Chapter 17
Internet of Things Using Software–Defined Network and Cognitive Radio Network

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ABSTRACT

Internet of things (IoT) is a new area of advanced networking where things or devices share information among each other though collected sensor data and perform tasks together. This chapter is a detailed description of IoT and its architecture, challenges, security, applications, and future scope. Since the devices are heterogeneous in nature, middleware are used for giving them a platform to communicate in homogeneous manner. Service requirement of IoT middleware is discussed further in the chapter. Furthermore, recent technologies integrated with IoT like software-defined networks and cognitive radios are a part of this chapter.

INTRODUCTION TO IOT

Internet of Things or IoT is a complex network wherein machines and objects are connected through the internet. IDC has predicted that IoT will be expanded to 212 billion devices globally till 2020. The technical report on Cluster of European research projects on the Internet of Things define the 'Things' active entities in social processes, business, and information systems which have the interaction and communication among themselves. They also exchange data and information with the environment by autonomous reaction to the events happening in physical world with or without human intervention.

Wireless communication has come up so far that enabled the joining of things and making communication possible among them through Internet as discussed in paper of Gil, R. (2014). Cellular communication that is happening use licensed frequency bands provided by Federal communication commission (FCC) – US and Conference of postal and telecommunication administration (CEPT)- Europe. Radio

waves propagate better especially inside buildings and hence, is being used for communication widely. Unlicensed bands are provided to ISM (Industrial, Scientific and Management applications) that vary from country to country. 433 MHz, 868 MHz, 915 MHz and 2.4 GHz are the unlicensed bands used popularly for wireless communication. 2.4 GHz is widely used in all regions due to its high throughput and serve large networks.

Devices connected with internet have to use TCP/IP protocol stack to be able to exchange data but if devices are connected in local network can use non-IP. Local network would then be connected to internet through Gateways. The use of IP provides flexibility and devices can add or remove applications without changing anything in home network. Local network is formed only for one specific application. Let us take the example of fire alarm system which uses the wireless sensors to form a local network with one function that sends the activation message to temperature controller. However, if the message has to be relayed through controller then the phone would be connected to TCP/IP.

The design complexity and huge size of TCP/IP stack poses the disadvantage as bigger data packets lead to more power consumption in data transmission. These reasons promote the design of proprietary protocols for communication by local networks. The wide range development of wireless network processors and wireless microcontrollers (WMCU's) has reduced the complexity of TCP/IP to make it more attractive. So there are high chances that proprietary protocols would be replaced by TCP/IP in future.

Proprietary protocol use lower ISM frequency bands and are referred to as Sub-1 GHz solutions. Proprietary NAN is created to relay meter reading. The security system, industrial control and monitoring etc. are the other popular applications developed on propriety protocols. To connect to the IOT, Sub-1 GHz systems need the application layer internet gateway. Internet of Things (IoT) may also be implemented on wired networks but drawbacks like cable cost and space complexity makes wireless communication a better option.

Popular wireless technologies that can be used in IOT are:

- **Bluetooth:** It can act as gateway in IoT application.
- **Zigbee:** It is based on IEEE 802.15.4 link layer standard, low power and low cost technology. It requires application level gateway to connect to IoT.
- **Wi-Fi:** This has been a major barrier for IoT due to its complexity and high power consumption.

Therefore, the type of wireless technology to be used will be decided according to IoT application.

ELEMENTS OF IOT

- **RFID:** This is a technology which enables making of microchips which support wireless data communication. As an electronic barcode is on things to identify it uniquely, this helps in identification automatically. Two types of RFID: In *Passive RFID* power does not come from battery but it comes from interrogation signals when reader tells the id to RFID. In *Active RFID* Power is generated by its battery and starts the communication automatically.
- **Wireless Sensor Network (WSN):** It is an efficient network comprising of low power, low cost sensor nodes communicating wirelessly. The components of WSN are:
- Hardware: Sensor node which consist of sensor, preprocessing unit and a battery for power.

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