IEEE 802.24
Vertical Applications TAG

Project	IEEE 802.24 Vertical Applications Technical Advisory Group
Title	Internet of Things (IoT) – Overview White Paper Draft
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Abstract	IoT in respect of IEEE 802
Purpose	IoT overview and find gaps that falls in the scope of IEEE 802
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Introduction

The Internet of Thing (IoT) is already reality. Even if the needed architectural framework is not ready in 2015, the market adopted IoT in his fundamental idea: bringing together the historical separated verticals so that the compatibility level between the things historically independently developed are in the future of a higher compatibility and with that usable in more application domains.

The sweeping convergence of technologies, markets, applications, and the Internet through the IEEE Future Directions Internet of Things (IoT) Initiative is the driving force.

1 Scope

This white paper provides overview of Internet of Thinks (IoT) activities that are ongoing and potential missing activities that are in scope of IEEE 802.

2 Normative References

NA

3 Definitions, acronyms

3.1 Definitions

3.2 Acronyms

4 Overview of standardization groups for IoT

4.1 Landscape of standardization groups for IoT

Subclause 4.1 briefly introduces main IoT initiatives of Standards Development Organizations (SDO) and Consortia or Alliances that have a worldwide visibility and applicability. Figure 1 shows the initiatives ordered as follows.

– The SDOs can be split in international standards bodies recognized by the world trade organization or by the SDOs with a general agreement to be recognized as an international standards body.

– An alternate method using open source to attract an approach is providing open source.

– Some SDOs and Consortia or Alliances explicitly say that they are doing promotion for IoT and coordinating standardization efforts without writing a standard.

– As IoT should cover cross domains, also new activities in some application domains are important as they could be participating in the IoT initiative with a limited scope, but under the umbrella of IoT.

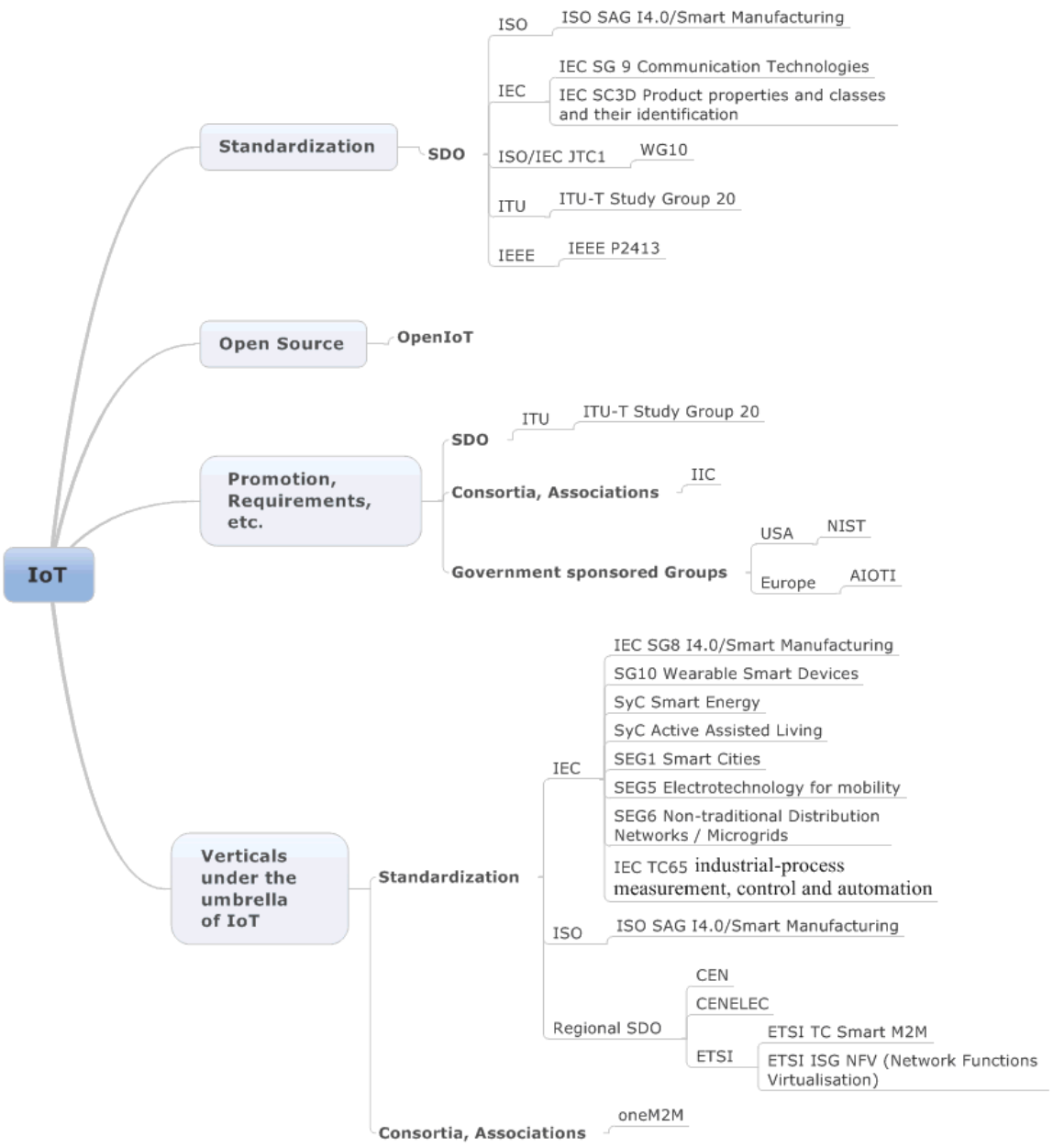

Figure 1 – IoT landscape

4.2 Description of the initiatives

4.2.1 Standardization

4.2.1.1 ISO

4.2.1.1.1 ISO SAG I4.0/Smart Manufacturing

4.2.1.2 IEC

4.2.1.2.1 IEC SG 9 Communication Technologies

4.2.1.2.2 IEC SC3D Product properties and classes and their identification

4.2.1.3 ISO/IEC JTC1

4.2.1.3.1 WG10

4.2.1.4 ITU

4.2.1.4.1 ITU-T Study Group 20

4.2.1.5 IEEE

4.2.1.6 IEEE P2413

4.2.2 Open Source

4.2.2.1 OpenIoT

4.2.3 Promotion, Requirements, etc.

4.2.3.1 SDO

4.2.3.1.1 ITU

4.2.3.1.1.1 ITU-T Study Group 20

4.2.4 Consortia, Associations

4.2.4.1 IIC

4.2.5 Government sponsored Groups

4.2.5.1 USA

4.2.5.1.1 NIST

4.2.5.2 Europe

4.2.5.2.1 AIOTI

4.2.6 Verticals under the umbrella of IoT

4.2.6.1 Standardization

4.2.6.1.1 IEC

4.2.6.1.1.1 IEC SG8 I4.0/Smart Manufacturing

4.2.6.1.1.2 SG10 Wearable Smart Devices

4.2.6.1.1.3 SyC Smart Energy

4.2.6.1.1.4 SyC Active Assisted Living

4.2.6.1.1.5 SEG1 Smart Cities

4.2.6.1.1.6 SEG5 Electrotechnology for mobility

4.2.6.1.1.7 SEG6 Non-traditional Distribution Networks / Microgrids

4.2.6.1.1.8 IEC TC65 industrial-process measurement, control and automation

4.2.6.1.2 ISO

4.2.6.1.2.1 ISO SAG I4.0/Smart Manufacturing

4.2.6.1.3 Regional SDO

4.2.6.1.3.1 CEN

4.2.6.1.3.2 CENELEC

4.2.6.1.3.3 ETSI

4.2.6.1.3.3.1 ETSI TC Smart M2M

4.2.6.1.3.3.2 ETSI ISG NFV (Network Functions Virtualisation)

4.2.6.2 Consortia, Associations

4.2.6.2.1 oneM2M

4.3 Liaison

4.3.1 IEEE P2413

Established Liaison to

– IEEE 802.24
– IEC SG8
– IIC

4.3.2 IEEE 802.24

Established Liaison to

– IEEE 802.24

4.3.3 IEC SG8

Established Liaison to

– IEEE 802.24
– ISO SAG I4.0/Smart Manufacturing
– ISO/IEC JTC1/WG10

5 Activities in IEEE 802 related to IoT

As a general statement, most all networking technologies have potential use somewhere in the Internet of Things including all those developed in IEEE 802.

Beyond that, 802 has (and continues) to work on several projects seeking to address specific IoT problems/needs in an optimal way.

While IoT is most strongly associated with wireless communications, wired is a also an essential component.

The following text highlights a few of both in 802.

The whole of any networking solution can't work without a core infrastructure any more than leaves can work without the branches and trunk of the tree under them.

Wired (i.e. copper and fiber) infrastructure, be it twig or trunk is an essential element of IoT as a system. 802.3 is dedicated to providing that core infrastructure.

802.1 is working on a local addressing project (802c) to deal with scaling to much larger numbers of ports to handle the expected large numbers of things.

802.1 is also working on Privacy issues (802E)-- specifically looking at Privacy concerns applicable to Internet protocols and IoT, and will be providing suggestions on how IEEE can help address them.

The 802E work is also relevant to projects like 802c (local address usage) and to new groups that are starting to take privacy recommendations into account for defining requirements of new wireless technologies for IoT

802.3 is working on single pair systems to provide lower cost wired connections for IoT especially for things on vehicle platforms.

From a legacy perspective, 802.3 has defined Power over Ethernet (PoE) and Power over Data Links (PoDL, pronounced "poodle") for single pair, both of which are useful for powering things in a wired IoT The P802.3bt DTE Power via MDI over 4-Pair will provide at least 49 Watts. For example, LED lighting can get both power and control over the Ethernet.

Additionally, 802.3 provides the backbone infrastructure for the Internet including IoT the (ever improving) wired connections for end stations the main method to avoid the security and spectrum utilization issues of wireless IoT connections.

802.11ah is intended specifically to address IoT “sensor” like devices. Areas of optimization include:

– Operating in the 900 MHz frequency band, it achieves longer range, but provides relatively low data rates suitable for IoT
– Achieving enhanced power-savings based on better coordination between AP and sensor device.
– Efficiently supporting short data exchanges since data exchanges in an IoT network are typically short.
– Operating efficiently when there is a large imbalance between AP and non-AP device transmit power and receive sensitivity.

Additionally there is a “Long-range, Low-power” initiative in 802.11 (currently in its very early days):

– Will look to extend the range and reduce power consumption, both of which are important for IoT devices
– It is too early to know what technical approaches will be used, but it is likely to be an optional feature added to 802.11ax, which will be the next “must have” release (i.e. after 802.11ac).
– Will likely build on the OFDMA features of 802.11ax to provide long range and low power using narrow channels and other PHY techniques.

802.15.4 was developed specifically for IoT. It provides:

– A very low energy per payload bit ratio (ie very battery or harvested energy friendly)
– Data rates appropriate for IoT rather than streaming HD video
– Very low cost to implement as a consequence
– Support for easy mesh networking
– Support for location based services
– Widely adopted by multiple IoT centric Industry Groups such as Thread, Wi-SUN, and ZigBee

802.15.7 is a standard for Optical Wireless Communications. It provides a simple secure non RF method for Things to communicate, particularly mobile devices.

802.15.10 Layer 2 Routing. It provides an integrated layer 2 method to mesh network in 15.4, essential for large scale self organizing IoT networks.

Plus many more targeted IoT optimization projects

802.16 is crafting a proposal to apply the 4G WirelessMAN-OFDMA standard to narrowband applications relevant to smart grid and other utility IoT applications.

IEEE 802 and IETF are collaborating on Internet Privacy. With new technologies showing up (e.g. IoT, wearables, etc.), users will become more prone to privacy attacks. Privacy concerns are therefore more and more relevant when defining new technologies and regulations to protect users of these new technologies. Goal of this collaboration is to make the Internet more secure and protect users against criminal, commercial or national entities performing illegal or privacy-unfriendly practices.

This is just the tip of the iceberg in a large body of IoT applicable networking work ongoing in IEEE 802.

Bottom line: In addition to what it has already done and continues to do, IEEE 802 is highly responsive to the market and will efficiently produce high quality technical specs in response to IoT market drivers.

6 Gaps, proposed new work

7 Compatibility levels

The wide range of application domains in which IoT systems are deployed and the increasing number of IoT developers and equipment manufacturers requires a higher level of compatibility as before in a smaller ecosystem.

If combining IoT systems from different manufacturers/domains into larger systems up to a "systems of systems", then it is needed to define the compatibility levels. The related context and semantic requirements are described in IEC 61804-2 and also in a subset in IEEE P2413.

There are certain levels of compatibility when devices have to cooperate together. Especially when the IoT devices have to be applicable in different application domains, so that no implicit specified context and sematic can be assumed. The levels are dependent on well-defined communication and application features, see Figure 1.

Needed feature	Compatibility level					
	Incompatible	Coexistent	Interconnectable	Interworkable	Interoperable	Interchangeable
Dynamic performance						x
Application functionality					x	x
Parameter semantics					x	x
Data types Data Access				x	x	x
Communication interface			x	x	x	x
Communication protocol		x	x	x	x	x

Figure 1— Levels of device compatibility

NOTE—This figure and the used terms are copied from IEC 61804-2 **Error! Reference source not found.**. The same figure and terms are also used in IEC TR 62390 **Error! Reference source not found.**

Interoperability requires Semantic and context knowledge. Interoperability with this requirement is the basis requirement for IoT devices. In some application domains like process automation it is even required to provide interchangeable devices from different vendors. The interchangeable devices do not need any parameterization before an interchangeable device replaces another device. The parameters of the replaced device can be used for the interchangeable device without an alteration. This is not required for IoT devices. This feature is a domain specific feature.

Context and Semantic

One of the impediments to a development of interoperable IoT systems is the lack of a common language and understanding of IoT. It is desired that this document will foster both. Standard organization are a "common-denominator" addressee for such an approach.

Context and semantic of things becomes the most crucial issue to use IoT devices in different application domains. In the worldwide IoT a real thing shall be uniquely identified. The characterization of things shall follow the Property Principle (PP) which postulates that each thing shall have

— an unique standardized identifier (ID);

— a semantically standardized name;

— a standardized data format with a description of the context and semantic for its value.

NOTE—A lot of International Standards (or drafts) of IEC, ISO and IEEE invented by Industrial Automation domain may be the basis for the future IoT devices. The context and sematic description for industrial automation devices is specified in IEC 62769 **Error! Reference source not found.**.