14.2.4 IoT Technologies and Protocols Facts

IoT implements many new technologies and capabilities. The biggest obstacle to IoT's industry growth is lack of technology to support it. For this reason, IoT currently uses standard networking protocols. These protocols are divided into short range, medium range, long range, and wired.

This lesson covers the following topics:

- Short-range technology and protocols
- Medium-range technology and protocols
- Long-range technology and protocols
- Wired technology and protocols
- IoT operating systems
- IoT communication models

Short-Range Technology and Protocols

Short-range protocols provide connectivity for devices up to several meters. The following table describes short-range protocols in use.

Protocol	Description
Near-field communication (NFC) and radio-frequency identification (RFID)	Near-field communication (NFC) and radio-frequency identification (RFID) are two very simple, low-energy, and versatile protocols. RFID uses two-way radio transmitter receivers to identify and track object tags. NFC uses magnetic field induction to communicate between mobile and standard electronic devices.
Bluetooh Low Energy (BLE)	Bluetooth Low Energy (BLE), also known as Bluetooth Smart, is a wireless, personal area network protocol. It supports low-power, long-use IoT needs. It can be used in such sectors as healthcare, security, entertainment, and fitness.
Li-Fi	Light-Fidelity (Li-Fi) is very similar to Wi-Fi. The two key differences are speed and mode of communication. Li-Fi is a visible light communications (VLC) system. It uses light bulbs to transfer data at a high speed of 224 Gbps.
QR and barcodes	Quick Response (QR) codes and barcodes are tags attached to products. They are machine readable and contain information about the product. A QR code is two-dimensional and can be scanned using smart phones. Barcode codes are one- or two-dimensional.
Thread, Zigbee and Z-wave	Thread, Zigbee, and Z-wave are all radio protocols that create low-rate, private area networks. Their advantage is that although they're low-power, they offer high throughput. Thread uses an IPv6-based networking protocol. Zigbee is a short-range communication protocol based on the IEEE 203.15.4 standard. Z-wave is a low-power, short range communication protocol designed for home IoT systems.
Wi-Fi	Wi-Fi is very commonly implemented in wireless local area networking. The most common Wi-Fi standard is the 802.11n standard, which has a maximum speed of 600 Mbps and a range of about 50 meters.
Wi-Fi Direct	Wi-Fi Direct uses peer-to-peer communication without a set wireless access point. The devices in Wi-Fi Direct start communication only after an access point device has been selected within the system.

Medium-Range Technology and Protocols

Medium-range protocols provide connectivity up to 100 meters. The following table describes medium-range protocols in use.

Protocol	Description
HaLow	HaLow is a branch of Wi-Fi with extended range. It's most useful in rural areas because it uses low data rates, allowing it to reduce power requirements and cost of transmission.
LTE-Advanced	LTE-Advanced is a mobile communication standard. It improves traditional LTE by providing higher capacity for data rate, extended range, efficiency, and performance.

Long-Range Technology and Protocols

Long-range protocols have a range up to several thousand kilometers. The following table describes long-range protocols in use.

Protocol	Definition

Low power wide area networking (LPWAN)	Low power wide area networking (LPWAN) is a wireless telecommunication network. The three protocols associated with LPWAN are: ▪ Low power wide area network (LoRaWAN) provides secure two-way communication for IoT devices. Typical applications are mobile, industrial machine-to-machine, smart cities, and healthcare. ▪ Sigfox works well for devices with small battery life that need to transfer low-level data. ▪ Neul uses a small part of the TV white space spectrum and delivers high-quality, high-power, high-coverage networks at a low cost.
Very Small Aperture Terminal (VSAT)	Very Small Aperture Terminal (VSAT) uses small dish antennas to transfer both broadband and narrowband data.
Cellular	The cellular communication protocol can send and receive data over very long distances. It's used to send high-quality data. However, it's very expensive and consumes a lot of power.

Wired Technology and Protocols

Wired technologies and protocols are described in the following table.

Protocol	Description
Ethernet	Ethernet is a group of networking technologies. It's the most commonly used protocol in networking.
Multimedia over Coax Alliance (MoCA)	Multimedia over Coax Alliance (MoCA) technology uses existing coaxial cables to provide high-definition content.
Power Line Communication (PLC)	Power Line Communication (PLC) uses electrical wires to transmit power and data from one point to another. PLC is used in different sectors like automation, industry, and broadband over power lines (BLP).

IoT Operating Systems

The following table describes commonly use IoT operating systems.

OS	Description
RIOT OS	RIOT OS requires less resources and is energy efficient. It's used on embedded systems, actuator boards, sensors, and similar objects.
ARM mbed OS	ARM mbed OS is used primarily with low-power devices such as wearable devices.
RealSense OS X	RealSense OS X is used in Intel's depth sensing technology. It's used with cameras, sensors, and other devices of this nature.
Nucleus and Integrity RTOS	Nucleus and Integrity RTOS are both used in the aerospace, industrial, automotive, and medical sectors.
Brillo	Brillo is an android-based embedded OS. It's used for low-end devices.
Contiki	Contiki is used for low-power wireless devices. Those devices include street lighting and monitoring systems.
Zephyr	Zephyr is for devices that are low-power and resource-constrained.
Ubuntu Core Snappy	Ubuntu Core is used for home control, drones, robots, and industrial applications. Snappy provides a high-speed compression/decompression library.
Apache Mynewt	Apache Mynewt was created specifically for devices that work on the BLE protocol.

IoT Communication Models

The following table describes IoT communication models.

Model	Description
Device-to-device	The device-to-device model is used mostly for systems with devices transferring small data packets to each other at a very low data rate. The devices could include thermostat, light bulbs, door locks, cctv cameras, refrigerators, and wearable devices. These systems mostly use protocols such as Zigbee, Z-wave, or Bluetooth.

Device-to-cloud	In the device-to-cloud model, devices communicate directly with the cloud when sending data and receiving commands, not the user. Typical communication protocols used with this model are Wi-Fi, Ethernet, and cellular.
Device-to-gateway	In the device-to-gateway model, the device interacts with an intermediate device, or gateway, which then contacts the cloud to send and receive data. There is no direct contact with the cloud or the user. The gateway in this kind of model could be a smart phone or hub. The purpose of the gateway is to provide security and protocol translation. The most commonly used protocols in this model are Zigbee and Z-wave.
Back-end data-sharing	The backend data-sharing model is an expanded version of the device-to-cloud model. In this model, the data sent from the IoT device to the cloud can be accessed by authorized third parties.