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Guidance
"Use Cases and Applications"

Sub-Working Group Industrie 4.0/Intelligent Manufacturing of the Sino-German Standardisation Cooperation Commission

A joint project of

National Intelligent Manufacturing Standardisation Administration Group (IMSG) – Standardization Council Industrie 4.0 (SCI4.0)

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Context and Objectives:

This joint report is a result of the cooperation line “Use Cases and Applications” in the context of the Sub-Working Group Industrie 4.0/Intelligent Manufacturing of the SGSCC (Sino-German Standardiza-tion Cooperation Committee). The overall objectives of the Sub-Working Group are the discussion of standardization aspects in the focus of Germany and China to intensify and deepen Sino-German cooperation by defining concrete issues and steps to be taken.

The objective of the cooperation line “Use Cases and Applications” is to analyze business strategies and customer needs in the manufacturing industries manifested by concrete customer-projects. The findings will be compiled into descriptions – so called use cases – based on well-known best practices, e.g. the Industrial Internet Reference Architecture (IIRA), see [1]. These use cases facilitate a common understanding of markets, trends, drivers, concepts and solutions and then serve as basis to articulate requirements for standardization aspects.

Overall Drivers and Restrictions

We observe that our environment is subject of significant changes with respect to standardization. In the past, standardization often addressed established technologies, whereas in the context of digitization topics are discussed that often have not yet been realized. Additionally, in information technology standardization often is supported by industry groups organized in forums and consortia, whereas traditional engineering disciplines often use for market opening the established ways of consensus-based standardization.

This results in the challenge that we must change our perspective from a technical one and discuss customer problems and benefits. Thus, we must follow a holistic system engineering approach separating the levels strategy, processes, and technology. We must separate between requirements and solutions and must consider the needs and interests of the different stakeholders of the various industries.

There also are boundary conditions. From a systems perspective we are only a part of a larger overall system. From a process perspective we must admit that we can define a framework, but we can only fill this framework with some few selected examples.
The consequences are that our collaboration has to be driven by practical examples. Collaboration is a key element and we must identify suitable partners. Fortunately, the theoretical foundation already exists so that we “only” must apply it now.

History

There are many concrete projects in the context of Industrie 4.0/Intelligent Manufacturing, but the clustering of these projects is challenging. To structure the topic digitalization of manufacturing industries Plattform Industrie 4.0 had developed so-called application scenarios and China Intelligent Manufacturing had identified five kinds of intelligent manufacturing modes.

Application Scenarios of Plattform Industrie 4.0

The application scenarios, see Figure 1 and for details [2], describe how German industry perceives its digital future. The core of these application scenarios is to demonstrate based on examples how value-added processes in the manufacturing industry could be managed and organized in a better way with the help of digitization technologies. In addition, they show which innovations – in technology, work organization, law and society – German industry wants to utilize on its way to this digital future. However, the application scenarios also indicate areas posing major challenges and questions, for example standards, research, security, legal framework and labor, and thereby provide a common framework for the Plattform Industrie 4.0 Working Groups.

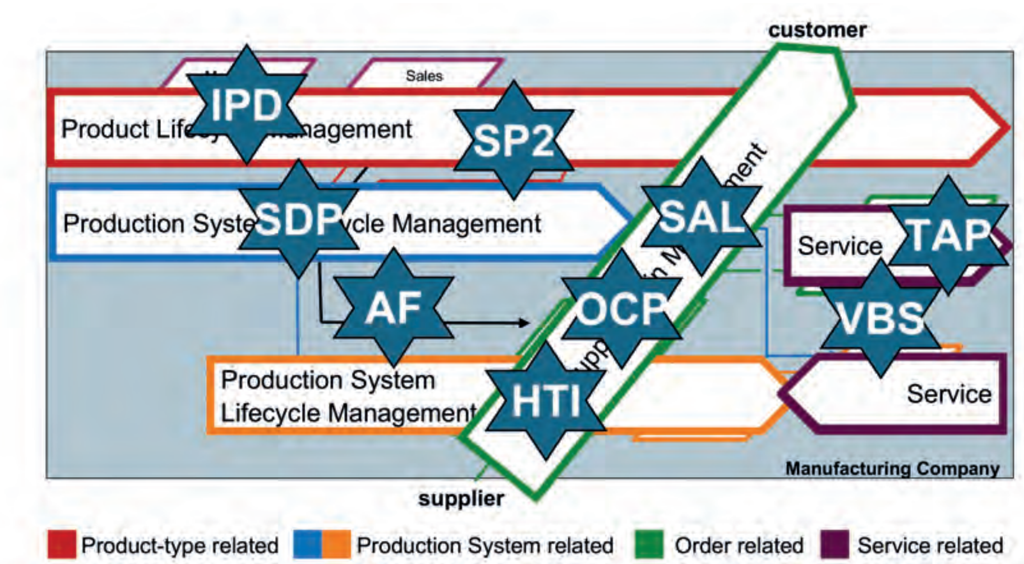

Figure 1: Application scenarios of Plattform Industrie 4.0

Intelligent Manufacturing Modes Identified by China Intelligent Manufacturing

According to China Intelligent Manufacturing Development Program (2016-2020) and China Intelligent Manufacturing Engineering Implementation Guide (2016-2020), five intelligent manufacturing modes, see Figure 2, were first identified and focused on to encourage new mode innovation and carry out intelligent manufacturing pilot demonstration.

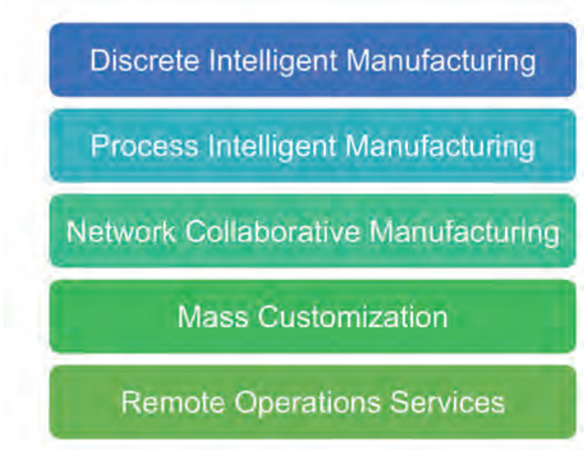

Figure 2: Five first identified intelligent manufacturing modes

The five intelligent manufacturing modes can be characterized as follows:

Discrete Intelligent Manufacturing
- The digital models have been established
- Achieve integrated management of the product data
- Intelligent sensing and control, intelligent detection and assembly shall be achieved
- Collect production site data such as production schedule, on-site operation, quality
- Efficient collaboration and integration between systems, such as PLM (Product Lifecycle Management), ERP (Enterprise Resource Planning), MES (Manufacturing Execution System) and field data acquisition and analysis system

Process Intelligent Manufacturing
- The digital models have been established
- Full-process monitoring and high integration are achieved
- Model-based control
- Dynamic optimization of the production process

Network Collaborative Manufacturing
- Collaborative cloud platform
- Integration of innovative resources and design capabilities
- Inter-enterprise management system and service support system
- Establishment of product traceability system
- Dynamic analysis of manufacturing resources

Mass Customization
- Module-based design
- Personalized product database
- Collaboration between planning and scheduling, flexible @ manufacturing
- High-speed and low-cost supply

Remote operations services
- Open data interfaces configured
- Data collection and uploading of the data
- Integration between software, such as PLM (product lifecycle management), CRM (customer relationship management)
- Corresponding expert library and expert consulting system

Common Understanding on Use Cases

Thus, Industrie 4.0/Intelligent Manufacturing is a multifaceted, complex topic that must consider the perspectives of many different stakeholders. Furthermore, the heterogeneity of manufacturing industries does not allow a "one-size-fits-all" approach. From the understanding of authors, the application scenarios of Plattform Industrie 4.0 and the concept of

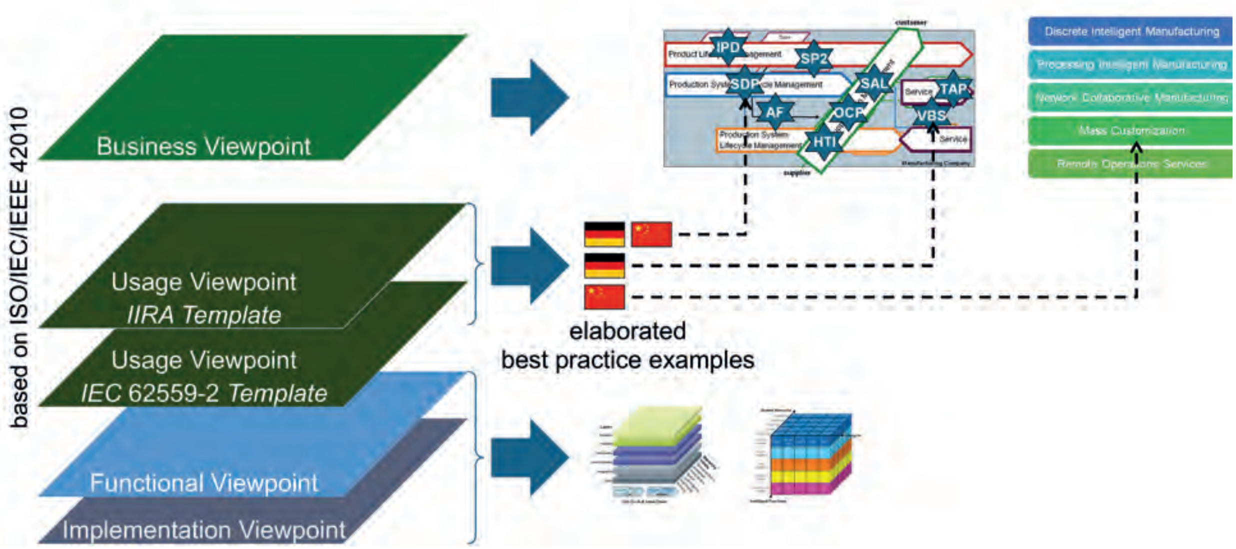

Figure 3: Common understanding on use cases

intelligent manufacturing modes are similar, nevertheless, it was a challenge to develop a common understanding on use cases.

We came to the conclusion that we need a rigid description of use cases. We did not want to develop a new approach but to apply an established methodology. Therefore, we decided to use the usage viewpoint of the Industrial Internet Reference Architecture (IIRA), see [1]. Together we have developed the overall understanding shown in Figure 3, which was also integrated into the German Standardization Roadmap Industrie 4.0, see [3]. This framework is generic and not limited to the cooperation between Germany and China.
Figure 3 shows on the left side the structure of the Industrial Internet Reference Architecture (IIRA) based on the international standard ISO/IEC/IEEE 42010. The basic idea is based on the proven practice to describe a system from different perspectives in the form of views. IIRA proposes four concrete views and for each view a description methodology in the form of a viewpoint.

- Both the application scenarios of the Platform Industrie 4.0 and the Intelligent Manufacturing Modes address primarily aspects that are elaborated in a business view according to IIRA. Here typically a so-called business scenario is described. Following a business model logic (i.e. business canvas), the business stakeholders are identified, and their relationships are described in a value-added network.

- According to Wikipedia a use case is a list of actions or event steps that define the interaction between a role (or actor) and a system to achieve a goal. The actor can be a human or another external system. We agree with this widely accepted definition of use case. The IIRA usage viewpoint also aims to describe use cases in this sense. Therefore, we have agreed to prepare concrete use case descriptions according to the usage viewpoint of IIRA.

- In addition to the descriptors suggested in IIRA's usage viewpoint, there are other suggestions for describing use cases, such as the template of IEC 62559-2. This template required a more detailed description than the IIRA's usage viewpoint. Our estimate is that you can describe use cases according to IIRA on about 20 pages, while a description according to IEC 62559-2 requires at least 50 pages. Regarding the resources available to us in the context of the "Use Cases and Applications" cooperation line, we decided not to use the IEC 62559-2 template.

- To illustrate the relation of the cooperation line "Use Cases and Applications" to other cooperation lines Figure 3 also indicates that discussions with respect to the alignment of RAMI4.0 and IMSA address the functional and implementation viewpoints.

We decided to validate our approach by creating such descriptions for concrete use cases. To work efficiently, we have agreed to develop the individual use case description independently, but to review each other in detail. The focus of elaboration is on the underlying general requirements and principles, but not the considered concrete implementation projects.

Use Case Template

The usage viewpoint proposed by the Industrial Internet Consortium comprises the following concepts, for details see [1]:

- The basic unit of work is a task[1]. A task is **carried**[2] out by a party assuming a role.

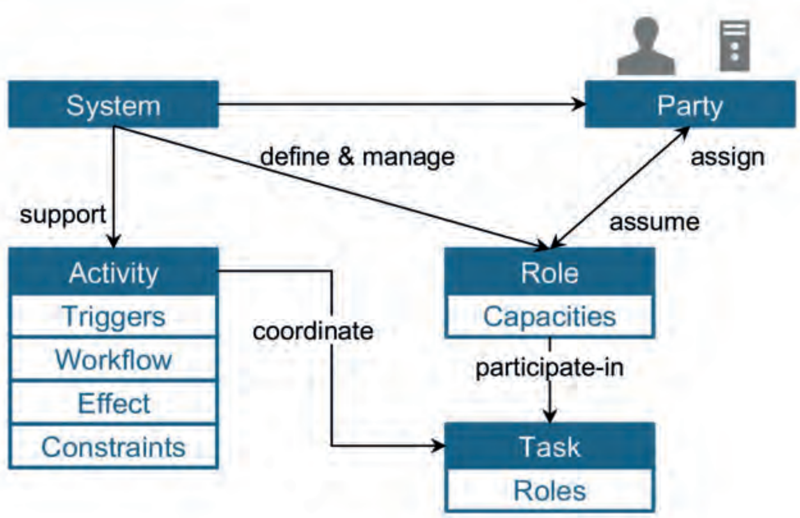

Figure 4: Overview of Usage Viewpoint (according to [1])

[1] The tasks according to [1] include a Functional Map referring to the Functional Viewpoint and an Implementation Map to the implementation Viewpoint. Since we are focusing on the Usage Viewpoint only, we do not consider Functional resp. Implementation Maps.

[2] The bold marked terms refine and illustrate the single term "participate-in" in Figure 4.

- A role is a set of capacities assumed by an entity to initiate and participate in the **execution** of, or consume the outcome of, some tasks or functions in a system as required by an activity. Roles are assumed by parties.

- A party is an agent, human or automated, that has autonomy, interest and responsibility in the **execution** of tasks. A party executes a task by assuming a role that has the right capacities for the **execution** of the task. A party may assume more than one role, and a role may be fulfilled by more than one party[3].

- An activity is a specified coordination of tasks required to realize a well-defined usage or process of a system. An activity has the following elements:

    o A trigger is one or more condition(s) under which the activity is initiated.

    o A workflow consists of a sequential, parallel, conditional, iterative organization of tasks.

    o An effect is the difference in the state of the system after successful completion of an activity.

    o Constraints are system characteristics that must be preserved during execution and after the new state is achieved.

For this reason, our use case descriptions follow the following chapter structure:

- System under consideration: This chapter explains the system under consideration and its super-ordinate structure.

- Roles: This chapter describes the different roles that interact with the system under consideration.

- Activities: This chapter describes the individual activities, with explaining for each action the trigger conditions, a workflow of individual tasks, the effects achieved, the constraints to be taken into account, and any other background information. In addition, some of these activities are also graphically illustrated.

Best Practice Examples

We described three concrete use cases following the described guiding principles, prepared them in the form of best practice examples and made them available to the general community in both English and Chinese:

- The so-called GER use case is a description of the usage view of the application scenario "Value-Based Service", see [4]. This work has been published at Hannover Fair 2018, see [5].

- The so-called CN use case is a description of "Mass Customization" of Intelligent Manufacturing Modes. This work has been published in April 2019, see [6].

- The so-called GER-CN use case describes the use case "Equipment Lifecycle Management" in the context of the Baowu and Siemens Go to Industry 4.0 (BSG2I4.0) project. This is an exemplification of the application scenario "Seamless and Dynamic Engineering of Plants", see [7]. This work has been published in May 2019, see [8].

Conclusion and Outlook

By working together on the three examples, we have demonstrated the viability of our approach. We think that the descriptions are clear, balanced and generally understandable and therefore promote our common understanding.

We will continue to exchange experiences on this topic. Specifically, there is currently a discussion on the usage view of the asset administration shell. In addition, activities were started to create a usage view for the application scenario "Seamless and Dynamic Engineering of Plants".

Nevertheless, through our basic work, we have now established a common understanding of the topic of use cases and finalize our basic work with this guidance report. Our expectation is that this framework is now promoted and applied, especially by the German and Chinese side.

For a next step, we suggest analyzing business scenarios in more detail and we plan to prepare concrete examples in the form of business views.

[3] Parties strongly depend on the business setup and the internal organization of the companies involved. We do not address the association of parties in this paper, because we do not discuss a business viewpoint here.

References

[1] The Industrial Internet Reference Architecture Technical Report, https://www.iiconsortium.org/IIRA.htm

[2] Aspects of the Research Roadmap in Application Scenarios, http://www.plattform-i40.de/I40/Redaktion/EN/Downloads/Publikation/aspects-of-the-research-roadmap.html"

[3] German Standardization Roadmap Industrie 4.0, Version 3, https://www.din.de/blob/65354/57218767bd6da1927b181b-9f2a0d5b39/roadmap-i4-0-e-data.pdf

[4] Proposal for a joint "scenario" of Plattform Industrie 4.0 and IIC, http://www.plattform-i40.de/I40/Redaktion/DE/Downloads/Publikation/joint-scenario.html

[5] Usage Viewpoint of Application Scenario Value-Based Service, https://www.plattform-i40.de/I40/Redaktion/DE/Downloads/Publikation/hm-2018-usage-viewpoint.pdf?__blob=publicationFile&v=8 (English)

[6] Usage Viewpoint of Mass Customization, http://s-g.imsg.org.cn/index/4/9.html (English)

[7] Application Scenario SDP – Seamless and Dynamic Engineering of Plants, VDI-Statusreport, https://www.vdi.de/presse/publikationen/publikationen-details/pubid/vdi-status-report-seamless-and-dynamic-engineering-of-plants/

[8] Use Case "Equipment Lifecycle Management"

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