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Heterogeneous Device Communication Models and Data Management in IoT

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ABSTRACT

Internet of Things is a platform where devices become smarter, processing becomes intelligent, and communication becomes informative. Internet of things (IoT) is a combination of spatially distributed smart objects which have sensing capabilities and embedded identification through RFID technology.IoT devices are highly heterogeneous in terms of underlying communication protocols, data formats, and technologies. One IoT device connects to another to transmit information using Internet transfer protocols. Communication between heterogeneous devices can occur securely and reliably.IoT platforms serve as the bridge between the devices' sensors and the data networks. The Internet of things requires huge scalability in the network space to handle the surge of devices. In this paper, described some widely adopted technologies and standards for IoT networking. I also explain when you might want to choose one network protocol over another. I then discuss key considerations and challenges that are related to networking within IoT, including range, bandwidth, power usage, intermittent connectivity, interoperability, and security.

Keywords: Internet of Things, Heterogeneous Device Communication Models, IOT Data Management. IOT Networking Technologies.

I. INTRODUCTION

The Internet of Things refers to the ever-growing network of physical objects that feature an IP address for internet connectivity, and the communication that occurs between these objects and other Internet-enabled devices and systems. Internet of Things (IoT) refers to a group of smart devices connected over a common network which can improve the quality of our lives via automation [2]. The internet of things (IoT) is the internetworking of physical devices, vehicles (also referred to as "connected devices" and "smart devices"), buildings and other items embedded with electronics, software, sensors, actuators, and network connectivity that enable these objects to collect and exchange data. The IoT refers to the connection of devices (other than typical fare such as computers and smart phones) to the Internet [4]. The Internet of Things (IoT) is defined as a paradigm in which objects equipped with sensors, actuators, and processors communicate with each other to serve a meaningful purpose. The phrase "Internet of Things" which is also shortly well-known as IoT is coined from the two words i.e. the first word is "Internet" and the second word is "Things"[8].The Internet of Things(IoT) is the latest Internet evolution that incorporates billions of Internet connected devices that range from cameras,sensors,RFIDs,smart phones, and wearables,to smart meters, vehicle medication pills, signs and industrial machines[1]. The IoT allows object to be sensed or controlled remotely across existing network infrastructure, creating opportunities for more direct integration of the physical world into computer-based systems, and resulting in improved efficiency, accuracy and economic benefit in addition to reduced human intervention [5]. When IoT is augmented with sensors and actuators, the technology becomes an instance of the more general class of cyber-physical systems, which also encompasses technologies such as smart grids, virtual power plants, smart homes, intelligent transportation and smart cities [6]. Internet of Things can connect devices embedded in various systems to the internet. When devices/objects can represent themselves digitally, they can be controlled from anywhere. The connectivity then helps us capture more data from more places [3]. One IoT device connects to another to transmit information using Internet transfer protocols. IoT platforms serve as the bridge between the devices' sensors and the data networks.

II. METHODS AND MATERIAL

Heterogeneous Device Communication Models

The four common communication models used by IoT "smart objects": Device-to-Device, Device-to-Cloud, Device-to-Gateway, and Back-End Data-Sharing.IETF 6LoWPAN would be used to connect devices to IP networks. The IoT sensors can use various types of connections such as RFID, Wi-Fi, Bluetooth, and ZigBee, in addition to allowing wide area connectivity using many technologies such as GSM, GPRS, 3G, and LTE. The IoT device will typically be connected to an IP network to the global Internet [7]. IoT protocols that are operating at different layers of the networking stack, including: Medium Access Control (MAC) layer, network layer and session layer. Commercial IoT, where local communication is typically either Bluetooth or Ethernet (wired or wireless).Bluetooth or ZigBee, 6LowPAN is a network protocol that defines encapsulation and header compression mechanisms[9]. **Device-to-Device:** Device-to-device communication represents two or more devices that directly connect and communicate between one another. They can communicate over many types of networks, including IP networks or the Internet, but most often use protocols like Bluetooth, Z-Wave, and ZigBee[10]. **Device-to-Cloud:** Device-to-cloud communication involves an IoT device connecting directly to an Internet cloud service like an application service provider to exchange data and control message traffic. It often uses traditional wired Ethernet or Wi-Fi connections, but can also use cellular technology.Cloud connectivity let the user (and an application) to obtain remote access to a device. It also potentially supports pushing software updates to the device.From a security perspective, this gets more complicated than Device-to-Device because it involves two different types of credentials – the network access credentials (such as the mobile device's SIM card) and then the credentials for cloud access [10].**Device-to-Gateway:** In the Device-to-Gateway model, IoT devices basically connect to an intermediary device to access a cloud service. This model often involves application software operating on a local gateway device (like a Smartphone or a "hub") that acts as an intermediary between an IoT device and a cloud service. This gateway could provide security and other functionality such as data or protocol translation [10]. If the application-layer gateway is a Smartphone, this application software might take the form of an app that pairs with the IoT device and communicates with a cloud service. Gateway devices can also potentially bridge the interoperability gap between devices that communicate on different standards. For instance, Smart Things' Z-Wave and Zigbee transceivers can communicate with both families of devices.

IOT Networking Technologies

IoT network technologies to be aware of toward the bottom of the protocol stack include cellular, wifi, and Ethernet, as well as more specialized solutions such as LPWAN, Bluetooth Low Energy (BLE), ZigBee, NFC, and RFID[11].

LPWAN (Low Power Wide Area Network) is a category of technologies that are designed for low-power, long-range wireless communication, and so they are ideal for use within large-scale deployments of low-power IoT devices like wireless sensors.

LPWAN technologies include LoRa (LongRange physical layer protocol), Haystack, SigFox, LTE-M, and NB-IoT(Narrow- Band IoT).

Cellular The LPWAN NB-IoT and LTE-M standards are aimed at providing low-power, low-cost IoT communication options using existing cellular networks. NB-IoT is the newest of these standards and is focused on long-range communication between large numbers of primarily indoor devices. LTE-M and NB-IoT were developed specifically for IoT, however existing cellular technologies are also frequently adopted for long-range wireless communication. These include 2G (GSM), which is mostly used in legacy devices, and which is currently being phased out, as well as CDMA, 3G, and 4G[15].

Bluetooth Low Energy (BLE) BLE is a low-power version of the popular Bluetooth 2.4 GHz wireless communication protocol. It is designed for short-range (no more than 100 meters) communication, typically in a star configuration, with a single primary device that controls several secondary devices. Bluetooth operates across both layers 1 (PHY) and 2 (MAC) of the OSI model, which is shown in Figure 1. BLE is best suited to devices that transmit low volumes of data in bursts, as the devices are designed to sleep to save power when they are not transmitting data. Personal IoT devices like wearable health and fitness trackers often use BLE [15].

ZigBee ZigBee also operates on 2.4GHz wireless communication spectrum, but it has a longer range than BLE of up to 100 meters. It also has a slightly lower data rate (250 kbps maximum compared to 270 kbps for BLE) than BLE. ZigBee is a mesh network protocol, and unlike BLE, not all devices can sleep between bursts, depending on their position in the mesh and whether they need to act as routers or controllers within the mesh. ZigBee was designed for building and home automation applications, like controlling lights. Another closely related technology to ZigBee is Z-Wave, which is also based on IEEE 802.15.4 MAC. Z-Wave was also designed for home automation, and it was a proprietary technology that was recently released as a public domain specification [11].

·NFC The near field communication (NFC) protocol is used for very small range communication (up to 4 cm), such as holding an NFC card or tag next to a reader. NFC is often used for payment systems, but it is also useful for check-in systems and smart labels in asset tracking in Industrial IoT applications.

·RFID RFID stands for Radio Frequency Identification. RFID tags store identifiers and data and are attached to devices for reading by an RFID reader. The typical range of RFID is less than a meter. RFID tags can be active, passive, or assisted passive. Passive tags are ideal for devices without batteries, as the ID is passively read by the reader. Active tags periodically broadcast their ID, while assisted passive tags become active when RFID reader is present. **Dash7** is a communication protocol that uses active RFID that is designed to be used within Industrial IoT applications for secure long-range communication. Similar to NFC, a typical use case for RFID is tracking inventory items within retail and industrial IoT applications [13].

·Wi-Fi Wifi is standard wireless networking based on IEEE 802.11a/b/g/n specifications. 802.11n offers the highest data throughput, but at the cost of high power consumption, so IoT devices might only use 802.11b or g for power conservation reasons. Although wifi is adopted within many prototype and current generation IoT devices, as longer-range and lower-power solutions become more widely available, it is likely that wifi will be superseded by these lower-power alternatives [12].

· **Ethernet** Widely deployed for wired connectivity within local area networks, Ethernet implements the IEEE 802.3 standard. Not all IoT devices need to be wireless devices that are designed to be stationery. For example, sensor units that are installed within a building automation system can use wired networking technologies like Ethernet. Power line communication (PLC) is an alternative hard-wired solution that uses existing electrical wiring instead of dedicated network cables [14].

IOT Data Management

The objects within the IoT may store data for a certain time interval or report it to governing components.Wired or wireless broadband communications may be used from there to transfer data to permanent data stores. Data may need to be pre-processed to handle missing data, remove redundancies and integrate data from different sources into a unified schema before being committed to storage.

III. CONCLUSION

In this paper, we discussed some of the Networking Technologies ;data management for the Internet of Things.

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