

In the workshop the basis for the development of the business perspective in the context of the "Industrial Internet Architecture Viewpoints "[IIRA] model (see Figure 3). This is explained below Chapter described in more detail.

2 background

2.1 The term "platform"

The meaning of the term "platform" is confused, which among other things, the different usage the term is owed in various disciplines and industries. Below is a short one Overview of typical "platform types" and the use of technological and Business perspective [1] :

Technical perspective (technological platform)	**Business perspective (Business platform)**
	Product platform
Software platform	Digital platform
	Service platform / product service platform
IIoT platform	IIoT / industry platform
	(multi-sided) market platform
	Collaboration platform / community platform

Another aspect after which platforms are differentiated is whether they are internal, organization-specific, or externally across industries (Gawer and Cusumano, 2014). One Intermediate stage would be platforms that are created by an organization for selected "partners" from the Value network are made available. Further dimensions of an IoT platform are presented in the following taxonomy:

Figure 2: Taxonomy of IoT platform business models (Hodapp *et al.* , 2019)

When the IIoT platform is later designed, these dimensions can be used as a guideline during development can be used.

[1] For more information on platform types from a business perspective: (Evans and Gawer, 2016)

2.2 Industry 4.0

In the context of Industry 4.0, platforms form an essential part of the foundation of modern technology Manufacturing systems (Burmeister, Lüttens and Piller, 2016). At the center of ongoing initiatives is the Integration of artificial intelligence into such systems, which opens up new possibilities, but Also poses challenges for all organizational areas and disciplines involved.

The framework architecture of the IIRA model provides four perspectives for development industrial platforms must be taken into account. In previous white papers, the functional view (Eichelberger *et al.* , 2021), as well as the usage view (Stichweh, Sauer and Eichelberger, 2021) of the platform. The perspectives were according to the recommendations of the German Standardization Roadmap Industry 4.0 [ZVEI I4] created and included the following elements:

Figure 3: Industrial Internet Architecture Viewpoints [IIRA] (Lin *et al.* , 2017)

2.2.1 Usage View

The usage view represents a kind of proto-architecture with relevant, logical entities (high-Level components or services) and their interaction with the actors of the system who take on appropriate roles. However, the focus is on the interaction of the roles with the System and not architecture styles or interfaces. An actor can have several roles at the same time and a role can also be fulfilled by several actors.

Roles from a usage perspective

In its current version, the usage view differentiates between 19 roles (see Figure 5, page 9). Depending on The purpose of the role can be a technical system, an individual person, a Organization or even a combination of these. A distinction is made between the following roles:

- Field device provider
- Edge device provider
- Edge runtime provider
- Cloud provider
- Application integration provider (service / application developer)
- Server device provider
- Server runtime provider
- Data provider
- Data consumer
- Asset data provider
- Application designer
- Service developer
- Broker
- Plant operator, system integrator and application integrator

- Platform provider
- Data scientist
- DevOps operator
- Plant operator, system integrator and application integrator
- IT infrastructure

While the usage view differentiates the roles of the actors on a technical level, the Business ***perspective suggests*** a differentiation according to ***value proposition*** . This is explained in more detail in section 2.2.3 explained.

2.2.2 Functional and quality view (functional view)

The functional and quality view (Eichelberger *et al.* , 2021) describes the requirements of the IIoT Platform. A distinction is made between the following categories of requirements:

- Terminology
- Sources for requirements
- General requirements
- Data sharing
- Data integration
- Configurability

- Connectors and Connections / interconnectivity
- Heterogeneous, dynamic deployment
- Security
- Data protection
- Central storage services
- Optimized or adaptive deployment
- AI (service) construction kit
- Adaptive service / component selection
- virtualization
- Application support

These have an impact on the design of the platform and the ecosystem around it. In the further development of the platform, this should be taken into account, but not The aim of this workshop is.

2.2.3 Business View

This document forms the basis for the business perspective of the “Industrial Internet Architecture Viewpoints "[IIRA] framework (Lin et al., 2017). This perspective includes accordingly the following components:

- Stakeholders (actors)
- vision
- Values
- Key objectives
- Fundamental Capabilities (Basic skills)

Figure 4: IIoT platform ecosystem

The "Ecosystem Pie Model" (EPM) was used to develop the business perspective (Talmar *et al.* , 2020), which is explained in more detail in Section 2.3 . This allows you to first Estimate the value contributions of the relevant roles and provide an overview of the value proposition of the Win platform. The EPM's approach is to switch between the platform and the ecosystem to distinguish these around.

Figure 5: IIP-Ecosphere platform structure according to usage view (Stichweh, Sauer and Eichelberger, 2021)

2.3 Ecosystem Models

In many cases, as is the case with an IIoT platform, ecosystem glasses are the ideal solution set up in order to structure and build multi-actor systems. A fundamental point here is the central value proposition (Adner and Kapoor, 2010). Have such value propositions the characteristic that they are often only manifested / implemented through the collaboration of these actors can. However, mutual interactions also create dependencies, relationships and Risks of failure between different actors (Adner, 2017). From an ecosystem perspective, there won't be single company viewed in isolation. Rather, the constellation of actors is around a focal organization around drawn into consideration. In the case of platforms, this is focal organization often the platform operator. The ecosystem perspective helps understand how Challenges, opportunities and strategies of other actors to which the consortium des affect the entire ecosystem (Adner and Kapoor, 2010).

The Ecosystem Pie Model (EPM)

The EPM (Talmar *et al.* , 2020) is a methodology to identify such constellations of multi-actors Systems to develop and visualize. This supports the identification of Relationships between different actors and the decision-making processes in Design of the ecosystem and in this case the underlying IIoT platform. That EPM comprises the following elements:

- The ecosystem's core value proposition
- Actors or roles (ie either roles can be modeled, or actors who represent real organizations, e.g. Lenze. In this case roles are modeled, whereby an actor can play several roles, including a role of several actors can be filled out.)
- The resources that they bring into the ecosystem (ie the tangible resources, eg in the form of IT infrastructure or other assets)
- The activities they do in the ecosystem (for the value proposition)
- The value contribution they make for the common value proposition contribute to the ecosystem
- The value contribution that this creates for the actor / role
- The dependencies of the actors / roles on the success of the shared value proposition
- The dependencies that arise between the actors
- And the risk to the ecosystem should an actor leave the ecosystem

The procedure of the methodology can be roughly described as follows: After the roles are determined Each role is iterative in the categories resources, activities, value contribution to Ecosystem and value proposition for actors analyzed. Then the default risk (center circle), the dependence on the ecosystem (districts outside) and the dependency between the individual Roles (red connecting lines) discussed (Talmar *et al.* , 2020) .

The process is iterative and can be supplemented and / or renewed with new knowledge at any time want. A revision is explicitly requested.

3 Ecosystem Model of the IIoT Platform

3.1 Core Value Proposition

The platform's core value proposition is as follows:

Lenze provides its customers with (own or third-party) smart services and Applications ready that simplify the administration of the machines, the operation of the machine optimize and generate new (repetitive service) revenues.

The machine supplier provides the machine operator with a machine with an IIoT platform based on a Edge / cloud / server infrastructure is available that ensures optimal operation (maximization Availability / quality / etc.) And important customer needs such as self-sufficiency / use of the Smart Services or data protection are taken into account.

The IIoT platform enables the combination of various smart services and applications, which can come from different providers.

3.2 Role models of the ecosystem around the IIoT platform

This chapter lists the roles and their characteristics from the workshop documented. These roles are listed below with relevant example actors from business:

• System integrator:	BTC Business Technology Consulting AG
• Machine operator:	Volkswagen, Gerresheimer, Sennheiser
• Machine component supplier:	Lenze
• Machine manufacturer:	Siemens AG, DMG Mori
• Application provider / consultant:	infor GmbH Germany
• Service provider / consultant:	ÍNDUMESS (industrial metrology), slashwhy
• Platform operator:	Trump (Axoom platform)

The cake or pie model is the table below (see Table 1 and Figure 6), as well attached separately as image and PDF file.

Down-stream roles and up-stream roles are both in the table and in the pie model Highlighted in color. The former represent the roles that are closer to the value chain End-users are, while the latter are more on the manufacturer's side.

The dependence of a role on the success of the ecosystem is indicated by the following circles, with red a high, orange a medium and yellow a low dependency.

Likewise, the risk for the ecosystem should be an actor with this role cease to exist in color and rated on a scale from low to medium and high. The risk is in this Form a first indicator and results from the probability of failure, as well as from the The severity of the consequence should this failure occur. For example, the probability that the Platform operator stops relatively low, but the consequences would be grave.

Next to the EPM model in Figure 6 , the items are also shown in Table 1 belo

Table 1: Roles of the ecosystem around the IIoT platform

Sample table	resources	activities	Value contribution to the ecosystem	Value contribution for the Actor in this role	Addiction of an actor in this role
Role 1: Machine operator	• The machine / system / Production line or even the work • ECS (Edge, Cloud, Server) • Basic IT Inf rastructure	• Applications on their own Deploy servers • Integration of the applications in the business processes • Select applications (What I want to have?) • Identify potentials / needs determine	• Can act as a data provider: eg for service optimization • Operators can create new ones themselves Adapt / innovate applications (Self-service) • Pays monetarily for: For services, For Use of the platform for Service and advice To integrate applications • Pays for the use of infrastructure: own and external • Has network effect contribution for that Ecosystem	• Optimizes the Business processes: eg Productivity, quality, Lower costs, new ones Market potential or in general new markets • New business models to use	

Role 2: **machine Components providers**	• IoT interfaces • Edge devices for the respective service • Sensor technology of the component • Field devices: sensors, Dev ices, whole Components	• Further development of the respective Field devices • Analyze the surveyed data • IoT • Provide interfaces with the respective descriptions • Developed services and Applications	• Provides information about which field Devices which provide data can and what quality this to have • Which standards are used and how the data is provided • The drive or Control components (Field & Edge Dev ices) • enables the provision of Process data of the machine operator • May offer even templates for Applications • Offers services	• Networking in Value network • Can offer entire PSS • (complete solutions) • Can expand market as he In addition to the Components also services can offer • Can own products and Services through complements (Services, hardware, ...) on valuations

Sample table	resources	activities	Value contribution to the ecosystem	Value contribution for the Actor in this role	Addiction of an actor in this role
Role 3: ***Machine manufacturer***	• IoT / Smart Service Experts | • Service engineer • Customer base • Parts, raw materials • Production facility for machinery • Installed (machine) base	• Integration of the applications in Machine / connectors for Provide business processes • Applications for machines to generate • Creates applications, services and / or integrates them from Third party • Adaptation of business processes (especially in service) • PSS management • Adaptation of business models • Identify potentials / needs for Identify machines	• Interface integration • Deployment templates for machines • Machines / software • Descriptions: Provides information ready according to a certain standard • Application templates for machines • Delivered with the machine part of the Smart service infrastructure • Provide after-sales services Disposal • Provide prod. Trade machines Disposal	• Enablers for new ones Business models (PSS, vGM, Pay per use) • Offer of applications	
Role 0: ***System integrator***		• Provides feasibility studies • Performs the deployment at User (possibly yourself) by • Must think about IT security and also advise if necessary • Closes service gaps if necessary own services	• Forms the interface between customers and providers • Creates an end-to-end solution (ie the Integration into the IT / OT ecosystem of the user) • Enable connectivity and Compatibility with other services and Components / machines	• Usually used by the user paid • Commission payments from Application providers	
Role 4: ***Application provider***	• Environment for Prototype ping • Machine models and Virtualizations	• Mediates active between the Service / application Provider side and the Request page • Provides incentives for new services • Combines services from the corresponding providers	• Increase the attractiveness of the platform • Reduce the complexity of the Solutions (all-in-one) • Provides solutions in the form of Applications for more complex Problems available	• Generates cash flow through Sale of services and indirectly through third party providers of Applications • Services become more visible for Interested • Expand its markets	

Sample table	resources	activities	Value contribution to the ecosystem	Value contribution for the Actor in this role	Addiction of an actor in this role
		• Conducts needs analysis for Services through			

Role 5: Service provider	• Converts its own servers Develop services	• Developed new services and Interfaces • Takes over DevOps activities (continuous deployment) • Registration of the service the platform / in the service store • Advises service users and Machine manufacturer	• Enable connectivity and Compatibility with other services and Components / machines • Increase the attractiveness of the platform • Forms part of the service offers	• Can use standards around Services compatible with do
Role 6: Platform operator	• IT infrastructure • Data storage • Server capacities for Platform	• Provides marketplace for SS Available (2-sided platform) • Configure service and Ensure combinability • Service package (application) must be deployable! • Offering a service store: Tech. Requirements, compatibility • Ensure connectivity • Interaction of the actors will enables	• Provides service and integration tools Disposal: Dev. Confi., Serv. Conf. (eg what can be combined with what?) • Provides basic legal Conformity assured • Opens the discovery of new Service packages (applications) • Provides validity management Disposal) • Drag'n'Drop workflow creation • Provides basic infrastructure • Enabler for Smart Services	• Platform as a means to Purpose: eg service included, when hardware is sold • Pay per use • Profit-oriented provider vs. altruistic (eg association) • Providers • Receives data from the Users • License model: Pro Service The operator deserves it

Figure 6: Pie model of the ecosystem (model in HD in a separate file and in the online white board)

3.3 Dependencies in the ecosystem

Various interdependencies were identified during the workshop
want. These are described in more detail here.

- Role 0: System integrator:

  The system integrator role has a key function in the value-added network of
  Ecosystem. The role often forms the interface between customer and provider. However
  can this be fulfilled by people in the user organization, or it is done externally
  bought. In the best case, the filling organization has in-depth expertise in the context of
  Application (e.g. laser welding, milling, etc.). However, the other roles are dependent on
  the ability (or success) of this role, otherwise an integration of the services and
  Applications in the customer's business processes cannot take place.
  Through this role is a service and / or application provider, as well as a
  User organization depending on the actor who exercises this role. A change in this one
  Role is based on the specifics of a business process as well as the specifics
  and the context of a user organization risky and should be avoided (the
  Familiarization with the data and business processes is time-consuming and difficult to catch up on
  want).

- Role 1: machine operator:

  One business-level effect the platform could have is itself
  Machine operators do not become dependent on a special system
  This is achieved by the fact that various providers offer services and
  Offer applications that are similarly compatible with the operator's machines. Ie it
  is an open platform and not a closed one (Dombrowski *et al.* , 2020). [2]
  This should make it easy for a machine operator to find the supplier for one if necessary
  To change service or an application.
  A further dependency on the ecosystem could result from this on a technical level
  result if standards (eg for interfaces to and from machine components)
  can only be used on the platform and thus a machine only with services
  and applications of the platform is compatible. This may seem like from the point of view of the
  Platform operators appear desirable, however, is a huge barrier to entry for that
  Customer side (Eisenmann, 2008).

- Role 2: Machine component supplier:

  Are components specially manufactured using standards used on the platform,
  the component supplier thus becomes dependent, since this also depends on
  depends on the offers of the other providers. A machine component supplier
  could therefore choose the strategy to offer services and applications itself in the event
  failure of the ecosystem, or when leaving it, a certain *mobility of* it
  Owns product service systems. That means that - to a certain extent - those who are suitable
  Services and applications are also offered without the other players in the ecosystem
  can be.
  The opposite case leads to a different dependency: Provided by the component supplier himself
  no services and applications ready, but relies on the offers of third parties, that is
  shared value propositions at risk. A machine operator would have problems

[2] For example, the 365FarmNet platform failed as a closed platform within the CLAAS Group, as an open one
On the other hand, successes were achieved on the platform (Dombrowski *et al.* , 2020).

should one of the service or application providers cease to exist without a
adequate replacement is available. The components should then also be used with others
Services or applications outside the platform can be made compatible.
This risk is borne by machine operators and machine component suppliers, and also by
Machine manufacturer.

- Role 3: Machine manufacturer:

  For machine manufacturers, there are similar dependencies on the ecosystem as for the
  Machine component supplier. In particular, the adjustment of the machine (s) to the

Services and applications are an important task. However, there can be dependencies here come when unequal power relationships between machine manufacturers and service / Application providers prevail and the platform operator too large Room for maneuver granted. For example, both sides want the existing ones if possible Bring (own) standards onto the platform, which the other side converts into a Dependency sets. Here the operator has to pay close attention to the platform's regulations. On the other hand, there are machine manufacturers who provide all of the services and applications that come with their machines are compatible, with a strong dependency on the ecosystem. This is because that the added value through the services offered in addition to the machine and Applications can only be guaranteed as long as there is enough of it via the Platform are available. An important point of the strategic positioning of the roles is, in the traditional (non-Platform) business services mostly from machine manufacturers to machine operators "Sold. This is the case because the contact with the machine operator is mostly exists exclusively through the machine manufacturers. Machine component supplier, as Service and application providers also usually do not see where their offers are being used come. With a high level of transparency on the platform, these market conditions could must be changed, which is essential when designing the platform and the ecosystem is taken into account.

• Role 4: Application provider:

While machine manufacturers depend on the quality and quantity of services and applications application providers are dependent on the application selection of the Machine manufacturer. If an application is unattractive, no machine manufacturer will make his machines compatible with this. The platform operator can do some Set standards, but this restricts developers in their freedom of innovation and makes the platform unattractive, as it also creates entry barriers. A. Application provider who has to redesign a large part of their portfolio in order to work with a Offer to be able to go on the platform would like to have low "retrofitting costs", to make it compatible. Ask in current (non-platform) store Machine manufacturers provide the deployment templates to which the Orientate application manufacturers. Depending on the regulation and balance of power, this could change change this mechanism. In addition, the application providers are dependent on the service providers because they are in have to orientate themselves according to these to a certain extent. Here is another one Power balance that can be regulated accordingly by the platform operator or got to. So that the application provider does not overly dominate by the service provider A reasonable ratio should be established here, but this is not so easy to do can be achieved, but must be taken into account by the operators.

• Role 5: Service provider:

Similar to the application providers, service providers are dependent on the Ecosystem, as well as other roles. For example, the contact via the ecosystem (eg via System integrators) from service / application providers to the machine operators and also necessary; For example in cases where the deployment of a service or a Application is implemented on the operator's own servers. This could conflict with the machine manufacturers who have previously been responsible for the services offered directly from Machine operators were paid. The interface role of the system integrator also represents a function here that is more detailed must be taken into account when designing the platform. In particular, the case should be internal A distinction is made between the external system integrator and the possibilities are determined how this role can be fulfilled so that no conflicts arise.

• Role 6: platform operator:

Depending on which form of platform operator is selected, different Dependencies arise. One possible scenario is that the platform operator is a Dominator type is (Iansiti and Levien, 2004a), if this is, for example, by an organization is represented, which is itself active as an actor on the platform (eg Apple on the iOS Platform, or Amazon in its web store). In the B2B context, however, this is a strategy which often achieves little success (Iansiti and Levien, 2004b; Dedehayir, Mäkinen and Roland Ortt, 2018). Another scenario is that several key players act as platform operators and

Identify ecosystem orchestrators who jointly take on this role
(Cusumano and Gawer, 2002; Nocke, Peitz and Stahl, 2004). This can create power conflicts
be resolved democratically as answers to platform design questions are co-created.
In a third scenario, a third party can take on the role of platform operator who
no offer placed on one of the pages (eg as on Ebay). Additionally there is
the possibility to select a third-party organization for this role, which is managed by
Reason is not profit-oriented (eg industrial intermediaries such as the industrial and
Chambers of commerce, associations or network actors), and thus more trust through the
Ecosystem actors learns.

4 next steps

In the next steps, these results will be further elaborated and converted into a
Business perspective (Business View) transferred that is compatible with the other perspectives (Views)
is. In particular, the methodology of the IIRA framework is intended for the development of a business perspective
can be applied and supplemented.

In addition, the next steps would be to develop the platform design and business model (GM),
which includes, among other things, the approved GM of the individual roles. This would be likely
further studies necessary and an agreement with the developing parties in the IIP-Ecosphere project.

Specifically, the following point is relevant:

- Platform design and business model
- Initiation and growth strategy
- Business strategies of the actors

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