European Trends in Standardization for Smart Cities and Society 5.0

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Abstract

In Japan, the trend towards Society 5.0 — the information society — has been identified. The digitalization of production, distribution and even consumption of goods and services creates value in the digital economy. The knowledge processing (including artificial intelligence and machine learning) that is needed for services, based on collection and combination of information from many different sources, requires that its metadata (quality of information, source, licensing and usage rights, including for personal/private information) is known. There are many hundreds of relevant standards and reference is made here to surveys. In the European standards group ETSI ISG CIM, an open API known as NGSI-LD is being developed for interchange of this information, and co-operations with many other standards bodies are helping achieve interoperability with IoT platforms, mobile Apps, legacy databases and linked open data systems.

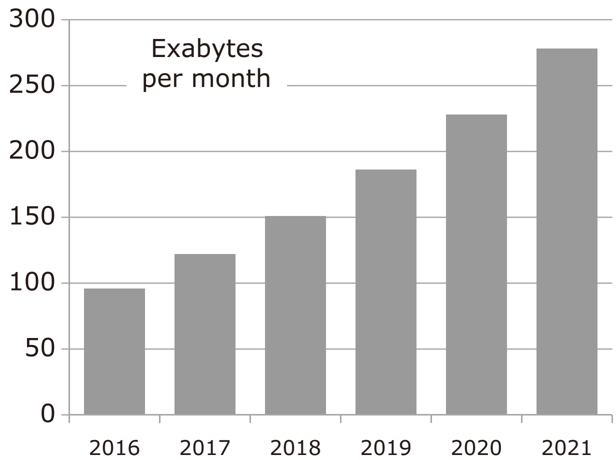
Keywords

Europe, Standardisation, ETSI, ITU-T, Smart Cities, Society 5.0, Semantic Interoperability, Context Information, NGSI-LD, API

1. Introduction – Trends in Digitization, Cities, Society

More and more economic value is generated and stored in the digital economy and services. Examples are everywhere. Manufacturing is evolving from just-in-time mass production towards point-of-sale customized production based on digital design (e.g. 3D printing[1]). Transportation is evolving from personally-owned cars or public-transport towards multi-modal transport and autonomous vehicles[2] which rely on digital modelling of the real-world. Analog signals for telecommunication were an absolute miracle of innovation when the first telephone was set up by A.G. Bell on 10th March 1876[3] and when chosen in 1898 as one of NEC's first products[4], but will likely disappear in our lifetimes, completely replaced by digital protocols. The rising tide (or tsunami?) of digital information is illustrated by the forecast in **Fig. 1** below indicating that global internet traffic is currently about 150 thousand petabytes per month and increasing.

Against this background, the Japanese government proposed in October 2017[6] that we should aim to exploit the innovations of the fourth industrial revolution (e.g. Internet-of-Things, big data, artificial intelligence, robotics and the sharing economy) to solve our social challenges (e.g. active-aging society, healthy society,



* Figure 1 is derived from data published in reference[5], courtesy of Cisco Systems, Inc. Unauthorized use not permitted.

Fig. 1 Trend in network traffic, Exabytes (1000 petabytes) per month for 2016-21.

inclusive society, smart cities, resilient economy).

Common standards and interoperable interfaces are essential for success. They reduce costs, enable successful ecosystems, facilitate innovation, enhance error-tracking, limit liability and preclude lock-in to the products and services of single suppliers.

The Society 5.0 will be an information society and access to information in smart cities will be as essential as access to water or air. NEC is strongly involved in co-creating the technologies and standards which will ensure the free flow of that "air" (information): internationally, in Europe and in Japan. This article focuses on Europe.

2. Segments of Standardization in the EU

Within Europe there are multiple layers and topics for standardization bodies, with various connections to government agencies which try to balance industry-driven activity with national or EU social goals.

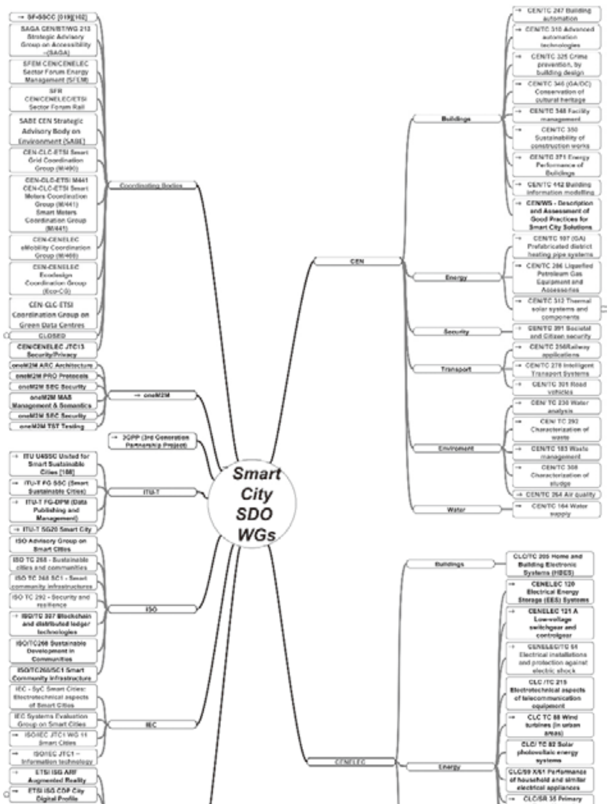
The three EU-wide standards developing organizations (ESOs) whose specifications are recognized for government procurement are CEN, CENELEC and ETSI. The organization CEN handles specifications related to international trading, the welfare of European citizens and the environment, CENELEC creates specifications focusing more on electro-technical areas, whereas ETSI focuses on specifications related to telecommunications. However, this separation of responsibilities has been disintegrating over the last decade, primarily due to the invasion of digitization into all aspects of the economy and life-style.

As examples of this overlap, when the European Commission recently (September 13th, 2017, see[7]) published a planning document for a European-wide cybersecurity certification and compliance scheme, all three ESOs responded immediately with their own critiques. In the case of digitalization of industrial processes, the European Commission was so concerned that proprietary and de-jure specifications were arising in such large numbers, at local and national and international level, that it initiated in early 2018 a special sub-committee MSP DEI of the Multi-Stakeholder Platform advisory group[8] to create by November an overview and recommendations for government action (see[9]). A NEC staff member was appointed by ETSI as its representative on this committee.

In the case of Smart Cities standards, all ESOs have various groups impacting the field: for example, CENELEC (similar to ISO) has high-level management guidelines and KPIs; CEN has environmental guidelines and measurement specifications, ETSI has IoT-related specifications. A special joint coordinating committee called SF-SSCC[10] has been set up to (at a minimum) map the overlapping work areas and specifications. NEC staff have been key contributors to its work, proposing methods to categorize the many different working groups impacting Smart Cites as shown in **Fig. 2**.

The drawing in Fig. 2 is part of a mindmap initiated by NEC as part of SF-SSCC work. Each branch of the drawing represents a different major standardization body, e.g. CEN, CENELEC, ETSI, oneM2M, ITU-T, ISO, IEC, all of them with (partially) overlapping work impacting Smart Cities. The mindmap activity provides links to hundreds of documents from many sources is reported in detail on the SF-SSCC website[10]. It is expected to continue to October this year, then be mainstreamed into an ongoing activity of the ESOs.

Such a detailed overview of standards is strongly



Excerpt from CEN-CENELEC-ETSI Sector Forum on Smart and Sustainable Cities and Communities[10]

Fig. 2 A partial overview of standardization organizations creating Smart City specifications.

needed, to avoid accidental duplication of effort and to assist Smart Cities in finding all relevant work. Obtaining an overview is practically impossible for individual experts or policy managers, as illustrated by the recent case when CEN created a group "CEN Workshop Good Practices for Smart City Solutions"[11)] but even many experts within CEN were not aware of its launch.

3. Prioritizing Smart City Standards

However, collecting and categorizing specifications and their responsible working groups is only the beginning. There are already so many hundreds of standards relevant to Smart Cities that the supreme need of policy managers and technical officers – expressed again and again in interviews and articles – is to get a top-down overview beginning with key issues and policy requirements, then the sub-categories of technology approaches which may be suitable, then the details of which specifications may apply, preferably selecting only the most relevant standards for their particular cities and use cases.

To help achieve such a prioritized view of useful standards for city managers, NEC co-founded at the beginning of 2018 the ETSI group ISG CDP (City Digital Profile[12)]). The initial difficulty was to achieve a paradigm switch, to analyse first what are the main goals and needs of the city managers and then what services and processes are needed and only then what technology choices are suitable and which standards apply. In most standards groups, unfortunately, first the technology is discussed, then there are discussions of how to apply it (even if that technology is not optimal for Smart City use cases).

It is acknowledged in ISG CDP that it is essential for Smart Cities to deploy horizontal platforms which can enable an initial use case (service) then be applied "cross-domain" to enable at low incremental investment more use cases in each city, as shown in **Fig. 3**. However, there is so far no guideline to policy choices such as: (a) which services first; (b) which sensor infrastructure to install first, but with flexible expansion; (c) which horizontal platform to allow easy expansion; (d) which platform APIs provide best interoperability (including with legacy systems).

4. Layers of Standardisation

Most analyses of platforms for Smart Cities or for Society 5.0 begin with the ISO seven-layer model. That can be simplified somewhat into five broader layers, as shown in **Fig. 4** (abbreviations are listed at the end of this article):

(1) Data Collection and Device Actuation Layer
(physical, link and network layers)
Technologies: LoRa, DECT ULE, 3GPP LTE, etc

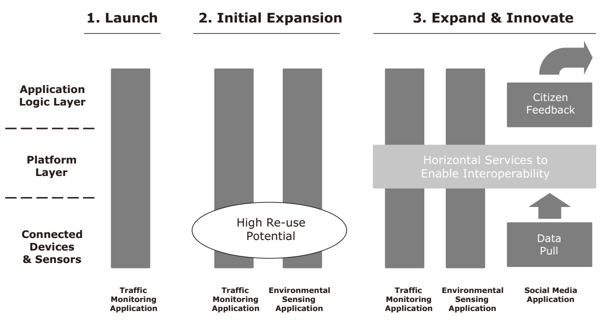
(2) Integration and Management Layer
(device detection and upgrades, data collection)
Technologies: MQTT, CoAP, oneM2M

(3) Information Access Layer
(align data using common definitions / vocabulary)
Technologies: OMA NGSI, ETSI ISG CIM (NGSI-LD)

(4) Knowledge Processing Layer
(integration of data into a real-world model, with plausibility checks, data analytics and artificial intelligence)

(5) Application Layer
(using domain-specific knowledge and services)
Technologies: applications for services like multi-modal transport planning, eHealth services integrating personal sensor and lifestyle information, citizen services access

At each layer there is an abstraction from details: for example the IoT standards developed by oneM2M[14)] for the "Integration and Management Layer" have the huge



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Source: The 4th Industrial Revolution and the Municipal CEO: ETSI City Digital Profile[13)]

Fig. 3 ETSI ISG CDP view of phased evolution of smart city initiatives.

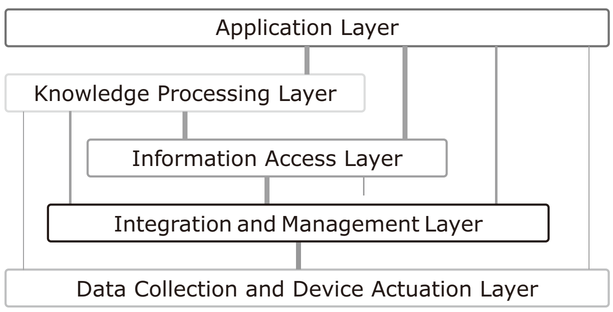

Fig. 4 Simplified Layered Architecture for Information Management.

advantage that they handle data collection independent of most device protocols. At the so-called "northbound" interface of oneM2M, which connects with the Information Access Layer, there is no need (and also much reduced possibility) to interact directly with the devices.

Similarly, the next layer, the information access layer, should provide a northbound interface to higher-level software, in the Knowledge Processing layer, such that the higher-layer software interacts only with the so-called "digital twin"[15] of the real-world objects which are connected i.e. there is no direct interaction of knowledge processing software with the sensors and actuators and databases which provide the status and historical information.

5. Successfully combining data from many sources, for reliable AI

Knowledge processing involves collection and combination of information (also known as context information) from many sources, as illustrated in **Fig. 5**. The current great difficulty is to develop a low-cost, flexible, scaleable system (shown by four arrow lines in Fig.5) for information exchange between legacy (e.g. SQL databases or even just file-servers), open data, IoT and user Apps systems, which is also able to preserve and exchange provenance and licensing information about the data.

Provenance information documents the source and quality (accuracy) of information, whereas licensing information documents the rights for using the information in different contexts, including for personal/private information. A key factor in successful A.I. is the ability to trace the source and accuracy of input information, for which the stringent attention to provenance and data quality is essential. Currently many companies spend large fractions of their data acquisition budgets on purchasing and "cleaning up" relevant data. Such an approach does not scale for Society 5.0.

NEC is working within two international bodies addressing these issues: (a) the ITU-T Focus Group on Data Publishing and Management to support IoT and Smart Cities & Communities[16]; (b) the ETSI Industry Specification Group for Context Information Management (ISG CIM)[17]. Indeed, NEC supplies managing staff to the ITU-T FG DPM committee and NEC was co-founder of ETSI ISG CIM. The author of this paper was twice elected as Chairman of that group.

The work in ISG CIM is culminating in an open API known as NGSI-LD API[18], which is scheduled for completion this year. A preliminary version is available for review. NGSI-LD API re-uses the JSON-LD protocol, which is already supported by many groups[19] for linking data. Similar topics are also under discussion within W3C Web-of-Things[20] and the Dublin Core[21] groups.

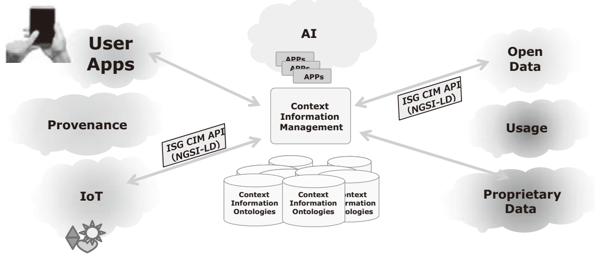

Fig. 5 The goal of NGSI-LD is interworking between six "silos" of context information.

The open source FIWARE Foundation[22] plans to implement NGSI-LD quickly within its suite of software. NEC supports the work of FIWARE Foundation through a Platinum Membership and provision of delegates for the Board and for the Technical Steering Committee.

6. NEC's Mission in Standardization

The above article discusses many aspects of standardization in Europe; but why is NEC supporting it so strongly? There are short term and long term reasons.

The short term reason is that the ICT industry follows a powerful paradigm of creative self-destruction based on standards and the self-reinforcing network effect[23]. Standards are necessary to enable interoperability at a given layer, enabling the N2 value-add for each additional node in an N-node network and providing so-called "points of interoperability" to the layer above. However, those same standards ensure the commoditization of the equipment using them: that is, when the major interactions of equipment are standardized, the only differentiator is price (plus reliability, performance or security, but these tend to be secondary to price in highly competitive businesses).

The result of commoditization is that sustainable profits are mainly available near the leading edge of innovation, which nowadays is always in software (including business models), and has reached the information and knowledge layers of Fig. 4. This is the chosen field of NEC.

As well as short term reasons, the long term reason to support European (and global) standardization is that only in this way can NEC ensure its mission[24].

7. Conclusions

The complexity and inter-relation between many IoT, Cloud and semantic technologies is threatening to overwhelm traditional standardization approaches, which historically tend to be vertical silos. The huge number of SDOs and alliances set up is very difficult to monitor, even for experts, and the traditional coordination approach based on 1-to-1 liaisons, which was satisfactory in the case of a few organizations, has not worked for today's much larger number of bodies.

The traditional approach of "modularising" some aspects (layers) to hide complexity can still be used, but additional coordination is needed at each higher layer, as is recognized by the formation of such groups as SF-SSCC, ITU-T DPM, ETSI ISG CIM and others.

Creation of Society 5.0 will require significantly increased commitment to transparency and inter-connection of information resources, not only within the many standardization groups, but from the people and companies which create and implement the solutions.

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