TCP/IP Protocol Suite and Internetworking

Raj Jain

Professor of CIS

Raj Jain is now at
Washington University in Saint Louis
Jain@cse.wustl.edu
http://www.cse.wustl.edu/~jain/

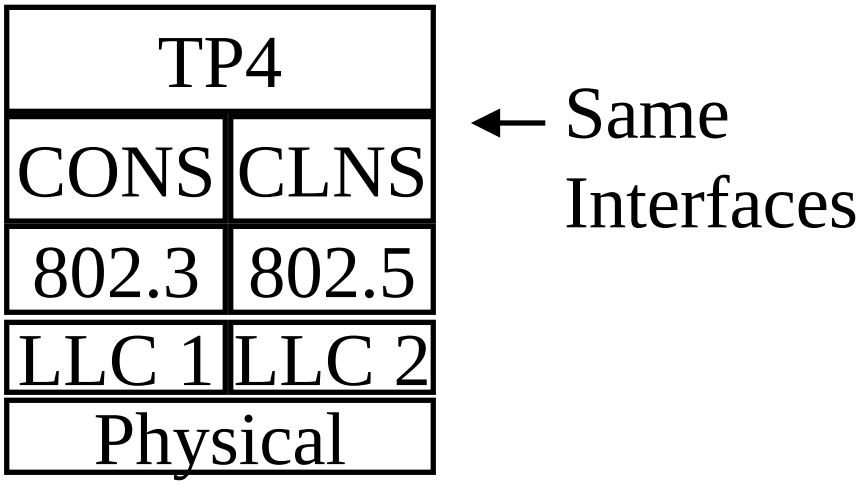
Overview

- 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

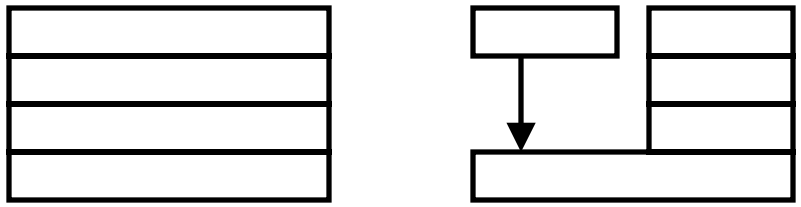
Layering



- 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
  $\Rightarrow$ 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)

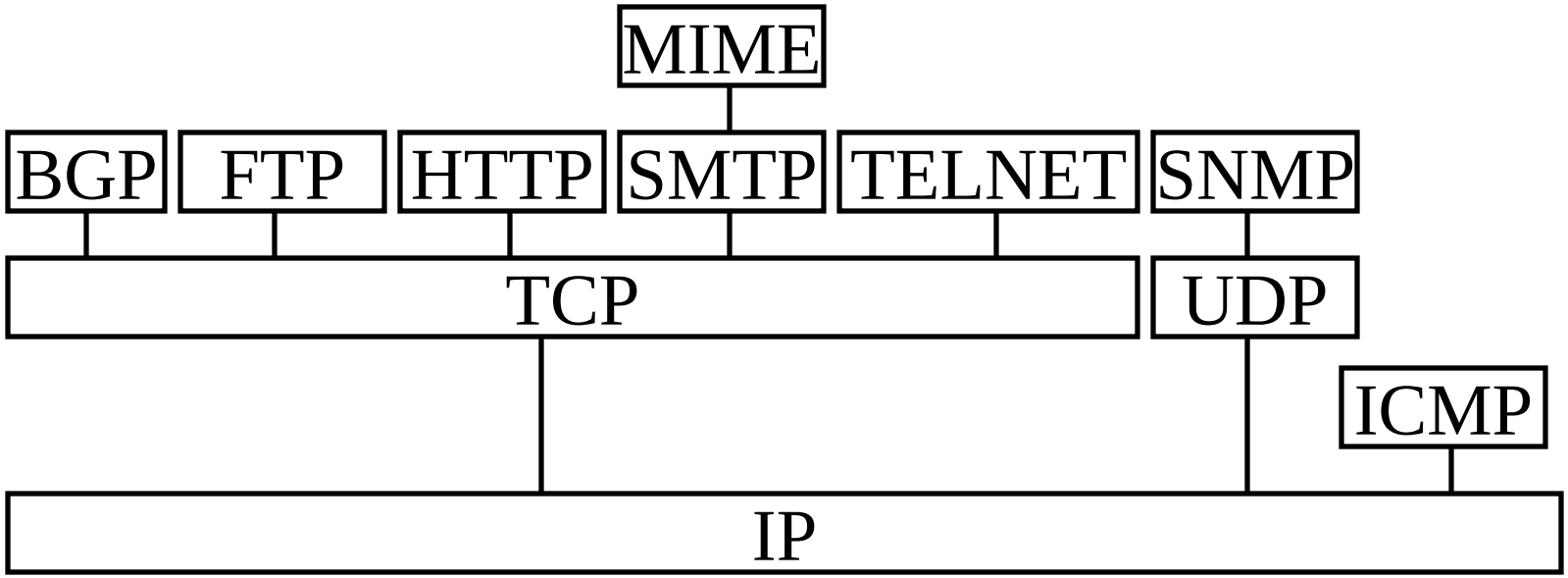
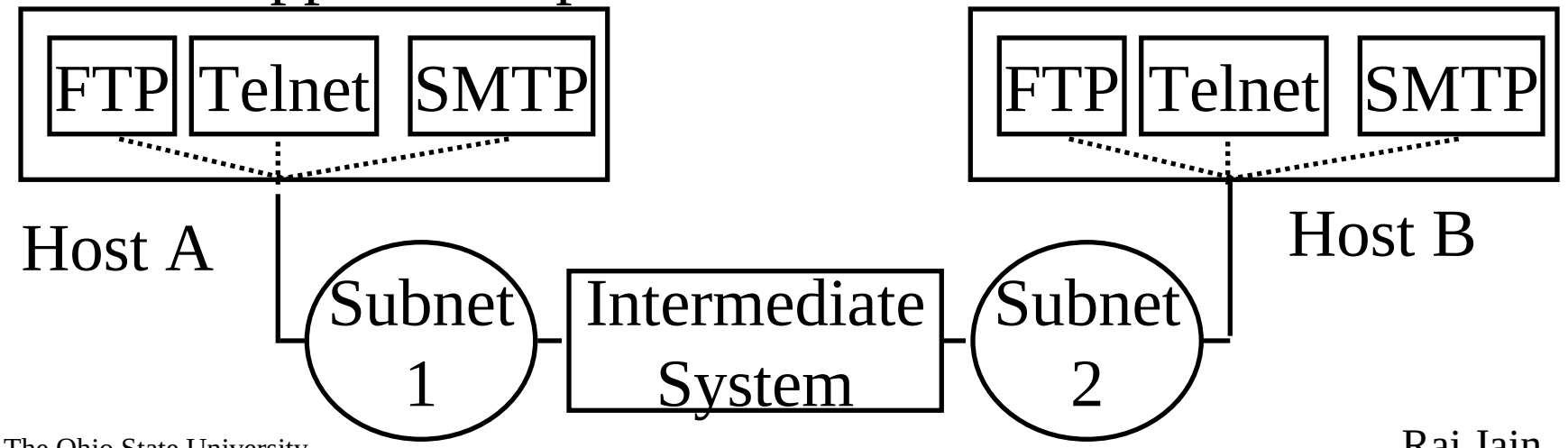


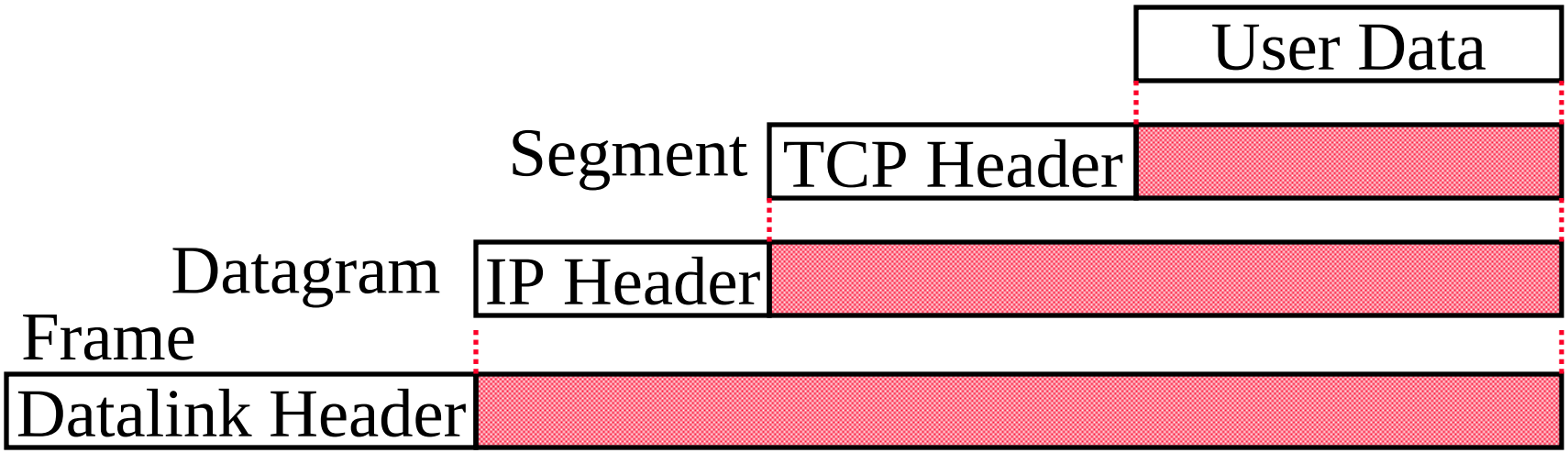
Fig 15.12

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

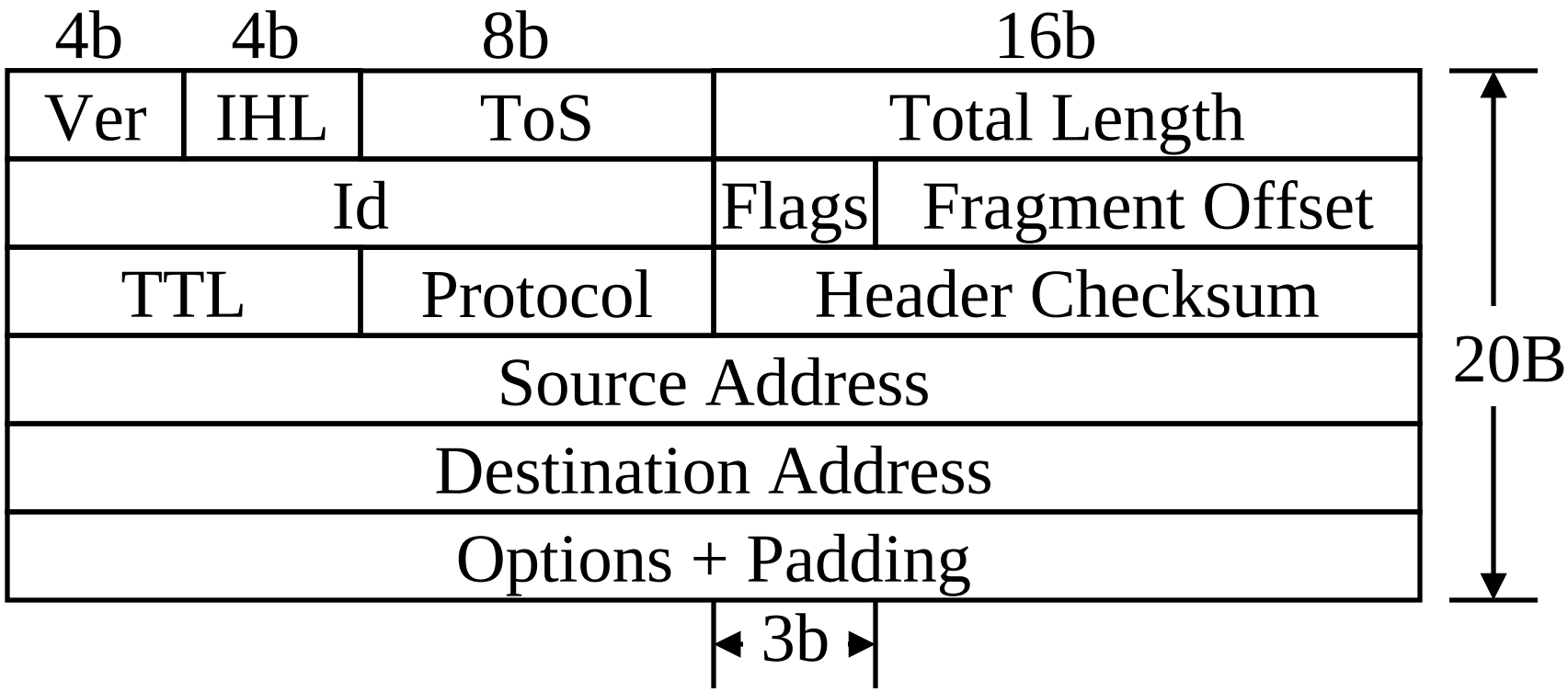


Fig 16.7

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)

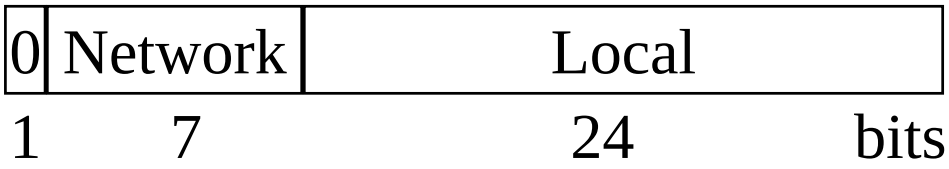
- Flags (3 bits):
  - More flag - used for fragmentation
  - No-fragmentation
  - Reserved
- Fragment offset (13 bits): In units of 8 bytes
- Time to live (8 bits): Specified in router hops
- Protocol (8 bits): Next level protocol to receive the data
- Header checksum (16 bits): 1's complement sum of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

IP Header (Cont)

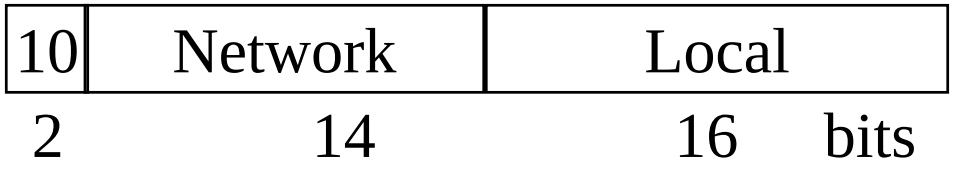
- Source Address (32 bits)
- Destination Address (32 bits)
- Options (variable): Security, source route, record route, stream id (used for voice) for reserved resources, timestamp recording
- Padding (variable):
  Makes header length a multiple of 4
- Data (variable): Data + header $\leq$ 65,535 bytes

IP Address

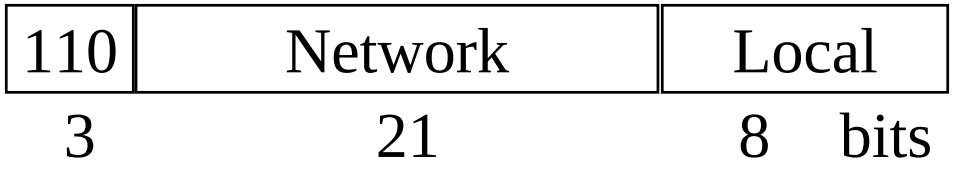
- Class A:



- Class B:

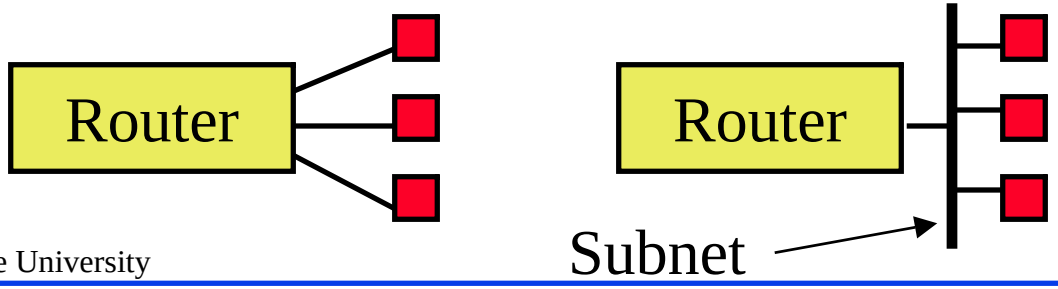


- Class C:



- 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

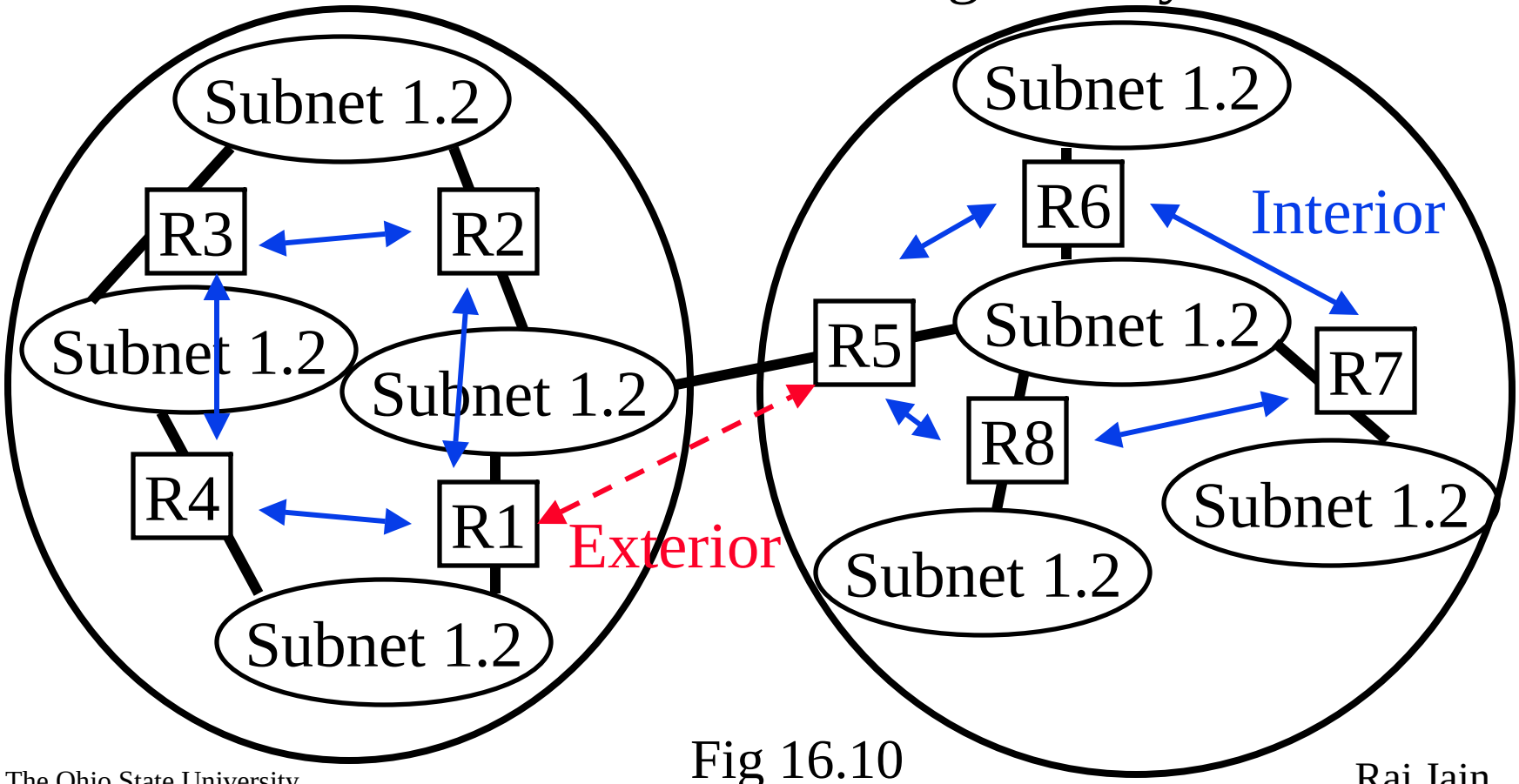


Fig 16.10

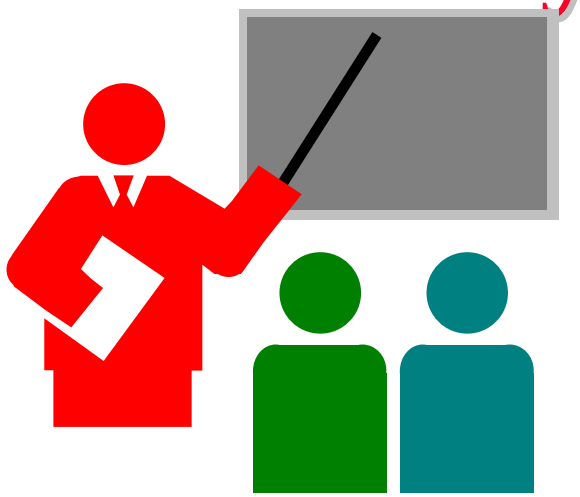
Other Networking Protocols

- 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.
  $\Rightarrow$ 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