CT106-3-M-BIA - Building IoT Applications

CT127-3-M-ODL - BIA - Building IoT Applications

Topic 4 - IoT Communications

TOPIC LEARNING OUTCOMES

At the end of this topic, you should be able to:

- Differentiate between the various IoT communication models and their respective characteristics, advantages, and limitations.
- Understand the TCP/IP network model and its layers: application layer, transport layer, Internet layer, and network access layer.
- Explain the role of each layer in the TCP/IP model and how it relates to IoT communication.

Contents & Structure

- IoT communication models
  - Device-to-device Model
  - Device-to-Cloud Model
  - Device-to-Gateway Model
- TCP/IP network model and its layers
- OSI network model and its layers
- How TCP/IP model relates to IoT communication

IoT Communication Models

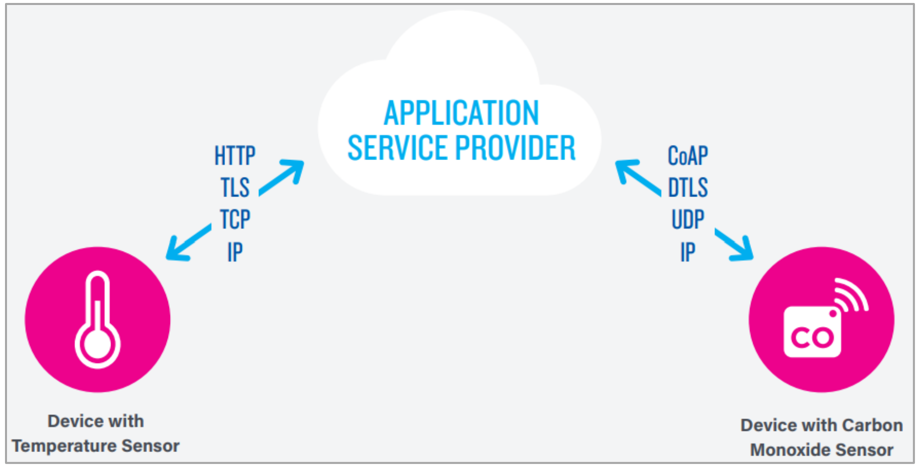
- Device-to-Device Model
- Device-to-Cloud Model
- Device-to-Gateway Model

Device-to-device Model

- Two or more devices that directly connect and communicate with one another, rather than through an intermediary application server.
- It's commonly used in applications like home automation systems, which typically use small data packets of information to communicate between devices.
- Device-to-device communication protocols are not compatible, forcing the user to select a family of devices that employ a common protocol.

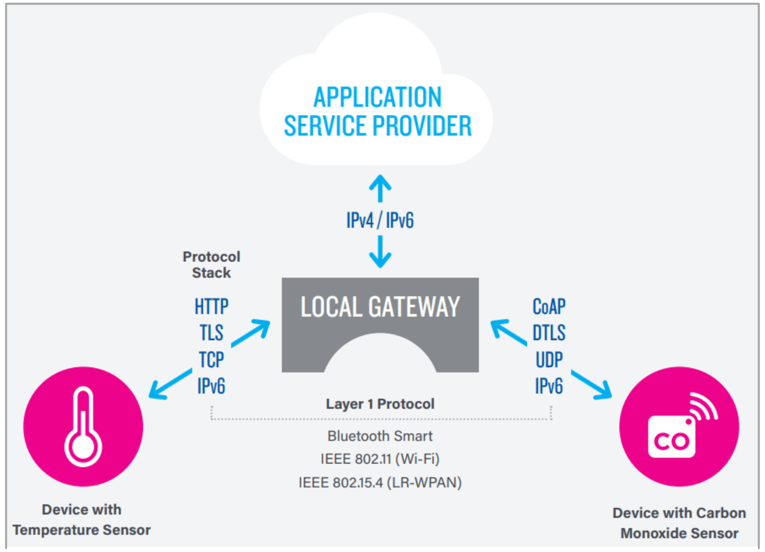
Device-to-Cloud Model

- The IoT device connects directly to an Internet cloud service like an application service provider to exchange data and control message traffic.
- This approach frequently takes advantage of existing communications mechanisms like traditional wired Ethernet or Wi-Fi connections to establish a connection between the device and the IP network, which ultimately connects to the cloud service.
- This communication model is employed by some popular consumer IoT devices like the Nest Labs Learning Thermostat and the Samsung SmartTV.
- Frequently, the device and cloud service are from the same vendor. This is commonly referred to as "**vendor lock-in**".



Device-to-Gateway Model

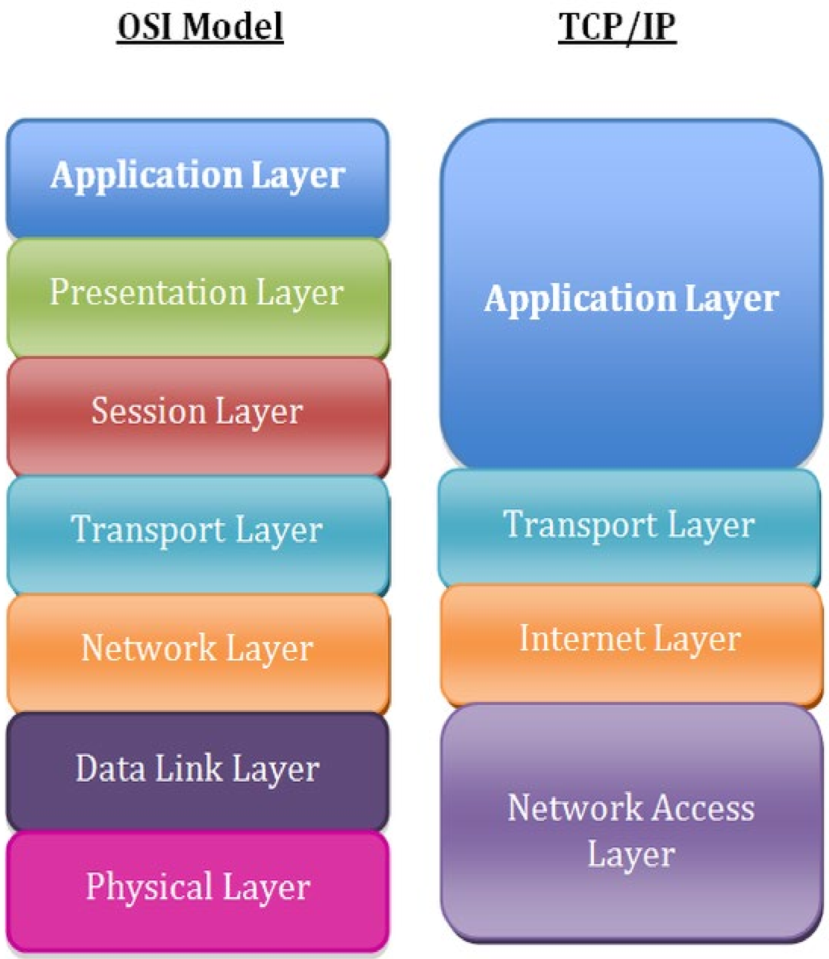
- The IoT device connects to a local gateway device, which acts as an intermediary between the device and the cloud service and provides security and other functionality such as data or protocol translation.
- For example, the local gateway device is a smartphone running an app to communicate with a device and relay data to a cloud service.
- The other form of this device-to-gateway model is the emergence of "**hub**" devices in home automation applications.



TCP/IP vs. OSI Network Models

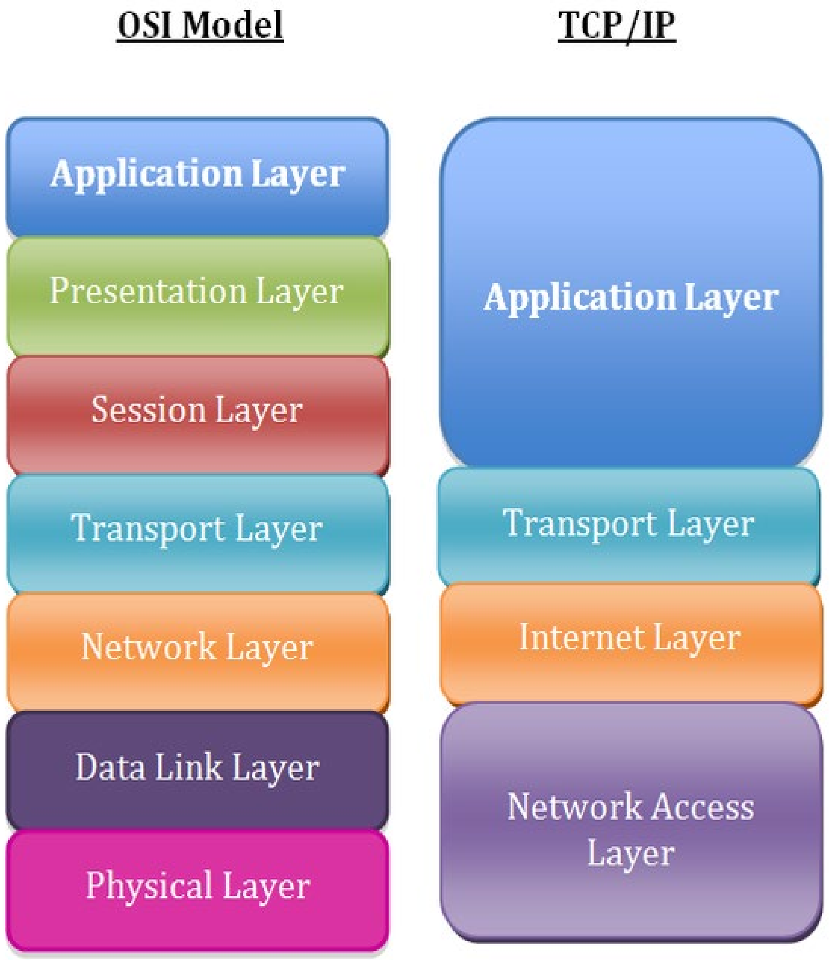
Aspect	TCP/IP Model	OSI Model
Layers	Four layers: Network Interface, Internet, Transport, and Application	Seven layers: Physical, Data Link, Network, Transport, Session, Presentation, Application
Origin	Developed by the Department of Defense (DoD) for ARPANET	Developed by the International Organization for Standardization (ISO)
Focus	Emphasizes on the internetworking of diverse networks and protocols	Emphasizes on standardization and modular representation of networks
Flexibility	Flexible and adaptable, allows the addition of new protocols easily	Provides a strict and standardized framework for networking
Widely Used	Widely used in the Internet and most modern network implementations	Widely referenced but less commonly implemented
Real-World Usage	Used in practical implementations and networking scenarios	Used as a reference model for understanding network communication
Relevance to IoT	Widely used in IoT implementations, especially at the network and application layers	Provides a conceptual framework but less commonly implemented directly in IoT

TCP/IP vs. OSI Network Models



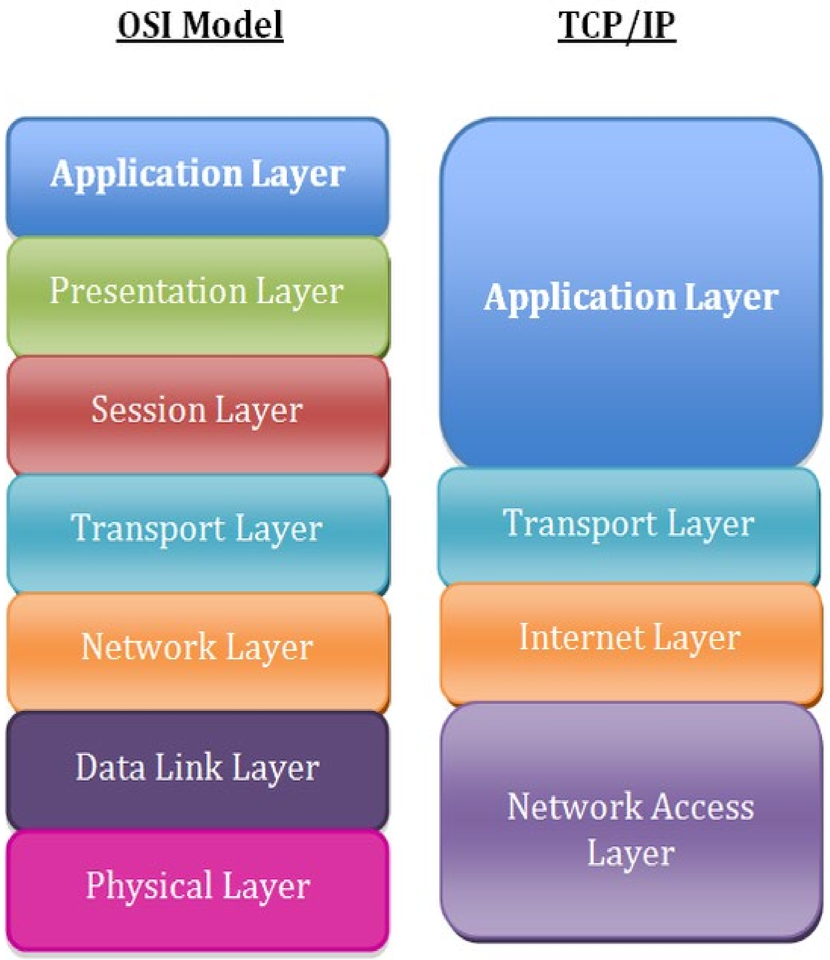
Application Layer

- Interface with the applications that use the network
- HTTP, FTP, Mail services etc.



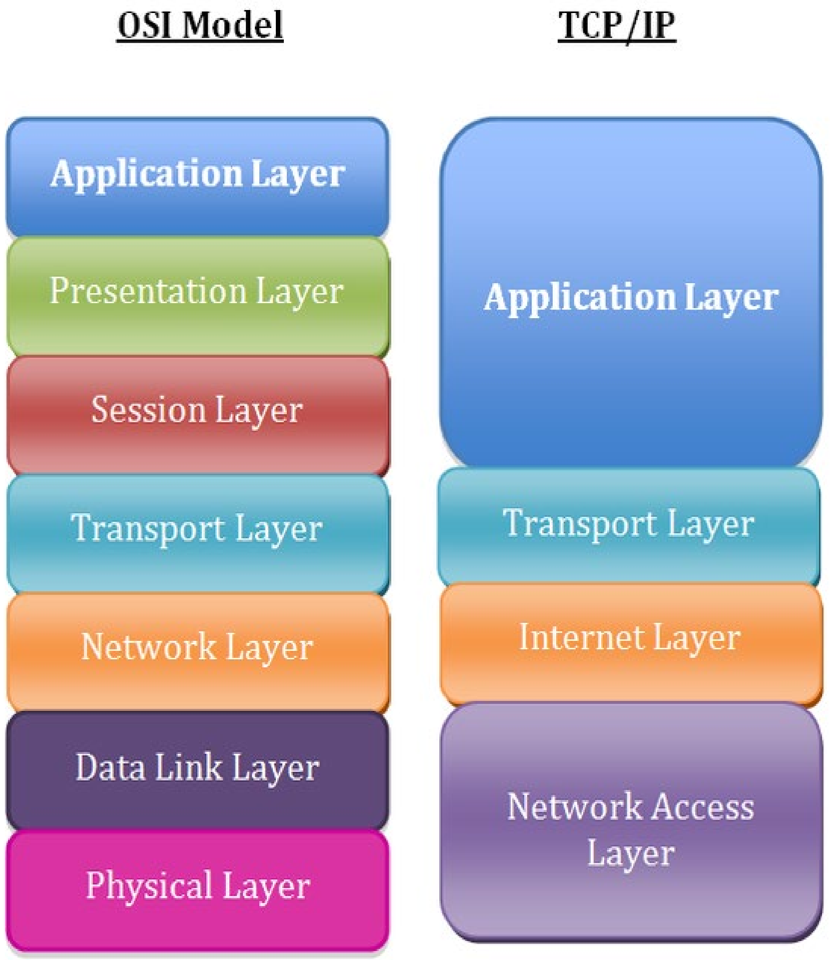
Presentation Layer

- Raw data from Sessions is converted to a proper format
- For example, to an Image file or XL sheet
- Also responsible for some important services like data compression, encryption, and decryption.



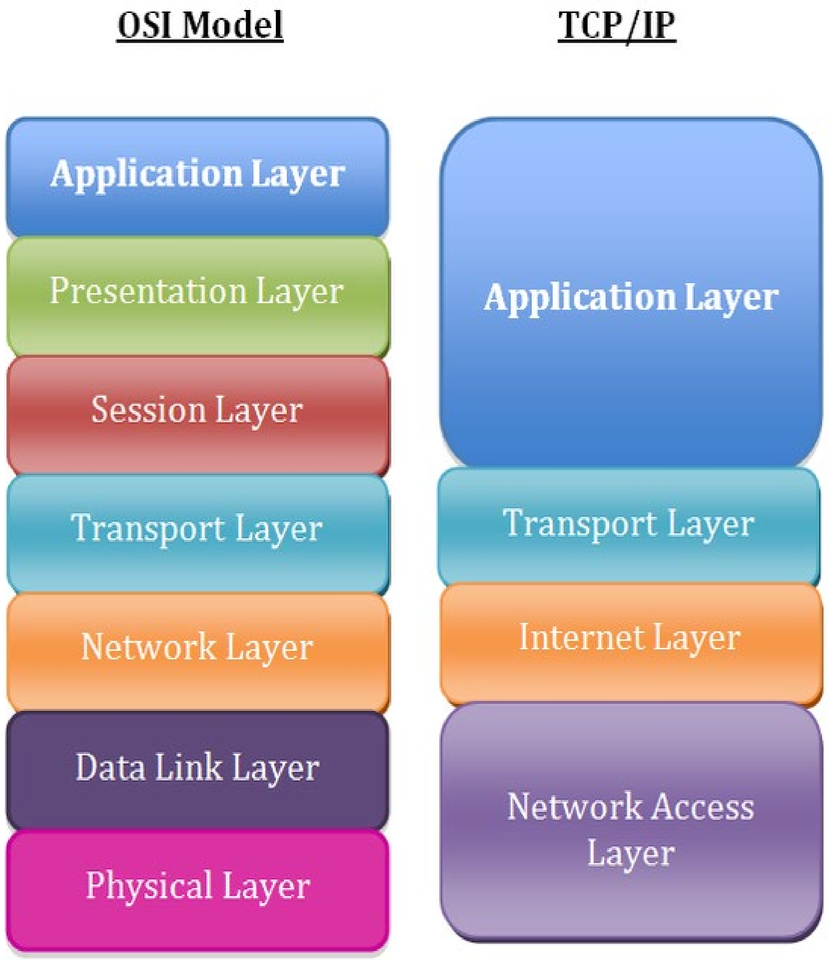
Session Layer

- Maintains Sessions
- Manages Authentication and Authorization



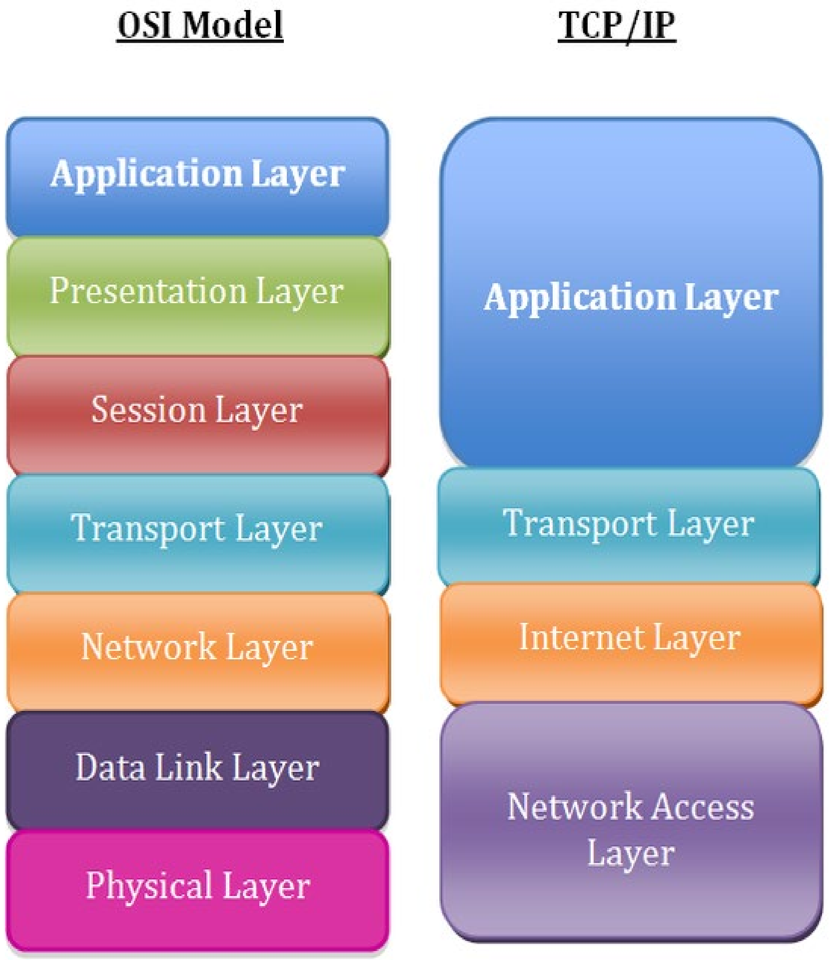
Transport Layer

- Divides the information into **Segments**
  - Chunks of data + Header
- Decides about Reliable vs Unreliable Communication
  - TCP (reliable) : Ack for every packet
  - UDP (unreliable) : No ack, Unreliable but faster due to less overhead
- Decides **port number**
  - IP Address + Port Number = **Socket**



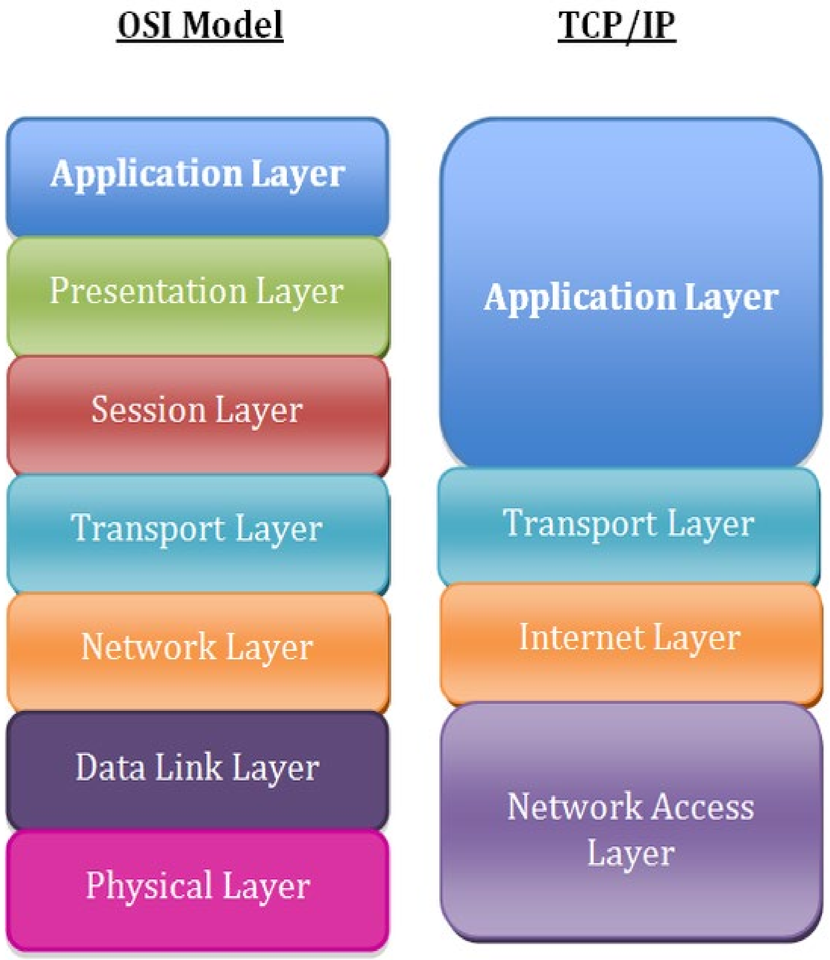
Network Layer

- Segments from Transport Layer converted to **Packets**
  - Extra information added as another header
- Uniquely identify hosts beyond the subnets (IP addressing or Logical Addressing)
- Defines the path which the packets will follow or be routed to reach the destination.



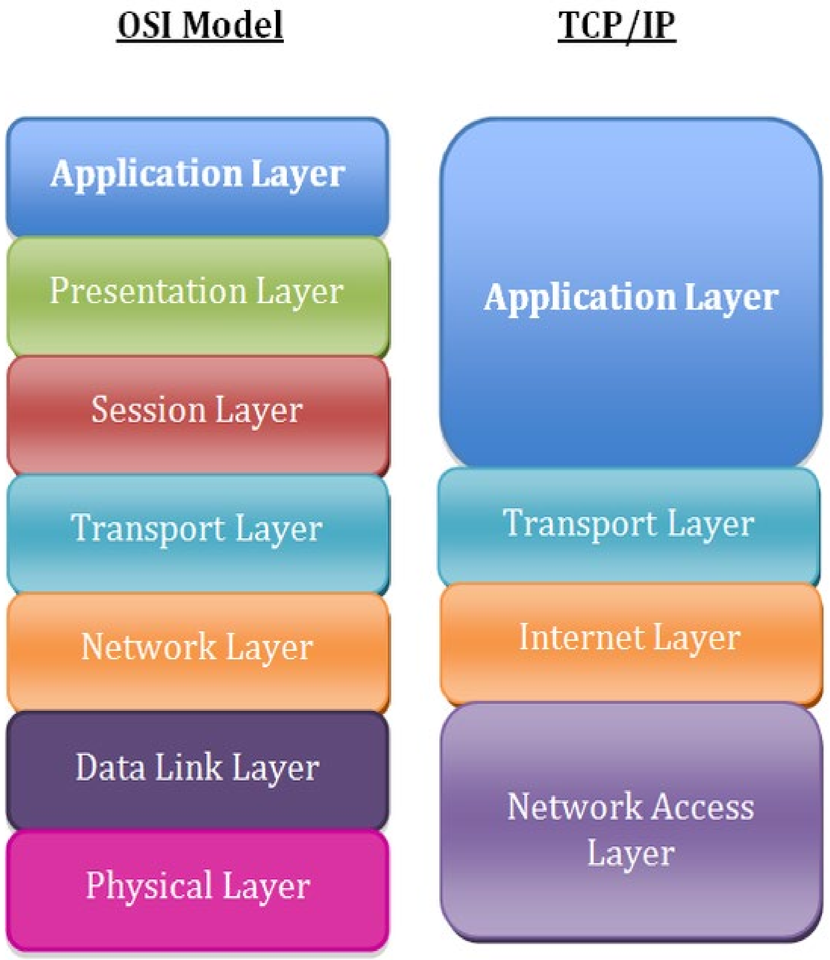
Data Link Layer

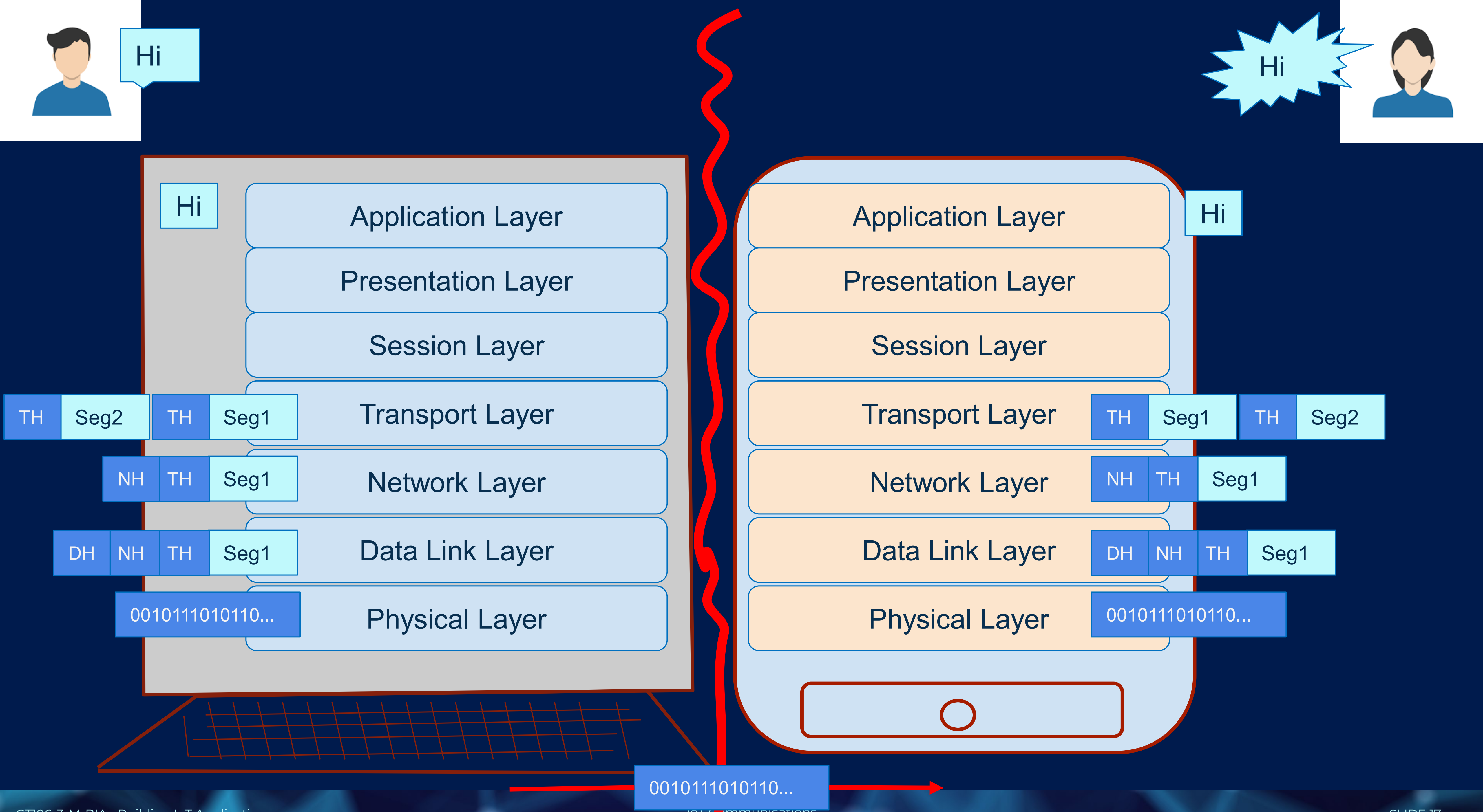
- Packets converted to **Frames**
  - Packet + Data Link Header
- MAC (Media Access Controller) addressing
  - Hardware address of the network card
- Flow Control
  - Keep flow of data *in-sync*
- Error checking
  - CRC, Parity



Physical Layer

- Actual Data Transfer
  - Deals with Hardware
- Frames are now treated as a sequence of Bits




Hi
Hi
Hi
Application Layer
Presentation Layer
Session Layer
Transport Layer
Network Layer
Data Link Layer
Physical Layer
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TH Seg1
NH TH Seg1
DH NH TH Seg1
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Hi
Application Layer
Presentation Layer
Session Layer
Transport Layer
Network Layer
Data Link Layer
Physical Layer
TH Seg1
TH Seg2
NH TH Seg1
DH NH TH Seg1
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IoT Network Layers and Protocols

TCP/IP model	IoT protocols
Application	HTTPS, XMPP, CoAP, MQTT, AMQP
Transport	UDP, TCP
Internet	IPv6, 6LoWPAN, RPL
Network access & physical	IEEE 802.15.4 Wifi (802.11 a/b/g/n) Ethernet (802.3) GSM, CDMA, LTE

Summary / Recap of Main Points

During this lesson, the following topics were covered:

- IoT communication models
  - Device-to-device Model
  - Device-to-Cloud Model
  - Device-to-Gateway Model
- TCP/IP network model and its layers
- OSI network model and its layers
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Review Questions

- Differentiate between the various IoT communication models and their respective characteristics, advantages, and limitations.
- What are the four layers of the TCP/IP model and their primary functions?
- How does the TCP/IP network model differ from other network models, such as the OSI model?
- How do the TCP/IP layers work together to enable communication in IoT systems?

What To Expect Next Week

In Class

Preparation for Class