Standardisation issues affecting EU/US ICT development collaboration

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Foreword

On January 1st, 2016, the project PICASSO was launched with two aims: (1) to reinforce EU-US collaboration in ICT research and innovation focusing on pre-competitive research in key enabling technologies related to societal challenges - 5G Networks, Big Data and the Internet of Things/Cyber Physical Systems; and (2) to support EU-US ICT policy dialogue related to these domains with contributions related to e.g. privacy, security, internet governance, interoperability and ethics.

PICASSO is aligned with industrial perspectives and provides a forum for ICT communities. It is built around a group of 24 EU and US specialists, organised into the three technology-oriented ICT Expert Groups and an ICT Policy Expert Group, working closely together to identify policy gaps in, or related, to the technology domains and to recommend measures to stimulate policy dialogue. This synergy among experts in ICT policies and in the three ICT technology areas is a unique feature of PICASSO. The Policy Expert Group we are chairing also includes Jonathan Cave, Avri Doria, Ilkka Lakaniemi and Dan Caprio and develops its insights in consultation with other specific experts in the field (depending on the topic).

This policy paper focuses on ICT standardisation policy considerations in the EU and the US that affect and are affected by, in particular ICT, development collaboration related to 5G Networks, Big Data and Internet of Things/Cyber Physical Systems. The content reflects the results of desk study and subsequent discussion and will be subject to further discussion during the PICASSO seminar on 20 June in Minneapolis and a Webinar <date to be determined> together with written comments by experts collected via email.

It is the third of five thematic Policy Papers and accompanying Webinars scheduled for the coming two years. A Policy Paper on Privacy & Data Protection and one on Cybersecurity have already been published. Future subjects for Policy Papers will be on Spectrum; and– provisionally - on "Smart Cities", a subject in which all the other issues come together. The intent is to provide a clear overview of the most pressing and/or challenging policy issues that confront technological, business and policy collaborations and to develop well-formed and practical insights into how they can be addressed from a transatlantic multistakeholder perspective operating in a global context.

Important inspiration for this paper came from all those who contributed to our understanding of the issues related to ICT standards, ICT security and Data protection policies in the EU and the US and of the specific policy issues related to the three PICASSO domains by their active participation in our meetings. We could not have done this without them.

Please feel free to share your thoughts via email to maarten@gnksconsult.com.
Looking forward to engaging with you all,

Best regards

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Introduction

One objective of the PICASSO project is to bring forward policy recommendations designed to improve EU/US ICT-orientated collaborations, specifically in the domains associated with 5G networks, Big Data and IoT/CPS.

The aim of this paper is to establish a framework for the consideration of ICT standardisation issues as they affect the development of future EU/US ICT-orientated research collaborations, specifically in the technological domains associated with 5G networks, Big Data and IoT/CPS.

The implementation of standards in industry and commerce became highly important with the onset of the Industrial Revolution and the growing need for high-precision machine tools and interchangeable parts. Originally such standards were set at the level of specific sectors; in many ways, this focus continues. However, ICTs increasingly pervade most sectors and an increasing range of economic, scientific and societal activities; the same ICT technologies or services are used in multiple sectors for diverse purposes. Standards setting and development within a single sector often does not keep pace with differing business interests across sectors and standards competition.

This highlights three points:

i) the impact of ICT-dependence on the complex web of standards in use;
ii) the significance and importance of standardisation processes; and
iii) the broader implications for the world e.g. the geometry of shared technical, economic and societal spaces defined using common or complementary standards.

How ICT dynamics affect standards

ICT penetration is often portrayed as a form of *convergence*; if "general purpose" ICTs can be used across sectors, the importance of broad-based or flexible standards may increase and existing standards may need substantial revision. But the implications for standards and their implementations are not simple and the extent of convergence should not be over-emphasised.

To the extent that convergence is a real and relevant source of pressure on existing standards, it is worth bearing in mind that it crosses sector boundaries (e.g. aviation, logistics, health care, etc.), societal roles (commerce, science, civil society, administration) and subject domains (i.e. merging transmission protocol and encryption standard-setting). These "crossovers" argue for a networked (as opposed to a federated or hierarchical) structure of standardisation. For concreteness, the following discussion uses an example of ICT across industrial, financial and healthcare sectors.

As a technology spreads into different areas, the associated standards cannot always be "broadened" without changing their essential nature. For instance, the *security* concepts that underpin standards for information exchange in industrial systems may be wholly distinct from those appropriate to financial service or healthcare settings. A standard intended to work for all of them may:

- Descend to a minimum level, with additional, context-specific standards and/or technological implementations;

- Be “gold-plated” to a maximum level, becoming needlessly cumbersome or expensive for many applications, weakening the perceived advantages of compliance and possibly distorting or limiting uptake; or
- Have no clear ranking from least to most restrictive standardisation, which may mean that standardisation is abandoned altogether or set to serve the interests of the most powerful businesses, sectors or perspectives affected.

Why should this matter? It could have negative or positive consequences. On the negative side, standards developed at the technological level to serve needs arising at the functional or application level may respond to increasing general–purpose applications by fragmentation to incompatible specific standards that limit further technological convergence. Continuing the above example, the development of incompatible standards for data sharing in industrial, financial and healthcare settings may frustrate the deployment of common data storage and analytic solutions and thus inhibit advanced services that draw on all three types of data, as well as globally implementable ways of ensuring privacy or security of personal data.

On the positive side, the challenges posed by technological convergence could provide useful impetus to the development of functional as opposed to technological standards, defined at the application or service level (e.g. business process standards) in a way that is compatible with basic technological standards for, e.g., security or data exchange. It may also enhance privacy by preventing the easy assimilation of all data sets into a common big data collection subject to artificial intelligence’s ability to combine data and inference mechanisms. In the same example, this could lead to standards that provide appropriate and negotiable levels of protection for different kinds and uses of data and limit reliance on “privacy and security by (technology) design” approaches, in which, more than ever before, design is done in multidisciplinary teams with people not used to work together – as solutions may not be found in technology alone.

Convergence should not be taken for granted. On the device level, the addition of functions to common devices (e.g. smartphones) has by no means eliminated other devices performing overlapping mixes of the same functions. This proliferation of supposedly converged devices and services occurs within a single class of user (e.g. people who routinely use multiple smartphones) and is complemented by a growing range of types of device whose functions overlap. The “right kind” of standardisation should reflect this inevitable tendency towards overlapping devices, functions and cultures of use; the assumption that convergence will lead to a single configuration of devices for which unified standards can always be devised is, almost certainly, refuted by experience.

For this reason, new forms of collaboration across perspectives on the interplay among standards, technologies and applications is required. Because technologies and markets cross EU-US boundaries more readily than do cultures of use, a transatlantic research collaboration seems essential and useful. Even more so: together, EU and US technologies standards will have a strong presents in markets across the world and further stimulate the emergence of interoperable technologies, services and things across the world.

Standardisation as a collaborative and competitive activity

Standard-setting and standard development are valuable activities in their own right, regardless of the types of standards produced. Killing off old standards (or bodies) may be as valuable as making new ones; as with laws, accumulating dense thickets is not helpful.

With regards to markets, standardisation can undercut the monopoly power of a dominant systems provider (e.g. the Xerox case) or lock in up and downstream users (e.g. mobile phone chargers). On the other hand, standards can be used to allow regulated hardware/systems providers to stoke competition in the supply chain on which they rely, driving down the price of parts that they use without requiring them to invest in equipment or fall foul of unfair competition regulations.

ICT technologies and services are now used around the world and across borders, which subjects the same technologies and services to multiple jurisdictions and national standards (such as the layout of power networks, or safety and privacy regulations). Hard and soft innovation continue to accelerate, bringing new technologies, services, business models and service are emerging as the result of world-wide R&D, deployment and competition.

ICT standards are increasingly global. Because telecoms networks and terrestrial spectrum use (esp. for mobile communications and radio) are geographically limited, associated standards were originally developed on a local basis, spreading as providers and markets (for services and equipment) expanded. Some Internet standards are sometimes developed in one country, in support of national standards and/or legislation, only later to be used on a global basis, but mostly they are developed for a global market, like the Internet itself.

The architecture[1] of standards-making organizations in the telecommunication and IT industry fields has fundamentally changed since the 1980s, from a simple and clear structure involving SDOs with explicit geographic and subject matter jurisdictions that followed slow and well-regulated processes to today's loose network of new bodies[2] with diverse and overlapping constituencies and boundaries, competing in global standards markets of a more-or-less commercial nature. This complexity has been mapped by many authors, for instance the so-called Rosetta Stone map first developed in 1990.

In industries where there isn't a dominant hardware or OS provider[3], interoperability of devices is critical. In older non-information industries, objects only need to interoperate in well-defined ways, though we do see some effort toward standardisation in replacement part in objects and systems. In the Internet, flexible interoperability, continuity of connections and non-interference with other traffic

[1] Adapted from Rutkowski, Anthony M. (1995) "Today's Cooperative Competitive Standards Environment and the Internet Standards-Making Model." Standards policy for information infrastructure (1995): 594-653.
[2] These take a wide variety of forms: industry clusters around technology, producer, vendor or user group specifications; national or regional competition-enhancing bodies; quasi-governmental or project-based 'standards initiatives' or global hyperdynamic developmental and technology transfer engines.
[3] If the hardware or OS layers are monopolised, there is no necessary problem of interoperability. This holds regardless of whether or not the services layer is competitive (look at the android or windows ecosystems, which are more open than iOS, but which have minimal issues).

are essentials that, if not provided by standardisation or voluntary action will be enforced through costly regulation.

With re-usable and flexible standards, 5G networks, Big Data services and applications and the Internet of Things/CPS will develop and contribute to increasing digitisation of our societies. We will find ourselves in a world that is sensing, effecting, registering, communicating, collecting, combining and sharing data and acting without human input, explicit consent or even knowledge – or with our participation as user, decider and (re)actor through increasingly mobile and ubiquitous interfaces and in which physical borders are permanently crossed by wired and wireless connections with the rest of the world. For sure, standards can enable all kinds of players to explore new ways to sense, effect, register, etc. and that the ultimate 'winners' of this ecological struggle are those that best address genuine needs rather than those the preserve existing power relationships.

Why should standards setting be addressed now?

1. *Standards are of critical economic importance; they help to create compatible products, leading to a vast connected "virtual marketplace" within which every product or service forms part of a coherent ecosystem.*

This allows more effective and efficient satisfaction of needs and value creation. Markets elicit, aggregate and "price" information through trade interactions; property rights provide incentives for people with things to trade. Standards provide the common "language" through which products communicate. Markets also combine competitive and cooperative interactions. Classically this was implemented via horizontal competition (within a market segment's supply or demand sides) and vertical cooperation (within supply chains and other contractual arrangements) and through individually-owned and transferrable property rights.

The transformation of markets associated with increasing data-intensity has changed this picture and calls for far richer architectures of cooperation and competition to identify and implement efficient outcomes, while preserving investment and innovation incentives. One aspect of this is an increasing need for property rights that are neither exclusive nor individually owned. In the information space, this is seen in the development of "open" alternatives to copyright[4] and in the Open Data, Software, Innovation and Information movements. Standards are perhaps the most concrete expression of this, representing as they do, a collective or shared form of intellectual property right (spread out along the spectrum from closed/proprietary to fully open).

2. *Standards enhance competition, especially within markets.*

Within markets, customers need standards to avoid being locked in to vendors. A good set of workable standards makes it easier to switch suppliers (without having to change other interacting products), thus forcing improvements in quality, price and other important attributes (e.g. privacy, security). Standards also facilitate user creation of new composite products and services, harnessing bottom-up innovation. Moreover, in the two-sided markets common for many ICT-mediated exchanges, standards enhance the joint mobility of buyers and sellers across platforms, helping to eliminate inefficient lock-in at the platform level. Another way competition is enabled by standards is that it allows developers to focus on value-add features to the projects instead of needing to concentrate on

[4] E.g. copyleft, Creative Commons, General Public Licence.

the research and development of basic functionality. Standards often allow products to interoperate while offering superior performance, security or other functionality for competitive advantage.

3. *Standard setting and development processes pull in more reviewers and facilitate non-market cooperation.*

This is to correct errors, identify and manage security issues and generally deal with problems arising between, as well as within, systems and solutions that might not otherwise be corrected by the market. On the market side, the relative stability of markets linked by interoperability relations can reduce the risks of stranded investment, making it safe to invest in improved infrastructures and innovation and limiting the twin tendencies towards excessive inertia and excessive volatility common to markets with strong network effects[5].

4. *Finally, standardisation and its associated activities can help to overcome the "frog-boiling" problem of emergent problems that are not recognised and dealt with until they have become irreversible.*

This is not only a result of the collaborative and multiparty nature of open standardisation but also reflects the advantages of this collaboration in dealing with problems that arise in one area or level, affect another and can be efficiently dealt with at a third.

In this document, we describe the current development of standards setting and development, the impact on the ability and need, for EU and US ICT developers' collaboration and specific opportunities further stimulate sustainable and successful collaboration.

Drivers for ICT Standardisation

As indicated above, the drivers of ICT standardisation are technical, social, economic and political. The primary goals of much of the technical community are interoperability and maintaining a stable and secure Internet. Much of business research and innovation is aimed at "serving markets" and addressing real needs. Investment money is scarce and R&I needs to be done in a way that ultimately contributes to the sustainable profitability of the enterprise. This often means the creation and defence of specific market niches and/r growing shares in broader, existing markets balanced by a need to keep development and operational costs as low as possible to insure the greatest possible profitability[6]. So there needs to be a reasonable scope that the invested funds are earned back and priority will be made for those investments that provide the best "return on investment, for some definition of "return" and of "investment."

One traditional driver, since the earliest beginnings of the Internet is the curiosity *and* interest of technology experts to develop something that works. Next to important investments by industry and governments, much of the work that has led to the Internet as we know it today has been voluntary,

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[5] Katz, Michael L. and Carl Shapiro. "Network externalities, competition and compatibility." *The American Economic Review* **75**, no. 3 (1985): 424-440.

[6] Note also that regulatory constraints on monopolisation and collusive behaviour mean that market power and profitability must often be pursued indirectly, e.g. through control of standards or dominance in neighbouring areas like IP or consumer information collection and use.

performed for minimal or no remuneration and often at a great personal cost. This has led to the current technology infrastructure that requires improvement of its stability, interoperability and functionality.

For many people that participate in standards organisations like the Internet Engineering Task Force (IETF), a primary mover in Internet standards, making the Internet better is what drives them. Though a large part of the technical community does work for corporate entities, many have chosen their jobs in order to work on specific components, technologies or topic areas in which they have become experts and to which they have devoted the professional lives. For many, if not most, of the technical participants, technical "correctness" in some sense is far more important than the identity of their corporate sponsor or employer. One will often see employees of the same company at odds within technical standards organisation because loyalty to a technical standard is more important than loyalty to a company. At the same time, there is a growing awareness of, for instance, the way corporates may attempt to control and distort both research (in public institutes to which they donate) and technical input to policy (including standards). The fact that the scientists involved are not actively seeking to promote commercial interests does not necessarily 'sanitise' the efforts of these corporates with sometimes high commercial stakes.

For commercial enterprises, priorities are clear: they're where the greatest return is to be made. Especially for social enterprises, "return" may not be purely financial, but also involve perceived usefulness, social responsibility or policy influence. This does not mean that financial considerations are irrelevant; even social enterprises need to be able to make enough money to pay their suppliers, investors and personnel. This may come from end users paying for products and/or services, or other means such as public or civil society funding of developments that support society or specific interest groups. In addition, CSR are known to bring market rewards – not only do commercial profits support 'good deeds' but good deeds bring enhanced reputation and regulatory forbearance.

Social drivers

Social drivers for standardisation can be found in the trend towards increased communication and sharing of data and services via online means. As people are part of many networks, interoperability needs become high and co-determine the choice of technology interfaces and services. Another concern that is becoming more salient is the non-neutrality of tech standards. The Internet, its architectures and protocols, have been recognised for their ability to affect society, for better *and* for worse. Standards work is increasingly taking into account the potential of protocol and architecture standards to support or undermine human rights imperatives including civil and political rights, freedom of expression and of association and such economic, social and cultural rights of access to knowledge, participation in the life of the community, or the right to participate in government and free elections. One example of a social driver influencing standards is the consensus decision by the IETF to make security and encryption the default in their protocols in the light of pervasive surveillance.

Technology drivers

For many the primary drive for technical standards is to guarantee the stability and function of the Internet. A major component of this goal for technological standardisation is to enable interoperability amongst products and services. Standardisation of the Internet enables permissionless innovation of many applications, technologies and services that build upon existing infrastructures to deliver services – as a part of a larger system of services and/or directly to end users. In essence, standards facilitate evolution, by enabling small or localised innovations to function within larger systems and increase the competitive contact between firms.

Use of standards allows developers to develop and offer "things" that users can use, while at the same time making it easier for them to be replaced by something better if the current "thing" fails to deliver the quality needed or to keep pace with emerging needs or if better "things" come on the market. According to Patrik Fältström (Chair of ICANN's Security and Stability Advisory Council), security is not prioritised because time to market is such a major sales driver; rather than emerging from an extensive and prolonged testing process, products are put on the market to be tested in "real-life" circumstances much faster. Another reason why security is often set aside is that it requires extra code and testing, which increases capital expenditure and, usually, price for products. Often customers cannot not be convinced they need the extra overhead of security and thus balk at products with extra complexity and price.

Internet protocols often rely on step-wise refinement. First those proposing the standards need to show running code to get a standard accepted and often release their products with nonstandard and incomplete implementations motivated by the attempt to capture a new market. The process of standardisation then requires reaching consensus on a first version, which often means the original code and those first-to-market products, need to be changed to interoperate. Later as experience with the standardized protocol is gained, the protocol needs to be further refined.

While there is always an attempt to do this in a backwards-compatible manner, this is not always possible, sometimes requiring a large-scale update of protocols on the Internet. This can only work if older versions of a product, which implements the protocol, can be updated or replaced with updated products when needed. Standardisation is necessary for creating and improving interoperable products, but this also means that protocols, systems and products have to be implemented and deployed in a manner that makes update and evolution possible.

Economic Drivers

From an economic perspective, standardisation can be driven by the potential to capture scale, scope and network economies and to constrain abuses of market power without damaging efficiency and innovation. Standards also help to reduce uncertainty that limits both investment (e.g. in common infrastructures and general-purpose technologies) and innovation, by improving the chances that such investments, goods and services will rapidly become available to and used by, a critical mass of those on the network. Beyond this, standards have the effect of establishing and clarifying market boundaries, potentially improving both performance and regulation.

This openness and ease of switching come at a price; users may switch to compatible alternatives "too fast." This can produce three distinct kinds of harm:

- First, fixed costs may not be recovered and firms may be encouraged to concentrate on the features that drive switching (easily visible characteristics like cost) rather than those that produce the greatest value in the long run (e.g. quality, security or customisability).

- Second, easy switching may choke off less-obvious forms of value creation, for instance when users discover new ways to use products in their particular context or adjust their own processes and activities to the possibilities offered by products. This form of discovery takes time and will be lost if it is too easy to switch to a slightly-better, but incompatible, product before learning how to make much better use of the existing one.
- Finally, easy switching (e.g. between apps that share a standard), when the application interface (API) is not stable and backwards-compatible, is almost certain to weaken incentives to invest in, maintain and improve complementary "platforms" because

  a) it reduces the returns available to app developers that are shared with platform providers;

  b) it may constrain improvements to platforms that would require a change of app-level standards.

In the face of these risks developers and providers tend to develop proprietary standards that "lock in" users by creating "thresholds" that make it impossible, or at least painful, to switch towards using technologies from other providers. Further down the road, this strategy for creating and exploiting market power may evoke an inefficiently strong regulatory response and limit the potential of standardisation to provide a form of self- or co-regulation. One strategy sometimes used in developing products, is for a market leader or market disrupter, to first release products with a proprietary protocol and then to take that protocol to a standards body for acceptance. This allows a market leader or disrupter to gain a first to market advantage that can last for months or even several years.

Beyond this essentially static view of the economics of standards lie some interesting dynamic drivers. As new technologies are developed and new products offered, standards will have to adapt to support new requirements for access and new forms of interaction (including new limits driven by security, privacy, regulatory imperatives and economic considerations). Moreover, this "standards ecosystem" is itself evolving as individual and linked clusters of standards change, wither or converge.

Standards development in practice

For those that want to engage in standardisation at a global level, there are three key principles that are widely embraced as global good practice: openness, consensus and transparency:

1. Openness includes the participation of all interested parties affected by the technical specifications under development. It also requires that standards be available for implementation without significant expense or requirements from intellectual property owners. That is, not only must the process be open, but the standards themselves need to be open to avoid a closed market.
2. Consensus indicates that a decision-making process is collaborative and on an equal footing and does not favour any single stakeholder.
3. Transparency requires that information concerning technical discussions and decision making is available, archived and identified; information on new standardisation activities is publicly and widely announced; and participation of all relevant categories of interested party is sought

Permissionless innovation

In addition, there is the embrace of the principle of permissionless innovation: the ability of anyone to create new things on top of the communications constructs that we create. Most new applications in the Internet are the results of grass-roots innovation, start-ups and research labs. No permit had to be obtained, no new network had to be built and no commercial negotiation with other parties was needed; such was the case when, e.g., Facebook started. The easier we make the creation of these innovations, free of coordination and permission-asking, the faster new innovations find their way to users and into the market.

There is a trade-off with advantages of permissioned innovation e.g. patents:

1. timing – whether use of legacy IP is sought before or after innovations are developed, and whether rights to innovations are or can be acquired by the legacy rights-holder, who may be able to pay more both because of incumbency – superior market access - and because use of the innovation may increase market power and hence total profit;
2. externalities – permission-less innovators may be less sensitive to e.g. privacy, security and other non-market impacts compared to permissioned innovation when permission is granted by an entity responsible for those effects or a representative (like a regulator).

Open Standards

This is supported by implementation of the five principles of the OpenStand paradigm; co-operation (respecting the roles of different organisations); adherence to fundamental principles[7]; collective empowerment (for instance, choosing standards on technical merit and global interoperability to enable efficiency-enhancing global competition; availability (standards can be accessed and implementations built on a fair basis); and voluntary adoption.

The role of SDOs

Standards organisations can be classified by their role, position and the extent of their influence on the local, national, regional and global standardisation arena. They can also be categorized based on who holds the final decision, the technical community, industry or intergovernmental organisations.

By geographic designation, there are international, regional and national standards bodies. By technology or industry designation, there are standards developing organisations (SDOs) and standards setting organisations for specific purposes (SSOs), also known as consortia. Standards organisations may be governmental, or not. SDOs are, still today, often sector focused, whereas consortia are often more dynamic, set up for specific purposes (such as 5G).

Most SDOs have specific rules to facilitate development and coming to agreement or consensus on standards. In respect to standards related to the global internet infrastructure, the different SDOs often have responsibilities that focus on specific layers of the architecture, for example the World Wide

[7] Due process, broad consensus, transparency, balance and openness.

Web Consortium (W3C)[8] for the web, the Internet Engineering Task Force (IETF)[9] for the logical infrastructure such as the internet, transport and applications layers and organisations like the IEEE[10] for lower layer and physical connectivity.

The role of Governments

Government is not heavily involved in standards but generally leaves it up to industry to generate and control standards. Government is mainly interested in ensuring that processes, procedures and legislation exist that work for standards and (ideally) only step in when there is a need to protect the public interest and when standards are needed for legislative and other governmental purposes. In general, the role is minimalist and supportive rather than directive.

For instance: the UK Government is relatively active in the domain of ICT standard making. The British Standards Institution (BSI), recognised by the government as the UK's national standards body, covers part of the ICT area. The Government also sponsors research and liaises with SDOs at the standards policy level via ETSI's board, the ITU, the EU ICT Multi Stakeholder Platform (MSP) etc. The UK Government believes that targeted in-depth participation is needed to get the best results in standards making and recognizes that building up confidence is key to getting influence.

Governments want to make sure areas of public interest are covered, as generally industry does not invest in areas where there is no business case (i.e. profit opportunity). Governments also have a role in influencing other Governments to back standards at international meetings and in intergovernmental organizations, ranging from OECD to WTO to G20 and G7 meetings. Governments' primary participation in standardisation is often done through Intergovernmental Organizations like the International Telecommunication Union (ITU)[11] where they work in cooperation with industry.

No standard is ever neutral as trade off decisions are made that are often value laden. This is by definition so for standards that support regulation, yet likewise standards made to produce profit can't be neutral as it is created to produce advantage for one part of the industry over other parts.

EU perspective

Within the context of the Digital Single Market, the European Commission pursues a strategy of harmonisation of the European ICT industry through funding of joint research and innovation and its public procurement of ICT.

The EC does not have many enforcement/regulatory tools for standards development. The Public Procurement Directive 2014/24/EU provides rules for what and how standards are used. Article 42 of the Directive is important. The EC can only use European standards or national (Member State) standards.

[8] https://www.w3.org/
[9] http://ietf.org/about/
[10] http://www.ieee.org/about/index.html
[11] http://www.itu.int/en/about/Pages/default.aspx

Another document is the EU 1025/2012 Regulation which adheres to the WTO principles of coherence, openness, consensus, transparency, voluntary application, independence from special interest and efficiency and promotes Open Standards.

Within the EC there is an overall coherent framework for standardisation activity based on Regulation 1025/2012, COM (2016) 176, COM (2016) 357, the Rolling Plan for ICT Standardisation, the activities of the Multi-Stakeholder Platform on ICT standardisation and the recently established Joint Initiative on Standardisation.

US perspective

US government agencies play various roles, depending on their mission, e.g. as a technical contributor to standards development via e.g. NIST (where approximately 30% of the almost 1200 technical staff participate in the development of consensus standards), as an enforcement agency e.g., through the role of competition agencies or as a consumer of the standards, e.g. the Department of Defence. Federal government agencies' participation in private sector-led standards development activities is strongly encouraged by US Government policy (Office of Management and Budget Circular A-119) as federal agencies' participation ensures that SDOs are aware of government standards needs and federal agencies can contribute to the development of the standard to make it more suitable for their use.

The key objectives of the U.S. government for participating in standardisation activities is to ensure the development of standards that are timely, relevant and cost-effective that conform with regulatory, procurement and policy objectives. The government wants to ensure that standards and a standardisation system promote and sustain innovation and foster competition. By engaging in standards development and related activities the US government also looks to champion approaches that support growth and competitiveness, market access, non-discrimination, trade, technology, innovation and competition and that other countries live up to their international obligations relating to standards development and their use.

Standardisation in PICASSO focus

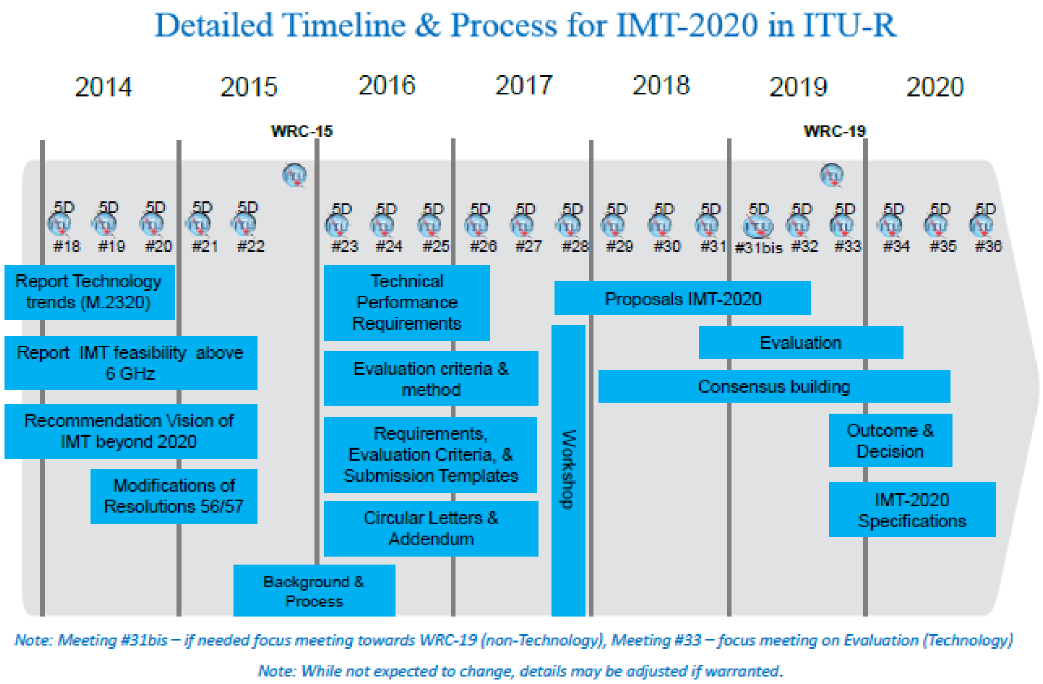
Within PICASSO, the focus is on 5G networks; Big Data; and the Internet of Things, specifically Cyber Physical Systems. From the background reflected above, we focus on these three domains, below.

5G networks

In early 2012, ITU-R embarked on a program to develop "IMT for 2020 and beyond," setting the stage for 5G research activities that are emerging around the world. Through the leading role of Working Party 5D, ITU's Radio Communication Sector establish the roadmap for the development of 5G mobile and the term that will apply to it: "IMT-2020" on October 26-30, 2015.

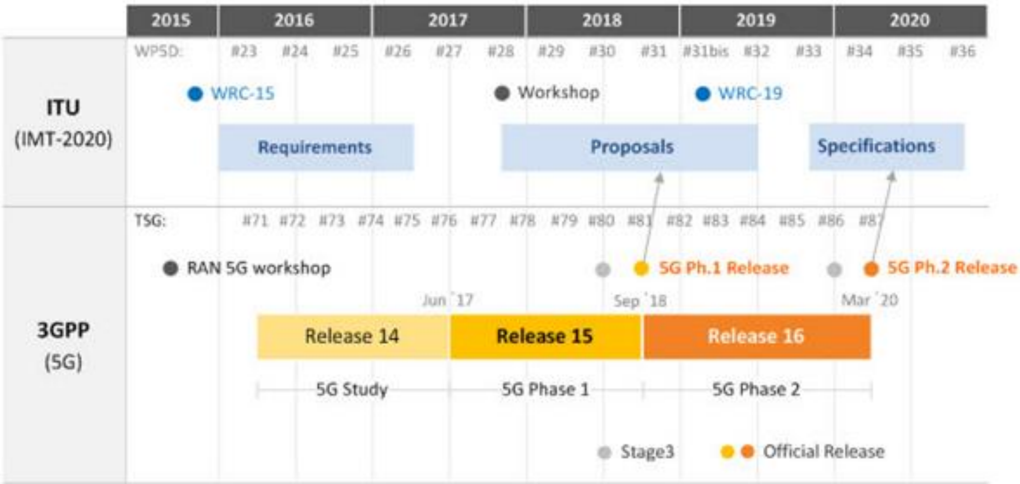
Based on reports on technical performance requirements and evaluation criteria and evaluation methods, ITU will start to receive proposals from late 2017 to mid-2019. At this point, ITU has agreed on key performance requirements for IMT-2020 on February 23, 2017. The final approval will be at ITU-R Study Group 5 next meeting in November 2017. All the submitted proposals will be evaluated by independent external evaluation groups. The definition of the new radio interfaces to be included in "IMT-2020" will take place from 2018-2020.

Detailed investigation of the key elements of 5G are already well underway, once again utilizing the highly successful partnership ITU-R has with the mobile broadband industry and the wide range of stakeholders in the 5G community.



Source: WRC

As one of the most important standardisation players, 3GPP set its roadmap and timeline of 5G standardisation in 2015. The target is to submit initial technology submission to ITU-R WP5D meeting #32, June 2019 and detailed specification submission to ITU-R WP5D meeting #36, October 2020. The study on scenarios and requirements for next generation access technologies was completed on December 2016. The study on channel model for frequency spectrum above 6 GHz was completed on June 2016. The study on new services and markets technology enabler was concluded on June 2016. The study on architecture and security for next generation system was completed on September 2016. The study new radio access technology is completed on June 2017. From the second half of 2017 to September 2018, 3GPP will start to work on "phase 1" 5G specification under release 15. The target is to address a more urgent subset of the commercial needs. It will focus on deploying lower frequency bands, as the higher frequency bands need to be approved in WRC-19. From September 2018 to March 2020, 3GPP will work on "phase 2" 5G specification under release 16. It aims for the IMT 2020 submission and to address all identified use cases & requirements.



Source: IEEE

The IEEE established a 5G initiative on December 2016. Currently it is working on its roadmap that it will announce in the autumn of this year. One important focus in the 5G initiative is standardisation. Under the IEEE 5G initiative umbrella, there are several highly important working groups, e.g., IEEE 802 LAN/MAN Standards Committee (where the first GBps broadband standard was made). In total, 6 IEEE society standards have joined the 5G initiative. The IEEE 5G initiative is expected to gradually play a bigger role when the roadmap is clear and different standard groups start to work towards it.

On an architectural level, the requirements are to virtualize the entire Radio Access Network (RAN) and Core Network (CN) infrastructure so that they can be as easy to deploy and scale as the data centres and other cloud infrastructure that have revolutionized the IT industry in the last few years. The main difference is that existing IT infrastructure concentrates on storage and compute virtualization. IETF will extend this to also support network virtualization, which has not been previously done in the IT industry, as only IETF has the mandate to change the IP protocols to support network virtualization.

An example of the standardisation efforts starting in IETF related to virtualization is the specification of the Service Function Chaining (SFC). SFC will allow dynamically linking of all the virtualized components of the 5G architecture, such as the base station, serving gateway and packet data gateway into one path. This is required because unlike previous generations, 5G processing components—called Virtual Network Functions (VNFs)—will be dynamically created in a cloud-like environment and so need to be dynamically linked together. The timeline for development and deployment is not clear.

End-user applications will be the commercial driver for 5G as it was for 3G/4G. In 5G, the application may be a virtual reality game running on a mobile phone. Or it may be a streaming HD video application running over each of a thousand security cameras covering a city shopping district. In most cases it is expected that these 5G applications will run over the HTTP protocol as nearly all applications that connect to the internet in a secure manner do today, or better yet on the emerging secure HTTPS protocol. Here again, important work needs to be done in improving the HTTPS protocol so it runs efficiently, easily and more securely in mobile environments.

Big Data

Big data promises to change the way we do business, management and science. It entails the scalable processing of huge amounts of data to draw conclusions and inferences on physical and technical phenomena, systems and human behaviours. There is a variety of data sources and volumes that could classify as big data, depending on the data types and application at hand. For example, 1 TB of data is considered small for gene sequencing in biomedicine (contains about 10 genomes), but it is considered huge when collecting sensor measurements in a field.

Additionally, there is a variety of data types, data storage models, data query languages, data access methods (accessing stored data offline, or accessing them in streaming mode before they are stored), data analysis and visualization methods.

There is broad consensus that, if we are to obtain the full potential from big data, outside of the realm of scientific research (where data intensive processing has been performed since many decades), the time has come for standardisation. Standardisation in big data aims to provide a common terminology, recommendations and requirements for data collection, visualization, analysis and storage. From several viewpoints standardisation is already happening, from the definition of large objects (LOBs), data storage models (XML, JSON, BSON), distributed query and analysis (e.g. map-reduce algorithms), big data compression (Anamorphic Stretch Transform), data query languages (SQL, SPARQL, XQuery) and languages for data analysis and visualization (R). Indeed, since big data processing contains several components, each of these can be studied separately and standardized processes can be derived as needed.

There are several challenges when viewing the Big Data ecosystem as a whole, or in specific applications. For example, the authors in [Chen, Min, Shiwen Mao and Yunhao Liu. "Big data: A survey." Mobile Networks and Applications 19.2 (2014): 171-209.] argue that an evaluation system of data quality and an evaluation standard/benchmark of data computing efficiency should be developed.

Many solutions of Big Data applications claim they can improve data processing and analysis capacities in all aspects, but there is still not a unified evaluation standard or benchmarks to balance the computing efficiency of Big Data with rigorous mathematical methods.

In addition, individual domains or scientific fields require their own standards; for example, Herbert et al. [Herbert KG, Wang JTL (2007) Biological data cleaning: a case study. Int J Inf Qual 1(1):60–82] proposed a framework called BIOAJAX to standardize biological data so as to conduct further computation and improve search quality.

Related standardisation bodies are the Cloud Security Alliance Big Data working group, the NIST public working group on big data ISO/IEC (International Organization for Standardisation and International Electrotechnical Commission). A small survey on standardisation in Big Data was done[12]. In 2015 the NIST Big Data Interoperability Framework was issued in seven volumes: Definitions, Big Data Taxonomies, Use Cases and General Requirements, Security and Privacy, Architectures White Paper Survey, Reference Architecture, Standards Roadmap.

[12] http://www.artezio.com/pressroom/blog/standardization-and-big-data

ISO/IEC began working on the standards in 2016. As a result, Joint Technical Committee ISO/IEC JTC 1, Information Technology developed the following standard: ISO/IEC CD 20546 – Information Technology – Big Data – Overview and Vocabulary. Besides, the committee outlined such standard as ISO/IEC TR 20547 Information Technology – Big Data Reference Architecture – Part 1: Framework and Application Process, Part 2: Use Cases and Derived Requirements.

In 2013 the ITU (International Telecommunication Union) first issued ITU-T Technology Watch Report under the title Big Data: Big Today, Normal Tomorrow and in 2015 the first recommendation known as ITU-T Y.3600 Big Data – Cloud Computing Based Requirements and Capabilities. This standard details the requirements, capabilities and uses of cloud-based Big Data, with an eye toward ensuring that its benefits can be achieved on a global scale. It also outlines how cloud computing systems can be leveraged to provide Big Data services.

The IEEE is also involved in standardisation, by launching the IEEE Big Data Initiative, with the aim to advance technologies that support and make sense of the growing mountains of data, but also to ensure that the information remains secure. Moreover, BDVA (Big Data Value Association[13]) is involved in initiatives aiming to produce value from data.

It is the private counterpart to European Commission's Big Data Value Public-Private Partnership, which aims at creating a functional Data Market and Data Economy in Europe, in order to allow Europe to play a leading role in Big Data in the global market.

Recently investigations have begun on the use of artificial intelligence techniques in visualising, interpretation and use of Big Data. The combined efforts in Big Data and in Artificial Intelligence have come to the attention of policy fora and can be expected to be the subject of future standardisation or regulation policies.

As one can view from the above, a number of initiatives related to Big Data standardisation is available worldwide, with more being created all the time. However, a joint EU-US standardisation coordination effort working on this subject, could fill in an existing large gap and bring both regions to the technological forefront.

Internet of Things/Cyber Physical Systems

Interoperability is a key challenge in the IoT and CPS domains in all of the application domains that we’ve analysed. While interoperability is often a technological challenge, standardisation is an important building block to achieve interoperability. This is also reinforced by the facts that a lack of interoperability is seen as a barrier for future IoT/CPS systems.

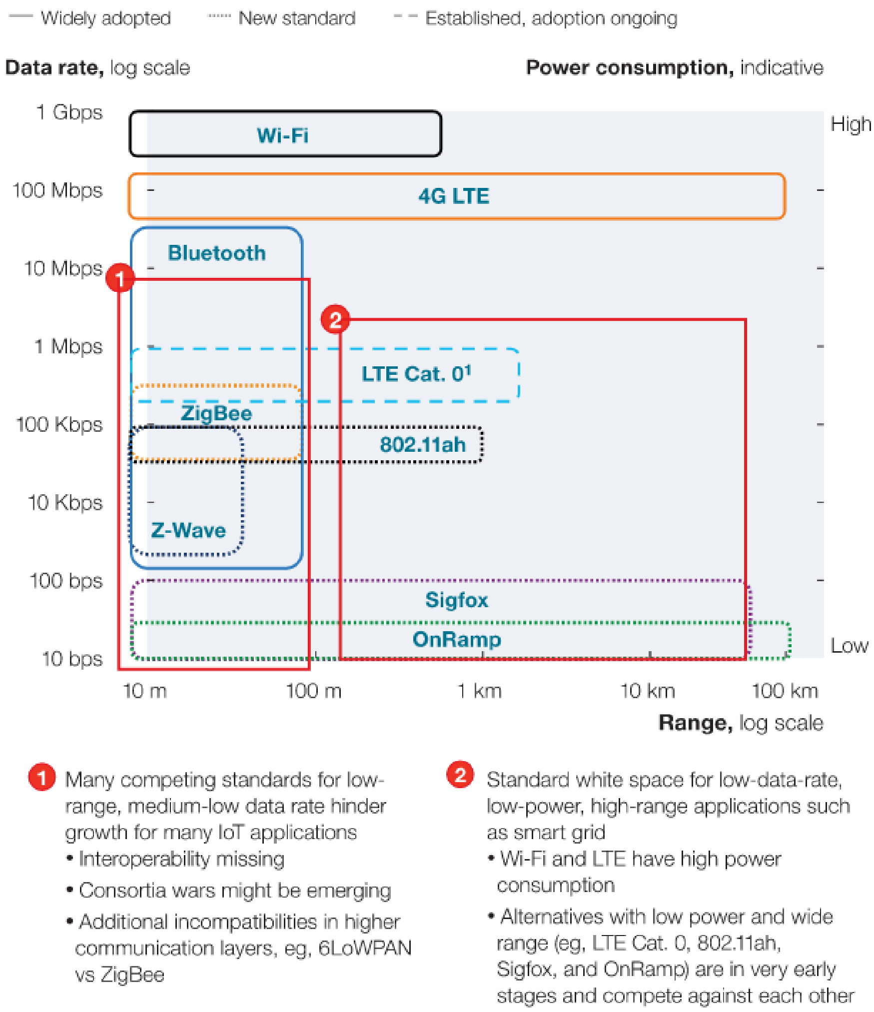
Production systems consist of thousands of (often proprietary) hardware and cyber components by a large number of manufacturers that should be integrated with each other and with legacy systems. This makes interoperability a key prerequisite for novel ICT technologies that will require global real-time access to all devices at the field and for automation levels.

Thus, challenges such as plug-and-play reconfiguration, zero-configuration integration of automation systems, real-time analytics and optimisation, monitoring and diagnostics, remote update and others

[13] http://www.bdva.eu

depend on the interoperability of technical systems. There is a need for companies to move away from proprietary solutions towards open interfaces and platforms.

The production of Industry 4.0 compatible automation products is seen as an opportunity for harmonisation within the industry and the expectation is that the cloud and the IoT will be used to connect smart components.



Source: McKinsey

Joint work on international standards and interoperability may be more feasible than close-to-market collaboration since it usually requires companies to release less sensitive IPR. PICASSO concluded in its Opportunity Report (D2.2) based on interviews and review of recently released strategic documents that (industry-driven) standardisation activities will gain importance in the next years, in particular in the quickly evolving IoT landscape and that international collaboration will be essential to ensure interoperability and successful integration of future large-scale infrastructures. Collaborative actions might either focus on pre-competitive R&I with a low-TRL (Technology Readiness Level) or on other efforts that do not require access to sensitive company-internal IP, such as increasing interoperability.

Many organisations are involved, in diverse ways and standards and activities are "cross-informed" as there is a big drive towards making things work together – more on some platforms (like the AIOTI in Europe) than others.[14]

Perspectives towards the future

A number of new developments will co-determine the role standards will play towards the future and the way they will be developed. It will also influence the types of standards that need to be developed. The following developments are expected to be key in this:

- Sharing economy – requires user convenience: interoperability related standards will be market driven, yet safety and quality standards may be rule driven. The term "sharing economy" is defined as "an economic system in which assets or services are shared between private individuals, either free or for a fee, typically by means of the Internet."[15] The sharing economy has surfaced and is grown significantly, ranging from sharing cars to bikes to power tools etc., with the clear leading examples the rapid emergence and growth of UBER and AirBnB. Many well-established industries have been transformed into new models built around this concept and approach towards consumption of goods and services. This fast-growing and constantly changing marketplace has prompted the need for the development of potential tools to help aid policy development and better protect users, consumers and industry alike – ICT standards are a key enabler in this.
- Technologies become invisible– require seamless interoperability. Ambient intelligence is an emerging discipline that brings intelligence to our everyday environments and makes those environments sensitive to people. Ambient intelligence (AmI) research builds upon advances in sensors and sensor networks, pervasive computing and artificial intelligence. Because these contributing fields have experienced tremendous growth in the last few years, AmI research has strengthened and expanded. Because AmI research is maturing, the resulting technologies promise to revolutionize daily human life by making people's surroundings flexible and adaptive. When intelligence gets embedded in our environments, moving around and interacting, it will require high levels of interoperability. It will also create privacy and surveillance liabilities.
- Blockchain – as a ledger without single owner. An issue is whether this facilitates secure interoperability. The Standards Australia report on the work of the Secretariat for ISO/TC 307 provides an overview of the effort to shape the future of international blockchain standards. Standards Australia's close collaboration with stakeholders and the standards development activities undertaken by ISO/TC 307[16] will be informed by the Roadmap for Blockchain Standards and the recommendations contained in that report. Priorities suggested in the report include:
  1. ISO/TC 307 should initially develop blockchain terminology standards as a means to clarify definitions in the sector and set a platform for the development of other related

[1414] An excellent overview of standardisation initiatives in the field of IoT can be found here https://www.postscapes.com/internet-of-things-protocols/

[15] Oxford Dictionary

[16] http://www.standards.org.au/OurOrganisation/News/Documents/Roadmap_for_Blockchain_Standards_report.pdf

blockchain standards. The standards for terminology could by developed in close coordination with the ISO/IEC committee JTC 1 SC 38 Cloud Computing and distributed platforms.

2. Privacy, security and identity issues are commonly sighted as concerns for most blockchain and DLT technologies. As such these issues can be addressed collectively through the development of one or a suite of standards under ISO/TC 307. These standards could be developed in association with ISO/IEC committee JTC 1 SC 27 IT Security techniques.
3. Governance and risk-related issues should also be addressed by ISO/TC 307 after the foundational standards for blockchain and DLT terminology. These standards could be developed with reference to existing ISO and ISO/IEC documents including ISO 31000 Risk management principles and guidelines and ISO/IEC 38500 Governance of IT for the organisation.
4. The development of standards for terminology, privacy, security, identity, risk, governance and other key issues relating to standards paves the way for the later development of a reference architecture standard for blockchain under ISO/TC 307. A reference architecture standard would provide stakeholders with a framework for developing and using blockchain and DLT. This should be considered as part of a future work program by ISO/TC 307.
5. Establishing interoperability amongst blockchain systems should be an overarching objective of ISO/TC 307. Standards for interoperability are more likely to be achieved after more fundamental matters are addressed such as the development of a consistent terminology and appropriate measures for managing privacy, security and identity.

- Artificial intelligence: will eventually be part of how our systems will help us manage the complexity and interactions. AI eventually will find its way in interacting with data, connected systems and other intelligence on the Internet. If any standards are to be set to ensure Artificial Intelligence is developing in ways we want, it is on standards such as “ethics” and embedding legal rules in systems. AI, especially in combination with Big Data and pervasive Internet of Things, can be used in a manner that threatens privacy and thus may be subject to governmental and Intergovernmental scrutiny that may result in regulatory frameworks.

These and other developments firmly indicate what we can learn from the past: the future, 10 years from now, will contain elements and characteristics that are currently beyond most imaginations. 10 years ago few thought data would be this abundant, mobile would provide so much functionality around the world and the Internet of Things would become embedded in our everyday lives.

Conclusions

Standardisation processes have changed dramatically over the last decades. Continuously increasing speed of R&I has grown to such a level that the traditional standardisation processes will not be able to keep up, speed wise. Convergence of use of components and technologies and services across sectors mean that standards can hardly be set per sector anymore. Markets becoming more global means that nationally oriented standardisation efforts are only useful when aligning with international developments. Industry is working in global networks and platforms and civil society if finding its way to the development tables. Standards are in many ways rapidly becoming “guidelines of good practice” rather than “strict rules to adhere to”.

Possible ways forward towards better collaboration would include on a general level:

- Letting go of the illusion of national policies striving for "competitiveness by exclusion": today, the industry goes global;
- Better use of IP for society and economy to benefit from new insights;
- Specifically for EU/US collaboration, considering both EU and US values – thus become relevant to multiple regions of the world.

It has become clear that 5G developments are very diverse across the world. Specifically for EU/US R&I collaboration, it seems that much of 5G development is already considered "commercial" in the US, whereas public money support for collaborative R&I is still available in Europe.

Big data goes global and needs to have global solutions, as well as adaptations to local laws. GDPR is an important driver in the generation of standards towards ensuring privacy of individuals.

IoT devices are used all over the world and data are exchanged between objects and aggregates in big data sets – sometimes by IoT ecosystems that have been set up to do this, at other times the collection and aggregation happens using big data techniques

At this point our conclusion is that also for EU/US collaboration it mostly makes sense to stimulate participation of sponsored research and innovation in global standardisation platforms, such as IETF, ITU, IEEE etc., rather than at regional level.

Towards the Summer of 2018, we intend to deliver a White Paper on policy issues such as privacy and data protection, security, standardisation and spectrum that are most relevant to technological and commercial development in the PICASSO domains and conversely to identify the aspects of such policies that are most likely to be affected by 5G, Big Data and IOT/CPS development. This PICASSO Policy Paper and the ones that follow will feed in to this White Paper, therefore we invite you to share any comments and suggestions relating to these policy papers with the PICASSO Policy Expert Group either in person during one of our meetings (workshops or webinars) or via email to the Chairman of the Policy Expert Group at maarten@gnksconsult.com.