

TCP/IP Protocol Suite and Internetworking

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- ❑ Key Philosophical Differences from OSI
- ❑ Layering vs Hierarchy
- ❑ Protocol architecture and interfaces
- ❑ Internetworking terms and services
- ❑ Internet Protocol (IP): Services, Header, Address format

Key Differences From OSI

- ❑ Connectionless Service: TCP/IP is pro-connectionless
- ❑ Simple Management
- ❑ Hierarchy vs layering
- ❑ Internetworking: Not in original OSI

Layering

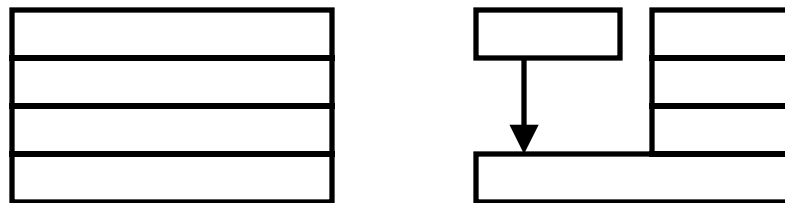
TP4	
CONS	CLNS
802.3	802.5
LLC 1	LLC 2
Physical	

← Same Interfaces

- ❑ Each layer has to perform a set of functions
- ❑ All alternatives for a row have the same interfaces
- ❑ Choice at each layer is independent of other layers.
- ❑ Need one component of each layer
⇒ Null components
- ❑ Nth layer control info is passed as N-1th layer data.

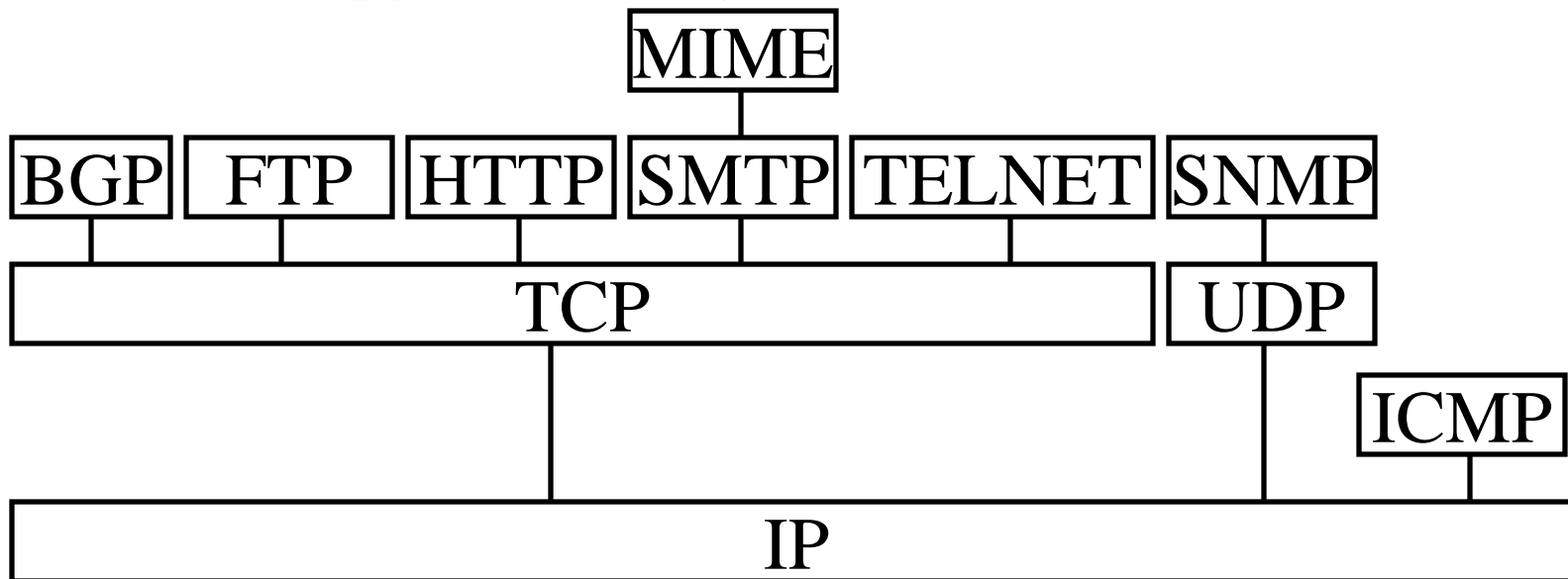
Hierarchy

- ❑ Can directly use the services of a lower entity even if it is not in an adjacent layer
- ❑ Control and data can be separate connections. Control connections may have different reliability requirements than data.
- ❑ Lower layer control information can be used for higher layer control, e.g., lower layer close may close all higher layers



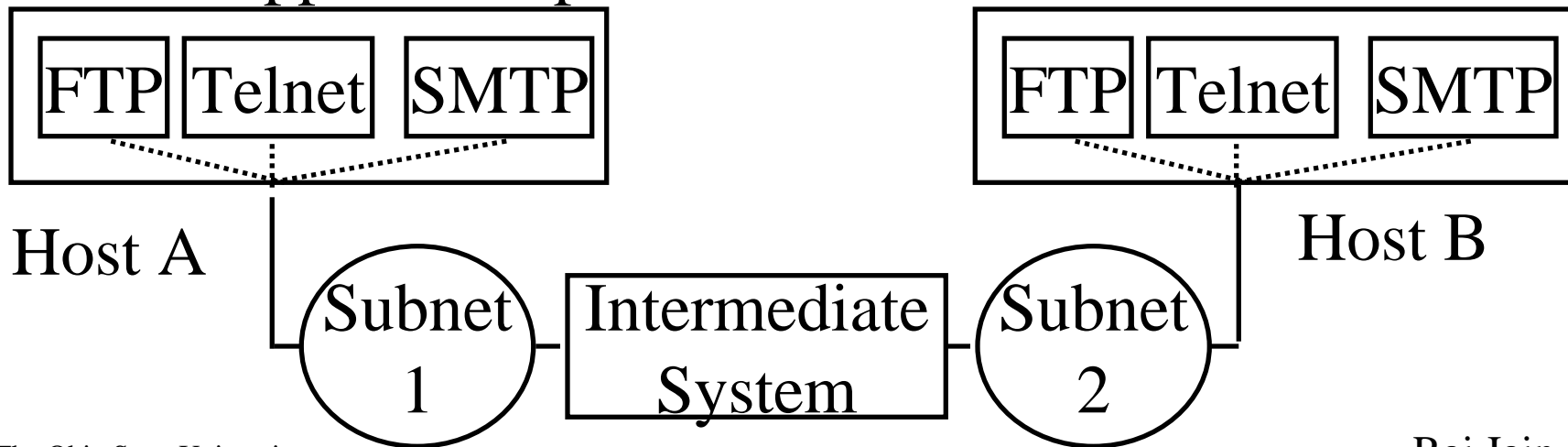
TCP/IP Protocols

- ❑ Network access layer: Ethernet, Token Ring
- ❑ Internet layer: IP
- ❑ Host-host layer: TCP, UDP
- ❑ Process/application layer: FTP, Telnet, Mail (SMTP)

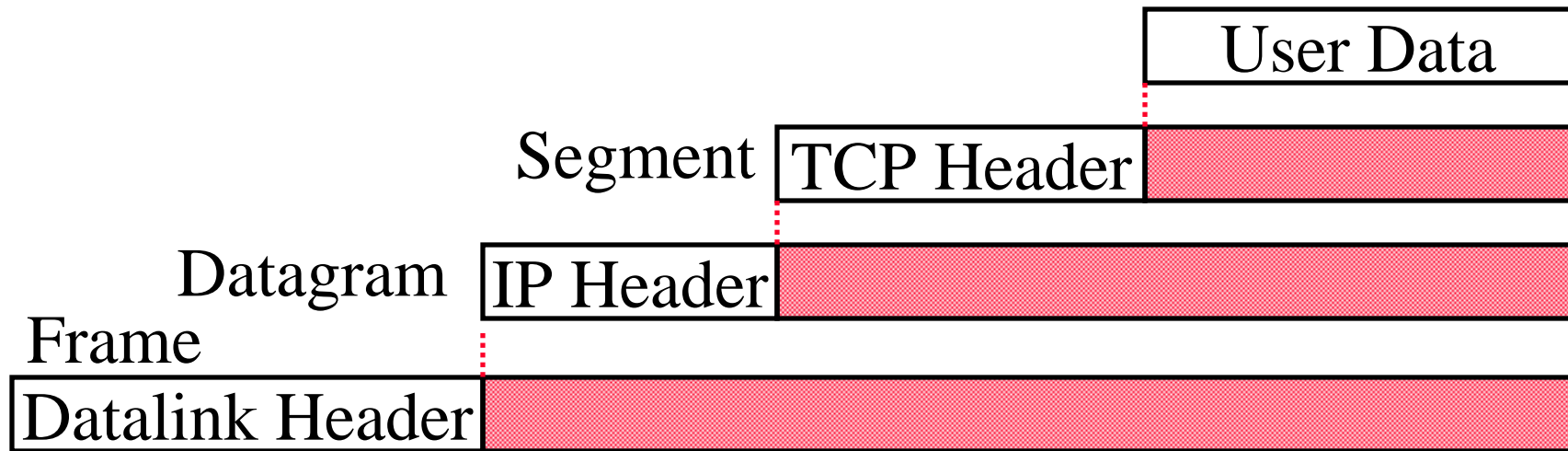


Internetworking Terms

- ❑ End-system: Host
- ❑ Network: Provides data transfer between end-systems
- ❑ Internet: A collection of networks
- ❑ Subnetwork: Each component of an internet
- ❑ Intermediate System: Connects two subnetworks
- ❑ Port: Application processes in the host



PDU's in TCP/IP



- ❑ TCP PDU = Segment
- ❑ IP PDU = Datagram
- ❑ Datalink PDU = Frame

Operation of TCP/IP

- ❑ Process address within a host = Port
- ❑ Host address on a network
- ❑ IP deals only with host addresses = Subnet + Host #
- ❑ Application messages are broken into TCP **segments**
- ❑ TCP
 - Uses segment sequence number for ordering and lost segment detection
 - Uses checksum for error detection
 - Passes the segment to IP for transmission
 - Delivers the data to appropriate port in the destination host

TCP/IP Applications

- ❑ Simple Mail Transfer Protocol (SMTP):
 - Mail transfer between hosts
 - Mailing lists, mail forwarding, return receipts
 - Does not specify how to create messages
- ❑ File transfer protocols (FTP):
 - Transfers files between hosts
 - Provides access control (user name and password)
 - Binary or text files are supported.
- ❑ Remote login (Telnet):
 - Initially designed for simple scroll-mode terminals

Internet Protocol (IP)

- ❑ IP deals with only with host addresses
- ❑ Services:
 - Send: User to IP
 - Deliver: IP to User
 - Error (optional): IP to User

IP Header

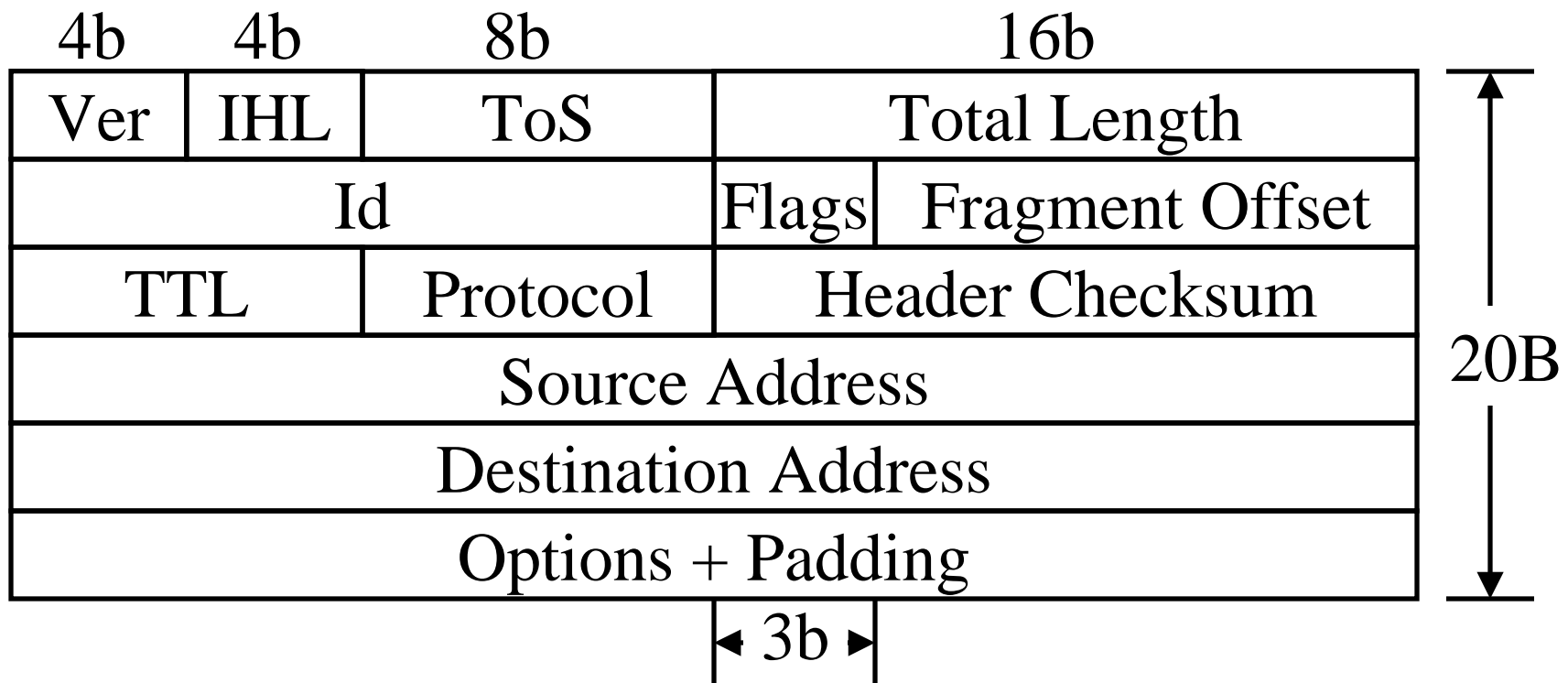


Fig 16.7

IP Header (Cont)

- ❑ Version (4 bits)
- ❑ Internet header length (4 bits): in 32-bit words. Min header is 5 words or 20 bytes.
- ❑ Type of service (8 bits): Reliability, precedence, delay, and throughput
- ❑ Total length (16 bits): header+data in bytes
- ❑ Identifier (16 bits): Helps uniquely identify the datagram during its life for a given source, destination address

IP Header (Cont)

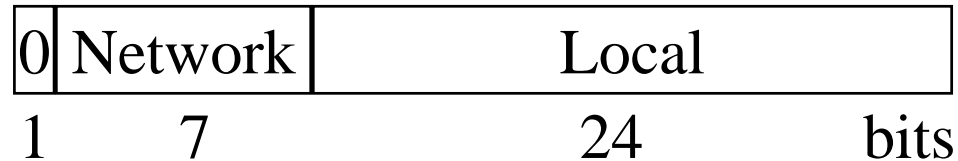
- ❑ Flags (3 bits):
 - More flag - used for fragmentation
 - No-fragmentation
 - Reserved
- ❑ Fragment offset (13 bits): In units of 8 bytes
- ❑ Time to live (8 bits): Specified in router hops
- ❑ Protocol (8 bits): Next level protocol to receive the data
- ❑ Header checksum (16 bits): 1's complement sum of all 16-bit words in the header

IP Header (Cont)

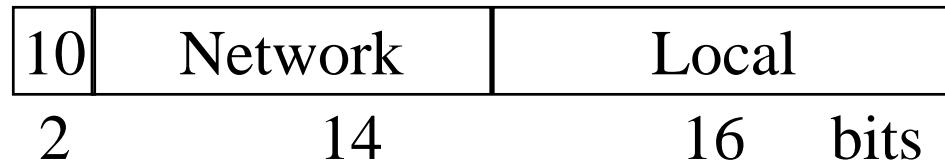
- ❑ Source Address (32 bits)
- ❑ Destination Address (32 bits)
- ❑ Options (variable): Security, source route, record route, stream id (used for voice) for reserved resources, timestamp recording
- ❑ Padding (variable):
Makes header length a multiple of 4
- ❑ Data (variable): Data + header \leq 65,535 bytes

IP Address

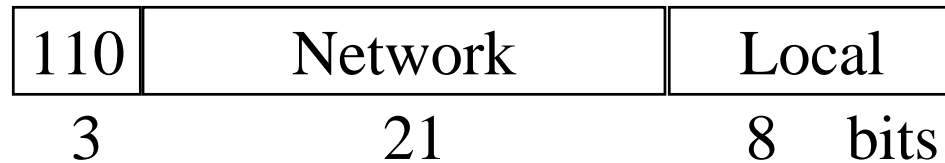
❑ Class A:



❑ Class B:



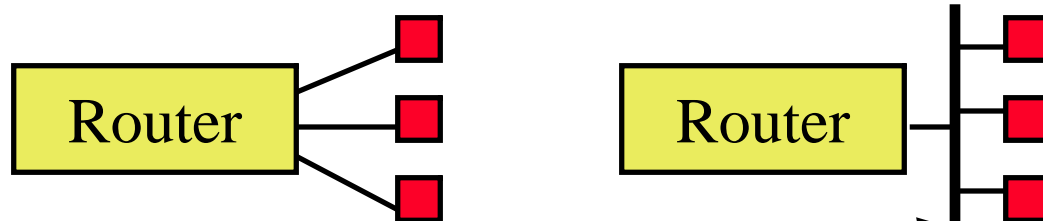
❑ Class C:



❑ Class D:



❑ Local = Subnet + Host (Variable length)



Address Resolution Protocol



- ❑ Problem: Given an IP address find the MAC address
- ❑ Solution: Address resolution protocol
- ❑ The host broadcasts a request:
“What is the MAC address of 127.123.115.08?”
- ❑ The host whose IP address is 127.123.115.08 replies back:
“The MAC address for 127.123.115.08 is
8A-5F-3C-23-45-5616”
- ❑ A router may act as a proxy for many IP addresses

Internet Control Message Protocol (ICMP)

- ❑ Required companion to IP. Provides feedback from the network.
 - Destination unreachable
 - Time exceeded
 - Parameter problem
 - Source quench
 - Redirect
 - Echo
 - Echo reply
 - Timestamp
 - Timestamp reply
 - Information Request
 - Information reply

Autonomous Systems

- An internet connected by homogeneous routers under the administrative control of a single entity

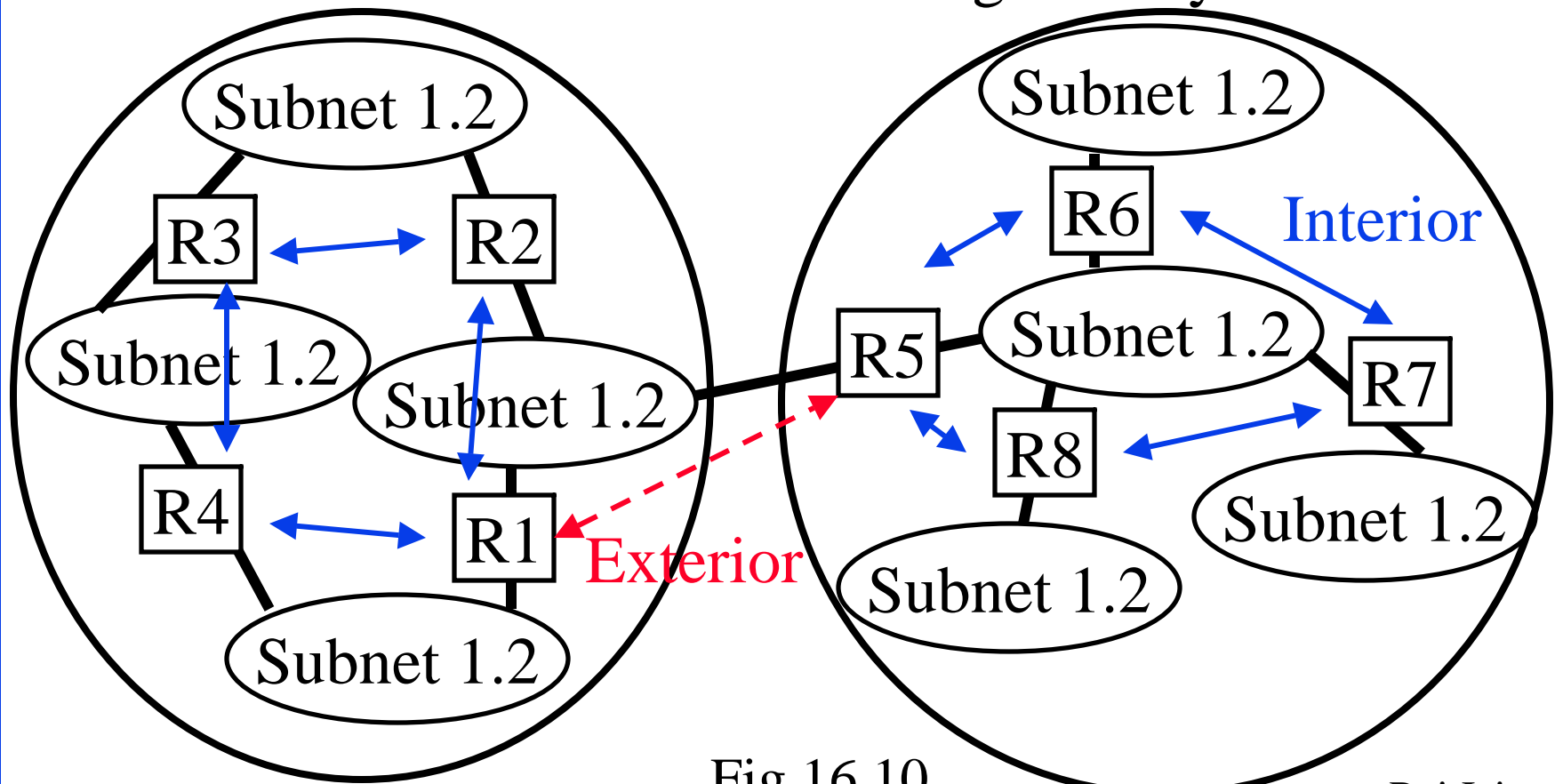


Fig 16.10

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Other Networking Protocols

- ❑ Interior Router Protocol (IRP): Used for passing routing information among routers internal to an autonomous system
- ❑ Exterior Router Protocol (ERP): Used for passing routing information among routers between autonomous systems
- ❑ Routing Information Protocol (RIP): First generation ARPAnet IRP protocol. Entire routing table sent to neighbors.
⇒ Distance vector routing.

Networking Protocols (Cont)

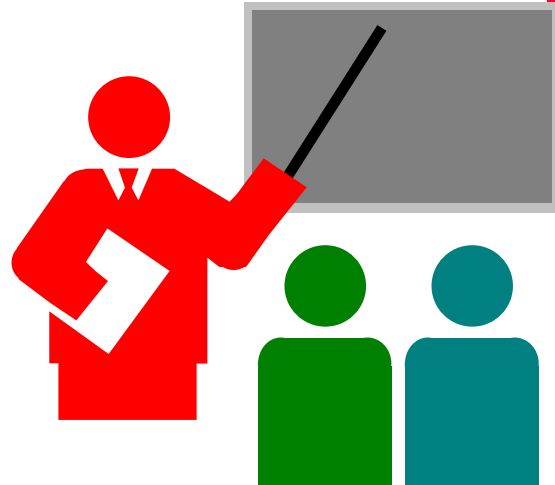
- ❑ Open Shortest Path First (OSPF): Interior routing protocol.

Provides least-cost path routes using a fully user configurable routing metric (any fn of delay, data rate, dollar cost, etc.)

Link costs flooded (Link-state routing)

- ❑ Exterior Gateway Protocol (EGP): Periodic hellos and responses with cost to other networks

Summary



- ❑ TCP/IP's hierarchy vs OSI's layering
- ❑ Processes, hosts, networks, ports, subnetwork
- ❑ IP: Address, header
- ❑ ARP, ICMP, EGP, OSPF

Homework

- ❑ Read Sections 15.3 and 16.3 in Stallings' book
- ❑ Submit answers to Exercise 16.7, 16.8