

Chapter 1

Uses of Computer Networks

Lesson 2: Network HW and SW

So far...

● Uses of Computer Networks

- Home
- Business
- Mobile
- Social/Entertainment

● Connectivity

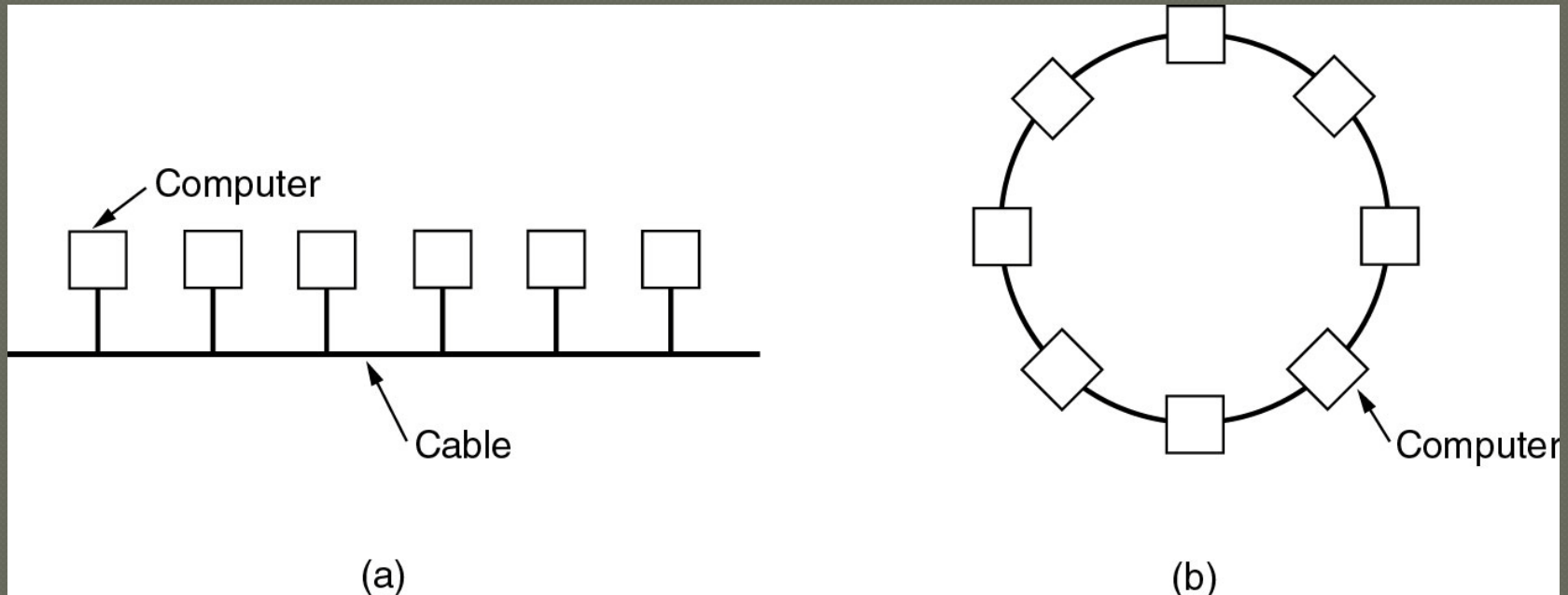
- Direct
 - Costly, not scalable
- Indirect
 - Delay

Networks by Size

● Classification of interconnected processors by scale.

Interprocessor distance	Processors located in same	Example
1 m	Square meter	Personal area network
10 m	Room	Local area network
100 m	Building	
1 km	Campus	
10 km	City	Metropolitan area network
100 km	Country	Wide area network
1000 km	Continent	
10,000 km	Planet	The Internet

Local Area Networks



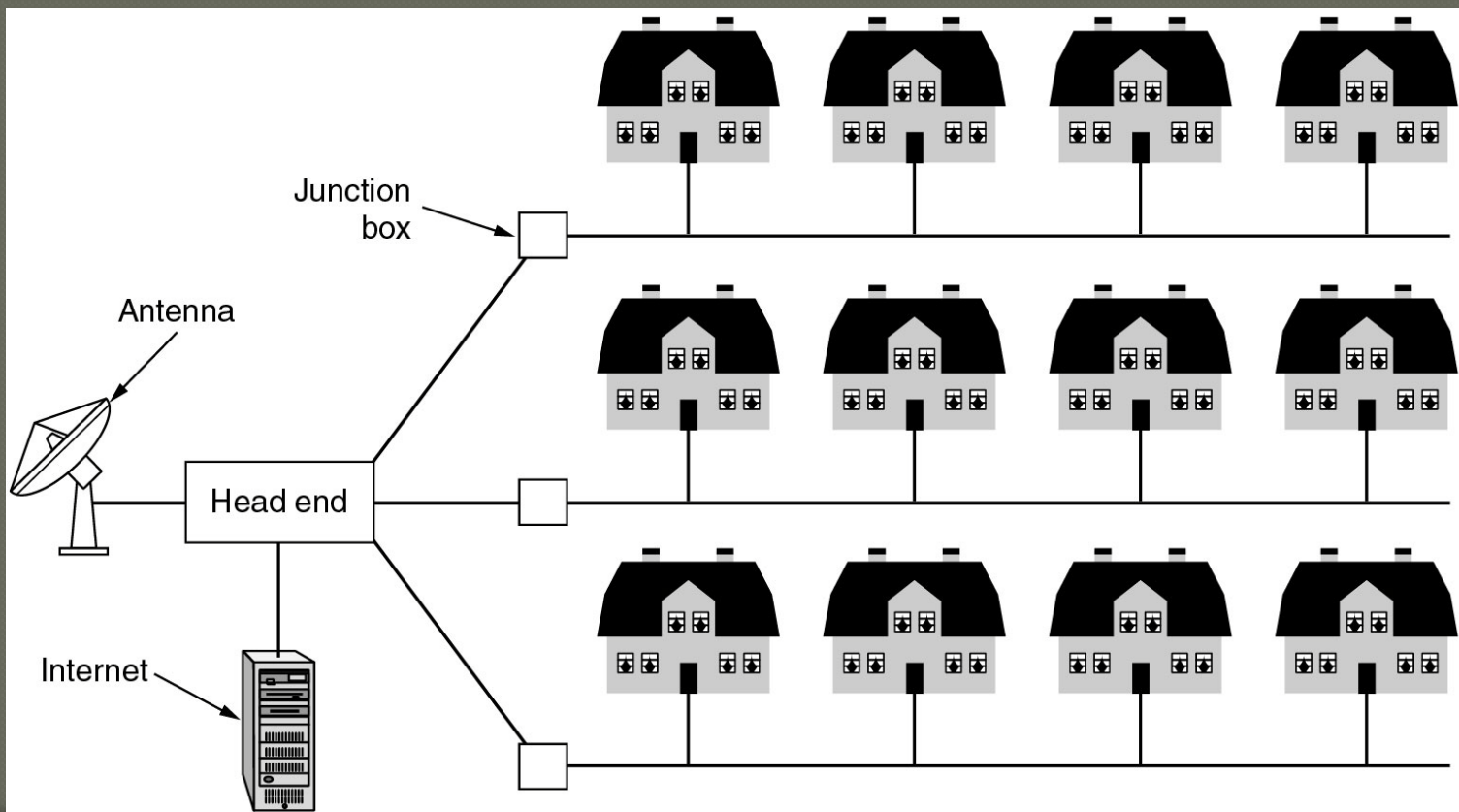
● Two broadcast networks

(a) Bus

(b) Ring

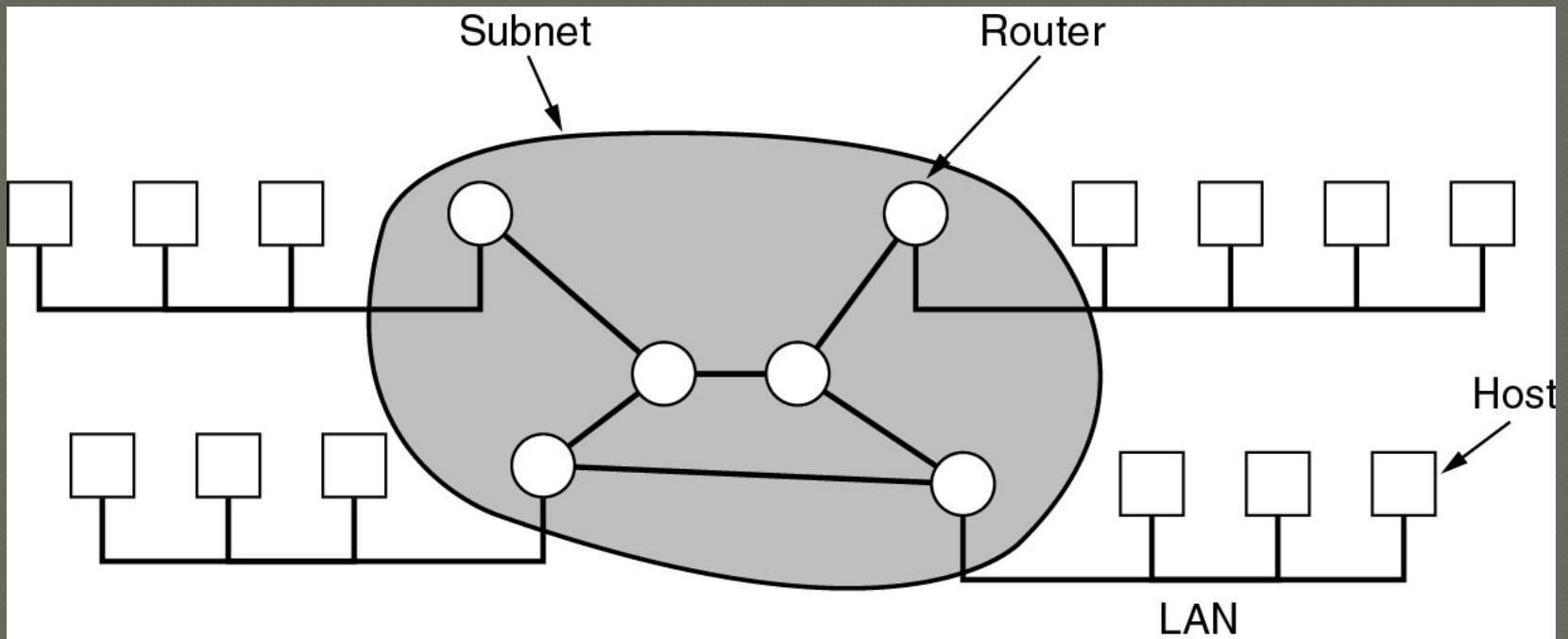
Metropolitan Area Networks

- A metropolitan area network based on cable TV.



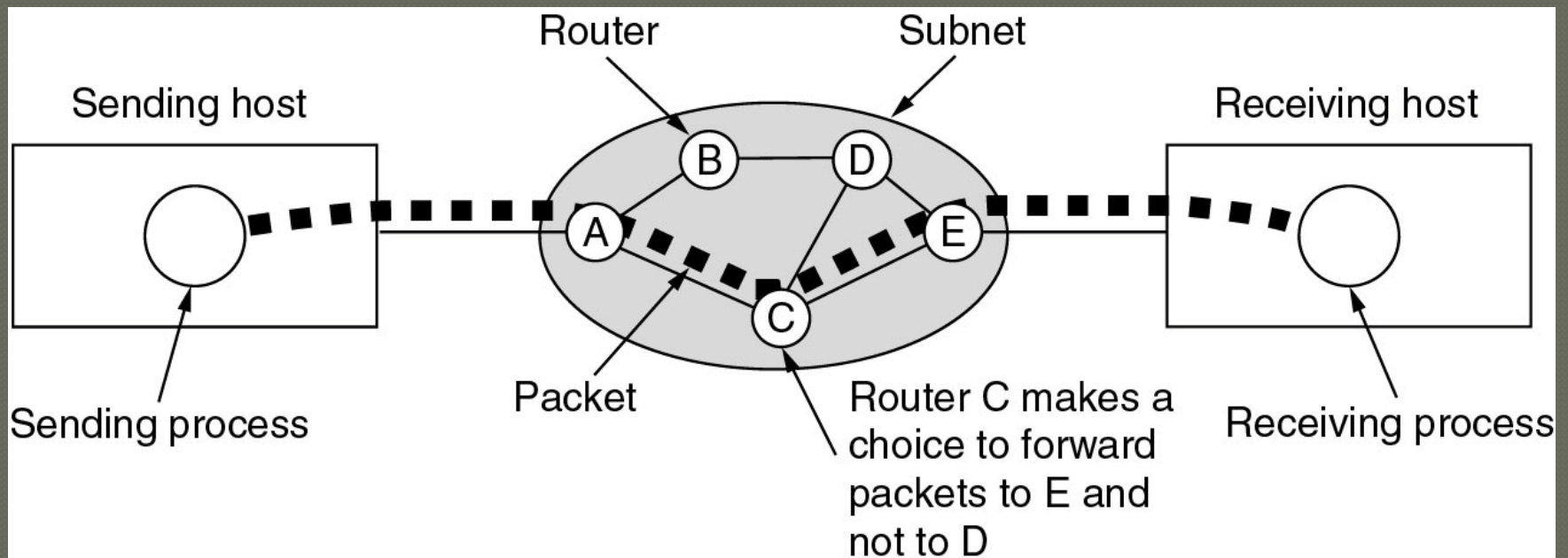
Wide Area Networks

- Relation between hosts on LANs and the subnet.



Wide Area Networks (2)

- A stream of packets from sender to receiver.
 - Filter and Forward



Filter and Forward

● Switching Strategies

- Circuit switching: Send/receive a bit stream (dedicated)
- Packet switching: Store-and-forward; send/receive message

● Addressing and Routing

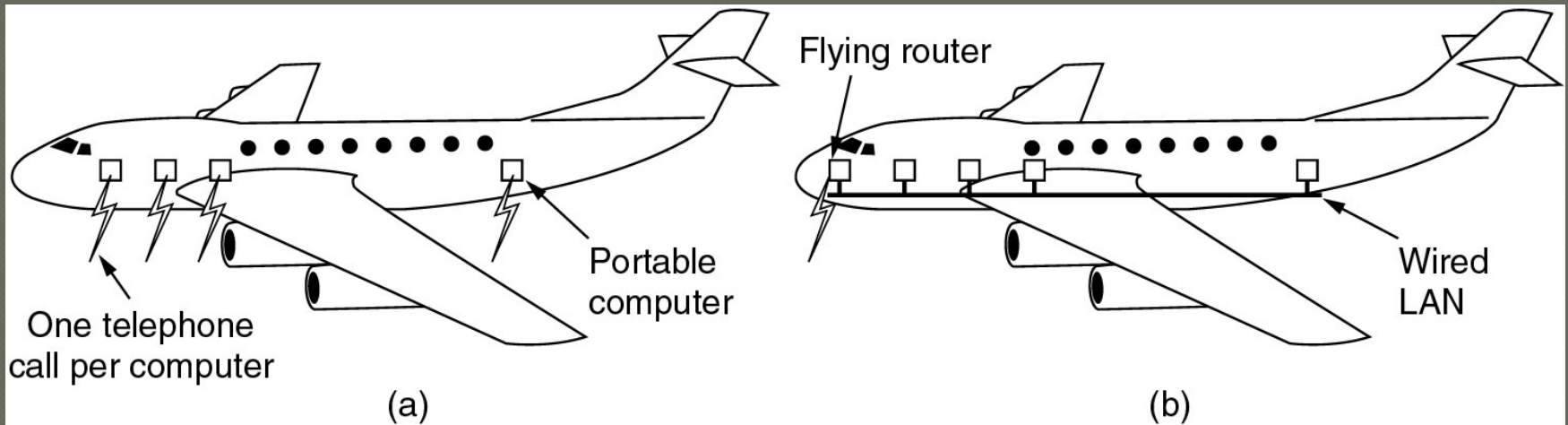
- Address: Byte-string that identifies a unique node
- Routing: process to determine how to forward messages to destination according to the address
- Type of addresses:
 - Unicast: node-specific
 - Broadcast: all nodes of the network
 - Multicast: some subnet of nodes of the network

Wireless and Mobile Networks

- ◉ Combinations of wireless networks and mobile computing.
- ◉ Categories of wireless networks:
 - System interconnection
 - Wireless LANs
 - Wireless WANs

Wireless	Mobile	Applications
No	No	Desktop computers in offices
No	Yes	A notebook computer used in a hotel room
Yes	No	Networks in older, unwired buildings
Yes	Yes	Portable office; PDA for store inventory

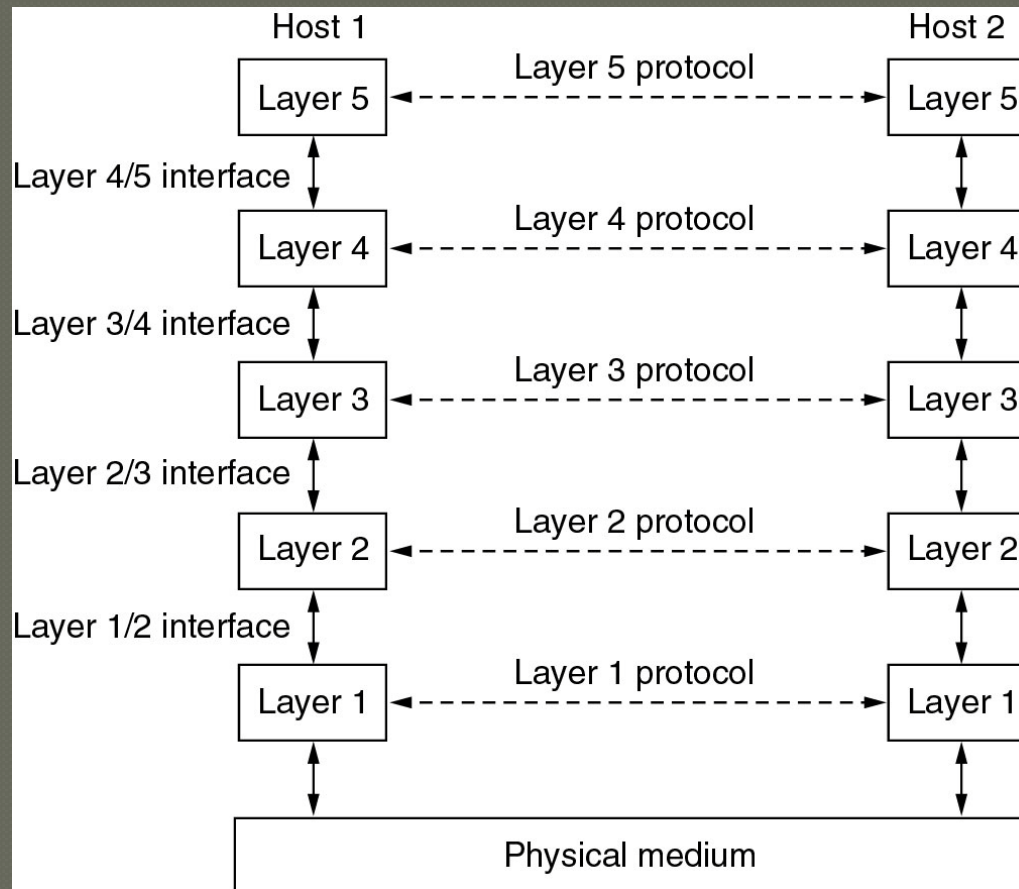
Wireless Networks (3)



- ◉ (a) Individual mobile computers
- ◉ (b) A flying LAN

Network Software Protocol Hierarchies

Layers, protocols, and interfaces.

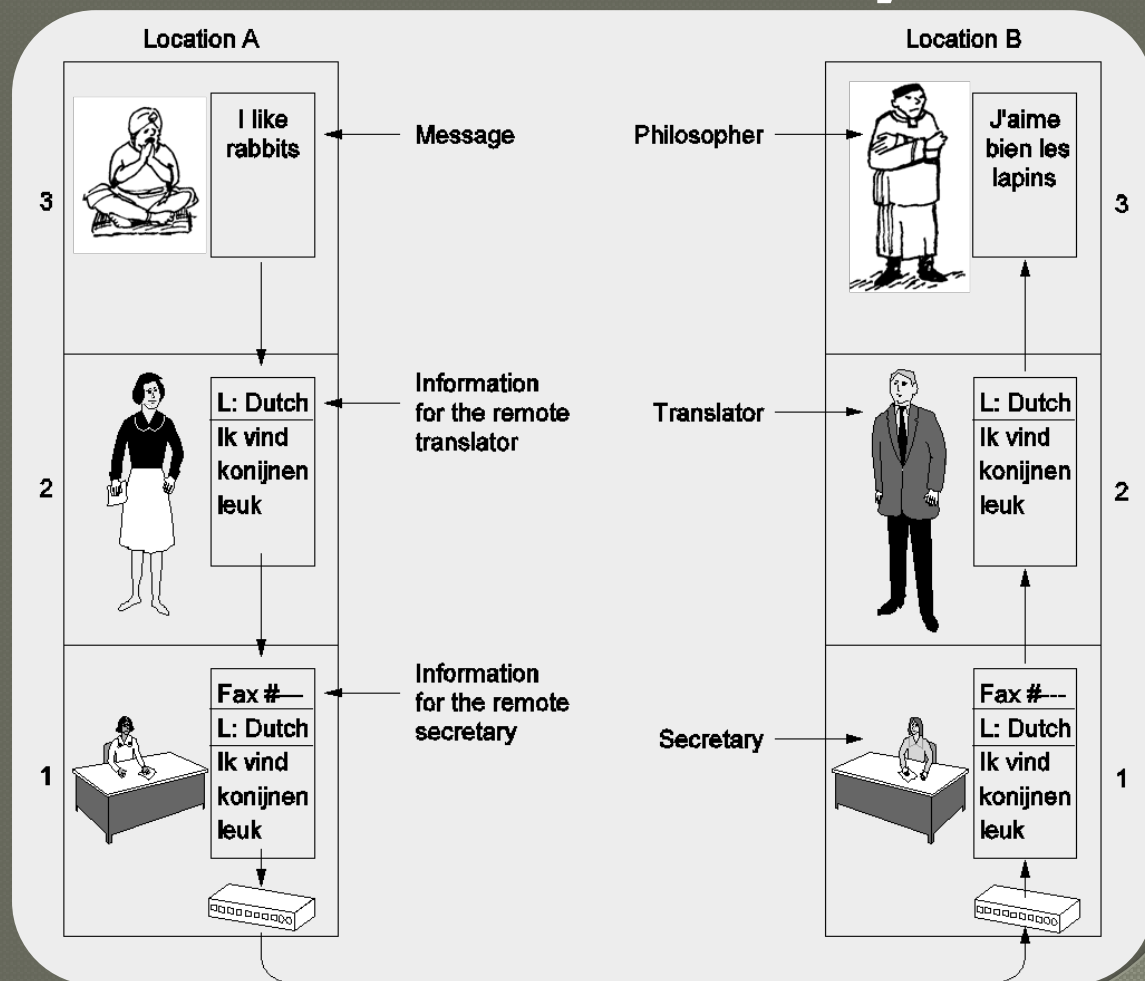


What is a Protocol?

- **Protocols:** a series of functions performed at different locations

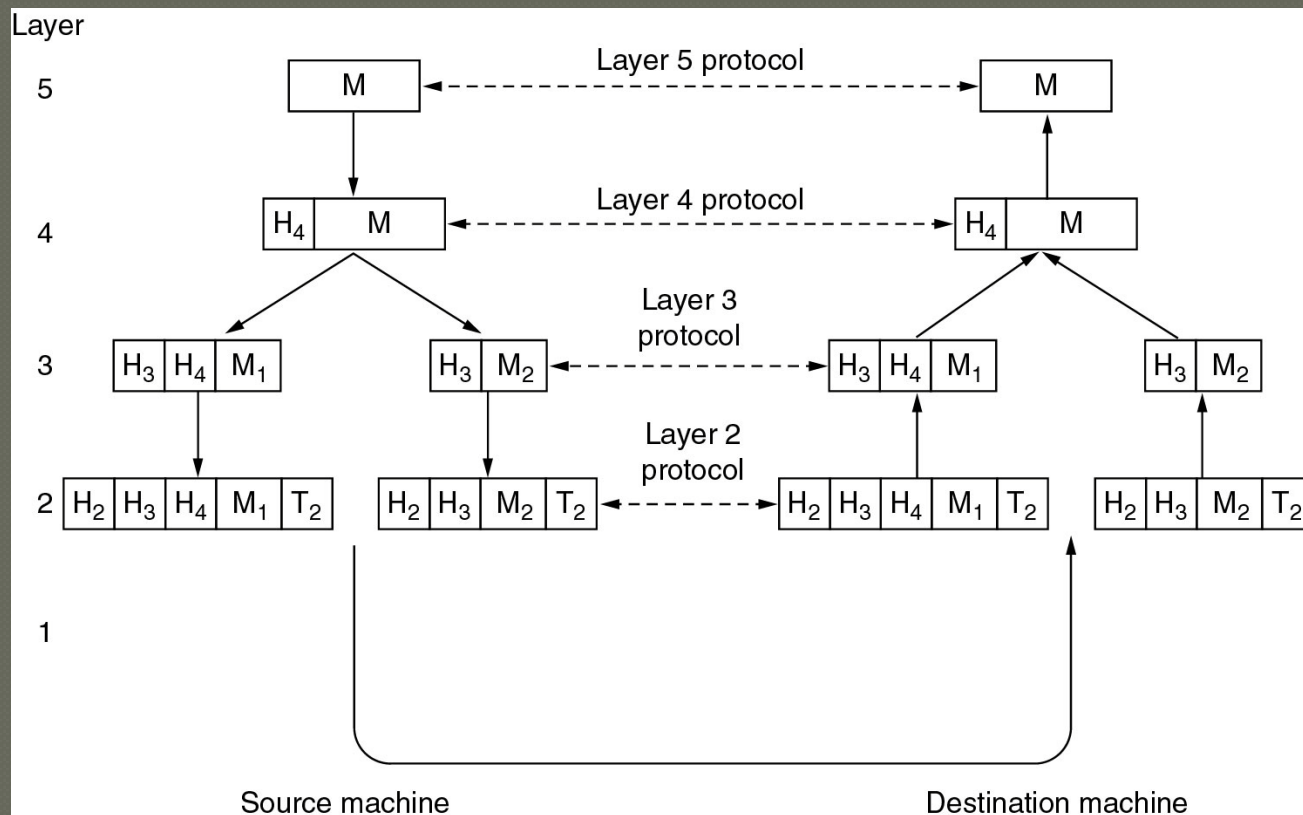
Protocol Hierarchies (2)

- The philosopher-translator-secretary architecture.



Protocol Hierarchies (3)

- Example information flow supporting virtual communication in layer 5.



Design Issues for the Layers

- Addressing
- Error Control
- Flow Control
- Multiplexing
- Routing

Connection-Oriented and Connectionless Services

- Six different types of service.

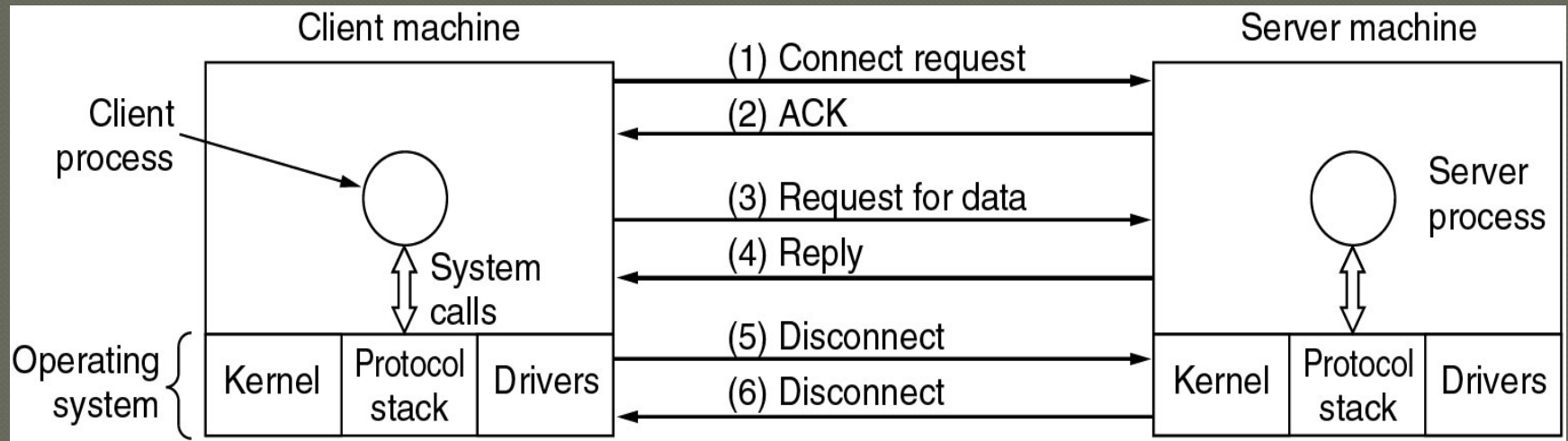
		Service	Example
Connection-oriented	{	Reliable message stream	Sequence of pages
		Reliable byte stream	Remote login
		Unreliable connection	Digitized voice
Connection-less	{	Unreliable datagram	Electronic junk mail
		Acknowledged datagram	Registered mail
		Request-reply	Database query

Service Primitives

Primitive	Meaning
LISTEN	Block waiting for an incoming connection
CONNECT	Establish a connection with a waiting peer
RECEIVE	Block waiting for an incoming message
SEND	Send a message to the peer
DISCONNECT	Terminate a connection

- Five service primitives for implementing a simple connection-oriented service.

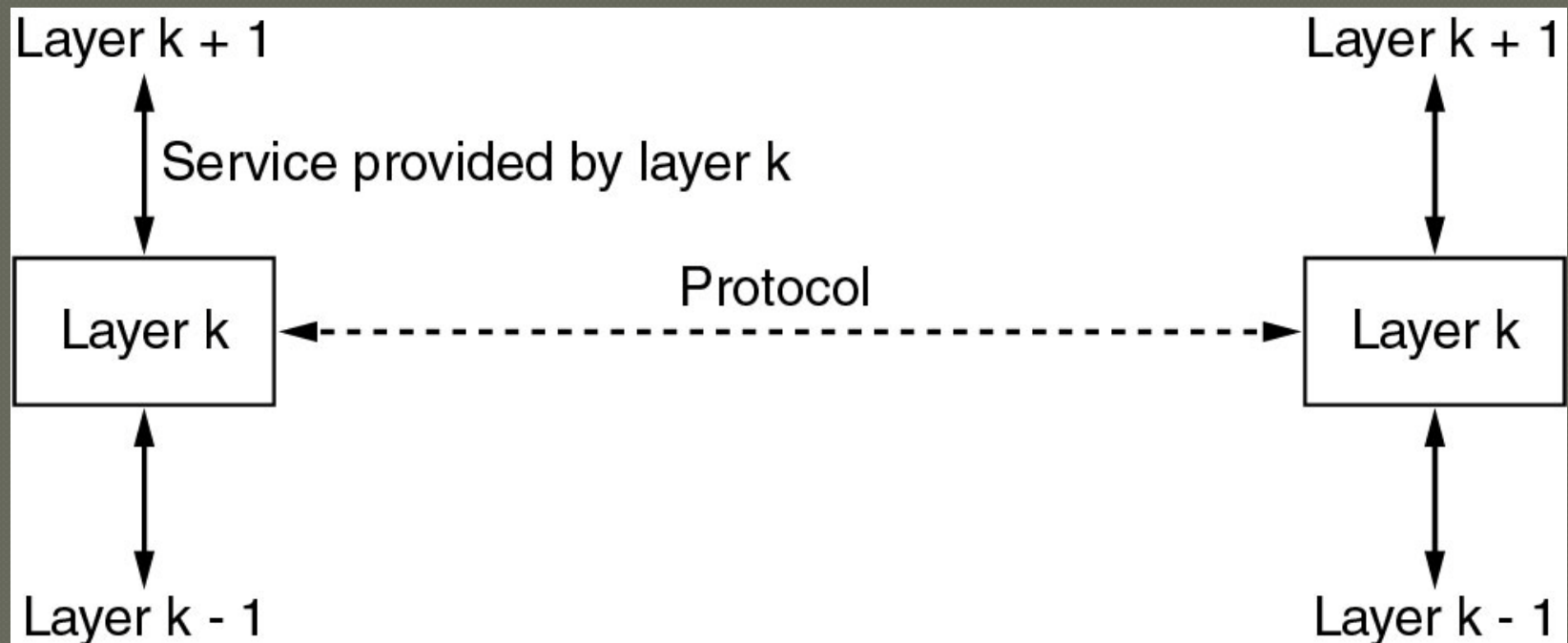
Service Primitives (2)



- Packets sent in a simple client-server interaction on a connection-oriented network.

Services to Protocols Relationship

- The relationship between a service and a protocol.



What can go wrong in a Network?

- Bit-level error

- Ex. Electrical surges

- Packet-level errors

- Ex. Congestion

- Node failure or link failure

- Ex. System crash

- Messages can be:

- Delayed
 - Delivered out-of-order
 - Lost
 - Can be listened secretly

Metric Units

Exp.	Explicit	Prefix	Exp.	Explicit	Prefix
10^{-3}	0.001	milli	10^3	1,000	Kilo
10^{-6}	0.000001	micro	10^6	1,000,000	Mega
10^{-9}	0.000000001	nano	10^9	1,000,000,000	Giga
10^{-12}	0.0000000000001	pico	10^{12}	1,000,000,000,000	Tera
10^{-15}	0.0000000000000001	femto	10^{15}	1,000,000,000,000,000	Peta
10^{-18}	0.0000000000000000001	atto	10^{18}	1,000,000,000,000,000,000	Exa
10^{-21}	0.0000000000000000000001	zepto	10^{21}	1,000,000,000,000,000,000,000	Zetta
10^{-24}	0.000000000000000000000001	yocto	10^{24}	1,000,000,000,000,000,000,000,000	Yotta

● Speed of Light

- 3.0×10^8 m/s in a vacuum
- 2.3×10^8 m/s in a cable
- 2.0×10^8 m/s in a fiber.

Performance

● Bandwidth (throughput)

- the maximum amount of data that can be transmitted per unit of time.
- Example: 11Mbps = 11×10^6 bits per second

● Latency:

- one-way - the time from the source sending a packet to the destination receiving it,
- round-trip - the one-way latency from source to destination plus the one-way latency from the destination back to the source

Performance

Latency = Propagation Time + Transmission Time
+ Queue Time

Propagation Time = Distance / SpeedOfLight

Transmission Time = Size / Bandwidth

Observe:

- No queuing in direct connection
- Process-process latency includes SW overhead
- SW overhead can dominate if distance is small

Can Speed Grow Indefinitely?

- ◉ We can improve Bandwidth
- ◉ We can improve Queuing

Latency will stay! ☹️

In Conclusion....

- Network Hardware
 - Fiber, cable, router, switches, etc.
 - We can classify the network by Size
- Network Software
 - Protocol
 - Connection Services
- What can go wrong?
- Performance
 - Cannot grow indefinitely!

Next Time

- ◉ Reference Models
- ◉ Transmission Media

An Assignment will be issued.