Strengthening Leadership in Digital Technologies and in Digital Industrial Platforms across Value Chains in all Sectors of the Economy

Digitising European Industry initiative (DEI)

The mandate is to:

- Reflect on the priority development of building blocks by the PPPs, as well as how Member States could commit to align and co-invest on the same industrial priorities in order to reach critical mass. The reflection shall include consideration for the role of Member States in the PPPs.
- Reflect on how building platforms should be approached on a European and national level.
- Reflect on the form and objectives for further EU and national platform-related projects and/or large-scale testing and experimentation pilots, how PPPs can align their strategic research agendas to develop the necessary platforms, large-scale pilots and standards, and how national efforts could be combined in an overall support.
- Reflect on the prioritisation of several initiatives under preparation, covering both: integration platforms addressing cross-sector challenges (Leadership in IoT, Industrial Data Platforms, and 5G demonstration); and sectoral platforms and full solutions (Connected Smart Factory, Connected and Automated Driving, and Robotics, IoT and AI for healthy living and active ageing).
- Reflect on further support to the full roll-out of digital integration platforms. The WG is invited to reflect on more integrated funding schemes (covering European, national and regional as well as private investments, including the use of financial instruments like EFSI) for other technology roll-out initiatives in areas such as 5G or Connected Automated Driving. It shall also encompass considerations for public procurement of innovations and framework conditions.
- Propose whether specific platform initiatives would deserve attention of one or more subgroups.

This working paper includes input to the report on strengthening European leadership in digital industrial platforms from the activities run under the European Research Cluster on the Internet of Things (IERC) and Internet of Things European Platforms Initiative (IoT-EPI).

The working paper presents the trend and the developments of next-generation platforms including IoT platforms based on market figures, reference to hubs, ecosystems from the IERC and EPI-IoT activities and reports, in the global context with reference to international competition of industrial platforms and IoT alliances.

The working paper highlights the role and importance of standards for IoT technologies and applications and the implementation of digitising industry concepts. Based on the technological trends and analysis of the market the working paper proposed concrete ways for IoT platform building initiatives and IoT large-scale pilots that are expected to emerged in the future and should be supported and promoted at the MSs and European level.

The IoT makes use of synergies that are generated by the convergence of Consumer, Business and Industrial Internet customer, Business and Industrial Internet. The convergence creates the open, global network connecting people, data, and things. This convergence leverages the cloud to connect intelligent things that sense and transmit a broad array of data, helping creating services that would not be obvious without this level of connectivity and analytical intelligence.

IoT's disruptive nature requires the assessment of the requirements for the future deployment across the digital value chain in various industries and in many application areas considering even better exchange of data, the use of standardized interfaces, interoperability, security, privacy, safety, trust that will generate transparency, and more integration in all areas of the Internet (consumer/business/industrial). These allow IoT application to extend to industrial sector, IIoT (Industrial Internet of Things), robotics IoRT (Internet of Robotic Things) providing new growth opportunities through boosting revenues by increasing production, creating new hybrid business models, exploit intelligent technologies to fuel innovation, and transform the workforce.

Given the disruptive nature of the IoT, current approaches when developing a business model should be adapted accordingly under a dynamic flexible IoT business models framework as suggested before. The most important chance in this regard is convergence of value chains to value networks on the context of IoT ecosystems [5].

The technology underpinning the IoT - acquiring, analysing, and activating data - is an essential element of generating innovative experiences and transforming operating models (see Figure 1- Source: IDC's Global IoT Decision Maker Survey, August 2015). According to IDC's 2015 Global IoT Decision Maker Survey, 58% of organizations worldwide see the Internet of Things as strategic to their business. Another 24% of organizations see IoT as transformational to their business.

Figure 1 Digitally Transform or Be Left Behind [6].

The digital transformation takes effect via four levers as presented in Figure 2:

- Digital data referring to capturing, processing and analysing digital data that allows better predictions and decisions to be made,
- Automation by combining traditional technologies with artificial intelligence is increasingly giving rise to systems that work autonomously and organize themselves (i.e. this reduces error rates, adds speed and cuts operating costs),
- Connectivity by interconnecting the entire value chain via mobile or fixed-line high-bandwidth telecom networks synchronizes supply chains and shortens both production lead times and innovation cycles
- Digital customer access using the internet (fix, mobile, tactile) that gives new intermediaries direct access to customers to whom they can offer full transparency and new kinds of services.

The enablers of the digital transformation of industry include the IoT, a high-quality broadband network and the increasing automation and autonomy of production. These enablers facilitate new market positions and value propositions such as smart fabrics, fourth-party logistics (4PL) and predictive maintenance. A harmonized, balanced and genuinely pan-European single digital market is needed in order to overcome current fragmentation. Such a market could slash costs and realize synergies through improved access to information, lower transaction costs, dematerialized consumption, a smaller environmental footprint and superior business and administrative models [2].

Drivers of digitization

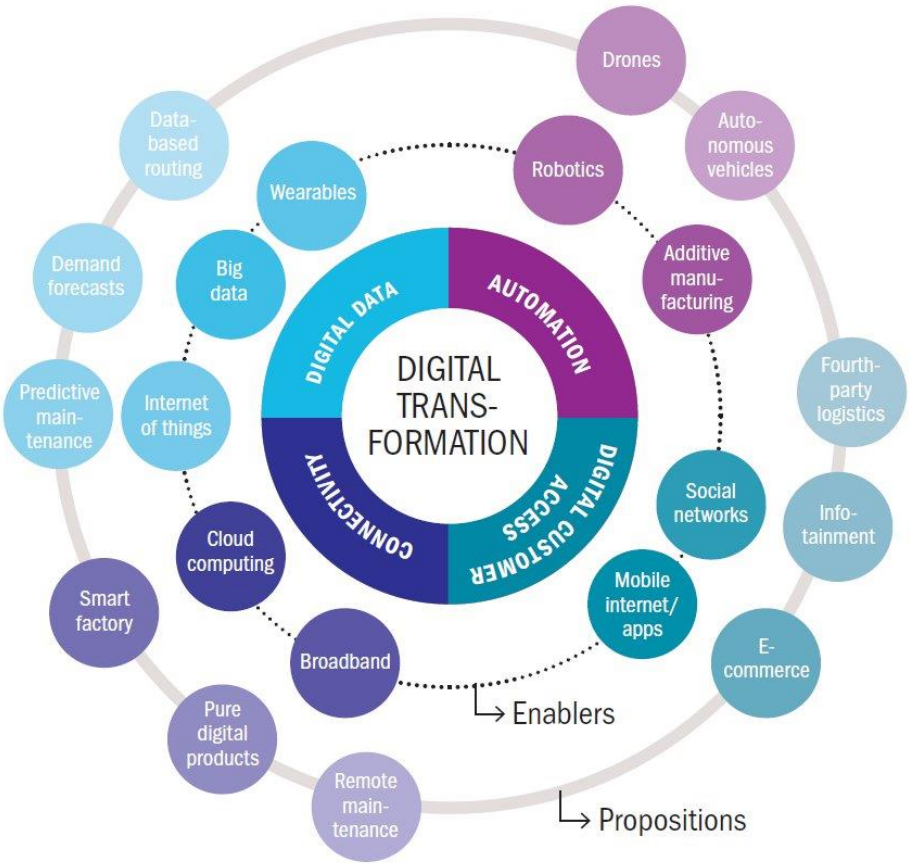

Figure 2 Digital transformation via four levers [2].

IoT solutions combine innovation, regulation, standardisation creativity in order to manage the complex questions raised by data circulation and capture, compatibility of systems and

intellectual property. In this context, a holistic product, service development seamless integration into applications has to be considered by addressing the IoT and circular economy through engagement with the knowledge ecosystem available via the IoT cognitive solutions.

This requires a systemic change perspective; where IoT becomes the new, virtualised infrastructure that governs assets use and movements along the value chain and the pervasive connectivity is rolled out at scale and redefines value generation by supporting economies bypass heavy upfront investments and material-intensive solutions.

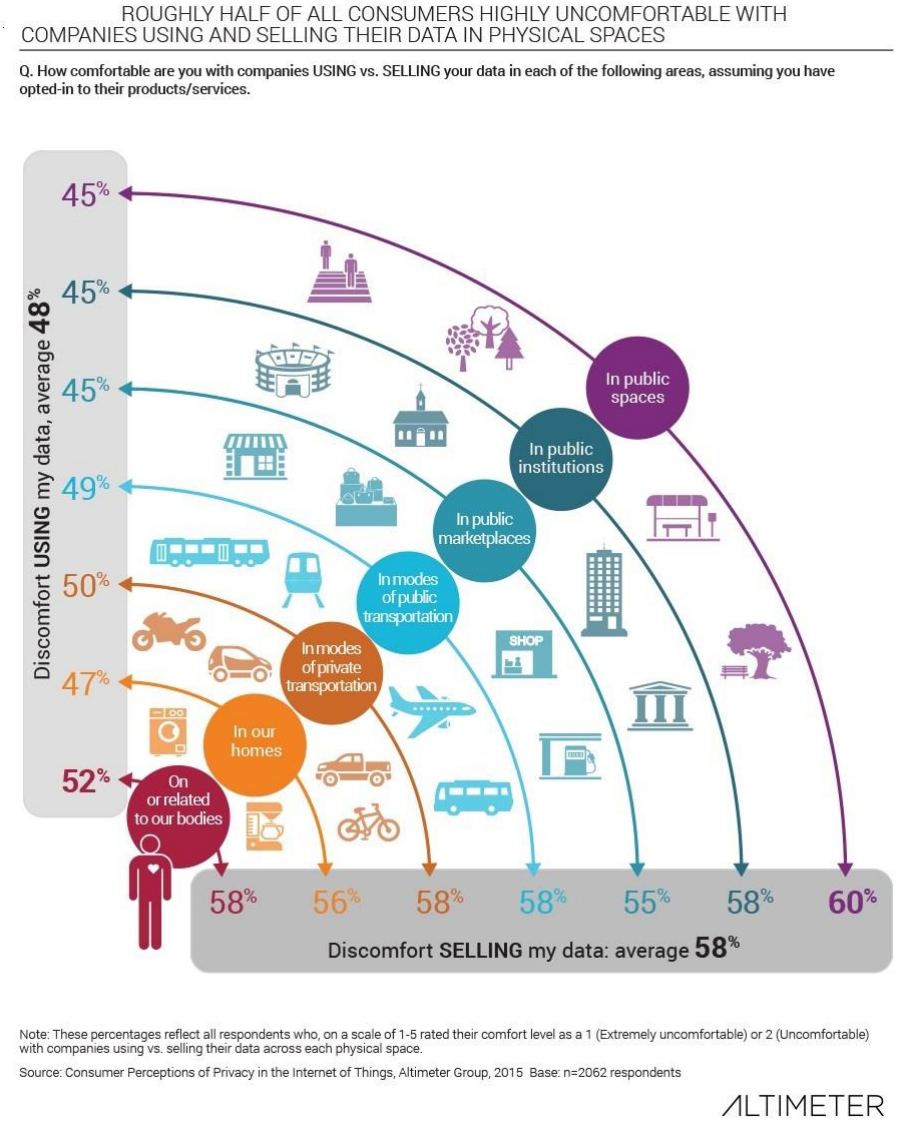

Figure 3 Data use and consumer perceptions in the IoT [9].

One of the most important parts of the digital transformation is to be able to connect the many devices that make up the business ecosystem. IoT is connecting the unconnected that enables information across the whole supply chain to be gathered and fed into an analytics process to gain insights into as many facets of the business as needed. Business value is created by combining the IoT device data, brokered with environmental, social, and enterprise data, while increasing the original value of the device manyfold. IoT-based solutions form an integral part of a business' operational model and therefore should be viewed as an integral part of a digital

transformation strategy. Combining data from IoT solutions and enterprise systems provides a more holistic view of customers, consumers, products and partners. The use of edge computing, cloud, data and analytics, social business, and mobile resources is bridging digital technologies with operational, organizational, and business models. The link, where digital transformation is the objective, allows the business process to run more efficiently while reducing its costs. Digital transformation increases customer satisfaction through better product and service quality while expanding the ways to engage customers (omni-channel, etc.) [6].

Data integration will bring new challenges as cloud services, edge computing, open source software, requires standards to make integration easier going forward.

The ethical data use as being beneficial, progressive, sustainable, respectful, and fair. The stakeholders must apply these principles, not just to the use - the collection, processing, analysis, governance, storage and security - of the data, but to communications about these elements. There is an inherent friction to privacy. Privacy is not something we can standardize or account for in a scripted template. It is a function of shifting contexts, motives, and frameworks: culture, religion, location, age, gender, income, family, sexual orientation, life events, experiences, exposure, and more. Privacy is subject to each of our unique, yet deeply human sensitivities. It is as ingrained in us, indeed related to, our innate imperative to maintain status in order to more effectively propagate forward our genes [9].

The end-user/consumer privacy will require new privacy by design scalable and context aware mechanisms for securing the personal data of individuals as the things they use become increasingly digitized. The IoT applications require a flexible standards-based framework that supports the implementation of privacy and security policies in these applications.

The policies need to provide information practices and principles, while offering guidelines for developing operational solutions to privacy issues in various application domains to support the take-up of the IoT in the context of the Digital Single Market, as well as from an Internal Market perspective, with a particular focus on trust, security, liability, privacy and net neutrality.

Next-generation platforms

A set of platforms have been identified as leading in accordance to an analysis performed in [4]. The analysis considered platforms across different IoT platform industries and vendor types, while distinguishing between commercial and open source platforms.

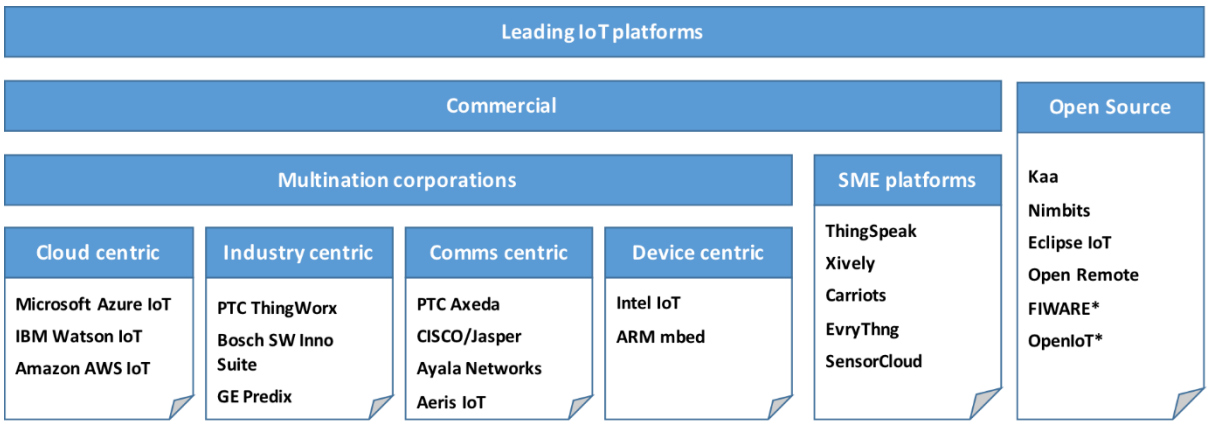

Figure 4 Selection of 23 leading IoT platforms for a more in-depth analysis [4].

Figure 5 represents the current distribution of the different types of companies all over the world. US based IoT platform providers account for the majority of leading platforms in our selection; however, its proportion increases from 60 to 75%. Proportionally European platform are still in second place but a lower percentage of platforms is considered leading, with only 22% percent coming from Europe as opposed to 28%. The other remaining leading platform providers are from Canada. This means that the Asian and South African market are not yet in a position to compete globally.

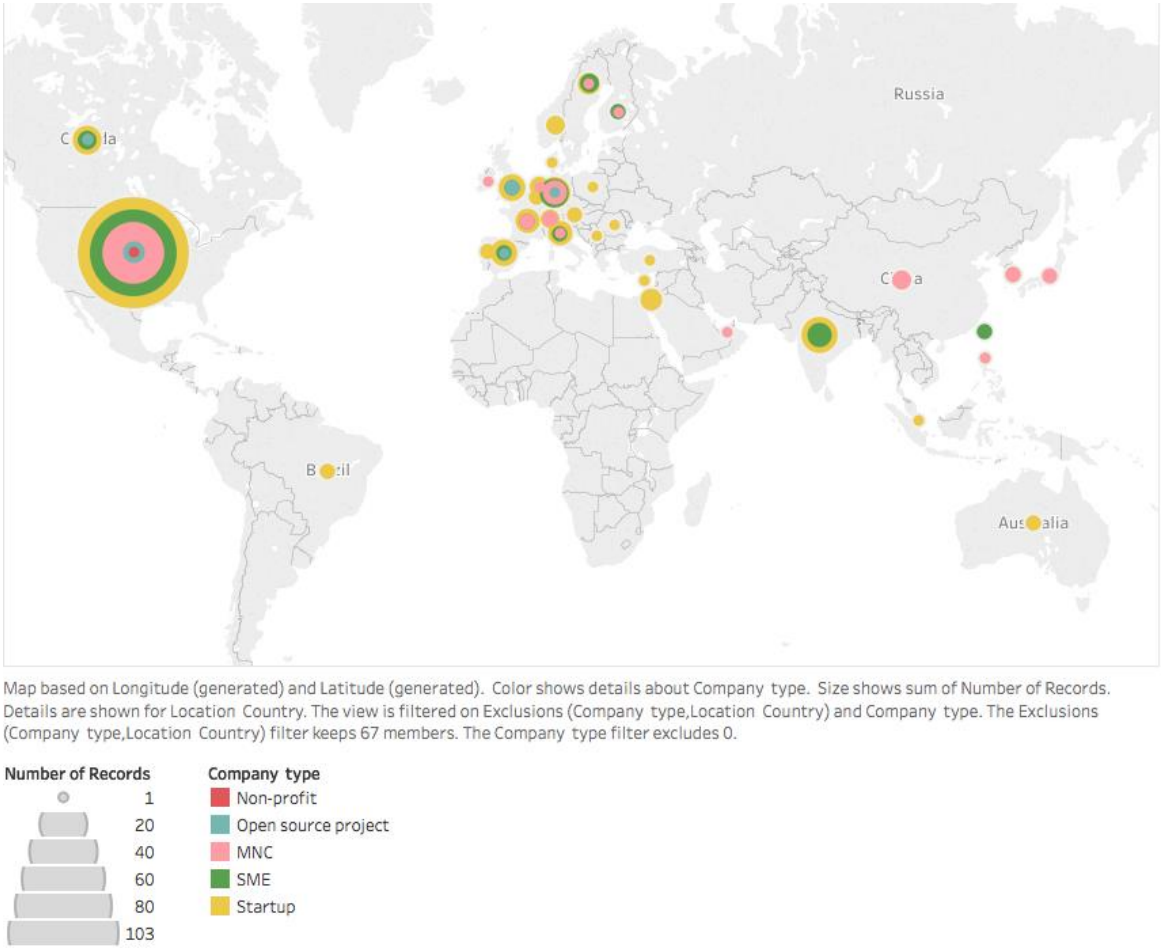

Figure 5 Global distribution of different type of companies [4].

Reaping optimal value from intelligent technologies requires a robust technical architecture and infrastructure. IOT/IIoT platforms will be critical to the success of manufacturers and service providers. These companies need the IIoT platforms to develop product-service hybrids, enable the development of applications by third parties, provide APIs for sharing data and control the channel for delivering services to their customers. Asset owners and operators will use these platforms to operate equipment and applications, to deliver and analyse data, to link and control processes, and to connect with other companies in their ecosystems [3].

The next generation IoT open platforms have to bring strong software defined horizontal capabilities to address the cross-sectorial requirements for IoT applications based on decentralized, distributed, asynchronous decoupled architectures allowing IoT service integration capabilities to implement large-scale deployments from the edge to cloud.

The IoT platforms need to be and act as a complete IoT/IT/OT ecosystem converging the consumer/business/industrial applications by collecting and sharing data broadly within an

organization, sectors, and IoT applications. This need to be converted into an IoT platform strategy, based on open specifications, strong interoperability principle, security and standardization. The focus today is developing and deploying IoT technologies and applications using a federation of IoT platforms and a strong IoT ecosystem of integrators, aggregators, service providers, RTOs across various industries. These ecosystems need including industrial, consumer, business stakeholders that enable customers/end-users/stakeholders to create managed services offerings, co-create value (products, services, experiences) based on new business models and exchange data thus unlocking the true data value chain in order to deploy solution for digital single market [4].

This requires the strengthen of IoT ecosystems where various stakeholders across the architectural layers and across the verticals are collaborating for developing platforms that orchestrate the integration of IoT micro-services and APIs that are the centre piece of development, machine to machine learning over the IoT application lifecycle and circular economy. This will allow interoperable IoT service portfolio over horizontal applications, enabling new business models and the hybridisation of B2B, B2C and B2B2C models for future cross-sectorial applications.

The IoT platforms need to include scalable computing at the edge capabilities allowing the applications to perform the task for which they were created and learn from their environment and evolve, while leveraging a network of intelligent services through APIs to create applications.

The IoT platforms need to evolve in becoming more than a development platform. The IoT platforms need to be autonomous, evolution driven co-creative environments with inbuilt machine learning, self-evolving that connect, communicate, collaborate, contextualize, cognitive integrate the IoT distributed devices at the edge. This will allow the users to create applications that lend themselves to rapid and/or autonomous modification, where the focus will be both on the solution and on the technology considering that the technology will undergo continuous orchestration and improvement.

Build upon the large investments of individual EU member states into national initiatives to digitise their industry.

European efforts should focus on fostering alignment between these efforts towards common reference architectures for a converged single digital European market place, instead of reinventing and developing competing solutions to the national initiatives.

Many European countries have launched various initiatives on digitising their industries based on IoT technologies. Many of these are large investments in new architectures, platforms and large-scale pilots of these for different verticals, well exceeding available funding of the EU in this area. Examples are the Industrie4.0 platform[1] in Germany aiming at digitising manufacturing industry, the French Industrie du Futur[2] programme or IoTUK[3] programme of the UK.

[1] http://www.plattform-i40.de/
[2] http://industriedufutur.fim.net/
[3] https://iotuk.org.uk/

In the past EU projects have focused on developing new platforms and solutions that do not directly consider national efforts or compete/overlap unnecessary with national initiatives, increasing the fragmentation, rather than fostering an alignment towards common solutions and standards that can be deployed across Europe in a harmonised fashion.

Digitising European industry requires a better alignment between national resources at European level. Instead of funding yet another technology platforms, much of the EC investment should focus on federating initiatives that bring together the results and platforms developed in the different national programmes to strengthen the emergence of converged architectures and solutions that can form the foundations of single digital market place for European industries. This includes initiatives for knowledge exchange between different national member state initiatives and initiatives for active development of standardised reference architectures for the alignment of platform architectures and technologies. It also should include large-scale pilots that demonstrate the feasibility of an interoperable digital market place across European countries and foster a validation and benchmarking of candidate technology options. Finally, it should support specific initiatives that allow member states who have fallen behind or lack large investments to take advantage of advances of other EU member states, in order to close the growing digitisation gap.

Bridge the gap between the current implementations and the future developments to address the digital market requirements. Concrete platform building initiatives and large-scale pilots expected for the future developments.

While the overall IoT market is starting to mature, there are various gaps still existing both on technology and business models. One of these gaps is the support for integrated cloud, mobile edge computing and edge analytics solutions in current IoT platforms. As the number of IoT devices grows, it will become increasingly inefficient to extract necessary insights in the cloud. Emerging industrial IoT applications, Tactile Internet and autonomous/robotic systems solutions will require much faster reactivity at the edges of the networks. In order to support these requirements, analytics algorithms will have to operate in a distributed context between edges and cloud with heterogeneous capabilities. Apart from the algorithmic, artificial intelligence and M2M learning advances, this requires much more sophisticated frameworks in place to enable effective synchronisation and adaptability. Another important gap is the lack of 3rd party market places inside of the current IoT platforms. Despite the increasing focus to capture developer mind share, concrete market place mechanisms to enable revenue share between the providers of the IoT platform and 3rd party app or analytics component developers are not yet existing. This is however a crucial element to spark the success that we know of the app economy in the mobile world [4].

The need for initiatives to enable the validation of IoT open platforms capabilities across various industrial sectors to secure, connect, and manage the complete application lifecycle. Take advantage of open platforms to manage large-scale IoT deployments addressing the energy across different sectors, circular economy and blockchain solutions across multiple industries.

The initiatives have to consider a large variety of use cases, from consumer to industrial applications, run as reference solutions for demonstrating IoT platforms capabilities for operations with decentralized control, enabling a secure, scalable approach to managing IoT deployed devices and applications across various industrial sectors.

The emergence of market places is the beginning of leveraging more easily economies of scale. The creation of a single digital market for IoT requires federated market places across currently emerging IoT platform silos. By enabling re-use of assets across different IoT ecosystem boundaries, secondary revenue streams can be generated for IoT infrastructure investments, which will boost the overall IoT market. Open source technology will play an increasing role in fostering common foundations across vendor specific ecosystems. By overcoming proprietary technology choices and giving in on initial market position, more powerful market place can emerge with less barriers and more revenue growth opportunities for all IoT stakeholders involved [4].

This requires to extend the concept of IoT platform as a service to applications and services as a platform with the use of the market place purposely architected, designed and developed as a collection of various IoT services and application that can be consumed and managed independently or as a batch through a vast number of APIs.

Standardisation is one of the key elements in digitising European industry and establishing European standards that could shape the future digital economy is essential in order to bridge the gap between the current implementations and the future developments to address the digital market requirements. This requires that the stakeholders involved in the IoT ecosystem define these standards and are working together to create suitable platforms for the sharing of ideas, knowledge and experience. By being involved proactively, Europe attains influence over the design of standards that are necessary to ensure interoperability and generate economies of scale and can open the door to the redistribution of global market shares in the digital economy.

Several consortia of technology and industrial companies have emerged, jockeying to set the standards for interoperability and ecosystem participation. The IIoT Consortium (IIC) is working on connecting and integrating machines with people, processes and data via a common architecture and interoperable mind set. The Open Interconnect Consortia and the AllSeen Alliance are two recently launched open source Internet of Things consortia [7][8].

Alliance for Internet of Things Innovation (AIOTI) as a European initiative is based on collaborative and innovation driven activities in order to drive a successful take-up of the IoT, where industries with production and research activities in Europe are participating. The core principles are to cooperate and share knowledge with existing and new partners of all sizes along IoT value chains, to adopt agile approaches and to search flexible agreements for convergence, interoperability and standardisation by focusing on policy/regulation, gaps in IoT standardization and Go to Market activities using Large Scale Pilots and EU Industry feedback.

AIOTI contribute to shape IoT related research and innovation agenda, including technology and applications for the EU, where cooperation between Member States and international actors is integral part, while stimulating creation of IoT ecosystems, which supports openness, value creation, scalability, sustainability and co-existence across industrial sectors and digital value chains.

Important elements for the future developments is the work on standardisation of IoT elements in the digital value chain including platforms, hardware and software. The standardizing of operating systems and software used in IoT applications including autonomous vehicles, internet of robotic things and combining them with other services such as data analysis and storage is essential for European industry.

The trend in the future is that proprietary solutions will be replaced by open standards National and European standardization organizations should be involved in the dialog with international bodies, and agree suitable norms in order to preserve and build up the value that the digital transformation can add to industry in Europe [2].

Strengthening leadership in digital technologies and in digital industrial platforms across value chains in all sectors of the economy can be achieved through:

- A holistic, comprehensive and coordinated strategy at the European level, avoiding fragmentation by looking at MSs best practices while encouraging the creation of pan-European IoT ecosystems across various industrial sectors involving the stakeholders in the different architectural layers and the different type of participants in the value networks large enterprises, RTOs, SMEs and start-ups.
- An IoT based roadmap for digital transformation across the industrial sectors on pursuing the IoT applications and technologies, interoperability at different layers, end-to-end security, market-relevant standards, and define uniform guidelines for intellectual property, data protection and data security.
- Assuring sustainability of IoT based digital transformation for all companies including SMEs by providing various forms of financing, investments, supporting research and development and linking the activities of various existing Innovation Hubs across Europe with new created IoT Innovation Hubs.
- Promote the establishment of IoT clusters for the digitization of industry and strengthen Europe's IoT industry
- Build upon the large investments of individual EU member states into national initiatives to digitise their industry and foster knowledge exchange and the emergence of converged solutions for a digital single market for European industrial solutions.
- Adopting a European innovation-based policy related to free data flow across Europe that will allow the industry to realise the benefits of the Digital Single Market for IoT and ensure that Europe remains in the lead on IoT research and innovation and will continue to create opportunities for its start-up community, which cannot be fenced within national boundaries.

References

[1] Digital Transformation of Industries: Digital Enterprise, World Economic Forum White Paper, 2016 online at: http://reports.weforum.org/digital-transformation-of-industries/wp-content/blogs.dir/94/mp/files/pages/files/digital-enterprise-narrative-final-january-2016.pdf

[2] Digital transformation of industry, Roland Berger Report, 2015, online at: https://www.rolandberger.com/publications/publication_pdf/roland_berger_digital_transformation_of_industry_20150315.pdf

[3] P. Daugherty, P. Banerjee, W. Negm and A. E. Alter, Driving Unconventional Growth through the Industrial Internet of Things, Accenture Report, 2015, online at: https://www.accenture.com/us-en/_acnmedia/Accenture/next-gen/reassembling-industry/pdf/Accenture-Driving-Unconventional-Growth-through-IIoT.pdf

[4] Gluhak, O. Vermesan, R. Bahr et., al. Report on IoT Platforms Activities, UNIFY-IoT Report, 2016, online at: http://www.internet-of-things-research.eu/pdf/D03_01_WP03_H2020_UNIFY-IoT_Final.pdf Final.pdf

[5] O. Vermesan, R. Bahr, A. Gluhak, F. Boesenberg et., al., IoT Business Models Framework, UNIFY-IoT Report, 2016, online at: http://www.internet-of-things-research.eu/pdf/D02_01_WP02_H2020_UNIFY-IoT_

[6] L. Dunbrack, S. Ellis, L. Hand, K. Knickle and V Turner, IoT and Digital Transformation: A Tale of Four Industries, IDC White Paper 2016, online at: http://www.digitalistmag.com/files/2016/03/IDC_IoT_white_paper_Mar2016.pdf

[7] D. Clark, New Tech Group Joins Crowded Field to Set Rules for "Internet of Things", The Wall Street Journal, July 8, 2014;

[8] Q. Hardy, Intel, Qualcomm and Others Compete for "Internet of Things" Standard, The New York Times Bits Blog, July 8, 2014.

[9] J. Groopman with S. Etlinger, Consumer Perceptions of Privacy in the Internet of Things - What Brands Can Learn from a Concerned Citizenry, Altimeter Group Report, June 2015, online at: http://www.altimetergroup.com/pdf/reports/Consumer-Perceptions-Privacy-IoT-Altimeter-Group.pdf