



Introduction to Networking

Lecture 34

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CS241 Administrative

- Read Stallings Chapter 13, R&R 18.1-18.3
- LMP3 Start Early!!!

Content

Communication

- Motivation

- Network Categories and Applications

Client-Server Model

- Communication Channels

- Naming of Client/Server

- Types of Communication and Protocols

- Connection-oriented Server Strategies

Motivation

Share: workstation, PC, Cray, database, radio
telescope, work

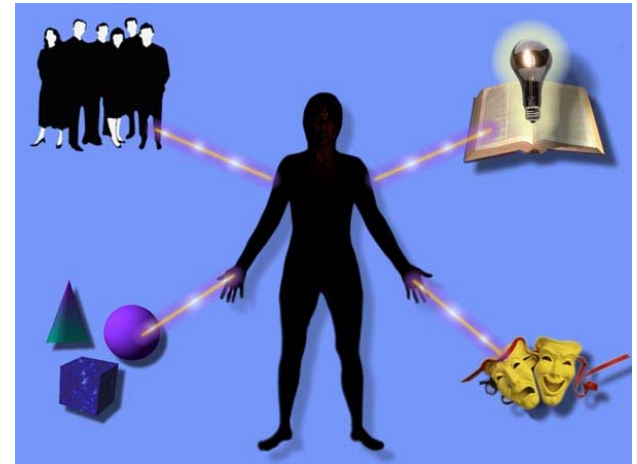
resource sharing

computation speed up

reliability

communication

Emails, web queries, on-line banking, internet game,
chat...



Network Categories

Resource Sharing Networks.

Communication is typically between a user process on one host and a resource manager process on another host.

Examples:

- Access remote files

- Transfer files between hosts

- Database distributed among hosts

- Access peripheral device (e.g., printer) on remote host

Distributed Computation Networks.

A group of processes cooperating in one activity are distributed over several hosts throughout a network.

Examples:

- Large database systems

- Real time process-control systems

Network Categories

Remote Communication Networks.

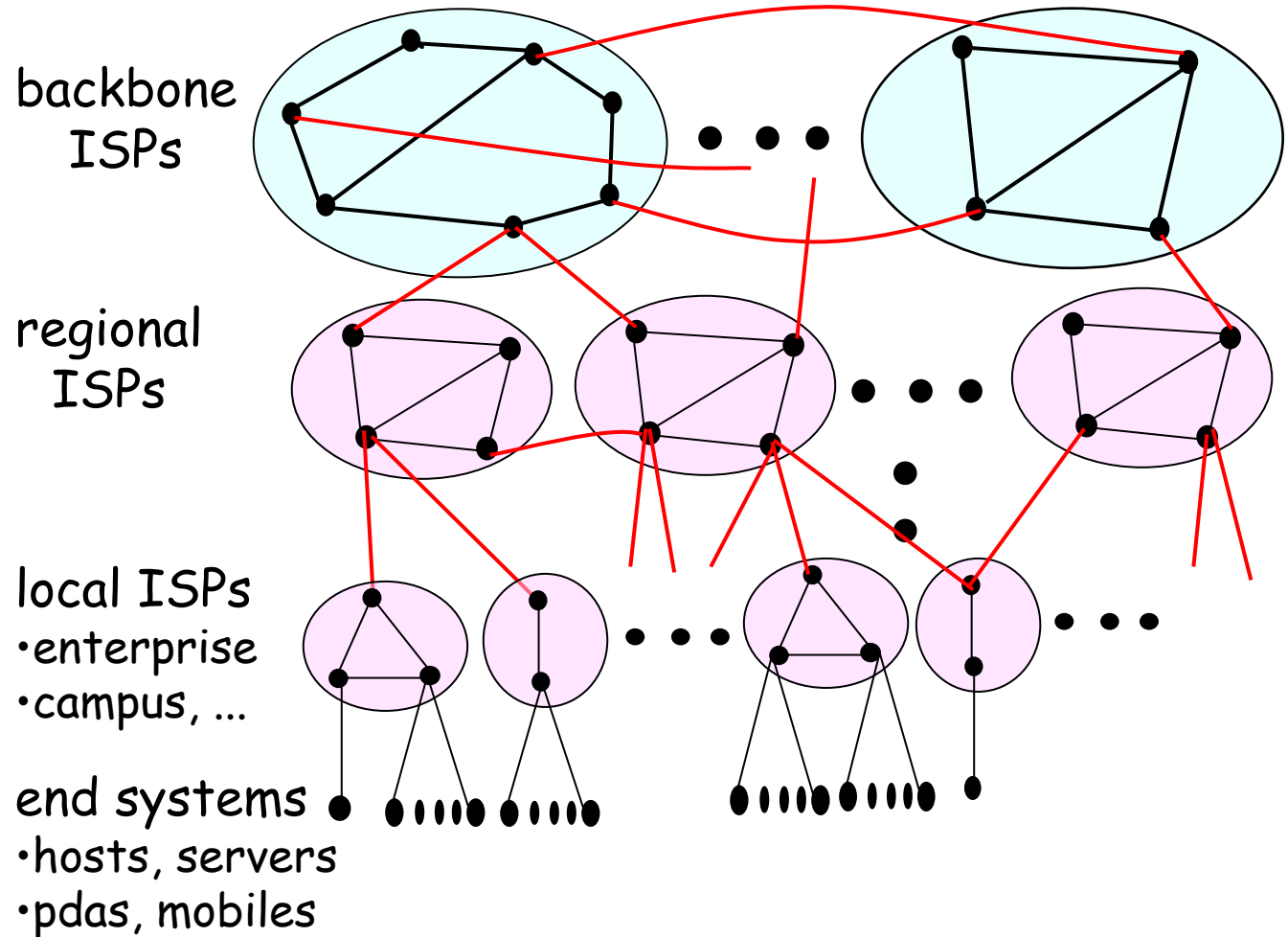
Typically a batch system with most facilities in one or a few central locations, accessed from many remote locations.

Examples:

Bank ATMs

What's the Internet

- **network of networks:**
loosely hierarchical
- **communication links:** fiber, copper, radio, satellite
- **routers:**
forward data packets
- **end-systems**
run *network apps*
- **protocols:**
TCP, IP, HTTP, FTP, PPP, ...



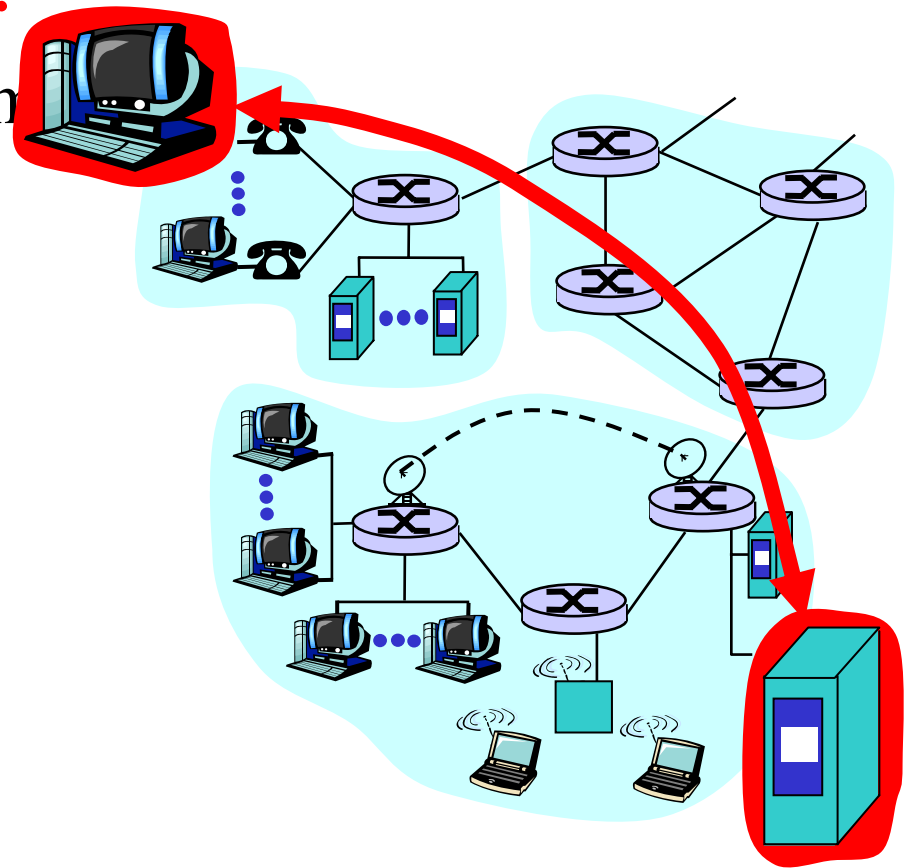
The network edge:

- **end systems (hosts):**

- run application programs
- e.g., WWW, email
- at “edge of network”

- **client/server model**

- client host requests, receives service from server
- e.g., WWW client (browser)/ server; email client/server



Client-Server Model

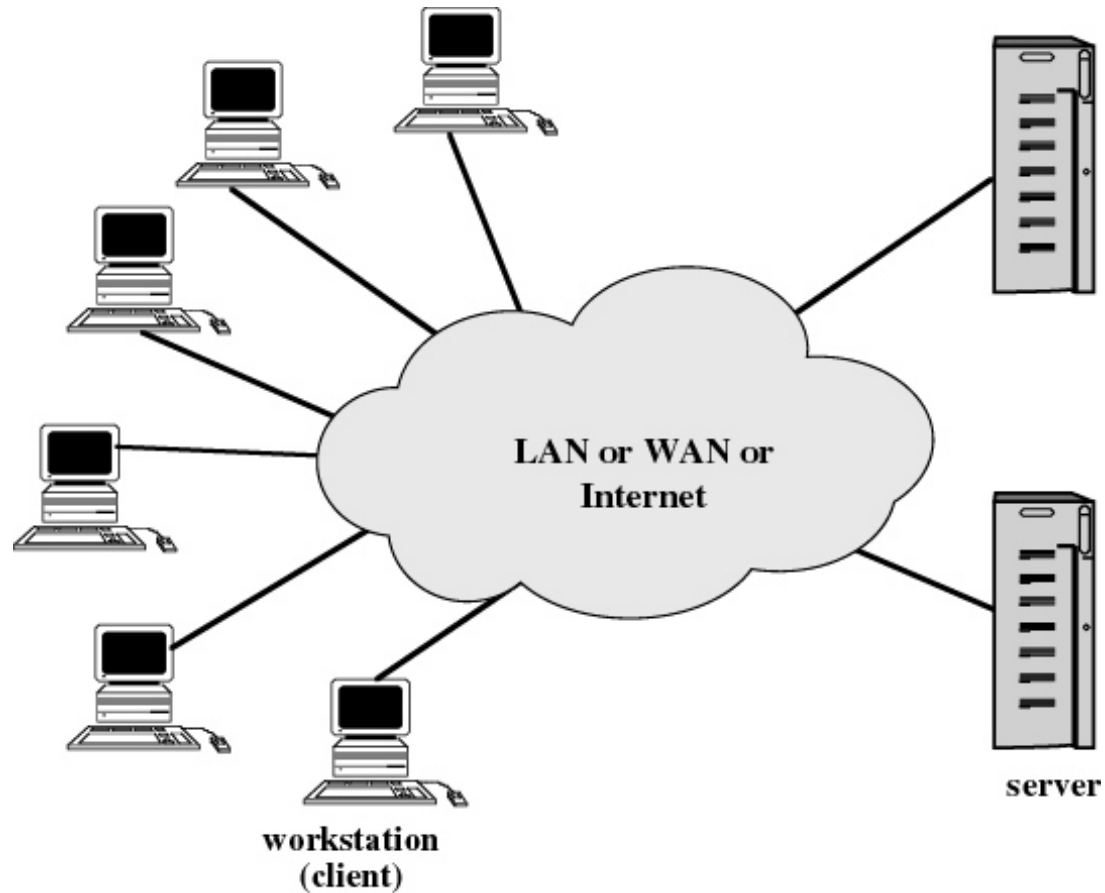


Figure 13.1 Generic Client/Server Environment

Client-Server Model

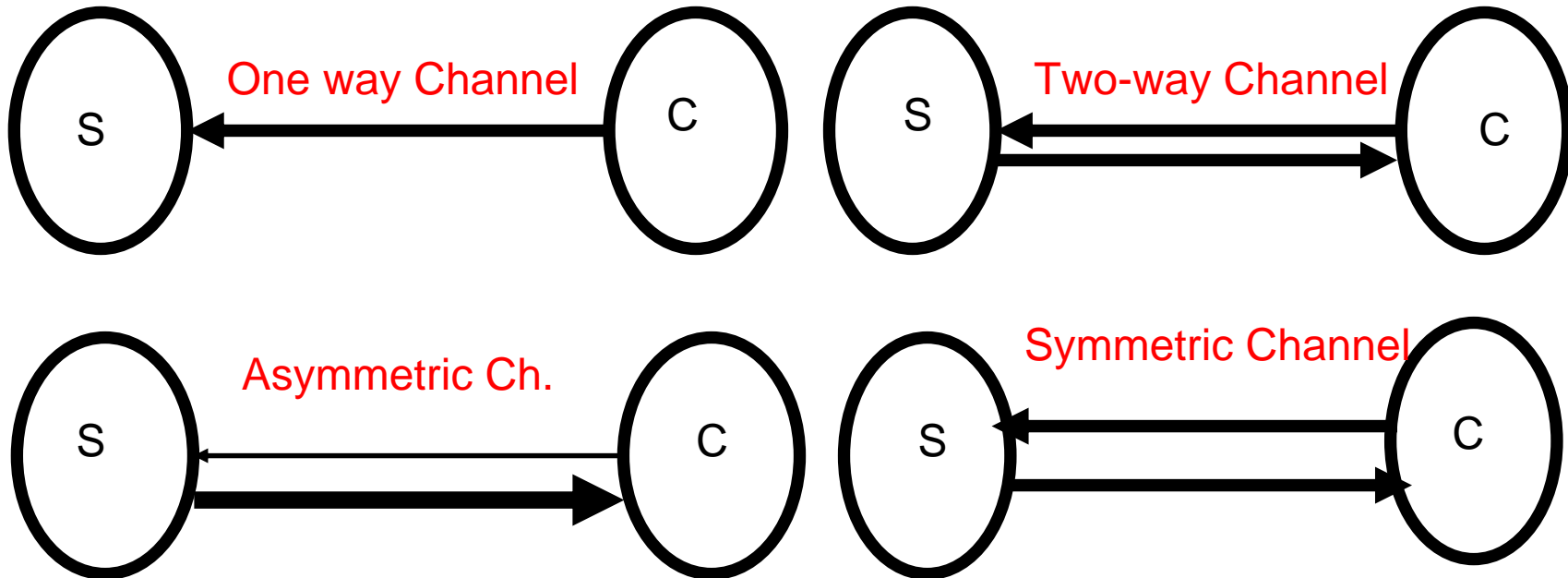
- The **client-server model** is used in many types of network communication including
 - mail, ftp, telnet, rlogin, http, and nfs.
- In this model, the **server waits** for requests and the **client makes requests** for service from the server.

Communication End Point

Communication End Point



Communication Channel



Naming of Servers and Clients

In Network environment – naming is difficult

Possible Server naming by Process ID and Host ID

Problem: Client cannot know the process ID of the server process on a host in advance

Most common naming – use **address of host** (Internet address) and an integer called **port number**

Ports

Ports < 1024, standard

Ports > 1024, user created

Well-known Port Numbers

mail: 25

ftp: 21

telnet: 23

rlogin 513

http: 80

nfs: 2049

IP address (161.25.19.8)

`ifconfig` – configure network interface on Linux

`ipconfig` – show network address information on Windows

 show Ethernet address, Internet address, DNS address

`ipconfig /all` – show all

Kinds of Communication

Connectionless communication

The client makes a request to an endpoint on a server and the server can respond to the client's endpoint

No handshake required before sending messages

Analogy: ordinary mail

Connection-oriented communication

The client sets up a connection using the server's well-known port number and then communicates over a private communications channel as shown

Analogy: telephone

Examples of Protocols for Client-Server Process Communication

Connectionless – UDP (Unreliable Datagram Protocol)

Unreliable – no retransmission

Connection-oriented – TCP (Transmission Control Protocol)

Hand-shake between initiator and destination

Receiver sends acknowledgement

In case sender does not get acknowledgement within certain time,
it retransmits message (packet)

Flow Control

klara|csil-linux1|~|[2]% netstat

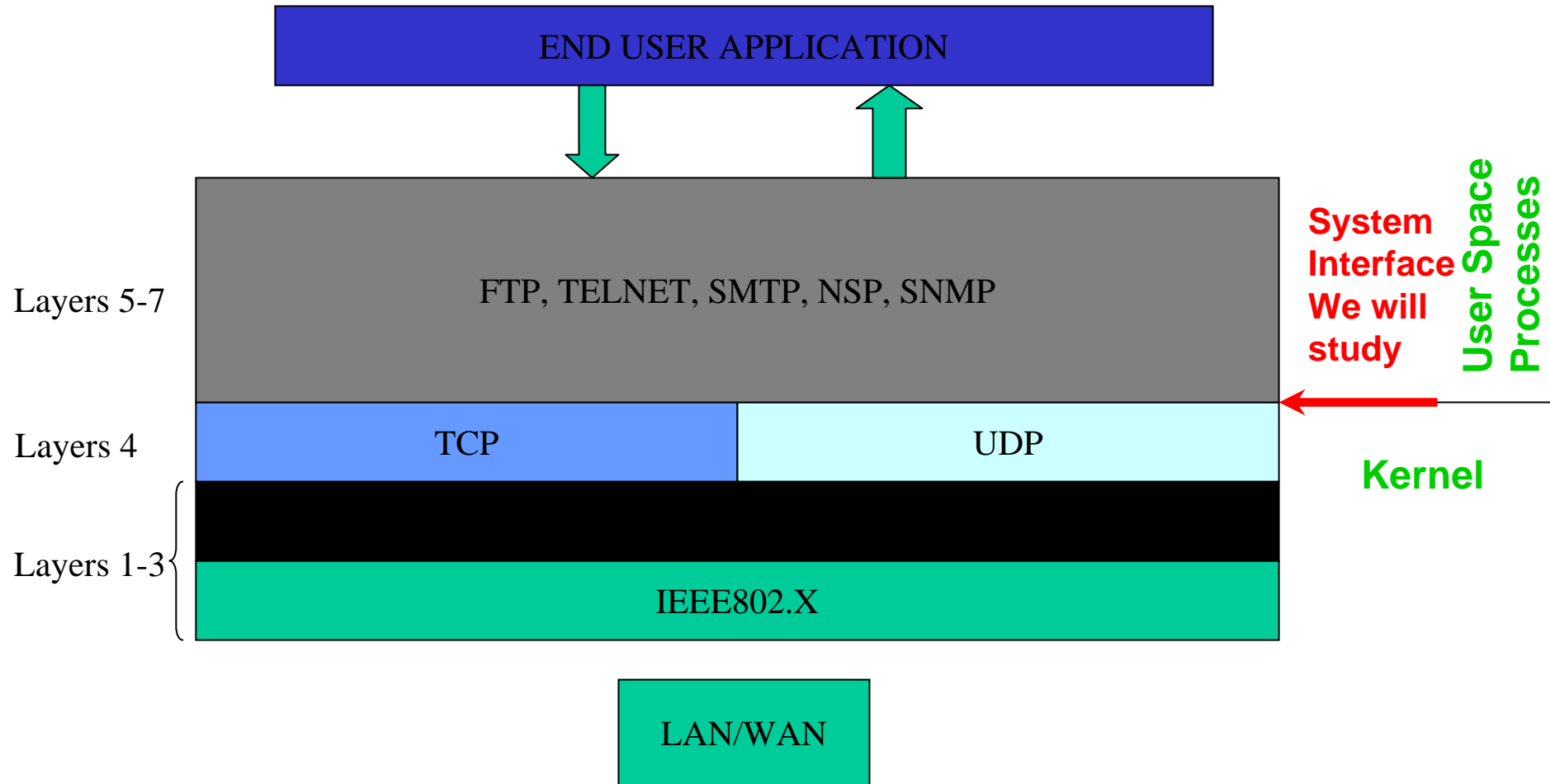
Active Internet connections (w/o servers)

Proto	Recv-Q	Send-Q	Local Address	Foreign Address	State
tcp	0	0	csil-linux1.cs.uiuc.edu:800	dcfiles.cs.uiuc.edu:nfs	ESTABLISHED
tcp	0	0	csil-linux1.cs.uiuc.e:56492	csil-projects.cs.uiuc:mysql	ESTABLISHED
tcp	0	0	csil-linux1.cs.uiuc.e:56593	dcfiles.cs.uiuc.edu:sunrpc	TIME_WAIT
tcp	0	0	csil-linux1.cs.uiuc.e:56594	dcfiles.cs.uiuc.edu:nfs	TIME_WAIT
tcp	0	0	csil-linux1.cs.uiuc.edu:799	dcshome.cs.uiuc.edu:nfs	ESTABLISHED
tcp	1	0	csil-linux1.cs.uiuc.e:38887	ad-dc-p2.ad.uiuc.edu:ldaps	CLOSE_WAIT
tcp	0	0	csil-linux1.cs.uiuc.e:56590	dcslldap1.cs.uiuc.edu:ldap	TIME_WAIT
tcp	0	0	csil-linux1.cs.uiuc.e:56602	dcslldap1.cs.uiuc.edu:ldap	TIME_WAIT
tcp	1	0	csil-linux1.cs.uiuc.e:55284	ad-dc-p2.ad.uiuc.edu:ldaps	CLOSE_WAIT
tcp	0	0	csil-linux1.cs.uiuc.e:32780	dcslldap1.cs.uiuc.edu:ldap	ESTABLISHED
tcp	1	0	csil-linux1.cs.uiuc.e:50378	ad-dc-p2.ad.uiuc.edu:ldaps	CLOSE_WAIT
tcp	0	0	csil-linux1.cs.uiuc.e:38888	dcslldap1.cs.uiuc.edu:ldap	ESTABLISHED
tcp	0	0	csil-linux1.cs.uiuc.edu:ssh	74-134-234-93.dhcp.ins:2057	ESTABLISHED
tcp	0	0	csil-linux1.cs.uiuc.edu:ssh	darmstadt.cs.uiuc.edu:1605	ESTABLISHED
tcp	0	0	csil-linux1.cs.uiuc.edu:ssh	74-134-234-93.dhcp.ins:3025	ESTABLISHED
tcp	0	0	csil-linux1.cs.uiuc.edu:ssh	seclab-tehran2.cs.uiuc:2555	ESTABLISHED
tcp	0	0	csil-linux1.cs.uiuc.edu:ssh	sydney.cs.uiuc.edu:1980	ESTABLISHED

Active UNIX domain sockets (w/o servers)

Proto	RefCnt	Flags	Type	State	I-Node Path
unix	2	[]	DGRAM	9167	@/var/run/hal/hotplug_socket
unix	2	[]	DGRAM	3425	@udev
unix	16	[]	DGRAM	7674	/dev/log
unix	2	[]	DGRAM	1634536	
unix	3	[]	STREAM	CONNECTED	1634179

TCP/IP Protocol Layers



Connection-oriented Communication Protocol

Server monitors a passive end-point whose address is known to clients

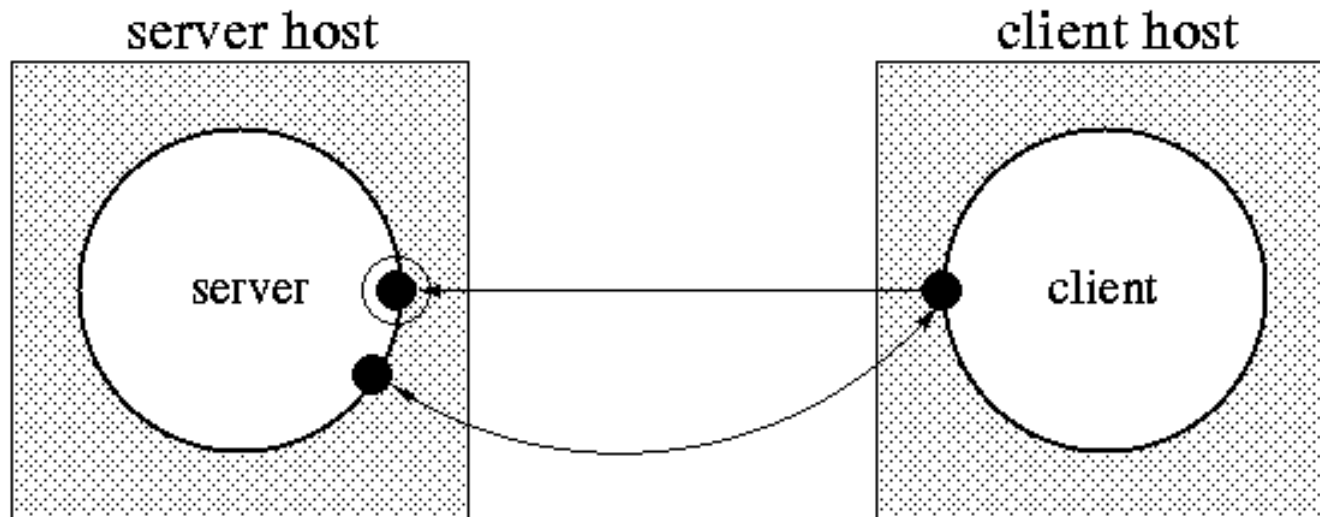
Listening (passive) endpoints have resources for queuing client connection requests and establishing client connections

Action of accepting a client request creates a new endpoint for private, two-way symmetric communication with that client

Client and server communicate by using handles (file descriptors) and do not explicitly include addresses in their messages

When finished, client and server close their file descriptors, system releases resources associated with the connection

Connection-Oriented Communications Illustration



- communication endpoint
- passive communication endpoint

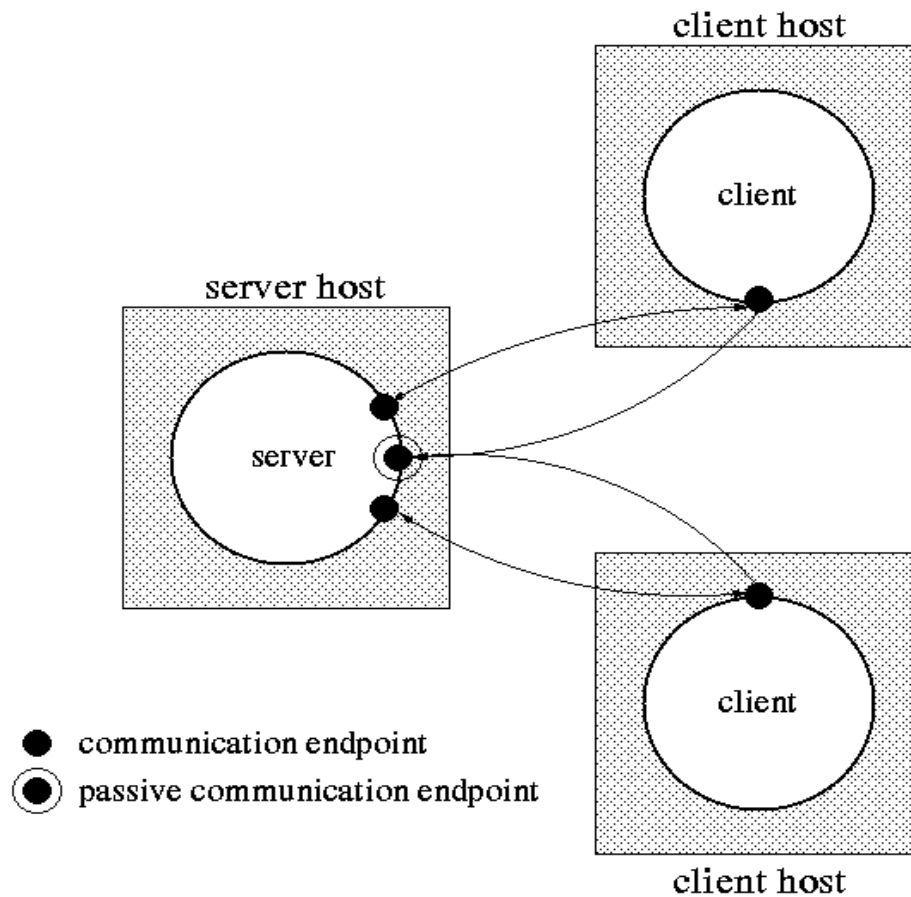
Connection-Oriented Server Strategies

Serial-server strategy

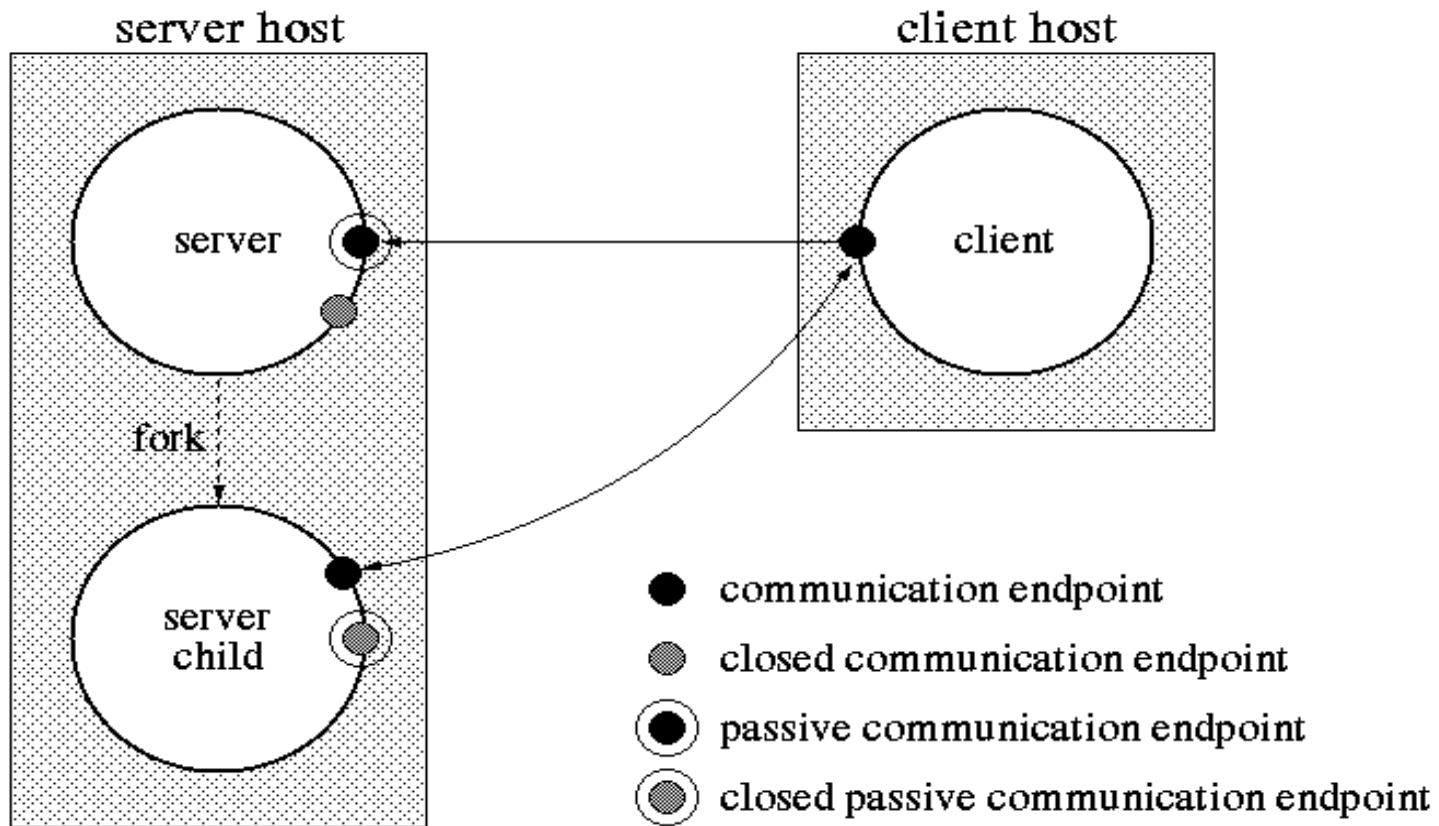
Parent-server strategy

Threaded-server strategy

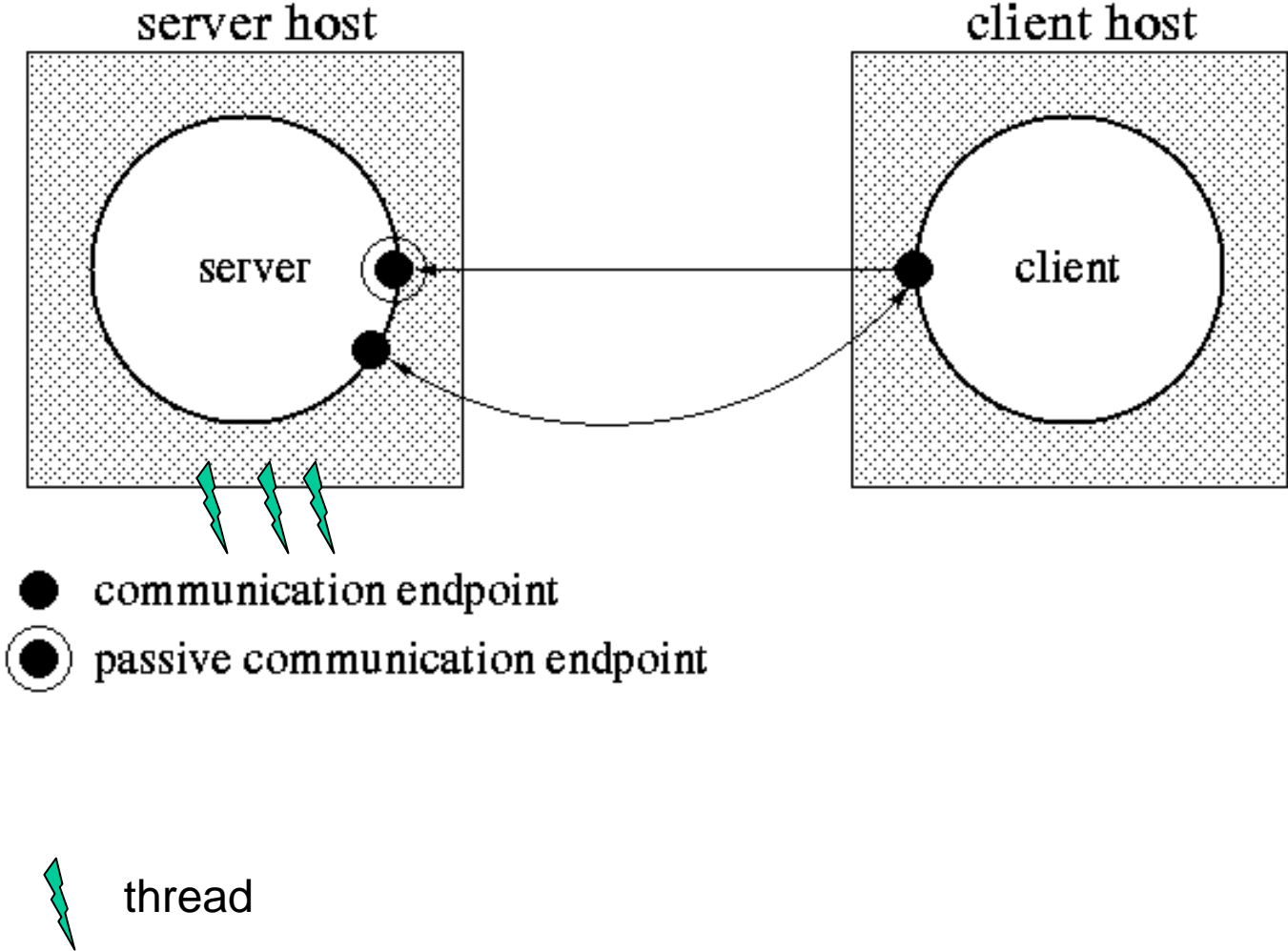
Multiple Clients (Serial-server Strategy)



Parent-server Strategy



Threaded-server Strategy



Summary

Client-Server Process Communication

Communication Channel

Communication Protocols

Connectionless vs Connection-oriented

Connection-oriented Server Strategies