Chapter 2: Network Models

2.1 OSI Model

- **A network** is a combination of hardware and software that sends data from one location to another.
- **A model** is just a guide, not something physical
- In 1990, there were different networks, computers and operating systems
- There was no standard way of communication among those networks/computers/operating systems.
- People wanted to share data.
- **OSI Model** was created to solve that interoperability problem.

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- **ISO OSI Model:**
  - **ISO:** International Standards Organization
    - A multinational body dedicated to worldwide agreement on international standards
  - **OSI:** Open Systems Interconnection
    - An ISO standard that allows communication between all types of computer systems
    - OSI Model is a layered architecture

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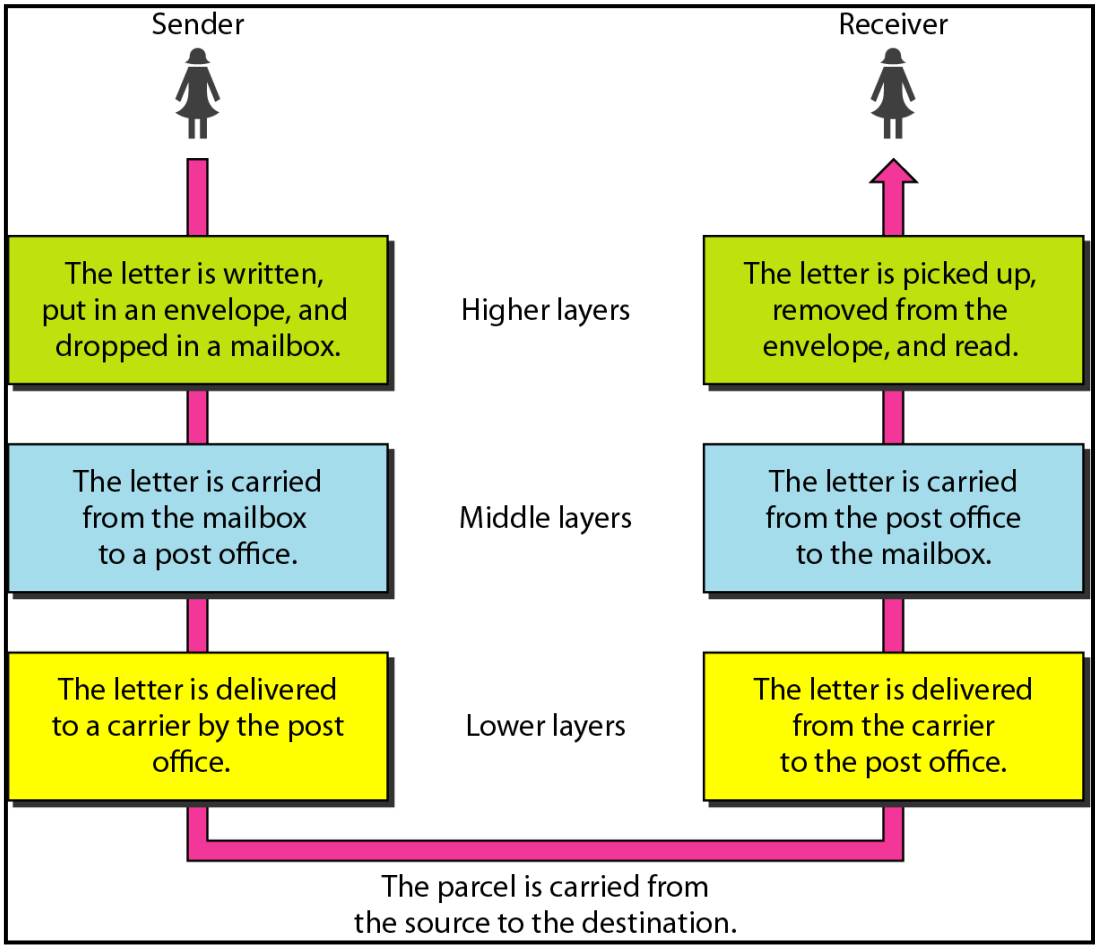
- We use a layered architecture in daily tasks

Example:

Sending a letter

Via Post Office



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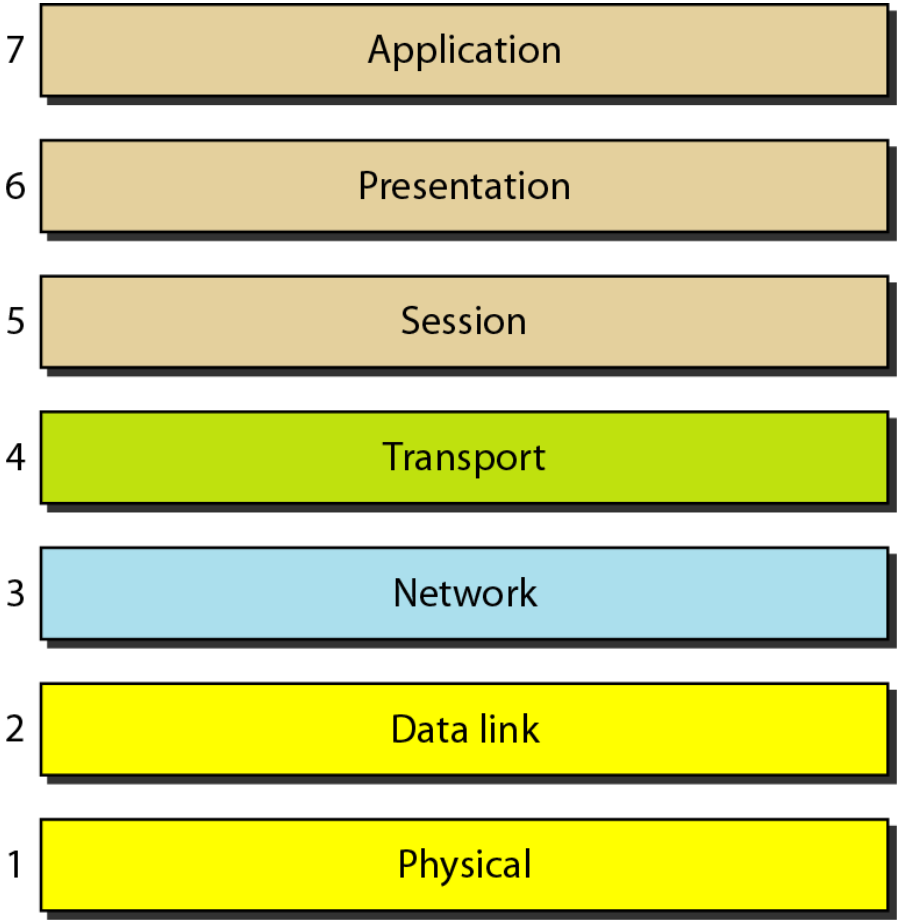
- **OSI Model** consists of 7 Layers:



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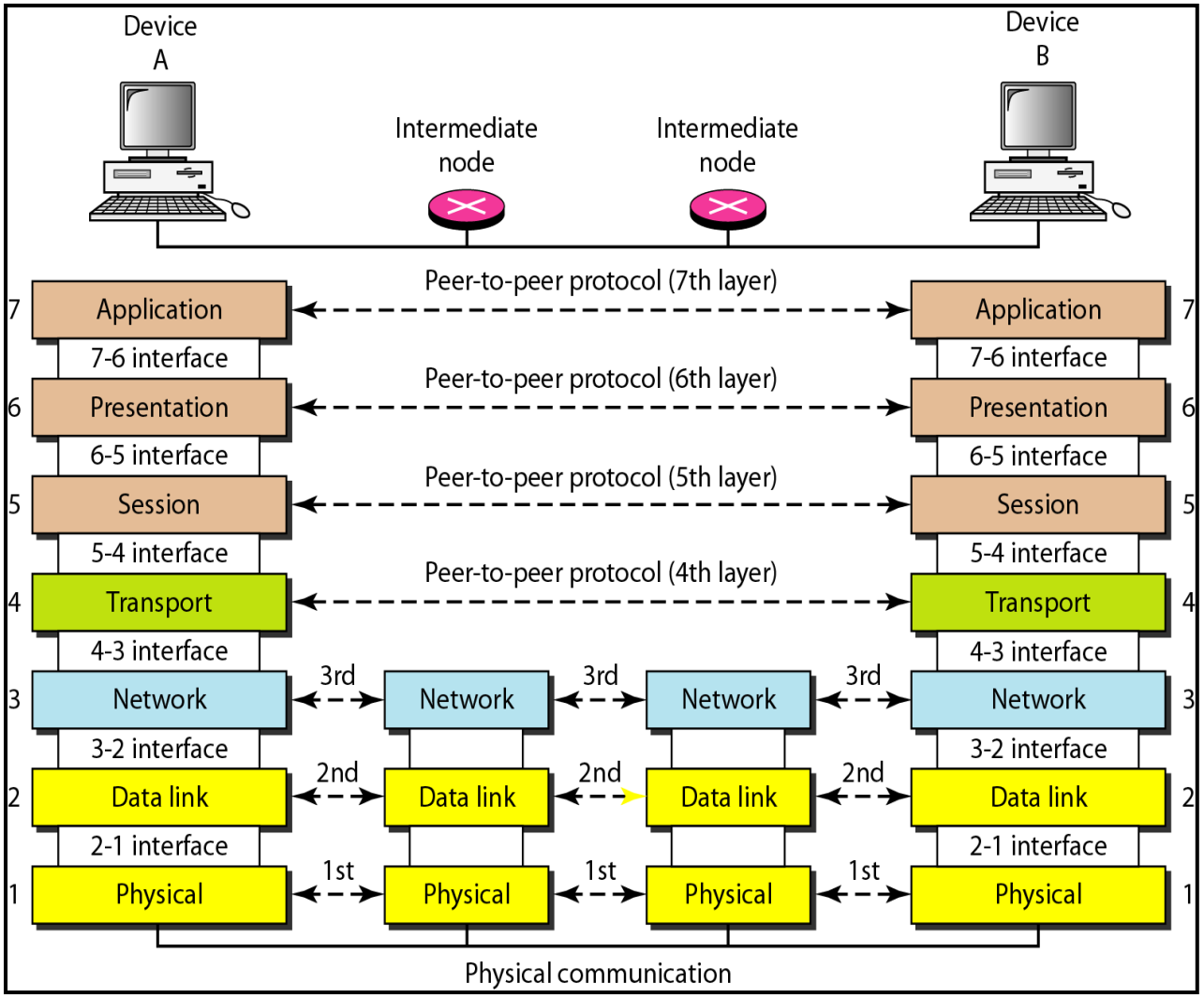
- As the message travels from A to B, it may pass through many intermediate nodes.
- These intermediate nodes usually involve only the first three layers of the OSI model



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- Within a single machine, each layer calls upon the services of the layer just below it.
- Layer 3, for example, uses the services provided by layer 2 and provides services for layer 4.
- Each **interface** defines the information and services a layer must provide for the layer above it.
- Between machines, layer x on one machine communicates with layer x on another machine. This communication is governed by an agreed-upon series of rules and conventions called protocols.
- The processes on each machine that communicate at a given layer are called **peer-to-peer processes**.

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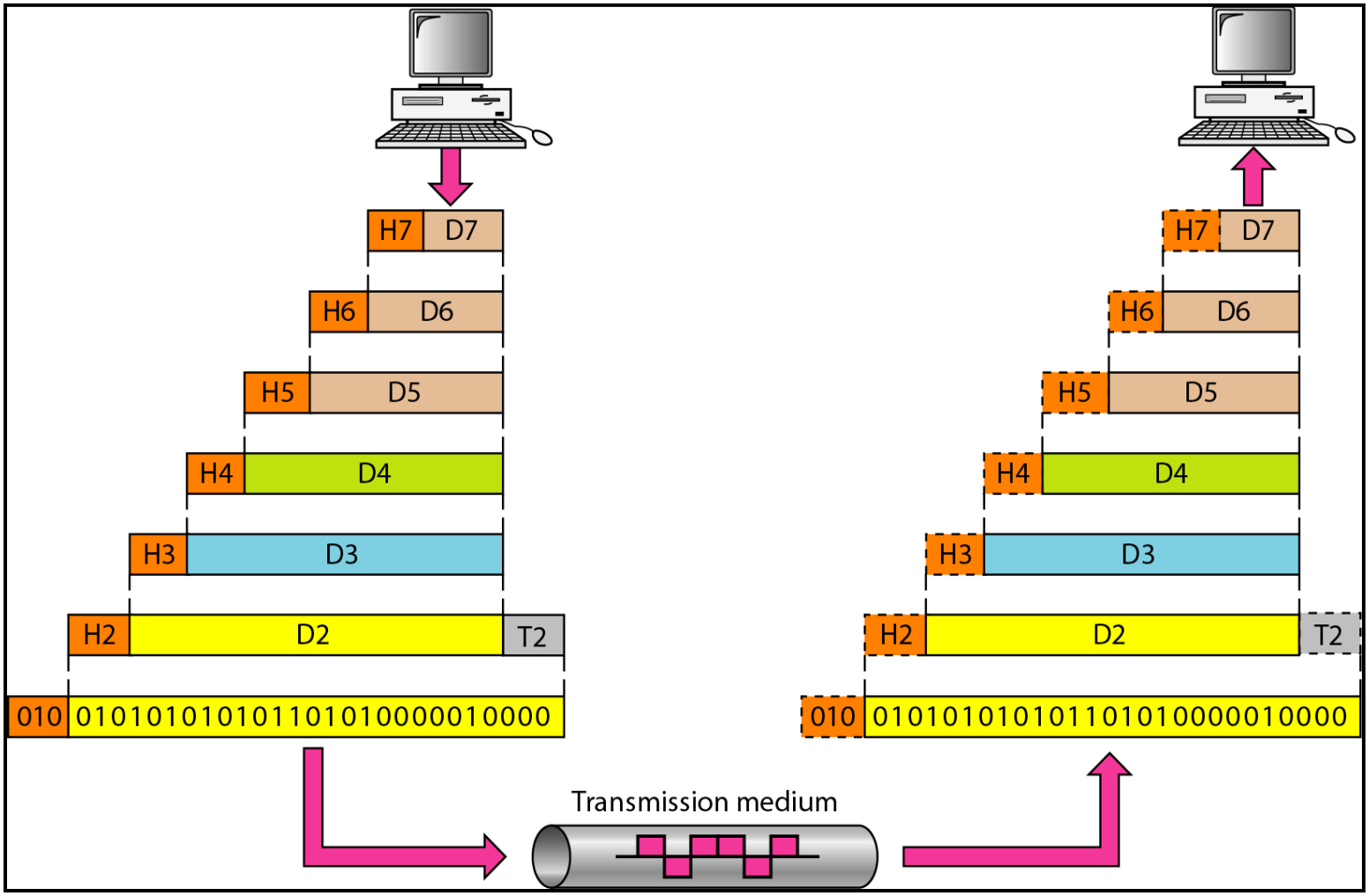
Data exchange using the OSI Model



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- **Data exchange using the OSI Model**
  - D7 means the data unit at layer 7, D6 means the data unit at layer 6, and so on
  - At each layer, a **header**, or possibly a **trailer**, can be added to the data unit.
  - When the data unit passes through the physical layer (layer 1),it is changed into an **electromagnetic signal** and transported along a physical link
  - Upon reaching its destination, the signal passes into layer 1 and is transformed back into **digital form**
  - When the data reaches layer 7, the message is again in a form appropriate to the application and is made available to the recipient

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- **Layer 7: Application Layer (Top Layer)**
  - ***Task****: Responsible for providing services to the user*
  - Consists of network aware applications:
    - Email
    - Web browsers
    - Facebook,….
  - They need Internet in order to work
- **Layer 6: Presentation Layer**
  - ***Task****: responsible for Encryption, Compression and Translation*
- **Layer 5: Session Layer**
  - ***Task****: Responsible for dialog control and synchronization (login rights/permissions)*

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- **Layer 4: Transport Layer**
  - ***Task****: Responsible is responsible for the delivery of a message from one process to another*
- **Layer 3: Network Layer**
  - **Task:** *responsible for the delivery of individual packets from the source host to the destination host (finds the shortest path to the destination network)*
- **Layer 2: Data Link Layer**
  - **Task:** *responsible for moving frames from one hop (node) to the next*
- **Layer 1: physical Layer**
  - **Task:** *responsible for movements of individual bits from one hop (node) to the next*

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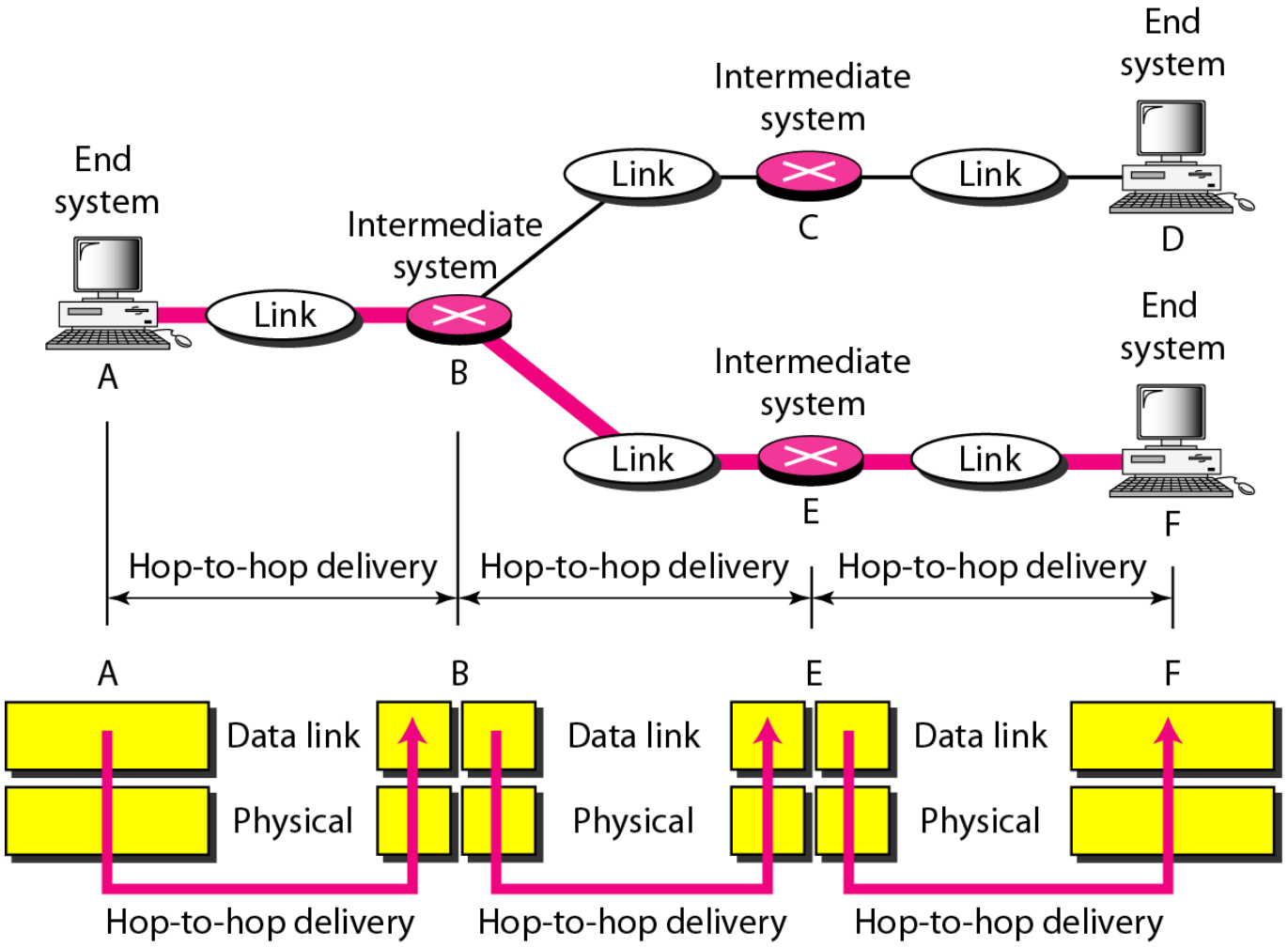

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2.2 TCP/IP Model

- TCP/IP Is a suite of protocols used by Internet today
- It consists of 4 layers
  - Layer 4: Application Layer
  - Layer 3: Transport Layer
  - Layer 2: Internet Layer
  - Layer 1: Network Access Layer

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2.2 Protocols of the TCP/IP Model

- Application Layer (OSI: Application, presentation and session layers)
  - Some protocols
    - HTTP
    - HTTPS
    - FTP
    - POP3
    - SMTP
  - Protocol data units (PDU): **Data**
  - **A PDU** is a generic term used to describe the information of each layer

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2.2 Protocols of the TCP/IP Model

- Transport Layer:
  - Protocols:
    - TCP: Transmission Control Protocol
      - Guarantees end-to-end delivery of data
    - UDP: User datagram protocol
      - Send n Pray: Hope the data arrives
  - PDU:
    - **Segment** for TCP
    - **Datagram** for UDP

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2.2 Protocols of the TCP/IP Model

- Internet Layer (OSI: Network Layer)
  - Protocols:
    - IP: Internet Protocol
    - ICMP: Internet Control Message Protocol
      - Sends a message when the destination node is unavailable
    - ARP: Address Resolution Protocol
      - Maps IP addresses to physical addresses
      - Halfway between Internet Layer and Network Access Layer
      - PDU: **Packet**

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2.2 Protocols of the TCP/IP Model

- Network Access Layer (OSI: Data Link and Physical Layers)
  - Protocols:
    - Ethernet
    - EIA 568 A/B
    - Token Ring
    - CSMA/CD
    - ISDN
  - PDU:
    - **Frames** (Data Link)
    - **Bits** (Physical Layer)

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2.2 Protocols of the TCP/IP Model

- Each layer has the addressing technique: a way of identifying the source address or the destination address
  - **Application Layer** has no addressing as it just deals with data
  - **Transport Layer** addressing: **Ports**

  when it gets data, the data is broken into segments which use ports to identify the destination:
    - HTTP: port 80
    - HTTPS: port 443
    - FTP: Port 20 and 21
    - DNS: port 53

  Port number: 16-bit address represented by one decimal number

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2.2 Protocols of the TCP/IP Model

- **Internet Layer addressing:**
  - The packets use **IP Address** to identify destinations
  - An IP Address is a 32-bits address: 4 dotted decimal numbers where each number represents 8 bits
  - Example: 192.168.109.122
- **Network Access Layer addressing:**
  - The frames use the **Physical Address** (MAC Address) to identify the destination
  - MAC address: a 48-bits Hexadecimal number (00-12-F4-AB-OC-82)
  - Consists of 12 digits and every 2 digits represent 8 bits

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2.3 Mapping Network Devices to the TCP/IP and OSI Model

- **Physical Layer Devices (OSI)**
  - Consists of devices that extend the physical network
  - Works on bits
  - Deals with the physical characteristics such as voltage, cable type and transfer rate
  - **Repeaters**: Extend LAN
    - Ethernet Cable length is 100m (max), if you want to go further, you use a repeaters/transreceivers
    - Transreceivers onvert signal from copper to fiber (many KMs) at one end and from fiber to copper (100 m) at another end
  - Multiport Repeaters: **Hub**

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2.3 Mapping Network Devices to the TCP/IP and OSI Model

- **Data Link Layer Devices (OSI)**
  - PDU=Frame; Addressing=MAC address
  - Devices
    - **Bridges**
    - Multiport Bridge: **Switch**

  These devices examine frames and make decisions to forward the frames or not to forward based on the MAC address

Chapter 2: Network Models

2.3 Mapping Network Devices to the TCP/IP and OSI Model

- **Internet/Network Layer Devices**
  - PDU=Packets; Addressing=IP address
  - Devices
    - **Router**
    - **Layer 3 Switches (Brouter):** do the work of both the switch and router

  These devices examine packets and make decisions to forward the packets or not to forward based on the IP address

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2.3 Mapping Network Devices to the TCP/IP and OSI Model

- **Transport Layer Devices**
  - PDU=Segments; Addressing=Ports
  - Devices
    - **Firewalls**

  Make decisions based on the port number
- **Application Layer Devices**
  - PDU=Data; Addressing=None
  - Devices
    - **Application Layer Gateway (ALG)**

  Examine the contents of the data and make decisions to forward the data or not