



Platforms for Connected Factories of the Future

Report from the Workshop on Platforms for Connected Factories of the Future

held on 5 and 6 October 2015 in Brussels, Belgium

Organised by Communications Networks, Content and Technology Directorate-General DG
CONNECT, A3

<https://ec.europa.eu/digital-agenda/en/digitising-european-industry>

and

European Factories of the Future Research Association (EFFRA)

<http://www.effra.eu/>

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For any information about the content of this report, contact nect-a3@ec.europa.eu Through the following link the report of the January initiative can be accessed:

<https://ec.europa.eu/digital-agenda/en/news/european-co-operation-innovation-digital-manufacturing>

Disclaimer: The views expressed here are those of the workshop participants and do not necessarily represent the official view of the European Commission on the subject.

EXECUTIVE SUMMARY

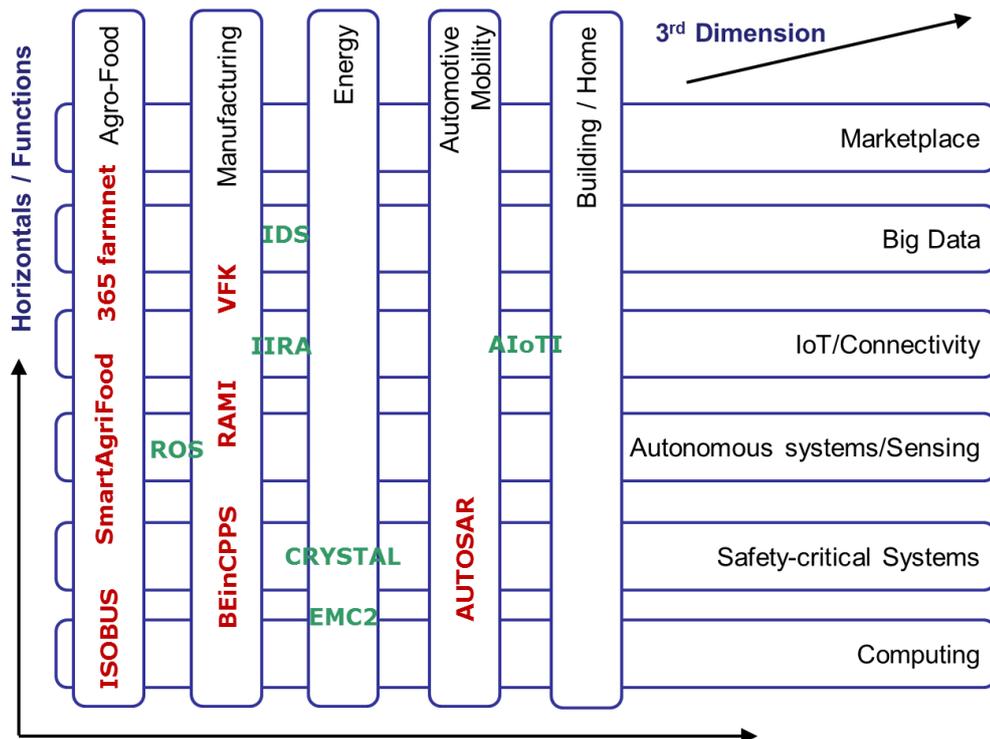
The workshop "Platforms for connected Factories of the Future"¹ took place on 5th and 6th of October 2015 in Brussels. It aimed to exchange views on platform building in the context of Digitising European Industry. About 80 high level participants from industry, research organisations and academia took part in the workshop, which was organised by the European Commission in cooperation with EFFRA – the European Factories of the Future Research Association.

Objective on the first workshop day was to give an overview on existing activities in research and industries regarding platforms for the manufacturing area. Many of the major platform-type activities across Europe were presented (Virtual Fort Knox, BEinCPPS, RAMI, Industrial Data Space, Logistics, IIRA, CyProS, AIoTI, Arrowhead, Vanguard), followed by presentations of several industrial approaches (Atos, Dassault Systemes, IBM, SAP, Siemens).

Guiding questions structured the exchange of views in three breakout sessions on the second day.

Main analytic results are:

- The presented platform approaches can be classified as follows (simplified, not complete, only examples)



- Digitising Industry, different strengths – different approaches²
 - EU – Bringing engineering excellence to the digital world
 - US - Bringing digital innovation to the physical world
 - China - Pragmatic adoption of potentials and long-term strategy
 - Japan - Innovation through adoption

¹ <https://ec.europa.eu/digital-agenda/en/news/platforms-connected-factories-future>

² Results from the German project InBenZHaP, funded by the Federal Ministry of Education and Research

- How to build the ecosystem around platforms?
 - Collaboration in the platform. Competition in the services
 - Collaborate on integration – compete on components and functionality
- How can EU R&I Programmes support platform building?
 - Europe's role is to make sure that platforms development is not done in silos but that critical scale is reached through pan-European collaborations.
 - European industry should join forces even if competing on the market and should agree where and what to collaborate on and where and what to compete on. A critical mass in collaboration is needed.
 - Establish European approach building on national/regional networks and activities
 - The European approach should be to build on what is there and not to start from scratch.
 - Development of reference implementations, test-beds, demonstrators, validations and ecosystem building
 - Education and training of the existing workforce on emerging platforms.

Main Findings of the workshops are:

- European research organisations and Industry is acting at the forefront of platform-building for the connected factory of the future.
- Platforms are reference architectures in combination with appropriate ecosystems. They form multi-sided market places with complementary groups of market actors.
- Holistic approaches along the entire value chain (SME and large enterprises) are needed. Platforms for connected Factories of the future deal with manufacturing at large including the supply chain and the energy supply. It will therefore be essential to bring together manufacturers, manufacturing equipment suppliers and IT companies. It is in this triangle where the current dynamics take place and where borders are blurring. Manufacturing companies play an increasing role as technology drivers and creators of data-driven business models.
- There will be several different platforms in the future. Peer-to-peer platform integration and/or the interoperability along the whole value chain are becoming more and more important. In order to develop broader approaches in a next step, components, functions and services are to be included. Relevant aspects, such as developing reference architectures and testbeds and implementing them, ecosystem-building and validation through demonstrators should be supported by several national and European initiatives.
- Acting on European level is required in order to avoid inefficient silos and bring platforms on an appropriate scale.
- Data protection is a must. Authorities should audit the trustworthiness and privacy of data.
- Industry, particularly users, should be the driving actors in platform building. Funding programmes on regional, national and EU level should provide the framework to make it happen. Research organisations should develop reference architectures, have a mediation role between different market interests and provide infrastructural support for test beds and demonstrators.

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INTRODUCTION AND SCOPE OF THE MEETING

The future of Europe's industry is digital. For Europe to seize its opportunities and be competitive worldwide, we need to act fast, jointly and at appropriate scale. Digital technologies increasingly play the central role in value creation in the entire economy and bring about radical transformation to all aspects of production and related services. This is why the EU's target of 20 percent share of industry in GDP can only be achieved if digitisation of products, processes and business models becomes a core element of all industrial sectors in Europe.

Commissioner Oettinger has proposed the outline of an EU-wide strategy for the digitisation of European industry in order to "ensure that all industrial sectors make the best use of new technologies and manage their transition towards higher value digitised products and processes". A key element of this strategy is "**Leadership in next generation open and interoperable digital platforms**". The workshop on which this report is based addresses exactly this, in order to ensure the availability of state-of-the-art open and interoperable platforms for connected factories of the future which any business can use to make its products, processes and services ready for the digital age.³

Platforms: what are they and why are they so important?

Recent economic analysis⁴ shows that platforms are creating most of the value in the digital ecosystem. Platforms are two-sided (or multi-sided), and they *create value by enabling interactions between two or more customer groups*. Although platforms often include specific stakeholder groups (such as Industrie, 4.0) and although they could include technical platforms (such as Middleware or reference architectures), the platforms we are talking about here are not limited to either one of them: A multi-sided market approach implies that platform providers must get both users and developers of complementary applications on board in order to succeed.

The value of the platform often comes from its size: the more users, the larger the set of peers to connect to and the more developers and equipment providers, the more features will be available on the platform. Platforms also support the creation of ecosystems where specialised and innovative features can be added through *complementary innovations* by any company that wishes to develop this offer. The critical mass and the base technology that is already available are crucial to enabling an *interdependent ecosystem of businesses*.

Platforms can include open or closed ecosystems, but some level of openness is necessary to enable complementors (developers) to interact with the platform. Examples of this are API (Application Programming Interface) and SDK (Software Development Kit). Another characteristic is the level of standardisation of a platform: some are based on standards, others are not. Standardisation is mostly limited to the interoperability with other platforms – if it even exists at all.

³ <https://ec.europa.eu/digital-agenda/en/digitising-european-industry>

⁴ http://is.jrc.ec.europa.eu/pages/ISG/documents/BREUGEL-NewICTsectors_PlatformsforEuropeangrowth.pdf

Well-known examples are in the smartphone domain, where it is attractive for developers to produce "Apps" and for consumers it is attractive to buy a certain brand of phone when many Apps are available. The Apple App store does not have standards, interoperability, or reference architecture, but it does include a software development kit, quality control and a clear revenue model for Apple and complementors. The two-sided relationship between Iphone/Ipad owners and the IOS developers is synergistic in the sense that the growing of one group means more value for the other. It is this *value creating by the interaction of two or more customer groups* that makes platforms so interesting.

Steps in developing 2-sided platforms

Whereas Europe is weak on consumer platforms, Europe is performing well on industrial and professional platforms - open or proprietary (AUTOSAR, fly-by-wire, PLM and CAx, enterprise software. Companies like Dassault, Siemens, SAP, Bosch and ATOS are world leaders in their fields). For this reason it makes sense to start this initiative around the industrial sector in the EU.

In order to build a platform, the following steps have to be taken:

- 1) Identify an area with a clear need of supporting platform building
- 2) Define the (two) sides and scope of the technical basis
- 3) Decide on how to open parts of the infrastructure to attract complementors
- 4) Solve tech issues and create test beds to accelerate the innovation process and help maturing the platform
 - a. complementors can start building applications
 - b. Users can try out the system and the applications build by the complementors
 - c. Consortium can learn what complementors and users need
- 5) Create the ecosystem
- 6) Manage the quality of the contribution of complementors

The development of platforms requires collaboration of key actors and could be supported through research and innovation funded by H2020 and the joint undertaking ECSEL. If Europe doesn't continue to invest in platforms, actors from other parts of the world will do. In particular the large non-EU internet industry is already starting to make strategic alliances with European industry through initiatives like the US-driven "Industrial Internet".

For connected Factories of the Future already several initiatives have started across the EU and beyond. Examples are RAMI, Virtual Fort Knox, FI-Ware based work in FITMAN and BEINCPPS, Industrial Data Space, IIRA, etc. These initiatives will be discussed in section chapter 2.

Purpose of the workshop "Platforms for connected Factories of the Future"

The workshop on which this report is based, aims to stimulate the beginning of the conversation that is needed to achieve the integration of digital technologies. The aim of this initiative is not to create one single platform, but to accept and work on multiple approaches and to think about how we can integrate multiple platforms in a pragmatic way on peer-to-peer basis.

Structure of the workshop

The expectations of the workshop were to clarify in which domains platforms are most needed, which are the business actors to be involved, which business interest they would have, and which technical elements need to be developed.

In order to guide the discussion on platform building, the workshop was structured around the following questions:

- 1) In which **domains** platforms are most likely to bring advantages to EU industry (e.g. the "operating system" of the connected factory of the future)? Which are the **groups** that should be brought together in a multi-sided market?
- 2) How would you build the **ecosystem** around the platform?
 - a. What are **representative companies** that will make up the ecosystem?
 - b. Which **business interest** would they have in being part of the ecosystem?
 - c. How would you **attract** them to participate in the development of the platform?
- 3) What are the **key building blocks and components** (including proprietary/commercial technologies and common/standardised frameworks) for the domains identified? What are you prepared to collaborate/ join forces on platforms? What would you rather compete on?
- 4) Which **technical activities** are needed for the development of a platform?
 - a. Derive and maintain reference architectures?
 - b. Develop and validate reference implementations?
 - c. Support test-beds, pilots, demonstrators and validation environments?
 - d. Support standardisation activities?
 - e. Anything else (please specify)?
- 5) How do we best complement and reinforce **national** and **industrial** approaches/initiatives with EU R&I activities under Horizon 2020?

The workshop was attended by over 70 participants from various fields of interest throughout the EU. These fields included universities, research organisations and several key players in IT infrastructure (Siemens, Dassault Systemes, SAP, IBM, ATOS). The first day various speakers shared their vision related to the questions above, also various existing platforms were discussed and the representatives of the key players presented their notions on the subject.

The second day the attendants were divided into three groups with the assignment to come up with one or two of the most important domains for digital platforms. Then, the questions above were answered for each of these domains. Afterwards the outcomes were shared with the rest of the groups, followed by a general discussion and take-home messages by Maurizio Gattiglio (EFFRA) and Khalil Rouhana (EC). This document follows the same structure as that of the workshop itself.

During the first day of the workshop the following existing platforms were discussed: RAMI, Virtual Fort Knox, FI-Ware based work in FITMAN and BEINCPPS, Industrial Data Space, IIRA, CyPros, ROS, Arrowhead, Vanguard, and key national initiatives.

In this section these platforms are compared according to several characteristics that are explained below, by using AUTOSAR (standardised architecture for automotive software) as an example.

EXISTING PLATFORMS AND THEIR CHARACTERISTICS

Type

Platforms can be made for different purposes, such as organisational, technological and operational purposes. If we take AUTOSAR as an example, we can see that this platform has a technological purpose.

Domain

This refers to the sectoral domain in which the platform is active. For example: AUTOSAR is a platform in the automotive domain.

Status

This refers to the status of a certain platform. For AUTOSAR the status would be 'Implemented'. In other, less developed cases we can see Reference Architectures for example.

Scale

This characteristic can vary from "Niche" to "Broad", the latter meaning that the platform is a broad consumer platform. Since the AUTOSAR platform is specifically focused on car software, its scale can be regarded as "Niche".

Level of standardisation

In the case of AUTOSAR the level of standardisation is high: the Middleware and all interfaces are standardised. However, not every platform is as standardised as AUTOSAR. The extent of standardisation often relates to the interoperability with other platforms.

Openness

This characteristic ranges from "Open" to "Proprietary". As stated before, a certain level of openness is necessary to enable complementors (developers) to interact with the platform. Although AUTOSAR has a high level of standardisation, these standards are open to everybody, which facilitates innovation.

Value creation

Value creation can either be achieved "with" the platform and/or "on" the platform. In the case of AUTOSAR value is created with the platform, as different software companies independently use its interface to develop a product for various types of cars.

Presence of ecosystem

Only when a platform is adopted by an appropriate network of actors it can really add value through a critical mass of users and a high diversity of actors. AUTOSAR eases the cooperation of automobile

manufacturers, suppliers and tool developers through an ecosystem that stretches all over the world, contributing to its success.

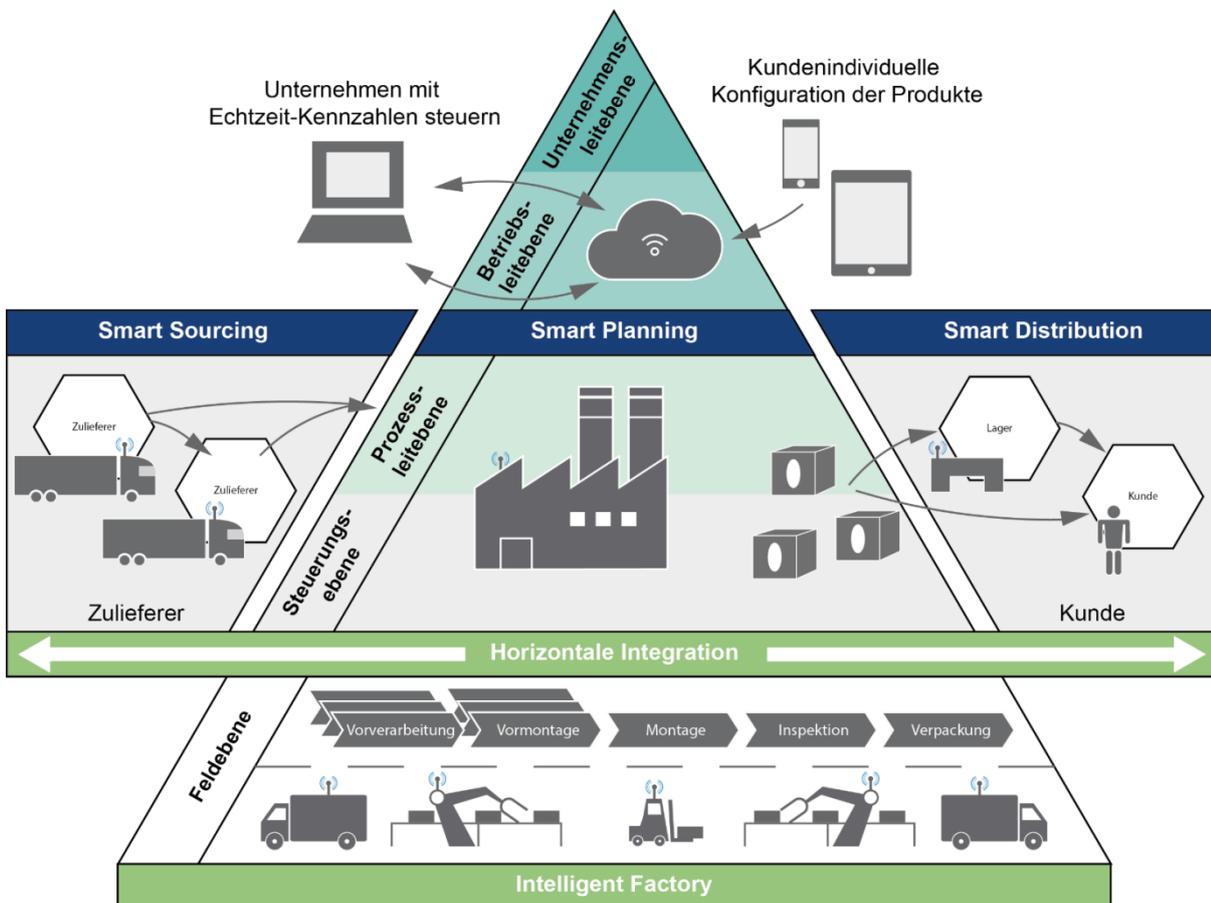
Involved stakeholders

Every platform consists of at least two stakeholders, on both sides of the market. In the case of AUTOSAR the stakeholders are car manufacturers, suppliers and tool developers.

User range

This characteristic refers to whether the user range of a platform is integrated *horizontally*, or *vertically*. Horizontal integration means that the range of users is connected among multiple sectors (cross-cutting), while vertical integration relates to a user range within a single sector (sector specific). Looking at the actors within the AUTOSAR system (manufacturers, suppliers and tool developers), we can conclude that vertical integration is applicable.

Typical technologies associated with *horizontals* are IoT (Internet of Things) and big data platforms. Both can be regarded as a technological subset needed for digitisation. Horizontal integration can be achieved through value creation system networks. The *verticals* on the contrary, are associated with manufacturing, supply chain optimisation and lifecycle and value streams. Vertical integration can be achieved through networked production systems. Also here IoT could play an important role.



Source: Arbeitskreis Industrie 4.0, 2012

Combining horizontal and vertical integration can lead to severe flexibility and connecting of individual production facilities to implement a demand-oriented production. A trend we can see here is that the US typically is dominant on the horizontals (data), and that they are trying to become better in the verticals (manufacturing). In the EU we are facing the contrary: we are bringing engineering excellence to the digital world (vertical) and our challenge is to bring this to the horizontal world.

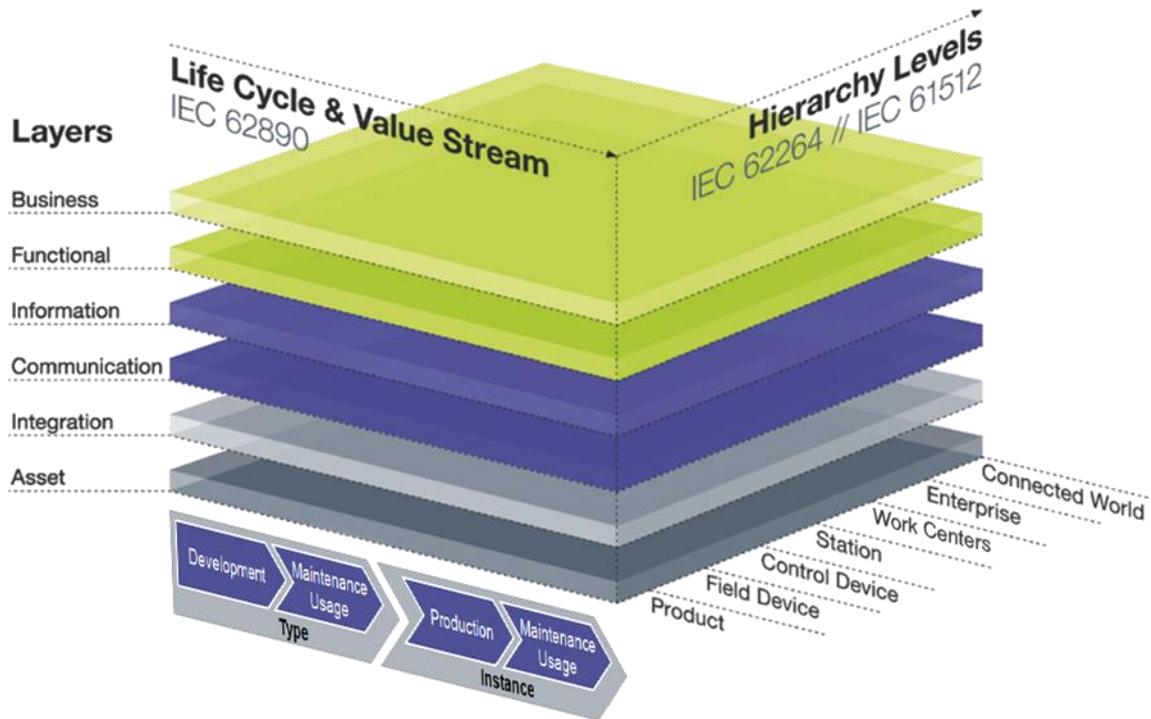
Availability of test beds

Testbedding in this case, is a method of testing a particular platform in an isolated fashion. It may be used as a proof of concept or when a new module is tested apart from the program/system it will later be added to.

Existing initiatives

RAMI

Short for Reference Architecture for Industry 4.0, RAMI is an abstract model for the participants of I4.0 compatible with communication and networking. RAMI has structure compatible with other IoT approaches and a special focus on the manufacturing industry and their specific additional needs. Furthermore, RAMI allows step-by-step migration from current systems.

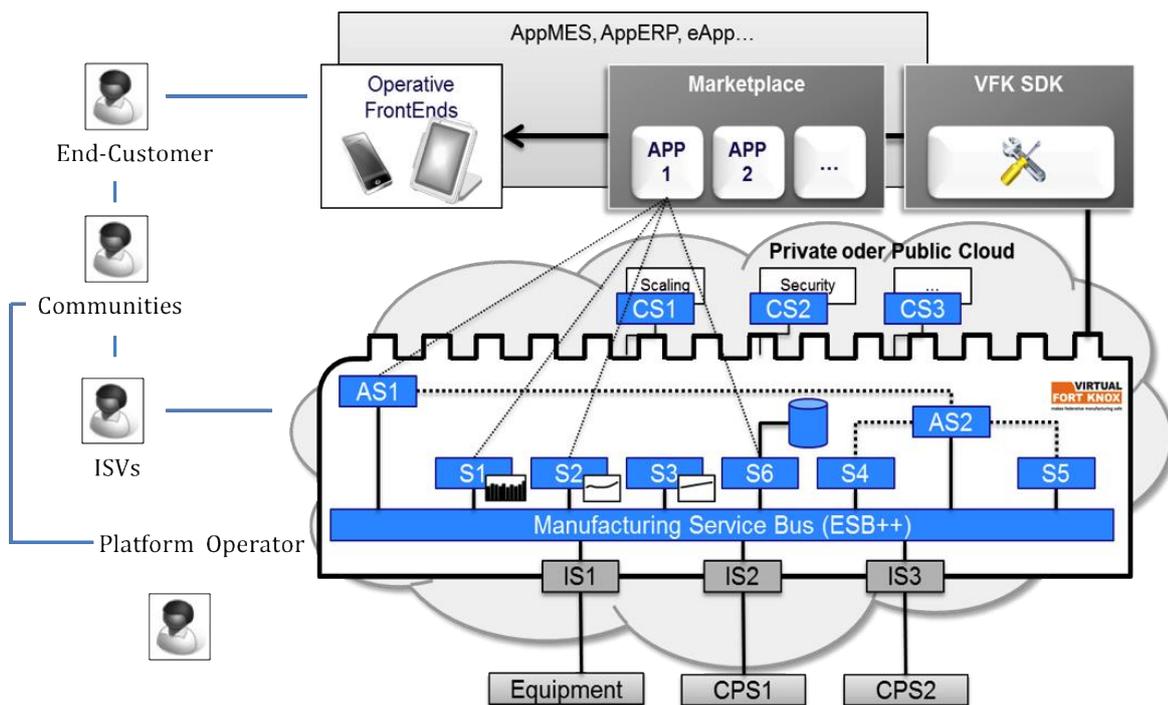


Virtual Fort Knox (VFK) – Industry 4.0 Service Platform

The clear hierarchically structured model we have today will be replaced by the more service-oriented structure of tomorrow. New applications will be based on services and concerning the development of these applications: this will be done by the process owner and simulation will take place in real time. Furthermore, open standardisation becomes more important, bringing efficiency advantages of IT clouds and a focus on information/semantics. These tendencies have contributed towards the development of VFK.

VFK is a secure federative platform for service-orientated applications providing manufacturing-IT services for production companies. The development is based on project founded by the state of Baden-Württemberg, and it has extensive involvement of SMEs from the IT and the manufacturing domain during development. Its advantages are externalization of skills, services and maintenance; lean clients; centralised collection of data; optimisation by statistical learning and the accessibility of best practice solutions.

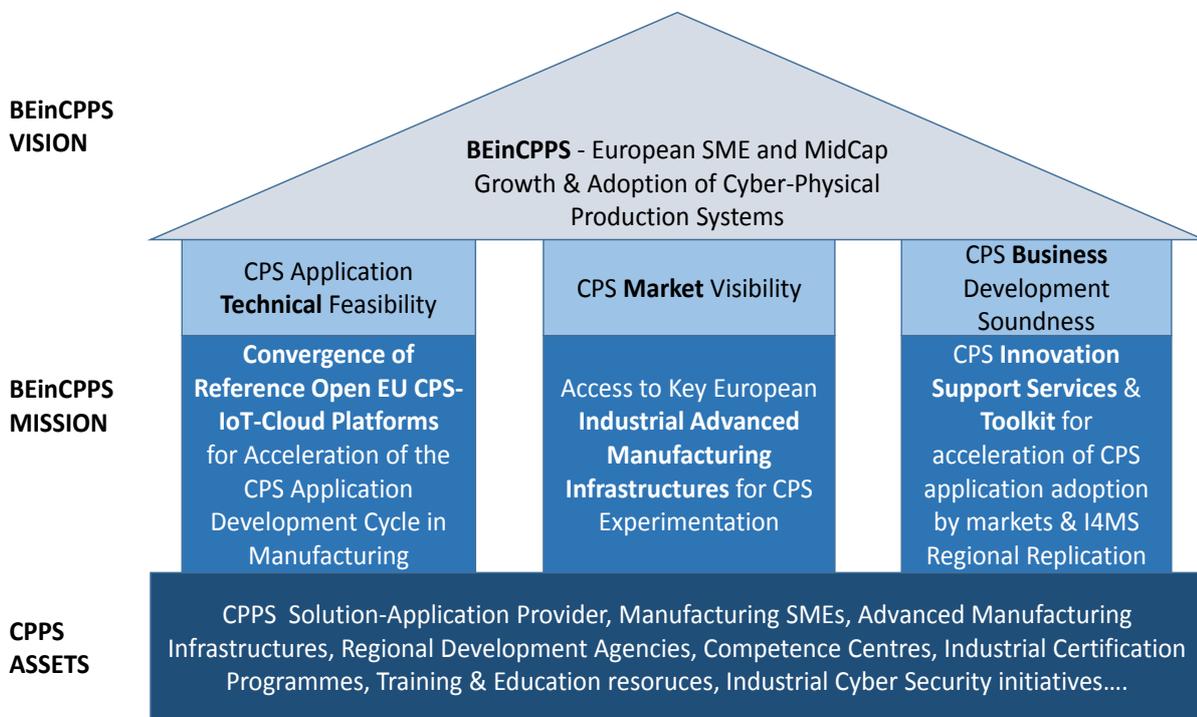
Virtual Fort Knox – An Overview of Components and Roles



BEinCPPS - Business Experiments in Cyber Physical Production Systems

VISION: The full adoption by EU SMEs of CPPS systems and their related service platforms and innovation business models will allow Europe to achieve the ambitious target by 2020 to have 20% of the GDP coming from Manufacturing & Services.

MISSION: BEinCPPS project aims to integrate and experiment a FI-based machine-factory-cloud service platform firstly intensively in five selected S3 Vanguard regions, afterwards extensively in all European regions, by involving local competence centers and manufacturing SMEs. The final aim of this IA is to dramatically improve the adoption of CPPSs all over Europe by means of the creation, nurturing and flourishing of CPS-driven regional innovation ecosystems, made of competence centres, manufacturing enterprises and IT SMEs.

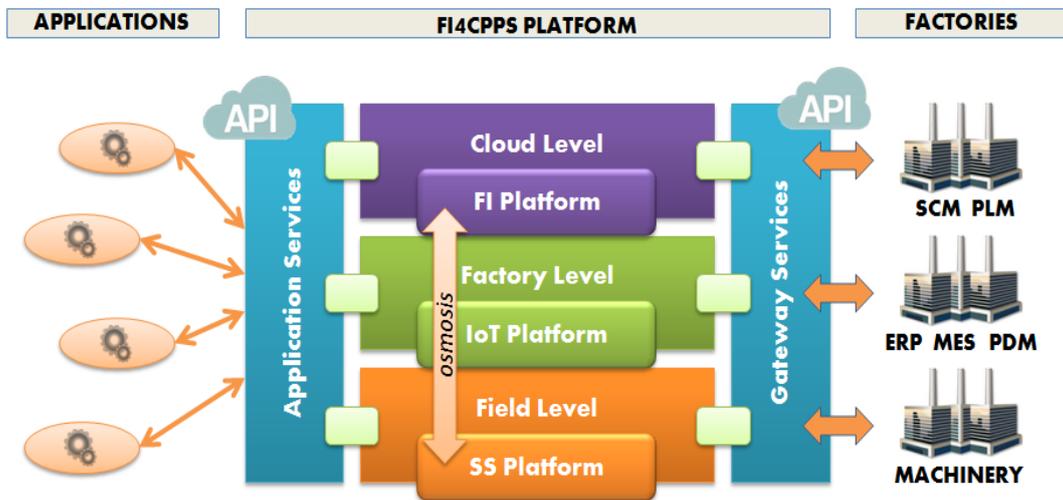


FIWARE-IoT (FITMAN)

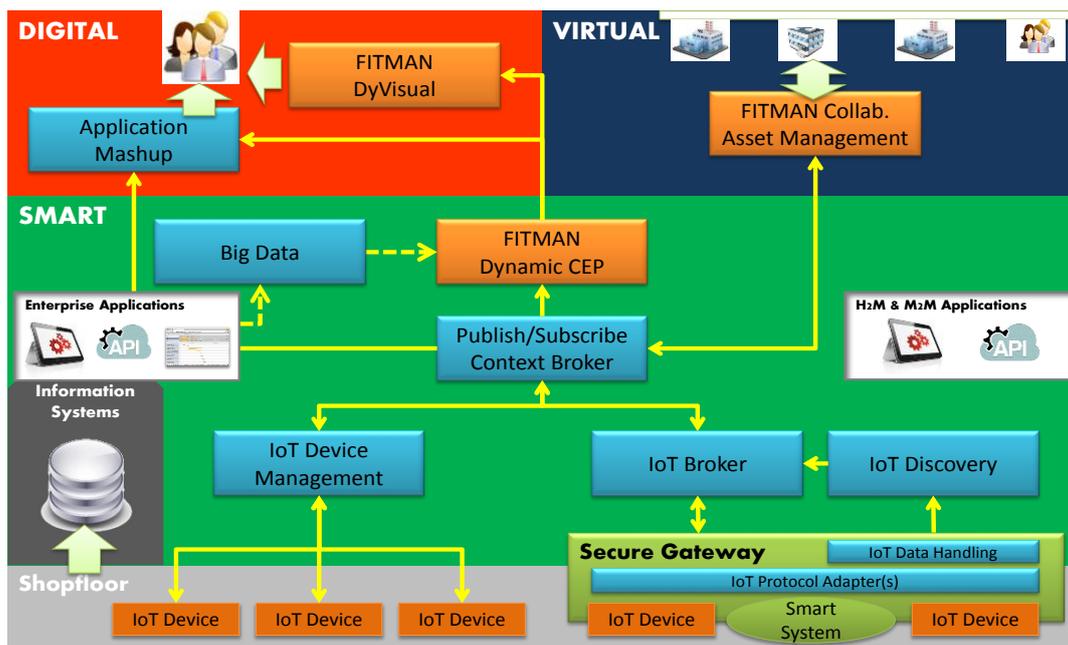
The FITMAN project has been concluded recently. It consists of a work floor of components that transfer IT innovation into manufacturing. The interface of FITMAN will be integrated with the CPPS interface of BEinCPPS.

This platform is two sided by nature: development of applications on the left forms a separated part of the platform. The platform does not want to replicate an enterprise system, but to transfer the new movement of its innovation.

FIWARE is the backbone for the IT part. It does not exactly comprise of two sides, but there are providers and consumers.



The FITMAN IoT for Manufacturing Platform



FIWARE for Industry Value Proposition

FIWARE GENERIC ENABLERS

Generic Enablers (GE) offer a number of general-purpose functions, offered through well-defined APIs, easing development of smart applications in multiple sectors. They will set the foundations of the architecture associated to your application.

Specifications of FIWARE GE APIs are public and royalty-free. You can search for the open source reference implementation, as well as alternative implementations, of each FIWARE GE in the FIWARE Reference Architecture.



DATA/CONTEXT

Data/Context Management
Enabling access, gathering, processing, publication and analysis of context information at large scale.



INTERNET OF THINGS

Internet of Things (IoT) Services Enablement
Make connected things available, accessible, accessible, and usable.



ADVANCED UI

Advanced Web-based User Interface
3D & AR capabilities for web-based UI.



SECURITY

Security
Make delivery and usage of services trustworthy by meeting security and privacy requirements.



I2ND

Interface to Networks and Devices (I2ND)
Build communication-efficient distributed applications, exploit advanced network capabilities and easily manage robotic devices.



APPS

Architecture of Applications / Services Ecosystem and Delivery Framework
Generate, publish, orchestrate and consume applications/services, addressing all business aspects.



CLOUD

Cloud Hosting
Provides computation, storage and network resources to manage services.

DOMAIN SPECIFIC ENABLERS

The FIWARE Catalogue will be extended to include domain-oriented enablers to be combined with those serving general purposes (Generic Enablers - GE). They will cover functionalities that are specific and will help accelerating development of applications, in certain domains.

The perfect solution to make your app focus on a specific vertical.



Manufacturing



Media



eHealth



Energy



Agrifood

BUNDLES

BUSINESS FRAMEWORK CONSUMPTION

The business Framework Consumption Bundle includes a set of GEIs that support different monetization and revenue sharing features.

WIRECLOUD MONETIZATION

The Wirecloud (App Mashup) Monetization Bundle represents one of the use cases of the business Framework and intends to show the potential of the BF features provided by FIWARE in a concrete use case. This use case is based on the use of the business framework.

DATA CONTEXT STREAMS

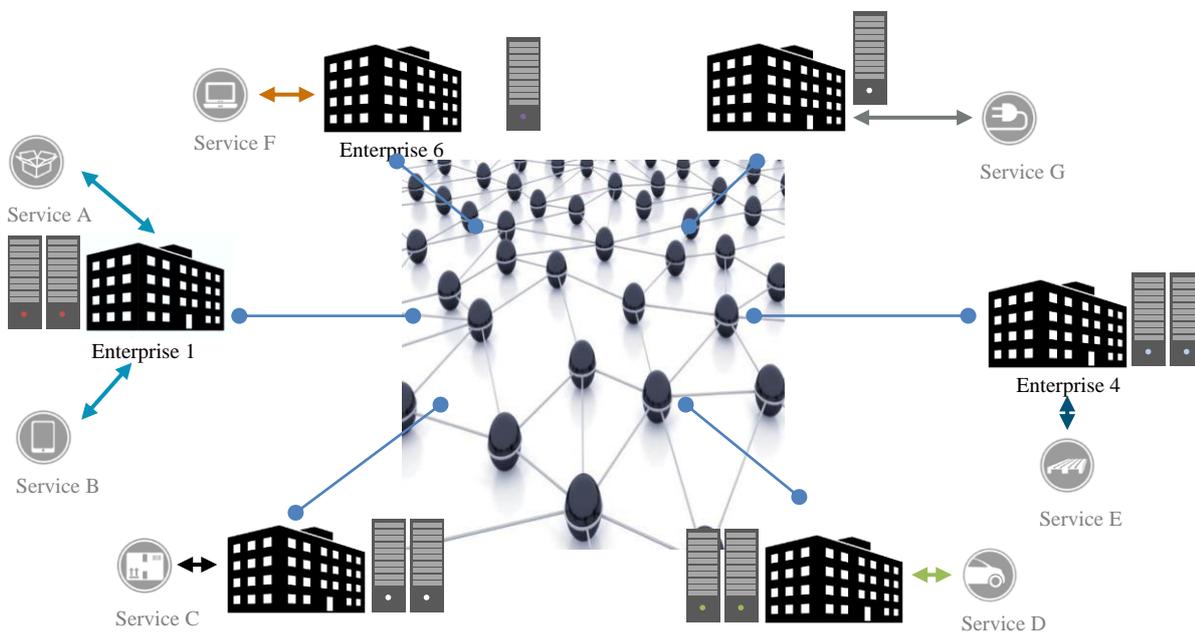
Context Streams generation storage and analysis.



Industrial Data Space (IDS)

This platform consists of a community of more than 30 large German and European Companies that cooperate in a pre-competitive, publicly funded innovation project which involves 11 Fraunhofer institutes for developing IDS reference architecture. For Industry 4.0 IDS forms a Semantic Model bridge between Shop & Office Floor. This *Data-driven Service Architecture* defines *governance, data services, the functional domain* and *security* through the following basic principles:

- **On Demand Interlinking**
 - All Data stays with its owner and is controlled and secured. Only on request for a service data will be shared. There is no central platform
- **Linked Light Semantics**
 - IDS offers a lightweight approach for Data Interlinking with Reference vocabularies and automatic translation/mapping. It forms an intelligent and structured bridge between local representations that creates semantic interoperability.
- **Security with Industrial Data Container**
 - The certified system provides security for all its users.
- **Certified Roles**
 - *Data Owner, Data User, Broker (registry for data sources), IDS-AppStore Provider, Clearing House (usage tracking, accounting/invoicing) and Certification.*



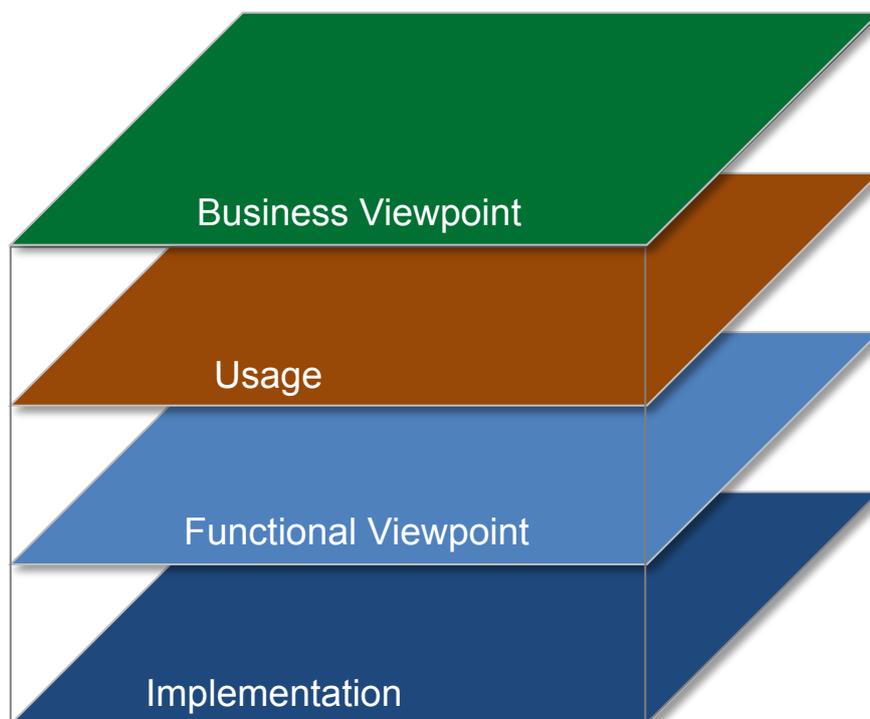
Industrial Internet Reference Architecture (IIRA)

The Industrial Internet Reference Architecture (IIRA) is a standard-based open architecture for Industrial Internet Systems. To maximize its value, the IIRA has broad industry applicability to drive interoperability, to map applicable technologies, and to guide technology and standard development. The description and representation of the architecture are generic and at a high level of abstraction to support the requisite broad industry applicability. The IIRA distills and abstracts common characteristics, features and patterns from use cases well understood at this time, prominently those that have been defined in the Industrial Internet Consortium (IIC). The IIRA design is intended to transcend today's available technologies and in so doing is capable of identifying technology gaps based on the architectural requirements. This will in turn drive new technology development efforts by the Industrial Internet community.

The various concerns of an Industrial Internet System are classified and grouped together as four viewpoints:

- Business
- Usage
- Functional
- Implementation

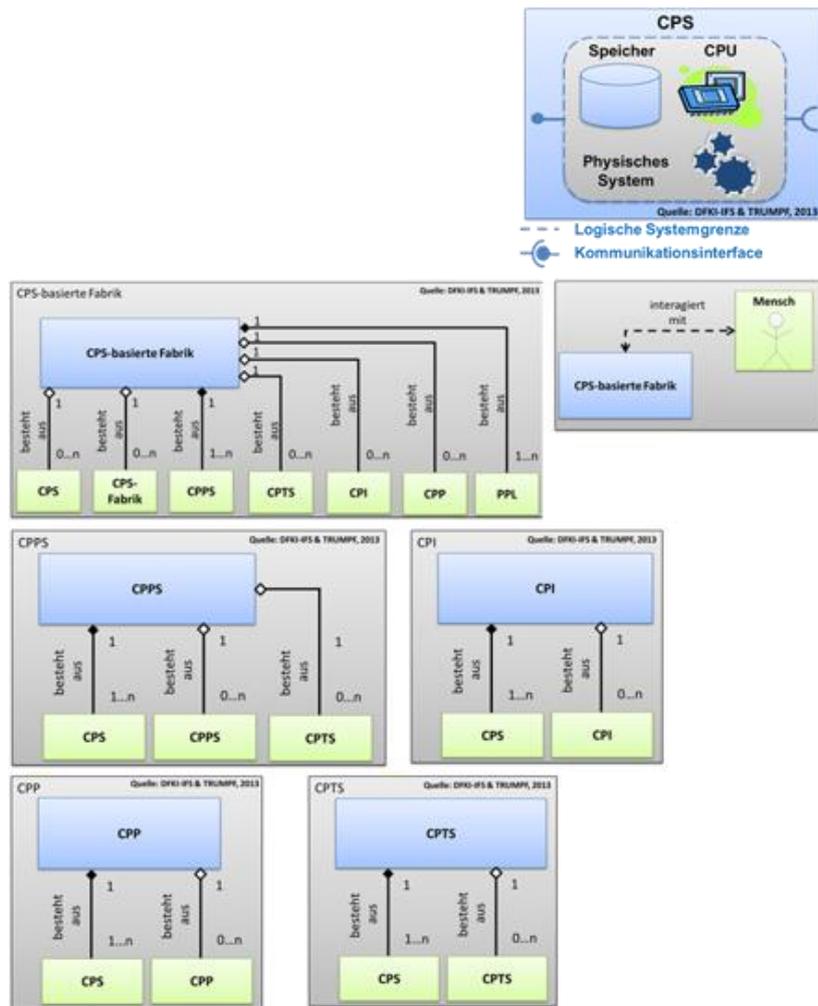
These four viewpoints form the basis for a detailed viewpoint-by-viewpoint analysis of individual sets of Industrial Internet System concerns.



CyPros - Reference Architecture for CPS-Platforms

CyPros aims to increase productivity and flexibility through networked intelligent systems at the factory. It describes the structure of the CPS-based factory and the relation of elements to one another. CyPros provides a framework for developer to model a CPS-based factory. The smallest unit in the Reference Architecture is the CPS (self-contained CPS and distributed CPS). Other examples of elements are CPT, CPP and CPI.

CyPros uses a collection of methods for modelling the CPS-based factory. It matches the architecture elements and procedural model with different views for the purposes of analysis. CyPros has a structured, iterative approach (top-down, with up to 14 steps) that supports the development of CPS-based solutions. It uses the methodology and architectural elements and it is suitable for modelling the actual and target stage from strategy and business model layer to technology - and infrastructure level.



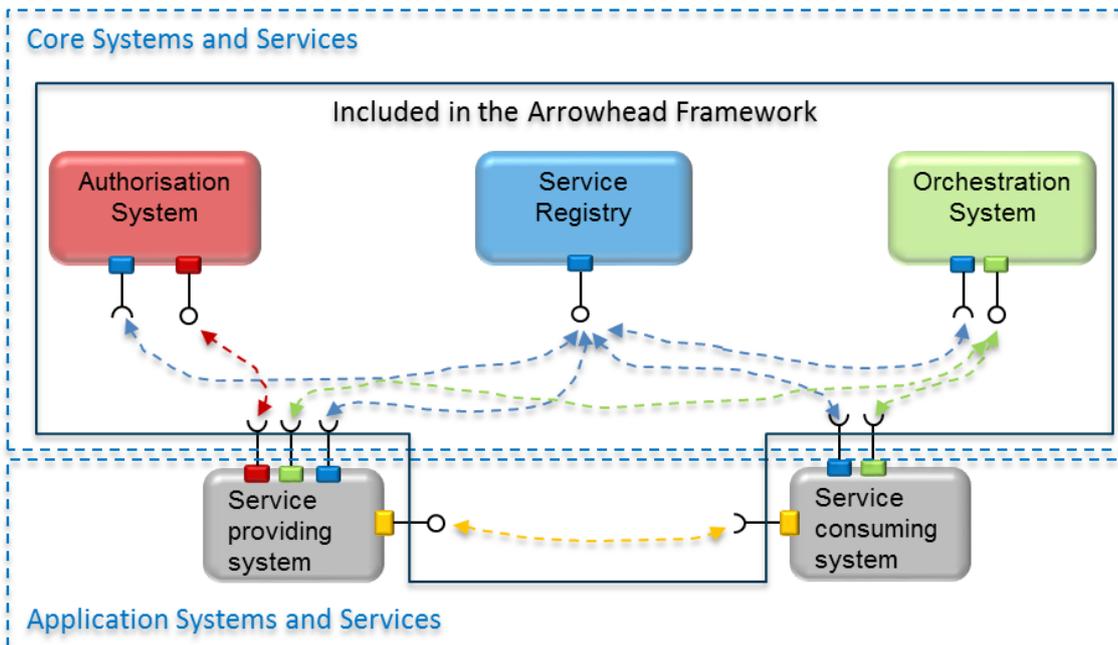
Architecture of CPS-based components in production environment

Arrowhead Framework – concepts and basic architecture

The Arrowhead Framework includes principles on how to design Oriented Architectures (SOA)-based systems, guidelines for its documentation and a software framework capable of supporting its implementations. The design guidelines provide generic “black box” design patterns on how to implement application systems to be Arrowhead Framework compliant. Furthermore, these guidelines allow making legacy systems Arrowhead Framework compliant.

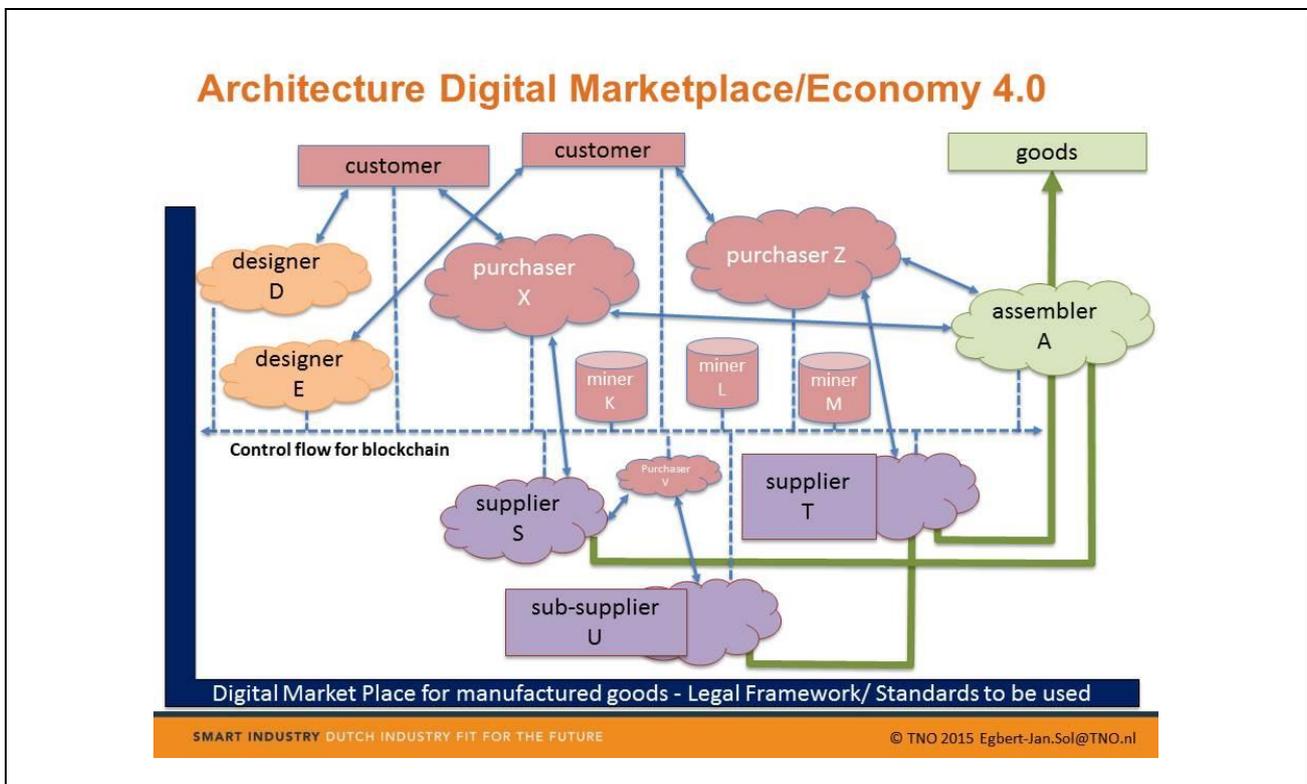
One of the grand challenges of Arrowhead is to enable interoperability between systems that are natively based on different technologies. One main objective is to achieve that, thus keeping the advantages of SOA, e.g., the flexibility obtained by the loose coupling. The strategy to meet that objective is to identify what are the least common denominators needed and select the most suitable common solutions.

The Arrowhead Framework is based on collaborative automation in the cloud and it contains common solutions for the core functionality in the area of Information Infrastructure, Systems Management and Information Assurance as well as the specification for the application services carrying information vital for the process being automated. The automation is local and *real time*, which is beneficial for latency, security and decreased engineering dependencies.



Economy 4.0 + Vanguard platforms

With all the factory floor automation (robots, CNC, 3D printing) and the automatic program changeover per product the manufacturing costs of small series and soon unique one-of-a-kind products become as low as mass produced products. Small series production, close to the customer and able to respond to changing demands, in regional or metropolitan settings is the European answer for reshoring and avoiding moving more manufacturing to mass production in large economy of scale Asian factories. However the transaction costs for small series and single orders in requests-for-quotation, quotations, purchase-orders, order-confirmation, delivery and payment orders needs to come down too. TNO/Smart Industries (Egbert-Jan Sol) proposes a Economy 4.0 digital marketplace platform for manufacturing goods using blockchain where purchase agents on behalf of consumers and end-producers can negotiate with the supplier-agents automatically. "For this platform ICT can create the agents and miners as needed for the blockchain protocol, but we also need cooperation on defining the standard framework on design specification, production processes and materials as to be used by the partners. And for this digital marketplace for manufactured goods we also need the (regional/metro) logistics agents and financial agents. However using the blockchain there won't be a single controlling party as USA-based companies as Google, Uber and Airbnb that would otherwise grab a share of any transaction. Creating this platform is a challenge where manufacturing community needs to cooperate. Once success is created in a few launching branches, it can be expanded to a level that it will become a paradigm shift in manufacturing that not economy of scales determine the success but economy of networking."



Summarising existing initiatives

Name system	Type	Domain	Status	Level of standardisation	Openness	Value creation	Ecosystem	Stakeholders	User range	Test beds available
RAMI	Operational	Manufacturing industry	Reference Architecture	High	Open	With system		Industry, Software vendors	Vertical	Yes
Virtual Fort Knox	Technological, operational	Manufacturing industry	Implemented	High	Open	With and within system	Yes	Industry, Software vendors, Government	Vertical	Yes
BEinCPPS	Technological	Manufacturing industry	Under construction	Low	Open	Within system	Yes (5 ecosystems)	University of Milan, Big industrial companies, SMEs, EC	Horizontal	Yes
FIWARE - FITMAN	Technological	Manufacturing industry	Implemented	High	Open	With system	Yes	Industry, Software vendors, machine producers	Vertical	Yes
Industrial Data Space	Technological, operational	Pharmaceutical, Automotive, Retail, and Production industry	Reference Architecture	High	Closed	With system	Yes	Big (industrial) companies, Government,	Horizontal	Yes
IIRA	Technological	Energy, Healthcare, Manufacturing, Public Sector, Transportation	Reference Architecture	High	Open	With system	Yes	Business decision makers, System engineers, product managers, developers	Horizontal	Yes
CyPros	Technological, operational	Manufacturing industry	Reference Architecture	Low	Open	With and within system		Manufacturing industry (big and small companies)	Vertical	
Arrowhead	Technological	Manufacturing industry, Smart Buildings and infrastructures, Electro mobility, Energy (production and Virtual Markets of Energy	Reference Architecture	High	Open	With system		Service providing and consuming companies in diverse sectors	Horizontal	

During the workshop also presentations were given about several initiatives related to platforms. The key insights of these presentations are discussed in this section.

OTHER (NON-PLATFORM) INITIATIVES

International Benchmark (INBENZHAP)

Industry 4.0 offers exciting perspectives for economic growth, but there are also some challenges that need to be overcome because new players will enter the global competitive arena. Against this background, we need to ask the following questions:

- What is happening in leading industrial nations? How well are they prepared?
- Where are the markets of tomorrow? What do they require?
- Who are the strongest competitors? Who is new?
- What is the impact on working conditions? Is Industry 4.0 getting the acceptance of the relevant stakeholders?

These questions need to be answered for the following objectives:

- The project presents the strengths and weaknesses of selected economies in detail.
- The project highlights potential markets for Industry 4.0 and deduces requirements.
- The results facilitate shaping the future of research and development in the context of Industry 4.0.

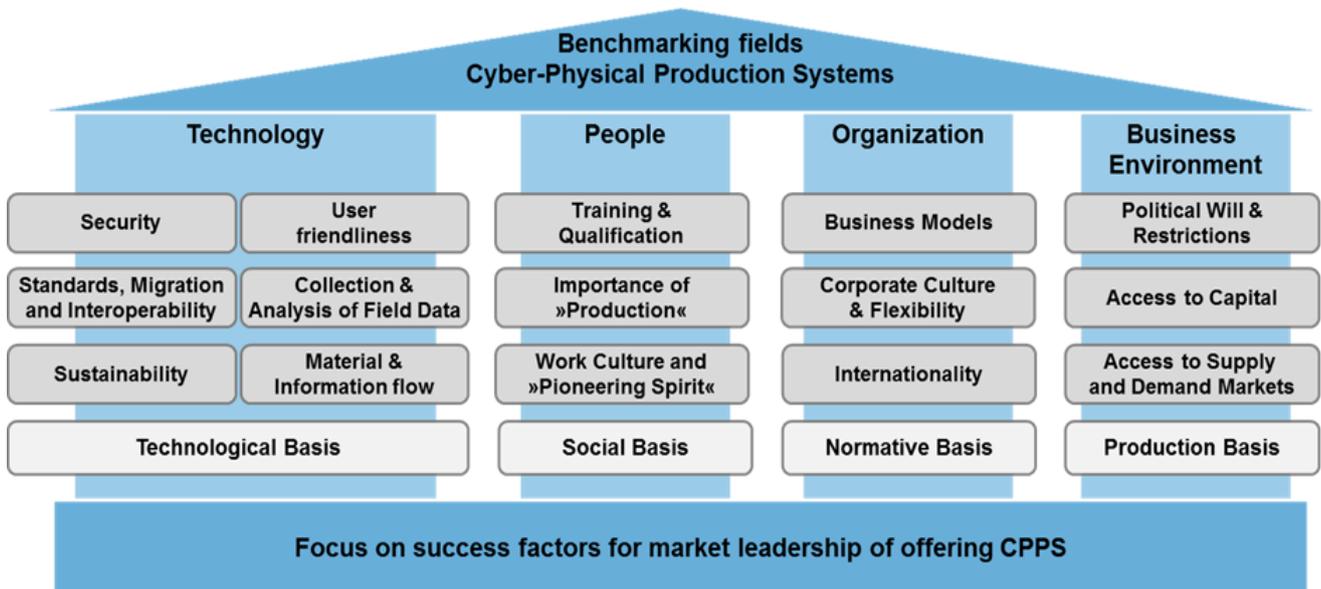
Focusing on the *benchmark*, we can see that it is structured around four main dimensions: **Technology, People, Organization** and **Business Environment**. Until now the following observations have been made:

Importance of production

Industry 4.0 becomes a global grand - especially in Asia. However, it needs to move from words to deeds, otherwise we risk losing our reputation. Concerning Internet-based services we ask ourselves if Germany/Europe is able to offer them, because Asia is interested, but we have to deliver or we will lose their attention.

Security

Security forms a worldwide obstacle for digitalization. In many cases we perform security measures in two steps: first on in-house networks later on external networks. Concepts for risk assessment are necessary.



International Benchmark & Business Models

Standards, Migration and Interoperability

We need standards, but how do we achieve these? The investments: we do must be future-proof: standards must be able to update any time because of the high-speed environment. Therefore we need open, interoperable standards.

Business Models

As far as current conditions do not change, consisting business models work also in the future. Experience from the past provides us with cost-benefit-assessment and we should strive for promotion and integration of Start-up innovations.

Selected world-wide activities and drivers

- **Europe** is bringing engineering excellence to the digital world. By using visionary concepts it is able to integrate technology, society and industry in the digital world
- **USA:** Bringing digital innovation to the physical world, e.g.: Start-ups for the Internet of Things and a renaissance of manufacturing.
- **Japan and South Korea:** Innovation through adoption. Here we see a massive build-up of smart factories and very large OEMs building up business through own demand with large scale advantages.
- **China:** Pragmatic adoption of potentials and long-term strategy. They use existing technologies and have a strategic development of selected key technologies.

sCorPius

This project funded by European Commission to define the roadmap for CPS4MFG (CPS for Manufacturing) in Europe. 17 gurus were interviewed from both academia and industry. Also three events were organised in order to capture knowledge in the field. More than 100 strategic breakthroughs CPS adoption can bring into Manufacturing Industry have been identified.

These breakthroughs were categorised according to six main clusters:

- **New data-driven services and business models**
 - It relates the company as a whole, regarding top managerial decisions. CPS, with its digital world, opens a wide range of new business possibilities. Not only to already configured enterprises, e.g. giving the possibility of being closer to customers and offering high value services, but the appearance of new business models exploiting the capabilities of this new technology.
- **Data-based improved products**
 - Concerns the breakthroughs coming from the digitalization of the product. The product behaves as an intelligent component inside and beyond the factory, sharing information at different levels, enabling a better understanding and configuration of the processes and services and bringing a high value added to its usage.
- **Closed-loop manufacturing**
 - Corresponds to an “expansion” of the limits of the company. It takes into account other stakeholders in the value network, such as suppliers and customers, integrating their feedback into the production.
- **Cyberized™ plant/ “Plug & Produce**
 - Embraces the benefits that the adoption of CPS has in the plant. Permits a more holistic insight of the production processes, a better information management and facilitates tasks performance by mean of digital support.
- **Next step production efficiency**
 - Compromise breakthroughs that enable a better utilization of management assets translated into a more efficient production.
- **Digital ergonomics**
 - Corresponds to breakthroughs that make easier the integration of people with the new CPS environment. Although the processes are getting more complex with CPS, e.g. more data is analysed, people have to access them in an easy and understandable way.

Also, about 80 key CPS related enabling technologies that can bring the bigger impact to the Manufacturing Industry have been identified. E.g.:

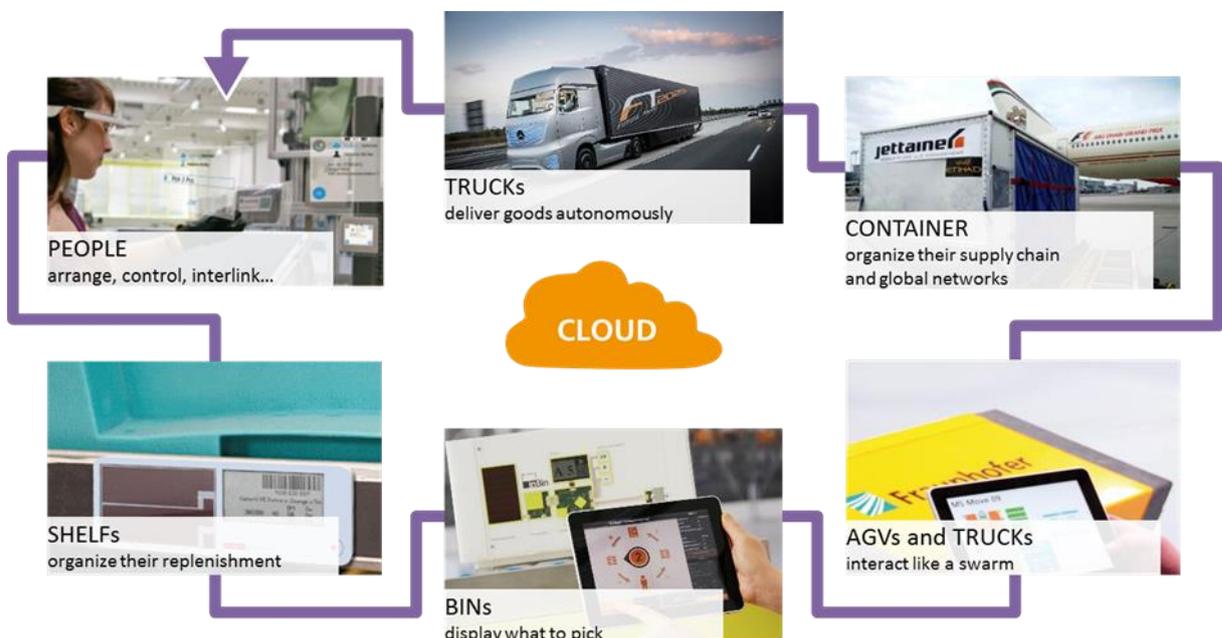
- "visual" analytics: technology for grasping complexity
- Big Data and HPC (High Performace Computation) infrastructure
- IoT O.S. open source
- Open frameworks and standards (CPSoS, IoT, etc.)
- MEMS (Micro Electro-Mechanical Systems)
- Artificial intelligence
- Distributed & connected sensors
- CAD/CAM seamless digital world integration

Logistics 4.0 and the Internet of Things

Industry 4.0: Developments towards Smart Factory

In Industry 4.0 we can see a number of developments:

There are **Intelligent Transport Items** that poses *Sensor Intelligence* through which they can communicate with each other. Besides that, they also are capable of *Energy Harvesting*. A second development is the **Cellular Transport System** that is capable of *Autonomous Driving*, which occurs through *Self-controlled Behaviour* and *Swarm Intelligence*. A third development is the **Rack Racer**: an *Autonomous Vehicle* with a *Bionic Shape* that moves *diagonally* in the shelf.



Within the Internet of things all things are equipped with a small part of “intelligence” and able to chat with their community.

From factory to eco-system

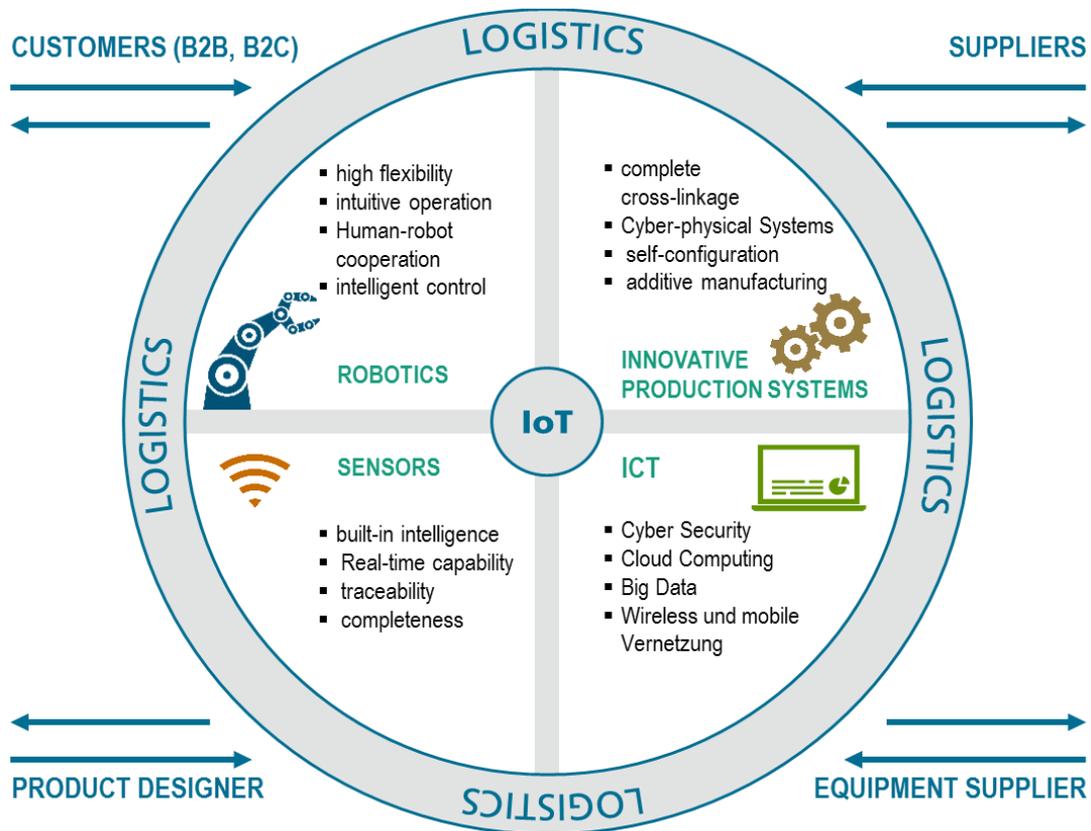
The new approach is to make the customer part of the value adding system. Then we go to completely new business models. We are moving from product focus, to service focus, to solution focus. We are moving from vendor driven, to customer driven, to community driven. In the latter we have standardized platform services, with help of open source communities. If not, we go to a oligarch driven approach: a few big players that dictate the market. Example: Amazon took out products that support other formats than their own (Google and Apple).

The consumer will be able to combine different software services from different providers. An example is software service as a skill (machine focus): a robot can move around with different with bin picking as cloud service. The robot chooses the components it needs from the cloud and sends it back to the machine.

Logistics

Transportation accounts for roughly 25% of the EU greenhouse gas emissions. Roughly 24% of freight vehicles are running empty and the average loading of is 57%⁵. Logistics and SCM can help European Competitiveness in Manufacturing and Services by increasing the share from Industrial Manufacturing of European Union GDP from about 16 Percent to above 20 Percent⁶. Logistics can connect Europe's Manufacturing Networks, which leads to a better coordination of value-adding networks in Manufacturing, Trade, Retail and Service. For this, innovation in Logistics Technologies, Enterprise-IT and Management is required.

Smart Industrial Creation of Value Is more than Manufacturing and Transport. We are talking about adaptable value-added company networks based on the factories and their systems are required to realize the full potential of cps and smart factories. Smart supply chains and services will link customers and markets to smart design and smart operations being already part of the FoF roadmap. This vertical integration can make the European value chains even more efficient.



⁵ EUROSTAT

⁶ [1]: European Commission (2012): A stronger European industry for growth and economic recovery, COM (2012) 582

AIOTI (Alliance for IoT Innovation)

AIOTI was launched by the European Commission in March 2015 to create a vibrant IoT ecosystem in Europe and aims notably at breaking silos between leading vertical IoT application areas.

AIOTI Standardisation work

Standardisation will play a key role in the uptake of IoT. Since many of the benefits from the Internet of Things will occur on the basis of widespread adoption, sharing data across the value chain and novel services, the development of global - industry-led - standards is pivotal to ensure effectiveness, interoperability and economies of scale. In particular reference models as the basis for a reference architecture, that can be shared by industrial actors across different application domains can help breaking silos between leading vertical IoT application areas.

The scope is to develop an accompanying document for the IoT LSP (Large Scale Pilot) calls. The document should make reference to existing and emerging IoT architectures from SDO's, consortia, alliances and should provide recommendations on guidance to be given to call respondents. The document may also make recommendations with regard to gaps, issues facing IoT architectures and challenges which may be included within the scope of the calls (e.g. the challenge of semantic interoperability).

Semantic interoperability is key for IoT

AIOTI WG03 is focussed on Semantic Interoperability, since application across the domains is a major issue for IoT. Key challenges are ontologies that formalise the meaning of domain data and information models. Also these ontologies need to be merged, matched and aligned by strategies across domains. Other challenges are the semantic discovery of services, devices, things and their capabilities and semantic metadata.

In this section a synthesis is presented of the answers given to the questions that were central in this workshop. The answers are the result of the discussions held by three separate groups, during a two-hour break-out session. All groups were instructed to choose one or two of the most promising domains with regard to platforms, and to answer the other questions based on these domains.

REPORT BREAK-OUT SESSIONS

In which domains platforms are most likely to bring advantages to EU industry (e.g. the "operating system" of the connected factory of the future)?

The domains that were mentioned during the discussions were:

- Network-based Programme Logic Control systems (PLC) (delocalisation of control technologies)
- Supply chain management / Digital market environment for manufacturing services
- Product Lifecycle Management (PLM) (strong focus on product lifecycle)
- Product-Process-Automation (stronger interconnection of automation technologies and product/process life-cycle management technologies)

Choosing the right domain proved to be easier said than done in some cases.

However, consensus was reached easily on certain characteristics of platforms that are regarded as important for any platform: *openness and interoperability, connecting existing standards and connecting existing commercial platforms*. The overall goal is a well-integrated system that reduces complexity. Step by step, we should get into the good direction and the steps should be coherent. What we do not want is a top-down platform that imposes a business model.

Looking at the functionality of a platform, *sharing of knowledge* and the *improvement of efficiency and productivity* are regarded as important. Furthermore, the discussion around platforms could be divided into three parts: IT, Hardware and Knowledge.

Concerns that were raised in all groups were centred around the *reliability of data, data ownership, control and protection of data, privacy, trustworthiness, independency and ease of use*. Also we have to take into account that industry do not want to share knowledge and data.

The following domains were chosen to focus on: **Network-based Programme Logic Control** systems and the **Digital market environment for manufacturing services**. The remaining questions will be centred around these two topics.

Which are the groups that should be brought together in a multi-sided market?

Although both platforms are different, to some extent there will be an overlap in stakeholder groups. The groups that were mentioned were:

- **Manufacturing industry, including Manufacturing equipment and service providers**

- **IT companies** for their service development capacity and technology push (not only big players, but also SMEs)
- **Software and application developers**
- **Platform managers**
- **Shop floor owners** with specific problems (SMEs)
- **Authorities** auditing the trustworthy and privacy of data, (public authorities (chambers of commerce, local authorities, etc.)
- **Broker or orchestrator**

*How would you build the **ecosystem** around the platform?*

- *What are **representative companies** that will make up the ecosystem?*
- *Which **business interest** would they have in being part of the ecosystem?*
- *How would you **attract** them to participate in the development of the platform?*

Building the ecosystem

The ecosystem will build and grow around the platform and not the other way around. Platforms should support the creation innovative features can be added by any company that wishes to develop them. Then they will create the ecosystem.

Representative companies

The ecosystem needs to be potentially open to the whole world, but the initiative needs to come from some heavyweights, otherwise it would not have enough support. For *Network-based PLC*, some of the *big players* from the automation industry that were identified are Siemens, Abb and Scheider. Also for this domain *machine manufacturers* were identified as an extra stakeholder group: they should be invited, but they are not part of the core. Regarding *IT companies*: these should be selected for their qualities as system integrators. Maybe even start-ups could bring new ideas and new components to the platform.

Another interesting notion is that although the discussions are mostly centred around big players, for both domains the role of *SMEs* was regarded as important. Both from development and user perspective *SMEs* could have valuable contributions that should not be neglected. Concerns were raised about a possible digital divide between big players and *SMEs*; so although *SMEs* probably will not play an important role in setting up a platform, they should be able to have easy access to it and they should be able to benefit from it.

Also many agreed that the value of the platform comes from its size. The more users, the larger the set of peers to connect to and the more developers and equipment providers, the more features will be available on the platform. *Conclusion: Large companies should lead by example; small companies should lead on usability. Large development companies should promote new business models.*

Business interest

Here we can see that the majority agrees that technology is pushing, but that we should not miss the *end user* perspective. This includes short term requirements, such as improved effectiveness at shop floor level. Furthermore increase profitability through market responsiveness and scale advantages are business interests for every player.

For big players the business interest is quite clear: the need is to get organised now in order to be ready for the IT-induced changes that are coming. *Conclusion: if the platform is open from the beginning, on good conditions, then big players will come automatically because they want to be part of it.*

From the shop floor perspective came the following: “if you could get rid of local support that would have clear benefits on a global scale. Shop floor owners are looking for custom made solutions to their problems”. On the other side shop floor owners should be willing to provide information and feedback to device producer in order to improve systems, which require an open relationship.

One of the concerns that were raised regarding business interest was the economic part: “Who contributes and who profits most? This sharing of value is regarded as very important. All players in Europe should be able to have a fair share of the value and we need legal templates and guidelines for this”. Monopoly should be prevented.

Attraction

The major point of attraction is the need to face future needs of the market: end-users are looking for improved competitiveness; big players are looking for way of providing new added value to customers through innovative technology.

One thing is to develop the platform, another is to develop the services provided by the platform. For both a trustworthy and secure system are crucial requirements in order to attract companies to the platform.

What are the **key building blocks and components** (including proprietary/commercial technologies and common/standardised frameworks) for the domains identified? What are you prepared to collaborate/ join forces on platforms? What would you rather compete on?

The following Key building blocks for platforms were identified during the sessions:

- **Peer-to-peer communicating systems**
 - Blockchain: secure way of transaction without third party such as a bank
- **Distributed intelligence** on a **real-time** runtime;
- **Control Algorithms**, 'System of systems' from other domains, which are new to the industrial domain;
- **Safety**;
- **Data protection, privacy and security**;
- **Capacity for traceability**;
- **Wireless connectivity**:
 - Wireless is the challenge, but a mixture is most likely.
 - The faster you need to react, the closer you need to be to the process. So the location of the intelligence depends on the process itself.
- **Components and machines**;
 - Middleware and an abstract layer like IEC16499 (standard made by NXT control)
- **New generation "PLCs"**
 - PLCs, combined into IPC (internet PLC). So we have intelligent components, intelligent system and the control over that.
- **Interoperability and data ownership**
- **Semantics, ontologies, taxonomies**
 - Open API's and interfaces, agreed semantics
- **Low cost communication modules**
 - With support for specific plug-and-play manufacturing protocols
- **Network providers**
 - Communication bottlenecks on large amount of data, real time constraints....
- **No monolithic system**
 - The challenge is the broad range of data in manufacturing
- **Institutionalisation**
 - Including compliance, legal aspects, match with legal European Framework, etc.
- **Respect for commercial mechanisms**
 - Without monopolising
- **Validation**
 - On supply chains

Collaboration

Most companies would be willing to cooperate on things that are too big or too expensive to handle alone. Other areas of collaboration would be *advanced solutions* that stick to the intelligence part and work on standardisation and requirements. Collaboration among the multiple stakeholders (ecosystem) needs to be based on a well-defined "networking standard" (example: IEC-61850 from the smart grid domain). A standard and industrial implementation (fully open and interoperable) already exists: IEC-61499.

Also important to mention is that in a pre-competitive state collaboration is possible, but in a competitive state companies legally cannot do this.

Competition

Once we have the standards, we should let the market work with them. Everybody has the system, but what you do with it is your own responsibility. In other words: competition would take place in the services facilitated through/with the platform.

Which **technical activities** are needed for the development of a platform?

- A. *Derive and maintain reference architectures?*
- B. *Develop and validate reference implementations?*
- C. *Support test-beds, pilots, demonstrators and validation environments?*
- D. *Support standardisation activities?*
- E. *Anything else?*

The answer to all the elements mentioned above is: yes.

- A. **Yes**, if they are industry supported. The reference architecture is a model integrating the different viewpoints. From this you can have specific instantiations.
- B. **Yes**. Based on the previously mentioned instantiation you can then have an implementation. The reference implementation is specific for your use cases as well as for a domain or sector.
- C. **Yes**, but they should be industry-driven. We could analyse what is already there, as it might fit our needs (such as IEC-61499). Questions raised here are: “Is standardisation before or after the platform? Who should be the standardisation organisation? Formal or informal standards? Groups are already talking, quasi-standards are arising”.
- D. **Other (technical) activities:**
 - *Education and digital skills development* are important.
 - *Memorandum of understanding*: Defining economic conditions under which users can use the tools (such as for the GSM).
 - Acceptance – ease of use
 - Requirements of manufacturing requirements

*How do we best complement and reinforce **national** and **industrial** approaches/initiatives with EU R&I activities under Horizon 2020?*

Today we do not have a very coherent connection between these programmes on a European level. These workshops try to contribute to it, but we should establish a European approach building on national and regional networks.

Furthermore, we should create awareness, for example through workshops like these. We should participate in IoT (however, it is one of the many alternatives). We should also look at European test beds for a better discussion and interchange of information.

The German government will launch a similar project with complementary components. The EC and Germany are in close contact about this, but is there need of a big master plan for more coherencies?

Leadership must come from the EC, with reinforcement of the national initiatives and not the other way around to bridge the digital divide. For example, the EC could launch an initiative for research collaboration on Mfg, like IPCEL.

Finally, Europe should consider not only competition but also collaboration and participation to horizontal initiatives. We could learn from best practises in the US: National Network for Mfg Innovation (promoted by the government).

In this section the key insights and messages of the workshop are presented. First from the perspective of the workshop in general, and after from the perspective of the big companies and EC representatives that were present.

KEY MESSAGES

Workshop key insights

Industry 4.0 offers *great opportunities* for Europe, but we need to *act now*.

This workshop is a *starting point* and although it is not conclusive and although it will not solve everything, at least we had the opportunity to come together to share our thoughts and to think about the next steps to achieve it eventually.

The objectives of the workshop were to look at platform building in order to make use of our competitive advantage in manufacturing, while *avoiding national silos*. For that, we need to answer: what kind of platforms do we need to pursue on a European scale? We are not looking for one single solution, but rather for a way to *integrate the multiple initiatives* that are already out there and how the EU can support that.

Already Reference Architectures, ecosystems, products, etc. exist and we will not start anew. Different platforms were discussed during the workshop: we had various *vertical initiatives*, of which **Virtual Fort Knox** and **FIWARE-FITMAN** are already implemented platforms. **CYPROS** and **RAMI** are *Reference Architectures*, the latter being an initiative of German associations in the Industry 4.0 platform. In the vertical initiatives, a recurring topic is *logistics*. The goal is to make all logistic elements *autonomous* and to line factories together, preferably with *real-time, wireless* technology (although we acknowledge that this will be quite a challenge).

Regarding the *horizontal - sector crosscutting* initiatives, **Industrial Data Space**, **Arrowhead** and **IIRA** are existing Reference Architectures. Although still under construction, **BEinCPPS** is a promising initiative with *test beds* available in five ecosystems.

Although all platforms have a slightly different approach and focus, they are all connected through their valuable contribution to the *manufacturing industry* and a strong focus on *smart services*.

There is a new value chain dynamic which connects the interests of the buyer with capabilities. This can create totally new *collaborations across value chains*, which will be governed from a *democratised* platform. Ideally, this creates equal opportunities and matchmaking tools for its participants.

The best way to act is to *start from our strength*, which is bringing our *vertical engineering excellence to the digital world*. We are clearly stimulated and inspired by innovation that comes from the digital world. Our challenge is to bring this to the horizontal world, for example through the use of *IoT* and *Big Data*, which in a way can be regarded as a *subset of the technologies* that are needed for the digital transformation of industries.

So how to achieve this? We need to start thinking about *integrating* our digital strengths through platforms on a *peer-to-peer basis* and we need to start talking the same language through shared *semantics*, while taking into account that *Security*, *Standardisation* and *Business Models* are three of the most important topics for differentiation.

The platform should *not* have a *top-down approach* and it should *facilitate a business model* while not imposing one. Furthermore, we should take into account the *accessibility* of the platform: although the platform needs to be initiated by players, *SMEs should not be excluded* because of a possible *digital gap*. Monopoly should be avoided at all costs, especially since *the next major platform is knowledge*: infrastructure and knowledge services should be separated, as it is the case in traditional industries.

For the development of the platform we should always keep in mind the *end-user perspective*. Also *Research Associations* such as the European Knowledge and Innovations Communities (KICs) can play an important role in achieving success.

Concerns were raised about *data ownership, security and privacy*. *Regulation and supervision* are therefore crucial elements in any successful platform. Another concern is that there are many different solutions and *we do not have the time* to see how they work out. Assuming it all works out, we also need to think about who will benefit from it: the winner takes it all is not what we want, so we need *clear guidelines* and rules on how to we will distribute the merits.

Besides these high-level concerns, we should not forget the gap between our discussion and the current technical mass: the maintenance guys talk a certain language they have since 30 years, so we should not forget to train and educate the people that use it.

Collaboration is possible on the integration of platforms, preferably through (existing) networking standards. Competition is possible on the functionalities and services that are achieved with those standards.

In this section several statements are presented that were raised by the representatives of several big industry players that attended the workshop. Please note that no guarantees can be made regarding the accurateness of the statements, and that the content of the statements does not necessarily reflect the opinion of the company itself.

Statements from large industry players

Representative of VOLVO trucks

“We have platforms to connect to customers”.

“We spend a lot of money and manpower to provide solutions. The platform should be focused on knowledge creation and distribution”.

“We need to come back to this, perhaps in smaller teams for different sectors, because one big solution might be too difficult”.

“Why are platforms so of an interest right now? We see that you have platforms for connecting to customers and to internal product development. We are desperately in need of a platform focusing on platform operations”.

“Volvo spends a lot of resources on IT solutions supporting operations. Platforms would mean that we could target resources on developing products. It’s all about bringing together and preserving knowledge over time. We need to look into the differences of different sectors for manufacturing. We won’t have one general solution for all but there will be elements you can share across domains”.

SME representative (company of 300 people):

“The needs and offers of big players to the platform are clearer than those for SMEs. What can we do? Our production technology is our strength, but how can we help?”

“It is interesting to see lobbyists discussing, but it’s hard to get an idea of the word platform. How can an SME contribute in the future? The discussion wasn’t specific enough. How can the SME be supported by the EC?”

“Don’t forget the SMEs in all that you will do in the future”.

Shop floor owner/manager from Fraunhofer:

“We have new manufacturing process every week, with different requirements for every process”.

“We are not discussing how to make a product a bit more cheaper, but how a feature is implemented based on the available technologies”.

“We should focus on disruptive implementations based on market requirements. Not on logistics: we have plenty examples of this (Amazon)”.

“Use cases would help greatly: if I have a problem with my factory, could I go to this platform to see if this already has been solved?” Answer: “This would be a good addition, but we have to focus on the domain first”.

Question to shop floor owner: "Would you also be willing to be contributing to the platform?" (in terms of data and such that we need to improve the platform).

Answer from shop floor owner: "Yes for sure, we are working together with equipment builders to get better solutions. However, how do I convince them of IoT and such?"

"Do not underestimate the creation of awareness around this topic, because this can create leverage".

Bernd Korves - Siemens

"At Siemens they talk about Industry 4.0 a lot".

"We have a holistic approach for the entire value chain: Full integration from CAD (computer aided design) and CAM (computer aided manufacturing) to Services".

Laurent Zibell – Industiall : "Nobody is big enough to convince everyone ex ante that their system will be THE system. But everybody wants to be the biggest. There is thus a risk of a deadlock in the discussion of standards and of being overtaken by an external, proprietary solution."

Reaction Bernd Korves: "Every time this happened, this was because there was no market yet. Like mobile phones and computer systems. However, for manufacturing this is different, due to large installed base so do not fear monopoly tendencies."

"Data is better with domain know how. Data should be aggregated before its distributed. Smart data is sensors plus domain know how plus context know how plus analytics know how".

"Data connectivity is no problem, but what to do with actors that do not have signed a contract? How do we secure that data is being used legally without these contracts?"

Uwe Kubach – SAP

"We have applications for many things. The challenge is to integrate the separate silos".

"The cloud is central: here data is connected. Uniform access to and from the cloud is essential".

"The higher you go in the hierarchy, the more complex it becomes".

About IoT @ SAP: "On the higher level there is work to be done, for example on the standardisation".

"Customers want one solution that works".

Silvia Castellvi – ATOS

"Services are becoming increasingly more important. Organisations using IoT can increase their efficiency, quality and customer satisfaction".

"The new ecosystem should be built on data: the use of data will be almost free, in the first step of ecosystem development, and it can increase the value of services".

Nuria de Lama - Atos

“ATos is fully committed to FIWARE, especially with regard to smart cities. First we want to do smart cities and then other initiatives”.

Friedrich Vollmar – IBM

If we look toward to the future of manufacturing, we will see the trend towards individualized products visible today to grow stronger and define more parts of the industrial value chain.

-1- Production machines are getting more intelligent and versatile; the range of individualized products machines will be able to produce will expand. A good example for such machines is the 3D Printer, which has the build in ability to produce products from a jet-turbine to any metal-spare parts including spare parts for vintage cars or metal parts for the health industry.

This machine can be part of very different value chains; it represents an industrial capability which can serve in different industrial value chains.

-2- There is a trend, that customer want more individualized products.

With the new intelligent machines a lot-size one will be possible to produce at a price very close to the price of today's mass-produces goods.

A couple of industries today are on their way to offer individualized products and refining the capabilities to produce them in lot-size one production processes.

-3- In addition to today markets offering of produced goods the consumer can select from, there will be a rising demand for a platform, where customer can define their interest in an individualize product asking for offers to get it produced. This customer interest will be defined in a digital form that intelligent machines can transfer into a real product.

In our view , a key element to connect the individualized customer interest with industrial capabilities to produce it will be a platform as the Digital Marketplace Platform we presented in the meeting.

To offer possible matches between the customer interest and the available industrial capabilities to connect customer and produces and to transfer the interest into a produce will be the task of the Digital Market Platform..

This new pattern of an Digital Marketplace Platform will be an import key enabler for the future of Customer to Supplier relationship and the future economy in Industrie 4.0 times.

To fulfill the posted individual interest of customer, an industrial value chain has to be build and contracted on the fly in realtime to produce the product in a lot-size one production process end-to-end.

As with all platforms, this platform will have a tendency to become a monopole. Regarding the importance of this platform for the future of manufacturing and the future of industrial value chains, a monopole seems to be inappropriate for many good reasons.

To avoid a monopole, we proposed a public private partnership to establish

an democratised control over this platform.

We are convinced that Industrie 4.0 represents a kind of Industrial revolution with a strong impact on manufacturing and the way, customer and producer will interact. To prepare for this changing market relationship, a Digital Marketplace Platform with an appropriate legal framework will be an innovative step forward in our view

“The 3d printer is not depending on a particular industry, the use is everywhere”.

“A centred market place. That’s where business takes place. We need to go to one legal framework for our market with underneath a market place implementation”.

“Ease of use is often missed in IT, it should be accessible for any SME”.

“We don’t want monopoly but democratized ownership. You need to have a place that is not monopolized. This is possible when there is a public interest in the company: 50% ownership for example. Water supply is an example and also other infrastructures require public involvement. Other options are: Cooperative system, or a heavy regulated system”.

“We need a legal framework in Europe: Who is saying that this guy in Australia only prints the jet engine once? Copying data is no crime, stealing is”.

Reactions from audience:

Prof. Herman Bruyninckx (KU Leuven):

"One should regulate IT in the same way as non-IT. Monopolies are inevitable if governments allow companies to put access to a platform behind a login, and to allow them to offer, both, the infrastructure and the services on top of that infrastructure. We need to regulate before such de facto "the winner takes all" monopolies have had the time to kill competition and innovation."

Legal expert: “We don’t need more regulation on cloud computing:, but actual law enforcement. There are cases of non-compliance. We make laws and expect people to abide, but we see the contrary: look at privacy laws. Google, Facebook, etc. do not respect these laws. The data owner and processor have different laws, and they do not respect it.”

In this section the final speeches of Maurizio Gattiglio (EFFRA) and Khalil Rouhana (European Commission) are summarised to provide a ‘take home message’ for future discussions.

Take home message from the European Commission

Maurizio Gattiglio (EFFRA)

The world is changing rapidly and a lot is happening: a lot of jobs will be replaced. 10 years from now 50% of all companies will be new.

One of the biggest concerns are monopolies, we need to prevent these. Another concern are the non-material investments for companies that they have to do in order to survive. These are expensive, but crucial for survival. The SMEs need a guarantee for their investment regarding interoperability. Their investments are on a different level, if they fail are done.

It is important to have discussions about this right now. Are we leaving the game to the market, or do we need political intervention? Take broadband for example, which is private right now. We see that it is not adequate, while it's an important part of the infrastructure.

Concerning digitalisation: we will increase the gap between large companies who are well organised, while the rest is lagging behind. How do we focus on needs of SMEs and software providers?

Another question we have to ask ourselves is: are standardised platforms really needed, and if so on which level?

Khalil Rouhana (Director for "Components & Systems" in European Commission, DG CONNECT)

“Many thanks for sharing your views, it's a complicated theme”.

Strategy is very important. We do understand that it's an industry matter, but what needs to be done on Member State level and on regional level? The role of the EU is depending on its instruments: legislation, facilitation (meetings like this, etc) and finance.

The goal is to get the best use of digital technologies, to grow from this, to get new product, services and to get new business models, since these are the most disruptive developments.

The *Digital Single Market (DSM)* enables all users to grow and to produce for our 500 million people market. We want similar conditions for productions in all Member States. This means that you can invest in every Member State.

There are 16 actions to achieve this DSM. Most measures are logistic based, but we are also looking at the system. Important issues for the DSM are:

Data ownership: Who collects, who owns, who prevents us from using it? etc. We try to ensure free flow of data. How can we tackle concerns of the industry, and what should legislation look like?

Online platforms: Should we regulate ex ante, or should we leave the competition policy to do this? They are extremely important, because this is where the vertical meets the horizontal and where disruption happens in business models. We are still thinking on how to address this: *there is an online consultation, so if you have ideas please respond.*

Access to finance is important: 300ml Euros are available on investments for the private sector for value creation in Europe. Please use it for modernising your production! What is the advantage? The money guarantees risk taking by countries: they are committed to digitalise. Please respond, so we have the best available baseline standards.

Four other lines of actions that are important:

Making sure that any business in the EU has access to technology, from agriculture to furniture, everyone should have access. We want bottom-up innovation and we want to help making knowledge available to SMEs in different markets.

Concerning skills, we are requiring an *adaptation of our workforce*. Looking at the *legislative hurdles* we ask you: what needs to be eliminated to facilitate the process? There are new ways of using data for example. Do we need new legislation for other things? Liability, safety and future use of data?

We are contributing to major gateways with which we create value. How do we make sure that we are *present in these gateways*? E.g. devices such as smart phones; we are not very present here. Neither online platforms, app stores, etc. Our industry is under major risk of losing value because we are not in these gateways. So how can we help to be there so that we have a competitive advantage? This can be achieved through the verticals and horizontals. Whatever we do should be in line with the industry.

We build partnerships, but we don't want to intervene in the innovation process because we do not want to kill it. So the question to you is: *where should we intervene*? What should we do in public partnerships?

Summarising: we want to create the right conditions; ensure investments are available, with an outreach throughout the whole industry; we need an adaptation of our workforce and legislation; and we want to support you in being competitive in major gateways.

TERMS OF REFERENCE

1. Workshop "Platforms for connected Factories of the Future"

5 and 6 October 2015, Diamant Building, Boulevard Auguste Reyers 80, 1030 Brussels -

Organised by the European Commission CONNECT Unit "Complex Systems & Advanced Computing" in cooperation with the European Factories of the Future Research Association (EFFRA)

Introduction:

The future of Europe's industry is digital. Commissioner Oettinger has proposed the outline of an EU wide strategy for the digitisation of European industry in order to "ensure that all industrial sectors make the best use of new technologies and manage their transition towards higher value digitised products and processes"⁷. A key element of this strategy is "**Leadership in next generation open and interoperable digital platforms**". (See "Background information" for details)

Recent economic analysis⁸ shows that platforms are creating most of the value in the digital ecosystem. Platforms are two-sided (or multi-sided). Platform providers must get both consumers and developers of complementary applications on board in order to succeed. The value of the platform often comes from its size. The more users, the larger the set of peers to connect to, and the more developers and equipment providers, the more features will be available on the platform. Platforms also support the creation of ecosystems where, because of the critical mass and the base technology that is already available, specialised and innovative features can be added by any company that wishes to develop this offer. Well-known examples are in the smart phone domain, where it is attractive for developers to produce "Apps" and for consumers it is attractive to buy a certain brand of phone when many Apps are available.

Whereas Europe is weak on consumer platforms, Europe is performing well on industrial and professional platforms - open or proprietary. For connected Factories of the Future, several initiatives have started across the EU and beyond (RAMI, Virtual Fort Knox, FI-Ware based work in FITMAN and BEINCPPS, Industrial Data Space, IIRA, ...).

Purpose:

In order to avoid national silos and to promote platform building at appropriate scale, the forthcoming H2020 Work Programme for 2016-17 of Factories of the Future (to be published after summer) will prioritise platform building in order to support the integration of digital technologies in several or all stages of the manufacturing process from cradle to grave (development, production, maintenance/service, supply chain and logistics, ...).

In order to guide the discussion on platform building, the workshop is structured around the following questions. Participants are asked to submit ahead of the workshop a short contribution (1 to 2 pages) addressing these guiding questions. In case of over-subscription, selection of the participants will be done based on the quality of the submitted papers.

⁷ <http://ec.europa.eu/digital-agenda/en/digitilising-european-industry>

⁸ http://is.jrc.ec.europa.eu/pages/ISG/documents/BREUGEL-NewICTsectors_PlatformsforEuropeangrowth.pdf

Guiding questions:

- 6) In which **domains** platforms are most likely to bring advantages to EU industry (e.g. the "operating system" of the connected factory of the future)? Which are the **groups** that should be brought together in a multi-sided market?
- 7) How would you build the **ecosystem** around the platform?
 - a. What are **representative companies** that will make up the ecosystem?
 - b. Which **business interest** would they have in being part of the ecosystem?
 - c. How would you **attract** them to participate in the development of the platform?
- 8) What are the **key building blocks and components** (including proprietary/commercial technologies and common/standardised frameworks) for the domains identified? What are you prepared to collaborate/ join forces on platforms? What would you rather compete on?
- 9) Which **technical activities** are needed for the development of a platform?
 - a. Derive and maintain reference architectures?
 - b. Develop and validate reference implementations?
 - c. Support test-beds, pilots, demonstrators and validation environments?
 - d. Support standardisation activities?
 - e. Anything else (please specify)?
- 10) How do we best complement and reinforce **national** and **industrial** approaches/initiatives with EU R&I activities under Horizon 2020?

Target audience:

Relevant representatives at strategic level from European industry and research.

Expected outcomes:

We expect that the workshop will clarify in which domains platforms are most needed, which are the business actors to be involved, which business interest they would have, which technical elements need to be developed. A report capturing the key elements of the discussion and the outcomes will be made publicly available.

Registration and Logistics:

The workshop is by invitation only in order to allow for discussions. Participation is normally limited to one person per participating organisation. Participants were requested to submit a short contribution addressing the above questions, specifying if it can be made publicly available.

Contacts:

Workshop secretariat: CNECT-A3-EVENTS@ec.europa.eu

Responsible at EC: Clemens Zielonka, CONNECT A3 (Clemens.ZIELONKA@ec.europa.eu)

Contact at EFFRA: Chris Decubber (chris.decubber@effra.eu)

Agenda - Workshop "Platforms for connected Factories of the Future"

5 October 2015, Diamant Building, Brussels

14:00-14:15	Welcome Clemens Zielonka (EC), Željko Pazin (EFFRA)
14:15-14:30	International Benchmark & Business Models Benedikt Echterhoff (Uni Paderborn)
14:30-14:45	Setting the Scene Max Lemke (EC)
	Existing Platform Activities (Chair: Max Lemke, Clemens Zielonka (EC))
14:45-14:55	Virtual Fort Knox Thomas Bauernhansl (FhG IPA)
14:55-15:05	BEinCPPS (incl. FITMAN and FI-Ware) Sergio Gusmeroli (Politecnico di Milano)
15:05-15:15	RAMI Peter Adolphs (Pepperl+Fuchs)
15:15-15:25	Industrial Data Space Sören Auer (FhG IAIS)
15:25-15:35	Role of CPS in manufacturing Marco Taisch (Politecnico di Milano)
15:35-15:45	IIRA Sebastian Haag (TU Darmstadt)
15:45-15:55	Logistic Platforms Thorsten Huelsmann (FhG IML)
15:55-16:05	Knowledge is the next platform Herman Bruyninckx (KU Leuven)
16:05-16:15	Platforms in CyProS Dominic Gorecky (DFKI)
16:15-16:25	AIOTI: Platforms and Standardisation Jürgen Heiles (Siemens)
16:25-16:35	Arrowhead Jerker Delsing (LTU, Sweden)
16:35-16:45	Economy 4.0 + Vanguard platforms Egbert-Jan Sol (TNO)
16:45-17:00	Questions
17:00-17:45	Coffee Break
	Industrial Platform Approaches (Chair: Željko Pazin (EFFRA))
17:45-17:55	Siemens Bernd Korves
17:55-18:05	Dassault Systemes François Bichet
18:05-18:15	SAP Uwe Kubach
18:15-18:25	ATOS Silvia Castellvi
18:25-18:35	IBM Friedrich Vollmar
18:45-19:15	Questions
19:15	Networking Dinner

6 October 2015, Diamant Building, Brussels

08:30-09:00	Welcome coffee and splitting in three groups
09:00-11:00	Break-out sessions for structured Discussions (Chair: Chris Decubber (EFFRA), Anne-Marie Sassen, Francesca Flamigni, Clemens Zielonka (EC)) Discussion will be based on the "Guiding questions" above and including the user's perspective
11:00-11:30	Coffee Break
11:30-12:30	Reporting and discussion of results of the break-out sessions (Chair: Max Lemke, Clemens Zielonka (EC)) Introduction Maurizio Gattiglio (EFFRA)
12:30-13:00	Conclusions and Next Steps Khalil Rouhana (EC)
13:00	Light Lunch

Background information:

The future of Europe's industry is digital! For Europe to seize its opportunities and be competitive worldwide, we need to act fast, jointly and at appropriate scale. Digital technologies increasingly play the central role in value creation in the entire economy and bring about radical transformation to all aspects of production and related services. This is why the EU's target of 20 percent share of industry in GDP can only be achieved if digitisation of products, processes and business models becomes a core element of all industrial sectors in Europe.

At Hannover Fair 2015, Commissioner Oettinger proposed the outline of an EU wide strategy for the digitisation of European industry "to ensure that all industrial sectors make the best use of new technologies and manage their transition towards higher value digitised products and processes" ([http://europa.eu/rapid/press-release SPEECH-15-4772_en.htm](http://europa.eu/rapid/press-release_SPEECH-15-4772_en.htm)). He indicated four lines of actions (http://ec.europa.eu/newsroom/dae/itemdetail.cfm?item_id=24190&newsletter_id=0&lang=en):

1. Digital innovation hubs accessible for any business in Europe to facilitate access to digital technologies and expertise in support of digital transformation,
2. Leadership in next generation open and interoperable digital platforms,
3. Preparing our workforce for digital opportunities and
4. Digitally fit-for-purpose regulation.

This workshop addresses line 2 to ensure the availability of state-of-the-art open and interoperable platforms for connected factories of the future which any business can use to make its products, processes and services ready for the digital age.

Recent economic analysis⁹ shows that platforms are creating most of the value in the digital ecosystem. Platforms are two-sided (or multi-sided). Platform providers must get both consumers and developers of complementary applications on board in order to succeed. The value of the platform comes from its size. The more users, the larger the set of peers to connect to, and the more developers and equipment providers, the more features will be available on the platform. Platforms also support the creation of ecosystems where, because of the critical mass and the base technology that is already available, specialised and innovative features can be added by any company that wishes to develop this offer. Well-known examples are in the smart phone domain, where it is attractive for developers to produce "Apps" and for consumers it is attractive to buy a certain brand of phone when many Apps are available.

Europe is performing well on industrial and professional platforms - open or proprietary (AUTOSAR, fly-by-wire, PLM and CAX, enterprise software. Companies like Dassault, Siemens, SAP, Bosch, ATOS are world leaders in their fields).

The development of platforms requires collaboration of key actors and could be supported through research and innovation funded by H2020 and the joint undertaking ECSEL. If Europe doesn't continue to invest in platforms, actors from other parts of the world will do. In particular the large non-EU internet industry is already starting to make strategic alliances with European industry through initiatives like the US-driven "Industrial Internet".

*A successful platform arising from Europe is **AUTOSAR** (AUTomotive Open System ARchitecture), an open and standardised automotive software architecture that was jointly developed by automobile manufacturers, OEM suppliers and tool developers in Europe. AUTOSAR is used for more than 90% of the cars worldwide. The partnership now expands to include all European, most US and Japanese players, and many other actors that aim at creating and establishing open standards for automotive electrics/electronics architectures. European R&I programs, all led by the ARTEMIS JTI, have been instrumental in supporting the platform. But for example: In the 2014 Consumer Electronics Show, Audi announced a cooperation on vehicle infotainment technologies with Google and its Android-based operating systems. Audi and others are lacking alternatives at this important level of the value chain. The mobility platforms of the future are likely to be a merger of the embedded control system and entertainment systems all linked to the mobility infrastructure platforms.*

⁹ http://is.jrc.ec.europa.eu/pages/ISG/documents/BREUGEL-NewICTsectors_PlatformsforEuropeangrowth.pdf