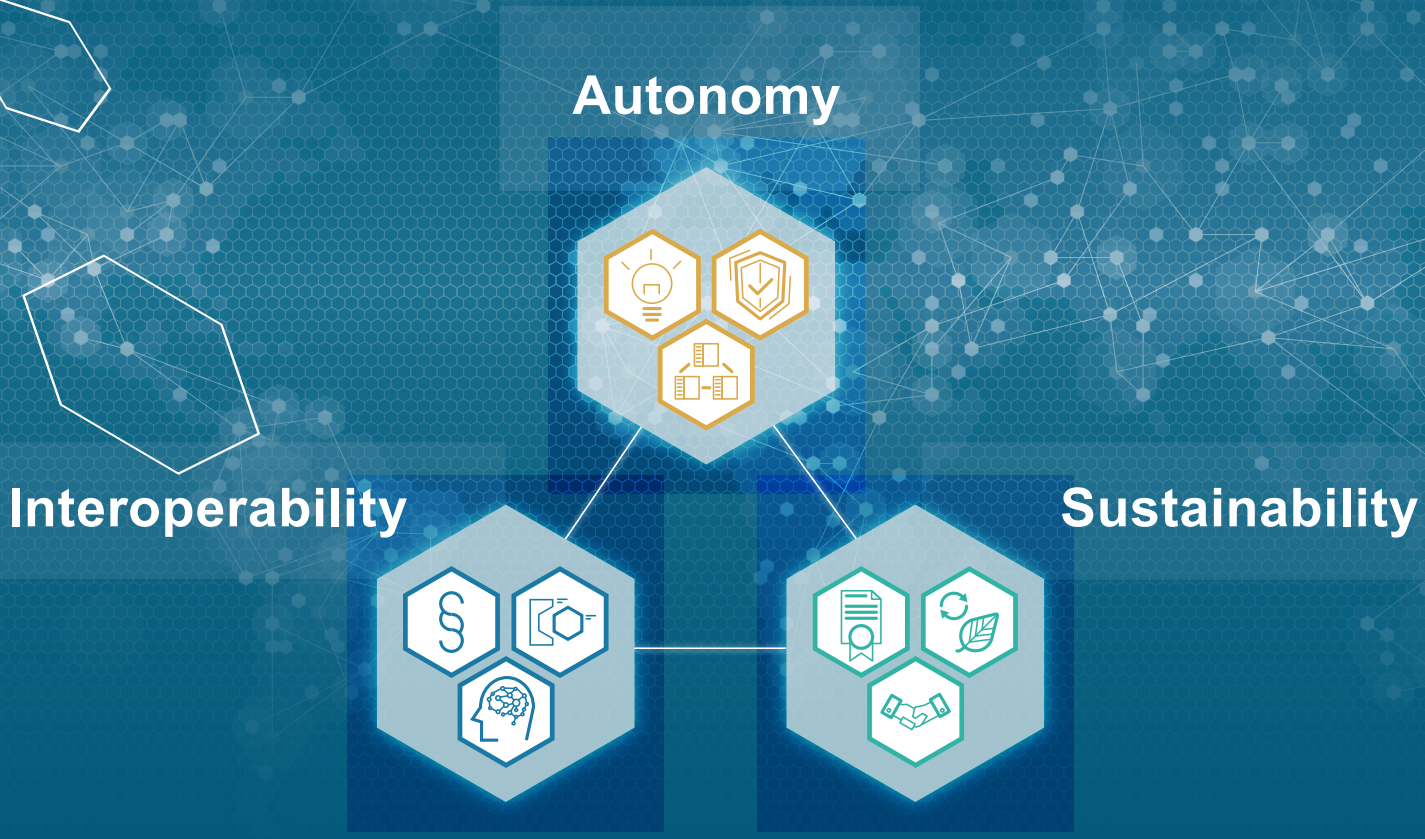
PLATTFORM INDUSTRIE 4.0

2019 PROGRESS REPORT



Shaping Industrie 4.0.
Autonomous, interoperable and sustainable

Imprint

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Preface

The term "Industrie 4.0", or the fourth industrial revolution, first entered our vocabulary eight years ago. Much has changed since then. Industrie 4.0 is no longer considered to be just a buzzword, but an approach that has been tried and tested in practice. In the last eight years, new technologies such as artificial intelligence, blockchain and 5G have opened up new opportunities for Industrie 4.0. Meanwhile, more and more industrial companies around the world have implemented their ideas about digital production, services and business models into practice.

It is now time to reflect on this experience and consider the next steps for Industrie 4.0: What will a global digital value creation system look like? And what form should it take? With this in mind, experts from the Plattform Industrie 4.0 have worked together to draft a 2030 vision of Industrie 4.0 over the past year. We know that Industrie 4.0 goes beyond business or technology. It secures our competitiveness by deploying complex digital business models in flexible and globally connected value creation systems. Industrie 4.0 will also play an indispensable role in improving the quality of life in our German, European and global societies through digital transformation.

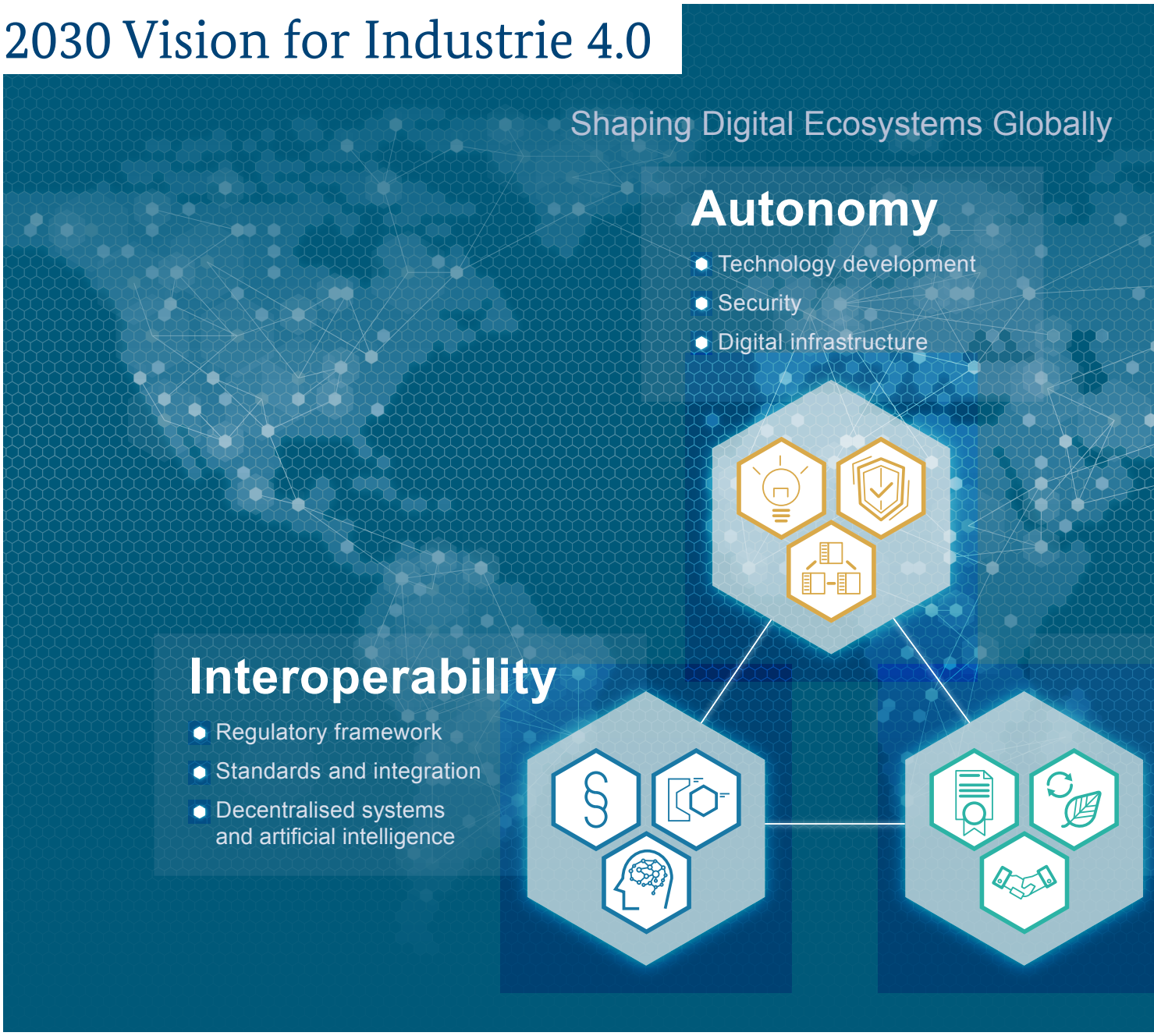
At the 2019 Hannover Messe trade fair, the platform will present its planned 2030 vision for Industrie 4.0 – comprising the three pillars "autonomy, interoperability and sustainability". We hope this vision will contribute to discussion and look forward to hearing your views. Our aim is to draw on this dialogue and learn how to shape global digital ecosystems together. The European vision for a competitive, open and sustainable Industry 4.0 should be underpinned by concrete goals.

This progress report outlines the Plattform Industrie 4.0's plans and our achievements to date in shaping the digital ecosystems of the future: Last year, we intensified our many collaborations and also formed new alliances. The interest in partnerships and discussion continues to grow. International cooperation has surely shown that we can only tackle the challenges of Industrie 4.0 by working together. We have, for example, made significant progress in addressing the challenge of standardisation: We have also demonstrated successful implementation of the administration shell. Furthermore, our experts have formulated pioneering approaches to key challenges in IT security, education and training, research, business models and law. These steps are also aimed in particular at small and medium-sized businesses (the German Mittelstand). An increasing number of partners in the Industrie 4.0 Transfer Network are offering expertise to SMEs.

More details and information on the 2030 vision for Industrie 4.0 are provided in the following report. We hope you enjoy reading it and look forward to hearing your views!

Plattform Industrie 4.0

2030 Vision for Industrie 4.0



Shaping Digital Ecosystems Globally

Industrie 4.0 describes a fundamental process of innovation and transformation in industrial production. This transformation is driven by new forms of economic activity and work in **global, digital ecosystems**: today's rigid and strictly defined value chains are replaced by flexible, highly dynamic and globally connected value networks with new forms of cooperation. Data-driven business models prioritise the benefit to the customer and solutions, replacing the focus on the product as the prevailing paradigm of industrial value creation. **Availability, transparency and access to data** are key factors for success in the connected economy and largely determine competitiveness.

In this **2030 Vision**, the stakeholders of Plattform Industrie 4.0 present a holistic approach to the shaping of digital ecosystems. Working from the specific situation and established strengths of Germany's industrial base, their aim is to create a framework for a future data economy in line with the requirements of a social market economy: **emphasising open ecosystems, diversity and plurality and supporting competition between all the stakeholders on the market**. The Vision is primarily addressed to industry and commerce in Germany, but explicitly highlights the importance of openness and a willingness to work together with partners in Europe and around the world.

The **strength of German industry** is rooted in a system of innovation and commerce driven by **heterogeneity, diversity and specialisation**. In combination with commercial

freedom, data and information security, and the protection of individual personal rights, these are the central pillars of the European industrial society. A decentralised system of open and flexible ecosystems is built on this structure, and offers the best preconditions for shaping the digital economy within the set of values of a free and social market economy.

Three closely interlinked strategic fields of action are crucial for a successful implementation of Industrie 4.0: **autonomy, interoperability and sustainability**. The stakeholders of Plattform Industrie 4.0 commit jointly to these fields of action as guiding principles for the coming decade of the incipient scaling-up of Industrie 4.0 in Germany, Europe and globally. In a dialogue with all the stakeholders in the industrial society, the aim is to establish a framework for action. In this way we can sustainably shape the digital transformation of the German industry, based on its outstanding global position, as well as successfully establish Industrie 4.0 in the midst of German SMEs.

Autonomy

The principle of autonomy underpins the freedom of all stakeholders on the market (companies, employees, scientists, individuals) to take self-determined, independent decisions and to interact in fair competition – from the defining and shaping of the individual business model to the individual's decision to make a purchase within the I40 ecosystems.

Autonomy in the global Industrie 4.0 ecosystem requires:

- ***Digital infrastructure***
  The permanent dynamic configuration of value networks between different companies requires a powerful, autonomous infrastructure for digital industrial value creation. **This infrastructure must be equally accessible for all participants and available without restriction**. It defines access to the ecosystems of Industrie 4.0 and guarantees pluralistic action and market diversity. As a strategic asset, a resilient infrastructure brings together all the overarching requirements and services needed for the cross-border and cross-sectoral collection, exchange, analysis and use of data.

- ***Safety and security***
  Data protection, IT and information security are a firmly established principle in our industry and society. They are a basic precondition for Industrie 4.0 and for cooperation within digital ecosystems. In the face of all the challenges, they have established the **basis for the high level of global confidence in Industrie 4.0**. Companies, employees and private individuals will in future increasingly need to be able to rely on their data being protected, on the use of it being transparent, and on their being able to decide autonomously what use they permit, what use they do not permit, and when they wish to deploy their "right to be forgotten".

- ***Technology development***
  Autonomy in Industrie 4.0 requires technology-neutral research, development and innovation in the core areas of digital industrial value creation. In addition **to the leading role played by the developments in technology, it is also particularly important to implement data protection and security by design**, as well as sustainability and interoperability. Finally, dynamic integration into the applications and digital business models ensures that all participants in the ecosystem participate in and benefit from the advances in technology.

Interoperability

The flexible networking of different stakeholders to form agile value networks is one of the core building blocks of digital business processes in Industrie 4.0. The interoperability of all stakeholders is a key strategic element in the shaping of such complex, decentrally organised structures. A high level of interoperability – to which all the partners commit and contribute equally – is required to ensure the direct networking of operations and processes across companies and sectors. In the other direction, interoperable structures and interfaces give both manufacturers and customers an unrestricted possibility to participate in digital value networks and thus to shape new business models. In this way, interoperability also boosts autonomy.

- ***Standards and integration***
  The outstanding global position when it comes to the **integration of individual solutions to become Industrie 4.0 systemic solutions** is largely rooted in the intensive and long-standing efforts to develop standards. This considerably facilitates integration and thus represents a basis for interoperability. This core competence needs to be used and developed further in accordance with the needs of digital ecosystems. Not least due to cross-sectoral reference architectures and the establishment of an administration shell as a digital image of the real world, new approaches are now available and are being underpinned and developed to form a "USB standard for Industrie 4.0".

- ***Regulatory framework***
  In order to ensure networking, exchange and cooperation in open ecosystems with fair and equal conditions for all stakeholders, a regulatory framework is required – at the national, European and also international level. This entails the anchoring of governance rules and the development of the innovation system, as well as the reflection of aspects of data autonomy and security, and the interests of employees and individuals in general.

- ***Decentralised systems and artificial intelligence***
  Decentralised, autonomous systems with embedded intelligence are of far greater significance in the digital ecosystems of industrial value creation (B2B) than in the B2C sector. The cooperative and transparent use and interconnection of various types of machine and user data in a well integrated ecosystem based on a standardised architecture permits the development of new solutions and business models through the use of artificial intelligence in a variety of ways. When it comes to the beneficial use of AI at the various levels of industrial

practice (edge, premises, cloud), a key role alongside **Big Data** is played by the collection and use of **Smart Data**.

Sustainability

Economic, environmental and social sustainability is a fundamental pillar of the values of our society. This works in two directions: firstly, this sustainability is being embedded in Industrie 4.0, and secondly, Industrie 4.0 permits substantial progress on sustainability. For example, the prosperity and quality of life of each individual largely depends on a forward-looking and competitive industrial sector. The ecosystem of innovation and the implementation of Industrie 4.0 thus create a fertile environment in which sustainability can result from Industrie 4.0 and Industrie 4.0 itself can be sustainable – and thus make a key contribution towards maintaining the standard of living of our society.

- ***Decent work and education***
  By placing the human being at the centre, Industrie 4.0 is making significant contributions towards a further improvement in working conditions. In view of our innovative equipment manufacturers and an internationally competitive user industry, **Industrie 4.0 is helping us to maintain a high level of employment**. Multiplier and spill-over effects extend the impact to other sectors. The **outstanding level of education of the workforce** offers a stable basis for life-long learning, and the numerous further training opportunities offer needs-oriented possibilities to deliver this. This should be used and promoted proactively in order to respond to the ongoing skills shifts.

- ***Social participation***
  Industrie 4.0 stands for a process of transformation which embraces the whole of society, entailing far-reaching changes for the stakeholders. The overarching goal is that the **industrial and social innovations generated by Industrie 4.0** should not only create challenges for these stakeholders, but also and in particular new opportunities. This process of societal change requires not only close cooperation at corporate level, but also participation and co-determination by all stakeholders: starting from a dialogue between the social partners in the individual enterprise to cross-company and cross-sectoral aspects of cooperation and issues embracing the whole of society in terms of the use of digital technologies and artificial intelligence in our day-to-day lives.

- ***Mitigating climate change***
  Industrie 4.0 makes it possible to leverage additional potential for resource efficiency. A combination of design-based and process-based approaches can create closed material cycles throughout the entire product lifetime. Service-oriented business models make products the basis for services and thus keep them under the care and maintenance of the manufacturer, meaning that the latter can build a more sustainable design into its product. **This means that Industrie 4.0 is a key enabler for the circular economy, and for environmental protection and climate action in general**.

Digital business models in the data economy

Value chains are increasingly turning into globally connected and flexible value creation systems. Data-based services are now an integral part of these systems. An example of an "as-a-service" model is as follows: Rather than selling tyres per se, the retailer sells the operational life of tyres. For the customer, this reduces both investment costs and financing risks. Responsibility for correctly maintaining the tyres lies with the manufacturer. The manufacturer, in turn, can avail of greater opportunities than ever before to record and evaluate data on how its tyres are used. The manufacturer can then optimise the portfolio on offer and ideally generate higher profits. At the same time, the manufacturer can gain a better understanding of customers' needs and tailor and expand portfolios accordingly. Value-added components are increasingly shifting from production to data-based services. As part of this shift, platforms are playing an ever greater role in coordinating processes and business partners. With the importance of data and services (smart services) increasing exponentially in value creation, companies must now reassess their traditional business models and evaluate their future viability – irrespective of their current status. For data to be incorporated in value creation networks, it must not only be collected and shared. It must also and in particular be assigned a value.

Achievements

One year after its foundation, the "Digital Business Models in Industrie 4.0" working group highlighted the opportunities and challenges presented by digital business models

Definition of a business model

The working group defines a business model along the same lines as Osterwalder and Pigneur (2010), as follows: "A business model describes the rationale of how an organization creates, delivers, and captures value." According to Jaekel (2015), digital business models in value creation architecture are characterised by their focus on data and analytics and they typically organise their partner network as a scalable ecosystem via platforms. This is associated with a transformation in the value proposition (products and services) and in the revenue model (cost structures and revenue).

in a report published for the Hannover Messe. For this purpose, 22 practical examples of digital business models were compiled from German industry. The findings and recommendations of the working group include:

- **Digital business models** are the basis for competitive differentiation.
- Nowadays, no single company can become competitive on its own. **Cleverly coordinated value creation networks** that benefit each partner involved are the key success factor for digital business models.
- The networks revolve around **new value propositions** for the use of smart products. These value propositions are made possible by combining smart products with services that are provided during the operating phase and in real time using the data from the product during operation.
- **New organisational skills** are essential to make technological adaptations and implement business models. Organisational ambidexterity, for example, is an increasingly important skill in companies.

Since it was set up in March 2018, the working group has stimulated discussion in a variety of formats such as conference papers, press articles, vlogs, tweets and LinkedIn posts. Three input papers have also been published:

- The **Input Paper on innovation drivers for digital business models** examined success factors. Successful digital business models are using technological advances to monetise new value propositions. As a result, companies must adopt an "ambidextrous" approach when creating their digital strategy: they need to optimise their existing business while also creating a digital vision that focuses all activity on the individual needs of potential customer groups.
- In another input paper, experts coordinated by the Fraunhofer Center for International Management and Knowledge Economy IMW investigated **the growth paths used by companies to digitise their traditional business models**. Working together with approximately 50 leading international industrial companies, the working group identified five growth paths that companies can pursue on their way to digitalisation: digital elements, connectivity, product-as-a-service, applications and digital platforms. These are described in detail in the input paper. The authors also show, in each case, what adjustments need to be made to the core components of the business models.
- In a third input paper, the working group analysed the German platform landscape. In Germany, many industrial companies are expanding their B2B platforms, but still need to scale these further.

Outlook

The working group has three items on its agenda: First, the experts plan to identify the essential prerequisites for successfully implementing digital business models. The second topic is data monetization. This focuses, among other things, on the financing and revenue mechanisms of digital business models, which are also analysed here using concrete practical examples. The working group will also look into the new requirements arising in relation to leadership, organisation and cooperation as as a result of digital business models.

Working group “Business models in Industrie 4.0”

HEADED BY: Prof. Dr. Svenja Falk, Accenture

Data, platforms, innovative technologies and new customer expectations – all of these factors are changing the value creation of manufacturing companies. Value-added components are increasingly shifting from production to data-driven services. New digital business models are emerging. The success of these models will be determined by their sustainability.

What are the challenges involved in developing digital business models? What are the drivers of innovation? How do companies change in terms of culture and organisation? The working group addresses all of these questions. Its goal is to understand the architectures and dynamics of digital business models and provide recommendations for action.

Current publications of the working group:

Digital Business Models for Industrie 4.0

April 2019 | Working paper
(German only)

https://bit.ly/3Gst9x5

Drivers of innovation for digital business models

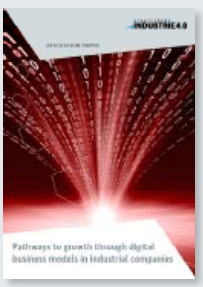
April 2019 | Working paper

https://bit.ly/3muKYUF

Germany’s evolving platform landscape

February 2019 | Input paper

https://bit.ly/3w1oA8s



Pathways to growth through digital business models in industrial companies

March 2019 | Input paper

https://bit.ly/2XWzyPW

Vision 2030: Autonomy

As a guiding principle, autonomy prioritises the freedom of all stakeholders in the market to make their own self-determined, independent decisions and to interact with each other in a spirit of fair competition – from defining and designing a business model to making a purchasing decision, as an individual, within Industrie 4.0 ecosystems.

In the global Industrie 4.0 ecosystem, autonomy presupposes the following:

Digital infrastructure

A powerful, autonomous infrastructure for digital industrial value creation is crucial for the permanent dynamic configuration of value creation networks, including cross-company networks. **This infrastructure must be equally accessible for all participants and available without restriction**. It defines access to Industrie 4.0 ecosystems and ensures plurality in operation and market diversity. A resilient infrastructure is a strategic asset incorporating all the general requirements and services needed for cross-border and cross-sectoral collection, exchange, analysis and use of data.

Security

Data protection, IT and information security are already highly valued in industry and society. They are basic preconditions for Industrie 4.0 and for cooperation within digital ecosystems. They have also laid **the foundation for the high level of confidence worldwide in Industrie 4.0**, notwithstanding all of the associated challenges. In future, companies, employees and private individuals will need to be able to rely more than ever on their data being protected, on transparency on the use of their data, and on their own ability to decide autonomously what data use they permit, what data use they do not permit, and when they wish to deploy their "right to be forgotten".

Technological development

The principle of autonomy in Industrie 4.0 requires technology-neutral research, development and innovation in the core areas of digital industrial value creation. In addition to **the leading role played by developments in technology, it is also important to implement data protection and security "by design"**, as well as sustainability and interoperability. Dynamic integration into the applications and digital business models will ultimately ensure that all participants in the ecosystem take part in and benefit from the technological advances.

The following section outlines the activities and discussions of the working groups that are addressing the action area of autonomy.

Secure global data exchange

The idea sounds promising: A customer gets to design his own trainers using an online configurator. This takes everything into account: colour, size, foot shape. As soon as the customer clicks “Buy”, an auction for manufacturers is launched on the digital platform: The shoe brand awards the order to a factory offering capacity and the lowest price. It then transfers the production-relevant data (CAM data) directly to robots and 3D printers in the factory. This transaction requires trust between the value-added partners. Protection of personal data is as important to the customer in this process as protection of the design for the shoe brand. Companies also need compatible national/international security policies which take into account their respective national regulatory requirements. In this way, IT security is both a challenge and an enabler for Industrie 4.0.

The working group “Security of networked systems” is dealing with four key issues, with the aim of ensuring IT security in global Industrie 4.0 ecosystems:

1. **Secure ecosystem:** Global ecosystems require comprehensive security architectures for all participants, irrespective of which country they are in. This in turn requires recognised interoperable security policies from all participants along with a common regulatory framework. The working group is committed to establishing security-by-design as the overriding principle. Together with international partners from companies, initiatives and authorities, it is working to make technical, organisational and regulatory requirements interoperable.

2. **Secure communication:** In connected industry, people, machines and software applications interact and exchange data on a large scale. However, this is only successful if technical communication mechanisms

At the IT Theme Day in May 2018, experts discussed secure industrial value-added networks.

ensure that all stakeholders can make contact with each other securely. The working group is drafting technical requirements for secure communication, while outlining and evaluating solutions.

3. **Secure identities:** For secure data exchange, the senders and recipients of data must clearly be who they purport to be and be authorised to send and receive the relevant information. The working group provides an overview of the essential requirements for secure identities and prepares recommendations for action for policymakers and industry representatives.

4. **Trustworthiness:** Trust is a core prerequisite for data exchange and interaction between stakeholders. People will only pass on their data if they know it is in good hands. Trustworthiness becomes a qualitative decision-making criterion for business activity along the entire value chain. The working group is examining how trustworthiness can be proven or evaluated and also how the correctness, immutability and completeness (= integrity) of data, systems and processes can contribute to this process.

In May 2018, the working group and the Federal Ministry for Economic Affairs and Energy organised the international conference "Securing Global Industrial Value Networks – synchronizing international approaches". Some 140 international decision-makers from China, France, Korea, Japan, the US and many other countries discussed IT security issues in Berlin and agreed on the next steps for cooperation. The experts from the working group recently highlighted the safety aspects of Artificial Intelligence (AI) in Industrie 4.0. They presented the advantages of AI for industrial cybersecurity and also described new security risks posed by the technology. In conclusion, they offered recommendations for action to manufacturers, integrators and operators as well as to policymakers. The requirements

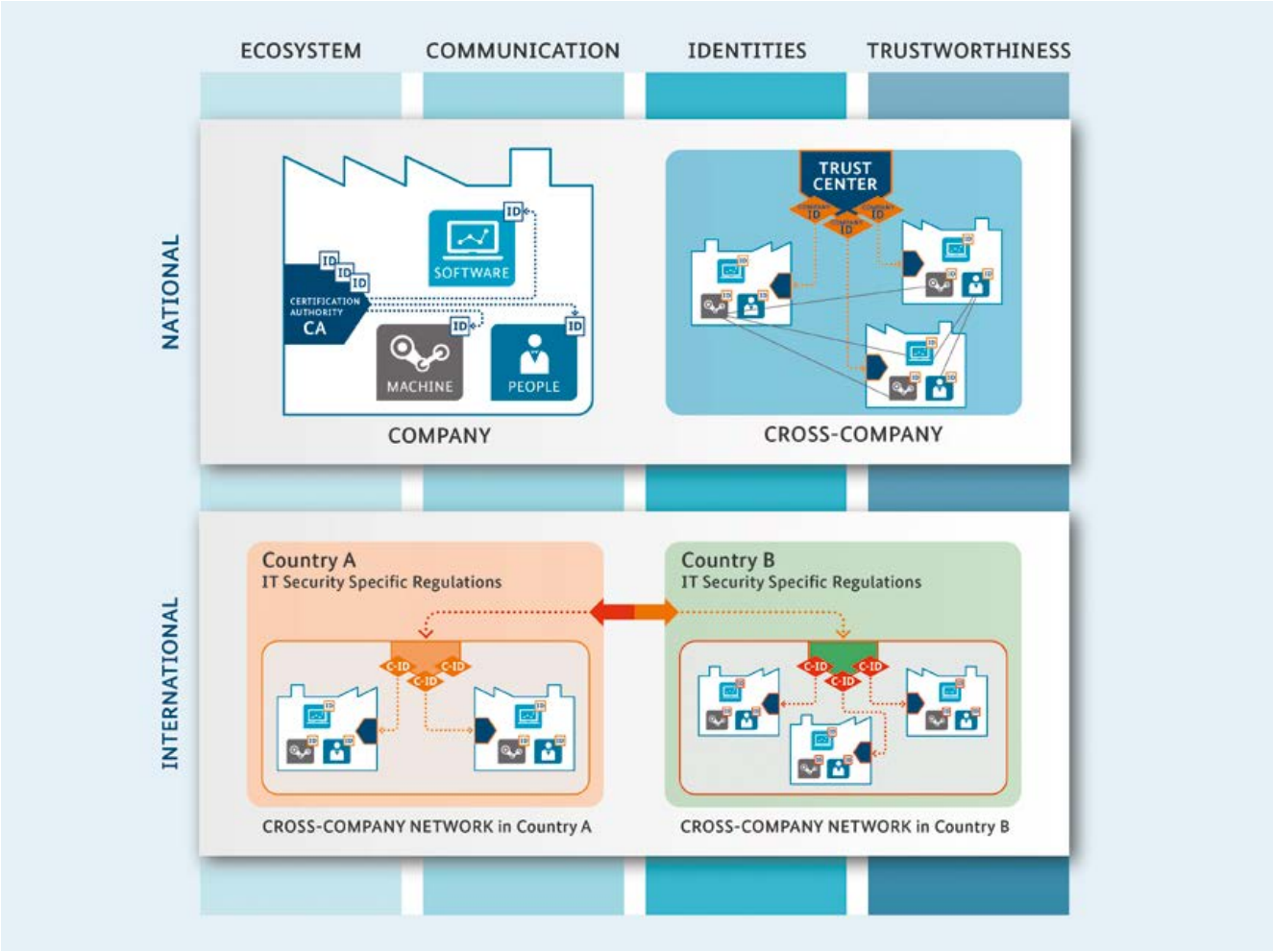


Fig. 1 – The four key areas of IT security in national and global Industry 4.0 ecosystems.

for secure use of OPC UA[1] for cross-company communication have been developed, based on the application scenario "Condition Monitoring and Parameterisation". Various possible solutions have been presented and evaluated by the platform experts and their partners.

Outlook

There are plans to create an API (Application Programming Interface) for the interaction of administration shells in collaboration with the working group on "Reference architecture, standardisation and norms", based on the structural principles. In another work package, a description of the necessary infrastructure elements is created.

Sample implementation of a business relationship between customer and supplier across two continents is on the agenda for 2020 in a demonstrator with the RRI (Robot Revolution Initiative) from Japan. The conditions for automatically concluding the contract and exchanging data must be determined beforehand and possible solutions also discussed.

Security requirements are being developed with the Chinese partner CAICT, In accordance with the "value-based services" application scenario, in order to enable communication and cooperation between Industrie 4.0 locations in China and Germany.

1 OPC UA is an architecture for describing and exchanging machine data, which includes data models and interaction concepts in addition to a communication protocol.

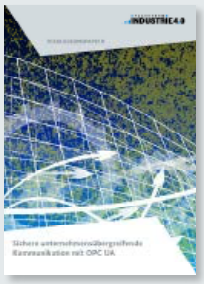
Working group “Security of networked systems”

HEADED BY: Michael Jochem, Robert Bosch GmbH

In connected production, producers, suppliers and customers from all over the world exchange data on a large scale. The key requirement for this process is trust: people will only pass on their data if they know it is in good hands. This makes IT security an important quality feature of companies and puts it to the forefront of Industrie 4.0. Companies that implement verifiable IT security measures are trustworthy and in demand as partners within digital ecosystems.

IT security must therefore occupy a permanent position in management perspectives, employee qualifications and also in international standards. It must be an established quality feature in the development and execution of connected production. The working group supports this process with solutions, recommendations for action and concrete application examples for a secure, connected industry.

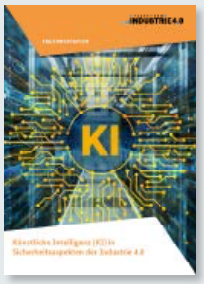
Current publications of the working group:



Secure cross-company communication with OPC UA

April 2019 | Discussion paper (German only)

https://bit.ly/3GrqfsD



Artificial intelligence in security aspects of Industrie 4.0

April 2019 | Working paper (German only)

https://bit.ly/3pGKb4N

Access control for Industrie 4.0 components for use by manufacturers, operators and integrators

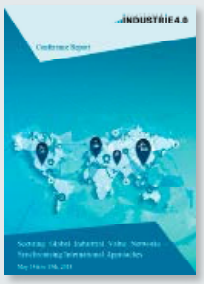
November 2018 | Discussion paper (German only)

https://bit.ly/3bcDH5n

Secure access to CAE data

November 2018 | Discussion paper (German only)

https://bit.ly/3miIAQA



Conference Report “Securing Global Industrial Value Networks – synchronizing international approaches”

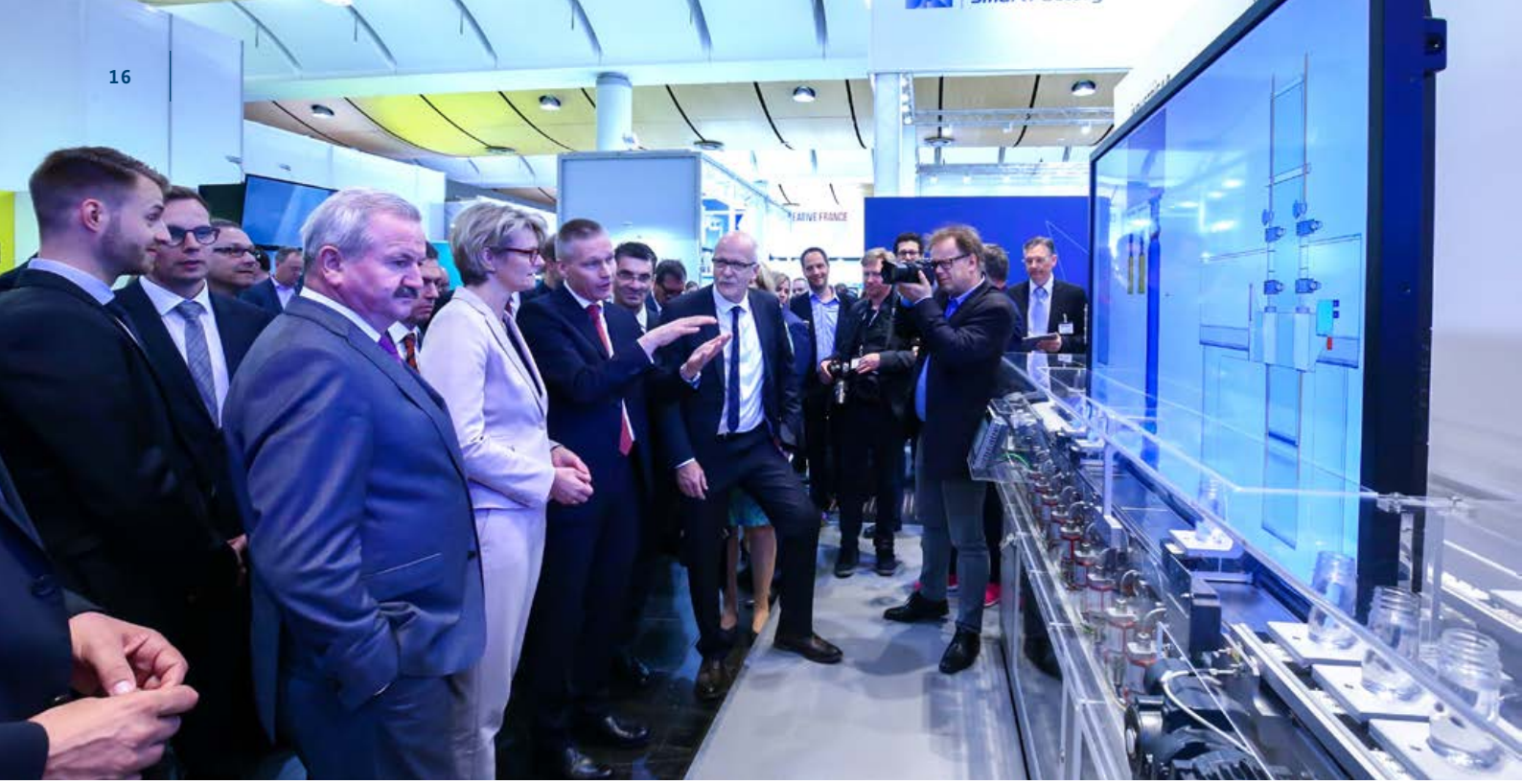
May 2018 | Conference Report

https://bit.ly/3EsLict

Details of the Asset Administration Shell: Part 1 – The exchange of information between partners in the value chain of Industrie 4.0 (Version 1.0)

November 2018 | Guidelines

https://bit.ly/3xlczLJ



Vision 2030: Interoperability

One of the core components of digital business processes in Industrie 4.0 is the flexible forging of links between various stakeholders to form agile value networks. Interoperability between all stakeholders is a key strategic element in the shaping of such complex, decentrally organised structures. Only a high level of interoperability – to which all the partners in an ecosystem commit and contribute equally – can ensure direct connectivity between operations and processes across companies and sectors. At the same time, interoperable structures and interfaces allow both manufacturers and customers to participate in digital value networks without restriction and thus shape new business models. Interoperability thus also enhances autonomy.

Standards and integration

Industrie 4.0's outstanding global positioning relating to the **integration of standalone solutions into system solutions** is largely thanks to intensive and long-term efforts to develop standards. Integration is thus facilitated and a basis for interoperability is provided. This core competence must be used and further developed in line with the requirements of digital ecosystems. Thanks in part to cross-sectoral reference architectures and the establishment of an administration shell as a digital image of the real world in the digital world, new approaches are now available that are being rigorously underpinned and elaborated towards a "USB standard for Industrie 4.0".

Regulatory framework

Regulatory frameworks are required at national, European and also international level in order to ensure networking, exchange and cooperation **in open ecosystems with fair and equal conditions for all stakeholders**. These frameworks must enshrine governance rules and further develop the innovation system, while reflecting aspects of data autonomy and security, and the interests of employees and individuals in general.

Decentralised systems and artificial intelligence

Decentralised, autonomous systems with embedded intelligence are much more important in the digital ecosystems of industrial value creation (B2B) than in the B2C sector. The **cooperative and transparent use and interconnection of various types of machine and user data** in a well-integrated ecosystem that is based on a standardised architecture allows new solutions and business models to be developed by using artificial intelligence in a variety of ways. In relation to the beneficial use of AI at various levels of industrial practice (edge, premises, cloud), the collection and use of **Smart Data** plays an especially key role alongside **Big Data**.

Standards and integration: Defining principles for interoperable systems

Autonomous forklift trucks store goods on high shelves, intelligent machines coordinate production processes independently and also order consumables. Diverse digital business models are created when people, machines and products are directly connected and able to work together flexibly and smoothly in digital ecosystems. Precondition: interoperable systems in the overall production and value chain. The Platform Industrie 4.0 is therefore working to enable connectivity within Industrie 4.0 ecosystems. An important example of this is the reference architecture model for Industrie 4.0 (RAMI 4.0) developed by the Platform. RAMI 4.0 has since become a DIN standard and international prestandard. The platform also translates the concept of the administration shell into practice through pilot projects and specifications.

Achievements: Foundation laid for Industrie 4.0 ecosystems

Over 100 experts, more than 50 meetings, countless lectures and visits to events and fairs: The working group on "Reference architecture, standardisation and norms" and its now eight sub-working groups have worked hard over the past twelve months to develop a basis for consistent and open standards and to put their findings into practice. Their efforts have been remarkably successful: In November 2018, the working group laid the foundation for Industrie 4.0 ecosystems and provided a blueprint for smart connection of assets. Specifically, the platform's experts present in detail, in a series of publications, how companies can network assets (hardware and software components in production) using the administration shell. In this way, the platform completes the foundations for building digital ecosystems that allow interoperable interaction between all assets. Businesses and developers can now begin to set up administration shells themselves and create virtual copies of their assets. In the publication, the working group describes a technology-neutral UML model that contains all the necessary information, primary exchange formats in XML and JSON, and an access concept, in order to meet cyber security requirements.

Industrie 4.0 administration shell sparked conversation at trade fairs

Outlook: Publication series “Details of the Administration Shell” part 1.0 is just the start

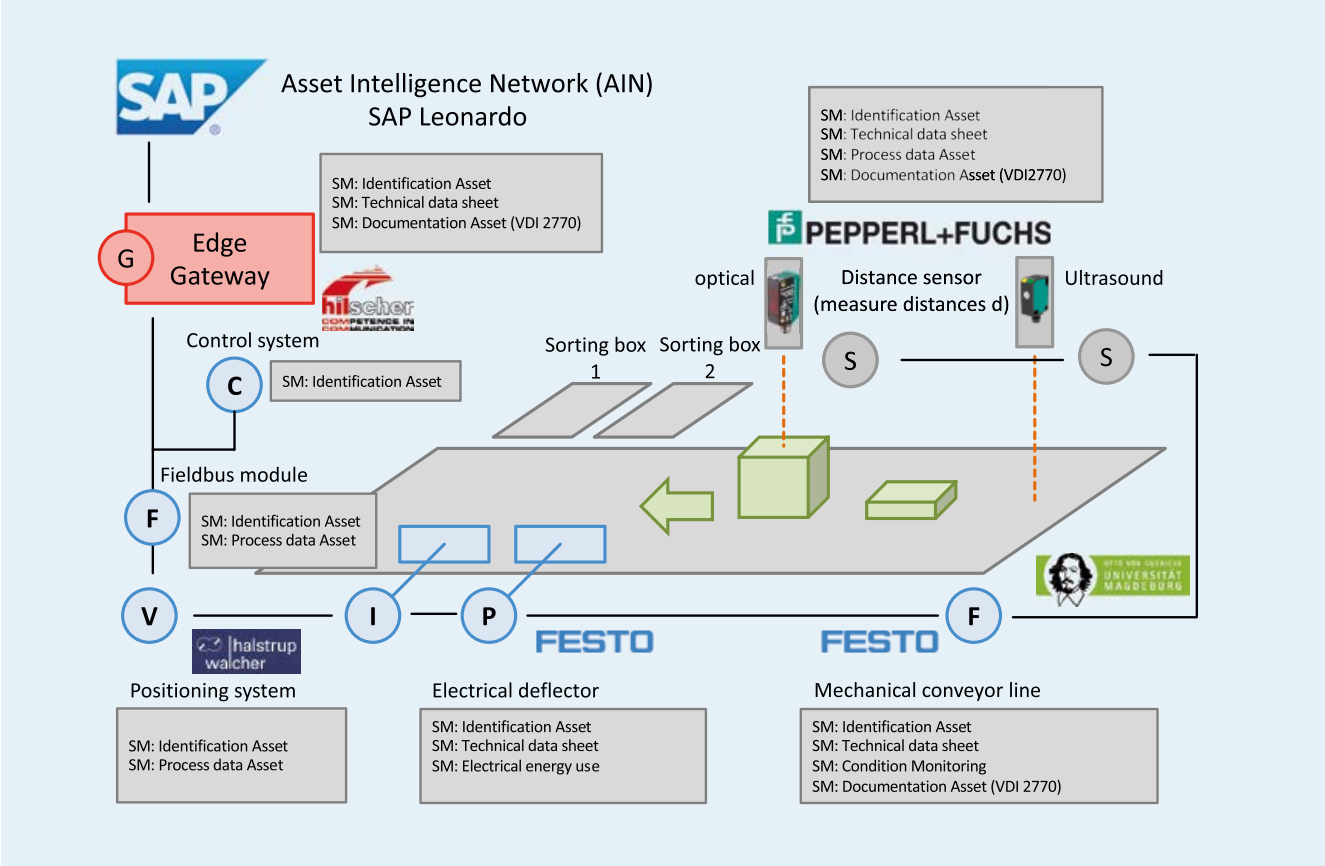
A multipart publication series provides a complete description of the administration shell. The content published in Part 1 will be supplemented gradually in the coming months. The full title of the publication is: “Details of the Administration Shell – Part 1: The exchange of information between partners in the value chain of Industrie 4.0; Release V1.0” It describes how information in the administration shell must be prepared and structured in order to transfer all of the information contained as a package (compound file format) from one partner to the next.

In the next step, the Plattform Industrie 4.0 defines defines application programming interfaces (APIs) in Part 2 to provide online access to information and capabilities of the asset. Part 3 describes how several administration shells interact in a network.

In practice: Using data in production – field-testing the administration shell

The Plattform Industrie 4.0 can also look back on a successful year in terms of practical testing: The working group “Reference architecture, standardisation and norms” successfully implemented practical examples of the administration shell with its submodels in a demonstrator that was developed over two phases, each showing one scenario. These will provide inspiration for all Industry 4.0 pioneers. The application scenarios are accompanied by the publication “The administration shell in practice”, which is easy to understand and allows users to carry out their own tests. It provides a summary of key aspects of the administration shell and shows users how they can develop generic, asset-specific and free submodels themselves.

Submodels with standardised content are prerequisites in addition to the structure of an administration shell that companies must fulfil if they wish to create an inter-



The administration shell in practice – A demonstration on how the administration shell works in practice

operable cross-discipline system in production and in other areas. The publication serves, in part, as the demonstrator's specifications and allows the Plattform Industrie 4.0 to validate and implement its guidelines and defined structures for the "Administration shell in detail".

Blocks and cans are conveyed along a conveyor belt. A sensor recognises the objects and sorts them into one sorting box or the other, depending on the order. This simple logistics scenario involves more than is obvious at first glance. All of the demonstrator components and the sorting machine itself have a administration shell. The demonstrator was developed in two phases and shown at the 2018 and 2019 Hannover Messe trade fairs.

Scenario 1:

The administration shells of the sensor and the positioning system (motor), for example, visualise and aggregate relevant process data in the background and calculate KPIs. These in turn are transferred to the administration shell of the conveyor line and used for condition monitoring. Generic (e.g., identification, documentation) and free submodels (e.g. process data) are represented in the administration shells.

Scenario 2:

A negotiation scenario illustrates how the administration shell of the sorting machine negotiates with customers (independently and without a higher-level, omniscient system such as MES) about the sequence in which orders are to be processed. For example, the sorting machine accepts new orders, taking into account already existing orders, processes them and creates quotes according to the situation.

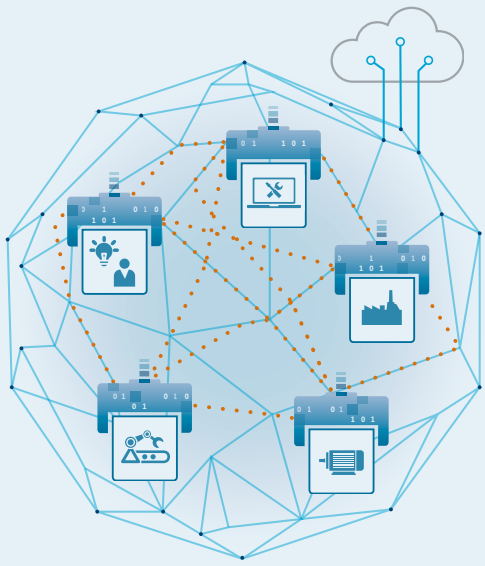
Administration shell

For example, the administration shell of a drilling machine assigns a unique ID, features and capabilities to the asset in the virtual world. As a kind of standardised communications interface in the network, the administration shell allows access to all information about the asset and execution, for example, of the command "Drill a hole 3.5mm in diameter and 4mm deep at position 4".

The actual object, such as the drill, a component or a product, and its administration shell together form the Industrie 4.0 component. Products, equipment and processes are connected by means of information and communication technology, as the real production world increasingly moves closer to the virtual IT world. The Industrie 4.0 components can communicate with each other in the factory and across companies.

A common language is necessary for Industry 4.0 components to share information with each other. The Plattform Industrie 4.0 platform has developed such a language over the past few months, based on the interaction model. To establish the interoperability of interactions between administration shells or their assets, the administration shells must be able to communicate with each other about the content of their submodels and the resulting potential interactions.

The Plattform Industry 4.0 presents the concept of a language for Industrie 4.0 components by explaining the vocabulary structure and message structure for data exchange. Taking the interaction model of "awarding a contract" as an example, it shows how these structures work together and also illustrates the rules for an interaction. In this way, the Plattform is further rolling out the administration shell concept and introducing it into practice.



With the administration shell, assets such as machines or orders can be integrated into Industrie 4.0.

Working group “Reference architecture, standardisation and norms”

HEADED BY: Kai Garrels, ABB Stotz-Kontakt GmbH

Standardisation in industry is nothing new. However, Industry 4.0 brings one major change to the table: Standards that regulate only a small part of production are no longer sufficient. With connected production, standards now have to take into account hardware and software, user and supplier sectors as well as product design and recycling. Only in this way can different components work together smoothly in digital ecosystems (key word: interoperability). Uniform and open standards are very important to companies. They ensure fair competition and reduce investment risks. The working group on “Reference architecture, standardisation and norms” is developing principles for uniform, open standards and contributing its ideas to international standardisation processes.

Current publications of the Working Group:

Details of the Asset Administration Shell:
Part 1 – The exchange of information between partners in the value chain of Industrie 4.0 (Version 1.0)

November 2018 | Guidelines

https://bit.ly/3xlczLJ

Administration shell in practice

April 2019 | Discussion paper (German only)

https://bit.ly/3Bv6AEm

Details of the administration shell

March 2019 | Guidelines (German only)

https://bit.ly/2XTsxiS

Administration shell in practice

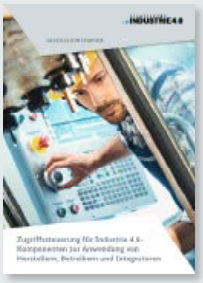
April 2019 | Flyer (German only)

https://bit.ly/2Zgm5D7

Language of I4.0

April 2018 | Discussion paper (German only)

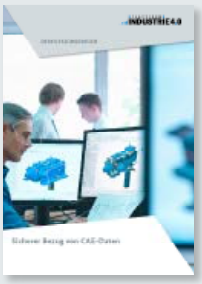
https://bit.ly/3EnMWMm



Access control for Industrie 4.0 components for use by manufacturers, operators and integrators

November 2018 | Discussion paper (German only)

https://bit.ly/3bcDH5n



Secure access to CAE data

November 2018 | Discussion paper (German only)

https://bit.ly/3miIAQA

RAMI 4.0 – a reference framework for digitalisation

Presentation

https://bit.ly/3k8DPrx

Shaping law for Industrie 4.0

Introduction

Petra R. works in an connected factory. She gets help with her tasks from Max-3000, a semi-autonomous robot. On its screen, Max-3000 always shows precisely the information that Petra needs right now. It supports her with the individual work steps. Petra appreciates this function. However, what Petra doesn't know is that Max-3000 is also storing information about how quickly and effectively she completes her tasks. Data-driven assistive systems can help people with their daily work. However, the information collected during this process not only makes it possible to optimise production processes, connect them across company boundaries and make them increasingly autonomous. It also raises questions. Who does this data belong to? Who has the right to use this data? How can the security of this data be guaranteed? The "Legal framework" working group is addressing these questions.

Achievements

Over the past year, the "Legal framework" working group has taken an in-depth look at the issues of antitrust law, blockchain and artificial intelligence. Three working papers examine the challenges raised by these issues from a legal perspective while also presenting recommendations for action. The following questions are highlighted, among others:

- **Antitrust law:** Who is allowed to cooperate with whom and under what conditions? What is the significance of access to data for market power and what constitutes misuse in this case? Who is responsible for the antitrust-related behaviour of self-learning systems?

- **Blockchain:** What legal norms apply to participation in a blockchain in an international context? What role can smart contracts play in the application area of a blockchain? How can rights and property be transmitted via blockchain? What data protection requirements need to be considered in relation to personal data on the blockchain?

- **Artificial intelligence:** Is is necessary to introduce a new legal entity with its own rights and obligations? What changes to the GDPR would be necessary to take appropriate account of the use of AI systems and their further development in Industrie 4.0? Whose responsibility is it to prove the causation of damage caused by AI (causality)? Is it possible for AI to create an intellectual work in terms of copyright?

On March 14, 2019, the working group also organised an expert day together with the Federal Ministry for Economic Affairs and Energy. Under the title “Industry 4.0 and Law”, roughly 130 experts from various sectors discussed the effects of AI on existing legislation and the challenges facing the legal profession in the future.

Next steps

The next item on the working group’s agenda is sustainability. The experts will address the subject of sustainability and Industrie 4.0 from a legal perspective.

Working group “Legal framework”

HEADED BY: Dr. Hans-Jürgen Schlinkert, thyssenkrupp AG

Industrie 4.0 applications are increasingly transforming business processes and models. These changes bring about new challenges for many companies: How can current laws be applied to digitised production? Ambiguities in relation to contract arrangements, antitrust proceedings, data usage and liability often prevent companies from taking the leap into Industrie 4.0.

The working group covers the legal aspects of implementing Industrie 4.0. To this end, it analyses the current status of German and European law and identifies areas requiring action by companies and policymakers. The aim is to provide legal certainty for companies on their way to digitalisation.

Current publications of the working group:

Cartel law in the light of Industrie 4.0

April 2018 | Working paper
(German only)

https://bit.ly/3Gu56hB

Blockchain and the law in the context of Industrie 4.0

February 2019 | Working paper
(German only)

https://bit.ly/3EmPlXL

Artificial intelligence and the law in the context of Industrie 4.0

February 2019 | Working paper
(German only)

https://bit.ly/3nAEnXL

Artificial intelligence and assistance with complexity

Every second, data from production chains and entire factories is made available on energy consumption, temperature data of machines or product quality data. Artificial intelligence helps manage increasing complexity as this data mounts up and processes become more confusing. It makes it possible to recognise correlations based on large amounts of data. Information is transformed into structured data and knowledge with added value. For example, it can be predicted that a robotic arm will require less frequent servicing for a particular job. An AI-based assistance system can also identify, for example, that factory worker Paul is a visual learner and then support him using videos and graphics. Anomalies detected by AI are used to locate unknown disturbances or correlations.

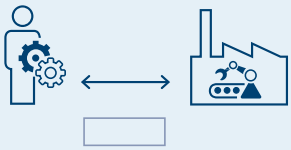
Achievements

The AI project group of the Plattform Industrie 4.0 platform has worked intensively since its foundation on the impact of artificial intelligence on industrial production. The project group brings together a wide range of the Plattform Industrie 4.0 perspectives: Legal professionals, engineers, IT and security experts, AI and HR professionals have worked together on the cross-cutting issue. The body has also benefitted from contributions from experts from the “Plattform Lernende Systeme” and supporting research from the Federal Ministry for Economic Affairs and Energy technology program “Smart Services Worlds II”.

The first working paper completed by the group was “Technology scenario: Artificial Intelligence in Industrie 4.0” (available only in German) In this paper, the experts describe the new opportunities opened up by AI capa-

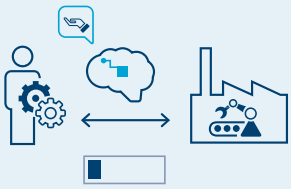
Autonomy levels of Industrie 4.0

Level 0



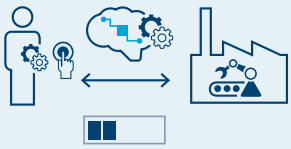
No autonomy,
human beings have full control without any assistance.

Level 1



Assistance with respect to select functions,
human beings have full responsibility and make all decisions.

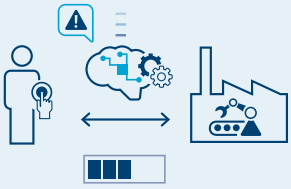
Level 2



Temorary autonomy in clearly defined areas, human beings have full responsibility and specifies (partial) goals.

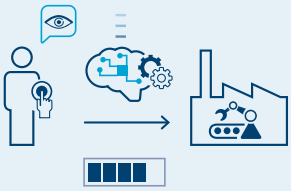
Environment monitored by the system

Level 3



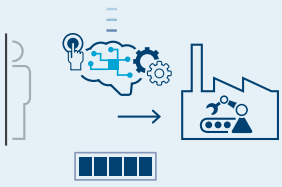
Delimited autonomy in larger sub-areas, system warns if problems occur, human beings confirm solutions recommended by the system or function at a fall-back level.

Level 4



System functions autonomously and adaptively within defined system boundaries, human beings can supervise or intervene in emergency situations.

Level 5



Autonomous operations in all areas,
including in cooperation and in fluctuating system boundaries, human beings need not be present.

bilities. Different autonomy levels describe the design possibilities offered by AI for industrial processes from manual to autonomous processes. The levels in this case are not intended as an assessment. Instead, the differentiation between the levels of autonomy shows where a current need for action exists and which questions will only become relevant in the future. The classification provided allows discussion on the use of AI and provides a basis for future recommendations for action. The authors of the paper encourage readers in companies to engage with the topic, recognise results chains and be able to make their own decisions.

The publication "Artificial intelligence (AI) in security aspects of Industrie 4.0" (only available in German) describes the current status in spring 2019. It is aimed at professionals and decision-makers from industry and politics who want to gain a basic understanding of AI's technologies and applications. Our experts present the advantages of AI for industrial cybersecurity and also describe new security risks posed by the technology. In the closing chapter, they offer recommendations for action to manufacturers, integrators and operators as well as to policy-makers.

The "Legal framework" working group has also covered the topic of artificial intelligence. In their publication "Artificial intelligence and the law in the context of Industrie 4.0", the experts of the working group examine whether existing legal norms adequately cover artificial intelligence. They also provide recommendations for action.

Outlook

In the months ahead, the Plattform Industrie 4.0 will explore the impact of using artificial intelligence on the ten application scenarios it has developed. It will prepare practical recommendations for action on this basis.

AI & Learning – HR managers and works councils tackle this topic intensively in the platform. It is undoubtedly clear that further education and lifelong learning are becoming more important in the world of connected industry. Intelligent assistance systems can help employees develop the necessary skills. Initial presentable results on the use of AI in education should be available before the end of 2019.

Working group “Technology and application scenarios”

HEADED BY: Johannes Kalhoff, Phoenix Contact GmbH

Industrie 4.0 signifies constant change. Technologies continue to evolve and find new fields of application. In a world of moving targets, mobility is key. Experts from the “Technology and application scenarios” working group are therefore exploring new topics. They attend symposiums and talk to specialists in the relevant fields. Based on this experience, they evaluate developments and integrate them into the work of the Plattform 4.0 Industrie. One of the working group’s initiatives was to set up the Artificial Intelligence project group, which straddles multiple working groups but is managed by this working group. This group is presenting its first results at the 2019 Hannover Messe.

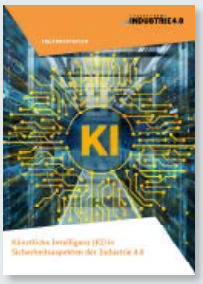
The working group not only discovers new topics, it also combines existing topics. Its application scenarios make abstract concepts and big ideas more accessible and tangible. These scenarios show how technologies and aspects of Industrie 4.0 (standards, security, work, etc.) interact and how they benefit businesses and their customers.

Current publications of the Plattform Industrie 4.0 on AI (only available in German):

Artificial Intelligence in Industrie 4.0 AG2/PG KI

April 2019 | Working paper (German only)

https://bit.ly/3Gu6kcH



Artificial intelligence in security aspects of Industrie 4.0

April 2019 | Working paper (German only)

https://bit.ly/3CkqIuf

Artificial intelligence and the law in the context of Industrie 4.0

February 2019 | Working paper (German only)

https://bit.ly/3nAEnXL

Usage View of the Asset Administration Shell

February 2019 | Discussion paper

https://bit.ly/3pIp567

MCP – Mobile Controlled Production/ 5G for Digital Factories

January 2018 | Working paper

https://bit.ly/3vTqwzK

Usage Viewpoint of Application Scenario Value-Based Service

February 2018 | Discussion paper

https://bit.ly/3BiwUBK

Vision 2030: Sustainability

Economic, ecological and social sustainability are fundamental social values. Industrie 4.0 incorporates these values, while also enabling significant progress in sustainability measures. Essentially everyone's prosperity and quality of life is largely based on a forward-looking and competitive industrial sector. Industrie 4.0's ecosystem of innovation and implementation therefore provides a fertile environment, both for a sustainable Industrie 4.0 and for achieving sustainability through Industry 4.0. In so doing, it also makes an important contribution to maintaining our society's standard of living.

Decent work and education

By placing human beings at the heart of its approach, Industrie 4.0 significantly supports the dialogue between the social partners and contributes to further improvements in working conditions. Furthermore, with an innovative equipment manufacturing industry and an internationally competitive user industry, **Industrie 4.0 helps maintain a high level of employment**. Multiplier and spillover effects extend to other industries. The **outstanding educational level of the workforce** provides a stable basis for lifelong learning, which is supported by a variety of further education opportunities tailored to particular needs. These opportunities must be proactively used and developed to meet shifting skill requirements.

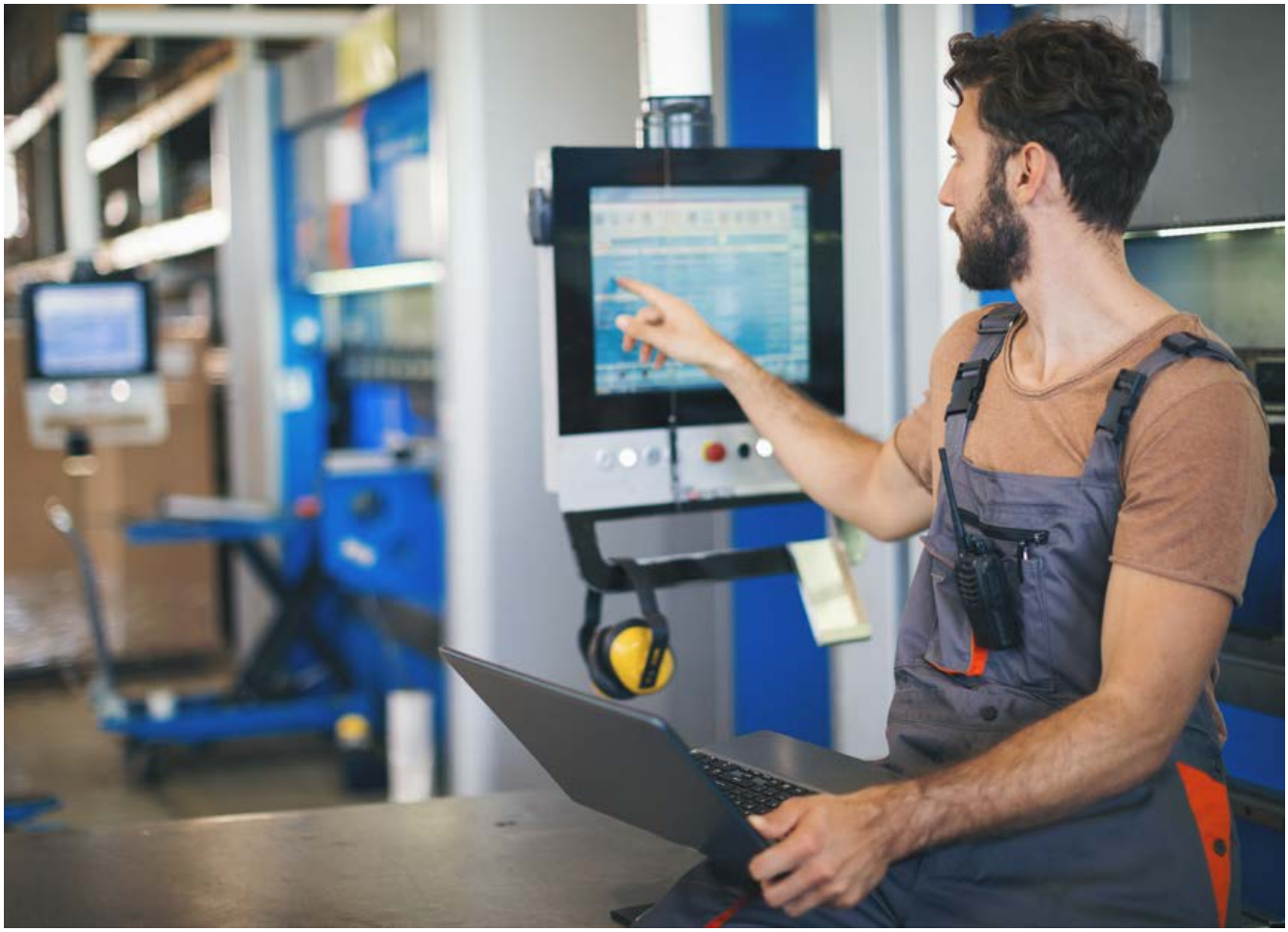
Social participation

Industrie 4.0 represents a transformation of society as a whole. This will be accompanied by far-reaching changes for the stakeholders. The overarching goal is for **Industrie 4.0, as a force for industrial and social innovation**, to open up new opportunities for these stakeholders, as well as presenting them with challenges. This process of societal change requires not only close cooperation at company level, but also participation and co-determination by all stakeholders: It needs to start with dialogue between the social partners in individual companies, take account of cross-company and cross-sectoral aspects of cooperation and address questions affecting society as a whole in relation to using digital technology and artificial intelligence in our everyday lives.

Climate protection

Industrie 4.0 allows greater harnessing of potential resource efficiencies. In combination with design and procedural approaches, closed substance cycles can be concluded over the entire product life cycle. Products become carriers of services under service-oriented business models. They thus remain under the care and maintenance of the manufacturer, who is then in a position to implement more sustainable processes from the design stage. **Industry 4.0 is thus a key enabler for a closed substance cycle as well as for overall environmental and climate protection**.

Fig. 3: Success factors for effective training in a company environment



Training measures for the future

Digitalisation is fundamentally changing the way we work in industry. The advent of Industrie 4.0 signifies structural change that will also affect demands on employees. Significant measures must be taken in the area of further education in order to safeguard a long-term supply of skilled workers, a high level of industrial value creation and secure jobs with good working conditions.

This is also a task for society as a whole. The federal, state and local governments define the framework for qualifying employees and provide support with different programmes and instruments. Consultation on the development of this public framework is currently taking place, in particular as part of the National Training Strategy. The industrial partners have also agreed arrangements in this area, and chambers and social partners are engaged in creating the framework for training, particularly in the field of vocational training.

Training is also very much a matter for companies and employees. Even within such a sound legal or collective bargaining framework, it is not self-evident that the training provided will be good enough or extensive enough to benefit companies and employees in the long term. Training needs and measures cannot be conclusively defined or even optimised – and certainly not by external sources. These needs and measures depend on the values, preferences and objectives of the company decision makers as

well as the employees and general conditions. There are therefore no "One-size-fits-all" solutions.

In Autumn 2018, WG 5 "Work, education and training" held a "scoping workshop". During this workshop, existing and emerging changes relating to the topic of qualifications for the fourth industrial revolution were analysed, while the expectations and required actions of stakeholders were also considered. This workshop produced a new sub-working group of WG 5: "Training 4.0".

Based on their experience across a number of different companies, members of the sub-working group are identifying success factors for sustainable training in digitised industry which would make sense both economically and socially. Numerous interviews were conducted and evaluated with companies from the WG. Key success criteria were then defined in six categories (Fig. 3). These categories are:

- **Organisation, culture & management**
- **Strategic human resource planning, skills management**
- **Portfolio, supplier management & formats**
- **"Learning organisation" links?**
- **Learning in the process of work**
- **Digital infrastructure**

The next step for the sub-working group is to compile its findings from the interviews in an input paper. In addition, contact should be made with the Research Council to prevent any duplication of structures and a general exchange should also take place with the Federal Ministry of Education and Research (BMBF). This will contribute to the long-term goal of developing a Reference Model 4.0.

Future modes of working

The way people work together and organise themselves is also being transformed by Industrie 4.0. Since a single "one-size-fits-all" solution is no longer valid and we cannot predict what the factories and offices of the near future will look like, it is all the more important that we are able to act and react precisely, flexibly and quickly. The more work that robots and computers can take over, the more important it is for employees to focus on doing what only humans can do. The Plattform Industrie 4.0 wants to encourage an agile approach to work – in the interests of employees and companies and in order to help ensure that Germany remains attractive as a business location.

Agile working is fun. For that reason alone, it is useful work. It relies on feedback loops. If we consider that lack of feedback is one of the main causes of job dissatisfaction (including mental stress), the agile approach to work clearly offers potential for improving working conditions. Agile working must be combined with employee attentiveness and resilience. When properly interpreted, agile working is also a healthy approach, in which your own limits, existing regulations and protective regulations are still recognised.

Within the working group "Work, education and training", a group of thought leaders has developed its own sub-working group, which has set itself the goal of encouraging people to try new forms of work. In a first step, the sub-working group identified three levels at which an agile approach can take effect: the individual, the organisation and cooperation between organisations. The group then used interviews about specific projects at these levels to record particular obstacles and procedures and come up with an initial definition of agile working. In addition, the sub-working group is planning an event to try out new methods in a low-risk environment, while developing key issues and solutions to future modes of working. The concept was developed over a one-day retreat for the group and presented to the entire WG 5 in January. The logic and approach applied reflected elements of agile working: The planned event was tested after content input on a small scale with WG 5, which worked in three separate groups on different tasks with three agile methods. The participants' experiences and suggestions were captured in short videos and used to futher refine the event design. The key finding was that agile methods need to be actually experienced,

rather than simply discussed in theory. Agile working is a mindset that must be internalised.

The next steps will be to elaborate any federal policy issues in conjunction with the Federal Ministry for Economic Affairs and Energy and the Federal Ministry of Education and Research, plan the event in more precise detail and also examine possible synergy effects with the work completed by other sub-working groups. The event will take place in Berlin in the second half of the year. An input paper is also being drafted, summarizing the insights and key aspects of agile forms of work.

In addition, the third sub-group "Artificial Intelligence & Learning" and its members unites the Plattform Lernende System and the working group "Work, education and training". The sub-group tackles the future working environment with a focus on AI: What influence do forms of AI such as people analytics or automation of production and in the area of administration of industrial companies have on the future? What does crowdworking mean for society as a whole? The working group is striving to foster a more objective debate, analyse implementation examples and develop action areas. To this end, one of the working group's aims is to participate in the AI conference in autumn 2019. During this conference, it is planned that practical implementation examples will illustrate the difficulties and challenges associated with AI, while demystifying the term. Scientists, businesspeople and policymakers will be shown the use of AI in the modern workplace through practical examples. The sub-working group also works together with the above-mentioned, cross-project group AI.

Working group "Work, education and training"

HEADED BY: Martin Kamp, IG Metall

Using practical recommendations and best practices, the working group will show how skilled digitised work can be implemented in companies. In terms of social partnership, the working group acts as a practical sounding board and thought leader for the future working environment of industry.

Industrie 4.0 is transforming the working environment. New areas are emerging, while old areas are in flux. Education and training as well as employment models are being redesigned.

The transition to a connected industrial sector and good working environment can only succeed if everyone – from business owners to employees – is involved in the process of change. The experts from the Plattform Industrie 4.0 bring together works councils and training managers from companies to discuss key questions about work, education and training.

The aim of the "Work, Education and Training" working group is to proactively shape future changes in cooperation with the social partners.

Practical application for SMEs

Industrie 4.0 transfer network

Germany as a competitive location for business and industry: top of the class for innovation capability; must do better in the area of practical application

The World Economic Forum's Global Competitiveness Report ranks Germany in first place in terms of innovation capability.[2] However, with regard to "ICT adoption", Germany lags behind in 31st place. The extent, efficiency and speed of transferring these technologies into practice are critical factors in realising the added value of innovation capability, particularly in SMEs. Germany must do better in this regard.

The transfer network is an important economic policy initiative to help SMEs benefit from the efficiency and speed of Industrie 4.0 innovations by supporting their implementation in practice. This network was established by the Federal Ministry for Economic Affairs and Energy and the Federal Ministry of Education and Research and is a structure that actively links the transfer stakeholders and leverages common synergies. The number of partners almost doubled in the last year. They all share the same objectives: to consolidate strengths, share resources and together reach more of the small business community. All SMEs will ultimately benefit from this.

The Plattform Industrie 4.0 is also making a contribution by means of its own offerings, such as the Industrie 4.0 online map, online library or the Industrie 4.0 Compass. The partnership between the platform and the Association of German Chambers of Commerce and Industry in the form of a roadshow – Industrie 4.0@Mittelstand – is already entering its fourth year. To date, more than 50 events have taken place throughout Germany; another 20 dates are at the planning stage for 2019.

Ideas for new synergy projects are developed in the transfer network. The following new projects were initiated last year:

- Detailed testimonials from SMEs describing their entire transformation process as they move towards Industrie 4.0 (case studies). The examples are clearly presented with photographic and video documentation.

2 The Global Competitiveness Report (GCR) is published each year by the World Economic Forum (WEF) and ranks the economies showing the greatest opportunities for growth. A total of 144 economies are analysed. http://reports.weforum.org/global-competitiveness-report-2018/.

- A catalogue of Industrie 4.0-related technologies and transformation-related issues is in progress. More than 100 entries, including links to sample applications or scientific institutions, have been prepared for the catalogue. The result is a knowledge network, which, for example, provides a comprehensive range of services to the transfer stakeholders, helping SMEs to identify specific opportunities and possibilities.

The *Länder* have engaged in a more in-depth dialogue. More than 100 *Länder*-specific support programmes have been compiled and presented to other *Länder*. Initially planned as a one-off event, this initiative is now being continued due to the good response it has received.

In recent months, the transfer network has more actively addressed the transfer of technical content, with a particular focus on the transfer of the administration shell: there are great opportunities for SMEs to position themselves as innovation pioneers in global competition. At the same time, the issue is complex: What information do companies need? What impresses them? Where do they need support? This and other questions were reason enough for multiple partners to explore such a 'tough nut' issue in several pilot transfer workshops. With these lessons learned, SME-appropriate formats and contents can now be developed in order to apply the administration shell as a strategic key innovation in SMEs. Other technical initiatives, such as IT security, are currently being formulated.

Based on a preliminary study, the very experienced partners and the Research Council are already considering how the transfer itself, and its established mechanisms and formats, can be enhanced. In conjunction with the academic community, the transfer network could thus also become a nucleus that would boost the transferability of the innovation system as a whole and thus make a contribution in such a way that future country comparisons would show that Germany is an Industrie 4.0 innovation and application ecosystem.

For further information, see www.transfernetzwerk.de

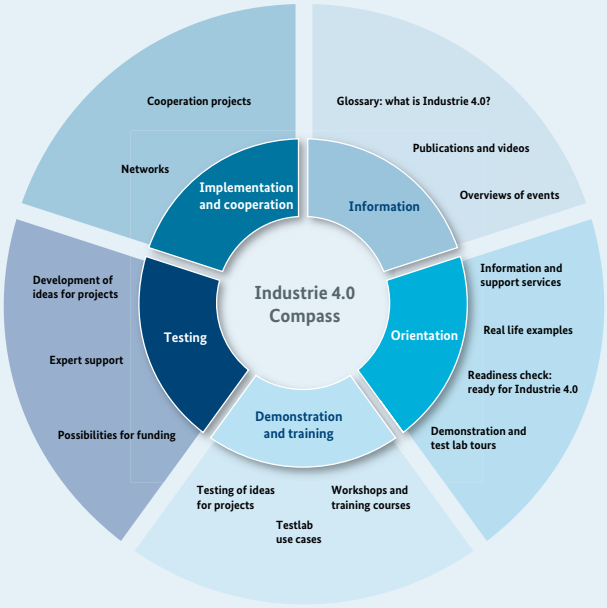
Support services for companies

Industrie 4.0 map: examples of application and use cases

The **Plattform Industrie 4.0's online map** depicts more than 360 examples of Industrie 4.0 in practice in Germany. The map also shows 76 test centres where companies can research, test and develop their Industrie 4.0 applications. Companies will also find **66 networks, clusters, centres and initiatives** that offer non-commercial information and advice services.

Industrie 4.0 Compass: roadmap for the digital transformation

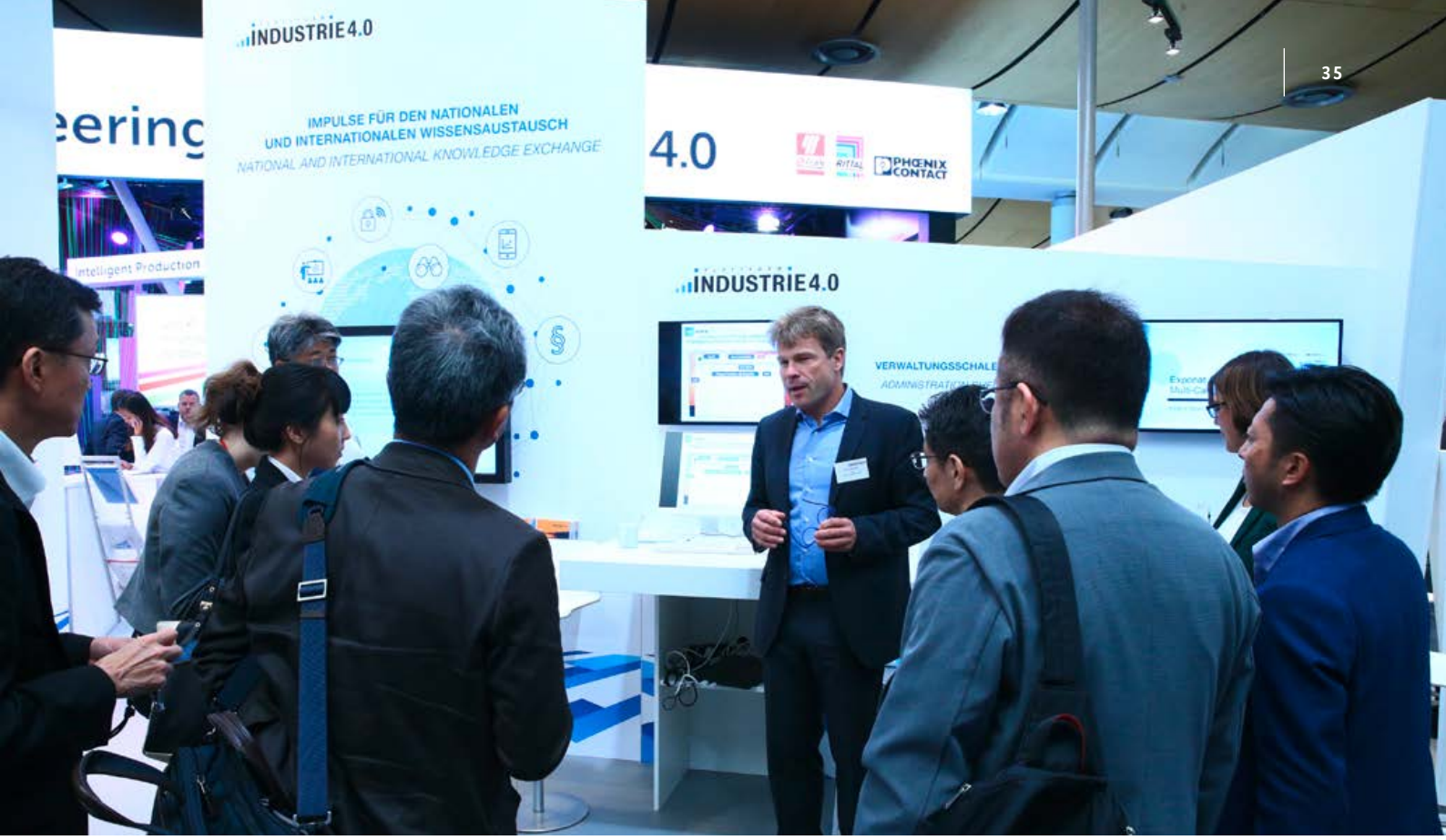
The Industrie 4.0 Compass provides guidance and a quick overview. To enable companies to gain a rapid overview of **Industrie 4.0 support services**, the Compass offers a structured and systematic categorisation of the available services. It lists services offered by centres of excellence, regional networks, *Länder* initiatives and many other transfer providers. The list is being constantly updated.



Industrie 4.0 online library and I4.0@Mittelstand workshop series: expert knowledge on hand

The **online library** contains **findings and guidelines produced by the platform**, as well as **publications issued by the platform's partners**. More than 130 publications are available as free downloads. They range from introductory documents about Industrie 4.0 to highly specialised expert papers, from recommendations for action and studies to guidelines. The Plattform Industrie 4.0 and the chambers of industry and commerce together offer a **series of workshops**. Here, companies can engage in a practical dialogue with the platform's experts and discuss issues such as digital business models, data and information security and standards.

All publications are available for download from the Plattform Industrie 4.0's online library:
www.plattform-i40.de/IP/Online-Bibliothek
Also available in English



International activities

The Plattform Industrie 4.0 as an international hub and driving force for debate

The platform tackles future-oriented issues in several bilateral and multilateral partnerships and helps shape international debate on the digital transformation of production. The action areas outlined in Vision 2030 are reflected in the international dialogue and the invitation to develop solutions together is carried through from the platform into the shared activities.

'Interoperability' is a buzzword that has been on the agenda since the platform was first established – primarily in conjunction with the key question of how internationally open and interoperable standards can be developed. In addition to harmonising various reference architectures, the experts are now also thinking about IT security when considering standards.

A highlight was the global security conference "Securing Global Industrial Value Networks – Synchronising International Approaches", which took place in May 2018. The two-day conference focused on concepts relating to IT security and trustworthiness in the cross-border movement of data. The issue is contextualised in the "autonomy" action area. International representatives from the European Union, ministries, regulatory authorities and industry initiatives from China, Germany, France, Italy, Japan and the USA also participated in the discussion. The findings are published in a conference brochure.

Extracts outlining the activities initiated within the framework of the international partnerships are presented on the following pages:

Conference report "Securing Global Industrial Value Networks – synchronizing international approaches"

May 2018 | Conference Report

https://bit.ly/3EifXt1

Japan: Robot Revolution Initiative

The activities involving our Japanese partners in the Robot Revolution Initiative (RRI) and the Japanese Ministry of Economy, Trade and Industry (METI) made the most strides last year.

In September, Jörg Hofmann (Chairman of IG Metall and a leading member of the platform) participated in an RRI seminar on the future of work where he presented the views of German workers. In October, a larger delegation from the platform travelled with Prof. Dr. Kagermann and representatives of different WGs to Japan. The German embassy's Global Symposium on Industrie 4.0/Connected Industries was on the agenda as part of the Ceatec technology trade fair. Just one day later, the 4th Robot Revolution and Industrial IoT International Symposium 2018 – Industrial IoT Future Images and International Standards Connecting the World took place at the World Robot Summit. Key topics were standardisation, IT security and digital business models and the introduction of the use case scenario of Value-Based Services. The trip concluded with a workshop on digital business models.

At the Plattform Industrie 4.0 conference Securing Global Industrial Value Networks – Synchronising International Approaches, the Japanese delegation, which included representatives of the RRI and the METI, was one of the largest international delegations. A position paper was presented outlining the findings of the previous joint work: Facilitating International Cooperation for Secure Industrie 4.0.

Expert workshops and the German-Japanese Economic Forum are planned as joint formats for the Hannover Messe 2019.

Usage Viewpoint of Application Scenario Value-Based Service
February 2018 | Discussion paper
https://bit.ly/3BiwUBK

Usage View of the Asset Administration Shell
April 2019 | Discussion paper
https://bit.ly/3pIp567

Facilitating International Cooperation for Secure Industrial Internet of Things/Industrie 4.0
February 2018 | Paper
https://bit.ly/3bhu19K

USA: The Plattform Industrie 4.0 at the Hannover Messe USA

In September 2019, the platform introduced itself in Chicago with a delegation and a German-American event forum on the fringes of the city's largest manufacturing technology show, IMTS. The platform had invited American initiatives to a partnership workshop. On the American side, the **Manufacturing USA network** and the **Manufacturing Leadership Council** used the opportunity to network with German experts and to bring each other up to speed on their activities. The Industrial Internet Consortium (IIC), with which the platform

has conducted a fruitful partnership for the last three years, and the **National Institute of Standards and Technology (NIST)** were also involved. Interoperability was high on the agenda as a joint priority. The experts discussed standardisation requirements on both sides of the Atlantic and presented interfaces between the RAMI 4.0 and IIRA reference architectures and the administration shell as possible solutions.

The partnership with the **Industrial Internet Consortium** was restructured over the course of the year, with the result that issues can now be processed faster. The subject of edge computing was also added to the discussion about the digital twin or administration shell, IT security and test beds.

China: New areas of focus defined

The platform's involvement dovetails with the many different partnerships that exist between Germany and China in the area of Industrie 4.0. In 2015, the Federal Ministry for Economic Affairs and Energy agreed to cooperate with the **Chinese Ministry of Industry and Information Technology (MIIT)** in the area of Industrie 4.0. As a result of this agreement, the Chinese invited the ministry to the **second annual meeting of state secretaries and vice ministers** in November 2018 on smart manufacturing and interconnected production processes in Beijing. The dialogue on the framework conditions for German and Chinese companies when implementing Industrie 4.0 projects in both countries gave rise to an animated discussion. Drawing on flagship projects as examples, subjects discussed included the protection of intellectual property, free and secure movement of data and internationally harmonised standards. The existing discussions are also being extended to include new topics such as robotics and artificial intelligence.

In a follow-up to the conference, the **Company Industrie 4.0 and Intelligent Manufacturing Working Group** met with approximately 80 German and Chinese company representatives and agreed to immediately draft a report with recommended actions for policymakers. The dialogue will be continued at the 2019 Hannover Messe.

In the area of research, the Federal Ministry of Education and Research has established a Sino-German partnership in the area of Industrie 4.0 and Smart Services. To this end, **four collaborative research programmes** were launched in 2018. The projects reflect the requirements of German companies and will develop applied solutions that will subsequently be implemented commercially.

Germany and China have already been cooperating in the **German-Chinese Standardization Cooperation Commission** since 1979 and in a sub-working group for standardisation in the area of Industrie 4.0 since 2015. The aim is to jointly develop norms and standards and to expand the associated cooperation in international standardisation organisations (in particular the IEC and ISO). As a result of their work, the group published a mutual recognition of the RAMI and IMSA reference architectures in April 2018.

Alignment Report for Reference Architectural Model for Industrie 4.0/ Intelligent Manufacturing System Architecture

April 2018 | Report

https://bit.ly/318xvJO

Trilateral cooperation between Germany – France – Italy – Europe

At a European level, the German Plattform Industrie 4.0, the **French Alliance Industrie du Futur** and the **Italian Piano Impresa 4.0 initiative** are increasing their cooperation as a trilateral alliance (TRICOOP). There is ongoing dialogue at operational level which takes place within the framework of three working groups on the subjects of standardisation, SME support and political framework conditions. In particular, the first two working groups have examined how they can benefit from the various national experiences. At the interface between standardisation and SME orientation a joint project on the validation of the Administration Shell was initiated and is now in progress.

Other cooperation

Various areas of cooperation were tackled as a result of the 2018 Hannover Messe. The Plattform Industrie 4.0 and the **Mexican Plataforma México I. 4.0** concluded a cooperation agreement. Further activities are planned for Mexico in 2019. The first joint use cases have already emerged from the cooperation between the DACH countries, i.e. the **Plattform Industrie 4.0 in Austria** and the **Initiative Industrie 2025 in Switzerland**. A partnership was signed with the **Smart Industry programme in the Netherlands** in October. The plan is to work together in the area of test centres and a joint inaugural conference has already taken place. In **Australia**, the former Industry Task Force has been ramped up and now operates as the **Industry 4.0 Advanced Manufacturing Forum**. An expert discussion on digital business models is planned for the 2019 Hannover Messe. The dialogue with **Korea**, which started in 2017, is also being continued, as are activities in various **EU countries**, with the **EU Commission**, the **World Economic Forum and many other international stakeholders**.

(Inter-)national standardisation

Industrie 4.0 is a joint effort – especially in the field of standardisation. The Plattform Industrie 4.0's working group "Reference architecture, standardisation and norms" (WG1) is gradually developing the principles for open Industrie 4.0 standards. The three major trade associations, Bitkom (German Association for IT, Telecommunications and New Media), VDMA (German Engineering Federation) and ZVEI (German Electrical and Electronic Manufacturers' Association) are closely involved with WG1's comprehensive conceptual work and are helping to drive it. The ZVEI has mirrored the platform's structure, setting up an equivalent group to WG1 called "Models and Standards". The VDMA is currently working together with the WG1 experts on companion standards for the OPC Unified Architecture (OPC UA) communication protocol. A uniform protocol creates the vocabulary for specific sectors and, using a set of practical instructions, a standardised method of developing submodels is specified. Bitkom has worked on communication protocols and is addressing the issue in its Communication sub-working group.

The Plattform Industrie 4.0 also has a partnership with Labs Network Industrie 4.0 (LNI 4.0) and the Standardisation Council Industrie 4.0 (SCI 4.0) to manage the transfer of the technology to international Industrie 4.0 standards. This cooperation results in a fast-response process consisting of strategy and concept, testing and standardisation. LNI 4.0 helps companies to try out their use cases in testbeds. The tests are subsequently considered in greater detail by the Cutting Edge Projects sub-working group, which is part of the "Reference architecture, standardisation and norms" working group. The sub-working group ensures that the findings from the tests are fed back into the work of the platform – not least in order to detect gaps in standardisation, identify relevant requirements and initiate discussion of such gaps in the international standardisation committees.

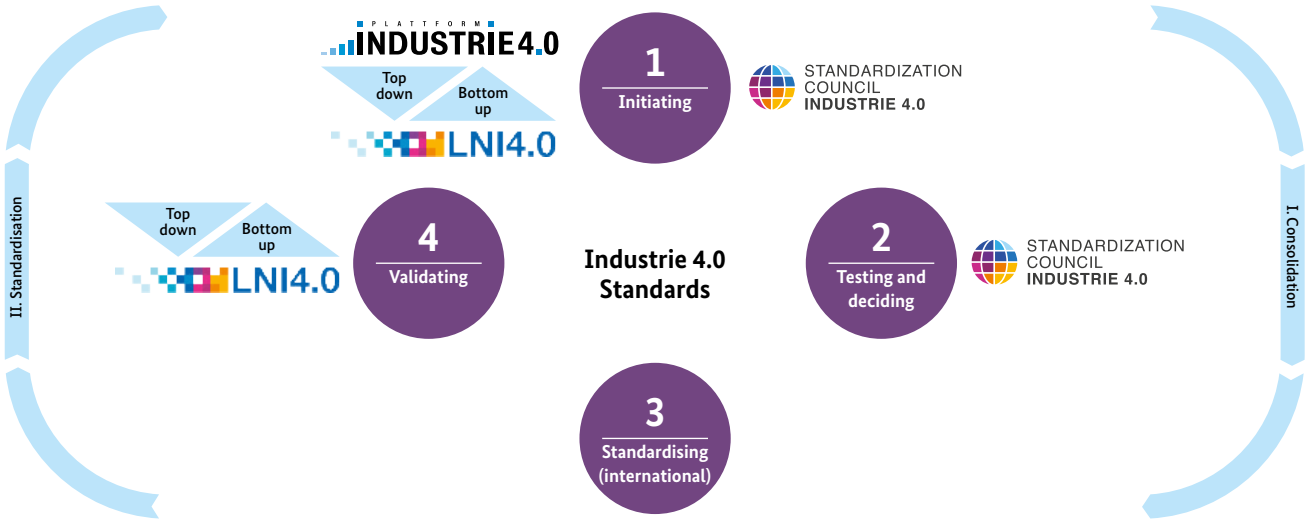


Figure 1 – Industrie 4.0 standardisation process via the three partner platforms, Industrie 4.0, LNI 4.0 & SCI 4.0

The collaboration with SCI 4.0 makes it possible to pool the findings and interests of German industry and to advocate these to consortia and international standardisation bodies. The Plattform Industrie 4.0 is a key driving force in this collaboration and will continue to build on this success in future in order to drive the international discussion on standards. It is also intensifying the cooperation with its partners.

Standard network – Standardization Council Industrie 4.0 and Labs Network Industrie 4.0

LNI4.0 LABS NETWORK INDUSTRIE 4.0

The aim of the **Labs Network Industrie 4.0 (LNI 4.0)** association, which was set up by companies involved with the Plattform Industrie 4.0 together with the Bitkom, VDMA and ZVEI associations, is to support German SMEs in their pioneering role in digitalisation. It acts as a catalyst between theory and practice and allows users to get acquainted with and test new technologies, innovations and business models in test centres and to check their feasibility before they are launched on the market – without any competitive pressure and with minimum financial and technical risk. Members also have the opportunity to incorporate validated results from their test projects into the standardisation process.

STANDARDIZATION COUNCIL INDUSTRIE 4.0

The **The Standardization Council Industrie 4.0 (SCI 4.0)** is the first port of call for future standardisation. Its purpose is to initiate standards for digital production in Germany and to coordinate these at a national and international level. The initiative accelerates standardisation processes and shapes the German standardisation roadmap for Industrie 4.0. SCI 4.0 also represents German interests in relation to consortia, defines requirements for new projects and organises their international implementation.

The Plattform Industrie 4.0

Research Council

The Plattform Industrie 4.0's Research Council comprises 19 representatives from academia and 12 representative from business. The council's role is to provide independent advice to the Plattform Industrie 4.0, its working groups and the federal ministries. As a strategic body, the Research Council supports the Plattform Industrie 4.0 in the development of Industrie 4.0 and in the pre-competitive planning of its implementation within the German economy. In doing so, the Research Council supports the Plattform Industrie 4.0 with its academic, research and development expertise and cooperates closely with its working groups.

The members of the Research Council prepare science-based research recommendations for the implementation of Industrie 4.0 concepts for industrial purposes. In doing so, the Research Council adopts a medium- to long-term perspective. It thus sees itself as providing the impetus for future research topics and acting as a supporter or advisor for the implementation of Industrie 4.0. Its aim is to prepare systematic statements and expert opinions in which current academic research can be amalgamated for industrial purposes. The Research Council then extrapolates conclusions, ideas for future research and recommendations for action from this knowledge.

The members of the Research Council assume the role of multipliers. As such, they initiate the transfer of knowledge both to interested scientific communities as well as to industry, particularly SMEs, the user and equipping industries. In addition, the Research Council strives to observe and evaluate the development of Industrie 4.0's performance profile, raise new pre-competitive, answerable research questions and transpose research results into suitable recommendations for action.

Three expert opinions from the Research Council will be presented at the 2019 Hannover Messe. The members of the Research Council have prepared a memorandum that should be seen as a boost to the development of the innovation system in Germany. The initial results from the project "Akzeptanz und Attraktivität der Industriearbeit 4.0" (Acceptance and Attractiveness of Industrie Work 4.0) and a preliminary study on the development of needs- and user-based SME support for the introduction and application of Industrie 4.0 are also being published.

For more information:
Information and publications from the Research Council are available on the Plattform Industrie 4.0 website (German only): https://bit.ly/3FHbpgz

Presentation of the Research Council on the acatech website (German only): https://bit.ly/3oTiGTs

Members of the Research Council at their meeting on 27.11.2018.

The Plattform Industrie 4.0 is the centralised network in Germany for driving the digital transformation in production.

Working together with policymakers, representatives from business, academia, trade unions and associations, over 350 stakeholders from more than 150 organisations cooperate actively in the platform. As one of the largest national and international networks, the platform supports German companies in implementing Industrie 4.0, in particular by familiarising companies with existing Industrie 4.0 real-life examples. It also provides companies with a significant boost by offering them concrete recommendations for action and referring them to support services and test environments. The platform's multiple international partnerships highlight its key role in the international debate on the subject of Industrie 4.0.

Plattform Industrie 4.0 stakeholders

(Date: March 2019)

A

ABB AG
ABB STOTZ-KONTAKT GmbH
acatech – National Academy of Science and Engineering
Accenture Dienstleistungen GmbH
admeritia GmbH
aicas GmbH
Airbus Group SE
Airbus Operations GmbH
Alexander von Humboldt Institute for Internet and Society (HIIG)
Alibaba Group
Assystem Germany GmbH
Atos Deutschland
AUDI AG

B

BASF SE
Bavarian Ministry of Economic Affairs, Regional Development and Energy
Belden Inc.
Benteler Deutschland GmbH
Benteler International GmbH
Berner & Mattner Systemtechnik GmbH
Bird & Bird LLP
BMW Group
Boge Compressed Air Systems
Bosch Rexroth AG
Bosch Software Innovation GmbH
Brose Fahrzeugteile
Federal Office for Information Security (BSI)
Bundesdruckerei GmbH
Federal Chancellery
Federal Ministry of Justice and Consumer Protection (BMJV)
Federal Ministry of the Interior
Federal Ministry of Labour and Social Affairs
Federal Ministry of Education and Research
Federal Ministry for Economic Affairs and Energy
Federal Network Agency
Federation of German Industries (BDI)
German Association of Energy and Water Industries (BDEW)
German Association for Information Technology, Telecommunications and New Media (BITKOM)

C

Coriant GmbH & Co. KG

D

Daimler AG
German Commission for Electrical, Electronic and Information Technologies of DIN and VDE (DKE)
Deutsche Telekom AG
Association of German Chambers of Industry and Commerce (DIHK)
German Research Centre for Artificial Intelligence (DFKI)
German Institute for Standardisation (DIN)
German Aerospace Center (DLR)
Dürr Aktiengesellschaft
DXC Technology

E

EABB Consulting
EnBW Energie Baden-Württemberg AG
Ericsson GmbH
ESR Pollmeier GmbH Servo-Antriebstechnik
Evosoft GmbH

F

Festo AG & Co. KG
Festo Didactic SE
Forschungskuratorium Maschinenbau e.V. (FKM)
Fraunhofer Institution for Microsystems and Solid State Technologies (EMFT)
Fraunhofer Society

Fraunhofer Institute for Applied and Integated Security (AISEC)
Fraunhofer Institute for Experimental Software Engineering (IESE)
Fraunhofer Institute for Material Flow and Logistics (IML)
Fraunhofer Institute of Optroniks, System Technologies and Image Exploitation (IOSB)
Fraunhofer Institute for Production Systems and Design Technology (IPK)
Fraunhofer Institute for Manufacturing Engineering and Automation (IPA)
Fraunhofer Institute for Machine Tools and Forming Technology (IWU)
Fraunhofer Center for International Management and Knowledge Economy (IMW)
Free University Berlin
Fritz Communication
Fujitsu Technology Solutions GmbH

G

GE Digital
GEA Group
genua GmbH
Gesellschaft für Informatik (GI)
Giesecke + Devrient Mobile Security GmbH
GREIF-VELOX Maschinenfabrik GmbH

H

HARTING AG & Co.KG
HDI Global SE
Helmut-Schmidt University, Institute for Automation
Hewlett Packard Enterprise
Hirschmann Automation and Control GmbH
HiSolutions AG
Hitachi High –Technologies Europe GmbH
Kaiserslautern University of Applied Sciences
Ostwestfalen-Lippe University of Applied Sciences, Institute Industrial IT (inIT)
HUAWEI TECHNOLOGIES Deutschland GmbH
HUAWEI TECHNOLOGIES Düsseldorf GmbH
Hugo Sinzheimer Institute of Labour Law

I

IABG mbH
IBM Deutschland GmbH
ifak, Institute for Automation and Communication
IG Metall
IG Metall Baden-Württemberg
IMA Klessmann GmbH
Infineon Technologies GmbH
Institute for Practical Interdisciplinarity (Institut PI, Berlin)
Institute of Electronic Business e.V. (IEB)
INTEC International GmbH
Intel Deutschland GmbH
ISRA VISION AG
IUNO coordination body

J

J. Müller Agri + Breakbulk Terminals GmbH & Co. KG
Jones Day

K

Karlsruhe Institute of Technology (KIT), wbk Institute for Production Technology
KLOECKNER DESMA Schuhmaschinenfabrik GmbH
Knick Elektronische Messgeräte GmbH & Co. KG
KORAMIS GmbH
KPMG International
KUKA AG
KUKA Roboter GmbH

L

Labs Network Industrie 4.0
Landesnetzwerk Mechatronik BW GmbH
Laserline
Leibniz Centre for European Economic Research (ZEW)
Lenze Engineering GmbH & Co. KG
Luther Rechtsanwaltsgesellschaft mbH

M

M&M Software GmbH
Maschinenfabrik Reinhausen GmbH
Merck KGaA
Microsoft Corporation
Microsoft Deutschland GmbH
Ministry of Finance and Economics, Baden-Württemberg
Mitsubishi Electric Europe B.V.

N

NewTec GmbH
Ministry of Economics, Labour and Transport, Lower Saxony
Noerr LLP
NXP Semiconductors Germany GmbH

O

OFFIS Institute for Information Technology, Oldenburg University
Otto-von-Guericke University Magdeburg (OVGU)

P

Pepperl + Fuchs GmbH
PHOENIX CONTACT Cyber Security AG
PHOENIX CONTACT Electronics GmbH
PHOENIX CONTACT GmbH & Co. KG
PHOENIX CONTACT Software GmbH
PSI Automotive & Industry GmbH

Q

Qualcomm CDMA Technologies GmbH

R

RWTH Aachen University, Fraunhofer Institute for Manufacturing Engineering and Automation (IPA)
Robert Bosch GmbH
Rockwell Automation
Roi Management Consulting AG

S

SAMSON AG
SAP SE
Scaltel AG
Schaeffler AG
Schaeffler Technologies AG & Co. KG
Schneider Electric Automation GmbH
Schuler AG
secunet Security Networks AG
Sick AG
Siemens AG
Sirrix AG
SKW Schwarz Rechtanwälte mbB
Software AG

T

T/S/C Fachanwälte für Arbeitsrecht Schipp & Partner Rechtsanwälte mbB
Technische Universität Berlin, Institute for Machine Tools and Factory Management
Technische Universität Chemnitz
Technische Universität Darmstadt
TU Dortmund University
TU Kaiserslautern University
Technical University of Munich, Institute for Machine Tools and Industrial Management, Department of Informatics
thyssenkrupp AG
tresmo GmbH
TRUMPF GmbH + Co. KG
T-Systems International GmbH
T-Systems Multimedia Solutions GmbH
TÜV Rheinland Industrie Service GmbH

U

UNITY Consulting & Innovation
College of Fine Arts Berlin
University of Göttingen
University of Hohenheim
University of Jena
University of Kassel
University of Paderborn, Heinz Nixdorf Institute
University of Passau
University of Siegen
University of Stuttgart, Institute of Industrial Manufacturing and Management (IFF)
University of Cologne, Chair for Private Law and Legal Theory, Anti-Trust and Regulatory Law, Digital Economy Law

V

Vattenfall GmbH
VDI Association of German Engineers
VDI/VDE Innovation + Technik GmbH
Automotive Industry Association (VDA)
German Engineering Federation (VDMA)
viastore SYSTEMS GmbH
Vodafone GmbH
Voith GmbH
Volkswagen AG

W

Weidmüller Holding AG & Co.KG
Weidmüller Interface GmbH
Werkzeugmaschinenlabor WZL RWTH
WIBU Systems
Wissenschaftliches Institut für Infrastruktur und Kommunikationsdienste GmbH
WITTENSTEIN SE

Z

Zentrum Digitalisierung Bayern
ZF Friedrichshafen
ZVEI – German Electrical and Electronic Manufacturers' Association

Ways to get involved

The broadbased inclusion and networking of all relevant stakeholders enables the Plattform Industrie 4.0 to achieve the dialogue necessary to find innovative responses to the challenges of industrial digitalisation.

The **Working Groups** are open to all interested representatives of companies and works councils. Other experts are invited as guests to be important innovation drivers, dialogue partners and shapers of the substantive debates of the Working Groups.

Participation in the Working Groups
If you would like to participate in the working groups, please send us a short summary of your expertise:
Geschäftsstelle Plattform Industrie 4.0
Bertolt-Brecht-Platz 3
10117 Berlin
Tel.: +49 30 2759506650
geschäftsstelle@plattform-i40.de

Companies are welcome to submit Industrie 4.0 solutions as **application examples** for inclusion on the Industrie 4.0 online map.

https://bit.ly/3l01cUj

Submitting examples of Industrie 4.0 applications
Have you implemented an Industrie 4.0 solution in your company that you'd like to include in our online map? Send us a brief description of your project and your contact information via our contact form.

Research institutes can suggest testing environments for Industrie 4.0 applications for inclusion on the online map.

https://bit.ly/3CoLGIy

Presenting test environments for Industrie 4.0
Would you like to suggest a test environment for the online map in which companies can test Industrie 4.0 applications? Send us your suggestion using our contact form.

Participation in the platform's events allows enables interested parties to discuss Industrie 4.0 topics and network with other stakeholders.

http://bit.ly/2ukZQaf

Events organised by the Plattform Industrie 4.0
Find out about the latest events organised by the Plattform Industrie 4.0 and its stakeholders under 'Termine' at the website below:
www.plattform-i40.de

Publications of the Plattform Industrie 4.0 at a glance

All publications are available for download from the Plattform Industrie 4.0's online library: www.plattform-i40.de/IP/Online-Bibliothek

Plattform Industrie 4.0/Cross-Working Groups

Shaping Industrie 4.0. Autonomy. Interoperability. Sustainability.

Progress report

10-point plan for Industrie 4.0 (only available in German)

10-point plan

Application Scenario in Practice

Working paper

Securing Global Industrial Value Networks – Synchronising International Approaches

Conference report

Reference architecture, standardisation and norms

Language of I4.0 (only available in German)

Discussion paper

Which criteria do Industrie 4.0 products need to fulfil?

Guidelines

Network-based Communication for Industrie 4.0 – Proposal for an Administration Shell

Discussion paper

Industrie 4.0 Plug-and-Produce for Adaptable Factories

Discussion paper

Relationships between I4.0 Components – Composite Components and Smart Production

Working paper

Secure Communication for Industrie 4.0

Discussion paper

Further development of the interaction model for Industrie 4.0 components (only available in German)

Discussion paper

Reference Architecture Model Industrie 4.0 (RAMI 4.0) – An introduction (only available in German)

Guidelines

Network-based communication for Industrie 4.0

Diskussionspapier

Structure of the Administration Shell

Working paper

Interaction Model for Industrie 4.0 Components

Discussion paper

Details of the administration shell – Abridged version (only available in German)

Flyer

Administration shell in practice – Abridged version (only available in German)

Flyer

RAMI 4.0 – a reference framework for digitalisation

Presentation

Secure implementation of OPC UA for operators, integrators and manufacturers

Discussion paper

Details of the Asset Administration Shell: Part 1 – The exchange of information between partners in the value chain of Industrie 4.0 (Version 1.0)

Guidelines

Secure access to CAE data (only available in German)

Discussion paper

Which criteria do Industrie 4.0 products need to fulfil?

Guidelines

Technology and application scenarios

Usage Viewpoint of Application Scenario Value-Based Service

Discussion paper

Benefits of Application Scenario Value-Based Service

Working paper

Exemplification of the Industrie 4.0 Application Scenario Value-Based Service

Working paper

Continuation of the application scenarios of Plattform Industrie 4.0 (only available in German)

Working paper

Research agenda Industrie 4.0 (only available in German)

Working paper

Aspects of the Research Roadmap in Application Scenarios

Working paper

MCP – Mobile Controlled Production/5G for Digital Factories

Working paper

Artificial intelligence in Industrie 4.0 (only available in German)

Working paper

Security of networked systems

Proposal for a joint „scenario“ of Plattform Industrie 4.0 and IIC.

Discussion paper

Integrity of Data, Systems and Processes as the Core Element of Networking and Digitalization

Discussion paper

Secure implementation of OPC UA for operators, integrators and manufacturers

Discussion paper

Security of the administration shell (only available in German)

Working paper

Industrie 4.0 Security in Education and Training

Working paper

Technical overview: Secure cross-company communication

Working paper

IT Security in Industrie 4.0 – Action fields for operators

Working paper

Security in RAMI 4.0

Guidelines

Technical overview: Secure identities

Working paper

IT security in Industrie 4.0 – First steps towards secure production

Guidelines

Access control for Industrie 4.0 components for use by manufacturers, operators and integrators (only available in German)

Discussion paper

Secure cross-company communication with OPC UA (only available in German)

Discussion paper

Artificial intelligence in security aspects of Industrie 4.0 (only available in German)

Working paper

Legal framework

Abridged version: Cartel law in the light of Industrie 4.0 (only available in German)

Working paper

Cartel law in the light of Industrie 4.0 (only available in German)

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