1.2 What are Connections?

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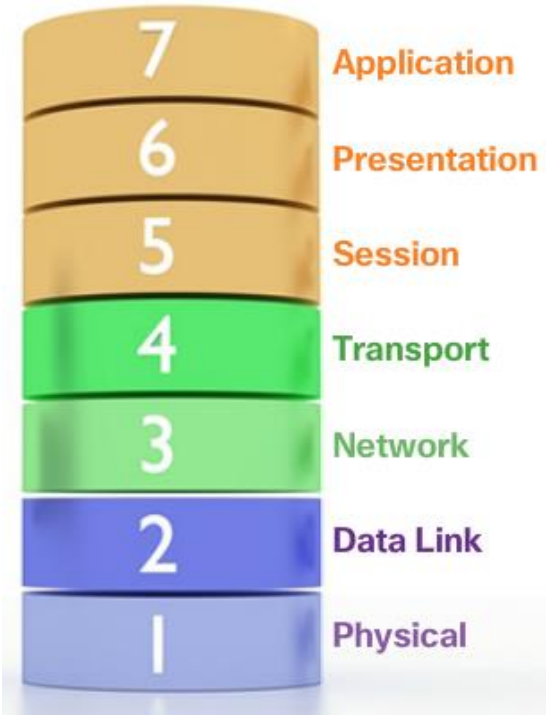
1.2.1 Models of Communication

- Models of Communication
  - Layered networking models are used to illustrate how a network operates. Benefits include:
    - Assists in protocol design.
    - Fosters competition.
    - Promotes technology or capability independence.
    - Provides a common language to describe networking functions and capabilities.

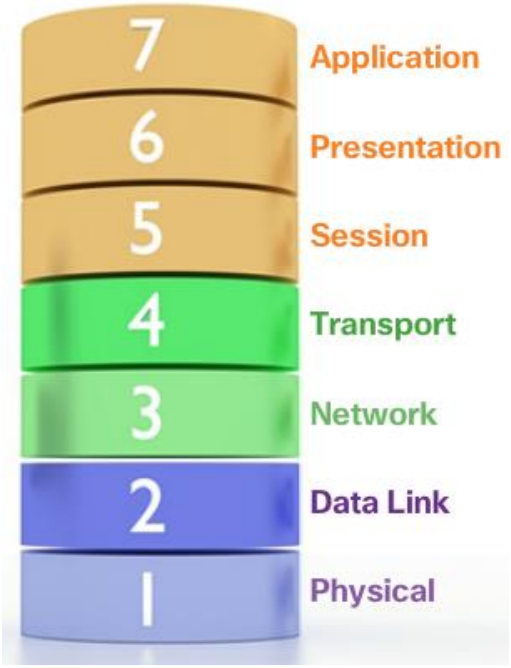


1.2.1 Models of Communication (cont'd)

- Standardization
  - The challenge for the IoT is to ensure these emerging IoT devices can connect securely and reliably to the Internet and to each other.
  - Consistent, secure, and commonly recognized technologies and standards is needed.
  - Organizations such as the Industrial Internet Consortium, OpenFog Consortium, and the Open Connectivity Foundation, are helping to develop standard architectures and frameworks.

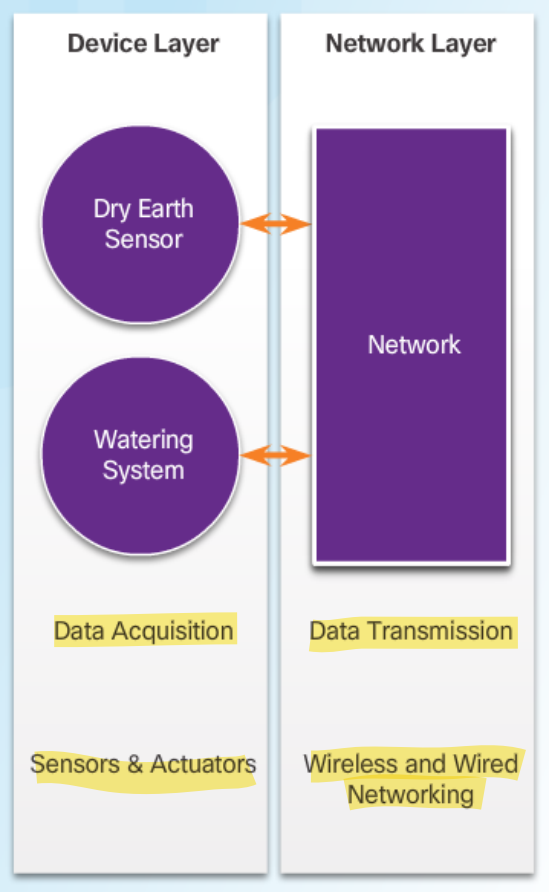
Models of Communication (Cont.)

- TCP and OSI Models
  - Both OSI and TCP/IP models are used to describe network connections and often used interchangeably.
  - The TCP/IP model is commonly referred to as the Internet model.
  - The OSI model provides an extensive list of functions and services that can occur at each layer.
- IoT World Forum Reference Model
  - Developed as a common framework to guide and to help accelerate IoT deployments.
  - It's intent is to provide common terminology and help clarify how information flows and is processed for a unified IoT industry.



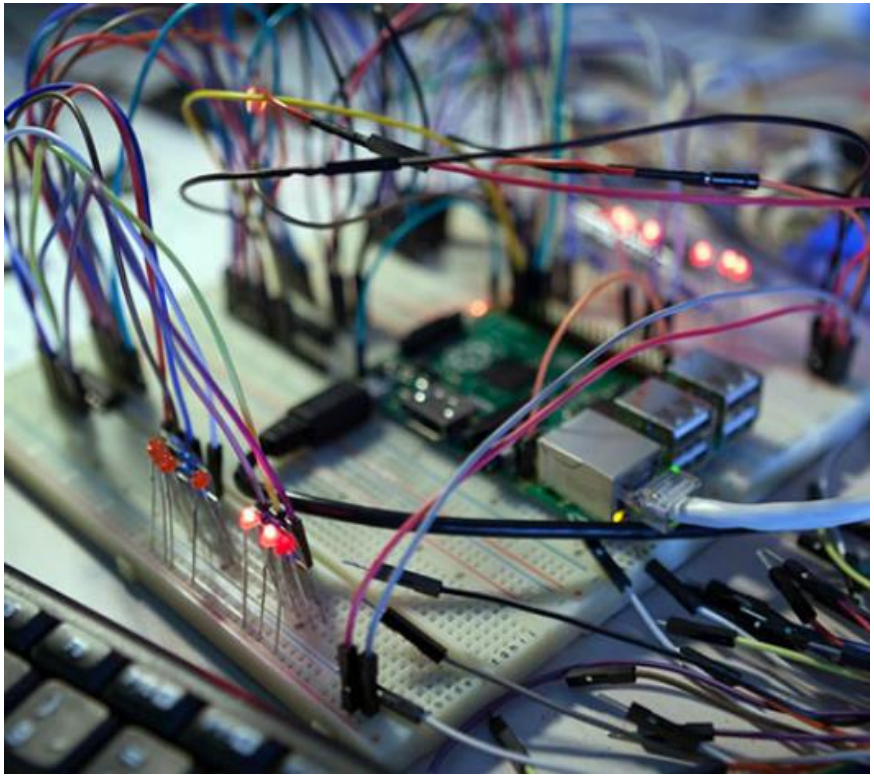
Models of Communication (Cont.)

- Simplified IoT Architecture
  - Several architectures exist to help facilitate the design and creation of IoT systems.
  - The OSI model, TCP/IP model, and the IoT World Forum Reference model have been presented as examples.
  - A simpler approach is based on connection levels. The levels are:
    - Device-to-Device
    - Device-to-Cloud
    - Device-to-Gateway-to-Cloud
    - Device-to-Gateway-to-Cloud-to-Application



1.2.2 Layers of Connections

- Connections Within Networks
  - Connections can have different contexts.
  - Power connections, circuit connections or network connections.
- Physical Connections
  - Relate to the media and cable type.
  - Common media types include copper, fiber optics and wireless.

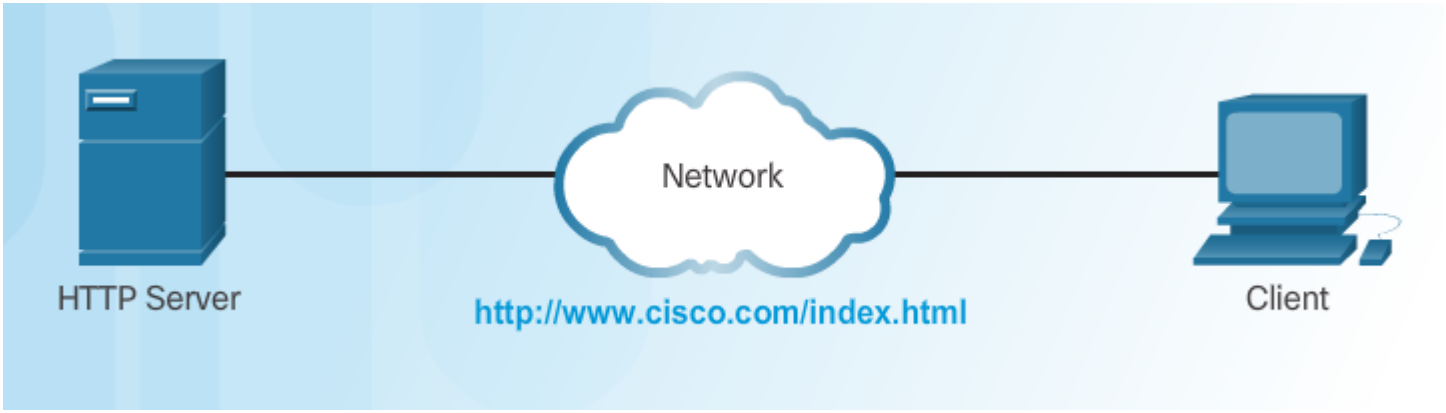


Layers of Connections (cont'd)

- Data Link and Network Connections
  - Network communication requires protocols to establish the rules of communications. Data Link protocols:
    - Allow the upper layers to access the media
    - Prepare network data for the physical network
    - Control how data is placed and received on the media
    - Exchange frames between nodes over a physical network media, such as copper or fiber-optic
    - Receive and directing packets to an upper layer protocol
    - Perform error detection
  - The most popular data link layer connection used in wired networks is Ethernet.
  - Other data link protocols include wireless standards such as IEEE 802.11 (Wi-Fi), IEEE 802.15 (Bluetooth), and cellular 3G or 4G networks.
  - LoRaWAN and NB-IoT are examples of emerging IoT supporting technologies.

Layers of Connections (Cont.)

- Application Connections
  - The IoT supports many types of connections.
  - Devices must use the same application layer protocols to connect.
  - The application will vary depending on the devices and type of connection involved.
  - MQTT and REST are newer application protocols, created to support IoT devices that connect in the myriad of different types of remote configurations.
  - MQTT is a lightweight messaging protocol with minimal overhead that provides high data integrity and security for remote environments.
  - REST or RESTful web services is a type of API designed to make it easier for programs to interact over the Internet.



1.2.3 Impact of Connections on Privacy and Security

- What is Metadata?
  - Metadata refers to the data about data.
  - Metadata can be embedded within a digital object or it can be stored separately.
  - Metadata is not usually seen by a user.
- The Impact of IoT on Privacy
  - Suggestions and design considerations concerning privacy include:
    - Transparency
    - Data Collection and Use
    - Data Access
- Challenges for Securing IoT Devices
  - Some IoT network security impacting factors include:
    - Increasing Number of Devices
    - Non-Traditional Location of Devices
    - Changing Type and Quantity of Gathered Data
    - Lack of Upgradeability

1.3 Chapter Summary

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Summary

- The Internet of Things (IoT) is all around us. An IoT system is usually made up of sensors to monitor events, actuators to influence the environment, hardware to create the platform and its connections, and software to provide a framework to execute processes.
- A process is a series of steps or actions taken to achieve a desired result.
- Layered networking models are used to illustrate and model how devices communicate. Physical, data link, and network layers are concepts that are used to illustrate how network communication operates.
- Security and privacy issues must be considered in all phases of creation of an IoT system. Each level of connectivity brings with it different requirements and concerns..