

# Chapter 16

## Internet of Things Applications: Current and Future Development

**Mahmoud Elkhodr**

*Western Sydney University, Australia*

**Syed Shahrestani**

*Western Sydney University, Australia*

**Hon Cheung**

*University of Western Sydney, Australia*

### **ABSTRACT**

*The Internet of Things (IoT) brings connectivity to about every objects found in the physical space. It extends connectivity not only to computer and mobile devices but also to everyday objects. From connected fridges, cars and cities, the IoT creates opportunities in numerous domains. This chapter briefly surveys some IoT applications and the impact the IoT could have on societies. It shows how the various application of the IoT enhances the overall quality of life and reduces management and costs in various sectors.*

### **INTRODUCTION**

The Internet of Things (IoT) is the future of the Internet. It provides societies, communities, governments, and individuals with the opportunity to connect and obtain services over the Internet wherever they are and whenever they want. The IoT enhances communications on the Internet among not only people, but also things. The IoT introduces a new concept of communications which extends the existent interactions between human and computer's applications to things. Things are objects of the physical world (physical things) or of the information world (virtual things). Things are capable of being identified and integrated into the communication networks. Physical things such as industrial robots, products and electrical equipment, are capable of being sensed, actuated and connected to the Internet. More specifically, a physical thing can be described as a physical object equipped with a device that provides the capability of connecting this physical object to the Internet. The International Telecommunication Union (ITU) defines a device in the IoT as a piece of equipment with the mandatory capabilities of communications,

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and the optional advanced capabilities of sensing and actuating (ITU, 2005). On the other hand, virtual things are not necessarily physical or tangible objects. They can exist without any association with a physical thing. Examples of virtual things are multimedia contents (Francesco, Li, Raj, & Das, 2012), and web services which are capable of being stored, processed, shared and accessed over the Internet. Notwithstanding this, a virtual thing may be used as a representation of a physical thing as well. For instance, most of today's computer databases and applications use some sort of virtual representation of physical entities i.e. the use of objects or classes in object oriented programming approaches (Rumbaugh, Blaha, Premerlani, Eddy, & Lorensen, 1991). Therefore, communications in the IoT can occur between not only the users and things, but also exclusively between things. This includes "physical things" to "physical things" communications, "virtual things" to "virtual things" communications, and "physical things" to "virtual things" communications. This heterogeneity of communications extends computation and connectivity on the Internet to anything, anyplace and anytime. As a result, the IoT is expected to be seen everywhere and in numerous application domains, such as manufacturing, smart cities, agriculture and breeding, environmental management, smart homes, and in a variety of service sectors among many others.

From a networking perspective, the IoT can be described as a heterogeneous network that combines together several wired and wireless networks, including low-power wireless networks and personal area networks, with an increasingly complex structure (Elkhodr, Shahrestani, & Cheung, 2014). This heterogeneous network connects a mixture of devices together. It encompasses devices which connect to the Internet using various types of wireless and LAN technologies such as Wi-Fi, RFID, ZigBee, Bluetooth, and 3G or 4G technologies among other evolving communication technologies.

The term IoT, while it may sound odd, was first coined in 1999 by the founders of the original MIT Auto-ID Center Kevin Ashton (Ashton, 22 July 2009). Auto-ID refers to any broad class of identification technologies used in the industry to automate, reduce errors, and increase efficiency. These technologies include barcodes, smart cards, sensors, voice recognition, and biometrics. Therefore, the initial vision of the IoT was to tag physical objects, using RFID tags, and to uniquely identify these objects using RFID transponders or readers. RFID technology has enabled users to identify and track objects within a relatively small networked environment e.g. within a warehouse. As Neil Gershenfield noted as early as 2000, the cost of individual RFID tags had dropped below a one cent, making their adoption within diverse business areas not just technically possible but economically feasible as well (Neil, 2000).

Nowadays, the IoT has grown from RFID tags to a global infrastructure of connected things. The current advance in technologies has extended the vision of the IoT by encompassing other technologies such as sensor networks. The IoT has now more potential to provide an intelligent platform for the collaborations of distributed things via local-area wireless and wired networks, and/or via a wide-area of heterogeneous and interconnected networks such as the Internet. This is inspired by not only the success of RFID technology, but by the advance of wireless communication technologies and their wide range and low-power consumption capabilities.

Consequently, the availability of information coming from non-traditional computer devices in the digital world will, in great parts, lead to improving the quality of life. If the IoT spreads to all sectors of the daily life, then information technology would be taken to a whole new level. Over the next couple of years, it is predicted that the industrial value of the Internet of Things will surpass that of the Internet 30 times over, and to be a market that is worth more than \$100 billion dollars (Clendenin, 2010). On the other hand, it is estimated that there will be more than 20 billion devices connected to the Internet by 2020 (Lomas, 2009). The number of connected devices rises to over 50 billion as predicted by Cisco (Evans, 2012).

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