

Plattform Industrie 4.0 & Alliance Industrie du Futur

Common List of Scenarios



PLATTFORM
INDUSTRIE 4.0



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Purpose and Summary

In the Shared Action Plan of Plattform Industrie 4.0 and Alliance Industrie du Futur, published on April 26th, 2016, see [1], the work on common comprehensive scenarios describing the future of manufacturing addressing the customer needs was announced. Scenarios are defined as top down archetypical stories made possible by new manufacturing and digital technology.

It was announced that in the second half of the year 2016 a common list of scenarios will be published.

Plattform Industrie 4.0 published a first version of application scenarios at Hannover Fair in April 2016, see [2], and

published an update at IT-Gipfel in November 2016, see [3]. In parallel Alliance Industrie du Futur worked on similar scenarios in its "Guide Pratique de l'Industrie du Futur", see [4], published in December 2015 at Midest Fair 2015.

In this paper we describe the objectives and setup of the complementary approaches of Plattform Industrie 4.0 and Alliance Industrie du Futur, we explain a common frame for the integration of the two approaches, we reference to the common list of scenarios, and we enumerate various possibilities to use the common list of scenarios.

Digitalization in Manufacturing Industries

Germany and France share the common goal of helping their industrial companies to transform more rapidly and to adopt principles of an economy based on the evolution of consumer's behaviors and the rapid development of new manufacturing and digital technologies. In this transformation, the impact of digitalization will be major. As important players in the field of manufacturing digitalization, with complementary strengths, Germany and France have both started initiatives to keep up and improve their position in this domain.

In order to facilitate a joint working on this topic, a common understanding of "digitalization" is needed.

Digitalization impacts different aspects. These aspects often are structured in multiple layers, which are based on each other. Between these layers there exist causes and effects dependencies. Typically a layer defines goals and sets rules for the layer below and inversely a layer enables and implements the layer above. An example, where this layer model was used for structuring, was the recommendation for the future project Industrie 4.0, see [5], as shown as a summary in Figure 1:

- **Strategic layer:** This layer addresses the business model of a company and the interaction of companies in a business ecosystem. Examples, how digitalization impacts this layer can be found especially in B2C, e.g. Amazon, Spotify Music, or Uber. But in B2B also such examples are emerging like pay per use models for power used instead of paying for a physical drive.
- **Value chain layer:** This layer addresses the value creation processes within a company as well as the value chains across different companies. This layer is impacted by digitalization already since years. Typical examples are building virtual prototypes instead of physical ones, supporting an operator onsite via remote service instead of travelling to the site, or executing online software updates instead of manual installation.
- **System layer:** This layer addresses the technical systems including the required and used technologies. Even this layer is impacted by digitalization since years, where products are augmented digitally for different stakeholder along their entire lifecycle. Typical examples are remote monitoring and control functions supported by telecommunication services offering wide area connectivity, the provision of online documentation for users and sales, or the provision of a “digital twin” for engineering and operation.

Strategic layer



defines goals

Value chain layer

implements



set rules

System layer

enables



Figure 1: The conceptual cornerstones of Industrie 4.0

A similar multi-layered approach has been also adopted by the Alliance Industrie du Futur to describe the different transformational challenges that the “New Economy”¹ is imposing on industry. This approach led to 6 layers, each one considering a different competitiveness driver and a different impact of digitalization. This approach is briefly described and mapped with Industrie 4.0 layers in the following sections of this document.

Besides a common understanding of digitalization we have to acknowledge that the manufacturing industry is a highly fragmented sector. This fragmentation concerns various aspects, for example the type of the manufactured *product* (e.g. pure mechanic products, electrical equipment, mechatronic products), the type of the used *production process*

(e.g. continuous processes, sequential processes, object related processes or other ways of classification), or the type of *production strategy* (e.g. engineer-to-order, make-to-order, make-to-stock, etc.).

As a consequence the so called “scenario based” approach we follow neither claims that each scenario fits to every customer, neither that the list of scenarios is exhaustive. Each scenario developed by Plattform Industrie 4.0 or Alliance Industrie du Futur has been elaborated by a group of industrial companies representative of specific industries and addresses the benefits for those industries in an explicit way. Each company willing to invest into digitalization should specialize and extend these scenarios in its own way.

¹ “New Economy” or “Experience Economy” is a concept introduced by Joseph Pine II and James Gilmore in 1999, see Harvard Business Review, [Link](#)

Methodology Applied to Develop Application Scenarios

Plattform Industrie 4.0 and Alliance Industrie du Futur describe a new level of organization and management of the entire value chain along the lifecycle of products. This cycle

orients itself by increasing individual customer requirements. It is postulated that this new level can be achieved by means of digitalization, see [6] and [7].

Application Scenarios of Plattform Industrie 4.0

By this strategic definition the impact of digitalization is focused on the value chain layer according to Figure 1. Of course the other layer will be affected because of the interdependencies, but the primary lever and the starting point for the discussions is seen on the value chain layer. As a consequence, the application scenarios of Plattform Industrie 4.0 were designed to illustrate, how digitalization may impact the organization and management of the entire *value chain* along the lifecycle of products.

Therefore it is important to develop a common understanding of the core value chains in manufacturing industries. AG2 of Plattform Industrie 4.0 has chosen the findings of Special Committee 7.21 of VDI/VDE-GMA as a basis, for details see [8]. From a technical point of view, there are four main value-added processes in manufacturing industries:

- Product lifecycle management, i.e. the product design
- Production system lifecycle management, i.e. the production planning and production engineering
- Supply chain management, i.e. the production execution
- Services

These value-added processes will be executed by the manufacturing companies in cooperation with its supplier, see Figure 2. This may even mean that a value-added process is completely outsourced, e.g. the production system planning and engineering is executed by an EPC² company or the production execution is done by a manufacturing service provider.

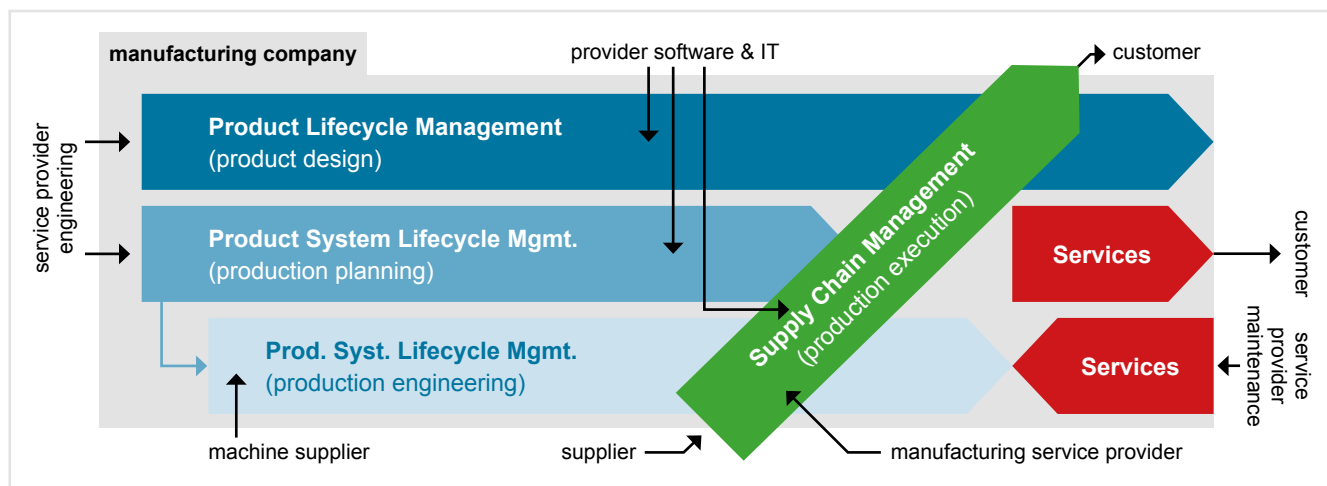


Figure 2: Core value-added processes in manufacturing industries
Source: Plattform Industrie 4.0 (based on GMA 7.21)

To guarantee a specific quality of the application scenarios AG2 has defined a common structure for the description. The long versions of the application scenarios follow the following structure:

- **Theme and motivation:** This section provides a summary of the application scenario.

- **Involved stakeholder and addressed value chain resp. value network:** Typically various stakeholder are involved in an application scenario. As a lessons learnt it is a good practice to start a discussion about a new application scenario in defining the involved stakeholder and their (future) relations in a value network.

² Engineering, Procurement, Construction

- **Driver and disruptive potential:** This section motivates the probability of the occurrence of the application scenario and describes the related effects in form of possible disruptions.
- **Benefits and challenges:** Typically the benefits are described from the perspective of the customer of the application scenarios and the challenges are described from the perspective of the other stakeholders which want to make the application scenario happen.
- **Effects on value creation chains:** This section summarizes the contribution of the application scenario to a new level of organization and management of the entire value chain along the lifecycle of products.
- **Relations to the various working groups of Plattform Industrie 4.0**

Each application scenario has an owner, who is responsible for setup, scope, and maintenance of the application scenario. This may explain why the level of scope is varying between the various application scenarios. Nevertheless AG2 of Plattform Industrie 4.0 guided the owner so that it is possible to separate the different application scenarios from each other and to address each core value-added process of Figure 2 with at least one application scenario.

The actual list of application scenarios does not claim to be complete. AG2 of Plattform Industrie 4.0 is open to include additional application scenario and has defined a process how to extend the list of current application scenarios. Nevertheless the effort to create a new application scenario should not be underestimated and typically requires profound discussions and the willingness to integrate complementary views.

It is also important to mention that the application scenarios do not elaborate a solution, but describe a challenge of a manufacturing company, maps this challenge to a business context and the associated value chains and sketches business pain points as basis for benefit discussions. A major objective was to provide a vision for the manufacturing industry in Germany. Thus, these challenges address mainly future topics and less daily problems of manufacturing companies. As a consequence the application scenarios are not designed to derive right away “quick wins” for a specific manufacturing company.

Scenarios of Alliance Industrie du Futur

A key objective of Alliance Industrie du Futur has been to develop approaches and mediate digitalization projects for each target group of enterprises, from large multinational industrial players to the smallest companies. As a basis for this approach a framework called “competitiveness drivers”

has been applied. Figure 3 shows the six core competitiveness drivers, representing the different transformational challenges that the “New Economy” is imposing on industry and the different impact of digitalization:



Figure 3: Competitiveness driver typology (drivers 1 to 6)
Source: Alliance Industrie du Futur

- **Connected Devices and Industrial Internet of Things:** By connecting together through secure industrial networks the production equipment, autonomous sensors, and products being manufactured, companies can reach better synchronization, adapt quickly, and feed big data analysis for instance for continuous improvement.
- **Advanced Production Technologies:** By adopting new high-tech and sustainable processes and materials, such as high-performance steel, bio-sourced materials, additive fabrication, or multi-function robotic equipment, companies can reinforce their capability to adapt quickly.
- **New Human-Machine Collaboration Approaches:** By automating repetitive and dangerous tasks, by empowering employees with digital tools to monitor and optimize industrial operations, and by regularly training them, companies can create highly adaptable organizations that focus on value creation.
- **Driven and Optimized Lines and Factories:** By connecting production units, lines, and plants together as a production network, far less siloed than today,

and constantly re-designed/re-optimized using digital technologies, companies can create fluid and flexible logistics and production systems and introduce new products to the market faster.

- **Integrated Customer Supplier Relation:** By connecting with suppliers and partners, and inviting customers in their design and manufacturing processes, companies can collectively strengthen and adapt the value chains to lead market and technology evolutions.
- **New Social and Business Models:** By providing customers with mobile interfaces to order any service right on time and interact closely with brands, and by developing better social and environmental practices, companies can reduce and automate bureaucratic and inflated intermediation layers, and respond to customers expectations for a more sustainable type of industry.

The first six competitiveness drivers as shown in Figure 3 can be arranged in the form of a layer model as shown in Figure 4.

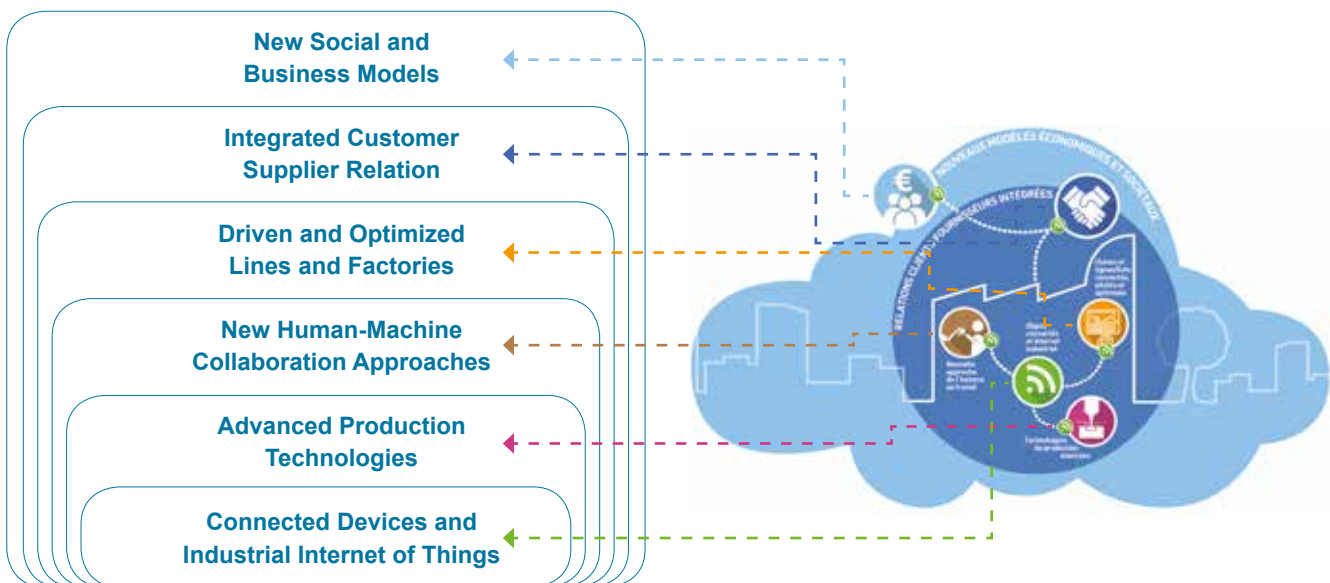


Figure 4: The 6 competitiveness drivers to stay in the race

Inside the framework of these competitiveness drivers, Alliance Industrie du Futur described first the challenges and opportunities associated. A first version of this work was published in the pages 14 to 57 of the “Guide Pratique de l’Usine du Futur”, see [4], especially dedicated to the small and medium enterprises of mechanical industry. The subsequent chapters of this guide present 28 “Fiche thématique” that we call “Improvement Scenarios”. They detail specific transformations of the industry and have a similar structure as the Industrie 4.0 application scenarios, although they are more solution oriented. An improvement scenario can be applied in several application scenarios:

- Description / Definition
- Specific Challenges & Opportunities
- Keys to Success
- Maturity of the Solutions
- Illustrations (Examples of Solutions)
- Useful Links to Resources, Professional Associations and Standards

A new version of the challenges and opportunities and additional improvement scenarios will be part of the second version of the guide, see [9], yet unpublished, and is based on the seven technology roadmaps currently in development

by the Alliance Industrie du Futur WG “Future Technology Offer Development”.

In the second part of 2016, reviewing a first version of the application scenarios of Plattform Industrie 4.0, Alliance Industrie du Futur decided to provide feedback based on its own challenges and improvement scenarios to the appli-

cation scenarios of Plattform Industrie 4.0. A first feedback has been shared with Industrie 4.0 Plattform in October 2016, and is the subject of following section. One objective was to achieve by combining the improvement scenarios of Alliance Industrie du Futur with the application scenarios of Plattform Industrie 4.0 the broadest possible coverage with respect to all layers as shown in Figure 4.

Common List of Scenarios

Plattform Industrie 4.0 and Alliance Industrie du Futur developed a common structure to explain their complementary approaches in a common picture, see Figure 5:

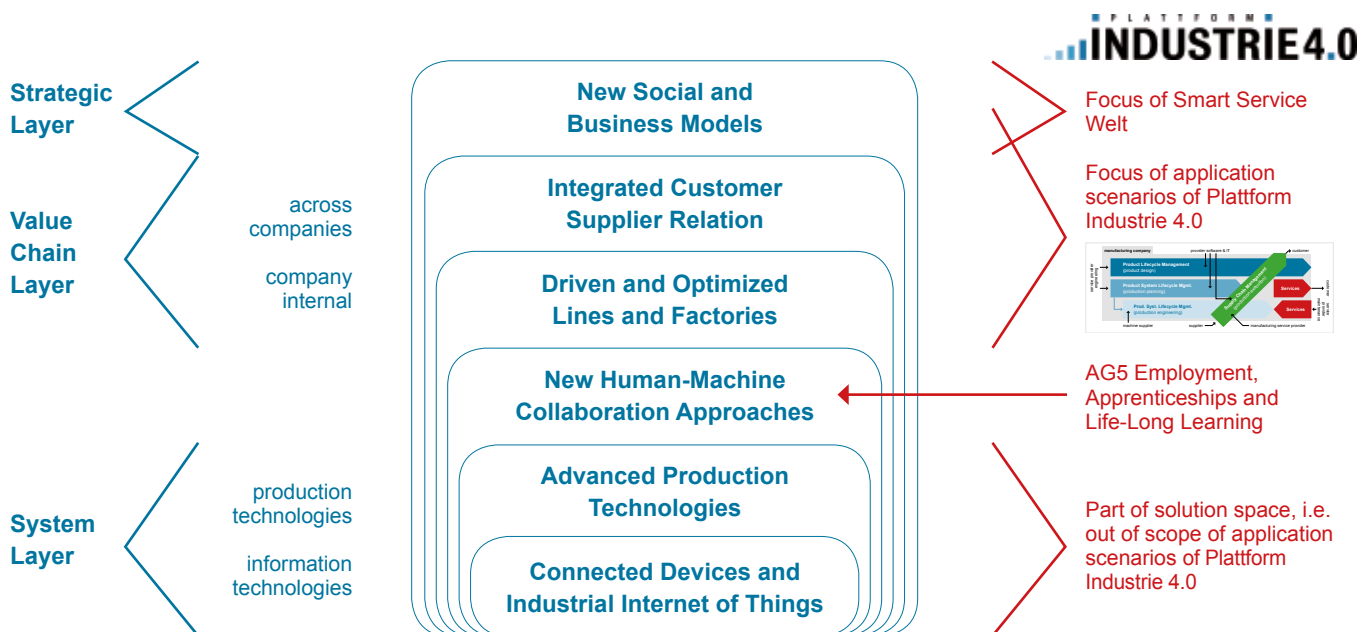


Figure 5: Common structure of Alliance Industrie du Futur and Plattform Industrie 4.0

Core of the picture are the six competitiveness drivers according to Figure 4. As illustrated in the left part of Figure 5 these drivers can be mapped in a direct way to the layers according to Figure 1. The right side of Figure 5 illustrates the link of the activities of Plattform Industrie 4.0 (resp. Smart Service Welt) to these drivers:

- As already emphasized the application scenarios of Plattform Industrie 4.0 focus on the value chain layer. The application scenario “HTI – Human-Technology-Interaction in the Production” occupies a special role as it can be associated to the driver “New Human-Machine Collaboration Approaches” as well.
- As the application scenarios of Plattform Industrie 4.0 do not describe a solution but a problem stated as a challenge of manufacturing industries, there is only an indirect impact of the application scenarios to the system layer.
- Even the business layer is not addressed directly by the application scenarios of Plattform Industrie 4.0, but a special aspect of the business layer, namely the design and consequences of a platform economy, is addressed by the future project “Smart Service Welt”, see [10].

Overview of Application Scenarios of Plattform Industrie 4.0

Figure 6 shows an overview of the application scenarios of Plattform Industrie 4.0, more details can be found in [2] and [3].

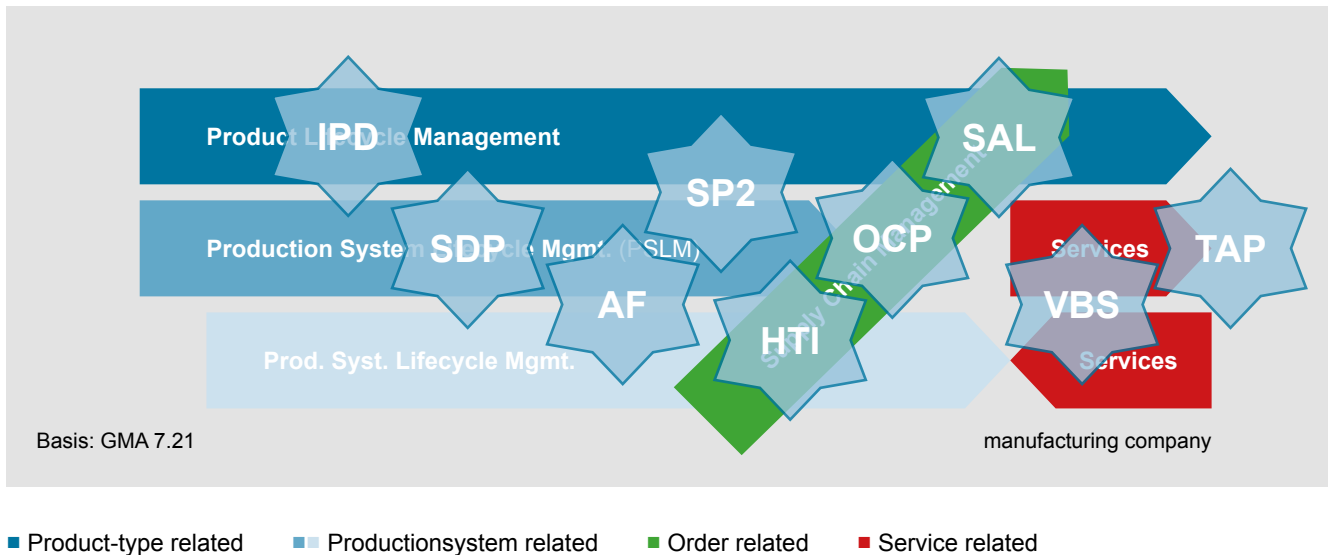


Figure 6: Overview of the application scenarios of Plattform Industrie 4.0

- **OCP – Order-Controlled Production:** This application scenario focuses on an order and describes how the necessary production resources are compiled and scheduled dynamically for the order.
- **AF – Adaptable Factory:** This application scenario focuses on a production resource and describes how this can be designed with respect to adaptability and how this impacts the supplier of production resource, the system integrator, and the operator of a plant.
- **SAL – Self Organizing and Adaptive Logistics:** This application scenario is closely linked to the application scenario OCP, but addresses the entire inter- and intra-logistics value chains.
- **VBS – Value Based Services:** This application scenario describes the design of service value networks, if product and/or process information is provided based on an IT platform.
- **TAP – Transparency and Adaptability of Delivered Products:** This application scenario focuses on a product and describes the design of transparency and adaptability of delivered products based on an IT platform.
- **HTI – Human-Technology-Interaction in the Production:** This application scenario describes future support of an operator in the production based on new technologies.
- **SP2 – Smart Product Development for Smart Production:** This application scenario describes collaborative product engineering, starting with product requirements and designing seamless engineering workflows to deliver the necessary information to production and service.
- **IPD – Innovative Product Development:** This application scenario describes new methods and processes in product development with focus on the early phases of a product.
- **SDP – Seamless and Dynamic Plant Engineering:** This application scenario describes that in an initial engineering process for the construction of a plant, an integrating plant model is created, which is then maintained over the full life of the realized plant in permanent interweaved processes between engineering, operation and service of the plant.

Overview of Improvement Scenarios of Alliance Industrie du Futur

Figure 7 shows an overview of the improvement scenarios of Alliance Industrie du Futur, as published in December 2015 in [4]. As already mentioned a new version of these improvement scenarios will be published in 2017 in [9].

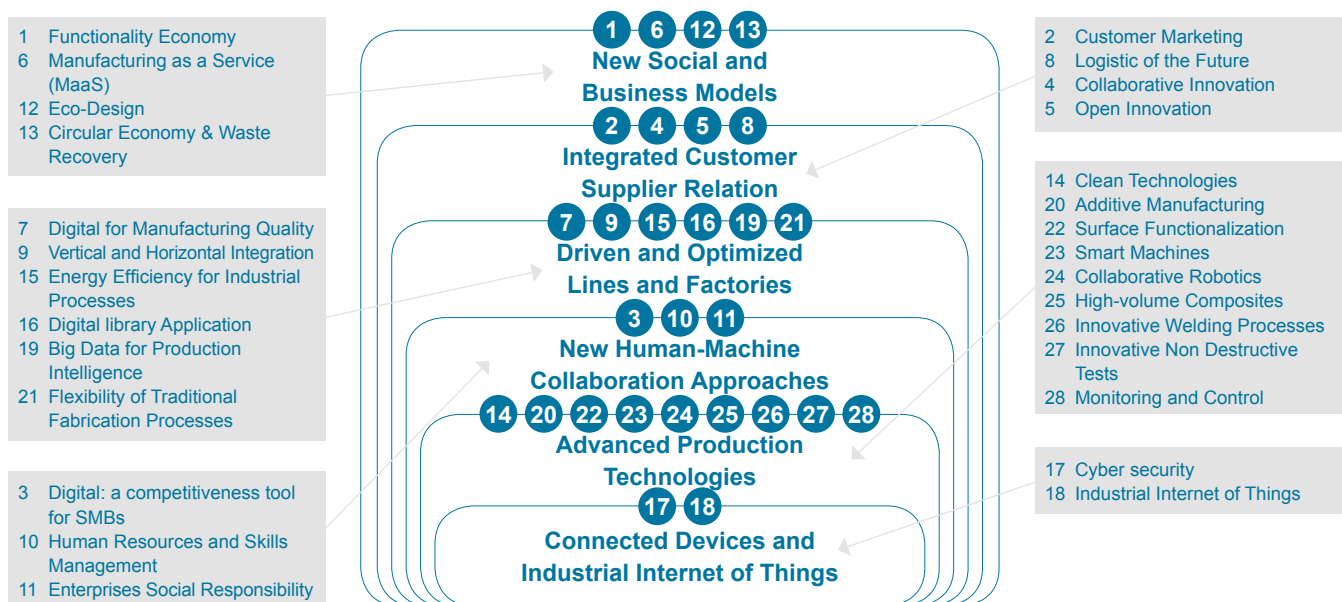


Figure 7: Overview of the improvement scenarios of Alliance Industrie du Futur

As a first remark, eleven improvement scenarios are mapped with the lowest two layers of the drivers, and emphasize improvement opportunities that should be seized by any industrial small and medium business.

- Connecting (18) and securing (17) industrial equipment to feed above layers with real-time data: This data should be leveraged to streamline transport, energy, and resources, or track and optimize material flow and energy based on optimization of production lines in a virtual world.
- Using new materials and production processes and automating existing processes to increase further competitiveness: New material and production topics include clean technologies (14), metal powders for additive printing (20), innovative coatings (22), high-volume composites (25), innovative welding (26), non-destructive test (27) and control processes (28). Automation topics include smart machines (23) and collaborative robotics (24).

Thirteen other improvement scenarios are mapped with the above three layers and provide examples of transformation toward new human-centric (3, 10, 11) and agile organizations (7, 9, 15, 16, 19, 21), integrated logistics (8) and collaborative innovation (4, 5).

Summary and Recommendation

Figure 8 summarizes the common list of scenarios of Plattform Industrie 4.0 and Alliance Industrie du Futur.

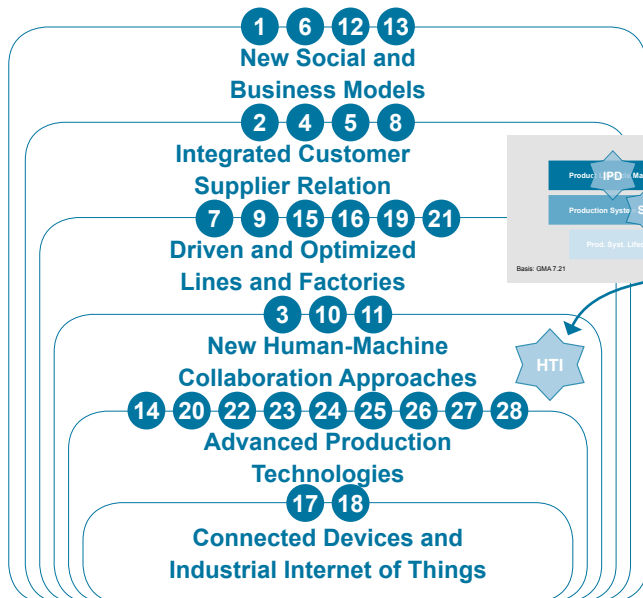


Figure 8: Common list of scenarios

In order to address a user with a clear message, the improvement scenarios and the competitiveness driver of Alliance Industrie du Futur can mutually benefit to and from the existing application scenarios of Plattform Industrie 4.0. In this way, additional application scenarios could be developed by Alliance Industrie du Futur according to the same structure and quality criteria as the already existing application scenarios of Plattform Industrie 4.0.

In addition, the competitiveness driver typology of Alliance Industrie du Futur could also be applied to the existing application scenarios. The application scenarios of Plattform Industrie 4.0 primarily address the value-chain layer, but they also have an impact on other competitiveness drivers. For this purpose, however, a more detailed and generally comprehensible description of the competitive driver will be necessary.

Benefits and Usage of Scenarios

The application scenarios of Plattform Industrie 4.0 and Alliance Industrie du Futur are a sound basis to explain the complex subject of digitalization in manufacturing industries in a clear and comprehensible way based on representative examples. Digitalization requires different technical disciplines (e.g. mechanical, electrical, and software engineering) at different level to work together and to understand their different vocabularies, positions, and approaches, thereby considering the multi-level strategy in an integrated view.

The scenarios are an enabler for those discussions and describe the future of manufacturing in Germany and France.

Plattform Industrie 4.0 and Alliance Industrie du Futur plan to synchronize the various working groups based on the common list of scenarios. This will also help to consolidate the work that has already been done.

Based on this foundation the scenarios have been and will be used in the following various contexts.

Communication of existing implementations

The first benefit of joint scenarios is to simplify communication to small and large enterprises about possible transformations that require relatively mature technology and processes and that are possible today.

Plattform Industrie 4.0 and Alliance Industrie du Futur have collected numerous existing implementations and have visualized them on a map of Germany, see [11], resp. France, see [12]. On Hannover Fair 2016 bitkom published a paper with an assessment of status quo and perspectives of implementation of Industrie 4.0, see [13]. This assessment mapped the implementations on the map of Germany to a draft version of the application scenarios of Plattform Indust-

rie 4.0 and various sectors in manufacturing industries. As a kind of next step there has been initiated a project of the academic advisory board of Plattform Industrie 4.0, which will do a transparent mapping of the implementations on the map of Germany to the application scenarios of Plattform Industrie 4.0. This mapping will illustrate which implementation pays in which application scenario and will thereby give orientation how (aspects of) an application scenario could be implemented.

AG2 of Plattform Industrie 4.0 will initiate workshop-series "14.0-Szenarien@Mittelstand" in coordination with "Mittelstand4.0-Kompetenzzentren" in Germany and the asso-

ciations bitkom, VDMA, and ZVEI. The objective of this workshop-series is to establish a way how the application scenarios of Plattform Industrie 4.0 can be communicated to especially the small and medium companies and to get a feedback of these potential users in order to improve the existing application scenarios. Special emphasis will be placed on the lines of reasoning in terms of customer benefits.

Alliance Industrie du Futur plans similarly to communicate and explain to companies of all sizes in France the objectives and advantages of available implementations based on the common list of scenarios. Alliance Industrie du Futur is creating a second edition of its Guide Pratique de l'Industrie du Futur, see [9], that will list technologies and methods to help companies willing to capitalize on the 4th industrial revolution. This guide will be based on the common list of scenarios.

Orientation to Research Programs

Joint scenarios will also provide benefits to orient areas of research and technologies that play a role in key scenarios, but still have a lower maturity.

AG2 of Plattform Industrie 4.0 published a research roadmap on Hannover Fair 2015, see [18]. There was a challenge to communicate this research roadmap because of its complexity. Having developed the application scenarios there was a lever to focus the research roadmap to the most important research topics. This was executed together with academic advisory board of Plattform Industrie 4.0 and published in [2]. In an additional step AG2 and the academic advisory board of Plattform Industrie 4.0 analyzed the

In Germany and France testbeds are created, in which companies and their cooperation partners can execute precompetitive trials and validate specific scenarios.

In Germany one example for a testbed is the so-called Industrie 4.0 Demonstrator, see [14] and [15]. This demonstrator illustrates (aspects of) selected application scenarios of Plattform Industrie 4.0, namely AF, VBS, and SDP. This demonstrator has been used also to explain various technical concepts, e.g. assets, RAMI 4.0, and Industrie 4.0 component, see [16]. It is planned that this demonstrator will be extended to validate the results of the openAAS³ project also. This will be demonstrated on Hannover Fair 2017 in form of a common testbed of Labs Network Industrie 4.0, Plattform Industrie 4.0, and Industrial Internet Consortium (IIC).

application scenarios in order to identify additional research topics not listed in the previous research roadmap. The result is a research agenda published in [19].

The working group of Alliance Industrie du Futur on “Future Technology Offer Development” is currently finalizing a research and development roadmap on seven selected technologies: additive manufacturing, digitalization, collaborative robotics, augmented reality, monitoring and quality control, composite and new materials assembly, automation, and energy efficiency, see [22]. Challenges and opportunities of each roadmap will be mapped with the different application scenarios.

Orientation to Standards Development and Training Programs

Joint scenario will also serve as guideline to development of standards and training programs.

In France the various sectors of manufacturing industries are now working together inside the Alliance Industrie du Futur. They plan to use the common list of scenarios for identification and clarification of the requirements of each industrial sector, and use it as an input to the next version of the standardization roadmap developed by Alliance Industrie du Futur.

In June 2016 a workshop of all working groups was organized to synchronize the various activities of Plattform Industrie 4.0. A main concept of this workshop was to structure the discussion based on selected application scenarios.

In France and Germany there is also a need to help education to assimilate the new concepts developed by Alliance Industrie du Futur and Plattform Industrie 4.0. In France it

is believed that most of the jobs resulting from the digital revolution do not exist yet. The common list of scenarios will help to define these new job profiles.

There are various other approaches all over the world to illustrate and shape the digitalization based on use cases. AG2 of Plattform Industrie 4.0 has analyzed some of these approaches, namely the use-cases of Smart Service Welt, ZVEI, Dr. Tauchnitz, and BCG and the testbeds of the IIC. Details about the relation of these use cases to the application scenarios of Plattform Industrie 4.0 are described in [3].

Plattform Industrie 4.0 has a cooperation agreement with IIC. AG2 proposed to use the application scenario VBS – Value-based service as a joint “scenario” of Plattform Industrie 4.0 and IIC to guide the discussion in JTG1: Products, Production Systems and IIoT Solutions – the lifecycle perspective, see [20]. These discussions are ongoing.

³ openAAS: open Asset Administration Shell, see [17]

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