bitkom

Position Paper

Recommendations for standardisation in the context of Industry 4.0

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Bitkom represents more than 2,400 companies in the digital sector, including 1,600 direct members. With more than 700,000 employees, our members generate a domestic turnover of 140 billion Euros a year, exporting high-tech goods and services worth another 50 billion Euros. Comprising 1,000 small and medium-sized businesses as well as 300 start-ups and nearly all global players, Bitkom' members offer a wide range of software technologies, IT-services, and telecommunications or internet services. They produce hardware and consumer electronics or operate in the sectors of digital media and the network industry. 78 percent of the companies' head-quarters are located in Germany with an additional amount of 9 percent in other countries of the EU and 9 percent in the USA as well as 4 percent in other regions. Bitkom supports an innovative economic policy by focussing the modernization of the education sector and a future-oriented network policy.

Federal Association
for Information Technology,
Telecommunications and
New Media

Wolfgang Dorst
Head of Industry 4.0
P +49 30 27576-243
w.dorst@bitkom.org

Christian Herzog
Head of Technical Regulations & IT-Infrastructure
P +49 30 27576-270
c.herzog@bitkom.org

Albrechtstraße 10
10117 Berlin
Germany

President
Thorsten Dirks

CEO
Dr. Bernhard Rohleder

1 Preface

Industry 4.0 is a vision of the future, which has taken on a more precise definition and structure since 2012. The results of the Industry 4.0 platform to date form a good basis for further work. Standards are fundamental elements of this.

This paper contains 17 recommendations for further definition of the standardisation process for Industry 4.0.

2 Introduction

Industry 4.0 is a key issue for the future of German and European industry and society. Industry 4.0 marks the next stage in the digital transformation of processes, services and interaction on all levels, from production and manufacture to the relationship between provider and customer.

Bitkom recognised the central significance of Industry 4.0 for Germany early on and, together with the associations VDMA and ZVEI, established the Industry 4.0 platform and continues to run it. Several working groups involved with the Industry 4.0 platform have performed pioneering work in various fields connected with it. This includes technical work, for example development of the Reference Architecture Model Industry 4.0 (RAMI 4.0), which provides a framework for concrete implementation and application. DIN has recently initiated a standardisation procedure, and is expected to publish RAMI 4.0 as DIN SPEC 91345 at the end of 2015.

Bitkom welcomes the transfer of the Industry 4.0 platform to a ministerial structure, which includes political levels and strives to achieve a broader dynamic for industrial policy. This is also reflected by the Digital Agenda, which the German federal government presented last year. Bitkom actively supports this approach. The results of the Industry 4.0 platform are freely available, and Bitkom is certain that they will form a good basis for further work.

Standards are a fundamental aspect of Industry 4.0 and of central importance for its implementation. Bitkom and members of Bitkom have actively contributed to the formulation of the Industry 4.0 Standardisation Roadmap presented by DIN and DKE, and are also working on revising and updating the roadmap. The standardisation roadmap is a ground-breaking contribution to connecting standardisation in the fields of information and communications technology (ICT), machine manufacture and automation.

Building on this work, in this paper Bitkom will set out several considerations and recommendations for further work in the field of standardisation for Industry 4.0, with the objective of promoting rapid progress in this field and, in the process, doing further targeted work on the basic technical requirements for the implementation and success of Industry 4.0.

3 Standardisation: Technology standards, and analysis and drafting methodology for Industry 4.0 systems

3.1 Broad range of standardisation activities

There will not be one single Industry 4.0 standard. Since Industry 4.0 is concerned with integrating technologies – some of which differ greatly – many different standards, as well as other products of standardisation, are required for its implementation.

There is no longer a consistent product specification using standards for a concept like Industry 4.0, but rather a combination of technologies oriented towards application scenarios, and therefore a combination of standards.

Besides standards, architectures and roadmaps, as well as 'use cases' have also proven to be an important supplementary tool for work on standardisation – especially where the structure of the necessary transformation processes is concerned. In this context, Bitkom supports the pioneering work on methodology and classification of use cases being carried out by DKE, particularly in the 'Smart Grid' field, and sees here a good basis for extending this to Industry 4.0. The DIN/DKE steering group is currently planning to set up a working group to study use cases for Industry 4.0.

Recommendation 1:
Make more use of the DIN/DKE Industry 4.0 steering group for strategy. The DIN/DKE steering group brings together all the relevant interested parties concerned with standardisation for Industry 4.0 in Germany. It should be more strategically orientated, identify coordination tasks, set objectives for standardisation and formulate accompanying measures.

Recommendation 2:
Continue work on use cases and consolidate use cases. Drawing up use cases is an important element in implementing Industry 4.0. Consolidating and structuring use cases along the value chain is an important next step for Industry 4.0, as shown in RAMI 4.0.

Recommendation 3:
Pay constant attention to analysis and drafting methodology for Industry 4.0 applications. Analysis and drafting methodology for Industry 4.0 must be specified, in addition to the technological foundations for securing the interoperability of Industry 4.0 applications. Using the business objectives (e.g. safety objectives) as a starting point, non-functional requirements in particular (e.g. data security, functional safety and reliability) must be taken into account during the drafting process for the relevant use cases.

The great majority of standards are not really specific to Industry 4.0; rather, they are technology standards and reference architectures/models for the Internet of Things and services that are also used for Industry 4.0. These standards and draft standards are adjusted to suit the specifics of industrial production for Industry 4.0. These are summarised in inventories and structured ('standards landscaping'), and set out in standardisation roadmaps.

The German Industry 4.0 Standardisation Roadmap has carried out an initial identification and listing of the relevant standards, and also extends and supplements them as required.

The Reference Architecture Model Industry 4.0 (RAMI 4.0) sets out and classifies the complex communication and interaction processes that are important for Industry 4.0. RAMI 4.0 is based on a streamlined but scalable service-oriented architecture, by means of which the various services for communicating between levels, process stages and value chains are implemented. This architecture model is the basis for structured development and implementation of solutions and systems during the digitalisation of industry. After being adopted as a DIN SPEC, it should also be introduced to international standardisation systems so that it can be applied globally.

Recommendation 4:
RAMI 4.0 is an architecture model which brings together the perspectives of three sectors: IT, automation technology and mechanical and plant engineering. It should form the standard for the digitalisation of industry and industrial value chains at an international level.

Standards and norms are successful if all interested groups can collaborate on drawing them up. In this respect, it is important to assemble technical expertise, in order to develop standards of high quality

3.2 Global standards for global business success

Numerous technical standards which are relevant for Industry 4.0 already exist, or exist as work in progress. These standards are fundamental drivers of innovation for Industry 4.0, as they enable the technologies necessary for Industry 4.0 to converge, and therefore determine innovation on the level of implementing the standards.

Relevant technology standards are created both in German, European and international standardisation committees and in international industrial organisations such as OASIS, IEEE, OMG or W3C. No significant loopholes have yet been identified in standardisation.

The market success of Industry 4.0 is strongly dependent on global implementation. Therefore, global standards are necessary. The continuing efforts of industry to promote such standards should be supported on the political level, in so much as the overall strategy for promoting Industry 4.0 should appropriately reflect and take into account global activities. Global standards should be given priority over national or regional standards.

Besides the actual standardisation activities in connection with Industry 4.0 in Germany, there is also activity in industrial associations and consortia, both in Germany and internationally. Examples of this are the findings of working groups in Bitkom, ZVEI, VDMA, VDE/VDI as well as the Industrial Internet Consortium (IIC), which is very active internationally. These activities focus on developing use cases and test scenarios, as well as architecture models and modules for specific application scenarios.

DIN has initiated a strategy group on Industry 4.0 (SAG Industry 4.0/smart manufacturing) at the ISO. Under the leadership of DIN, its objective is to organise the ISO's contribution and, in this way, to support a joint course of action, particularly with IEC and ITU-T. The strategy group focuses on the following tasks:

- Strategic and conceptional development of the Industry 4.0 issue at the ISO
- Identification of missing standards
- Drawing up implementation strategies and recommendations for Industry 4.0
- Coordination of standardisation activities on the international level
- Achieving early, cross-committee and cross-organisational coordination
- Working together with other organisations on national, European and international levels, in which particular value is placed on cooperation with IEC ITU-T.

The ISC classification or the easier-to-remember ICC could form the basis for a classified search system for standards and information on rejection, adjustments or additions, such as ISO 19439 and ISO 19440 (perceptions of layers), ISO 11354-1 (interoperability) and other standards.

Recommendation 5:
Carry out standardisation in open, consensus-based processes. Standards are successful if all interested groups can participate in drawing them up. In this respect, it is important to assemble technical expertise in order to develop high quality standards. This open standardisation process should be continued.

Recommendation 6:
Strive for global standards. Industry's efforts to promote such standards should be supported on the political level by including and considering global activities appropriately in the overall strategy for promoting Industry 4.0. Global standards should be given priority over national or regional standards.

Recommendation 7:
Avoid duplication of work. In striving to make Industry 4.0 a success, action should be focused. Many activities have already begun in the field of standardisation. Where any new activities are concerned, checks should always be made first to see what is already available or in progress, in order to avoid duplication or even competing activities.

3.3 Promoting implementation and practical testing of Industry 4.0 systems

An important extension of these standardisation activities is testing the technologies involved in actual implementations. Currently, there is no shortage of standards for Industry 4.0. However, it is important to profile the standards for Industry 4.0 requirements and create pilot projects with accompanying test environments for Industry 4.0 in Germany. Politicians' highest priority should be the promotion and use of pilot projects or cluster formation in the field of Industry 4.0. There have been excellent results with these in the fields of e-energy and Smart Grid. Further, pilot projects deliver findings regarding the necessary further development of standards, as well as regarding any loopholes in standardisation.

Furthermore, companies should be encouraged to present tested reference implementations and examples of best practice in their specialist areas and put these forward for discussion. The goal is to make optimal use of the knowledge available in Germany, in order to enable and accelerate progress towards digital fabrication in as many areas as possible.

Collaborative testing is an additional instrument for effectively testing technologies in connection with the realistic testing of standards, infrastructure and architecture. When standardising and developing software, plug tests and plug fests have demonstrated their value for exchange on a technical level and for active practical testing of interoperability and functionality. DIN/DKE should design and implement appropriate plug test and plug fest workshops in cooperation with other standardisation organisations.

Recommendation 8:
Give pilot projects and test environments priority over standardisation mandates. The promotion and use of pilot projects or cluster formation should have the highest priority in the Industry 4.0 sector. In turn, through pilot projects knowledge of the necessary further development of standards should be gained, and of any loopholes in standardisation.

Recommendation 9:
Create a formal framework for making tested reference implementations and examples of best practice available. Companies should be encouraged to present tested reference implementations and examples of best practice in their specialist areas and put them forward for discussion. In this way, optimal use can be made of the knowledge available in Germany, in order to enable and accelerate progress towards digital fabrication in as many areas as possible.

Recommendation 10:
Organise plug tests and plug fests to support further technical development by means of practical testing. DIN/DKE should design and implement appropriate plug test and plug fest workshops in cooperation with other standardisation organisations.

3.4 Extension of cooperation between standardisation and open source

Open source and community developments are becoming increasingly decisive for innovation in the field of ICT. Open source developments use standards and thus contribute to disseminating the respective standards, as well as producing valuable knowledge about necessary improvements and loopholes in standardisation.

Open source also produces technologies that are important for standardisation, and which should therefore be used. Therefore, it is important for standardisation organisations to work together with open source, and that processes and interaction structures allow this to take place with the desired benefits in view.

Recommendation 11:
Make use of the dynamics of open source and community development. Standardisation organisations and open source communities should work together. Processes and interaction structures should allow this to take place with the desired benefits in view.

4 Testing and quality assurance of Industry 4.0 systems

4.1 Safety and reliability for intelligent, interconnected environments

Safety is a decisive factor for intelligent, interconnected environments that connect several departments of a company or even go beyond the company. There are already international safety standards that offer transparency by means of traceability. Industry 4.0 is not feasible without secure, reliable software. Professional auditing and testing of I4.0 software and systems is therefore an essential factor in the success of Industry 4.0. International standards provide a reliable, cross-manufacturer framework for testing and quality assurance of Industry 4.0 systems:

ISO/IEC 25010, 'Software Engineering – Software Product Quality Requirements and Evaluation' defines the quality characteristics for software. These are also relevant for the software in I4.0 systems. The quality characteristics of reliability, functional safety and protection from access by unauthorised third parties (security) are particularly significant.

Regarding functional safety, specific security levels should be defined for Industry 4.0. Orientation for these can be found in the Security Integrity Levels (SIL) according to IEC 61508/IEC61511 and/or 'Automotive Safety Integrity' (ASIL) according to ISO 26262. With respect to data security, the ISO/IEC 2700x series of standards, 'Information technology – Security techniques', as well as basic IT security catalogues and guidelines on information security from BSI can serve as a starting point for creating guidelines that are tailored to suit the requirements of Industry 4.0. Furthermore, on the international level, there are guidelines and proposals for frameworks, for example those initiated by NIST or private parties such as the OWASP Foundation, which can be used as best practice examples for further discussion and design of security technologies for Industry 4.0.

Recommendation 12:
Create secure environments for Industry 4.0 on the basis of international standards. International safety standards offer transparency by means of traceability and should be used for Industry 4.0. Existing global standards should be given priority over national or regional approaches.

Recommendation 13:
Configure existing security and quality assurance standards specifically for Industry 4.0. Security Integrity Levels (SIL) according to IEC 61508/IEC61511 and/or 'Automotive Safety Integrity' (ASIL) according to ISO 26262 in particular can form starting points for functional security. With respect to data security, the ISO/IEC 2700x series of standards, 'Information technology – Security techniques' can be used, as well as basic IT security catalogues and guidelines on information security from BSI. Internationally available guidelines and examples of best practice should also be considered.

4.2 Quality assurance and testing requirements

Depending on the system, the high level of connectivity (even between manufacturers) and data fluctuation in and between Industry 4.0 systems results in more possibilities for errors as compared to conventional IT systems. Therefore, it is essential to conduct systematic, risk-appropriate but also economically feasible testing of Industry 4.0 software and systems.

In Europe, standardisation has proven to be the best way of implementing stringent quality requirements in practice and guaranteeing compliance for the good of the user. ISO/IEC/IEEE 29119, 'Software and systems engineering – Software testing' sets out the requirements for the process and documentation of quality assurance and testing.

Implementing/fulfilling these standard requirements enables and promotes the recycling of Industry 4.0 test scenarios, even across manufacturers.

Recommendation 14:
Training in testing and quality assurance should be geared towards standards. Efforts should be made to ensure that staff who carry out or design tests of Industry 4.0 software have an adequate basic education. Building on this, specific additional training programmes can be developed, which provide instruction on how to appropriately test typical I4.0 technologies and use I4.0-specific tools. The necessary criteria for this, as well as an implementation plan, should be designed in an open process involving the interested groups.

Recommendation 15:
Standardise test requirements and test scenarios on a cross-manufacturer basis. Cross-manufacturer, generic Industry 4.0 test cases can contribute significantly to accelerating and reducing the costs of test development, test execution and operational launch of Industry 4.0 systems. It is recommended that a library of test cases should be built up on the basis of ISO/IEC/IEEE 29119 and made available (e.g. as part of plug tests and plug fests).

5 Legal framework and legal certainty

Industry 4.0 covers numerous fields of technology and therefore goes beyond classic sector boundaries. This raises questions about the extent to which such new forms of collaboration, use of data and information, and technical implementation with self-directed systems are subject to clear legal regulation and protection.

In many areas, legal questions can also influence the actual design of standards. To introduce standards which are appropriate to requirements, it is important to identify any potential legal grey areas and work out solutions. International compatibility must also be considered as part of this process.

Recommendation 16:
Guarantee legal certainty by means of a legal framework with international connectivity. Questions of liability with respect to Industry 4.0 must be regulated in a manner which is internationally compatible. For example, this affects possession and processing of data as well as the security of decentralised, self-directed systems.

6 Cooperation between research and standardisation

Parallel to the development of the market, Industry 4.0 also demonstrates particularly intense activity in the field of research. Therefore, it is necessary to maintain a permanent dialogue between research and industry, and to incorporate research findings that are appropriate for standardisation at an early stage. It is also important to ensure that standards are used in research.

To take account of this development, DIN offers, for example, standardisation alongside the development phase (EBN) of academic projects. The aim of EBN is to detect standardisation potential as early as possible and initiate standardisation processes, and also to make the results of these processes publicly available. W3C is also in regular contact with the research sector and is actively involved in research projects.

Such connections make it possible to effectively integrate research findings into standardisation projects at an early stage, and therefore make a fundamental contribution to evaluating the research results.

Recommendation 17:
Involve research at an early stage. Mechanisms for incorporating appropriate research findings in standardisation activities at an early stage should be set up and promoted.

Conversely, for research into, and practice of, interoperability in requirements analysis and interface design it is also very important that little effort is required to find and use proven concept definitions.

Interoperability, as set out in the Reference Architecture Model of Industry 4.0, RAMI 4.0, requires compliance with suitable interface definitions for connecting components horizontally in value chains, plus suitable collection and representation of parameters for the relevant vertical identification required for digital or physical fabrication.

In the best-case scenario, digitalised objects and components such as those featured in Industry 4.0 are associated with well-defined concepts, so that they can be understood both digitally and by people in the course of information exchange. Interfaces and discussions on parameters, descriptions of tasks, networks, services, functions and processes, characteristics, guidelines and standards require the creation of concepts in the respective specialist areas and contexts; the creation of these concepts must be organised.

Therefore, one of the most pressing tasks for politicians, science and industry is to promote and support these efforts financially, academically and practically.

The structure-oriented, multi-dimensional classification of the Information Coding Classification (ICC) or the International Classification for Standards (ICS), which can be mapped onto it, are suitable starting points for such efforts.

The World Standards Cooperation (WSC) uses the ICS classification for standards, together with the International Electrotechnical Commission (IEC), the International Telecommunication Union (ITU) and the International Organization for Standardization (ISO).

7 Annex: recommendations for the successful further structuring of standardisation work for Industry 4.0

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