# Chapter 48
# Converging Technologies for the IoT:
## Standardization Activities and Frameworks

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## ABSTRACT

*The Internet of Things (IoT) is the concept of linking various objects to the Internet that sense/acquire and transmit data in the environment to create a new application. From a standardization perspective, the IoT can be viewed as a global infrastructure, enabling advanced services by interconnecting (physical and virtual) objects based on evolving interoperable information and communication technologies (ICT). The success of the IoT will depend strongly on the existence and effective operation of global standards. The standardization initiative, research projects, national initiatives and industrial activities are outlined in this chapter. There are already many standardization activities related to the IoT, covering broad research areas: wireless and cellular technologies, networking protocols, emerging applications, media-centric IoT. What is needed, therefore, are a harmonization of standards and effective frameworks for large-scale deployment.*

## INTRODUCTION

The Internet of Things (IoT) is a global network of connected people and devices which is enabled by converging technology, sensors, connectivity, APIs, and more. The IoT ecosystem include 6.4 billion connected things in use worldwide in 2016, a 30 percent increase since 2015, and will reach 20.8 billion by 2020 (Gartner, 2015; Cisco, 2015; Intel 2016). In 2016, 5.5 million new things will get connected

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every day. The IoT support total services spending of $235 billion in 2016, a 22 percent increase since 2015. Services are dominated by the professional category (in which businesses contract external providers in order to design, install and operate IoT systems), however connectivity services (through communications service providers) and consumer services grow at a faster pace. Consumer impacts include convenience, life optimization, personal data collection and efficiency. However, IoT is a large area that needs segmentation to be meaningful and effectively deployed. The major applications and deployment scenarios for IoT are smart transportation, agriculture, smart cities, buildings, rural areas, energy and smart grid, healthcare and wellbeing.

The fundamental concept behind IoT is connecting (Figure 1) the vast majority of systems to a common network and infrastructure (IEEE, 2015; Gardasevic et al., 2017):

- **Interconnectivity:** With regard to the IoT, anything can be interconnected with the global information and communication infrastructure.
- **Things-Related Services:** The IoT is capable of providing things-related services within the limitations of things, such as privacy protection and semantic consistency between physical things and their associated virtual things. In order to provide thing-related services within the limitations of things, both the technologies in the physical world and the information world have to change.
- **Heterogeneity:** The devices in the IoT are heterogeneous as based on different hardware platforms and networks. They can interact with other devices or service platforms through different networks.
- **Dynamic Changes:** The state of the devices changes dynamically, e.g., sleeping and waking up, connected and/or disconnected as well as the context of the devices including location and speed. Moreover, the number of devices can change dynamically.
- **Enormous Scale:** The number of devices that need to be managed and that communicate with each other will be at least an order of magnitude larger than the devices connected to the current Internet. The ratio of communication triggered by the devices as compared to communication triggered by humans will noticeably shift towards device-triggered communication. Even more crucial will be the management of the data generated and its interpretation for application purposes. This relates to the semantics of data, as well as efficient data handling.

The characteristics of the IoT are as follows:

- Event-Driven Architecture (based on the context of processes and operations).
- Ambient Intelligence (autonomous and intelligent entities).
- IoT Complex System (due to the huge number of different links/interactions between autonomous actors).
- Semantic Interoperability (IoT objects will be able to understand each other through semantic interoperability - different stakeholders can access and interpret the data unambiguously).

Although many organizations work on the standardization process, the authors focus in this chapter on those that work on the IoT and provide a definition for it. Accordingly, we considered the IoT World Forum (IOTWF), International Telecommunication Union (ITU), Internet Engineering Task Force (IETF) and the Institute of Electrical and Electronics Engineers (IEEE). This chapter is organized as follows: