Deliverable 3.1

Survey of successful platforms

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Executive Summary

The document at hand presents the current results of the analysis of CPS technology platforms as well as relevant initiatives for the targeted application domains (smart manufacturing, smart health, smart energy and smart transport) with a potential of supporting European CPS standards. The aim of this document is to get a general overview ("big picture") of relevant CPS technology platforms in order to provide a basis for creating a "PlatForum" as well as "PlatformArenas"[3]. It will also be used for the identification of cross-domain building blocks of CPS technologies in the upcoming phase of the Platforms4CPS project. In the context of these activities, the survey of CPS technology platforms will be further refined.

This survey focuses on Cyber-Physical Systems (CPS) defined as engineered systems that are built from, and depend upon, the seamless integration of computational algorithms and physical components. In the understanding of the Platform4CPS consortium, the CPS concept can be placed somewhere between the concept of "Internet-of-Things" (more focus on big data analytics and business models) and of "smart devices enabled by smart systems integration" (more focus on miniaturised sensors, actuators, controllers etc. integrated in physical devices). Thus, with regard to European initiatives the focus of this survey is related to items of the ARTEMIS European Technology Platform / Industry Association[4] and can be placed between, and related to, initiatives like the European Alliance of IoT Innovation (AIOTI)[5] and the European Technology Platform on Smart Systems Integration (EPoSS)[6]. As CPS play an important role for the functionality and value of next-generation products, systems, and infrastructure in sectors such as manufacturing, transportation, health care, and energy networks, the survey also includes CPS applications in these sectors.

The focus of this platform survey is primarily on business-relevant technical and operational CPS platforms, thus concentrating on technical platforms such as e.g. IT-, IoT-, software development platforms as well as on operational communities, which work on reference architectures, interaction protocols, and interoperability frameworks for CPS. Organisational platforms such as stakeholder groups or networks for general representation are not in the focus of this survey, unless they are not directly linked to concrete conceptual framework or technical platform building activities.

The empirical findings – based on expert interviews and desk research – accordingly show a majority of technical and operational CPS platforms (72 out of 83 surveyed activities/initiatives can be assigned to technical or operational "platforms"). In sum, 83 platforms have been surveyed in order to get general insights to the structure of available platforms in the area of CPS in different focus industries.[7]

[3] "PlatForum" and "PlatformArenas" aim at demonstrating and showcasing the benefits of joining the ecosystems related to selected CPS platforms

[4] https://artemis-ia.eu

[5] www.aioti.org

[6] www.smart-systems-integration.org; EPoSS, ARTEMIS and AENEAS work together in the Electronic Components & Systems for European Leadership (ECSEL) Joint Undertaking (http://www.ecsel-ju.eu), representing the actors from the areas of micro- and nano-electronics (AENEAS), smart integrated systems (EPoSS) and embedded/cyber-physical systems (ARTEMIS).

[7] At this stage, the survey is a snapshot of the current situation and cannot be exhaustive. For the IoT sector, more than 360 platforms have been identified (UNIFY-IoT platform report, 2016). Taking into account additional CPS initiatives, we expect the total number of existing and emerging CPS platforms and initiatives to be even higher.

The analysis of the surveyed platforms reveals a multitude of diverse platforms foci and objectives. In the end, 15 different platform types could be categorised. Each of the platforms contribute to specific challenges during the development or “life-cycle” stage of a CPS, from research, community building and standardization to the design of a CPS to CPS operation management, and finally to CPS-based market places and IoT platforms. Whereas the surveyed platforms from the US are mainly technical and more cross-cutting and commercially-/market oriented (IoT-, IT- and hard-/software development platforms), a number of European platforms could be labelled as “organizational”, reflecting the current efforts of the European Commission to European platform building. These organizational platforms however can be seen as a seedbed for upcoming technical and operational CPS initiatives. The European technical platforms more often (in comparison to US platforms) have a problem- or domain-specific focus like e.g. the design and operation of CPS in the domain-specific cyber-physical environment. Nevertheless, common challenges such as e.g. modeling and simulation of CPS could be identified across the domain-specific vertical platforms, opening up the potential for cross-sectoral platform building within Europe, in particular as the European platforms are seen as more “open” than the US platforms.

In the next stage, the findings of this survey will be refined and technical, as well as organisational, key features of the platforms will be extracted. Based on this, a repository of common building blocks for CPS platforms will be created in order to support platform building across various contexts and sectors as well as hierarchy levels and product life cycles.

1 Introduction

The term **Cyber-Physical System (CPS)** describes hardware-software systems, which tightly **couple the physical and the virtual world**. CPS are established from networked embedded systems that are connected with the outside world through sensors and actuators and have the capability to collaborate, adapt, and evolve (cf. Figure 1; Song, H. et al. 2017). Support for development and integration of Cyber-Physical Systems is seen as essential for the future as there will be an increasing number of interacting systems with strong connectivity utilised in both society and in industry.

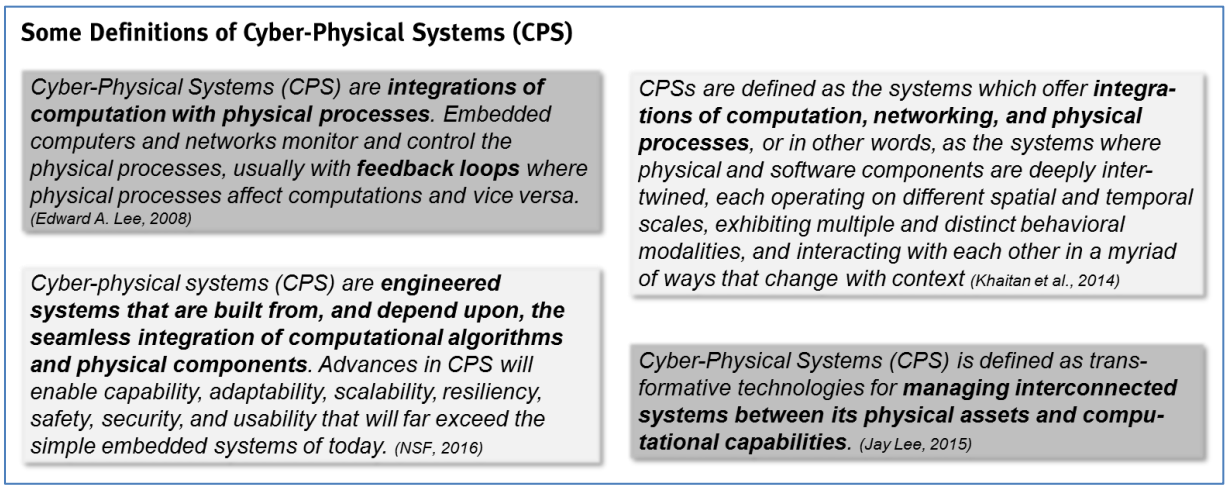

Figure 1: Some definitions of Cyber-Physical Systems (CPS)

Future CPS will find their application in many highly relevant areas to our society, e.g. in multi-modal transport, eHealth, smart factories, smart grids and smart cities among others (cf. Figure 2; acatech 2011). Enhanced by the advancements in various related technologies, the deployment of CPS is expected to increase substantially over the next decades, holding great potential for novel applications and innovative product development. However, the inherent complexity of CPSs, as well as the need to meet optimised performance and comply with essential requirements like safety, security and privacy, raises many questions still to explored by the research community.

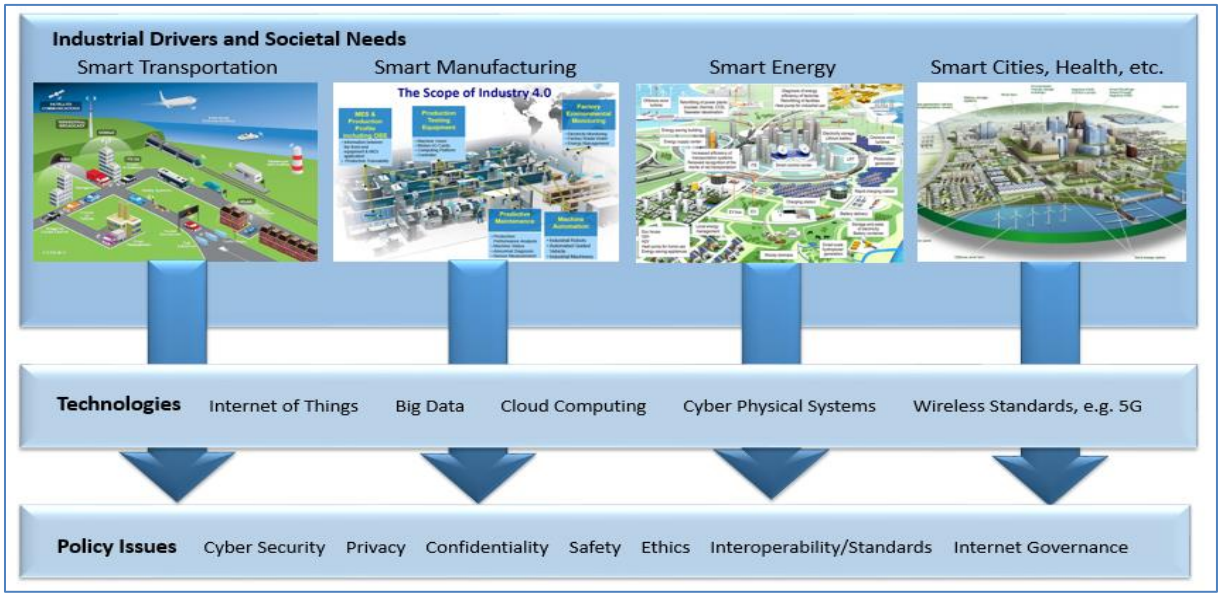

Figure 2: Platforms4CPS context

Europe is a world leader in the area of time-critical and safety-critical systems. To maintain this position, there is a need to be able to design, develop and deploy highly distributed and connected digital technologies on a broad basis. Therefore, there is a need to develop a foundational background to create a 'science of systems integration' to manage the complexity of future CPS, and to meet the need of demanding safety, security, power efficiency, performance, size and cost constraints of future cyber-physical systems. Furthermore, platforms for CPS deployment are seen as critical as well as a supporting ecosystem of CPS developers and users.

The Platforms4CPS project thus aims to 'create the vision, strategy, technology building blocks and supporting ecosystem for future CPS applications' with three key objectives (see Figure 3):

- Create a vision and strategy for future European CPS by analysing the ecosystem and market perspective and strategically updating and validating existing CPS roadmaps across multiple domains (Platforms4CPS work packages 1 and 2)
- Promote platform building, bringing together industry and academic experts and create a repository of CPS technology building blocks (Platforms4CPS work package 3)
- Build an ecosystem by creating a constituency and through cooperating with ECSEL, ITEA, and ARTEMIS projects on the foundations of CPS engineering, and consensus building on societal and legal issues related to the deployment of CPS (Platforms4CPS work packages 4 and 5).

In this context, this document contributes to the second objective and provides the basis for all related tasks in the Platforms4CPS project's work package 3 (and beyond).

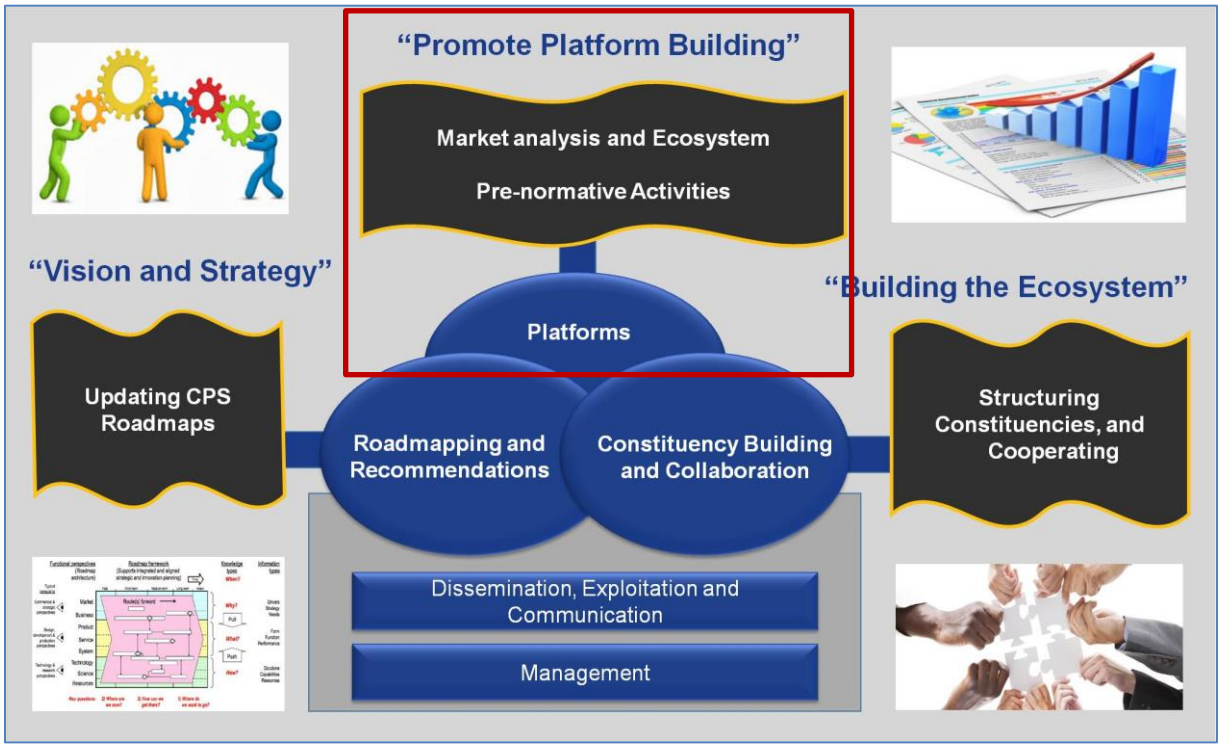

Figure 3: Overview of the Platforms4CPS Objectives

The overall goal of work package 3 is to **promote platform building within Europe, bringing together leading CPS experts from science and industry in order to collaborate on CPS architectures and platforms.**

The use and exploitation of platforms for systems integration is seen to be critical as systems become increasingly complex. Europe still holds a strong position in many industrial sectors with respect to CPS but there is a current fear across Europe, that this could be undermined by the dominance of de-facto platforms from the US (e.g. Google, Apple, Facebook, Amazon). From a European point of view, it is necessary to develop a strong European position and strategy to preserve European interests.

There is already a good basis for platform building, e.g. coming from European initiatives and projects such as ARTEMIS/ECSEL (Crystal, EMC2, Arrowhead), 5G/FI-PPP (FIWARE/FITMAN), etc., or from national initiatives like Platform Industrie 4.0, Industrie du Futur, smart industry, etc. in order to overcome the fragmentation of efforts in Europe and to develop a supporting ecosystem for European companies with 'open' interoperable digital platforms, the European Commission launched a "Digital Single Market Strategy"[8] and in March 2017 a "European Platform of national initiatives" (Figure 4). This European "platform of platforms" shall substantially contribute to the roll-out of digitisation of industry across Europe (exchange of experience, discussion of regulatory issues, joint actions, etc.).

Figure 4: List of national initiatives related to the new European "platform of platforms"[9]

[8] COM(2015) 192 final

[9] https://ec.europa.eu/digital-single-market/en/news/european-countries-join-forces-digitise-industry

In Europe, there is a need to ensure that platforms development is not done in silos but that a critical scale is reached through pan-European collaborations. In order to reach a critical mass – at global level – and to establish 'open' and interoperable digital platforms in Europe, a pan-European exchange of experiences, technologies and specifications between various CPS-related peer communities at the regional, national and European level is necessary. All stakeholders along entire value chains need to agree on issues like system specification, reference architectures, communication protocols, etc. to ensure peer-to-peer platform integration and interoperability. Both, large companies' interest and commitment in platform collaboration is needed as well as a supporting ecosystem for CPS developers and users, e.g. currently provided by major European initiatives such as ARTEMIS/ECSEL, IoT Focus Area 5G or FI-PPP among others.

In general, platform building can be seen in a very broad sense. It can refer to digital innovation hubs, hardware platforms, IoT platforms, digital market places, etc. Whereas the EU Communication on Digitising European Industry (DEI) defines platforms as "multi-sided market gateways creating value by enabling interactions between several groups of economic actors"[10], the DEI working group 2 report defines platforms in a broader sense as "agreements on functions and interfaces between industry players that create markets and market opportunities leading to ecosystems and standards"[11]. This encompasses platforms (in the narrow sense as used by the DEI Communication) together with reference architectures, interaction protocols, and interoperability frameworks.

In general, **platforms can be categorised as organisational, technology based or operational** depending on the purpose of the activities they cater for (Figure 5). In several cases, a platform may belong to more than one category. For example, the Autosar platform may refer to the Autosar consortium but also to the Autosar technical specifications for the respective middleware.

[10] COM(2016) 180 final
[11] DEI WG2 (2017)

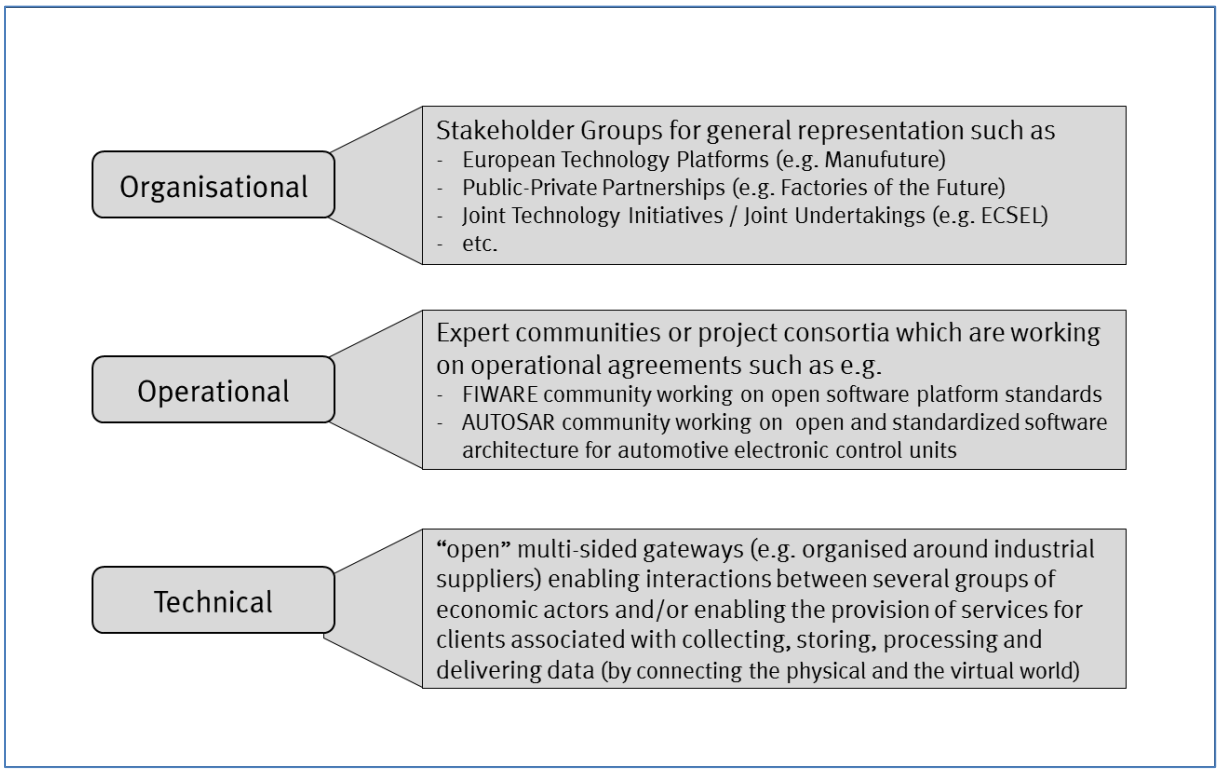

Figure 5: Organisational, Operational and Technology Platforms

2 Survey of CPS platforms

2.1 Objectives, Scope and Methodological Approach of the Survey

2.1.1 Objectives

The main objectives of the survey are

- to identify and to structure existing and emerging CPS platform initiatives in four sectors (manufacturing, transportation, health and energy) as well as relevant cross-cutting initiatives in order to get a **big picture of the current CPS landscape with different types of platforms** (stage 1), and based on this,
- to analyse these initiatives with regard to commonalities in the underlying technical visions and terminology in order to **prepare the ground for deriving common building blocks for CPS platforms** (stage 2) contributing to an open European CPS platform building.

2.1.2 Scope and Clarification of Concept

The focus of this platforms survey is primarily on business relevant technical and operational CPS platforms, thus concentrating on platforms as "open" multi-sided gateways (e.g. organised around industrial suppliers) as well as on communities which work on reference architectures, interaction protocols, and interoperability frameworks. Organisational platforms such as stakeholder groups or

networks for general representation are not in the focus of this survey, unless they are not directly linked to concrete conceptual framework or technical platform building activities.

In the following, the concept of "CPS platforms" as the object of this survey is clarified from our Platform4CPS consortium point of view.

Cyber-Physical Systems (CPS)

This survey is focusing on Cyber-Physical Systems (CPS) defined as engineered systems that are built from, and depend upon, the seamless integration of computational algorithms and physical components. In the understanding of the Platform4CPS consortium, the CPS concept can be placed somewhere between the concept of "Internet-of-Things" (more focus on big data analytics and business models) and of "smart devices enabled by smart systems integration" (more focus on miniaturised sensors, actuators, controllers etc. integrated in physical devices) (Figure 6). Thus, with regard to European initiatives the focus of this survey is related to items of the ARTEMIS European Technology Platform / Industry Association and can be placed between, and related to, initiatives like the European Alliance of IoT Innovation (AIOTI) and the European Technology Platform on Smart Systems Integration (EPoSS) .

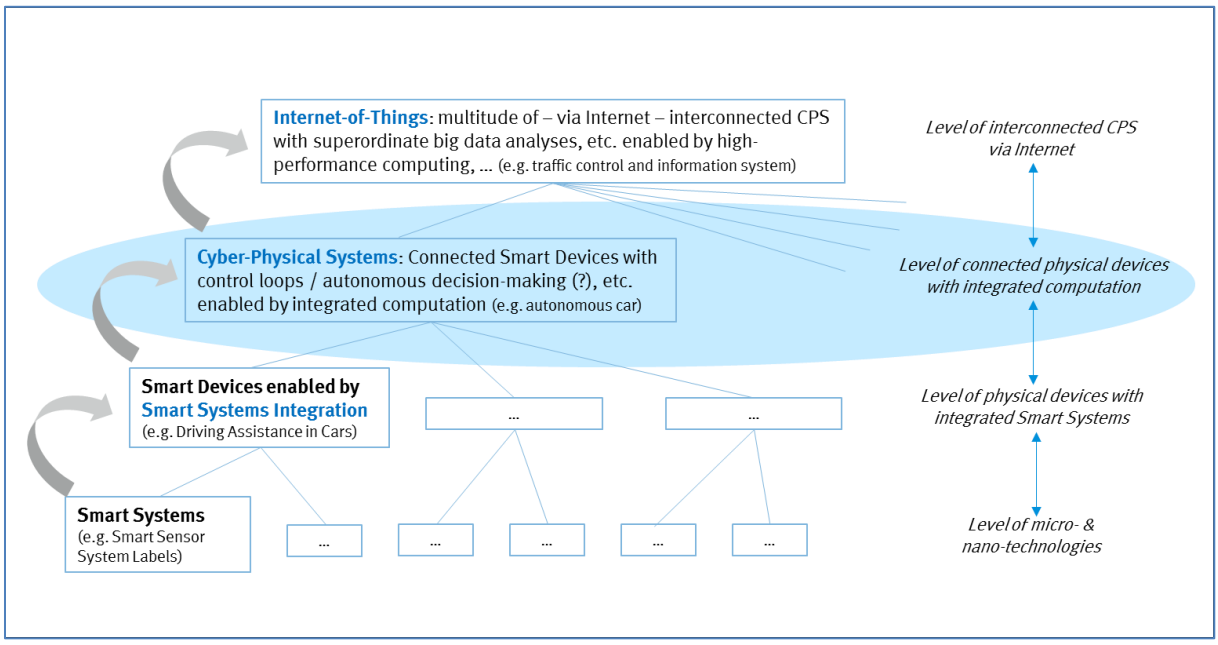

Figure 6: Distinguishing IoT – CPS – SSI by looking at different hierarchy levels

CPS Platforms

As discussed in chapter 1, there are different meanings of the term "platform". When we are looking for CPS platforms in general, we can find platforms at different levels (Figure 7):

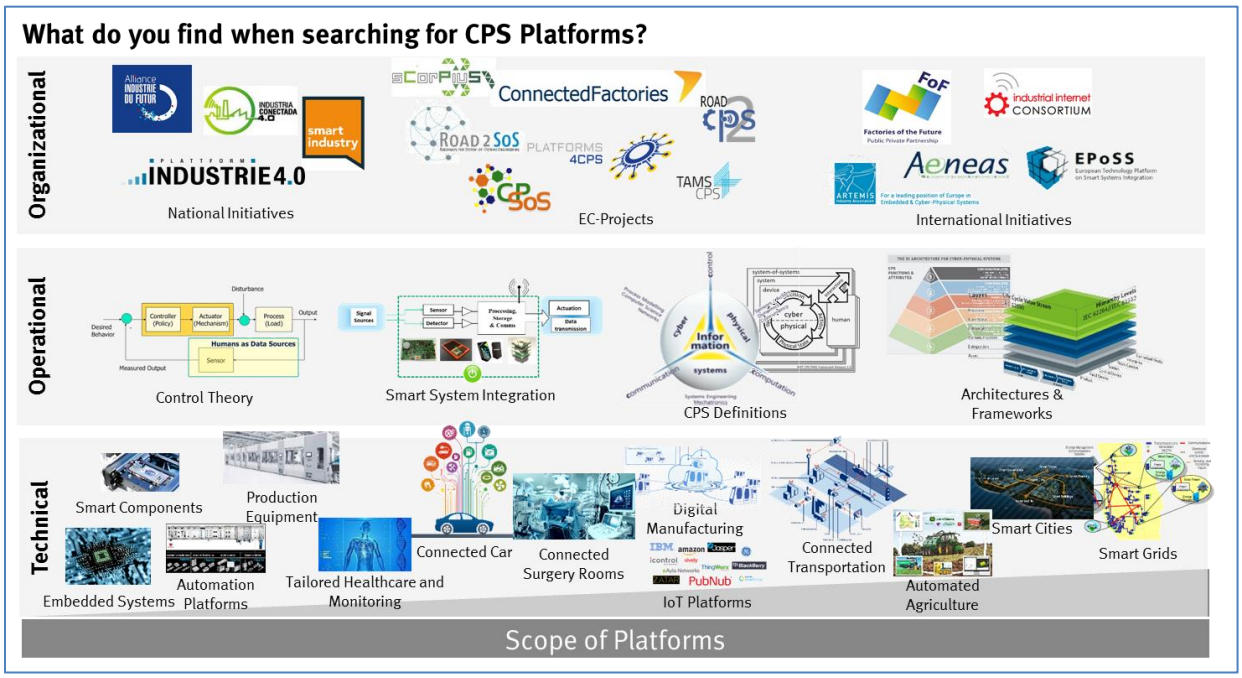

Figure 7: Examples of what we find when searching for CPS-related platforms in a broader sense

Organisational "CPS-related platforms" – in terms of organised stakeholder groups and platforms for general representation, exchange of experience, etc. – can be found at national, trans-national and international level and organised as projects (e.g. as European coordination and support actions, CSAs), contract-based Public-Private Partnerships (PPPs), or in another institutionalised way.

Operational "CPS-related platforms" – in terms of expert communities or project consortia which are working on operational agreements – can be found with a focus e.g. on control theory, smart systems integration, CPS definitions and foundations, reference architectures and interoperability frameworks.

Technical "CPS-related platforms" can be identified at a low level (e.g. intelligent devices with embedded systems), at a medium level (e.g. from hardware platforms to IoT platfroms) or at a high level (e.g. connected world of smart cities or smart grids).

The focus of this survey is NOT on organisational platforms, which do not have some clear and concrete initiatives on a CPS-related conceptual framework or technical platform building. For example, European Technology Platforms such as ManuFuture, etc. are not in the focus, unless they are actively involved in specific CPS framework and platform building initiatives (such as e.g. ARTEMIS with its CRYSTAL or ARROWHEAD projects). Clear focus is on operational platforms (focusing on standards, architecture, etc.) and on technical platforms whether they are domain-driven (vertical platforms) or cross-cutting (horizontal platforms).

As CPS play an important role for the functionality and value of next-generation products, systems, and infrastructure in key sectors such as manufacturing, transportation, health care, and energy networks, the survey focuses on CPS applications in these sectors. Beyond specific vertical platforms, the survey also considers cross-cutting, horizontal platforms (e.g. ICT platforms, which allow a certain process step in engineering or the management of assets (IoT related), often not related to a single domain)

2.1.3 Methodological Approach

The survey follows a two-staged approach, which is depicted in Figure 8. At **stage 1**, which is represented by the results of this document, the ambition is to get a broader insight into the structure of the current CPS and CPS platforms landscape. Thus, high level descriptive attributes are initially analyzed in order to **get a big picture of different types of platforms** (with regard to subjects, objectives, etc.) in key CPS application domains (manufacturing, health, energy and transport) as well as for relevant cross-cutting issues. To generally categorize the CPS landscape, following attributes were surveyed (a detailed description of the attributes can be found in Appendix A):

- Name and short description of the platforms (including URL for original platform information)
- Classification of platform subject: IT-Platform, Project, Initiative, Framework, Concept, …
- Organizational / Operational / Technical
- Vertical / Horizontal
- Specific domain or cross-cutting issue
- Open / Commercial
- Related Network / Community
- Vision (Objectives)
- Geographic coverage (Country, Region)
- Key stakeholders (founding members, …)

The basic structure and understanding derived from this analysis will allow a more precise scope for the **derivation of common building blocks for CPS platforms at stage 2**. Thus, the next stage will be a deep dive into the related platforms and the extraction of relevant organizational and technical features, which will be required to derive such common building blocks. The derivation of these building blocks will be considered in another deliverable of the Platforms4CPS project (D3.3).

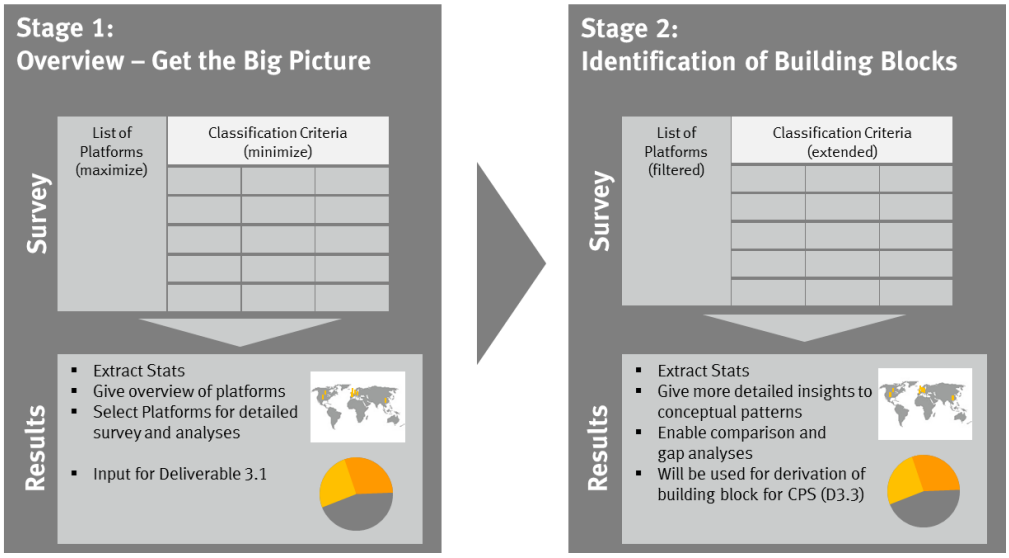

Figure 8: Methodological approach for the survey on CPS platforms

To identify relevant platforms for the initial stage, a general online research was conducted, some recent CPS and IoT survey documents were reviewed (e.g. DG CONNECT and EFFRA, 2015; Road2CPS 2015; UNIFY-IoT Project, 2016), and some CPS experts were consulted.[12] The main information for compiling the platforms' attributes list is taken from the website of the respective platform.

2.2 Results of the Survey

In the following, the main results of stage 1 of the CPS platforms survey are presented and discussed. The detailed list of the platforms' attributes is shown in Appendix B.

2.2.1 Limitations of the survey

As mentioned above, the main objective of stage 1 is to get a big picture of different types of platforms. Thus, the survey results are far from being exhaustive, and **the list of 83 identified platforms does not cover all the initiatives that could be labelled as "CPS platform"** in a broader sense. For example, in the IoT sector the UNIFY-IoT Project (2016) identified recently more than 360 platforms. Including the perspective of CPS platforms, the authors expect the number of respective platforms to be even higher. In consequence, this survey can only give an insight to the current landscape of CPS platforms and their structure in different industries. It must be expected, that the figures given below would change significantly, if more platforms were reviewed. Especially geographical or national attributes of the figures in the subsequent sections have to be correctly interpreted and should not be taken out of the given context. Identified biases will be discussed in the respective subsection.

Furthermore, the survey contains projects and research initiatives, which are currently running, but with a limited time horizon. Therefore, the survey may be seen as a **snapshot of the current situation**. Research projects will for instances result in new permanent platforms, which is not reflected in the survey.

2.2.2 Geographic coverage of surveyed platform initiatives

The current results of the platforms survey show national, trans-national (European) and even global initiatives. As Figure 9 shows, many European platform initiatives have been identified, in particular many organizational platforms, reflecting the current efforts of the European Commission to build CPS communities and networks at the European level.[13]

[12] Following Platforms4CPS experts contributed to this survey:

- Haydn Thompson and Daniela Ramos-Hernandez from THHINK
- Charles Robinson with colleagues from Thales
- Martin Törngren from KTH
- Holger Pfeiffer with colleagues from Fortiss
- Johannes Linzbach with colleagues from Festo

[13] Note: The visibility of the different platforms varies depending on the different countries and languages available for the search. As the survey experts are from Europe, there is a dominance regarding the EU and their member states. The classification of a platform with respect to its organizational, operational and technical nature does not have a sharp line. For the survey, the main recognition of a platform was considered in order to make a classification if possible. EU platforms at the organizational, operational and technical level were included in the first step of the survey, while other international initiatives at this level were not included. The European platforms were more well-known and visible to the experts. This leads to the observed dominance of European platforms.

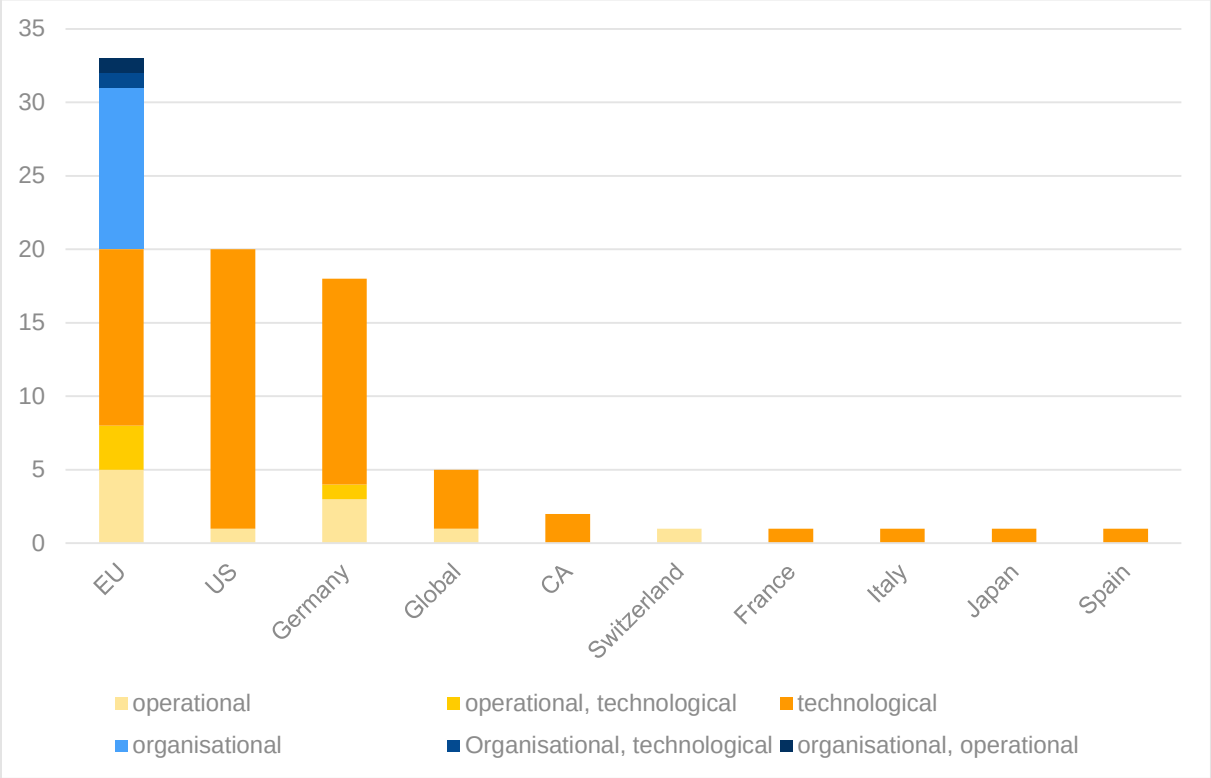

Figure 9: Geographic coverage of identified platform initiatives

With regard to technical platforms, the consulted experts identified many US platforms but also several European platforms. In particular, **US solutions and platforms coming from the ICT sector have a great visibility across the different domains**. Cross-cutting IoT and IT solutions are available to support asset management and cover architectural topics like connectivity, or security. The **European technical platforms often have a more problem-specific or a domain-specific focus**. These platforms aim at solving problems like connectivity, CPS development, data analytics and orchestration, communication and network building.

Several national initiatives were identified, indicating the potential for trans-national collaboration in particular across Europe. [14]

2.2.3 Horizontal and vertical platforms with specific domains

The surveyed platforms can be distinguished between cross-cutting, horizontal platforms and domain-specific, vertical platforms. In total, 48 cross-cutting, horizontal and 35 domain-specific,

[14] Note: With regard to national initiatives as well as to addressed sectors/domains (e.g. high number of "manufacturing platforms" in Germany), the survey is clearly biased due to the national and domain-specific expertise of the involved experts (e.g. experts regarding manufacturing were located in Germany).

vertical platforms were analyzed. Figure 10 shows the specific domains addressed by the vertical and some more horizontally-oriented platforms.[15]

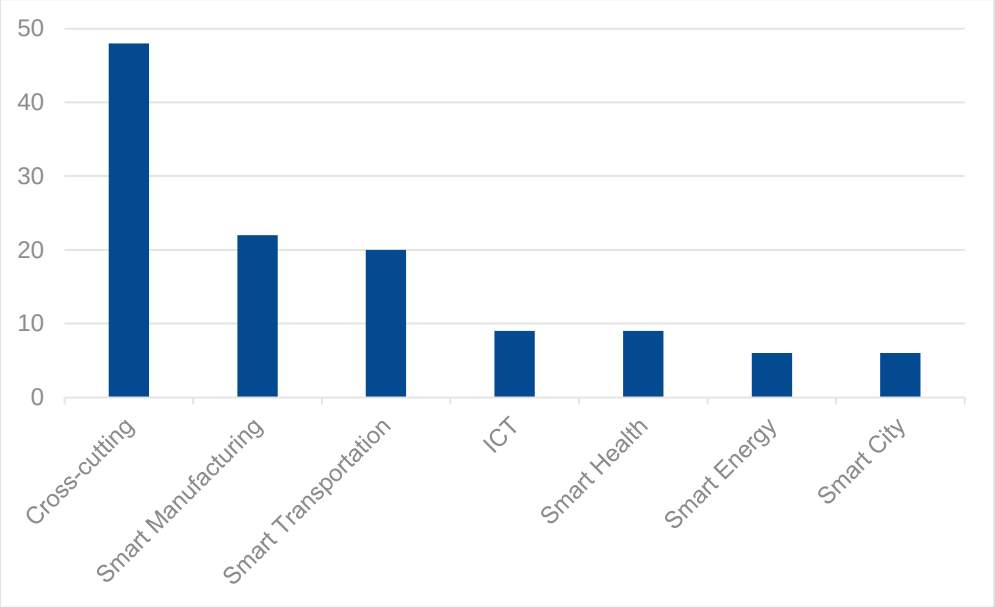

Figure 10: Domains addressed by the surveyed platforms

The **vertically oriented platforms** often focus on certain **standards or reference architectures for the specific domain**. Examples are IEC 62357 in the energy domain, IEC61131-3 in engineering or the reference architecture model for Industry 4.0 (RAMI4.0). These standards and architectures are **more dedicated to the physical systems, their design and their control in operation**. For instance, standards for the software structure of PLC systems are established and different providers offer development environments for project implementation. The standardization in this area is driven by the domains. The requirements regarding the physical implementation of the CPS are often specific for the respective domain. A generalization of these standards is often not purposeful to keep the specifications applicable. Nevertheless, the vertical platforms face **common challenges regarding the simulation of the systems that they implement**. For instance, the control of distributed networks in smart energy environments have to be modeled. There are similar challenges in network modelling in other verticals like smart logistics. Another partition of the vertical platforms that can be made is with respect to **specific product platforms** that implement CPS. These development platforms often address specific industries. The vertical alignment is expected to come from domain specific standards and requirements that products must fulfil, e.g. safety issues in automated applications.

More **horizontally oriented platforms** often relate to **interoperability and communication across specific layers or across several life-cycle stages**. Examples are platforms which implement 5G connectivity as well as other telecommunication standards. In terms of interoperability, the connection of different data sources and the provision of web standard interfaces is increasingly adopted in different aspects of CPS. An example is FIWARE, which offers an ecosystem based on

[15] Note: The numbers given in this chart add up to more than 83 platforms, because multiple assignments were possible in the classification.

open APIs at different levels, including the interfaces to physical assets. The lifecycle is another driver for horizontal platforms. Portals like TIA from Siemens give support in the all product development and production stages. The methodologies used can be adopted for different domains like smart manufacturing or smart energy. Further simulation standards and middleware reference architectures including, for instance, the High Level Architecture (HLA) and Functional Mock-up Interface (FMI) support interoperability issues (both are standards with open source software available). Finally, middleware standards, such as the Data-Distribution Service (DDS) (a standard with open source software available), are experiencing increased attention and adoption in CPS domains.

2.2.4 Specific types of surveyed platforms

The analysis of the surveyed platforms reveals a multitude of different foci and objectives, as shown in the previous subsections. With the aim to get a big picture of the current CPS platforms landscape – as main objective of this survey –, the platforms could be categorised into 15 specific platform types (see Figure 11).

Regarding the regional foci in the sample of platforms (see Figure 12), an obvious **dominance of IoT platforms from the US** can be seen. Further IT-platforms and hardware based development platforms still include a remarkable number of platforms from the States. These software oriented fields are traditionally strong branches in the US. The focus on this high-level market place layer opens the chance for other global regions to provide convincing integration frameworks for CPS by strong standards.

Figure 11: Structured overview of surveyed platforms by type

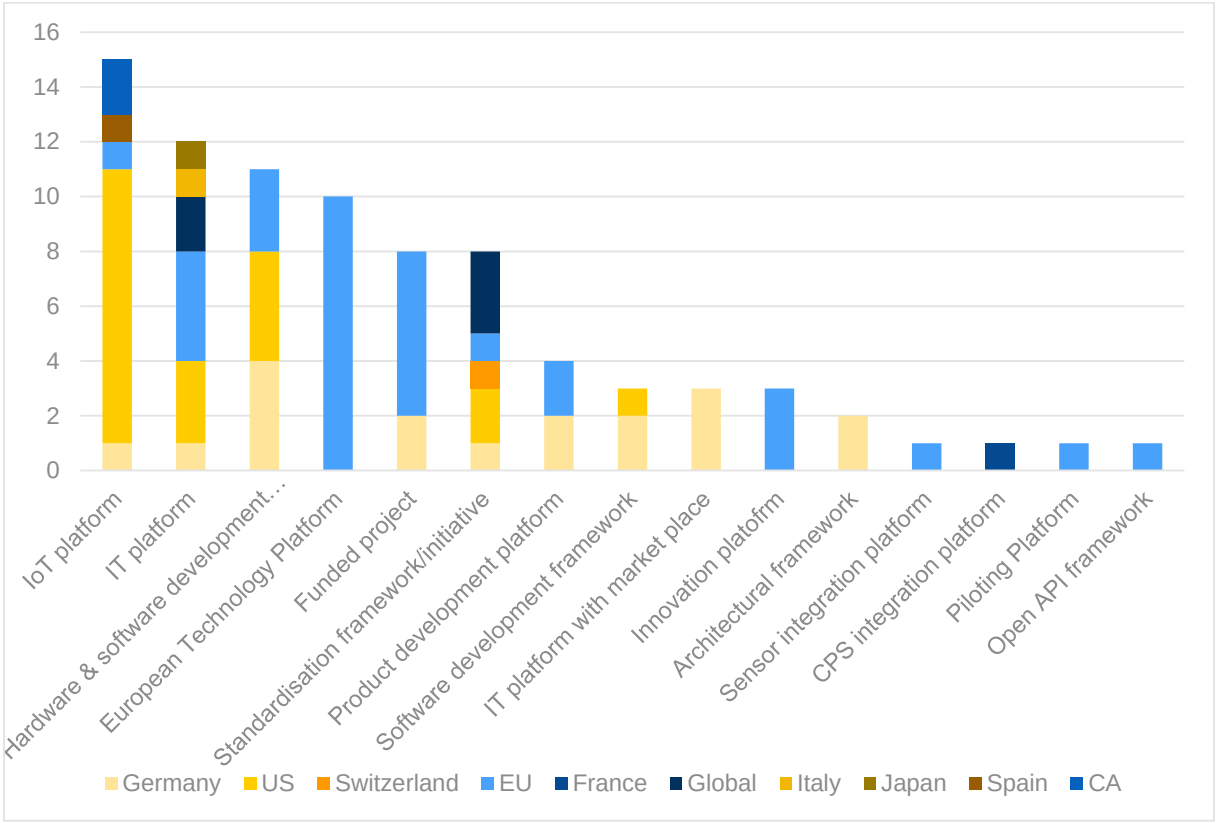

Figure 12: Types of platforms per region

Each platform provides support for different challenges during the development or "life-cycle" stage of a CPS:

(1) At a very abstract and early "life-cycle" stage of a CPS, **research activities and community building** around CPS occur in different technological fields and different domains.

(2) The **design** of cyber-physical systems is a central characteristic of some of the surveyed platforms at an advanced stage .

(3) The **operational phase** of CPS and their orchestration are the third aspect which could be observed.

(4) At the highest level, **market places and IoT platforms** of CPS-assets have been observed.

In the following, these four categories will be described in further detail.

Research, community building and standardization: Platforms for community building to connect experts from different domains to share commonalites made up a significant amount of the platforms (e.g. ARTEMIS, ALICE and NESSI) identified. Funded research projects for implementing parts of CPS and CPS platforms are another type of platform observed. These initiatives build technological and methodological foundations for CPS. Within this cluster also standardisation initiatives play a foundational role. In many industries standards are required to ensure a minimum of interoperability and quality control. The standardisation activities are closely connected to architectural considerations. There are several initiatives, which try to provide architectural references and frameworks usually for a certain domain (e.g. RAMI4.0 and MAF/e-Maritime). Still, the architectural initiatives themselves must be differentiated, because some of them provide more development centric or more interoperability centric methods and descriptions.

Design of CPS: Within the platforms considering the design of new (CPS) products two main streams were identified. On the one hand, there are the providers of hardware platforms for the development of CPS (e.g. provided by Intel, ARM, Siemens, Festo) at different hierarchy levels. The levels range from microchips up to fully engineered machines. These hardware development platforms come with a software development framework to implement the logical functions of the CPS. The software development framework recently follows the trend to encapsulate complexity to make the development of higher systems functions easier (e.g. 3S application composer). On the other hand, product development platforms support the system design in a number of ways as well as its planning of production (e.g. Siemens TIA). Advanced system simulations and product development methods are available in these platforms to check the validity of subsystems or interaction of systems.

CPS operation management: In this cluster of platforms, mainly IT systems are integrated. They provide a rule management on a higher level for operational assets and often provide an interface for human operators to react to unexpected or undesired system states (e.g. OSIsoft). For the orchestration, commonly a high knowledge of the target domain is required. Management of connected CPS as well as observation of operations in SCADA and business intelligence are part of these operational oriented platforms (e.g. Factory Talk and GE Predix). A key objective is to provide for the advanced handling of systems with increasing complexity as well as the continuous optimization of those.

Market places and IoT platforms: Currently, this phase of CPS is receiving an increased attention fuelled by discussions about the Internet of Things (IoT). In the selected sample of platforms, the

dominance of IT and IoT platforms is eye-catching (cf. Figures 11 and 12). The increasing visibility of these platforms is likely to be triggered by the trends coming from the B2C markets, where data and the management of devices has led to lucrative new markets. Furthermore, these more web based markets have established many open standards. Data makes the difference in these businesses and exchange of data is critical to many business models. This is contrary to domains with high investments in physical assets which do not have high interoperability at the device level like that found in the mobile phone sector. The obvious reason for this is the potential damage by malfunctioning assets in these domains, e.g. manufacturing or energy. Therefore, IoT platforms aim at creating interconnectivity of devices to get access to data. The data is meant to be used for creating market places of different domains (e.g. Axoom, Siemens Mindsphere). The depth of the provided integration varies widely within these platforms, but only a few of them go down to critical system management with interruption of processes. The focus often lies in getting the data out of the systems via a gateway architecture. As standardization regarding connections from this high business level to the deep insights of technical systems does not cover safety-critical communication, these architectural patterns will be visible for the next years.

2.2.5 Open vs. commercial platforms

Open access to CPS platforms is critical, when collaborative approaches of platform building and creative ecosystems for CPS developers, providers and users shall be pushed forward, as currently done by the European Commission. On the other hand, commercial aspects of CPS platforms are of interest for companies in order to provide commercial services and to make money out of new business models. Thus, this survey distinguishes open from commercial platforms based on a high abstract level (not analyzing in the detail various platforms-related complex business models).

Several surveyed platforms labelled as “open” aim at enabling every interested entity to use the technological or methodological core of the platform. Standards like IEC 62357 or ARINC 653 fall within this category of platforms. Platforms providing free access to community activities were also classified as “open” such as e.g. CRYSTAL or ETP4HPC. Furthermore, initiatives on reference architectures like RAMI 4.0 as well as open source software development frameworks like projects initiated by the Eclipse foundation aim at providing open access to their core findings and developments. They often aim at cross-domain usage to reach many users.

Considering commercial platforms the abstraction is even higher. If the revenues with a platform were made by a payment models platforms were classified as “commercial”. As an example, the underlying business models often provide freemium models. A certain number of devices or transactions is for free to enable customers to run proof of concepts (POCs). After these free contingents, the user must switch to commercial use of the software.

Figure 13 shows the regional distribution of the surveyed platforms labelled as “open” or as “commercial”. It is obvious that **EU platforms are seen as more “open” in contrast to US platforms that are seen as more business-oriented and “commercial”**. Although open platforms (organizational, operational and technical) are also established in the US, NIST or the IIC are examples for that, almost only commercial platforms from the US are highly visible. This international visibility of the platforms is an important competitive factor. Visibility grants access to markets.

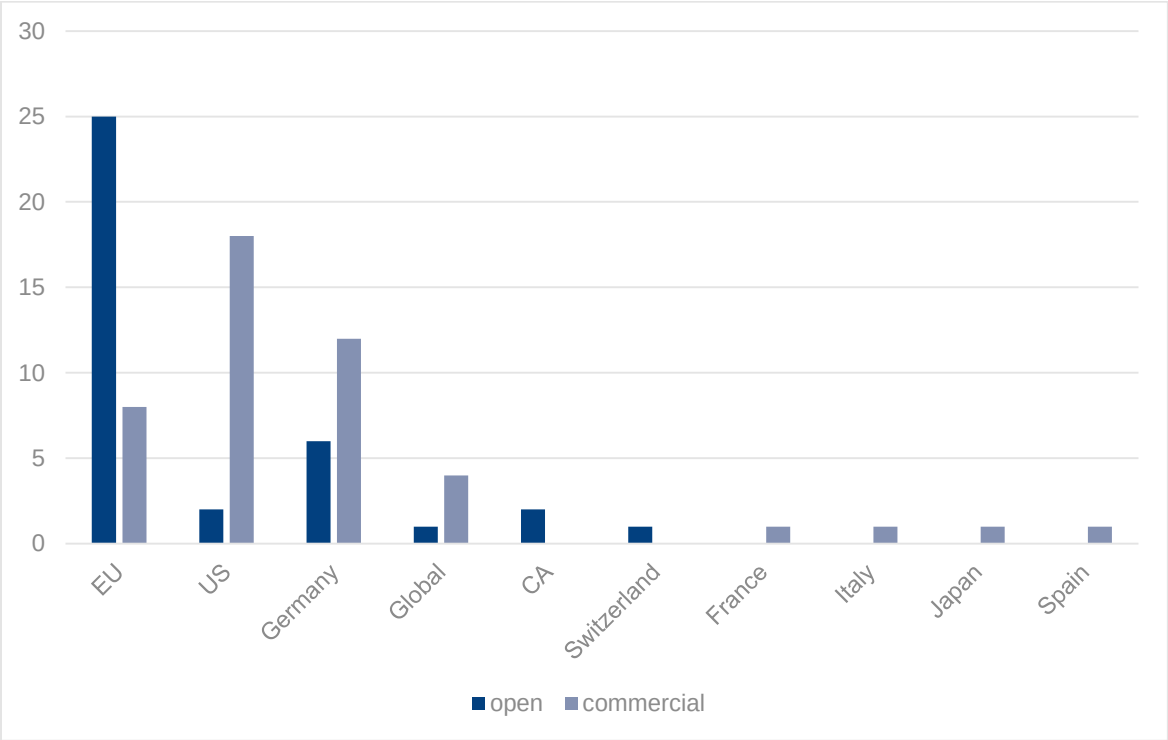

Figure 13: Open vs. commercial platforms by region

2.2.6 Commonalities and potential for European CPS platform building

The results of the platforms survey as presented above show a multifaceted landscape of CPS platforms with various foci, objectives, etc. of the respective initiatives. Thus, it seems to be a nearly hopeless undertaking to find some overarching commonalities between all the analysed platforms. However, all the platform activities – according to their underlying technical vision – could be assigned to specific development or "life-cycle" stages of a CPS, from research and community building to CPS design to CPS operation management, and to CPS-based market places and IoT platforms. Thus, European platform building has to take into account the life-cycle aspect, as it is already done to a certain extent in architectural frameworks (e.g. RAMI 4.0).

Vertically-oriented, domain-specific platforms are typically related to domain-specific challenges (e.g. a platform for individual health monitoring is very likely not to cover smart grid functionalities), but they also share some common challenges such as modelling, visualising or simulating CPSs. Furthermore, a higher level of managing CPS-assets provides a higher likelihood for standardisation needs with respect to connectivity. Here there is pressure for domains to follow the paradigms of open standards and interfaces of the web-technologies community. For instance, IoT solutions are applicable in current CPS business cases, because the communication is brought to a highly standardized level via gateways.

These finding of common challenges (simulation and modelling, interoperability and connectivity, etc.) are in line of currently discussed CPS challenges in academic literature (e.g. Mosterman and Zander, 2016) as well as described e.g. in the latest Strategic Research Agendas of ARTEMIS (ARTEMIS IA, 2016) or of the Tams4CPS project for EU-US collaboration (cf. Hafner-Zimmermann and Henshaw, 2017). **Such common challenges open up the potential for cross-sectoral platform**

building notably within Europe, in particular as the European platforms are seen as more "open" than the US platforms.

3 Conclusion

At this stage of the platform survey, 83 CPS - related platforms have been surveyed. The analysis of the surveyed platforms reveals a multitude of diverse platforms foci and objectives. In the end, 15 different platform types could be categorised. Each of the platforms contribute to specific challenges during the life-cycle stage of a CPS, from research to design to operate, and finally to monetize CPS in the domains. Whereas the surveyed platforms from the US are mainly technical and more cross-cutting and commercially-/market oriented (IoT-, IT- and hard-/software development platforms), a number of European platforms could be labelled as "organizational", reflecting the current efforts of the European Commission to European platform building. These organizational platforms however can be seen as a seedbed for upcoming technical and operational CPS initiatives. The European technical platforms often (in comparison to US platforms) have a problem- or domain-specific focus like e.g. the design and operation of CPS in the domain-specific cyber-physical environment. Nevertheless, common challenges such as e.g. modeling and simulation of CPS could be identified, opening up the potential for cross-sectoral platform building within Europe, in particular as the European platforms are seen as more "open" than the US platforms.

In the next stage, the findings of this survey will be refined and technical, as well as organisational, key features of the platforms will be extracted. A key challenge for industry is that CPS are used in different contexts and sectors, e.g. automotive, aerospace, manufacturing, etc., at different product life cycle stages and they appear also at different hierarchy levels (from sensors up to (inter-)organizational level).

Based on this platform survey a repository of common building blocks for CPS platforms will be created to support platform building across various contexts and sectors as well as hierarchy levels and product life cycles, and considering aspects such as the visualization of use cases or the interconnectedness of "things" in an Industrial IoT scenario.

The Reference Architecture Model for Industrie 4.0 (RAMI4.0) proposed by the German "Plattform Industrie 4.0" will be used as a starting point for the assignment of CPS building blocks in the repository (Figure 14). RAMI 4.0 is a three-dimensional map showing how to approach the issue of Industrie 4.0 in a structured manner and it ensures that all participants involved in Industrie 4.0 discussions understand each other. We propose to use this concept due to its relatively high maturity level, which is based on established standards. Standardisation activities are driven massively by different layers of the cube. The building blocks describe requirements to enhance a system to another coverage level (e.g. to make it a platform).

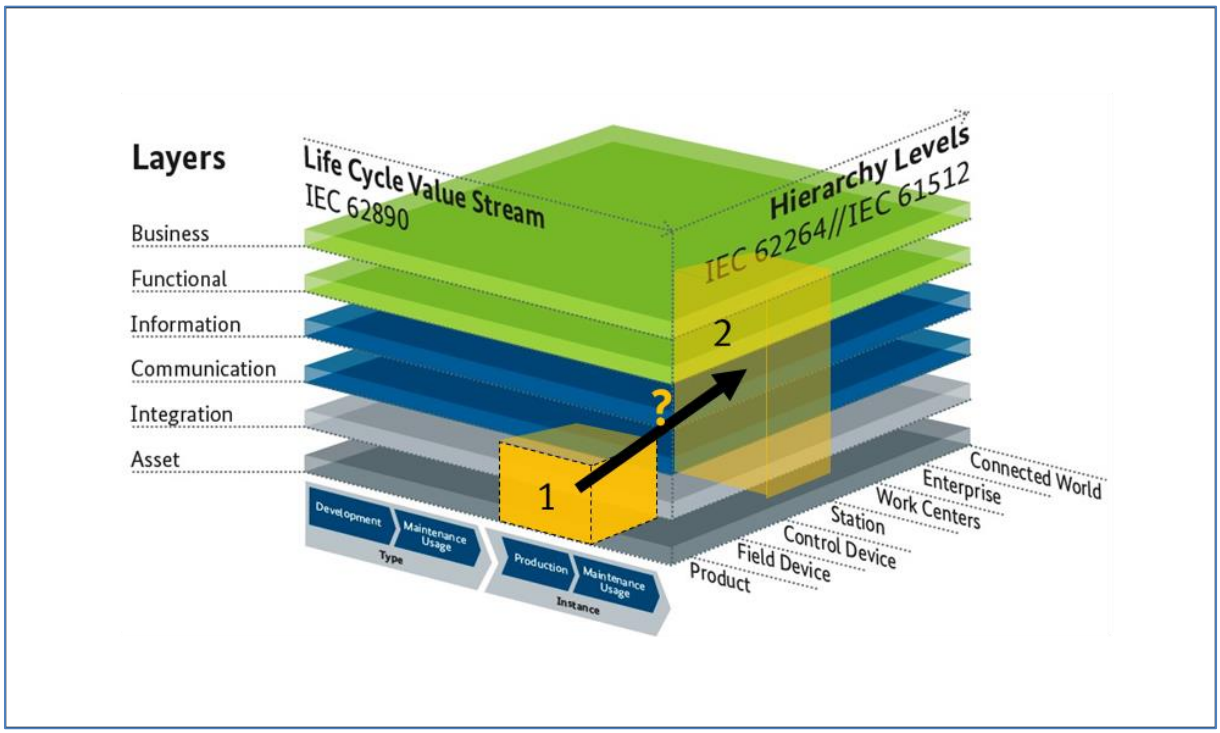

Figure 14: RAMI 4.0 concept as framework for classifying CPS building blocks

In our draft concept of the CPS building block repository, building blocks provide information for developers of CPS and CPS platforms (Figure 15). The repository should include basic building blocks, which are required for a system to fulfil the minimum definition of a CPS. Elements required for developing CPS on different levels should be added like interfaces or computational capabilities. The requirements should describe the implementation of standards regarding communication or technical requirements.

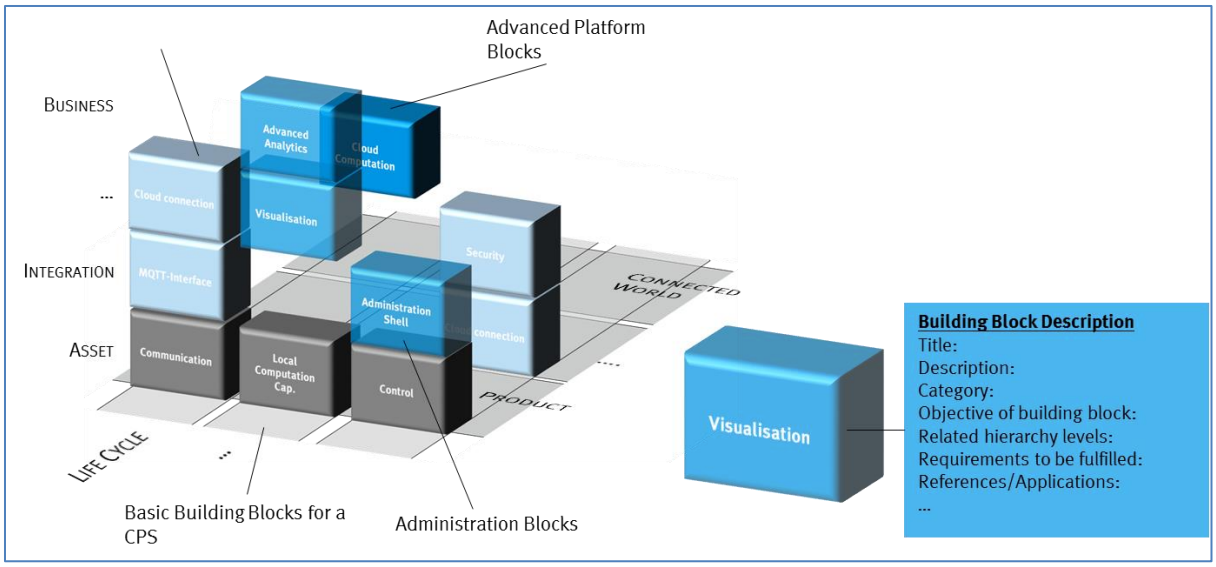

Figure 15: Draft Concept of CPS Building Blocks (just for illustration of our first ideas)

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[16] All References (links to websites, documents, etc.) for the surveyed platforms are given in Appendix B

UNIFY-IoT Project (2016): Report on IoT platform activities (http://www.internet-of-things-research.eu/pdf/D03_01_WP03_H2020_UNIFY-IoT_Final.pdf)

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5 Appendix A: Description of classification criteria for platform survey

Attribute	Description	Values
Platform / Initiative / Framework	Name of the Platform	[descriptive text]
Short Description	Short description of the platform / initiative / framework	[descriptive text]
Links	Links to supplementary information (websites, documents,…). Several entries possible	[list]
IT-Platform, Project, Initiative, Framework, Concept,…	Classification of the subject, whether it is e.g. a standardisation initiative rather than an innovation hub	IT-Platform, technological Platform, National Project, International Project, Standardisation Initiative, Concept, Framework,…
Vertical or Horizontal	Classifies the subject in regards of horizontal/vertical character of the platform. Does it address a certain market vertical, or does it address several industries?	vertical, horizontal
Domain	Indication of the domains (e.g. smart manufacturing, smart cities,…) or cross-cutting character, which drive the initiative/platform/framework	General, Industry, Manufacturing, Energy, Infrastructure (Energy), Infrastructure (Healthcare), Infrastructure (Transportation), Healthcare
Organizational / Technological / Operational	Organizational: e.g. communities, which discuss agenda setting and exchange activities Technological: e.g. Technological platforms (IoT, automation platforms,…) Operational: e.g. initiatives, which work on establishing standards	Organizational, Technological, Operational
Open or commercial	open: platform or product is accessible by any partner commercial: parts or the entire platform must be purchased to be fully accessible (including freemium or demo revenue approaches)	open, commercial
Related network / Community	Indication of related networks, communities, companies for the initiatives	[list: network / project / cluster / ...]
Vision (Objectives)	Short description of the objectives and vision of the platforms to identify commonalities among different initiatives on a high level	[descriptive text]
Country, Region	Indication in which geographical region or country the subject is driven, (e.g. EU, France,…)	COUNTRY, REGION

key stakeholders (founding members, …)	List of relevant stakeholders and members of the subject	[list: company / institution / country/...]

6 Appendix B: Detailed information from the survey of CPS platforms

				Type									
#	Platform / Initiative / Framework	Short Description	Link / Document	(IT-Platform, Project, Initiative, Framework, Concept,..)	Vertical or Horizontal	Domains	Organizational / Technological / Operational	Open or commerial	Related netwok / Community /	Vision (Objectives)	Country, Region	Key stakeholders (founding members, project partners,..)	Reference
1	RAMI 4.0	Reference Architecture Model for Industry 4.0, is driven by German industry and standardisation initiatives.	https://www.plattform-i40.de/I40/Redaktion/EN/Downloads/Publikation/rami40-an-introduction.pdf?__blob=publicationFile&v=3	Architectural framework	vertical	manufacturing	operational	open	Platform Industry 4.0	Standard setting for future digital manufacturing	Germany	BITKOM, VDMA, ZVEI, ABB, Bosch, Telekom, infenion, Phoenix Contact, SAP, Siemens, Festo, HP, IBM, Thyssen Krupp, Trumpf, Wittenstein	Expert Interview Festo / Online Research
2	Industry 4.0 Component	The "I4.0 component" is a concept to describe the required skills and abilities of components in connected manufacturing/automation.	http://www.zvei.org/Downloads/Automation/Industrie%204.0_Komponente_Download.pdf	Standardisation framework	vertical	manufacturing	operational	open	Platform Industry 4.0	- Define and standardise the skills and functions required by a components in an increaslingly connected environment - Make information (condition, documentation,..) about components and equipment available	Germany	BITKOM, VDMA, ZVEI, ABB, Bosch, Telekom, infenion, Phoenix Contact, SAP, Siemens, Festo, HP, IBM, Thyssen Krupp, Trumpf, Wittenstein	Expert Interview Festo / Online Research
3	BaSyS4.0 project	Project on open basic platform for Industry 4.0	www.basys40.de	Funded project	horizontal	manufacturing, logistics	operational, technological	open	BMBF, DLR	- Development of a basic (operating) system for manufacturing equipment - Increase of transofmability of production processes - Interconnection of legacy technologies by middle ware approach	Germany	Fraunhofer ISE, ZF, Kuka, Festo, Bosch, Bosch Rexroth, ABB, DFKI, eclipse, fortiss, ITQ, PSI, RWTH Aachen, SMS Group, SYSGO	Expert Interview Festo / Online Research
4	IIC	The Industrial Internet Consortium is a global, member-supported, organization that promotes the accelerated growth of the Industrial Internet of Things by coordinating ecosystem initiatives to securely connect, control and integrate assets and systems of assets with people, processes and data using common architectures, interoperability and open standards to deliver transformational business and societal outcomes across industries and public infrastructure.	www.iiconsortium.org	Standardisation initiative	vertical	manufacturing	operational	open	Industrial Internet Consortium IIC	Drive innovation through the creation of new industry use cases and testbeds for real-world applications; Define and develop the reference architecture and frameworks necessary for interoperability Influence the global development standards process for internet and industrial systems; Facilitate open forums to share and exchange real-world ideas, practices, lessons, and insights; Build confidence around new and innovative approaches to security.	US	Bosch, EMC², General Electric, Huawei, intel, IBM, SAP, Schneider Electric (http://www.iiconsortium.org/members.htm)	Expert Interview Festo / Online Research
5	IEC62357	Reference Architecture for Power System Information Exchange	https://www.google.de/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&cad=rja&uact=8&ved=0ahUKEwjvk7C7I5PTAhVILZoKHb9uCGcQFggaMAA&url=http%3A%2F%2Fiectc57.ucaiug.org%2Fiec%252062357%2520drafts%2F62357-1%2520tc57%2520ref%2520architecture%2520r6%252020111001.docx&usg=AFQjCNFuN4axyTDnV51HeuCgAEnj6MO8YQ&sig2=h18G2fpyD7nkEjIlu9JHPA&bvm=bv.152174688,d.bGs	Standardisation framework	vertical	energy	operational	open	IEC	- The first objective of this report is to provide a reference architecture to show how the various existing standards activities within IEC TC57 relate to each other today and how they individually and collectively contribute to meeting the objectives of TC57. - The second objective is to identify areas where harmonization between TC57 standards is needed and to suggest possible approaches to achieve it in order to facilitate a single, comprehensive, optimal plan for deployment of these standards in product development and system implementations. - The third objective is to define a vision for the future reference architecture that will help direct longer term goals and activities - The fourth objective is to provide an overview the TC57 standards and their role in the Smart Grid.	Switzerland	IEC	Expert Interview Festo / Online Research

				Type									
#	Platform / Initiative / Framework	Short Description	Link / Document	(IT-Platform, Project, Initiative, Framework, Concept,..)	Vertical or Horizontal	Domains	Organizational / Technological / Operational	Open or commerial	Related netwok / Community /	Vision (Objectives)	Country, Region	Key stakeholders (founding members, project partners,..)	Reference
6	CRYSTAL	Seamless Life-Cycle Collaboration for Safety-Critical Systems Engineering	www.crystal-artemis.eu	Standardisation Initiative (interoparability specs and technological patterns)	horizontal	Safety-Critical Systems Engineering, rail, healthcare, automotive, aerospace	operational	open	ARTEMIS	CRYSTAL as an ARTEMIS Innovation Pilot Project (AIPP) takes up research results of previous projects in the field of Reference Technology Platform (RTP) and Interoperability Specification (IOS) (e.g. CESAR, MBAT ...) and enhances and matures them with the clear aim of industrialisation take-up. RTP and IOS will allow loosely coupled tools to share and interlink their data based on standardized and open Web technologies that enablecommon interoperability among various life cycle domains. This reduces the complexity of the entire integration process significantly. CRYSTAL is strongly industry-oriented and will provide ready-to-use integrated tool chains having a mature technology-readiness-level (up to TRL 7). Following the ARTEMIS mission to strengthen the European market for Embedded Systems, CRYSTAL fosters cross-domain reusability (Aerospace, Automotive, Health and Rail) and pursuits driving forward the Interoperability Specification towards standardisation.	EU	BE(Barco), NL(IBM, TU/e, ps-tech, Philips, TNO), SE(ARC Core , Systemite, Volvo, Chalmers, Arcticus Systems), DE(AVL, TU Berlin, Uni Freiburg, Testing Technologies, Airbus, Airbus Defence & Space, Daimler, Offis, Siemens, Fraunhofer, AVL Schrik, ptc, itk, Airbus Group), CZ(Honywell, UM), AT(AVL, Thales, virtual vehicle, AIT, TU Graz, TTTech), IT(FBK, CRF, Alenia Aermacchi, Ansaldo STS, Uni di Napoli, Elios, mate consulting), ES(Universidad Carlos III de Madrid, ThalesAlenia Space, technalia, gmv, ITI, Orbital, RGB, The Reuse Company), FR(EB, beo, ThalesAlenia Space, All4Tec, Thales, Alstom, Airbus, Soyatec, Safran Sagem, Airbus Group, Valeo), UK(IBM, T&VS, CIC, Airbus, infineon, Airbus Group)	Expert Interview Festo / Online Research
7	Arrowhead	Framework enabling creation and engineering of IoT based automation systems. s open source as provided by Europes largest automations project	www.arrowhead.eu/	Innovation platform (Initiative)	vertical	production, smart buildings, smart infrastructure, electro-mobility, virtual market of energy	operational	open	ARTEMIS	Our vision is to enable collaborative automation by networked embedded devices. The grand challenges are enabling the interoperability and integrability of services provided by almost any device. The objective of the Arrowhead project is to address the technical and applicative challenges associated to cooperative automation: - Provide a technical framework adapted in terms of functions and performances - Propose solutions for integration with legacy systems - Implement and evaluate the cooperative automation through real experimentations in applicative domains: electro-mobility, smart buildings, infrastructures and smart cities, industrial production, energy production and energy virtual market - Point out the accessible innovations thanks to new services - Lead the way to further standardization work	EU	Luleå tekniska universitet 3E N. V. Aalborg Universitet Aktiebolaget Elektronik-Konstruktion Innovation (Abelko) ACCIONA Infraestructuras S.A. Airbus Operations SAS Akhela srl Artelys AIT Austrian Institute of Technology GmbH AVL List GmbH BITRON SPA BNearIT AB Boliden Mineral AB C2 SmartLight OY CAMPUS 02 University of Applied Science Graz Commissariat à l'énergie atomique et aux énergies alternatives (CEA) Centro Ricerche Fiat scpa Ceske Vysoke Uceni Technicke v Praze CORE AS EISTEC AB EUROTECH SPA Evolaris next level GmbH Fagor Electronica S. Coop. Fluidhouse OY Fomento de San Sebastián,	Expert Interview Festo / Online Research

				Type									
#	Platform / Initiative / Framework	Short Description	Link / Document	(IT-Platform, Project, Initiative, Framework, Concept,..)	Vertical or Horizontal	Domains	Organizational / Technological / Operational	Open or commerial	Related netwok / Community /	Vision (Objectives)	Country, Region	Key stakeholders (founding members, project partners,..)	Reference
8	EMC2	EMC² finds solutions for dynamic adaptability in open systems, provides handling of mixed criticality applications under real-time conditions, scalability and utmost flexibility, full scale deployment and management of integrated tool chains, through the entire lifecycle. The project is structured in 6 technical WPs and 6 living labs.	http://www.artemis-emc2.eu/	Funded project	horizontal	cross-cutting	operational	open	ARTEMIS, EC	The objective of the EMC² project is to foster these changes through an innovative and sustainable service-oriented architecture approach for mixed criticality applications in dynamic and changeable real-time environments. EMC² is part of the European Embedded Systems industry strategy to maintain its leading edge position by providing solutions for: Dynamic Adaptability in Open Systems Utilization of expensive system features only as Service-on-Demand in order to reduce the overall system cost Handling of mixed criticality applications under real-time conditions Scalability and utmost flexibility Full scale deployment and management of integrated tool chains, through the entire lifecycle Power supply challenges from dynamic operational changes in MCMC real time systems	EU	infineon, aicas realtime, BMW, AIRBUS Defence and Space, Denso, Airbus Group, Elektrobit, evision systems, Fraunhofer IESE, OFFIS, Siemens, TU Braunschweig, TU Dortmund, TU Kaiserslautern, SYSGO, AVL, TTTECH, TU Wien, virtual vehicle, AIT (Austrian Insitute of Technology), Frequentis, Thales, BluelCe, BRNO University of Technology, freescale, ia, UTIA, Danfoss, DTU, cea, magiem, Rockwell Collins, Silkan, Systematic, United Technologies Research Center, Alenia Aermacchi, CRFiat, Selex ES, cini, Universita Degli Studi di Genova, Thales Alenia Space, Politecnico di Torino, MBDA, Fornebu Consulting, Universitas Osloensis, Western Geco, simula, isep, Critical software, inesc id lisboa, Quobis, technalia, Integrasys, HI iberia, IXION smart automation, visure, Seven Soutions, Schneider Electric Telvent, ITI, AMBAR Telecomunicationes, Chalmers, Ericsson, KTH, Lulea University of Technology, Swedish ICT - SICS,	Expert Interview Festo / Online Research
9	Virtual Fort Knox	Secure federative platform for service-orientated applications providing manufacturing-IT services for production companies	www.virtualfortknox.de	IT platform, market place	vertical	manufacturing	technological	open	Fraunhofer IPA	The cloud IT-platform for manufacturing companies and service providers The advent of the Internet of Things (IoT) is transforming the business of manufacturing companies and mechanical engineers. A new level of service orientation is being created in the area of manufacturing. The progressive digitalisation of manufacturing processes demands modular and flexible software solutions. With Virtual Fort Knox (VFK), manufacturing companies are provided with efficient and secure access to software solutions which are independent of manufacturers. As the IT-backbone for Industry 4.0 solutions, VFK networks manufacturing companies with software providers and mechanical engineers through providing a secure cloud IT-infrastructure and an open marketplace environment for IT-services and applications.	Germany	Fraunhofer IPA	Expert Interview Festo / Online Research
10	FIWARE	APIs (Application Programming Interfaces) for easy development of Smart Applications in multiple vertical sectors. The FIWARE framework provides the platform for companies to access open source APIs (itnerafces, ontologies,..) as well the APIs themselves as a technological component of the platform.	www.fiware.org/	Open API framework, initiative, accelerator	horizontal	cross-cutting	operational, technological	open	Future Internet / 5G PublicPrivatPartnership ; FIWARE community	The FIWARE platform provides a rather simple yet powerful set of APIs (Application Programming Interfaces) that ease the development of Smart Applications in multiple vertical sectors. The specifications of these APIs are public and royalty-free. Besides, an open source reference implementation of each of the FIWARE components is publicly available so that multiple FIWARE providers can emerge faster in the market with a low-cost proposition.	EU	Platinum Members: ATOS, Engineering, NEC, orange, Telefonica Gold Members: apinf, f, hop, INFODOM, JG, Smart Cities Lab, TeamDev, ubiwhere, zabala	Expert Interview Festo / Online Research

				Type									
#	Platform / Initiative / Framework	Short Description	Link / Document	(IT-Platform, Project, Initiative, Framework, Concept,..)	Vertical or Horizontal	Domains	Organizational / Technological / Operational	Open or commerial	Related netwok / Community /	Vision (Objectives)	Country, Region	Key stakeholders (founding members, project partners,..)	Reference
11	FITMAN	The project provides enabling frameworks for the digital, virtual and smart factory.	http://www.fitman-fi.eu/	Funded project	horizontal	manufacturing	operational	open	Future Internet PPP	The mission of the FITMAN (Future Internet Technologies for MANufacturing industries) project is to provide the FI PPP Core Platform with 10 industry-led use case trials in the domains of Smart, Digital and Virtual Factories of the Future FITMAN Trials (4 conducted by Large Enterprises, 6 by SMEs) will test and assess the suitability, openness and flexibility of FI-WARE Generic Enablers while contributing to the STEEP (social-technological-economical-environmental-political) sustainability of EU Manufacturing Industries. The use case trials belong to several manufacturing sectors such as automotive, aeronautics, white goods, furniture, textile/ clothing, LED lighting, plastic, construction, and manufacturing assets management.	EU	TXT E-SOLUTIONS SPA, LABORATOIRE VIRTUEL EUROPEEN DANS LE DOMAINE DE L'INTEROPERABILITE DES ENTREPRISES AISBL, PORTUGAL TELECOM INOVACAO SA, ENGINEERING - INGEGNERIA INFORMATICA SPA, POLITECNICO DI MILANO, TEKNOLOGIAN TUTKIMUSKESKUS VTT, UNIVERSITY OF SOUTHAMPTON, ATOS SPAIN SA, NATIONAL TECHNICAL UNIVERSITY OF ATHEN, SASOCIACION DE EMPRESAS TECNOLOGICAS INNOVALIA	Expert Interview Festo / Online Research
12	Texas Instruments	Former freescale, now NXP, microchip supplier. Various software products and development tools regarding CPS and IoT on a micro controller level. The tools provided range from classical development tools, up to more sophisticated programming environments which provide supplementary tools for application development (graphical configuration, code generation, driver libs, ready compiled code)	http://www.ti.com/	Micro controller and software development platform	horizontal	cross-cutting	technological	commercial	TI	We're changing the world, one chip at a time. Our analog and embedded processing products power electronics across every industry and help to make the world smarter, safer, greener, healthier and more fun.	US	TI	Expert Interview Festo / Online Research
13	NXP Software Components and electronic components	Former freescale, now NXP, microchip supplier. Various software products and development tools regarding CPS and IoT on a micro controller level. The tools provided range from classical development tools, up to more sophisticated programming environments which provide supplementary tools for application development (graphical configuration, code generation, driver libs, ready compiled code)	http://www.nxp.com/webapp/software-center/library.jsp#/home/query/~query~/~filter~/popularity/0	Micro controller and software development platform	horizontal	cross-cutting	technological	commercial	NXP	NXP Semiconductors N.V. (NASDAQ: NXPI) enables secure connections and infrastructure for a smarter world, advancing solutions that make lives easier, better and safer.	US	NXP	Expert Interview Festo / Online Research
14	Infineon software development suites and microcontrollers for industrial applications	Provider of industially used microprocessors and related software development solutions. Software development includes tools for code generation for high reusable code for IoT/ CPS applications.	http://www.infineon.com/cms/en/	Micro controller and software development platform	horizontal	cross-cutting	technological	commercial	Infineon	We make life easier, safer and greener – with technology that achieves more, consumes less and is accessible to everyone. Microelectronics from Infineon is the key to a better future.	Germany	Infineon	Expert Interview Festo / Online Research
15	Visual Studio	Development framework for software applications (.NET framework,..). Recent releases include Azure Cloud infrastructure connectivity and IoT tool kits. Further platform independent cross compiling information are included.	https://www.visualstudio.com	Software development framework	horizontal	cross-cutting	technological	commercial	Microsoft product initiatives (fairs, summits,..)	Microsoft Corporation's vision statement is "to help individuals and businesses realize their full potential." This vision statement is based on the value of the company's computer technology and software products. Microsoft's vision statement has the following significant components: - Individuals and businesses - Help realize - Full potential	US	Microsoft	Expert Interview Festo / Online Research

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16	CPX Product Family	The valve terminal family CPX of Festo is a technical platform to integrate sensors, connect motor controlers and pneumatic vales. A controller block provides the opportunity to connect to higher hierarchical control levels via an IoT-gateway. Supportet protocolls are AMQP and OPC UA. The platform is designed to be used in factory automation environments	https://www.festo.com/net/en-gb_gb/SupportPortal/InternetSearch.aspx	Hardware and software development framework	horizontal	manufacturing, process automation	technological	commercial	Festo	Automation platform CPX is ideal as automation platform, valve terminal partner or remote I/O - it is electric, open and direct. It is also the perfect platform for electrical peripherals. With CPX, you can integrate pneumatic and electrical control chains easily, quickly, flexibly and seamlessly into all automation concepts and company-specific standards.	Germany	Festo	Expert Interview Festo / Online Research
17	Beckhoff TwinCat 3	Beckhopff is a provider of technology for automation purposes. TwinCat is a development entwironment for industrial automation applications. It operates on different technological platforms, ranging from smaller ARM based controllers up to high performance industrial computing clusters.	http://www.beckhoff.de/default.asp?twincat/twincat-3-platform-classification.htm	Hardware and software development framework	horizontal	manufacturing, process automation	technological	commercial	Beckhoff	Beckhoff implements open automation systems based on PC Control technology. The product range covers Industrial PCs, I/O and Fieldbus Components, Drive Technology and automation software. Products that can be used as separate components or integrated into a complete and seamless control system are available for all industries. The Beckhoff "New Automation Technology" philosophy represents universal and open control and automation solutions that are used worldwide in a wide variety of different applications, ranging from CNC-controlled machine tools to intelligent building automation.	Germany	Beckhoff	Expert Interview Festo / Online Research
18	CoDeSys	CoDeSys is a software development platform for industrial automation applications and is compliant to IEC 61131. The framework covers over 250 different hardware platofrms from different PLC vendors.	http://www.3s-systems.com/unternehmen.html	Software development framework	vertical	manufacturing	technological	commercial	3S-Systems	Provision of a software stack for industrial automation applications.	Germany	3S-Systems	Expert Interview Festo / Online Research
19	CODESYS Application Composer	Engineeringtool (based on IEC61131-3) for serviceoriented engineering with architectural support for fine granular modular automation	https://www.codesys.com/products/codesys-engineering/application-composer.html	Software development framework	vertical	manufacturing	technological	commercial	OPAK-Project, DEVEKOS-Project	Serviceoriented and architecture based engineering for automation systems	Germany	CODESYS GmbH	Expert Interview Festo / Online Research
20	Siemens TIA Portal	Siemens offers a portal for managing automation applications in regards of systematic programming of Siemens automation equipment (PLCs, controllers,..) as well as tools for simulation and reporting during development processes.	https://www.industry.siemens.com/topics/global/en/tia-portal/pages/default.aspx	Product development platform	horizontal	cross-cutting	technological	commercial	Siemens AG	Siemens helps industry capitalize on the opportunities digitalization offers. Products and systems for the Digital Enterprise give machine manufacturers and plant operators competitive advantages along the entire value chain. In the field of production engineering, TIA Portal is the gateway to automation in the Digital Enterprise.	Germany, global	Siemens AG	Expert Interview Festo / Online Research
21	Siemens Mind Sphere	MindSphere is a product provided by Siemens for developing manufacturing related applications and services.	http://www.siemens.com/global/en/home/company/topic-areas/digitalization/mindsphere.html	IT platform, market place	vertical	manufacturing	technological	commercial	Siemens AG	The open cloud platform from Siemens, MindSphere, is a centerpiece of a powerful IoT operating system with data analytics and connectivity capabilities, tools for developers, applications and services. It helps to evaluate and utilize your data and to gain breakthrough insights. Drive the performance and optimization of your assets for maximized uptime.	Germany, global	Siemens AG	Expert Interview Festo / Online Research
22	Siemens Products for Automation	Siemens offers a broad hardware platform to implement automated applications for various sectors (energy, manufacturing,..). The product portfolio represents a hardware platform for building CPS.	https://c4b.gss.siemens.com/resources/images/articles/dffa-b10183-00-76de.pdf	Hardware and software development framework	horizontal	cross-cutting	technological	commercial	Siemens AG	Siemens helps industry capitalize on the opportunities digitalization offers. Products and systems for the Digital Enterprise give machine manufacturers and plant operators competitive advantages along the entire value chain. In the field of production engineering, TIA Portal is the gateway to automation in the Digital Enterprise.	Germany, global	Siemens AG	Expert Interview Festo / Online Research

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23	Rockwell Products for Automation	Rockwell provides a large set of industrial automation systems. Product families are for example PlantPAx (Distributed Control Systems), Pavilion8® (predictive control for process automation) as well as a braod range of PLCs, drive systems and condition monitoring related hardware and software.	http://www.rockwellautomation.com/global/products/overview.page?	Hardware and software development framework	horizontal	cross-cutting	technological	commercial	Rockwell Automation	Provision of automation equipment for manufacturing and process industry	US	Rockwell Automation	Expert Interview Festo / Online Research
24	Rockwell Factory Talk	Factory Talk is a software framework which enables manufacturing companies to integrate their data relevant for production. The provided services include beside others multi-vendor integration opportunities and diagnostics of for automation components and systems. Aims at productivity of factories based on equipment integration by multi-device usage (desktop, mobile,...). Provides cloud infrastructure for services.	http://www.rockwellautomation.com/rockwellsoftware/applications/factorytalk-teamone.page?	IT platform	horizontal	cross-cutting	technological	commercial	Rockwell Automation	Objective is the integration of equipment related data (e.g. coming from Rockwell Logix PLCs) into manufacturing intelligence environment to increase shop floor productivity.	US	Rockwell Software	Expert Interview Festo / Online Research
25	Predix	Predix is ann IIoT platform, which provides various features and modules for industrial automation. The range covers edge analytical capabilities up to kind of an app store for industrial applications.	https://d154rjc49kgakj.cloudfront.net/GE_Predix_Architecture_and_Services-20161128.pdf	IoT platform	horizontal	manufacturing, energy	technological	commercial	General Electric	The platform aims at building an ecosystem for equipment operators, as well as for application developers in the industrial sector.	US	General Electric	Expert Interview Festo / Online Research
26	GE Products for Automation	Like Siemens, GE provides a very broad range of automation products. PLCs, drive technology, as well as equipment the energy sector. The engineering solutions of GE include hardware and software components to build "cyber-physical" systems in automation	http://www.geautomation.com/products/industrial-automation	Hardware and software development framework	horizontal	manufacturing, energy, cities infrastructure	technological	commercial	General Electric	GE Provides high reliable automation equipment to various industries. The hardware and engineering prtfolio is getting enhanced by monitoring and cloud-based platform solutions.	US	GE Automation & Control	Expert Interview Festo / Online Research
27	Axoom	Axoom provides a platform to interconnect industrial equipment to extract information, as well as to drive optimization. Third party developers and manufacturing equipment providers are able to deploy apps for their customers in the Axoom ecosystem.	https://www.axoom.com/de/	IT platform, market place	vertical	manufacturing	technological	commercial	Axoom, Trumpf	Provide platform services for manufacturing equipment OEMs to increase service business.	Germany	Axoom	Expert Interview Festo / Online Research
28	4DIAC	Engineeringtool to design distributed control systems. The tool includes domain specific modeling languages for encapsulating software components for increased re-usability. The development framework is based on IEC61499, which extends IEC61131-1 in the manufacturing automation domain. The framework contains a runtime environment, a development environment, funktion block libraries and example projects.	https://eclipse.org/4diac/	Product development platform	vertical	manufacturing	operational, technological	open	fortiss GmbH	Eclipse 4diac™ provides an open source infrastructure for distributed industrial process measurement and control systems based on the IEC 61499 standard.	Germany, Austria	fortiss GmbH, Profactor GmbH, ACIN TU Wien, Austrian Institure of Technology, nxtControl GmbH	Expert Interview Festo / Online Research

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29	SkillPro-Project	SkillPro is a research project funded by the Framework Program 7 of the European Commission. The objective of SkillPro is to bring the vision of smart reconfigurable manufacturing systems into application. It considers a modern production system as a combination and collaboration of cyber-physical assets that offer different skills. SkillPro provides an extension of the Plug-and-Produce paradigm using knowledge about the skills of the diverse automation system components and about their composition and cooperation and is based on the open standard of AutomationML (project ended in 2015)	http://www.skillpro-project.eu/	Funded project	vertical	manufacturing	operational, technological	open	FP 7 Call FP7-2012-NMP-ICT-FoF)	Provide "plug & produce" funktionality for physical assets in manufacturing based on a skill modelling approach.	EU	Fraude Group, AKEO plus, Visual Components, roboconcept, KIT (IPR& IMI), FZI, LMS Patras, Fraunhofer IOSB, technalia, dresden elektronik, K.MET, Actimage Consulting SAS	Expert Interview Festo / Online Research
30	innogy	Company providing solutions in the energy sector. A product example is a virtual plant, which integrates physical assets and enables direct marketing of energy on energy stocks exchanges.	https://www.innogy.com/web/cms/de/3109636/fuer-unternehmen/energie-vermarkten/eeg-direktvermarktung/	IT platform	horizontal	energy, smart home	technological	commercial	RWE	innogy ist die Antwort auf die großen Trends, die den Energiesektor weltweit, besonders aber in Europa und in Deutschland verändern: Dekarbonisierung, Dezentralisierung und Digitalisierung. Diese Trends spiegeln sich in den drei Geschäftsfeldern Netze, Vertrieb und erneuerbare Energien.	Germany	innogy, RWE	Expert Interview Festo / Online Research
31	OSIsoft	provider of SCADA and control software for transmission and deployment of energy. Asset management in energy sector is one product.	http://pages.osisoft.com/Transmission-System-Operators.html	IT platform	vertical	energy	technological	commercial	OSIsoft	Enables users to: - manage assets - mitigate risk - comply with regulations - drive innovations - make business decisions in real-time - identify competitive business and market opportunities http://pages.osisoft.com/Transmission-System-Operators_About.html	US	OSIsoft	Expert Interview Festo / Online Research
32	NESSI	Networked European Software and Services Technology Platform. NESSI aims to provide a unified view for European research in Services Architectures and Software Infrastructures that will define technologies, strategies and deployment policies fostering new, open, industrial solutions and societal applications that enhance the safety, security and well-being of citizens.	http://www.nessi-europe.eu/default.aspx?page=home	European Technology Platform	horizontal	ICT	organisational	open	EC	NESSI, the Networked Software and Services Initiative, is the European Technology Platform, for this new Digital Information Society and Economy powered by software and services and data NESSI promotes that software, services, and data are key enablers to help resolve European societal and economic challenges across all sectors, both private and public, such as manufacturing, transportation, energy, and healthcare. NESSI's vision is the "Digital Information Society and Economy 2.0" which allows European businesses and citizens to stay competitive, to swiftly create new economic value and to experience new service offerings. This digital world provides a hyper-connected environment, where services are accessible ubiquitously and immediately; where collaboration among organisations, communities, and individuals are happening in an agile, adaptive and dynamic manner; and where the growing amount of data provides opportunities for new business, increased well-being and productivity efficiencies.	EU	over 800 individuals representing over 450 member organisations, NESSI unites a large community from industry, research and academia. http://www.nessi-europe.eu/default.aspx?Page=partners	Expert Interview Festo / Online Research

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33	euRootics / SPARC	SPARC is the partnership for robotics in Europe to maintain and extend Europe's leadership in robotics. SPARC aims to make available European robots in factories, in the air, on land, under water, for agriculture, health, rescue services, and in many other applications in Europe which have an economic and societal impact.	https://eu-robotics.net/sparc/about/	European Technology Platform	vertical	robotics	organisational	open	EC	SPARC is a Public-Private Partnership between the European Commission, and European industry and academia to facilitate the growth and empowerment of the robotics industry and value chain, from research through to production.	EU	see https://www.eu-robotics.net/eurobotics/about/about-eurobotics/about-eurobotics.html	Expert Interview Fortiss
34	ETP4HPC	ETP4HPC is the European Technology Platform (ETP) in the area of High-Performance Computing (HPC). It is an industry-led think-tank comprising of European HPC technology stakeholders: technology vendors, research centres and end-users. The main objective of ETP4HPC is to define research priorities and action plans in the area of HPC technology provision (i.e. the provision of supercomputing systems).	http://www.etp4hpc.eu/	European Technology Platform	horizontal	ICT	organisational	open	EC	etc4hpc is the European Commission's partner in the contractual Public-Private Partnership (cPPP) for High-Performance Computing. The objectives of this cPPP are: * Develop the next generation of HPC technologies, applications and systems towards exascale * Achieve excellence in HPC applications delivery and use The HPC cPPP brings together technology providers and users via the ETP4HPC Association and Centres of Excellence (CoE) for computing applications. The cPPP focuses on technologies and usage and applications (pillars a & c) of the European HPC strategy along with training, education and skills development.	EU	ARM, BSC, CEA, IBM, Intel, Inria, Hvidia, STFC, CSC, et al see http://www.etp4hpc.eu/en/full-members.html	Expert Interview Fortiss
35	ARTEMIS	The Embedded Systems Technology Platform. Artemis provides a framework for defining and implementing a Strategic Agenda and for integrating research activities in Embedded Systems across the EU. The Industry Association is open to: SMEs, universities, R&D centres and Large Enterprises. It is a network of more than 200 members.	https://artemis-ia.eu/	European Technology Platform	horizontal	ICT / embedded systems	organisational	open	EC	ARTEMIS Industry Association continuously promotes the R&I interests of its members to the European Commission and the Public Authorities of the participating states. The association strongly believes that the continued success of the Embedded Intelligent Systems sector in Europe depends on one coordinated, pan-European strategy. Forming this strategy is a part of the ARTEMIS European Technology Platform, which is developed & executed by the ARTEMIS Industry Association	EU	Artemis-IA, cf. https://artemis-ia.eu/member-list.html	Expert Interview Fortiss
36	Networld2020	NetWorld2020 is the European Technology Platform for communications networks and services. Communications networks enable interaction between users of various types of equipment, either mobile or fixed. They are the foundation of the Internet. The NetWorld2020 European Technology Platform gathers players of the communications networks sector: industry leaders, innovative SMEs,	https://www.networld2020.eu/	European Technology Platform	horizontal	ICT / communication networks	organisational	open	EC	Contribute to collaborative research programmes on European and national level for collaborative research in the domain of mobile and wireless, fixed and satellite communication networks by a regularly updated research agenda.	EU	https://www.networld2020.eu/our-members/	Expert Interview Fortiss
37	STM32F	The STM32 family of 32-bit Flash microcontrollers based on the ARM Cortex™-M processor is designed to offer new degrees of freedom to MCU users. It offers a 32-bit product range that combines high performance, real-time capabilities, digital signal processing, and low-power, low-voltage operation, while maintaining full integration and ease of development.	http://www.st.com/en/microcontrollers.html	Micro controller and software development platform	horizontal	cross-cutting	technological	commercial	EuroCPS Platforms	The unparalleled and large range of STM32 devices, based on an industry-standard core and accompanied by a vast choice of tools and software, makes this family of products the ideal choice, both for small projects and for entire platform decisions.	EU	ST, EuroCPS	Expert Interview Fortiss

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38	iNEMO	iNEMO inertial modules integrate complementary types of sensors to offer more compact, robust, and easy-to-assemble solutions compared to discrete MEMS products.	http://www.st.com/en/mems-and-sensors/inemo-inertial-modules.html?querycriteria=productId=SC1448	Sensor integration platform	horizontal	cross-cutting	technological	commercial	EuroCPS Platforms	The integration of multiple sensor outputs bring motion sensing systems to the level of accuracy required for the most demanding applications, such as enhanced gesture recognition, gaming, augmented reality, indoor navigation and localization-based services.	EU	ST, EuroCPS	Expert Interview Fortiss
39	Intel Galileo	Intel Galileo is an excellent learning platform that can meet the demands of advanced projects. The Intel® Galileo Gen 2 board is the first in a family of Arduino*-certified development and prototyping boards based on Intel® architecture and specifically designed for makers, students, educators, and DIY electronics enthusiasts.	http://www.intel.com/content/www/us/en/internet-of-things/overview.html	Micro controller and software development platform	horizontal	IoT	technological	commercial	EuroCPS Platforms	Providing users with a fully open source hardware and software development environment, the Intel Galileo Gen 2 board complements and extends the Arduino line of products to deliver more advanced compute functionality to those already familiar with Arduino prototyping tools. The Intel Galileo Gen 2 development board is designed to be hardware-, software-, and pin-compatible with a wide range of Arduino Uno* R3 shields and additionally allows users to incorporate Linux* firmware calls in their Arduino sketch programming.	EU	Intel, EuroCPS	Expert Interview Fortiss
40	CPSDA	Connectivity Platform Solution for Digitalization Application from SEI. This CPS platform is a new digital microprocessor concept, combining Application Processing, communication switching and Fieldbus on a single chip	https://www.eurocps.org/eurocps-platforms/cpsda-sei/	Micro controller and software development platform	horizontal	cross-cutting	technological	commercial	EuroCPS Platforms	CPSDA is a single-chip solution, based on an ARM Cortex – an industry-standard core. It provides high performance and superior connectivity, in a low-cost, low-power design. By bringing Connectivity and ample processing performance in large set of devices, this HW & SW solution will be the enabler of offer digitalization and services-based business model.	EU, France	SEI, EuroCPS	Expert Interview Fortiss
41	DREAMS	Distributed REal-time Architecture for Mixed Criticality Systems -- develops a cross-domain architecture and design tools for networked complex systems where application subsystems of different criticality, executing on networked multi-core chips, are supported. DREAMS builds architectural concepts, meta-models, virtualization technologies, model-driven development methods, tools, adaptation strategies and validation, verification	http://www.dreams-project.eu/	Funded project	horizontal	cross-cutting, mixed criticality	technological	open	EC	The goal of DREAMS is to establish a mixed-criticality architecture based on networked multi-core chips. DREAMS will provide a hierarchical platform including both on-chip resources (e.g., processing cores, memory, NoCs) and off-chip resources. A fine-grained mixed-criticality integration will be supported using multiple partitions within each processor core where each partition can have a separate criticality level, including the highest criticality levels for certification.	EU	Alstom, STMicroelectronics, Thales, TÜV Rheinland, FENTISS, RealTime-at-Work, TTTech, Virtual Open Systems, FORTISS, IKERLAN, ONERA, Polytechnic University of Valencia, SINTEF, Technological Educational Institute of Crete, Technical University of Kaiserslautern, University of Siegen	Expert Interview Fortiss
42	openMOS	Open Dynamic Manufacturing Operating System for Smart Plug-and-Produce Automation Components	https://www.openmos.eu/	Funded project	vertical	manufacturing	technological	open	EC	The motivation for the openMOS project is for the European Manufacturing Industry to become increasingly agile in order to compete in the global economy. OEMs need to be able to produce premium quality on demand. openMOS aims to develop of a common, openly accessible plug-and-produce (P&P) system platform which allows all stakeholders in the automation system value chain to come together and jointly develop and exploit solutions. Hence, the openMOS project is proposing to integrate new plug-and-produce system concepts which have emerged in recent years, with well-established industrial-relevant technology platforms.	EU	Afag Automation AG Asys Automatisierungssysteme GmbH Centre for Engineering and Manufacturing Excellence Ltd Lbg Electrolux Italia S.P.A. Elrest Automationssysteme GmbH Ford Motor Company Ltd Fortiss GmbH Inotec Ltd Introsys - Integration for Robotic Systems, Integração de Sistemas Robóticos, SA Kunliga Tekniska Hoegskolan Linkopings Universitet Loughborough University Masmec SPA SenseAir AB Uninova - Instituto de Desenvolvimento de Novas Tecnologias We Plus S.r.l.	Expert Interview Fortiss

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43	SADA	Smart "Plug & Play" Modular architecture for Multi Sensor Data Fusion	http://www.projekt-sada.de/	Funded project	vertical	automous systems (automotive, robotics)	technological	open	Germany	The goal of SADA project is to facilitate the addition and removal of data fusion paths in systems while keeping the human intervention at minimum. SADA provides easy adaptation in autonomous systems, like cars and robots using various sensors, to utilize the available data sources and hence enabling a true "plug & play". SADA develops an architectural prototype of ICT platform that will support "plug & play" of sensor data fusion. The ICT platform will be supported by a modelling tool for faster construction and modification of complex multi-sensor data fusion systems.	Germany	Siemens, fortiss, NXP, DFKI, Baselabs, All4IP	Expert Interview Fortiss
44	TAPPS	Trusted Apps for open CPSs	http://www.tapps-project.eu/	Funded project	horizontal	cross-cutting	technological	open	EC	TAPPS provides an open platform for CPS (Cyber-Physical System) apps by addressing as solution all necessary layers, from hardware over software to a marketplace, to ensure security and full real-time support for the apps. TAPPS is based on a dedicated execution environment for distributed, safety-critical CPS applications offering multiple layers of security and a holistic, open end-to-end tool chain for developing and deploying CPS Apps.	EU	fortiss, ST, TTTech, Virtual Open Systems, actility, FCSR, TEI Crete, energic,	Expert Interview Fortiss
45	THALES Avionics Platform	This CPS platform is made of possibly interconnected building blocks for avionics computer systems provided by Thales.	https://www.eurocps.org/eurocps-platforms/avionics-thales/	CPS integration platform	vertical	Avionics	technological	commercial	EuroCPS Platforms	The purpose of this platform is to enable developments at real-time software level such as real-time operating systems and/or hypervisors, and possibly software engineering tools and methods.	France	Thales Group	Expert Interview THHINK
46	Integrated and Open Development Platform for CPS	This components platform from AVL supports the entire development process for road vehicles from office to lab to road by integrating real (hardware) and virtual (simulation models) development methods into one framework	https://www.eurocps.org/eurocps-platforms/iodp-avl/	Product development platform	vertical	Automotive	technological	commercial	EuroCPS Platforms	The platform offers a seamless exchange of data from the concept phase to road testing. Thereby, the characteristic operating conditions like legislative test cycles, real world driving emissions and customer specific drive profiles or misuse tests can all be applied in a real as well as in a virtual environment during all phases of development. This also includes a cross-phase usage of tools like automatic optimization and calibration. This approach facilitates an efficient and goal-oriented development and validation of extremely complex drive configurations.	Germany	AVL	Expert Interview THHINK
47	Cooperative Intelligent Transport Systems (C-ITS)	Connected and automated driving: Aims to set-up a cross-border testing facility pooling investments across Europe and connecting various stakeholders (AI-experts, automotive OEMs, communication service providers and more).	https://ec.europa.eu/digital-single-market/en/industrial-platforms-and-large-scale-pilots	Piloting Platform	horizontal	Transport and services	Organisational, technological	open	EC	To build on large-scale pilot deployment, testing and experimenting facilities available across Member States. This will stimulate EU-wide interoperability and continuity of services.	EU	AI-experts, automotive OEMs, communication service providers and more	Expert Interview THHINK
48	ARINC 653	**ARINC 653** (Avionics Application Standard Software Interface) is a software specification for space and time partitioning in safety-critical avionics real-time operating systems (RTOS). It allows the hosting of multiple applications of different software levels on the same hardware in the context of an Integrated Modular Avionics architecture.	https://en.wikipedia.org/wiki/ARINC_653 http://www.lynx.com/industry-solutions/industry-standards/arinc-653/	Standardisation Platform	vertical	Avionics	operational	open	It is part of ARINC 600-Series Standards for Digital Aircraft & Flight Simulators.	ARINC standards allow aircraft manufacturers to ensure that new installations are compatible and interchangeable.	Global		Expert Interview THHINK

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49	BUTLER	The BUTLER platform is part of the IoT Open Platforms initiative.	http://open-platforms.eu/	Innovation platform (Initiative)	horizontal	Smart Transport, health, shopping, office, parking, etc	organisational, operational	open	IoT European Research Cluster	The three-year BUTLER project, officially completed in October 2014, launched a portal to bring together new technologies and devices in order to fully exploit the potential of IoT.	EU		Expert Interview THHINK
50	MAFi e-Maritime	The Maritime Architecture Framework (MAF) is a framework for CPS development in the maritime domain. MAF provides conventions, methods, languages and tools to document, align, design and handle existing and future system architectures and architectural reference models within the maritime domain.	https://www.offis.de/en/offis/project/cpse-labs.html	Architectural framework	vertical	Maritime	operational	open	Cyber-Physical Systems Engineering Labs (CPSE Labs)	The envisioned goal of MAF is to enable the development of interoperable maritime CPS and services, by harmonizing maritime IT-architecture development including related regulations and standards to set them in context to each other in a consistent way.	Germany	German Association for Maritime Technologies (GMT), the Maritime Cluster Northern Germany (MCNG) and regional industry and agencies.	Expert Interview THHINK
51	RAMSYS	RAMSYS is a unique, integrated software platform for the management of all data related to railway infrastructure (e.g. assets, defects, measurements, activities, etc.) supporting maintenance and renewal planning and control.	http://www.railway-technology.com/contractors/track/mermec/mermec3.html	IT-platform	vertical	Rail	technological	commercial		RAMSYS is an integrated software platform for the management of all the data related to railway infrastructure maintenance (e.g. assets, defects, measurements and activities) designed and developed to support maintenance and renewals decisions. It enables the operator to implement the condition-based method, and to ensure an holistic approach to assets' lifecycles. With lots of data coming from numerous sources (diagnostic systems, work history, cost of assets, inventories, etc.), RAMSYS automatically produces work-order lists based on maintenance and renewal priorities and budgets based on actual and on-field information.	Italy	MERMEC Group	Expert Interview THHINK
52	Toyota & NTT	like Siemens, GE provides a very broad range of automation products. PLCs, drive technology, as well as equipment the energy sector. The engineering solutions of GE include hardware and software components to build "cyber-physical" systems in automation	https://eandt.theiet.org/content/articles/2017/03/toyota-and-ntt-to-collaborate-on-platform-for-connected-cars/?utm_source=Adestra&utm_campaign=New%20EandT%20News%20-%20Automation%20FINAL%20-%20MEMBER&utm_medium=Newsletters%20-%20E%26T%20News&utm_content=E%26T%20News%20-%20Members&utm_term=https%3A%2F%2Feandt.theiet.org%2Fcontent%2Farticles%2F2017%2F03%2Ftoyota-and-ntt-to-collaborate-on-platform-for-connected-cars%2F&utm_contact=32547089	IT-platform	vertical	Automotive	technological	commercial		The joint venture aims to establish a sustainable Smart Mobility Society operating worldwide; promoting smarter, sustainable and connected vehicles.	Japan	Toyota, NTT	Expert Interview THHINK
53	ACARE	Advisory Council for Aeronautics Research in Europe	http://www.acare4europe.com/about-acare	European Technology Platform	vertical	Aeronautics and air transport	organisational	open	European Technology Platform	ACARE is the Advisory Council for Aviation Research and innovation in Europe and provides a network for strategic research in aeronautics and air transport so that aviation satisfies the needs of society and secures global leadership for Europe in this important sector. ACARE is essential in bringing together the right stakeholders to turn the air transport vision in Europe into reality.	EU	Organisations and associations including representation from the Member States, the European Commission and stakeholders: manufacturing industry, airlines, airports, service providers, regulators, research establishments and academia.	Expert Interview THHINK

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54	ALICE	ALICE is set-up to develop a comprehensive strategy for research, innovation and market deployment of logistics and supply chain management innovation in Europe.	http://www.etp-logistics.eu/alice/	European Technology Platform	vertical	Logistics and supply chain	organisational	open	European Technology Platform	ALICE is based on the recognition of the need for an overarching view on logistics and supply chain planning and control, in which shippers and logistics service providers closely collaborate to reach efficient logistics and supply chain operations.	EU	Primary stakeholders: shippers and logistics service providers Other relevant stakeholders: transport companies, terminal operators, support industry and research and education	Expert Interview THHINK
55	ERRAC	ERRAC covers all forms of rail transport: from conventional, high speed and freight applications to urban and regional services.	http://www.errac.org/	European Technology Platform	vertical	Rail Transport	organisational	open	European Technology Platform	ERRAC is focussing on defining, and implementing steps to achieve a joint European rail research and innovation strategy and enhancing collaborative European rail research and innovation.	EU	Major European rail research stakeholders: manufacturers, operators, infrastructure managers, the European Commission, EU Member States, academics and users' groups.	Expert Interview THHINK
56	ERTRAC	ERTRAC is the European Road Transport Research Advisory Council.	http://www.ertrac.org/	European Technology Platform	vertical	Road Transport	organisational	open	European Technology Platform	Provide a strategic vision for road transport research and innovation in Europe. Define strategies and roadmaps to achieve this vision through the definition and update of a Strategic Research Agenda (SRA) and implementation research roadmaps. Stimulate effective public and private investment in road transport research and innovation. Contribute to improving coordination between the European, national, regional public and private R&D activities on road transport. Enhance the networking and clustering of Europe's research and innovation capacities. Promote European commitment to Research and technological development, ensuring that Europe remains an attractive region for researchers, and enhancing the global competitiveness of the transport industries. Support the implementation of Horizon 20250, the European Framework Programme for Research and Innovation.	EU	ERTRAC members are representatives from all the stakeholders of the Road Transport sector, including private and public organisations involved in Research, and gathering also administrations from both European and national levels.	Expert Interview THHINK
57	WATERBORNE	To maintain the EU maritime industry position as a global leader in high value maritime business.	http://www.maritime-rdi.eu/	European Technology Platform	vertical	Maritime	organisational	open	European Technology Platform	The WATERBORNE vision: Smart ships, smart ports and smart infrastructure Automated and autonomous vessels Ultra low energy and emissions vessels and systems Safe, secure and adaptable passenger vessels for inland, inshore and offshore duties Flexible craft for coastal and offshore duties Green, efficient and flexible inland-waterway vessels Trends and drivers	EU	WATERBORNE ETP includes all parties involved in the waterborne value chain: those who use and operate ships for transport and services, those who build ships, boats and their systems and equipment, those who provide the related infrastructure and ports and those who organise the exploitation of ocean resources.	Expert Interview THHINK
58	PTC ThingWorx	ThingWorx10 facilitates the streamlined creation of end-to-end smart applications for agriculture, cities, grid, water, building and telematics. Traditional industries are transformed and equipped with modern-day connectivity and smarter solutions through connected devicest hat provide comprehensive data collection and analysis for data-driven decision-making. ThingWorx reduces the time, cost and risks of building M2M and IoT applications.	http://www.thingworx.com/	CPS related IoT Platform	horizontal	cross-cutting	technological	commercial	PTC	The platform aims at integrating information sources, their exploration and the offering of a marketplace for third party application developers.	US	PTC	Reference:H2020 – UNIFY-IoT Project - Deliverable D03.01 »»Link: http://www.internet-of-things-research.eu/pdf/D03_01_WP03_H2020_UNIFY-IoT_Final.pdf

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59	PTC Axeda	Axeda provides a cloud-based platform for managing connected products and machines and implementing IoT and M2M applications. The platform is used to transform machine data into valuable insights, build and run applications and integrate machine data with other applications and systems to optimize business processes.	http://www.ptc.com/axeda	CPS related IoT Platform	horizontal	cross-cutting	technological	commercial	PTC		US	PTC	Reference:H2020 – UNIFY-IoT Project - Deliverable D03.01 >>>Link: http://www.internet-of-things-research.eu/pdf/D03_01_WP03_H2020_UNIFY-IoT_Final.pdf
60	Bosch IoT Suite	The Bosch Software Innovations Suite is modular for advanced flexibility, enabling device management, business process management, and business rules management for the IoT. It integrates seamlessly with existing IT infrastructures for streamlined connectivity and enhanced data analytics. The Bosch Software Innovations Suite is powering the IoT by connecting the four key elements of the ecosystem; people/ users, things, enterprises and partners.	https://www.bosch-si.com/iot-platform/bosch-iot-suite/homepage-bosch-iot-suite.html	CPS related IoT Platform	horizontal	cross-cutting	technological	commercial	Bosch SI	The platform aims at integrating information sources, their exploration and the offering of a marketplace for third party application developers. Further, rule based process design fosters domain users to create own processes.	Germany	Bosch SI	Reference:H2020 – UNIFY-IoT Project - Deliverable D03.01 >>>Link: http://www.internet-of-things-research.eu/pdf/D03_01_WP03_H2020_UNIFY-IoT_Final.pdf
61	Cisco Jasper	Jasper provides features to launch, manage and monetize connected devices and IoT applications. The configurable Jasper Control Board Platform is customizable to suit specific operational needs, business models and requirements across industries and across different geographical locations. Jasper serves IoT needs such as connected cars and enterprise mobility, offering network visibility across devices and real-time monitoring for precise control and deeper insights to drive decision-making.	http://www.jasper.com/	CPS related IoT Platform	horizontal	cross-cutting	technological	commercial	Cisco		US	Cisco	Reference:H2020 – UNIFY-IoT Project - Deliverable D03.01 >>>Link: http://www.internet-of-things-research.eu/pdf/D03_01_WP03_H2020_UNIFY-IoT_Final.pdf
62	Ayala Networks	Ayala offers a set of solutions that enables manufactures to connect their consumer devices and products to the Internet. Its offering consists of a cloud based Agile IoT platform to connect different devices.	ttps://www.aylanetworks.com/	CPS related IoT Platform	horizontal	cross-cutting	technological	commercial	Ayala		US	Ayala	Reference:H2020 – UNIFY-IoT Project - Deliverable D03.01 >>>Link: http://www.internet-of-things-research.eu/pdf/D03_01_WP03_H2020_UNIFY-IoT_Final.pdf

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63	Intel IoT Platform	The Intel® IoT Platform is an end-to-end reference model and family of products from Intel and the industry that provides a foundation for seamlessly and securely connecting devices, delivering trusted data to the cloud, and delivering value through analytics. 19The platform is one of several services by Intel that heavily pushes into the IoT, e.g. by Intel Open Labs or the Galileo developer kit. Remarkable about the platform is the entire integration of components for a "platform" including a hardware development platform.	http://www.intel.eu/content/www/eu/en/internet-of-things/iot-platform-solution-brief.html	CPS related IoT Platform	horizontal	cross-cutting	technological	commercial	Intel		US	Intel	Reference:H2020 – UNIFY-IoT Project - Deliverable D03.01 »»Link: http://www.internet-of-things-research.eu/pdf/D03_01_WP03_H2020_UNIFY-IoT_Final.pdf
64	ARM mbed	The ARM mbed IoT Device Platform provides the operating system, cloud services, tools and developer ecosystem to make the creation and deployment of commercial, standards-based IoT solutions possible at scale, according to its own website.	https://www.mbed.com/en/platform/	CPS related IoT Platform	horizontal	cross-cutting	technological	commercial	ARM		US	ARM	Reference:H2020 – UNIFY-IoT Project - Deliverable D03.01 »»Link: http://www.internet-of-things-research.eu/pdf/D03_01_WP03_H2020_UNIFY-IoT_Final.pdf
65	ThingSpeak	ThingSpeak23 is and Open Data Platform for the Internet of Things, it connects sensors to the web and the web to things. This open source platform was released by ioBridge in 2010 for creating "sensor logging applications, location tracking application, and social network of things with status updates"	https://thingspeak.com	CPS related IoT Platform	horizontal	cross-cutting	technological	open	ThingSpeak Community		US	ThingSpeak	Reference:H2020 – UNIFY-IoT Project - Deliverable D03.01 »»Link: http://www.internet-of-things-research.eu/pdf/D03_01_WP03_H2020_UNIFY-IoT_Final.pdf
66	carriots	Carriots is Platform as a Service (PaaS) for integrating customers' application with "external IT systems through" a development environment, open API and web services.	https://www.carriots.com	CPS related IoT Platform	horizontal	cross-cutting	technological	commercial	carriots		Spain	carriots	Reference:H2020 – UNIFY-IoT Project - Deliverable D03.01 »»Link: http://www.internet-of-things-research.eu/pdf/D03_01_WP03_H2020_UNIFY-IoT_Final.pdf

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67	Evrythng	Evrything is a platform that connects smart products to the web providing real-time web based application. This platform works with multiple kind of connectivity technologies from smart tags to chips that have digitally identified by Active Digital Identity (ADI). Evrything adopt an OAuth protocol for connecting external applications to products.	https://evrythng.com	CPS related IoT Platform	horizontal	cross-cutting	technological	commercial	Everythng		UK, US	Everythng	Reference:H2020 – UNIFY-IoT Project - Deliverable D03.01 >>>Link: http://www.internet-of-things-research.eu/pdf/D03_01_WP03_H2020_UNIFY-IoT_Final.pdf
68	Eclipse OM2M	Eclipse OM2M™ is an open source project managed by LAAS-CNRS™ and Sensinov™ 41 at the Eclipse foundation. It offers a horizontal IoT service platform based on oneM2M™ standard for cross-domain interoperability easing mass-scale deployment in various domains such as smart cities, factories of the future, health care, and connected cars.	http://www.om2m.org	CPS related IoT Platform	horizontal	cross-cutting	technological	open	Eclipse IoT Community, Eclipse Foundation	The Eclipse OM2M project, initiated by LAAS-CNRS, is an open source implementation of oneM2M and SmartM2M standard. It provides a horizontal M2M service platform for developing services independently of the underlying network, with the aim to facilitate the deployment of vertical applications and heterogeneous devices.	CA	Eclipse Foundation Members	Reference:H2020 – UNIFY-IoT Project - Deliverable D03.01 >>>Link: http://www.internet-of-things-research.eu/pdf/D03_01_WP03_H2020_UNIFY-IoT_Final.pdf
69	One MPOWER	InterDigital's Internet of Things (IoT) platform, oneMPOWERTM powered by wot.ioTM, is a horizontal solution that integrates and manages connected devices and data feeds across industries and diverse communication networks.	http://www.interdigital.com/iot	CPS related IoT Platform	horizontal	cross-cutting	technological	commercial	InterDigital	There is a large opportunity for IoT solutions to make an impact in a broad range of industries including transportation, smart buildings, smart cities, and industrial. InterDigital's IoT solutions make it easier to implement solutions that are scalable, agile, flexible, and able to unlock the true value of data.	US		Reference:H2020 – UNIFY-IoT Project - Deliverable D03.01 >>>Link: http://www.internet-of-things-research.eu/pdf/D03_01_WP03_H2020_UNIFY-IoT_Final.pdf
70	Microsoft Azure (IoT)	Azure IoT Hub is a fully managed service integrated into Microsoft Azure's cloud offering, that enables reliable and secure bidirectional communications between millions of IoT devices and a solution back end. The Mircosoft Azure IoT platform is composed of core platform services and application-level components to facilitate the processing needs across three major areas of a typical IoT solution. This includes 1) device connectivity, 2) data processing, analytics, and management and 3) presentation and business connectivity.	https://azure.microsoft.com/en-gb/services/iot-hub/	CPS related IoT Platform	vertical	cross-cutting	technological	commercial	Microsoft Azure		US	Microsoft	Reference:H2020 – UNIFY-IoT Project - Deliverable D03.01 >>>Link: http://www.internet-of-things-research.eu/pdf/D03_01_WP03_H2020_UNIFY-IoT_Final.pdf
71	Eclipse IoT/ smart home	Eclipse Smart Home (ESH) is a software running in the home. It contains the major code and data structures that are needed in a home automation server. ESH is developed within the Eclipse Java community.	http://www.eclipse.org/smarthome/	IoT home automation platform	horizontal	smart city	technological	open	Eclipse IoT Community, Eclipse Foundation		CA	Eclipse Foundation Members	Reference:H2020 – UNIFY-IoT Project - Deliverable D03.01 >>>Link: http://www.inte

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72	The European Institute for Innovation through Health Data (I ~ HD)	To become the European organization of reference for guiding and catalysing the best, most efficient and trustworthy uses of health data and interoperability, for optimizing health and knowledge discovery.	http://www.i-hd.eu	Innovation Initiative	Vertical	Health, IoT, partially CPS (personal health systems)	Operational	Commercial	EC	To enable, coordinate, and accelerate the efficient development and deployment of interoperable and seamless eHealth solutions2 and research strategies, towards achieving best practices and sustainable integrated person-centred health care, to optimize health and wellness in Europe, and beyond.	EU	Founding Members: University Collage London, Empirica, RAMIT. Stakeholders: Patients, Healthcare professionals, Pharma, Healthcare Decision Makers, Healthcare ICT industry, Standards developers, Scientific associations, Health data brokers.	
73	Platform-aware Model-driven Optimization of Cyber-Physical Systems (oCPS)	Create a multi-disciplinary research and education network bringing together all disciplines relevant for CPS to form a scientific basis to (i) develop model-driven design techniques for CPS and (ii) introduce platform-awareness in the design trajectories. Such techniques should allow dealing with tradeoffs towards cost-effective, quality-driven, reliable design of the CPS of the future	http://ocps.ele.tue.nl/	Product development platform	Vertical	Health, CPS	Organisational	Open	EC	The program aims to train a generation of young researchers in cross-disciplinary thinking and deliver industrially validated tool chains. We bring together the state of the practice through six key industrial players, including SMEs, and the state of the art through four top universities and one research institute across Europe.	EU	TNO, Den Haag, NL Ericsson, Stockholm, SE Scania, Soedertalje, SE Siemens, München, DE Ulm University (UULM), Ulm, DE IMT School for Advanced Studies Lucca (IMT), Lucca, IT Technische Universität Wien (TUW), Wien, AT Technolution	
74	HealthSuite Digital Platform	An open, secure platform of services, capabilities and tools designed to inspire and enable the development of next generation connected health and wellness innovations.	http://www.usa.philips.com/healthcare/innovation/about-health-suite	IT-Platform	Vertical	Health, IoT	Technological	Commercial	Philips	To enable doctors to connect electronic health records and patients to connect their devices to a secure cloud. HealthSuite digital platform offers both a native cloud-based infrastructure and the core services needed to develop and run a new generation of connected healthcare applications. Unlike other digital platforms, HealthSuite is purpose built for the complex challenges of healthcare, featuring deep clinical databases, patient privacy, industry standards and protocols, and personal and population data visualizations.	EU, USA	Philips, Amazon	
75	HealthShare	The platform provides reliable, high-performance, and scalable technology for three key capabilities: data management; connectivity to applications, data sources, and devices; and creating insights from the data.	http://www.intersystems.com/our-products/healthshare	IT-Platform	Vertical	Health	Technological	Commercial		Coordinated care requires a comprehensive view of a patient's history and status. Payers and policymakers need to understand patterns of care for populations. Strategic interoperability, provided by HealthShare, connects all the dots in healthcare to bring the right information to the right people, at the right time.	USA, global		
76	Jitterbit Healthcare Interoperability Platform	Enabling medical device manufacturers, healthcare providers, application developers and electronic medical record (EMR) vendors to automate and streamline operations with a dedicated healthcare data model and interoperability standards that enable the secure exchange of rich clinical data with minimal IT investment.	www.jitterbit.com/Files/Product/Jtterbit-Datasheet-Healthcare-Life-Sciences.pdf	IT-Platform	Vertical	Health	Technological	commercial	Jtterbit	New regulations require healthcare providers to shift from a fee-for-service to a fee-for-quality model, and to improve the patient experience with easy access to electronic medical records. To meet new regulatory requirements and provide a better patient experience, healthcare providers must have interoperability between medical devices, EMR systems and other healthcare applications. The Jtterbit Healthcare Interoperability Platform accelerates progress toward these industry goals with solutions that provide secure and repeatable interoperability between data, apps and devices. The platform includes a set of solutions that simplify the process of accessing, mapping and exchanging clinical data between specific applications and devices.	US	Jtterbit	

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77	MindSphere	MindSphere from Siemens offers a cost-effective, scalable cloud Platform as a Service (PaaS) that's perfect for developing apps. Designed as an open OS for the Internet of Things, it lets you seamlessly connect with your machines like never before so you can improve the efficiency of plants by harnessing the huge volumes of data that your assets generate. MindSphere offers seamless connectivity between data-based based services from Siemens and third party providers. And it lets you seamlessly integrate your own apps and services.	https://www.siemens.com/global/en/home/products/software/mindsphere.html	IT-Platform	horizontal	Cross-cutting, IoT	Technological	Commercial	Siemens		EU	Siemens, ATOS	
78	Sirius	Sirius is an Eclipse project which allows you to easily create your own graphical modeling workbench by leveraging the Eclipse Modeling technologies, including EMF and GMF.	https://eclipse.org/sirius/	IT-Platform	Horizontal	Cross-cutting	Technological	Commercial	Obeo	Sirius provides a generic workbench for model-based architecture engineering that could be easily tailored to fit specific needs. Based on a viewpoint approach, Sirius makes it possible to equip teams who have to deal with complex architectures on specific domains	EU	Obeo	
79	Capella	The Capella workbench is an Eclipse application implementing the Arcadia method providing both a Domain Specific Language (DSL) and toolset which is dedicated to guidance, productivity and quality. Intuitive model editing and viewing capabilities help engineers focus on the design and description of the system and its architecture.	https://polarsys.org/capella/	IT-Platform	Horizontal	Cross-cutting	Technological	Open	Eclipse	Capella has been specified, designed and developed for providing a high value engineering environment to the System Engineering and Software Architecting teams, promoting innovative approaches in engineering practices. It benefits from the return on experiment from previous deployment of MDE in Thales large projects and from recent progress in the MDE technology domain. It has been successfully deployed in a wide variety of industrial contexts and proved to have an acceptable maturity for deployment in terms of reliability, robustness, performance, efficiency and adaptability. Capella provides its integrated tooled-up process solution on top of the state-of-the-art de facto standard Eclipse Open Source IDE Platform.	EU	Thales	
80	Smart, Safe and Secure Platform (S3P)	The S3P Platform aims at enabling the rapid development and exploitation of IoT-capable devices and applications, combining unprecedented safety, security, agility and portability.	http://www.esterel-technologies.com/S3P-en.html	IT-Platform	Horizontal	Cross-cutting	Technological	Open	Embedded France Association, the Cap'tronic Association and the Eclipse Foundation	The S3P Project aims at developing a safe, secure and smart software development and execution platform (the S3 Platform) to facilitate the development, deployment and exploitation of IoT Devices, Gateway and Applications at the best cost and speed. The S3P Platform is a technology and development stack ecosystem that is open and interoperable with all major IoT platforms in the world and will add specific value in a number of well defined areas	France, EU	Esterel Technologies, CEA Tech, Krono Safe, MicroEJ Prismtech, Prove & Run, SYSGO, Telecom ParisTech and TrustInSoft, Airbus, Alstom, Altran Connected Solutions (World Class Center of Altran), Axa France, Continental, Eolane, NXP Semiconductors, Sagem, Schneider Electric, Sorin, STMicroelectronics, SurTec and Thales	
81	ISO/IEC TR 9789	Guidelines for the Organization and Representation of Data Elements for Data Interchange (Ref: Medolution)	https://www.iso.org/standard/17651.html	Standardisation framework	Vertical	Health	Technological	Commercial	ISO, IEC	Provides general guidance on the manner on which data can be expressed by codes. Describes the objectives of coding, the characteristics, advantages and disadvantages of different coding methods, the features of codes and gives guidelines for the design of codes.	USA	ISO, IEC	

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82	OGC® Sensor Web Enablement (SWE)	This series of standards support interoperability interfaces and metadata encodings that enable real-time integration of heterogeneous sensor webs. (Ref: Medolution)	http://www.opengeospatial.org/ogc/markets-technologies/swe	Standardisation framework	Horizontal	Cross-cutting, IoT	Technological	Commercial	Over one hundred. http://www.opengeospatial.org/ogc/members	SWE offers integrators: Open interfaces for sensor web applications "Hooks" for IEEE 1451, TML, CAP, WS-N, ASAP Imaging device interface support Opportunity to participate in an open process to shape standards Sensor location tied to geospatial standards Fusion of sensor data with other spatial data Ties to IEEE and other standards organizations	EU, USA, Asia, Canada	Airbus Defence & Space, Bentley Systems, Inc., DASSAULT SYSTEMES AMERICAS CORP. Department of Science & Technology, DigitalGlobe, Inc., Esri , Feng Chia University , GeoConnections - Natural Resources Canada, Google Harris Corporation , Intergraph Corporation , Oracle USA, Pitney Bowes Software Trimble Navigation Ltd., United Nations Geographic Information Working Group (UNGIWG) , US National Oceanic and Atmospheric Administration (NOAA)	
83	HL7 FHIR (Fast Healthcare Interoperability Resources)	FHIR leverages existing logical and theoretical models to provide a consistent, easy to implement, and rigorous mechanism for exchanging data between healthcare applications.(Ref: Medolution)	https://www.hl7.org/fhir/	Standardisation framework	Vertical	Health	Technological	commercial		Founded in 1987, Health Level Seven International (HL7) is a not-for-profit, ANSI-accredited standards developing organization dedicated to providing a comprehensive framework and related standards for the exchange, integration, sharing, and retrieval of electronic health information that supports clinical practice and the management, delivery and evaluation of health services.	International	HL7 Canada, Corepoint Health, HL7 International, Mayo Clinic, Accenture, HL7 New Zealand, HL7 Netherlands	