ECCS-3631
Networks and Data Communications

Module 1-4
Physical Media and TCP/IP Protocol

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Physical Media

- Physical link is what lies between a transmitter and a receiver.
- Examples of physical media include twisted-pair copper wire, coaxial cable, multimode fiber-optic cable, terrestrial radio spectrum, and satellite radio spectrum.
- Physical media fall into two categories: guided media and unguided media.
- **Guided Media**:

With guided media, the waves are guided along a solid medium, such as a fiber-optic cable, a twisted-pair copper wire, or a coaxial cable.

- **Unguided Media**:

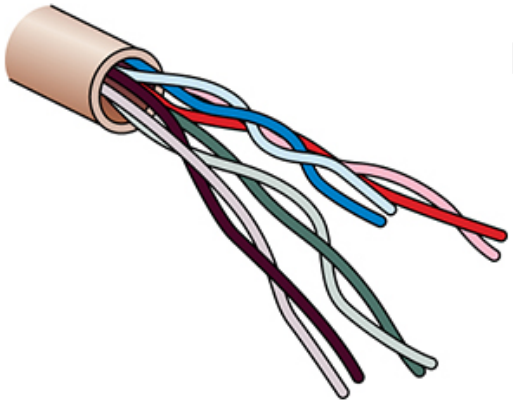
With unguided media, the waves propagate in the atmosphere and in outer space, such as in a wireless LAN or a digital satellite channel.

Physical Media

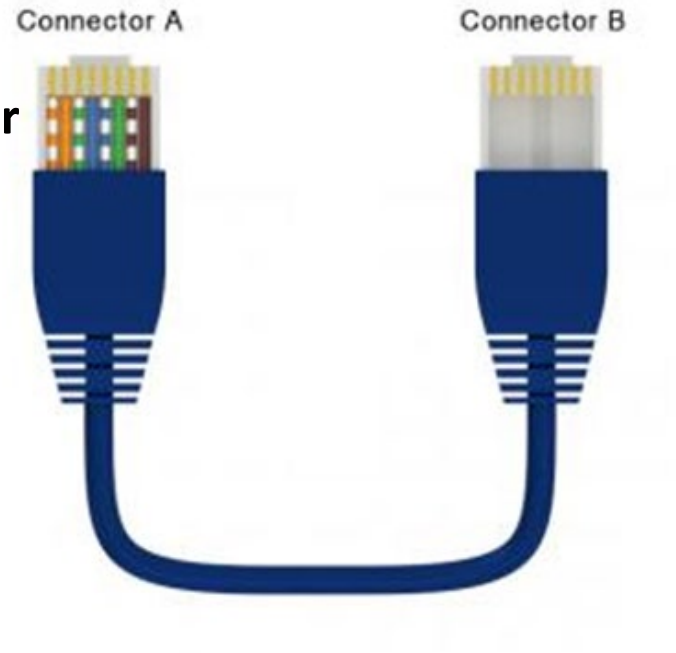
- **Twisted-Pair Cable**:

The wires are twisted together to reduce the electrical interference from similar pairs close by.

- **Unshielded twisted pair (UTP)** is commonly used for computer networks within a building, that is, for LANs. Data rates for LANs using twisted pair today range from 10 Mbps to 10 Gbps.

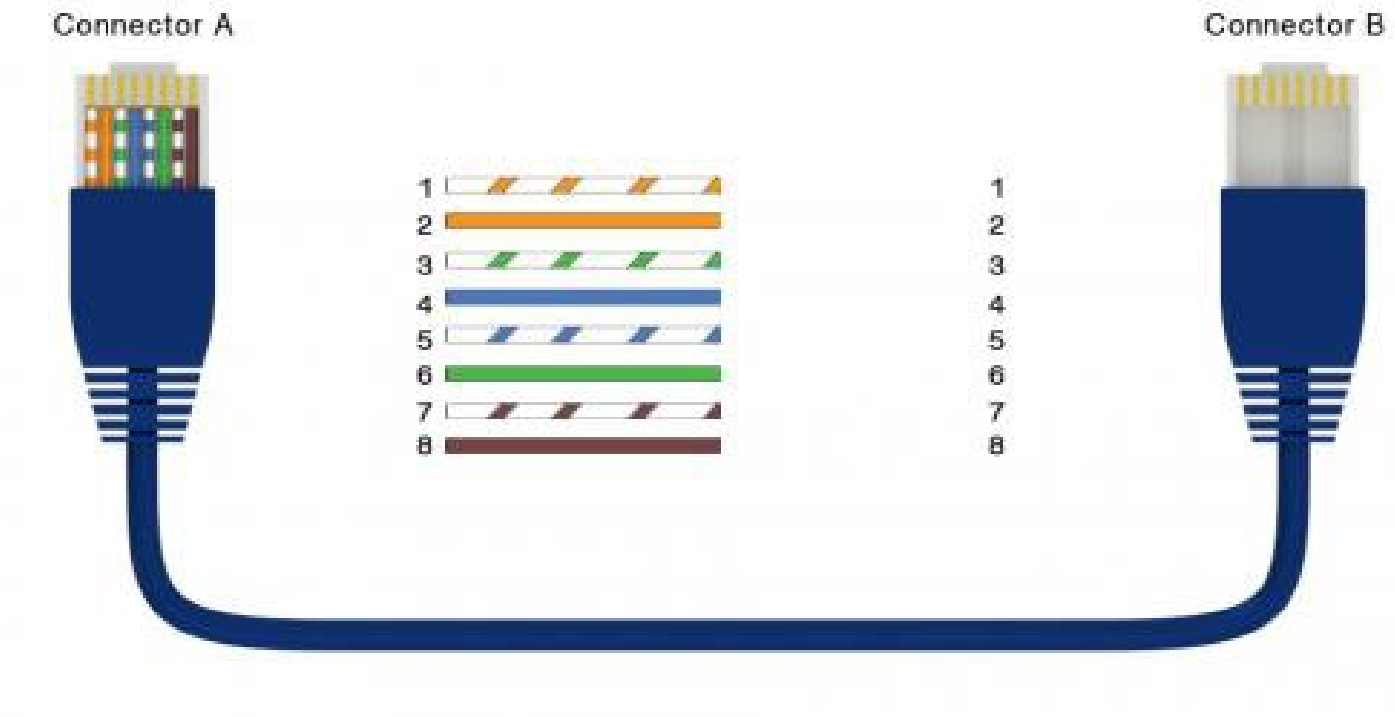


RJ-45 Connector

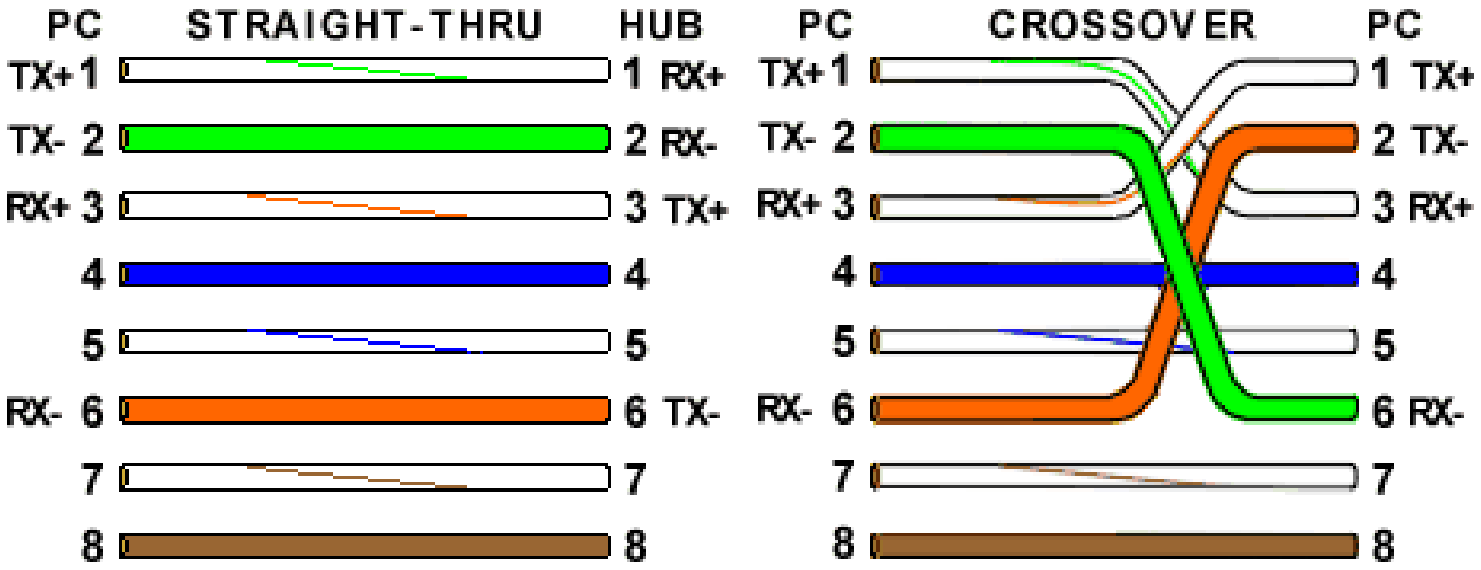


Physical Media

- Straight-Through Twisted-Pair Cable



Physical Media



Straight-Through Cable **Cross-Over Cable**

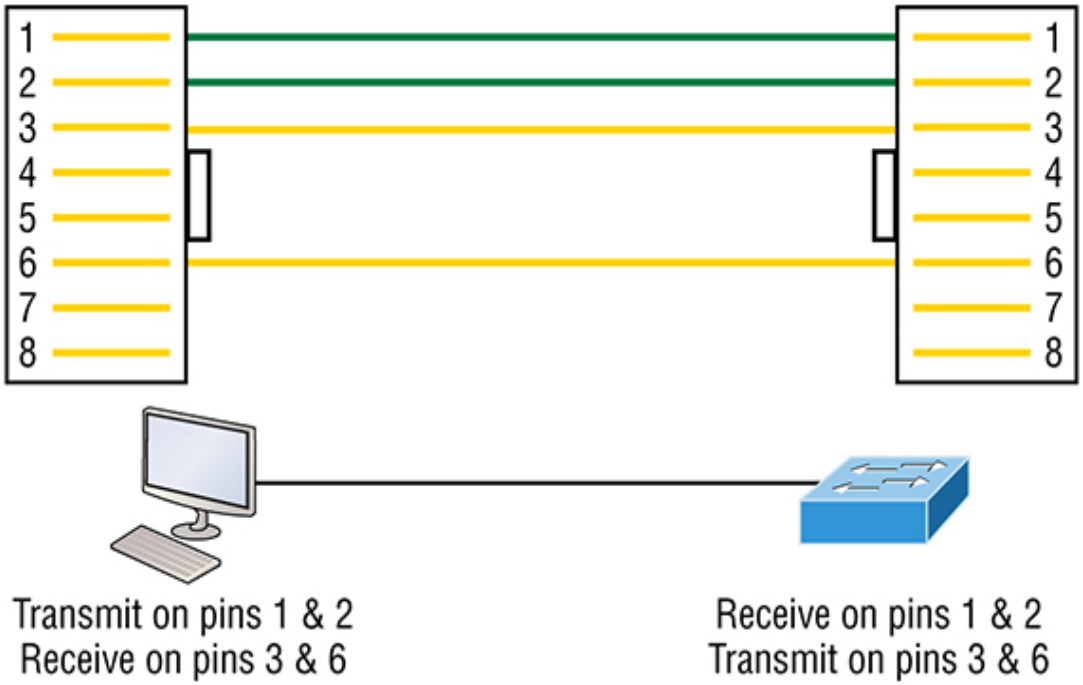
Physical Media

Straight Through Cable

Crossover Cable

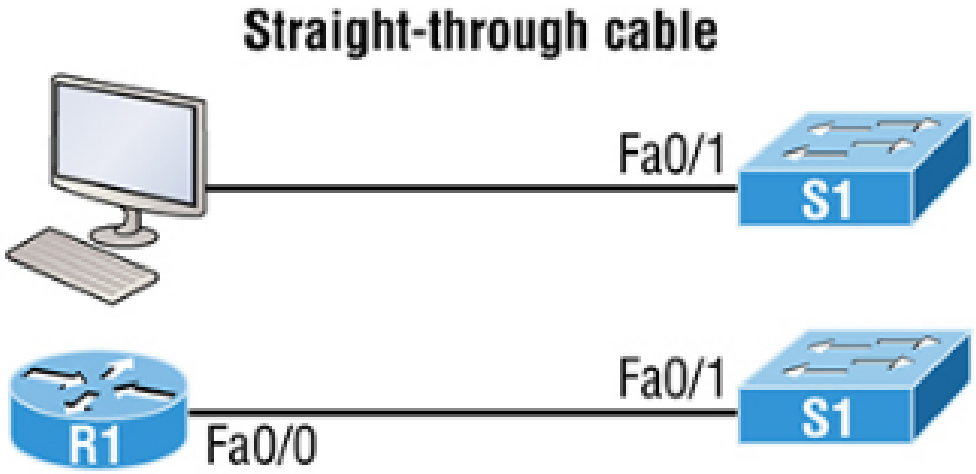
- Straight-Through Cable is used between two different devices such as connecting a PC to a switch, connecting a switch to a router, etc.
- Cross-Over Cable is used between two similar devices such as connecting a PC to another PC directly, connecting a switch to another switch.
- Note that, usually a PC is not connected directly to a router, if you want to connect then cross-over cable will be used, because Ethernet port of a router is similar to PC (MDI), while Ethernet port of switch is inverted (MDI-X).
- MDI: Media Dependent Interface. MDI-X: MDI cross-over

Physical Media



Physical Media

Straight-Through Cable is used between two different devices such as connecting a PC to a Switch, connecting a Switch to a Router.

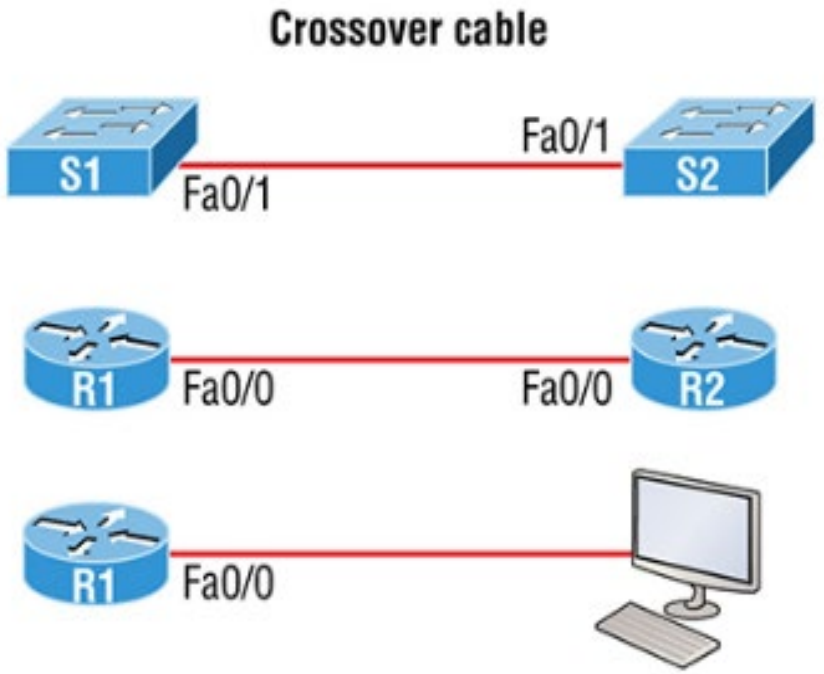


Physical Media

- Cross-Over Cable is used between two same devices such as connecting a PC to another PC directly, connecting a switch to another switch, etc.
- Note that, usually a PC is not connected directly to a router, if you want to connect then cross-over cable will be used, because Ethernet port of router is similar to PC, while Ethernet port of switch is inverted.

The crossover cable can be used to connect these devices:

- Switch to switch
- Hub to hub
- Host to host
- Hub to switch
- Router direct to host
- Router to router



Physical Media

- **Coaxial Cable**:

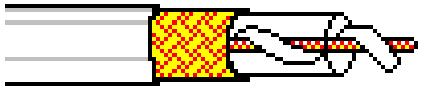
Consists of two copper conductors,

Two conductors are concentric,

Can be used as guided shared medium,

Bidirectional

Multiple channels on cable



- **Fiber-Optic Cable**:

Glass fiber carrying light pulses, each pulse is one bit,

High-speed operation, transmission rate in Gbps,

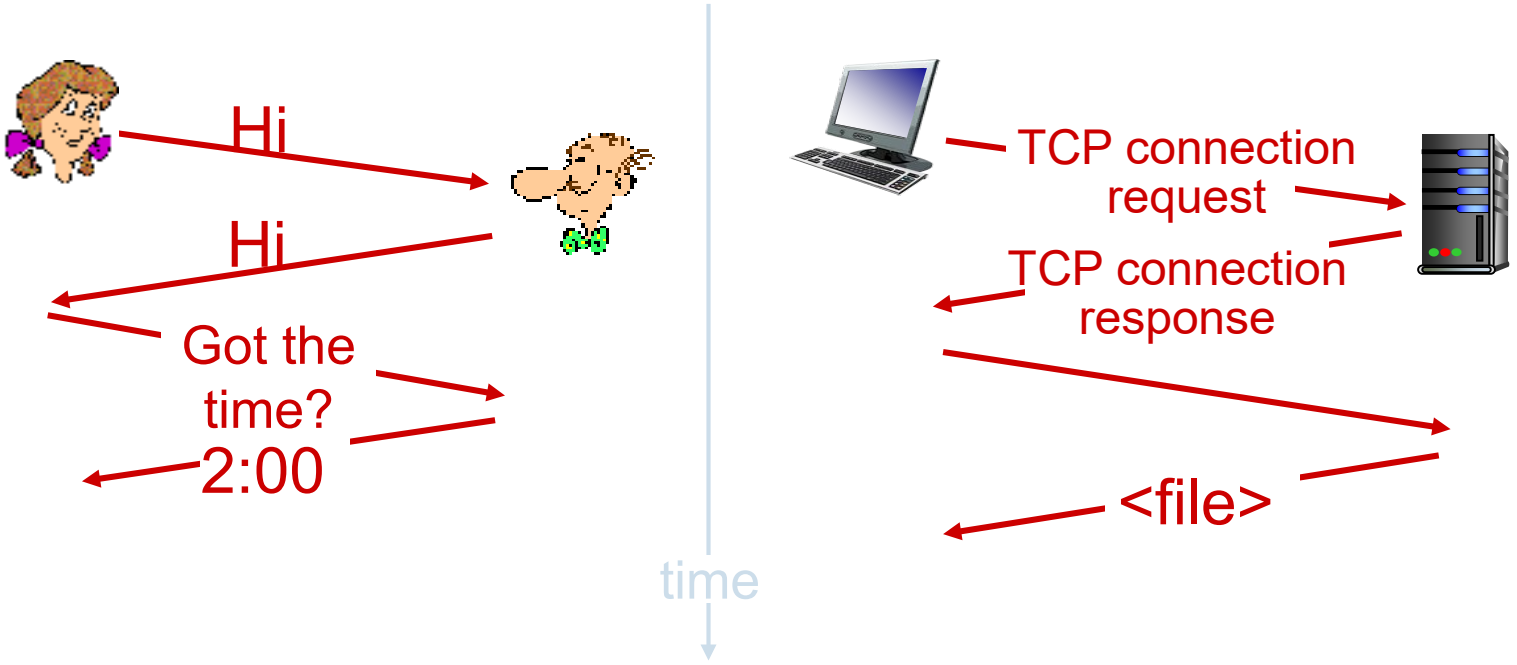
Low error rate,

Immune to electromagnetic noise

Physical Media

- Radio Channel (Wireless):
  - Signal carried in electromagnetic spectrum,
  - No physical wire, it is wireless
  - Bidirectional
  - Propagation environment effects:
    - Reflection
    - Obstruction by objects
    - Interference

What is a Protocol?



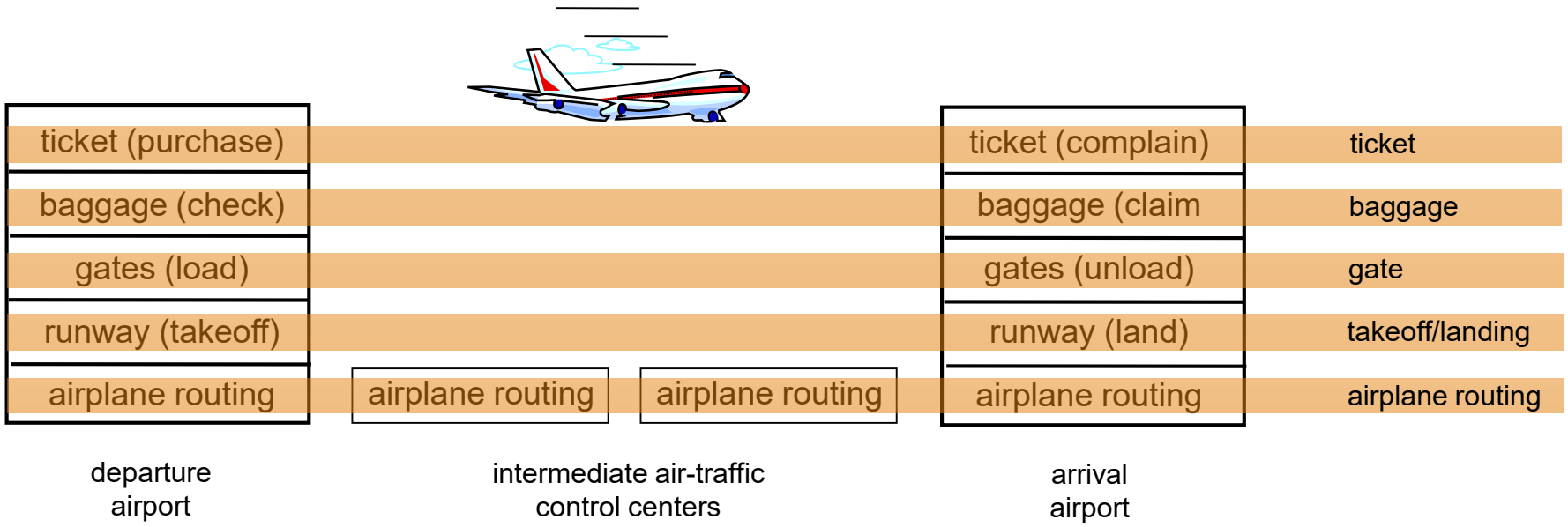
- The exchange of messages and the actions taken when these messages are sent and received are the key defining elements of a protocol.
- A protocol defines the format and the order of messages exchanged between two or more communicating entities, as well as the actions taken on the transmission and/or receipt of a message or other event.
- Examples: HTTP, SMTP, TCP, UDP, etc.

Protocol Layers

Networks are complex,
with many "pieces":

- hosts
- routers
- links of various media
- applications
- protocols
- hardware, software

Air Travel (Protocol Layers Analogy)



layers: each layer implements a service

- via its own internal-layer actions
- relying on services provided by layer below

Why Layering?

- Protocols are organized in layers, each protocol belongs to one of the layers.
- Each layer provides its service by performing certain actions within that layer, and by using the services of the layer directly below it.
- A protocol layer can be implemented in software, in hardware, or in a combination of the two.
- Modularization eases maintenance, updating of system, change of implementation of layer's service transparent to rest of system.
- **Drawbacks**: (1) Duplicate functionality, such as many protocol layers provide error recovery. (2) functionality at one layer need information from another layer only such as time-stamp.

Internet Protocol Stack

- The protocols of the various layers are called the Protocol Stack.
- The Internet Protocol stack consists of five layers:

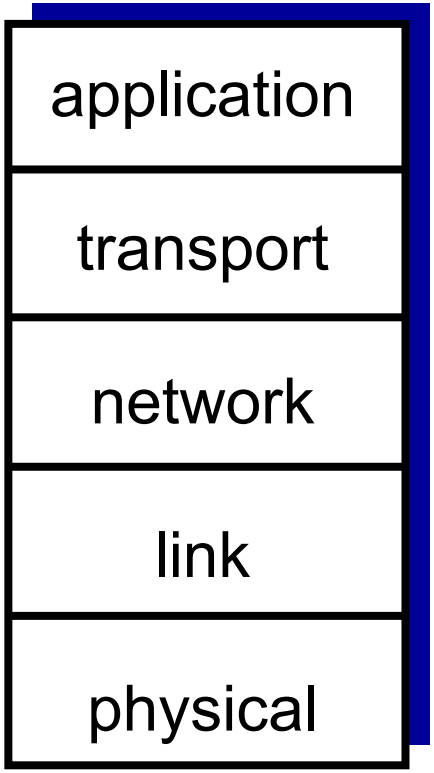
application: supporting network applications
- FTP, SMTP, HTTP

transport: process-to-process data transfer
- TCP, UDP

network: routing of datagrams from source to destination
- IP, routing protocols

link: data transfer between neighboring network elements
- Ethernet, 802.11 (WiFi), PPP

physical: bits "on the wire"



ISO/OSI Reference Model

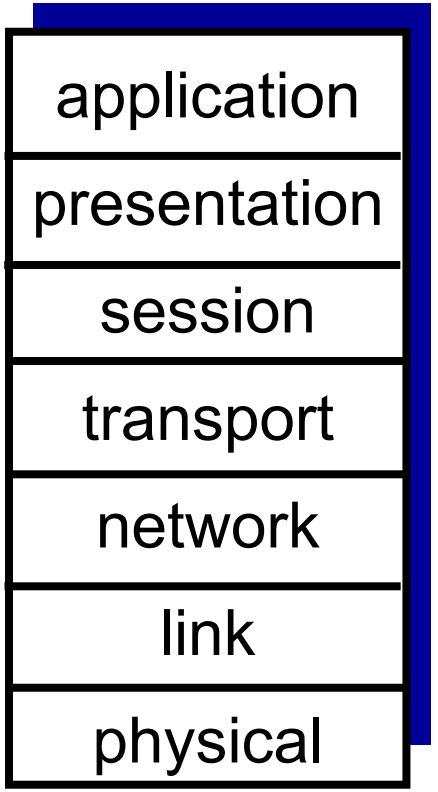
- Back in the late 1970s, the International Organization for Standardization (ISO) proposed that computer networks be organized around seven layers, called the Open Systems Interconnection (OSI) model.
- Two additional layers, however the functionality of five of these layers is roughly the same as Internet Protocol stack.

presentation: allow applications to interpret meaning of data, e.g., encryption, compression, machine-specific conventions

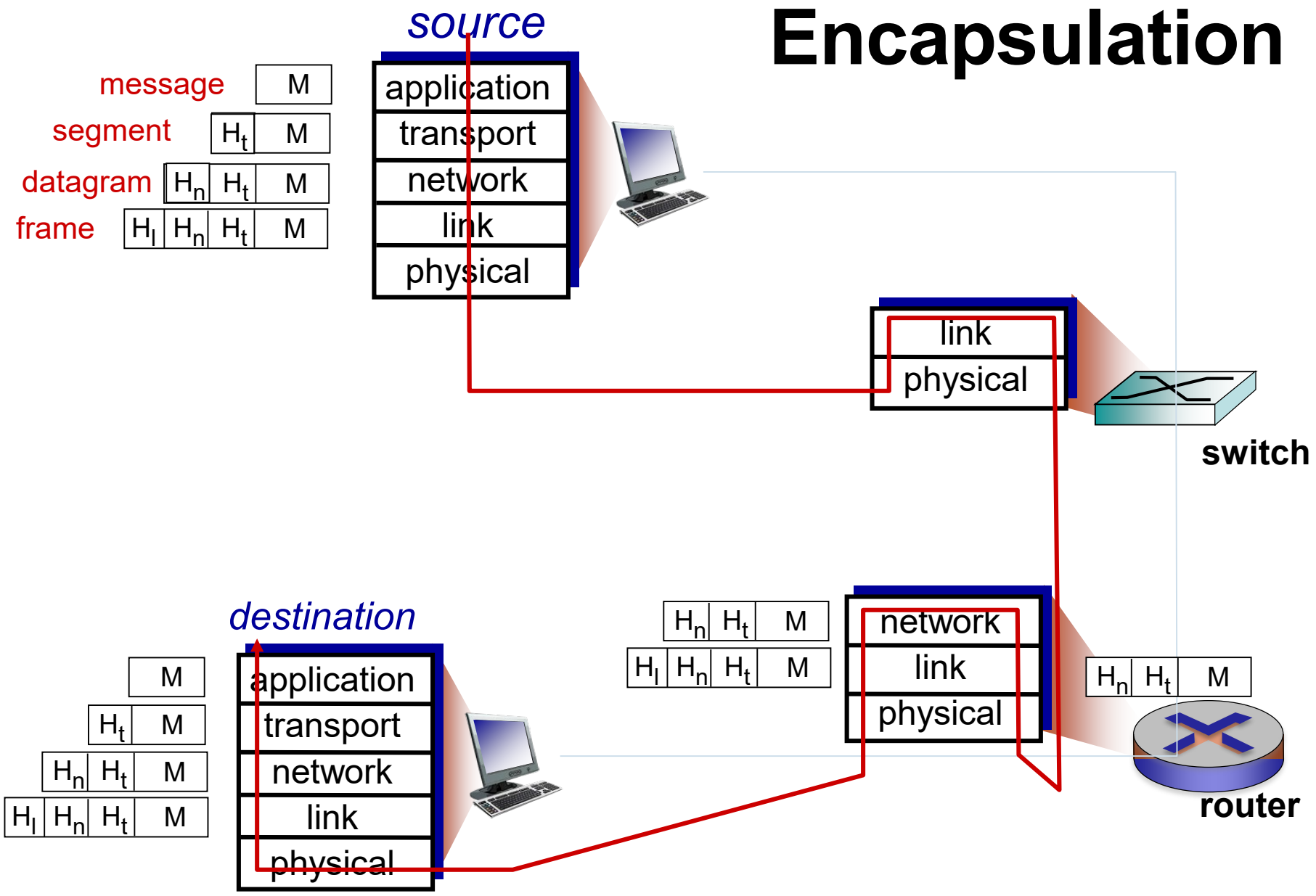
session: synchronization, checkpointing, recovery of data exchange

Internet stack "missing" these layers!

- these services, *if needed,* must be implemented in application



Encapsulation



Review Question

- List five tasks that a layer can perform. Is it possible that one (or more) of these tasks could be performed by two (or more) layers?

Five generic tasks are error control, flow control, segmentation and reassembly, multiplexing, and connection setup. Yes, these tasks can be duplicated at different layers. For example, error control is often provided at more than one layer.

Review Question

- What are the five layers in the Internet protocol stack?

The five layers in the Internet protocol stack are – from top to bottom – the application layer, the transport layer, the network layer, the link layer, and the physical layer.

Review Question

➢What is an application-layer message? A transport-layer segment? A network-layer datagram? A link-layer frame?

- Application-layer message: data which an application wants to send and passed onto the transport layer;
- Transport-layer segment: generated by the transport layer and encapsulates application-layer message with transport layer header;
- Network-layer datagram: encapsulates transport-layer segment with a network-layer header;
- Link-layer frame: encapsulates network-layer datagram with a link-layer header.

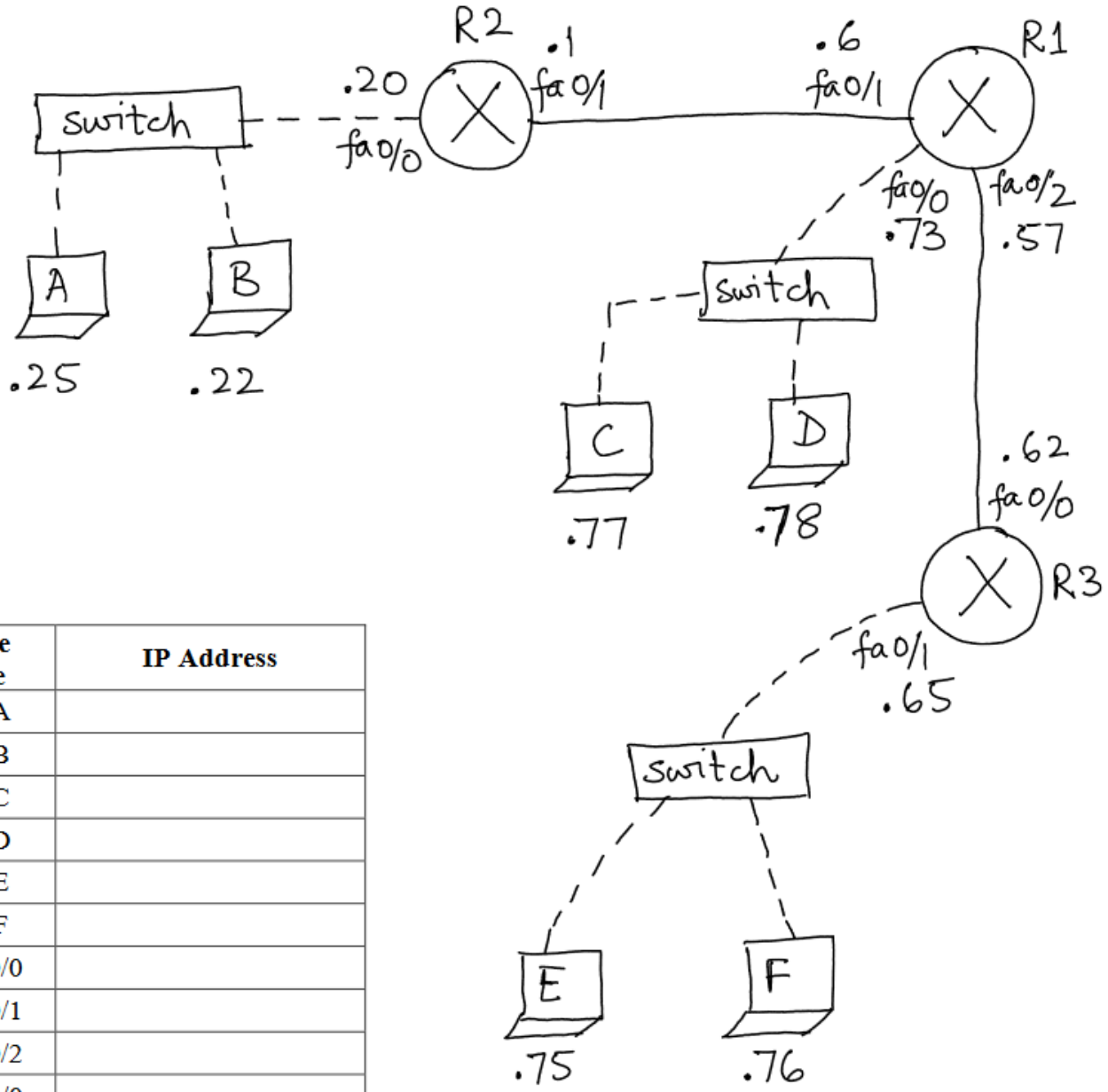
Review Question

➢Which layers in the Internet protocol stack does a router process? Which layers does a link-layer switch process? Which layers does a host process?

- Routers process network, link and physical layers (layers 1 through 3).
- Link layer switches process link and physical layers (layers 1 through2).
- Hosts process all five layers.

Practice Problem

In the given network diagram, some hosts are unable to communicate with others. Troubleshoot the network diagram and identify the errors in IP addresses and cabling. List only the correct IP addresses in the following table. Do not list those devices/interfaces that already have correct addresses. Circle/Highlight the incorrect cables. Note that all IP addresses belong to 195.1.X.X with subnet mask 255.255.255.248 and only last two bytes of IPs (X.X) are shown in the figure.



Device Name	IP Address
Host A	
Host B	
Host C	
Host D	
Host E	
Host F	
R1, fa0/0	
R1, fa0/1	
R1, fa0/2	
R2, fa0/0	
R2, fa0/1	
R3, fa0/0	
R3, fa0/1	