

课程介绍

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□ 主要参考资料

■ 思科网络技术学院教程

□ 网络简介

□ 路由和交换基础

■ 计算机网络

□ 谢希仁 第六版、第七版



课程考核

□ 考试

- 英文试题
- 内容

□ 上机

- 拓扑实现
 - 模拟器练习 packet tracer
-



NANJING UNIVERSITY · SOFTWARE INSTITUTE
南京大学 · 软件学院

Computer Network & Network Reference Model

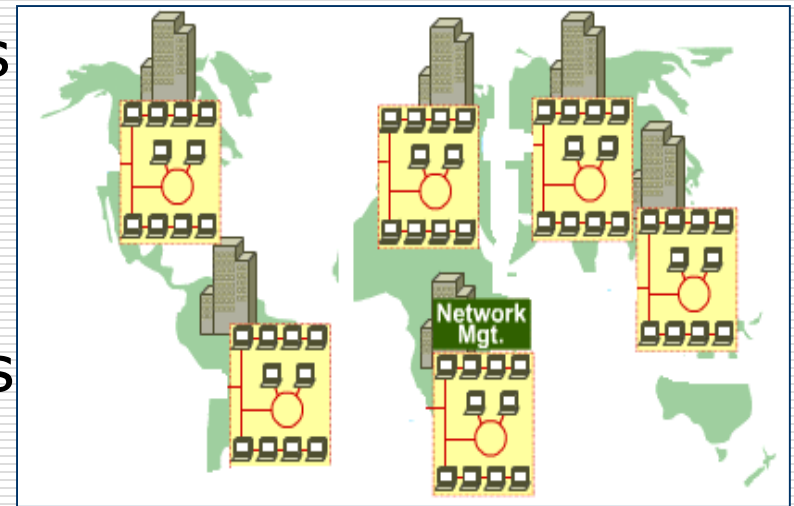


Computer Network & Network Reference Model

- Overview of Computer Network
 - OSI Reference Model
 - TCP/IP Model
 - Network Topology
 - Network Devices
-

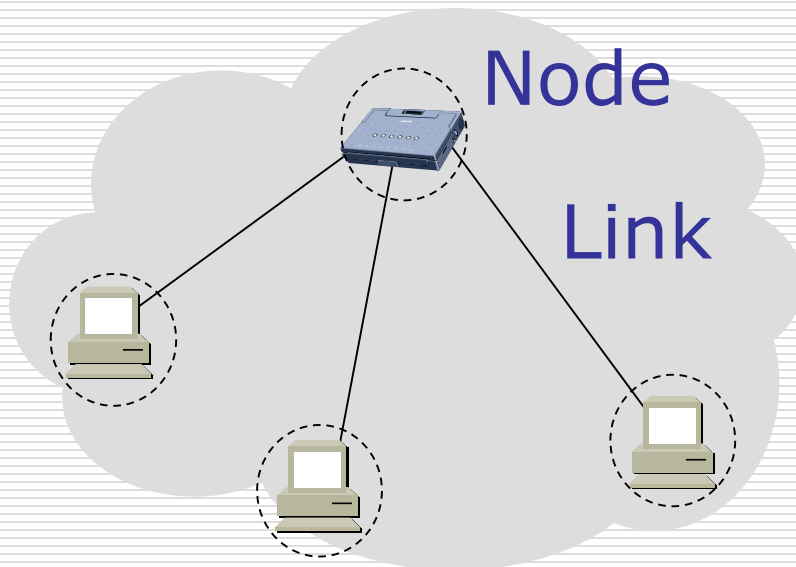
Networks

- What is a network ?
 - A network is an intricately connected system of objects, devices, or people
- Companies created networks
 - As companies expanded, the need for connecting networks at different sites became very important



Data Networks Classifications

- **LAN**(*Local Area Networks*)
- **WAN**(*Wide Area Networks*)

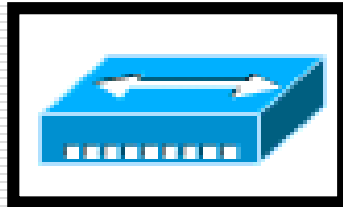


LAN/WAN

- ❑ Local Area Networks (LANs)
 - Operate locally (cover small areas)
 - Multi-user access
 - High speeds expected (up to Gbps/10Gbps)
 - Error rate is easily controlled
 - ❑ Wide Area Networks (WANs)
 - Operate over larger areas
 - Access over serial links, optical links, etc.
 - Traditionally, have Lower speeds
 - Error rate can not be easily controlled
-

LAN Devices

Hub



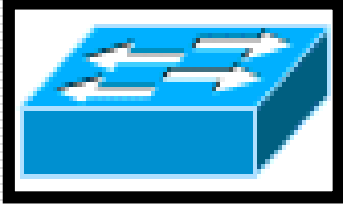
- Multiport repeater, connects PCs; Repeats signals

Bridge



- LAN segmentation; MAC addresses.

Switch



- Multiport-bridge; Full bandwidth

Router



- Path determination; Packet switching
-

WAN Devices

Router

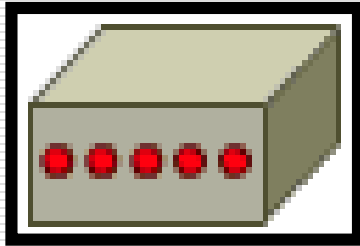


- Path determination;
Packet switching

Modem

CSU/DSU

TA/NT1

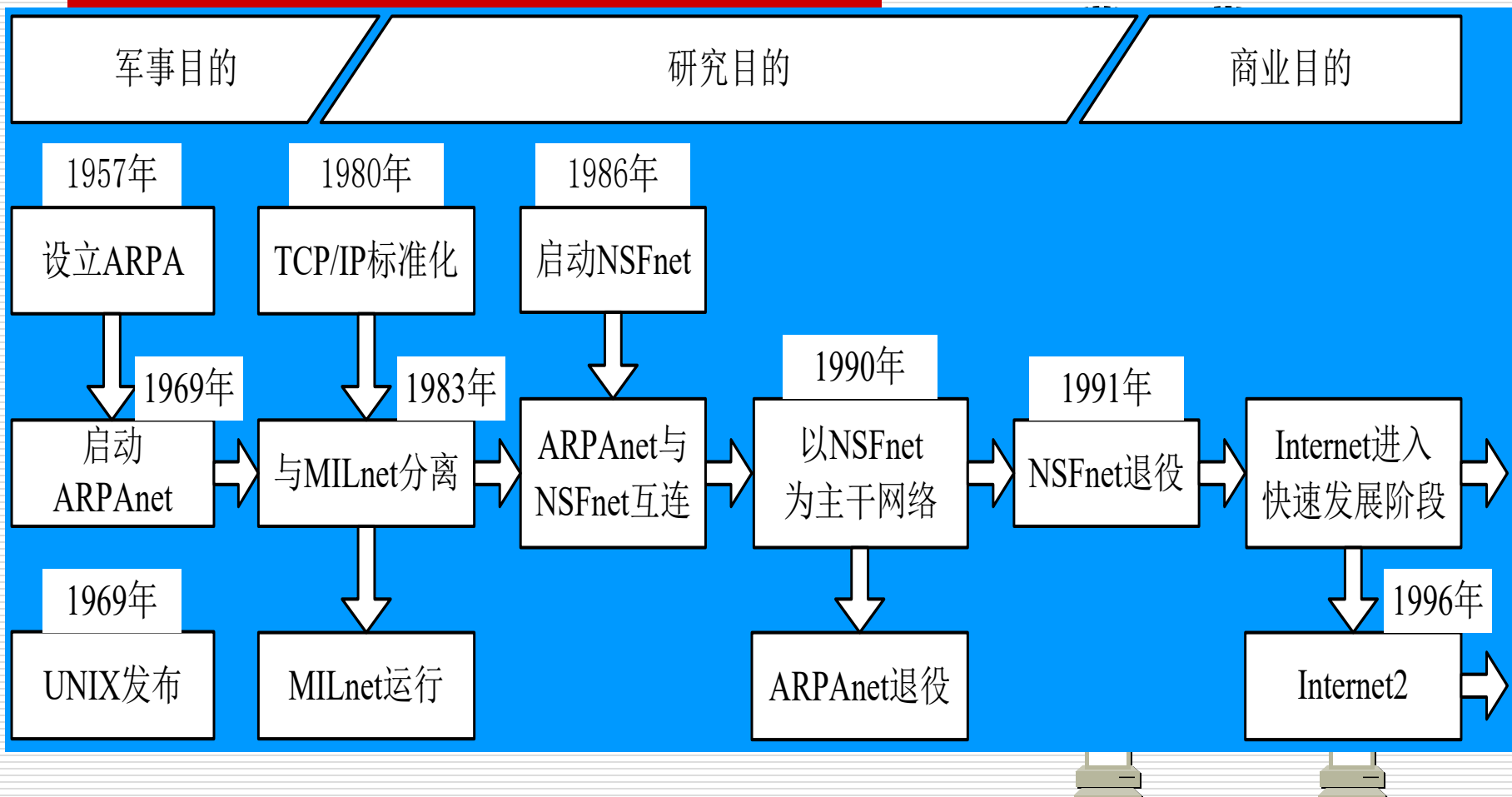


- Analog to Digital;
Remote LAN connections
-

LAN Services and WAN Services

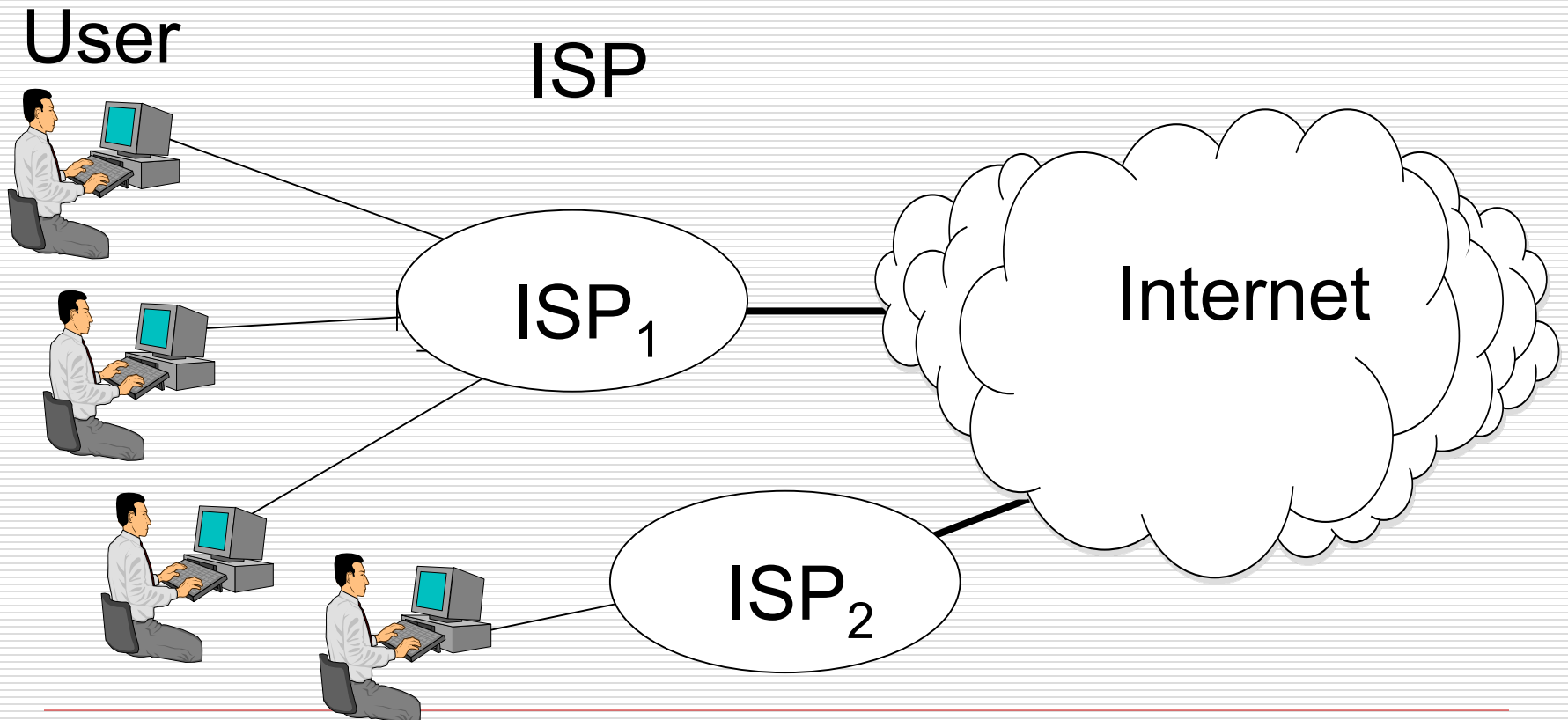
- LAN service: Ethernet, the most popular service
 - WAN services...
 - Modem
 - ISDN
 - DSL
 - Frame Relay
 - ATM
 - T1/E1
 - T3
 - STS-1, STS-3, STS-48 (SONET/SDH)
-

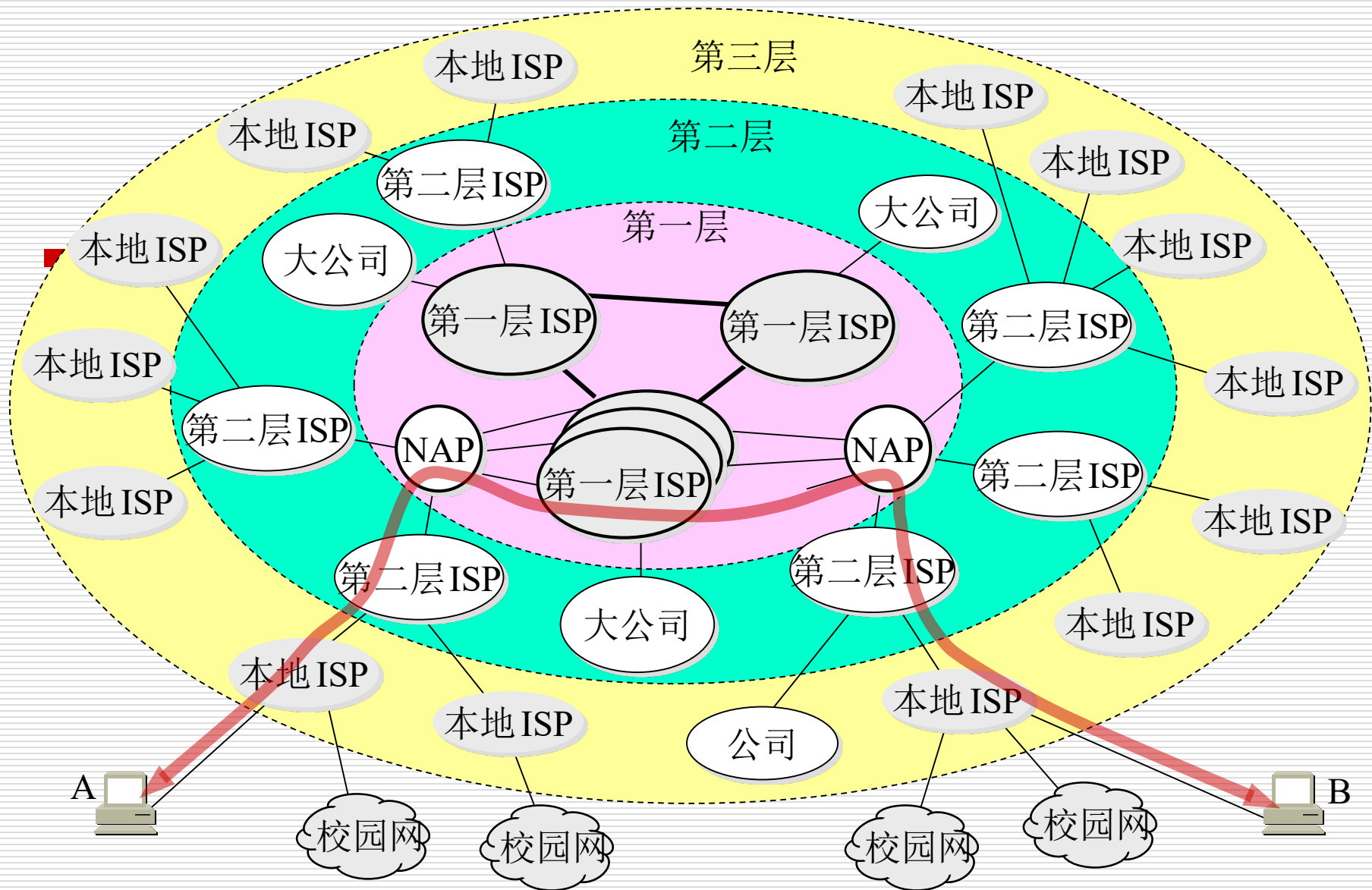
Internet



Internet with Multi-layer ISP structure

□ Internet Service Providers (ISP)





主机A → 本地 ISP → 第二层 ISP → NAP → 第一层 ISP → NAP → 第二层 ISP → 本地 ISP → 主机B

Internet with Multi-layer ISP structure

Data

- ❑ Data is sent in bits, 1s and 0s.
 - ❑ Data is not the information itself
 - ❑ Data is an encoded form of information which is a series of electrical impulses/optical signals into which information is transmitted for sending
-

Data Packets

- For transmission, computer data is often broken into small, easily transmitted units
 - Using the OSI model, these units can be called **packets**, or **frames** or **segments**
 - Why data packets?
 - Computers can take turns sending packets
 - If packet is lost, only small amount of data must be retransmitted.
 - Data can take different paths.
-

Protocol

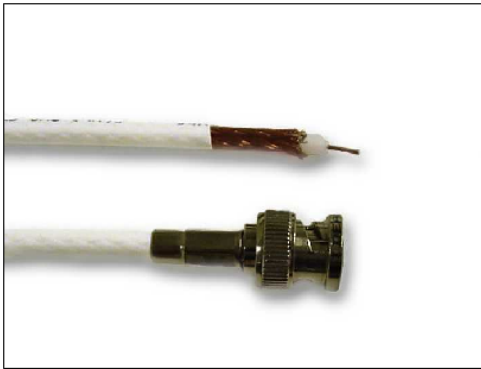
- ❑ It is possible for different types of computer systems to communicate
 - ❑ All devices must speak the same “language” or use the same ***protocol*** (use same set of rules).
-

Source and Destination

- ▣ Source address specifies the identity of the computer sending the packet.
 - ▣ Destination address specifies the identity of the computer designated to receive the packet.
-

Media Types

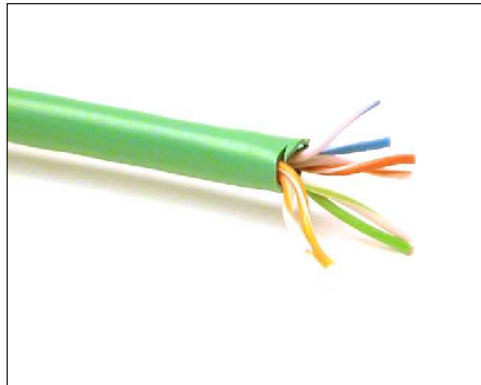
10BASE2 50 Ohm Coax Cable



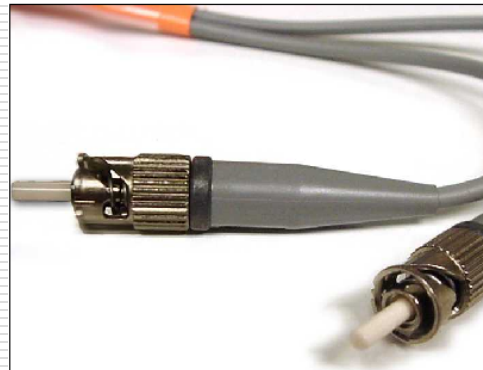
10BASE5 Thicknet Cable



UTP



Fiber Optic Cable Connectors



AIR

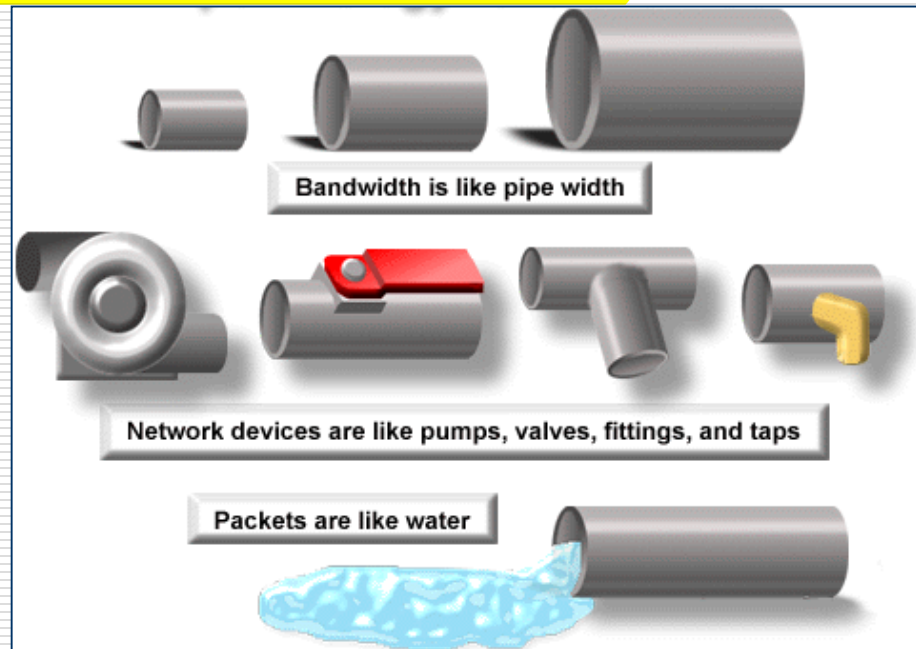
carries
light, radio,
microwave

Media—material through which data packets travel

Digital Bandwidth

❑ **Bandwidth** is the measure of how much information can flow from one place to another in a given amount of time.

Measured in:
bits/second (**bps**)



Throughput

Actual, measured, bandwidth, at a specific time

$$\text{Throughput} \leq \text{Bandwidth}$$

Computer Network & Network Reference Model

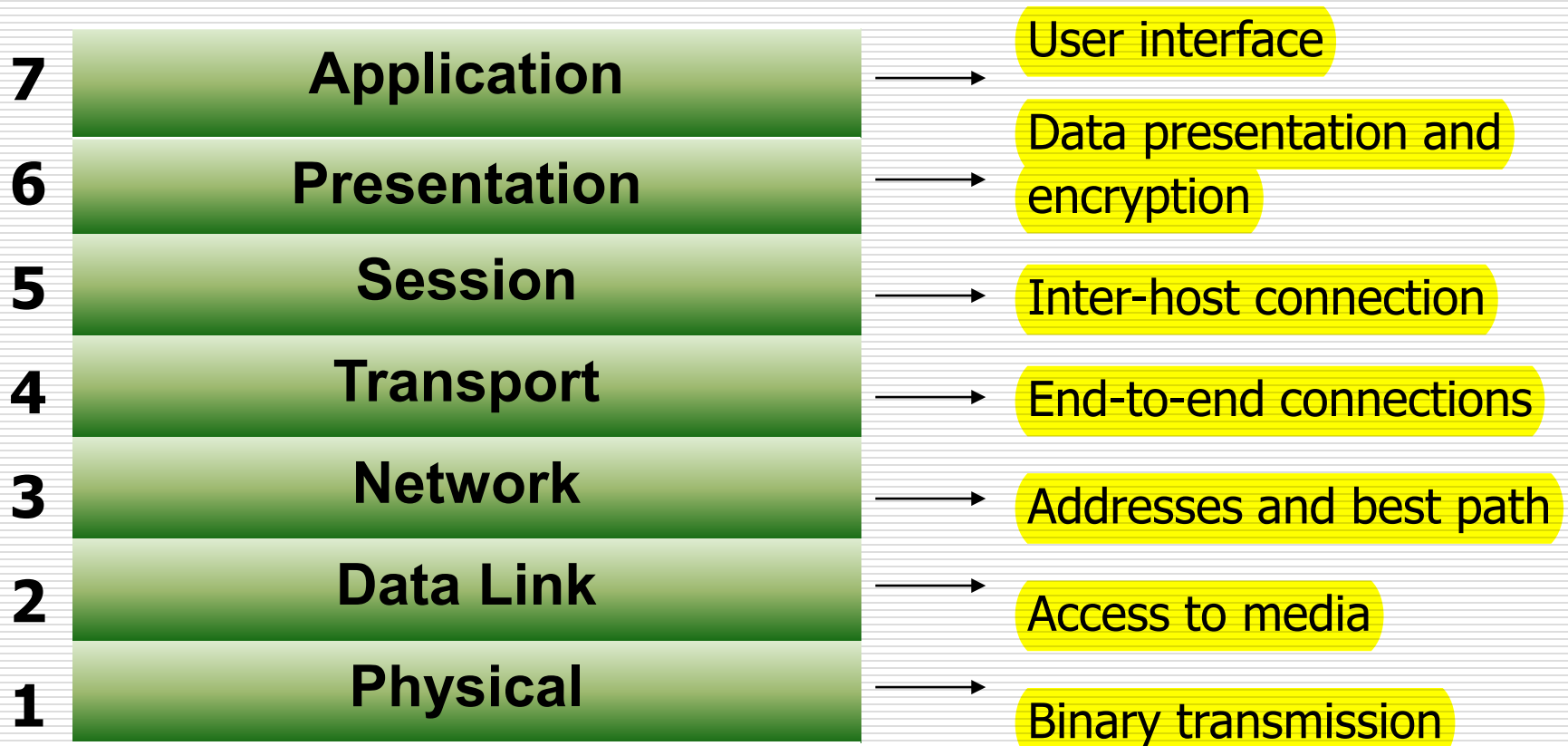
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OSI (Open System Interconnection) Model

- ❑ Proposed by International Organization for Standardization (ISO)
 - ❑ A network model that help network builders implement networks that could communicate and work together
 - ❑ Describes how information or data moves from one computer through a network to another computer
 - ❑ a *layered* communication process
 - Each layer performs a specific task
-

The OSI Reference Model

Each layer has a unique function.



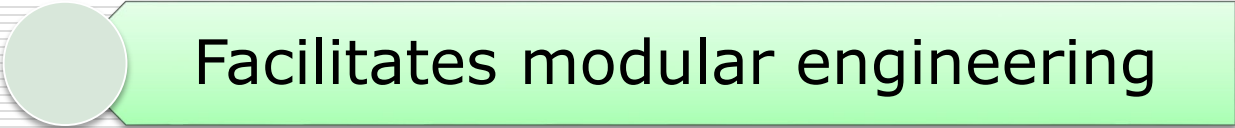
Why a Layered Model?




Reduce Complexity



Standardizes interfaces



Facilitates modular engineering



Ensures interoperable technology



Accelerates evolution



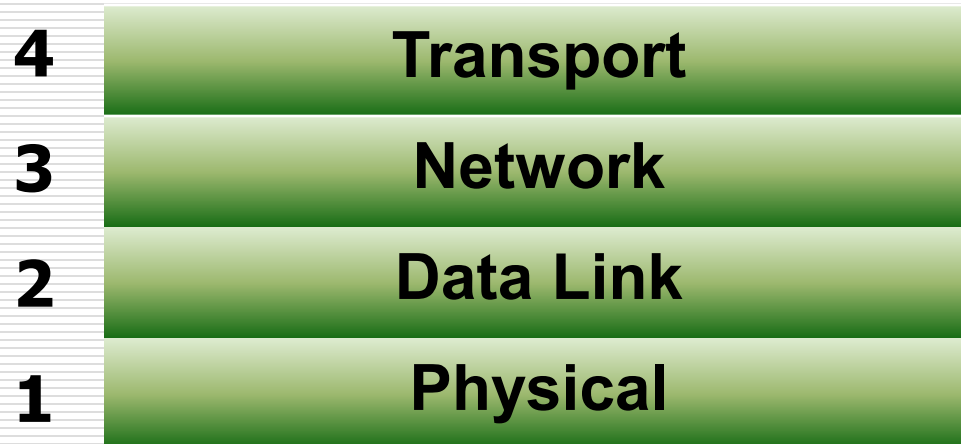
Simplifies teaching and learning

The OSI Reference Model



- ❑ The top 3 layers are known as the *application layers*
 - because they deal with the user interface, data formatting, and the application access.
-

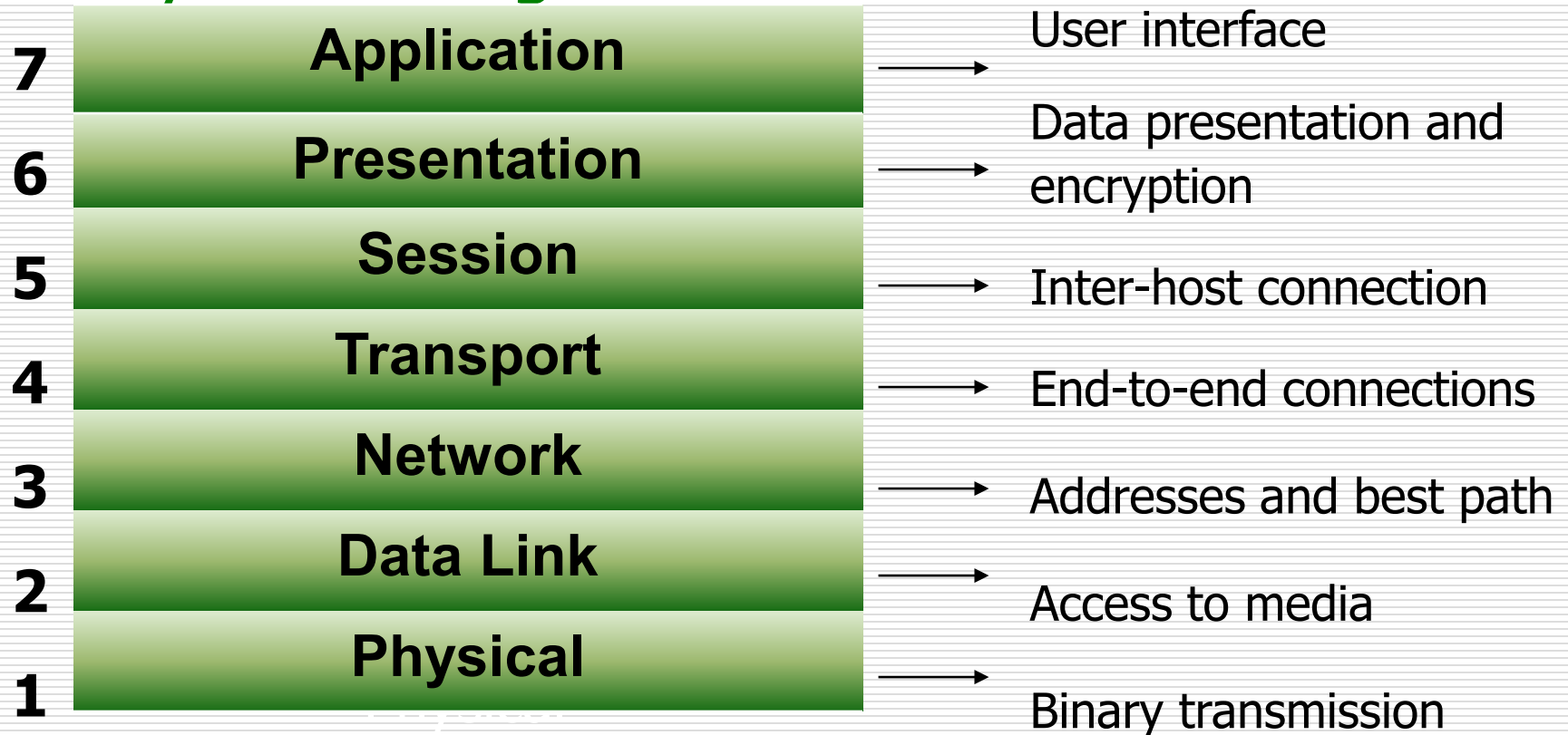
The OSI Reference Model



- Layers 1-4 are known as the *data flow layers*
 - because they control the physical delivery of messages over the network.
-

Layer 1: The Physical Layer

Keywords: Signal and Media

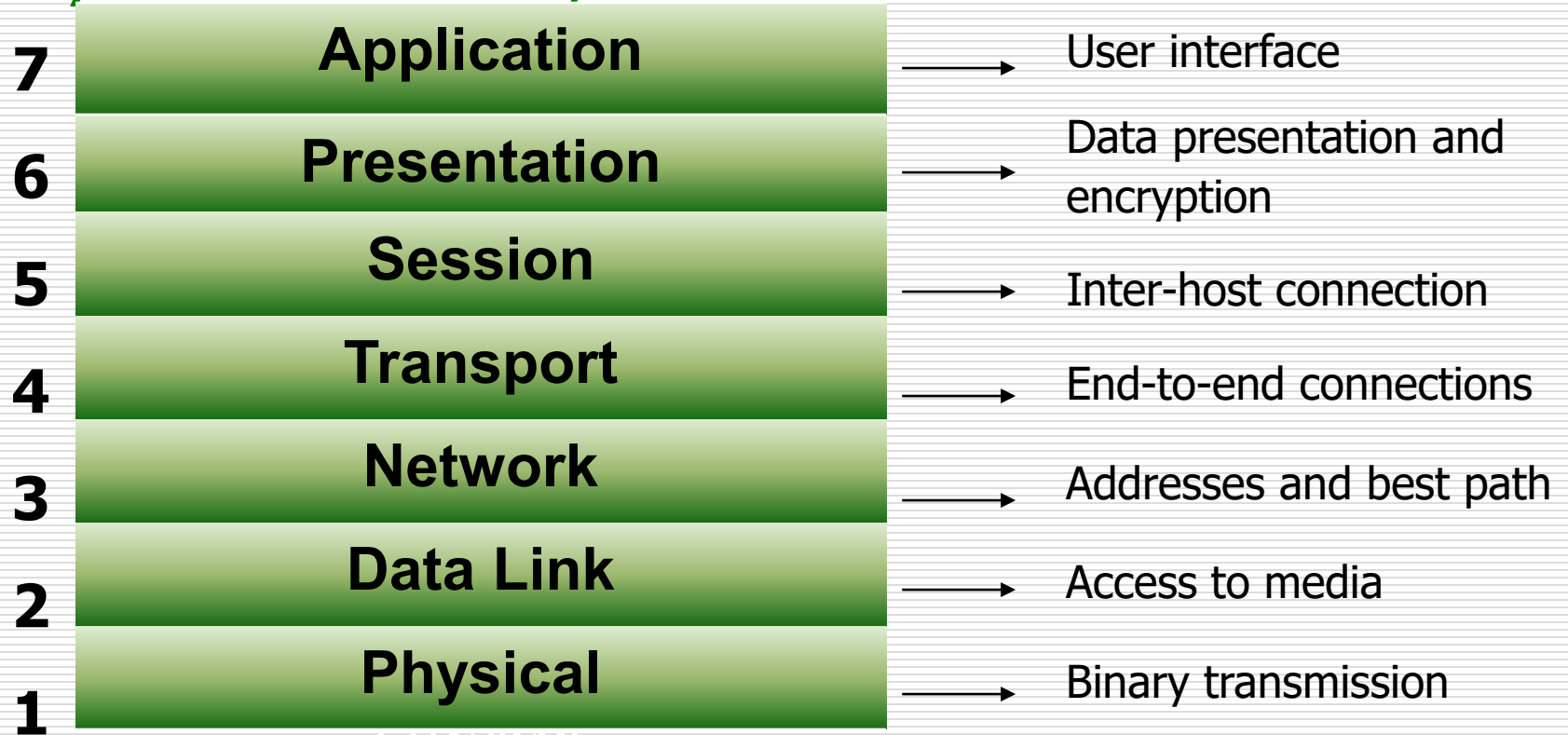


Layer 1: The Physical Layer

- ❑ defines the electrical and functional specifications for the link between end systems (including media)
 - ❑ defines voltage levels, timing of voltage changes, physical data rates, maximum transmission distances, physical connectors, and other, similar attributes
-

Layer 2: The Data Link Layer

Keywords: frame, media access control

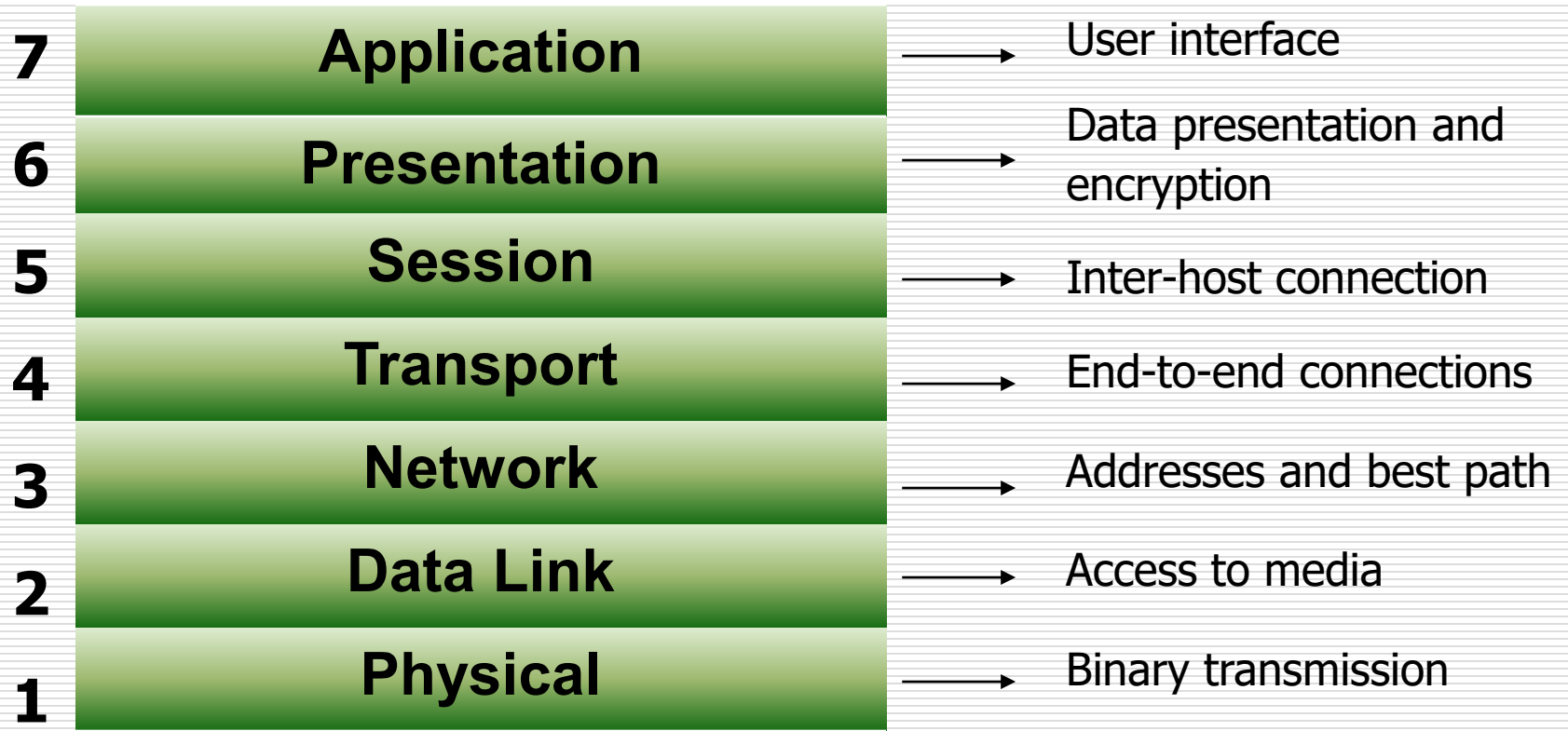


Layer 2: The Data Link Layer

- ❑ provides reliable transit of data across a physical link
 - ❑ is concerned with physical (as opposed to logical) addressing, network topology, network access, error notification, ordered delivery of frames, and flow control
-

Layer 3: The Network Layer

Keywords: Path selection, Routing, Addressing

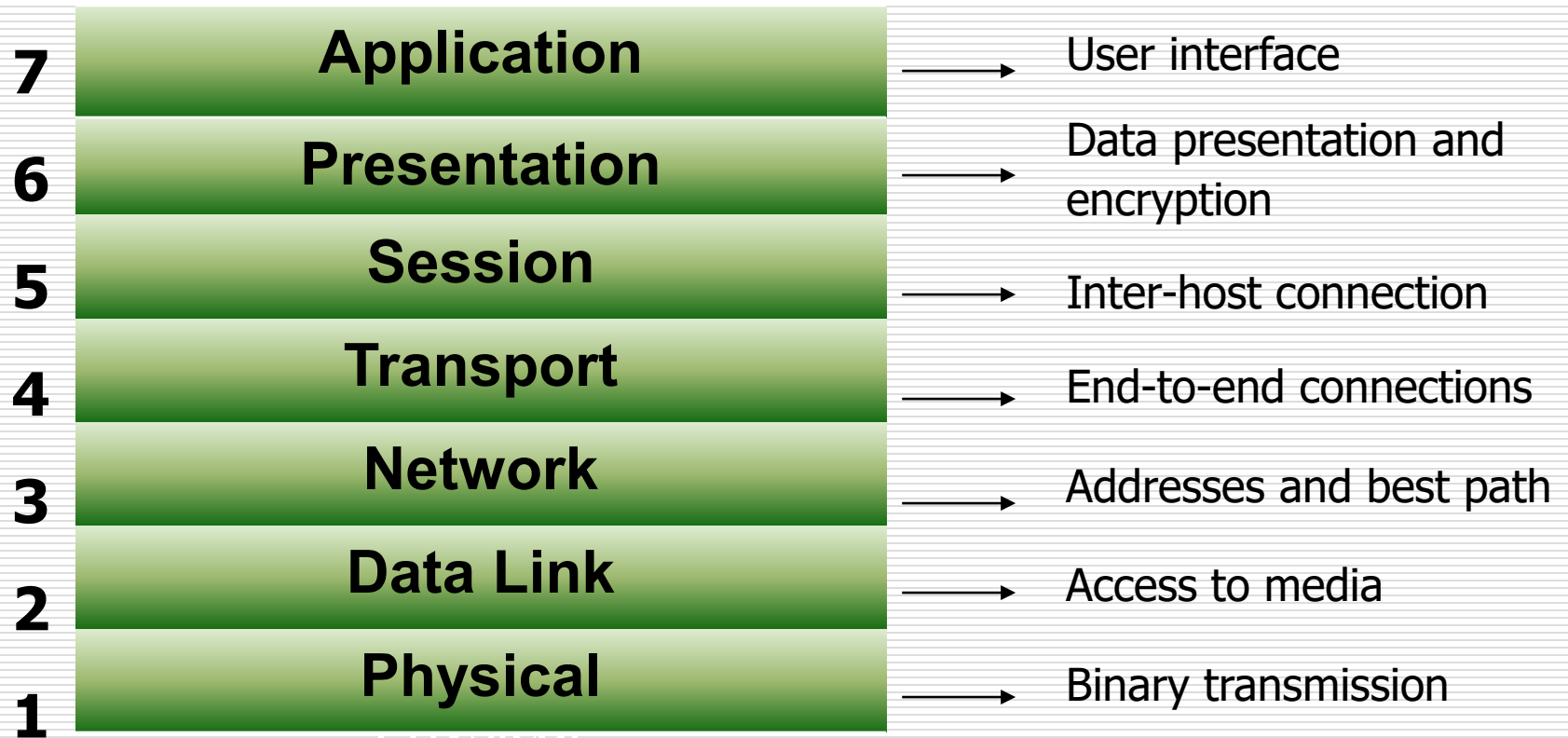


Layer 3: The Network Layer

- Provide connectivity and path selection between two end systems where routing occurs
 - These may be located on geographically separated networks
-

Layer 4: The Transport Layer

Keywords: Reliability, Flow control, Error correction

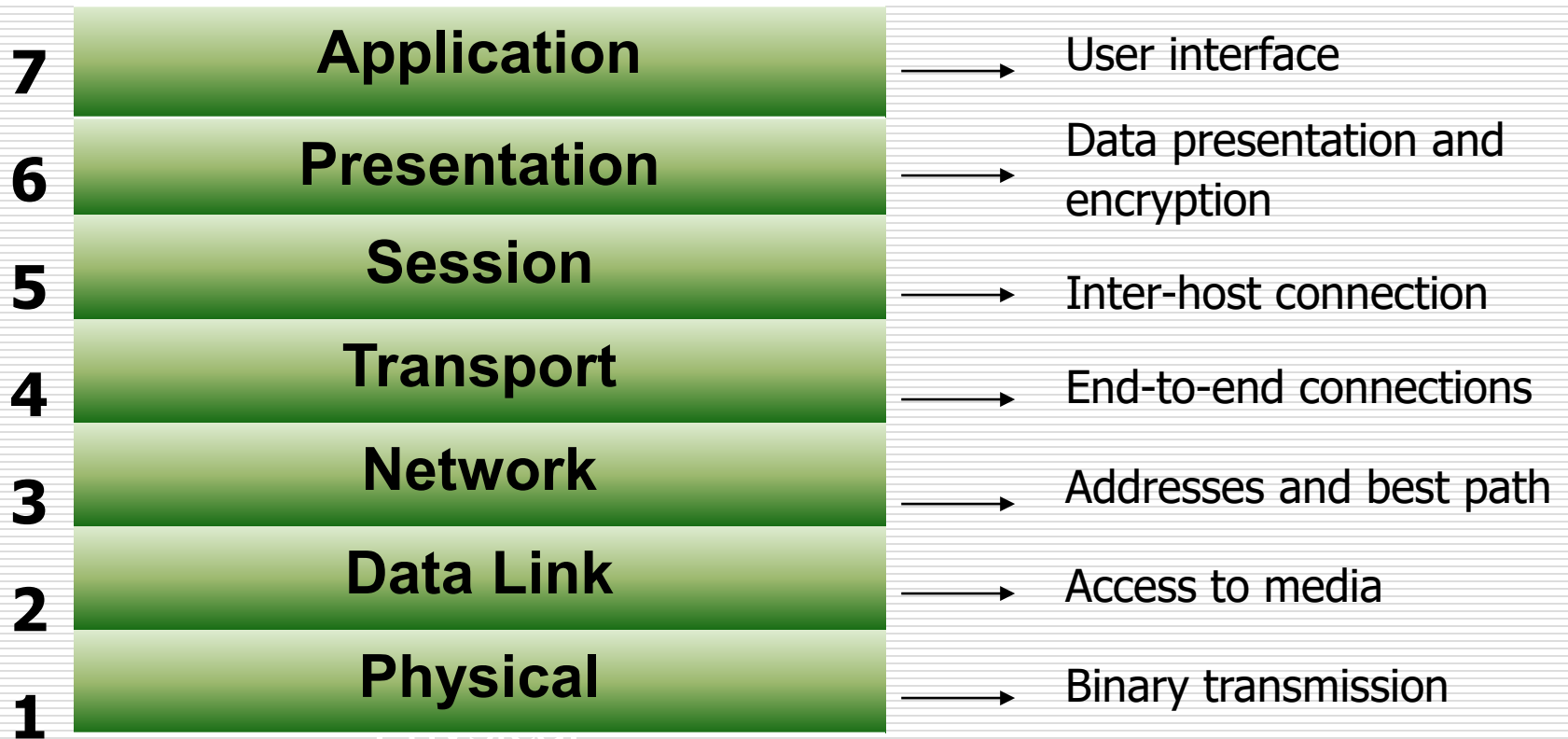


Layer 4: The Transport Layer

- ❑ segments and reassembles data into a data stream
 - ❑ concerned with how reliable transport over an internetwork is accomplished
 - ❑ responsible for reliable network communication between end nodes and provides mechanisms for the establishment, maintenance, and termination of virtual circuits, transport fault detection and recovery, and information flow control
-

Layer 5: The Session Layer

Keywords: Dialog and Conversations

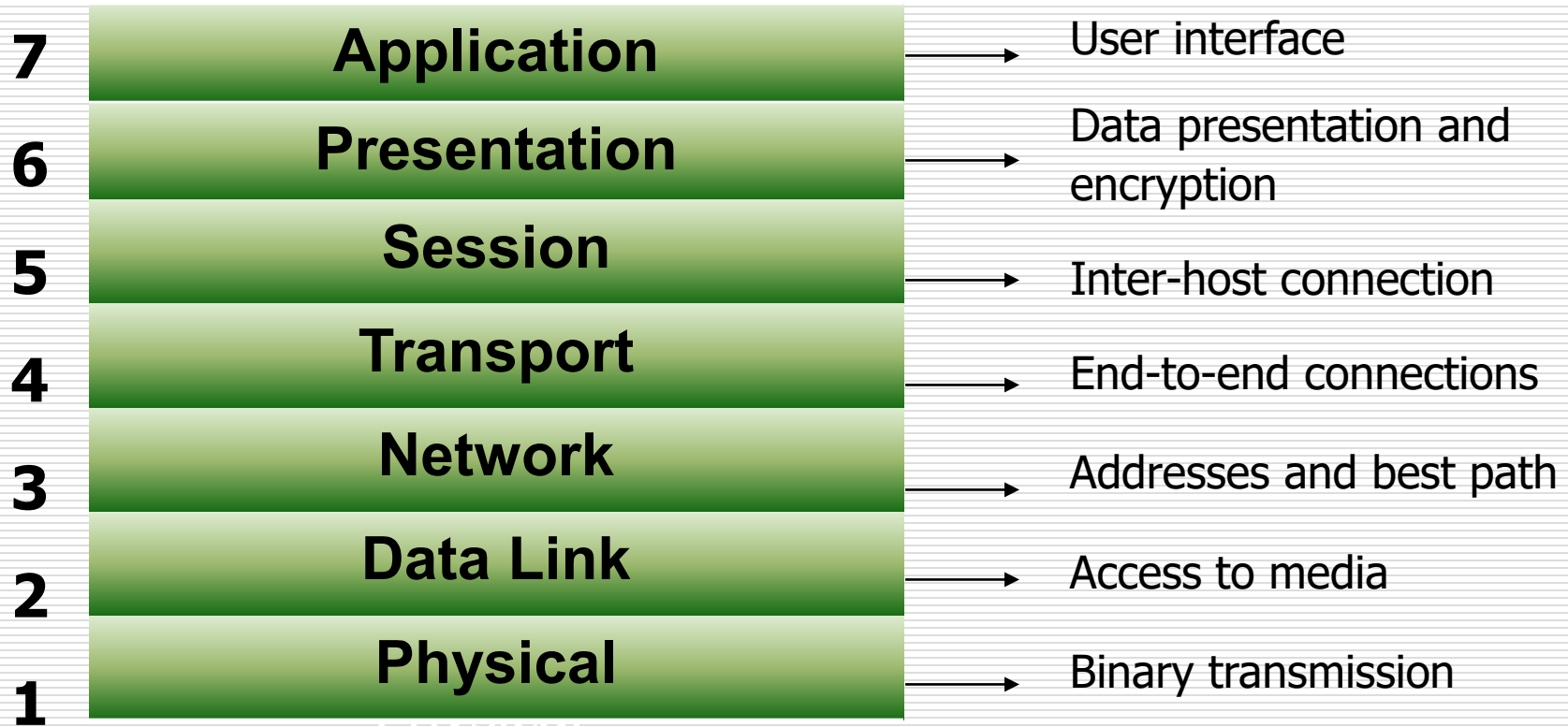


Layer 5: The Session Layer

- ❑ establishes, manages, and terminates sessions between communicating hosts
 - ❑ synchronizes dialog between presentation layer entities and manages their data exchange
 - ❑ offers provisions for efficient data transfer, class of service, and exception reporting of session, presentation, and application layer problems
 - ❑ manages data exchange between presentation layer entities
-

Layer6: The Presentation Layer

Keywords: Common Format

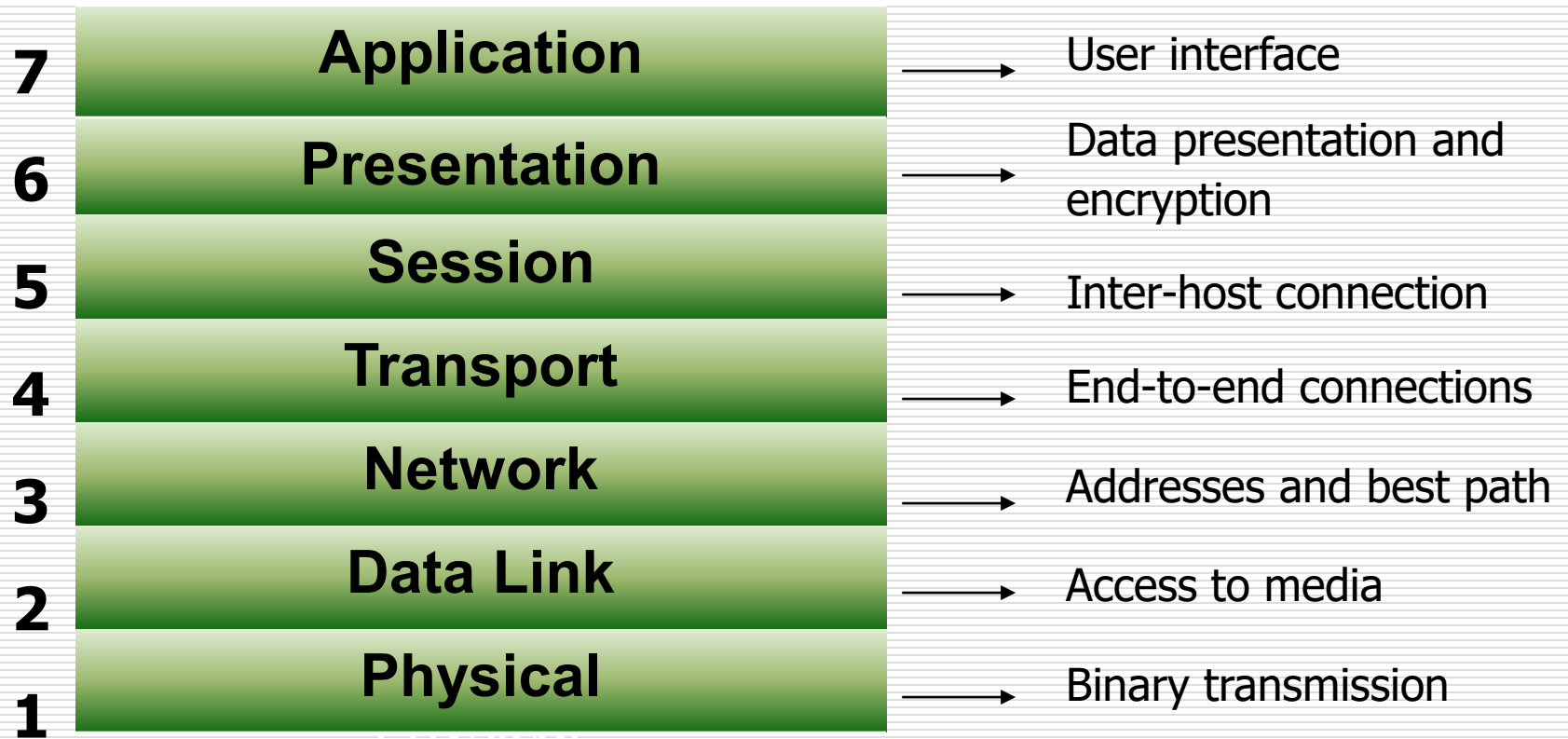


Layer6: The Presentation Layer

- ❑ ensures that information sent by the application layer of one system is readable by the application layer of another system
 - ❑ translates between multiple data representation formats by using a common data representation format
 - ❑ concerned with data structures and negotiation of data transfer syntax
 - ❑ responsible for compression and encryption
-

Layer 7: The Application Layer

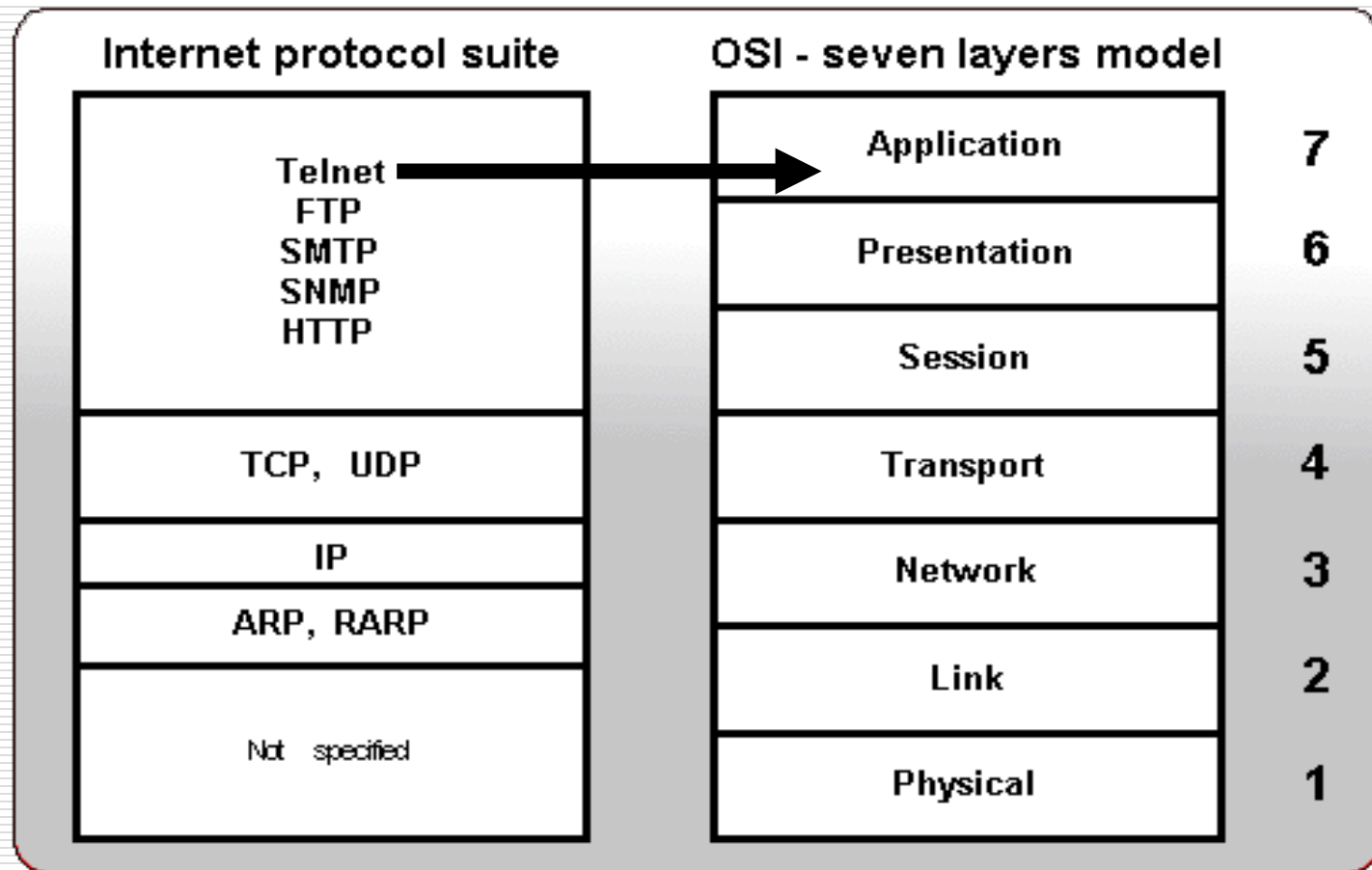
Keyword: Browser



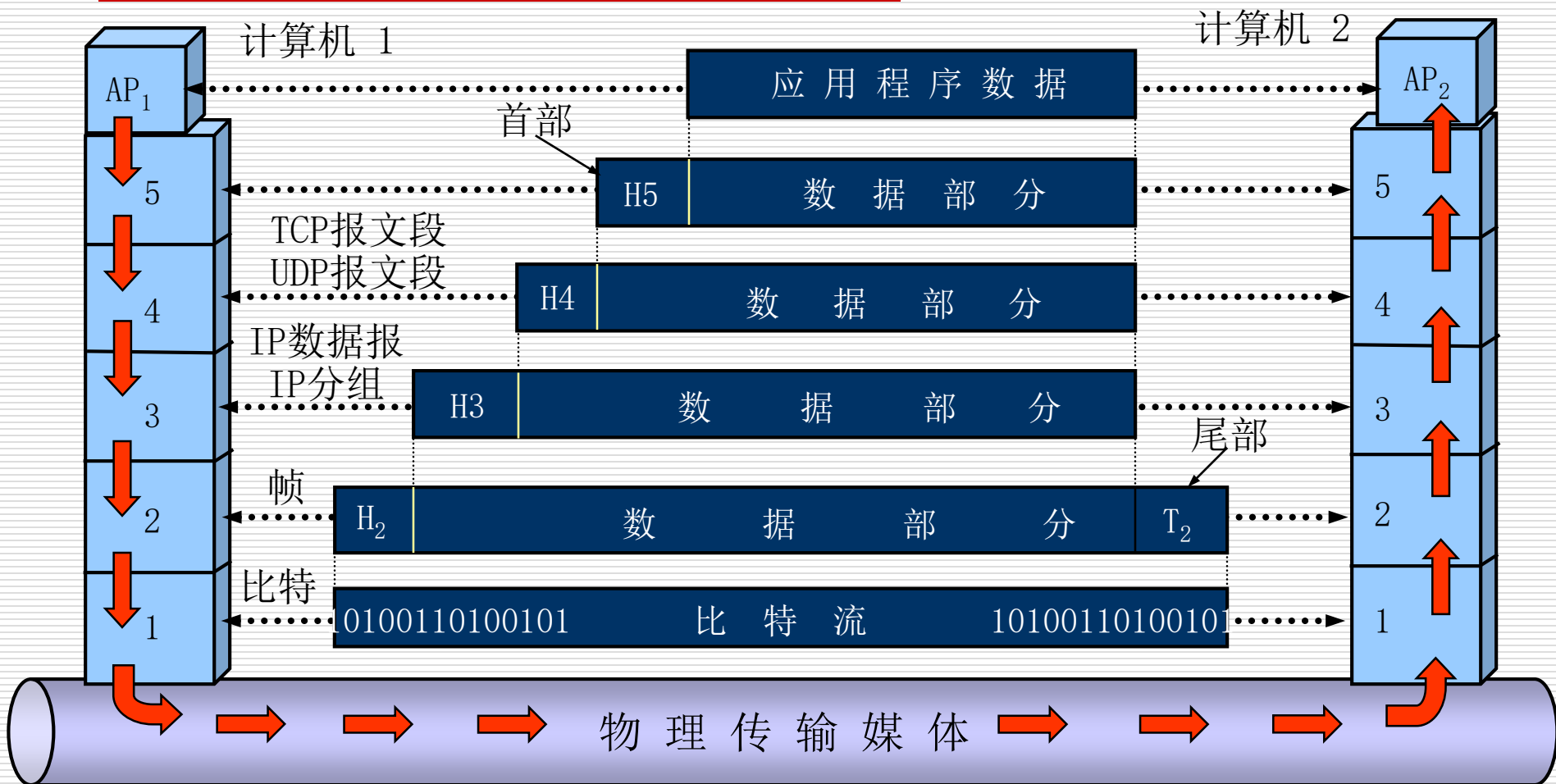
Layer 7: The Application Layer

- ❑ closest to the user
 - ❑ provides network services to user applications
 - ❑ does not provide services to any other OSI layer
-

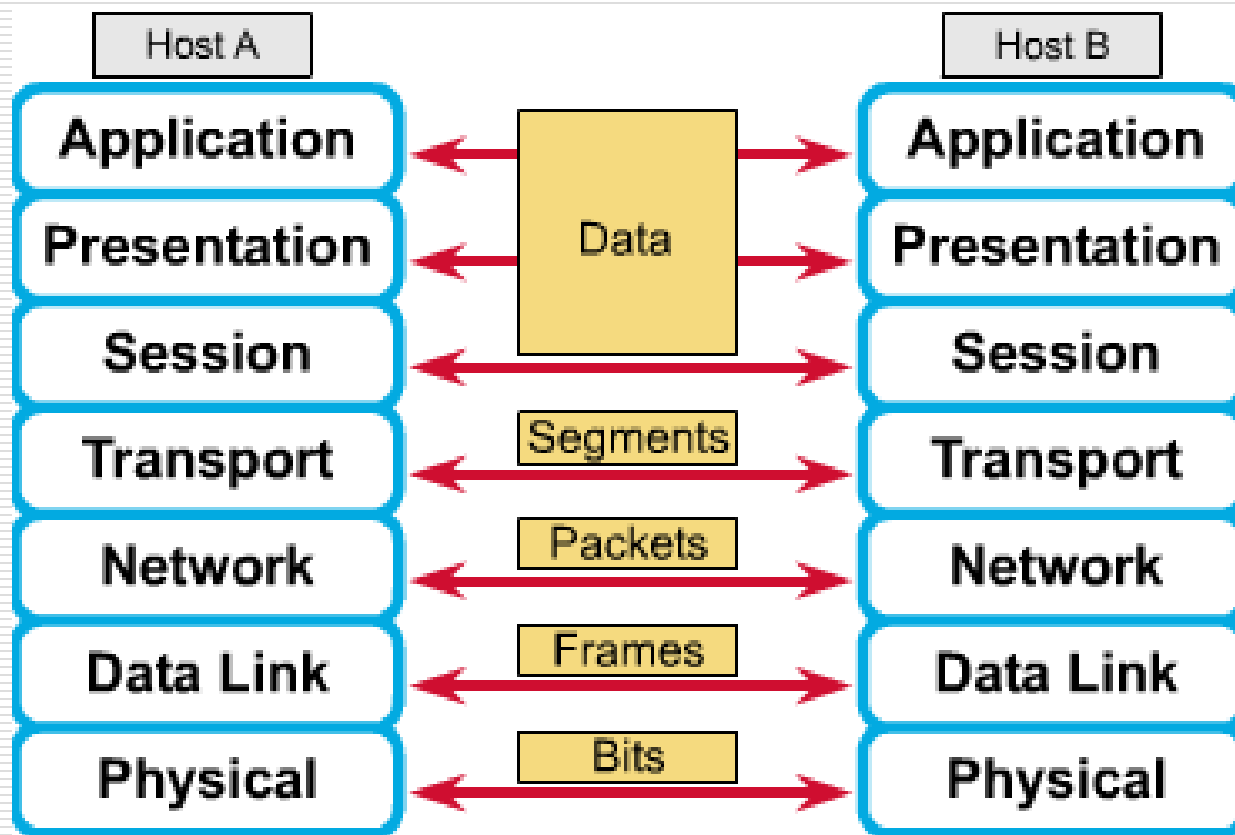
Protocols on ISO layers



Data Encapsulation



Peer-to-Peer Communications



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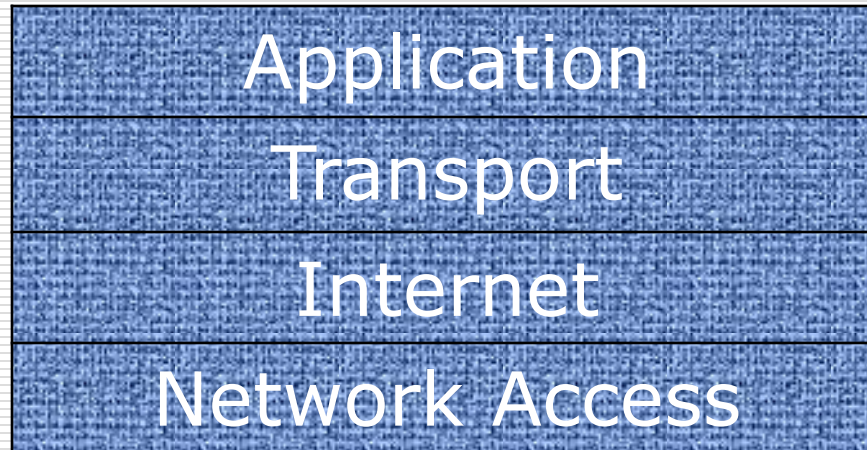


The TCP/IP Model

- ❑ The U.S. Department of Defense (*DoD*) created the TCP/IP reference model
 - ❑ The DoD wants its packets to **get through every time, under any conditions, from any one point to any other point.**
 - ❑ It brought about the creation of the TCP/IP model
 - ❑ TCP/IP model has since become the standard on which the Internet has grown
-

The TCP/IP Model

- The TCP/IP model has only four layers.



The TCP/IP Model - Application Layer

- ❑ Handles high-level protocols, issues of representation, encoding, and session control
 - ❑ TCP/IP combines all application-related issues into one layer, and assures this data is properly packaged for the next layer.
-

The TCP/IP Model - Transport Layer

- ❑ Deals with the quality-of-service issues of reliability, flow control, and error correction.
 - ❑ Transmission Control Protocol (TCP)
 - ❑ User Datagram Protocol (UDP)
 - ❑ It packages application layer information into units called segments
-

The TCP/IP Model - Internet Layer

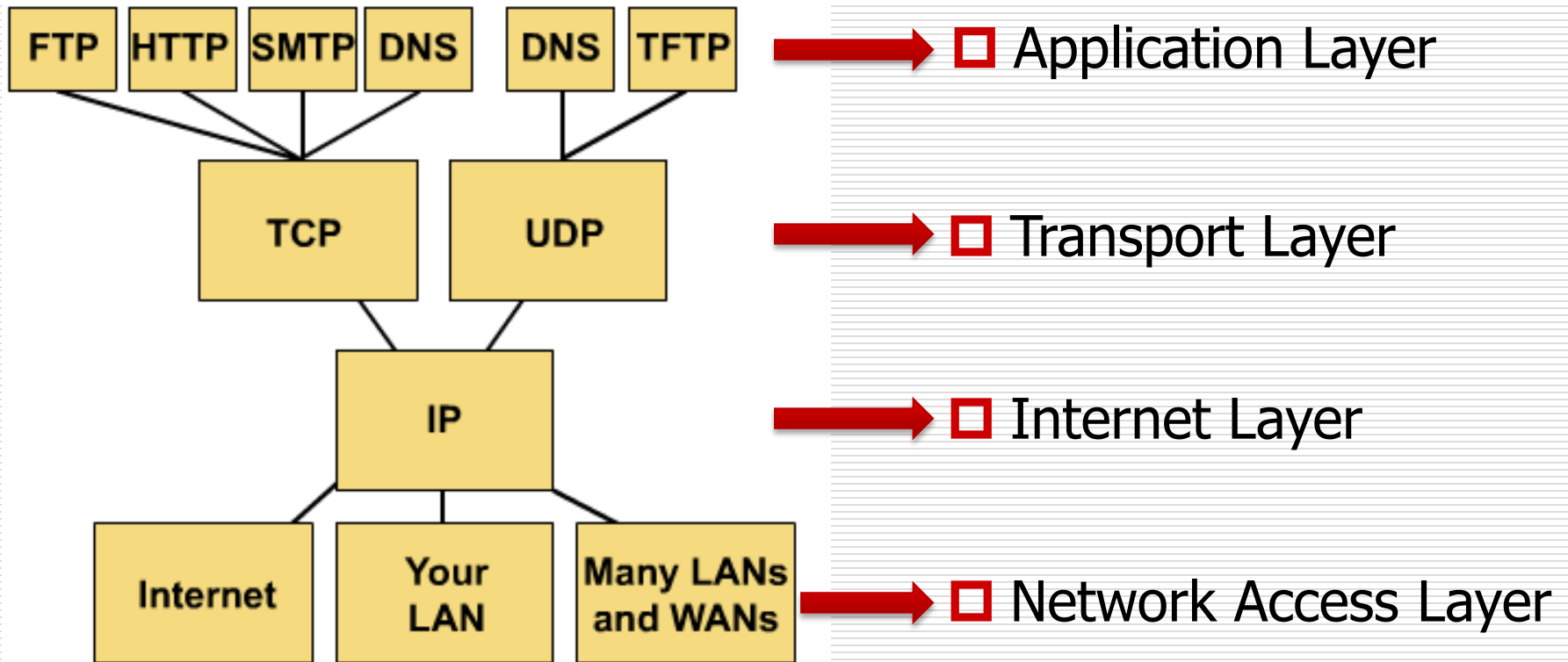
- ❑ Purpose: Send source packets from any network on the internetwork and have them arrive at the destination independent of the path and networks
 - ❑ Best path determination and packet switching occur at this layer
 - ❑ Internet protocol (IP)
-

The TCP/IP Model – Network Access Layer

- ❑ Is also called the host-to-network layer.
 - ❑ It is concerned with all of the issues that an IP packet requires to actually make a physical link, and then to make another physical link.
 - ❑ It includes the LAN and WAN technology details, and all the details in the OSI physical and data link layers.
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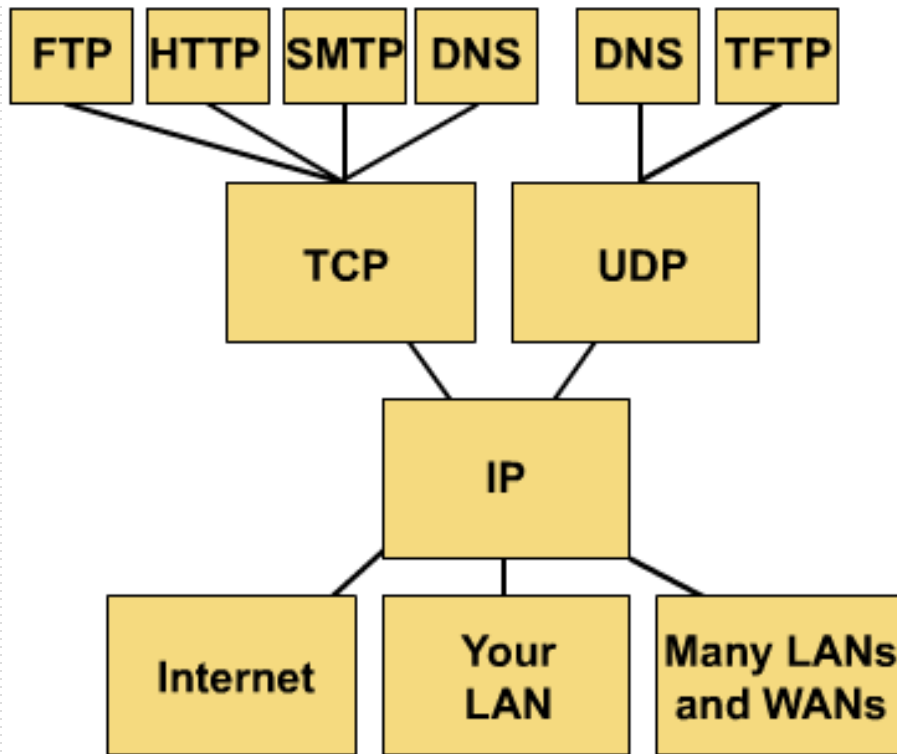
Common TCP/IP Protocols

Protocol Graph: TCP/IP



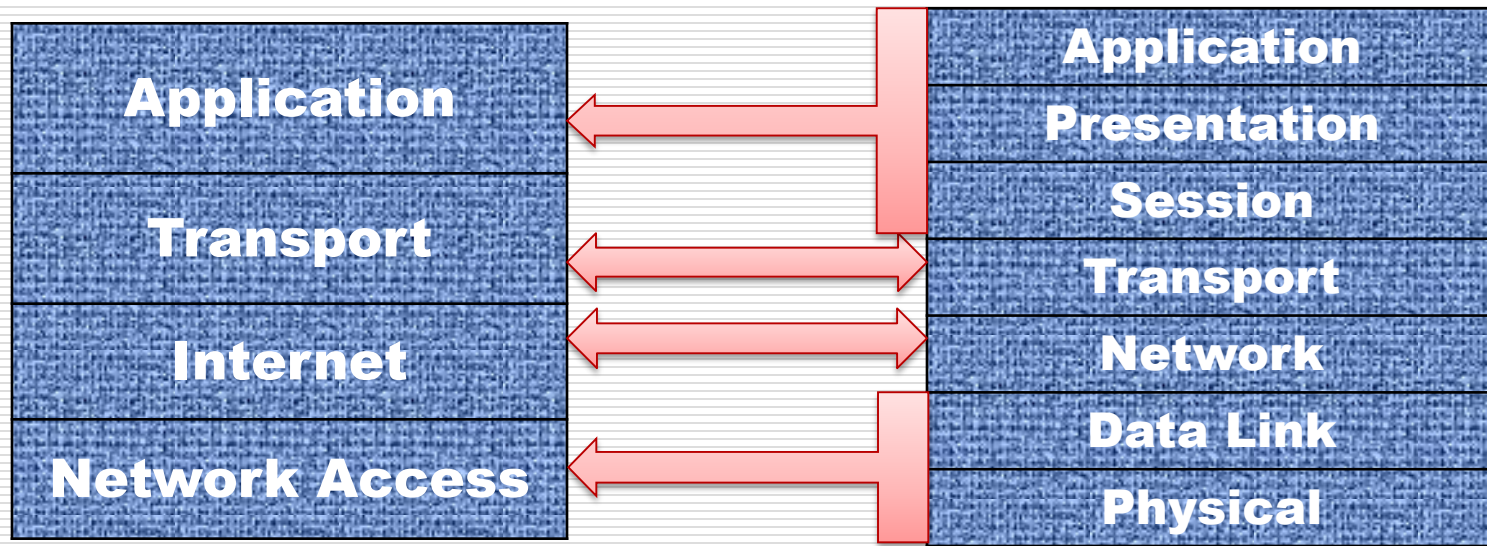
Common TCP/IP Protocols

Protocol Graph: TCP/IP



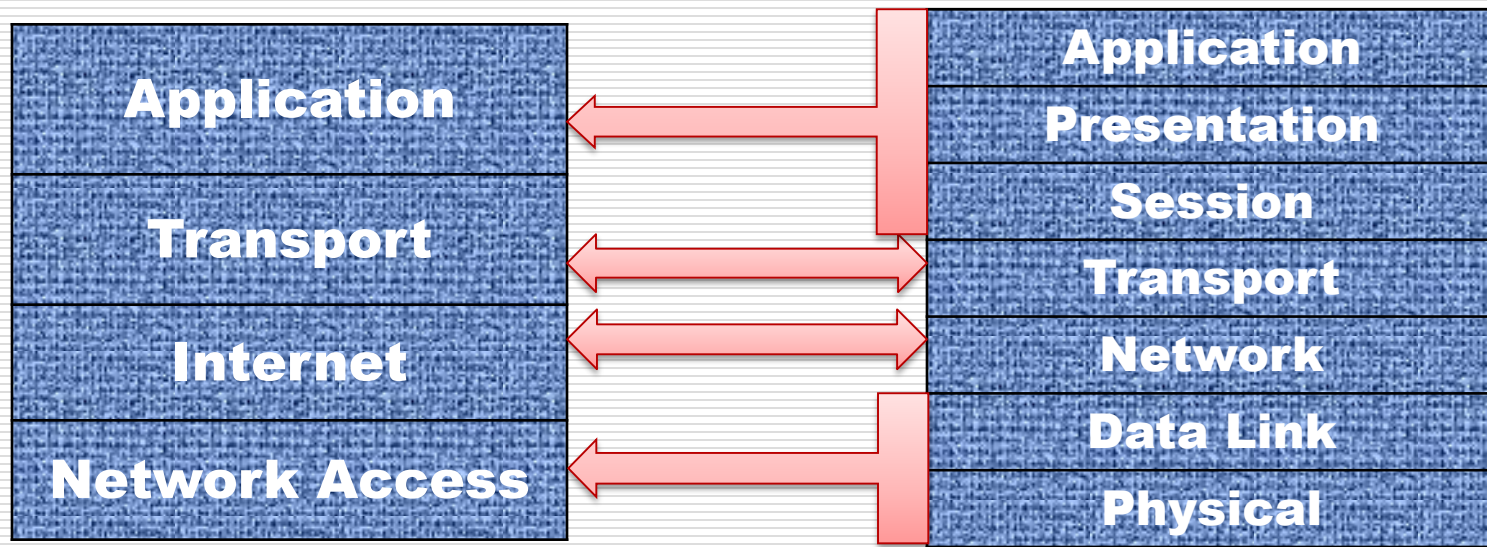
- ❑ *FTP* - File Transfer Protocol
- ❑ *HTTP* - Hypertext Transfer Protocol
- ❑ *SMTP* - Simple Mail Transfer protocol
- ❑ *DNS* - Domain Name System
- ❑ *TFTP* - Trivial File Transfer Protocol

Similarities of TCP/IP and OSI



- both have layers, networking professionals need to know both
 - both have application layers, though they include very different services
 - both have comparable transport and network layers
 - **packet-switched** (not circuit-switched) technology is assumed
-

Differences of TCP/IP and OSI



- TCP/IP appears simpler because it has fewer layers
- TCP/IP protocols are the standards around which the Internet developed, so the TCP/IP model gains credibility just because of its protocols.
- Typically networks aren't built on the OSI protocol, even though the OSI model is used as a guide.

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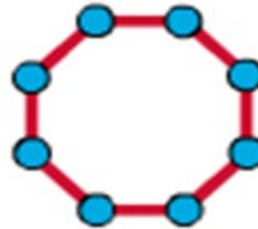
Topology

- ❑ Defines the structure of the network
 - ❑ Physical topology: the actual layout of the wire (media)
 - bus, star, ring, extended star, hierarchical, mesh
 - ❑ Logical topology: defines how the media is accessed by the hosts
 - token passing
-

Network Topologies



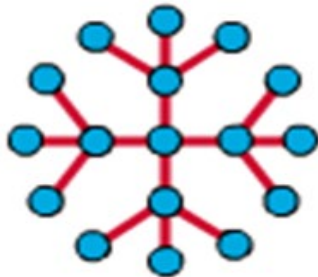
Bus Topology



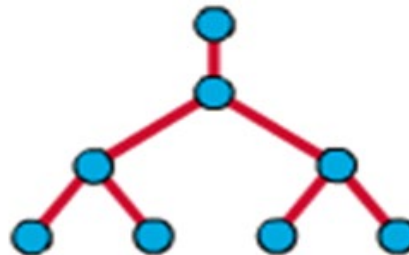
Ring Topology



Star Topology



Extended Star Topology

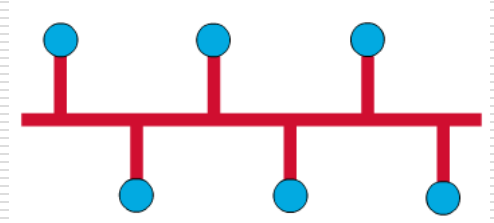


Hierarchical Topology



Mesh Topology

Network Topologies--Bus



❑ Physical Perspective

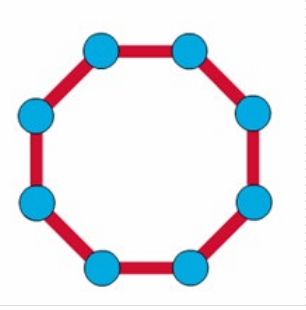
Each host is wired to a common wire.

- ❑ Advantage: all hosts can communicate directly.
- ❑ Disadvantage: A break in the cable disconnects hosts from each other.

❑ Logical Perspective

- ❑ Every networking device to see all signals from all other devices (advantage?)

Network Topologies--Ring



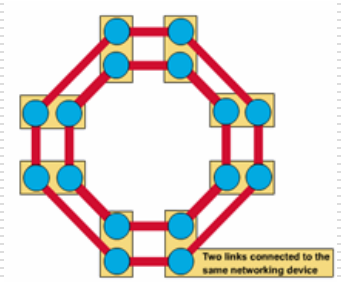
❑ Physical Perspective

- ❑ All devices wired directly to each other in what is called a daisy-chain.

❑ Logical Perspective

- ❑ In order for information to flow, each station must pass the information to its adjacent station.
-

Network Topologies — Dual Ring



Physical Perspective

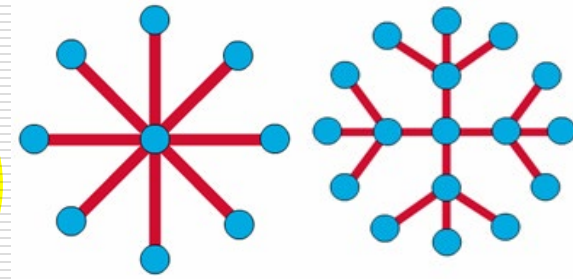
- A dual ring topology is the same as a ring topology, except that there is a second, redundant ring, that connects the same devices.

- Advantages: provide reliability and flexibility

Logical Perspective

- A dual ring topology acts like two independent rings, of which, only one at a time is used.

Network Topologies—Star



Physical Perspective

A star topology has a central node with all links radiating from it.

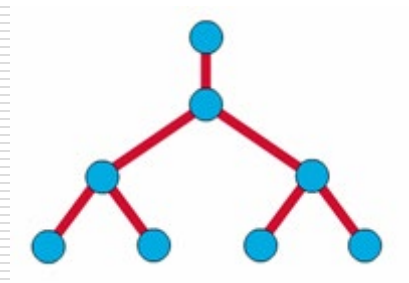
- Advantage: it allows all other nodes to communicate with each other, conveniently. It also might be desirable for security or restricted access reasons

- disadvantage: if the central node fails, the whole network becomes disconnected. Depending on the type of networking device used, collisions can be a problem.

Logical Perspective

The flow of all information would go through one device.

Network Topologies—Tree



❑ The tree topology uses a trunk node from which it branches to other nodes.

- binary tree (each node splits into two links)
- backbone tree (a backbone trunk has branch nodes with links hanging from it).

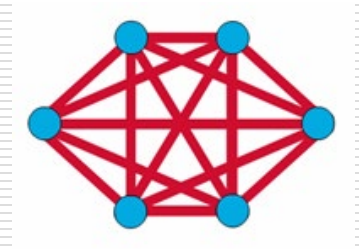
❑ Physical Perspective

The trunk is a wire that has several layers of branches.

❑ Logical Perspective

The flow of information is hierarchical.

Network Topologies— Complete (Mesh)



❑ Physical Perspective

- ❑ has distinct advantages and disadvantages

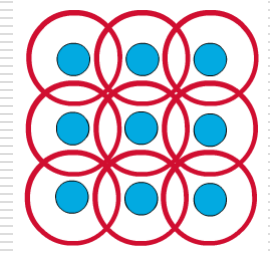
- ❑ Advantage: the maximum connectivity and reliability.

- ❑ Disadvantage: the amount of media for the links, and the amount of connections to the links becomes overwhelming.

❑ Logical Perspective

- ❑ The behavior of a complete, or mesh topology depends greatly on the devices used.

Network Topologies—Cellular



□ Physical Perspective

- The cellular topology is for wireless technology
- Sometimes the receiving nodes move (e.g. cell phone), and sometimes the sending nodes move (e.g. satellite)

□ Logical Perspective

- Nodes communicate with each other directly (though sometimes extremely difficult), or communicate only with their adjacent cells, which is extremely inefficient.
-

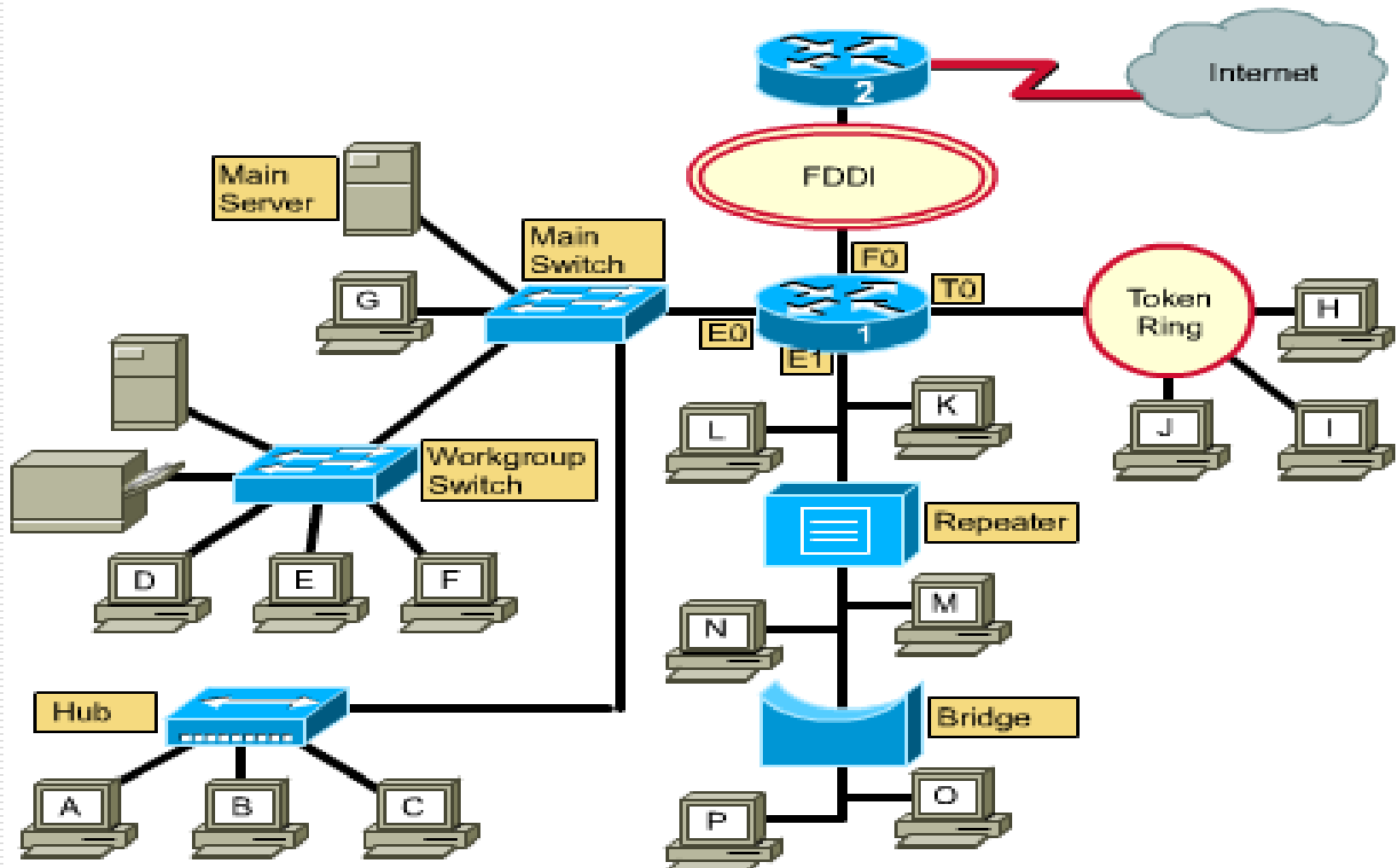
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LAN Devices in a Topology

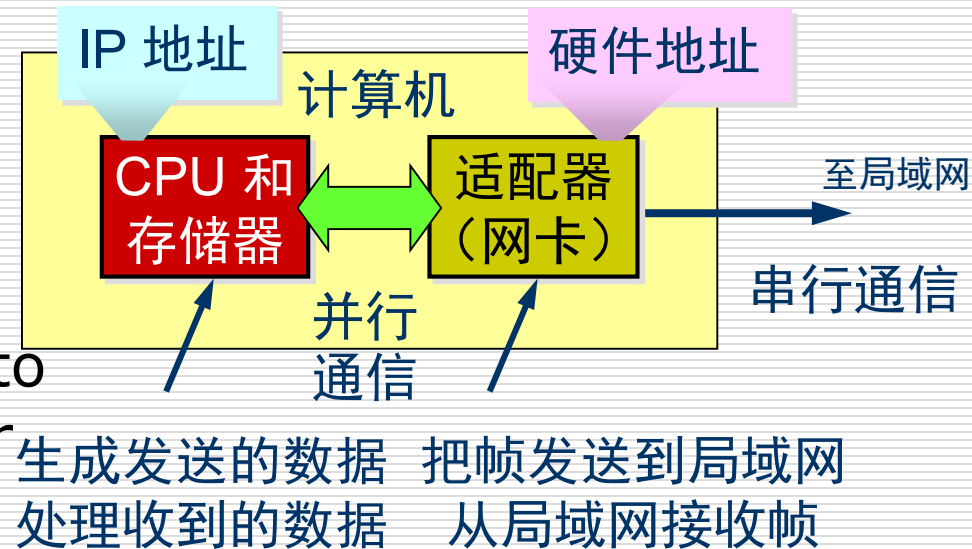
- Hosts—devices connected directly to network segment
 - printers, computers, servers, FAX, copier
 - Hosts—not part of any layer, but the functions of the OSI model are performed in software inside host
-

LAN Devices in a Topology



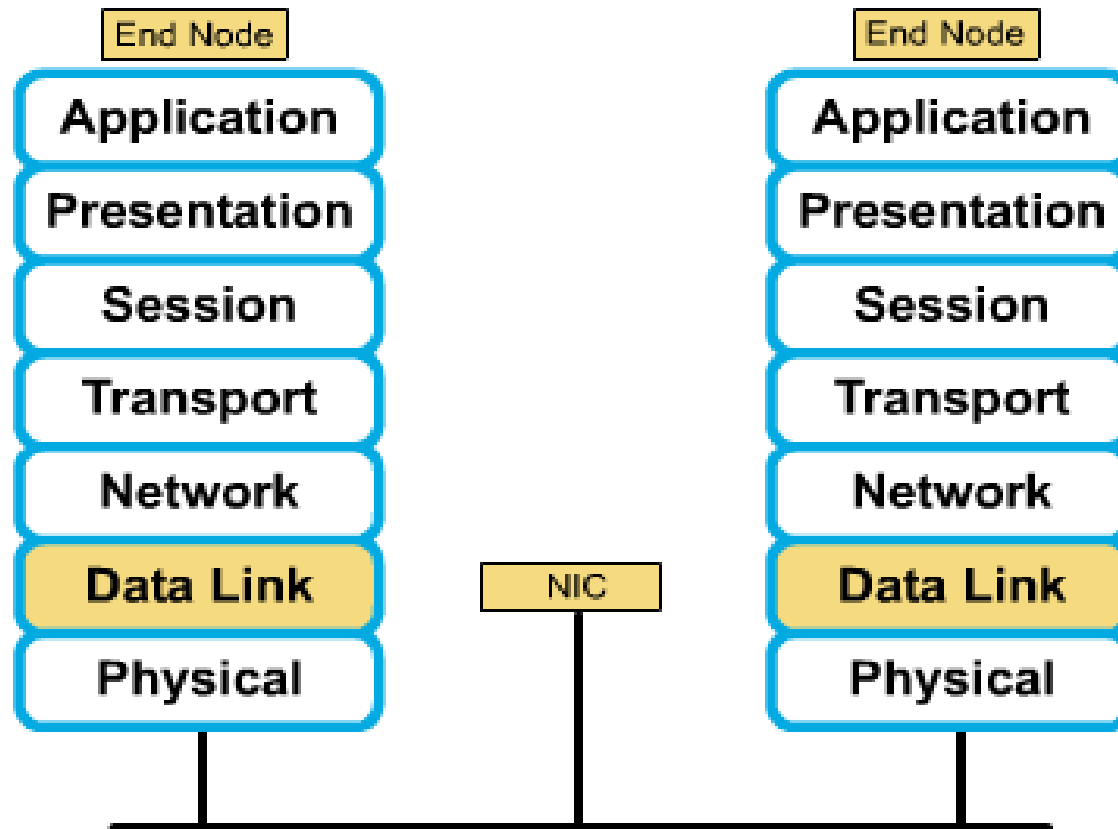
NICs – Layer 2

- ❑ Carries a unique code called a MAC address
- ❑ Is used to control data communication for the host on the network
- ❑ Translates parallel signal produced by computer into serial format to send over the network
- ❑ Transceiver used to convert signals as well as send and receive bits



- ❑ Provides the host's access to the medium

NICs – Layer 2

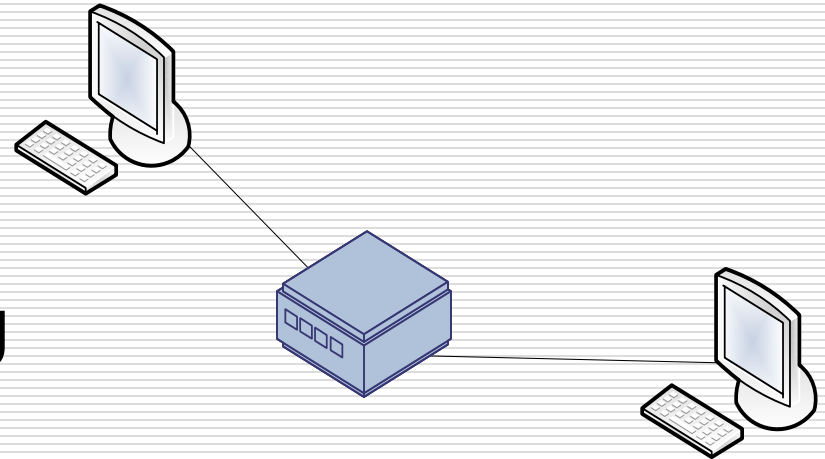


Media – Layer 1

- ❑ Carries a flow of information in bits
 - ❑ The means by which signals travel
from one networked device to another
-

Repeaters – Layer 1

- ❑ used to extend the length of the network
- ❑ clean, amplify, and resend signals that are weakened by long cable
- ❑ regenerate (amplify) and retime network signals at the bit level to allow them to travel a longer distance on the media
- ❑ perform no filtering



Hubs – Layer 1

- ❑ used to regenerate and retime network signals
- ❑ propagate signals
- ❑ cannot filter traffic
- ❑ cannot determine the best path
- ❑ used as network concentration points

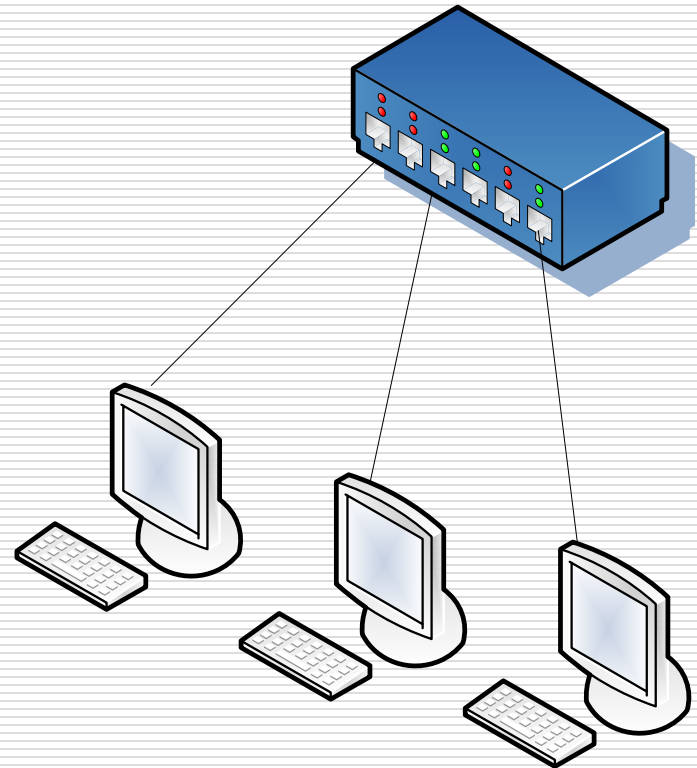
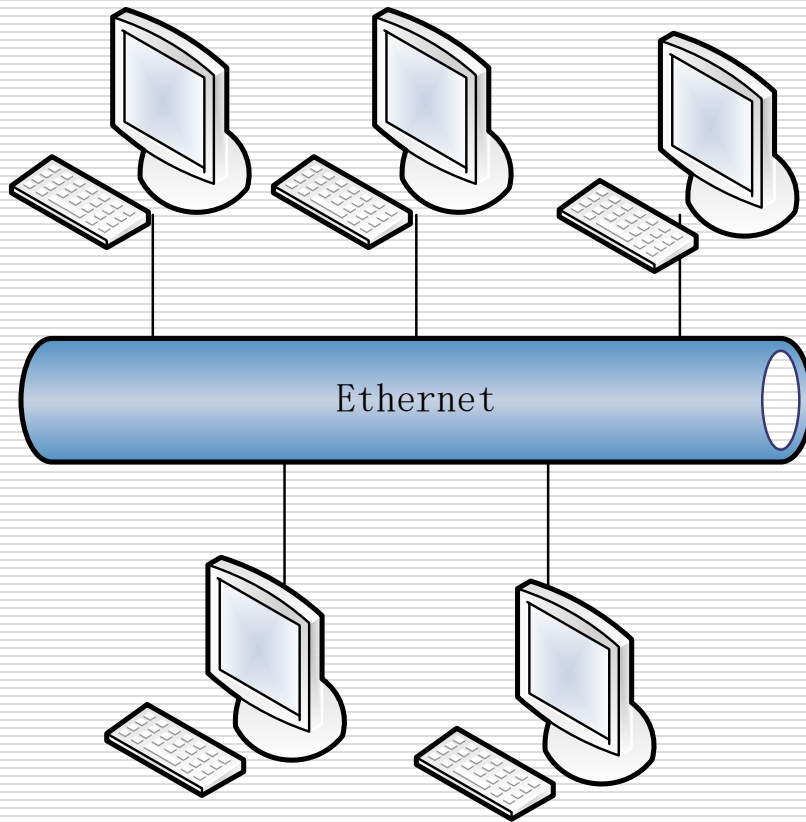


- ❑ sometimes called multiport repeaters

Repeaters/Hubs - Differences

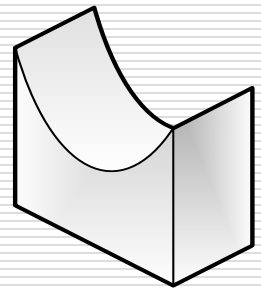
- ❑ Repeater typically has only two ports and a hub generally has from four to twenty or more ports.
 - ❑ Repeater receives on one port and repeats on **the other**, while hubs receive on one port and transmit on **all other ports**.
 - ❑ Hubs most commonly found in Ethernet 10Base T or 100Base T networks.
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Hub



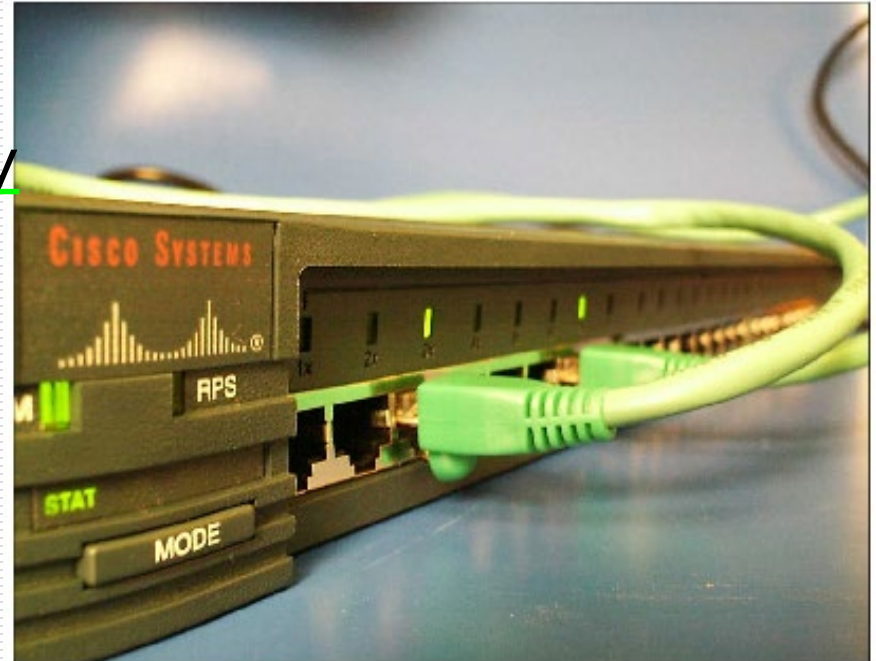
Bridges – Layer 2

- ❑ purpose is to filter traffic on a LAN—to keep traffic local—yet allow connectivity to other segments of the LAN for traffic that is directed there
- ❑ keep track of MAC addresses that are on each side of the bridge and make decisions based on this MAC address list
- ❑ more intelligent than hubs
- ❑ collect and pass packets between segments
- ❑ create collision domains
- ❑ maintain address tables



Switches – Layer 2

- ❑ used to concentrate connectivity
 - ❑ combine the connectivity of a hub with the traffic regulation of a bridge
 - ❑ switch frames from incoming ports to outgoing ports providing each port with full bandwidth
 - ❑ provide separate data paths
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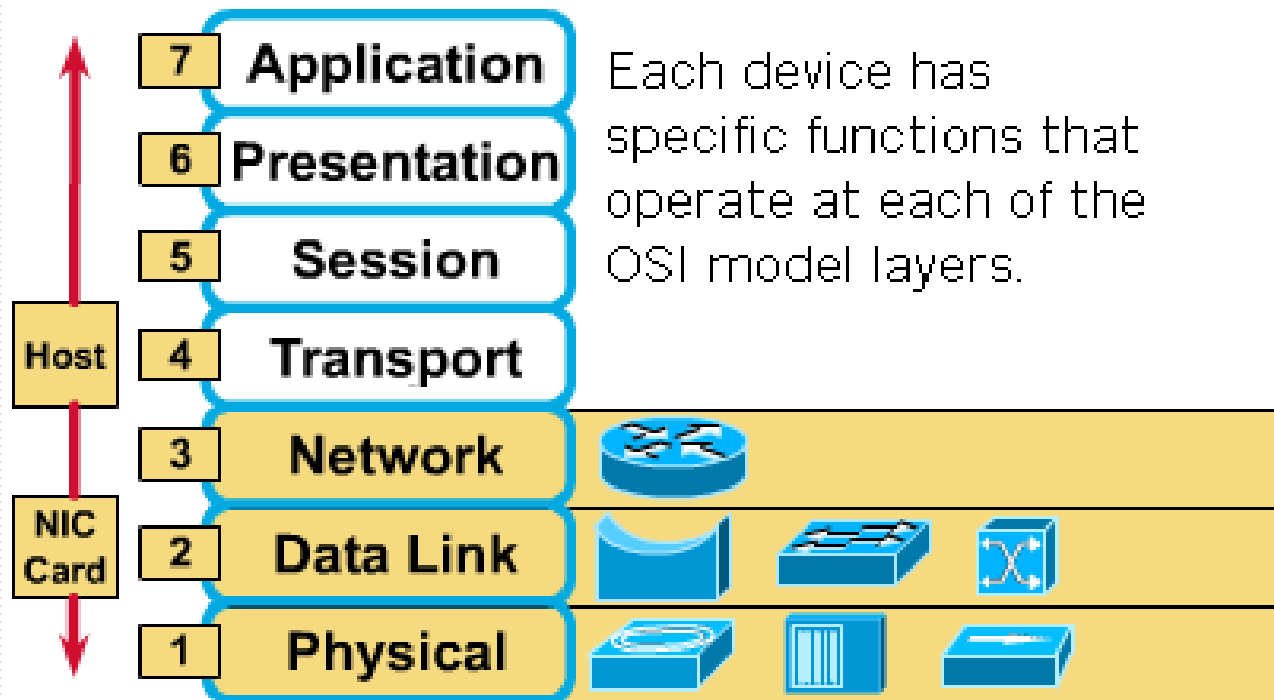


Routers – Layer 3

- ❑ important traffic-regulating device in large networks
 - ❑ Make decisions based on network addresses
 - ❑ examine packets (Layer 3 data), choose the best path for them, and then switch them out the proper outgoing port
 - ❑ two primary purposes: path selection and switching of packets to best route
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Evolution of Networking Devices and the OSI Layers

Devices Function at Layers



谢谢！