

Al-Mustaqbal Univerity

College of Science

Intelligent Medical Systems Departement

Computer Networks- 3rd Class



جامعة المستقبل
AL MUSTAQBAL UNIVERSITY

Lecture 1:

Introduction to Networking and Data Communication

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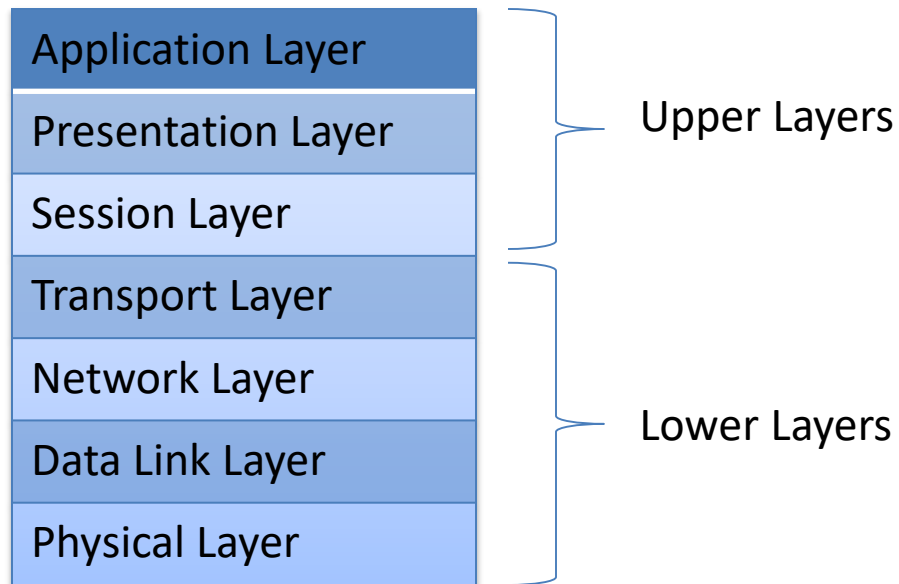
Network Fundamentals - Introduction

- **Data Network** is a network that allows computers to exchange data.
 - The simplest data network is two PCs connected through a cable.
 - Most data networks connect many devices.
- **internetwork** is a collection of individual networks connected by networking devices and function as a single large network.
 - The public Internet is the most common example which it is a single network that connects millions of computers.
- **Local Area Network (LAN)** is a network that enabled multiple users in a relatively small geographic area to exchange files and messages and to access shared resources such as printers and disk storage.
- **Wide Area Network (WAN)** is a network that introduced to interconnect these LANs so that geographically dispersed users could also share information.

Network Fundamentals - OSI Model

- OSI is stand for (Open System Interconnection) Reference Model.
- Why this model?
- The International Organization for Standardization (ISO) committee created a list of all the network functions required for sending data and divided them into seven categories. This model is the *OSI seven layer* model. The OSI seven-layer model was released in 1984.

Network Fundamentals – OSI Model



The OSI Model

Network Fundamentals - OSI Model – Physical Layer

- Layer 1, Physical layer defines specifications such as the electrical and mechanical conditions necessary for activating, maintaining, and deactivating the physical link between devices.
- Specifications include voltage levels, maximum cable lengths, connector types, and maximum data rates.
- The physical layer is concerned with the binary transmission of data. This binary data is represented as *bits* (which is short for *binary digits*). A bit has a single binary value, either 0 or 1.

Network Fundamentals - OSI Model – Data Link Layer

- Layer 2, the data link layer, defines the format of data that is to be transmitted across the physical network. It indicates how the physical medium is accessed, including physical addressing, error handling, and flow control.
- The data link layer sends **frames** of data.
- For LANs, the Institute of Electrical and Electronics Engineers (IEEE) split Layer 2 into two sublayers: Logical Link Control (LLC) and Media Access Control (MAC).
- Some examples of MAC sublayer protocols are IEEE 802.3 Ethernet and IEEE 802.5 Token Ring.
- The MAC sublayer specifies the *physical* MAC address that uniquely identifies a device on a network. Each frame that is sent specifies a destination MAC address; only the device with that MAC address should receive and process the frame. Each frame also includes the MAC address of the frame's source.

Network Fundamentals - OSI Model – Network Layer

- Layer 3, Network layer is responsible for routing, which allows data to be properly forwarded across a logical internetwork (consisting of multiple physical networks).
- The Network layer sends **Packets** of data
- Internet Protocol (IP) addresses (*Logical* network addresses) as opposed to physical MAC addresses are specified at Layer 3.
- Layer 3 protocols include routed and routing protocols. The routing protocols determine the best path that should be used to forward the routed data through the internetwork to its destination.

Network Fundamentals - OSI Model - Transport Layer

- Layer 4, the transport layer, is concerned with end-to-end connections between the source and the destination.
- The transport layer provides network services to the upper layers.
- The Transport layer sends **Segments** of data
- Connection-oriented reliable transport establishes a logical connection and uses sequence numbers to ensure that all data is received at the destination.
- Connectionless best-effort transport just sends the data and relies on upper-layer error detection mechanisms to report and correct problems.
- Reliable transport has more overhead than best-effort transport

Network Fundamentals - OSI Model - The Upper Layers

- The three upper layers represent the data that must be transmitted from the source to the destination; the network typically neither knows nor cares about the contents of these layers.
- **The Session layer, Layer 5**, is responsible for establishing, maintaining, and terminating communication sessions between applications running on different hosts.
- **The Presentation layer, Layer 6**, specifies the format, data structure, coding, compression, and other ways of representing the data to ensure that information sent from one host's application layer can be read by the destination host.
- **The Application layer, Layer 7**, is the closest to the end user; it interacts directly with software applications that need to communicate over the network.

Network Fundamentals - Network Devices - Terminology

- Some terminology related to the operation of network devices is:
 - **Domain** is a specific part of a network.
 - **Bandwidth** is the amount of data that can be carried across a network in a given time period.
 - **Unicast data** is data meant for a specific device.
 - **Broadcast data** is data meant for all devices; a special broadcast address indicates this.
 - **Multicast data** is data destined for a specific group of devices; a special address indicates this.
 - **A bandwidth domain**, known as a *collision domain* for Ethernet LANs, includes all devices that share the same bandwidth.
 - **A broadcast domain** includes all devices that receive each other's' broadcasts (and multicasts)

Network Fundamentals - Network Devices - Hub

- A typical Ethernet LAN uses unshielded twisted-pair (UTP) cables with RJ-45 connectors.
- Because these cables have only two ends, an intermediary device is needed to connect more than two computers. That device is a hub.
- A hub works at Layer 1 and connects multiple devices so that they are logically all on one LAN.
- **NOTE:** The physical connection point on a network device—a hub, switch, or router—is called an *interface* or a *port*.
- A hub has no intelligence—it sends all data received on any port to all the other ports. So, devices connected through a hub receive everything that the other devices send, whether or not it was meant for them.
- All devices connected to a hub are in one collision domain and one broadcast domain.
- Note: A hub just repeats all the data received on any port to all the other ports; thus, **hubs are also known as repeaters**.

Network Fundamentals - Network Devices - Switch

- LAN switches are Layer 2 devices and have some intelligence—they send data to a port only if the data needs to go there.
- A device connected to a switch port does not receive any of the information addressed to devices on other ports. Therefore, the main **advantage** of using a switch instead of a hub is that the traffic received by a device is reduced because only frames addressed to a specific device are forwarded to the port on which that device is connected.
- Switches read the source and destination MAC addresses in the frames and therefore can keep track of who is where, and who is talking to whom, and send data only where it needs to go.
- If the switch receives a frame whose destination address indicates that it is a broadcast (information meant for everyone) or multicast (information meant for a group), by default it sends the frame out all ports (except for the one on which it was received).
- All devices connected to one switch port are in the same collision domain, but devices connected to different ports are in different collision domains. By default, all devices connected to a switch are in the same broadcast domain

Network Fundamentals - Network Devices - Router

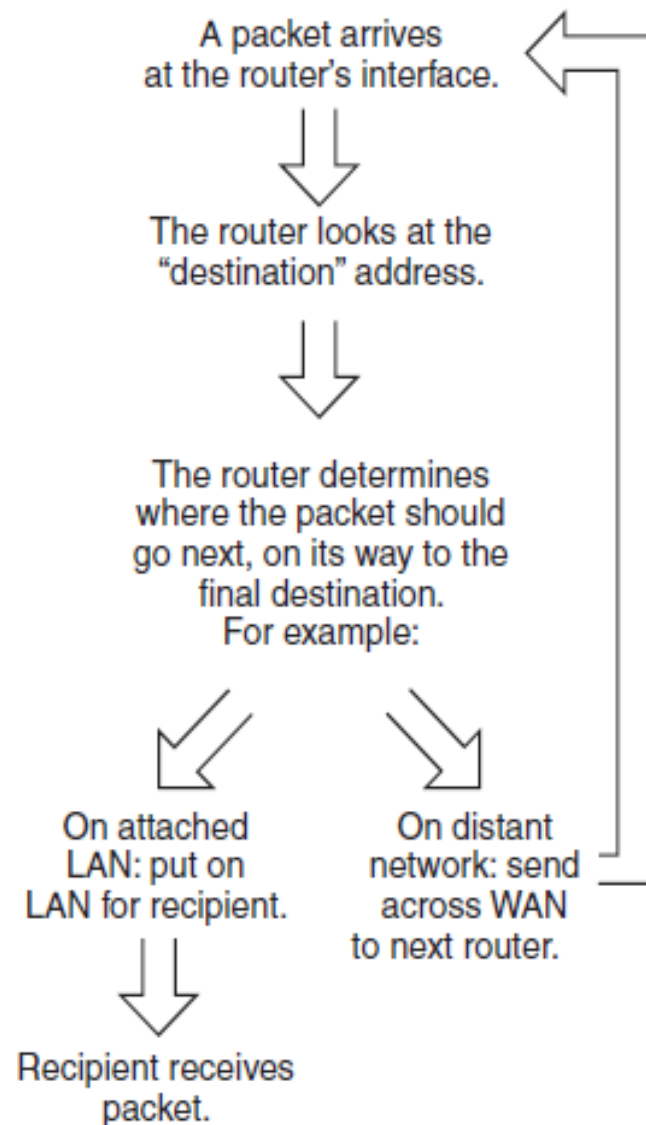
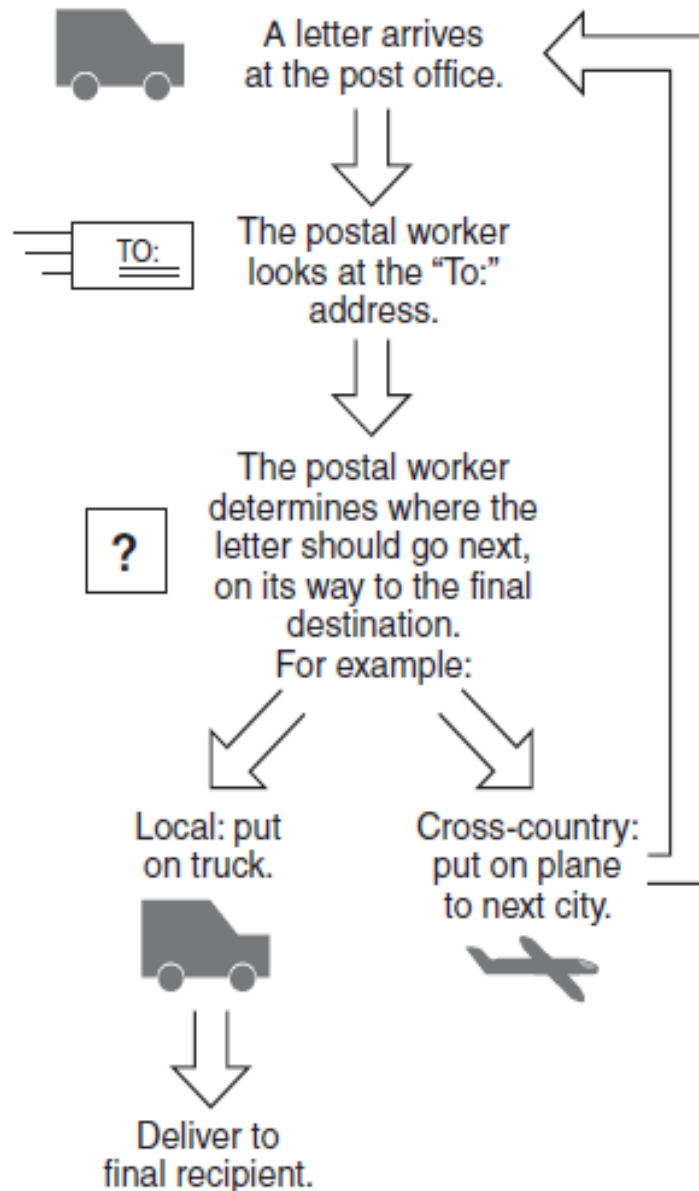
- A *router* goes one step further than a switch. It is a Layer 3 device that has much more intelligence than a hub or switch.
- By using logical Layer 3 addresses, routers allow devices on different LANs to communicate with each other and with distant devices—for example, those connected through the Internet or through a WAN.
- The logical Layer 3 addresses is the TCP/IP's IP addresses..
- The router reads the source and destination logical addresses in the packets and therefore keeps track of who is where, and who is talking to whom, and sends data only where it needs to go.
- All devices connected to one router port are in the same collision domain, but devices connected to different ports are in different collision domains.
- Routers block broadcasts (destined for *all* networks) and multicasts by default; routers forward only *unicast* packets (destined for a specific device) and packets of a special type called *directed broadcasts*.

Network Fundamentals - Routing

- Routers work at the OSI model network layer. The main functions of a router are first to determine the best path that each packet should take to get to its destination and second to send the packet on its way.
- Sending the packet out the appropriate interface, along the best path, is also called *switching the packet* because the packet is encapsulated in a new frame, with the appropriate framing information.

Network Fundamentals - Routing

A Router Behaves Much Like a Worker at a Post Office

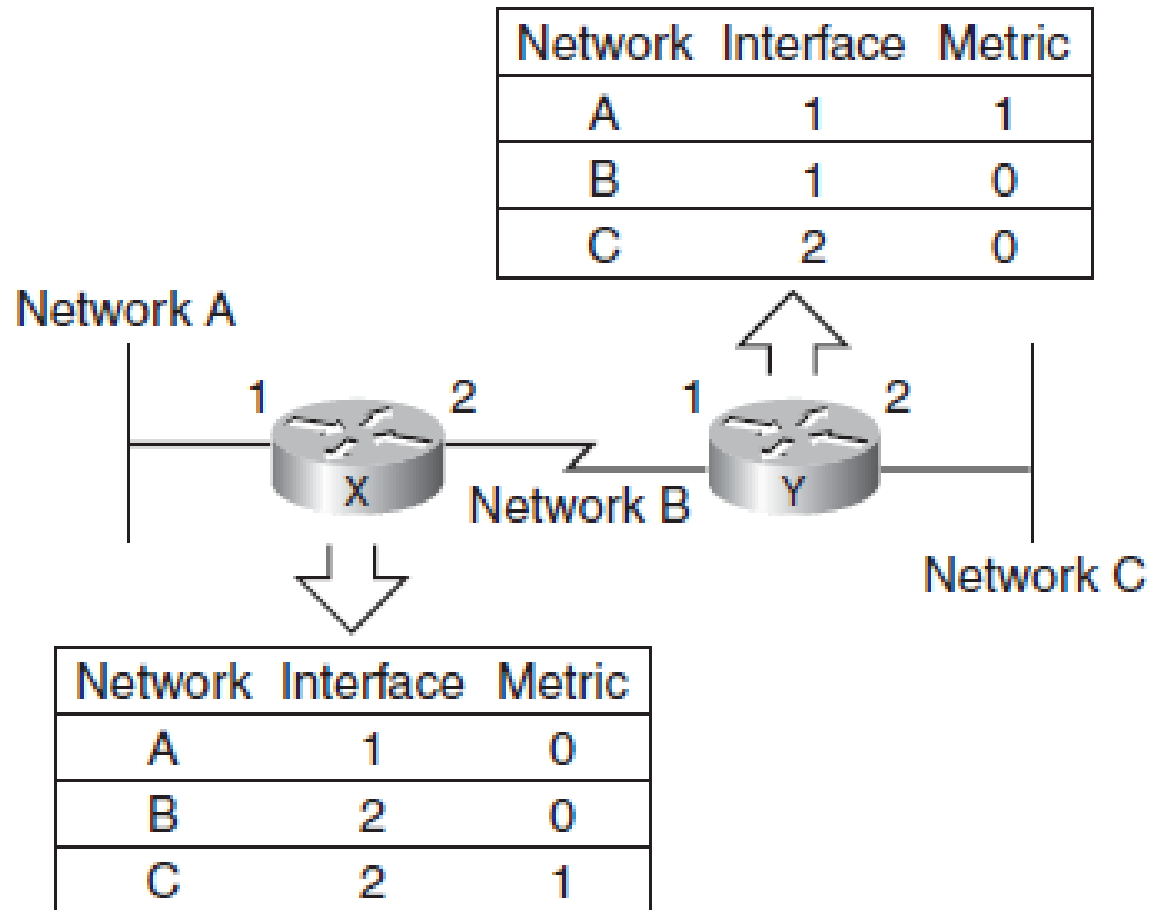


Network Fundamentals - Routing Tables

- To determine the best path on which to send a packet, a router must know where the packet's destination network is. Here is the use of Routing Table.
- Routers learn about networks by being physically connected to them or by learning about them either from other routers or from a network administrator.
- Routes configured by network administrators are known as *static routes* because they are hard-coded in the router and remain there—static—until the administrator removes them. Routes to which a router is physically connected are known as *directly connected routes*.

Network Fundamentals - Routing Tables

- Routers Keep Routing Information in Routing Tables*



Network Fundamentals - Physical Addressing

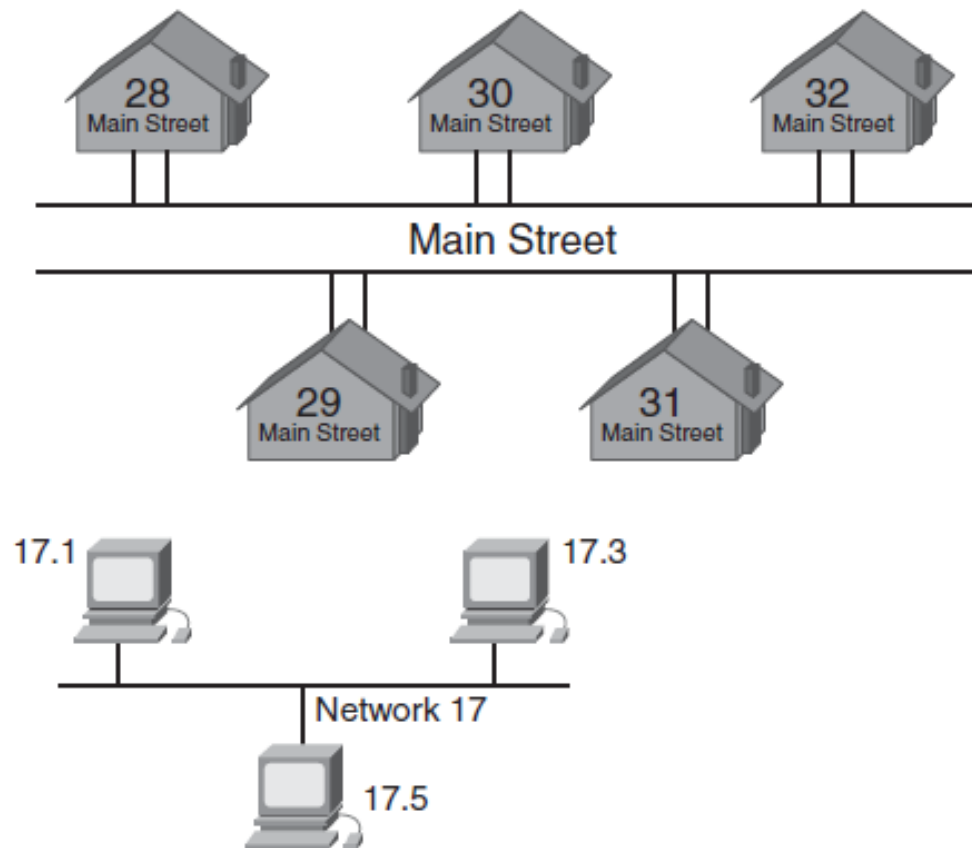
- **MAC addresses** are at the data link layer and are considered physical addresses.
- When a network interface card is manufactured, it is assigned an address—called a *burned-in address* (BIA)—that doesn't change when the network card is installed in a device and is moved from one network to another.
- Typically, this BIA is copied to interface memory and is used as the interface's MAC address.
- The MAC Address is a 48-bit value. The upper 24 bits are an Organizational Unique Identifier (OUI) representing the vendor that makes the device. The lower 24 bits are a unique value for that OUI, typically the device's serial number.

Network Fundamentals - Logical Addressing

- Network layer IP addresses are logical addresses, and they are either defined statically by an administrator or obtained automatically from a server.
- They have two main parts: the **network portion** which specifies the network where the device is on, and the **host portion** which specifies the number or the address of the device on that network.

Network Fundamentals - Logical Addressing

Network Layer Addresses Are Similar to Postal Addresses



Network Fundamentals - Routing and Network Layer Addresses

- A router typically looks at only the network portion of a destination address. It compares the network portion to its routing table, and if it finds a match, it sends the packet out the appropriate interface, toward its destination.
- A router needs to concern itself only with the device portion of a destination address if it is directly connected to the same network as the destination. In this case, the router must send the packet directly to the appropriate device, and it needs to use the entire destination address for this (network and host portions).

Network Fundamentals – Switching Types

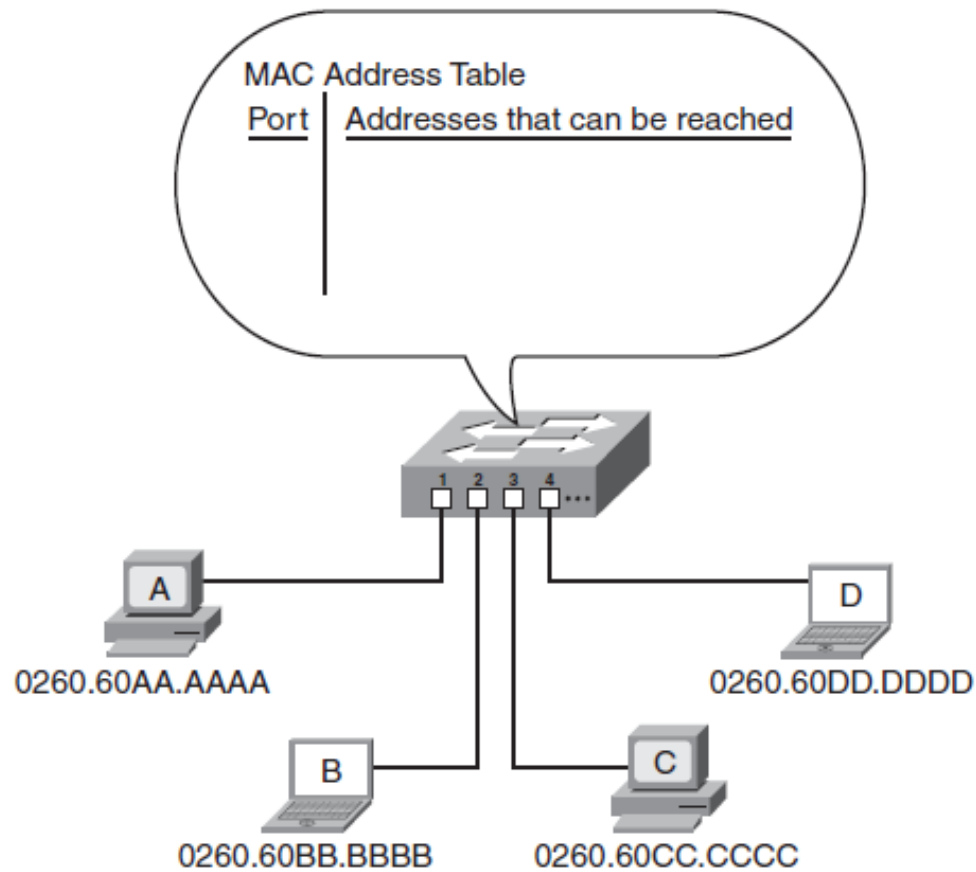
- Switches were initially introduced to provide higher-performance connectivity than hubs because switches define multiple collision domains. Switching was initially restricted to the examination of Layer 2 frames. But, switches can now process Layer 3 packets.
- So, there are two types of Switching:
 - Layer 2 switching
 - Layer 3 switching

Network Fundamentals - Layer 2 Switching

- The heart of a Layer 2 switch is its MAC address table, also known as content-addressable memory. This table contains a list of the MAC addresses that are reachable through each switch port. Recall that a physical MAC address uniquely identifies a device on a network. When a switch is first powered up, its MAC address table is empty.
- A switch uses the frame's **destination MAC address** to determine the port to which it sends the frame.
- A switch uses the frame's **source MAC address** to populate its MAC address table.

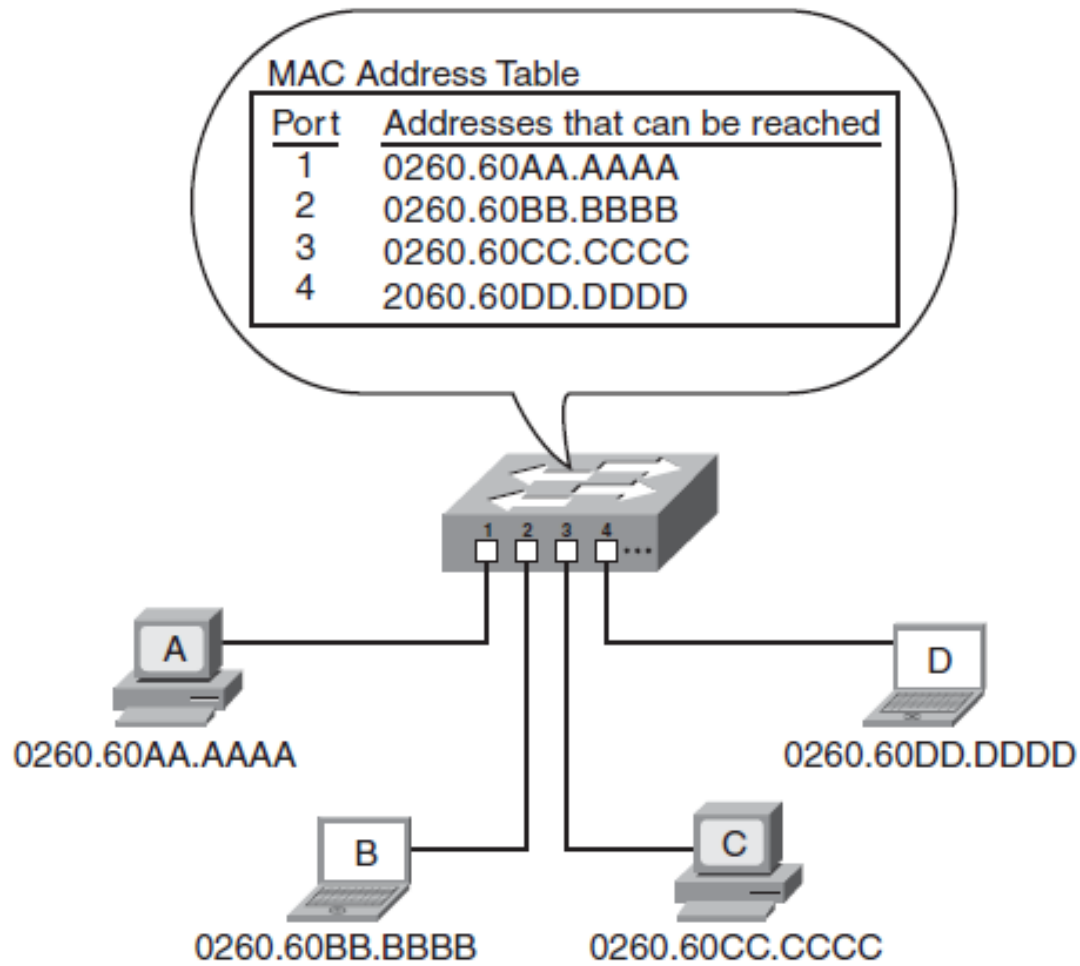
Network Fundamentals - Layer 2 Switching

The MAC Address Table Is Initially Empty:



Network Fundamentals - Layer 2 Switching

The Switch Learns Where All the Devices Are and Populates Its MAC Address Table



Network Fundamentals - Layer 2 Switching

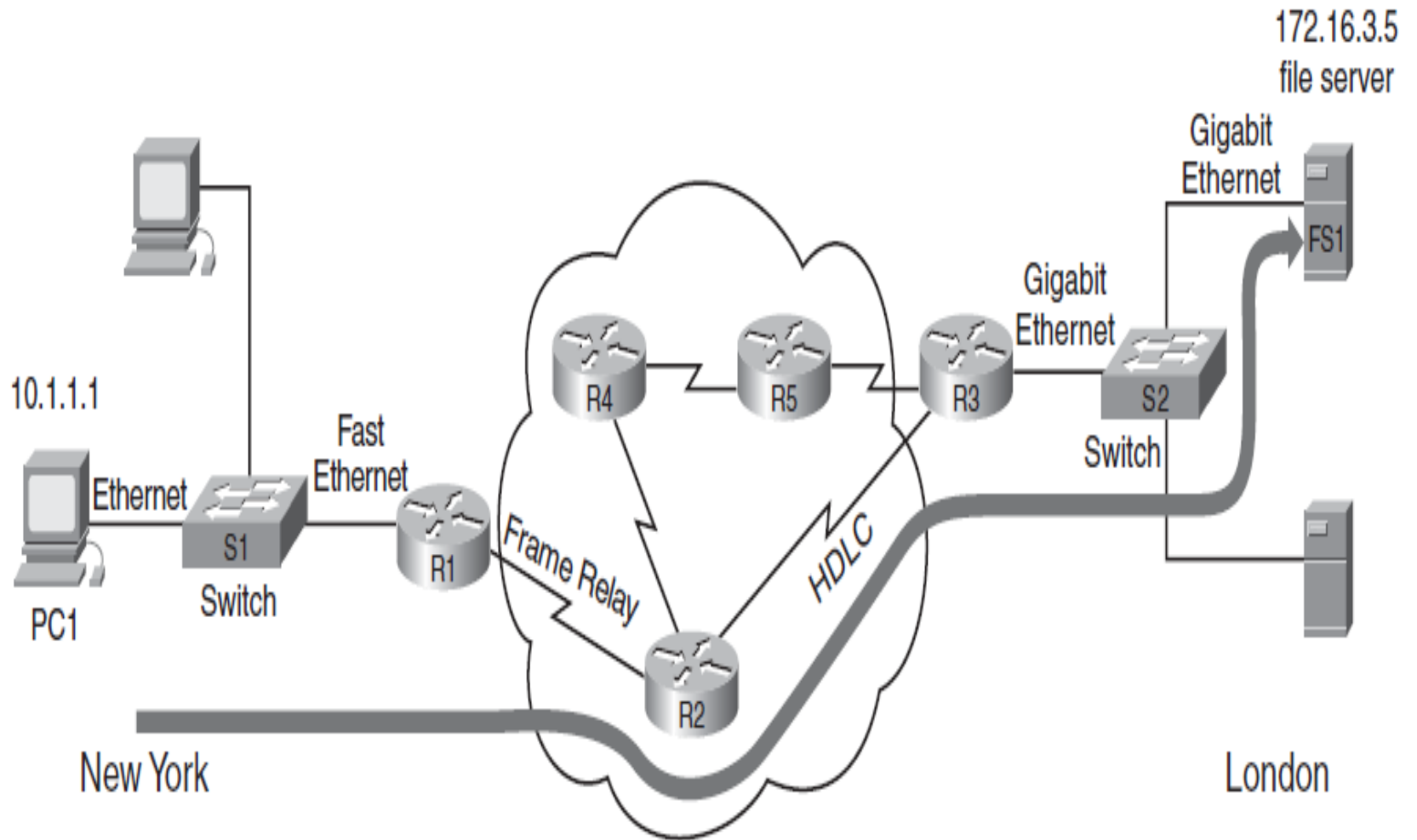
Learning ?

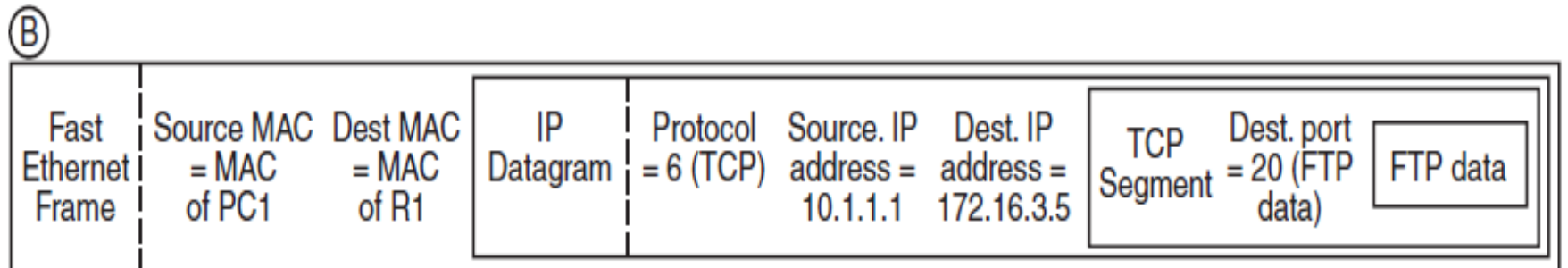
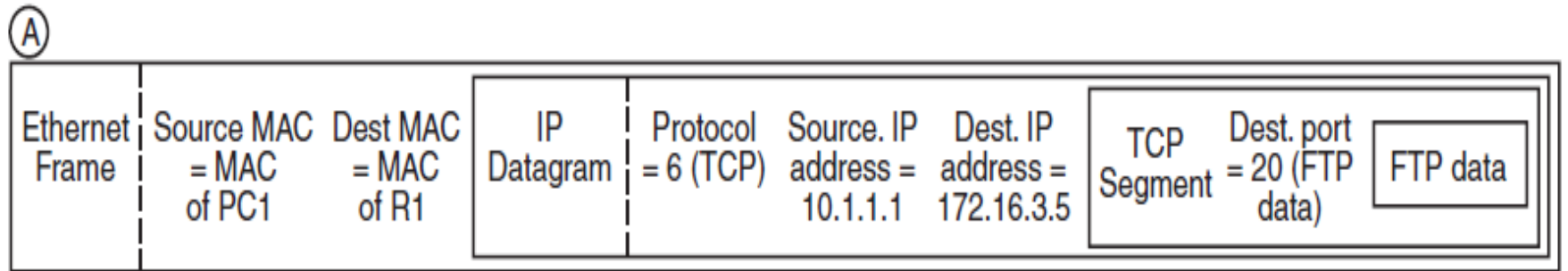
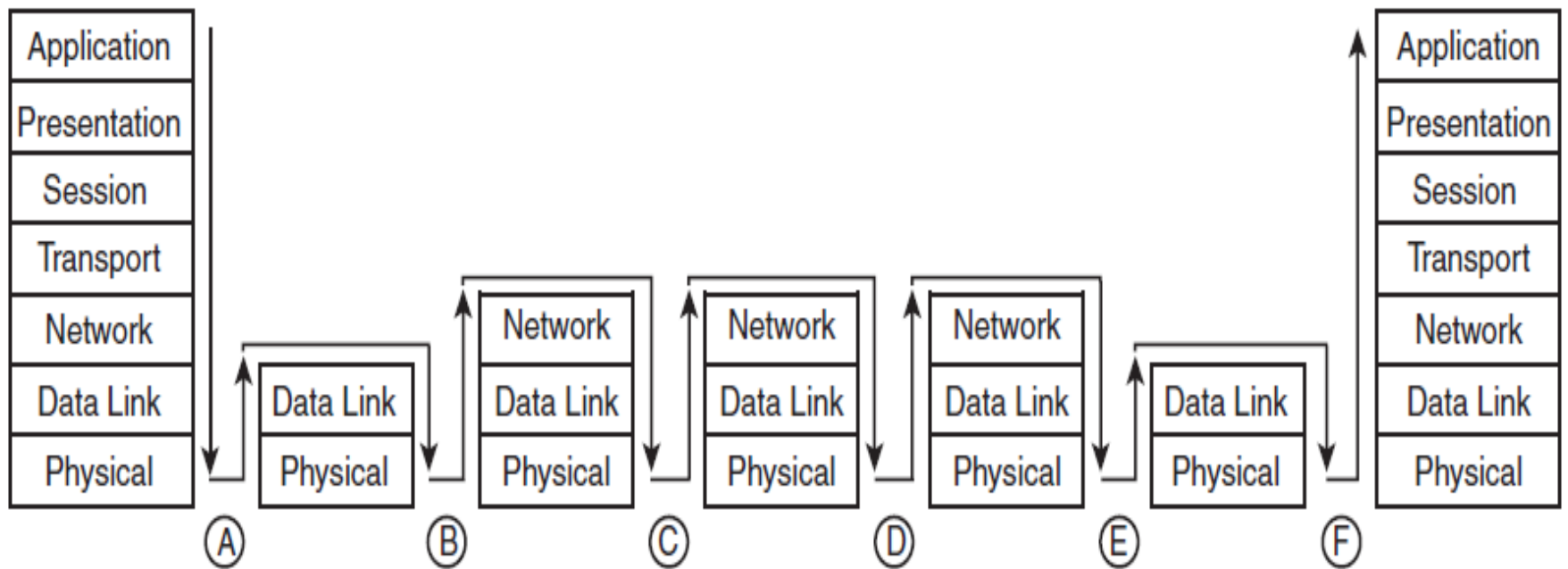
Filtering ?

Network Fundamentals - Layer 3 Switching

- A Layer 3 switch performs all the same functions as a router; the differences are in the physical implementation of the device rather than in the functions it performs.
- Therefore, functionally, the terms *router* and *Layer 3 switch* are synonymous.

Example of sending Packet from PC1 to file Server in London





Thank you