



Computer Networks 1

(Mạng Máy Tính 1)

Lectured by: Dr. Phạm Trần Vũ



Course details

- Number of credits: 4
- Study time allocation per week:
 - 3 lecture hours for theory
 - 2 lecture hours for exercises and lab work
 - 8 hours for self-study
- Website:
 - <http://www.cse.hcmut.edu.vn/~ptvu/net1/>



Course outline (1)

- Fundamental concepts in the design and implementation of computer networks
 - Protocols, standards and applications
 - Introduction to network programming.



Course outline (2)

- The topics to be covered include:
 - Introduction to network architecture, OSI and the TCP/IP reference models.
 - Network technologies, especially LAN technologies (Ethernet, wireless networks and Bluetooth).
 - Issues related to routing and internetworking, Internet addressing and routing.
 - Internet transport protocols (UDP and TCP)
 - Network-programming interface
 - Application layer protocols and applications such as DNS, E-mail, and WWW.



References

- “*Computer Networks*”, Andrew S. Tanenbaum, 4th Edition, Prentice Hall, 2003.
- “*TCP/IP Protocol Suite*”, B. A. Forouzan, Mc Graw-Hill, 1st ed., 2000.



Assessment

- Assignment 20%
 - Two assignments, 10% each
- Midterm exam: 20%
- Final exam: 60%
- Laboratory work is compulsory
 - No lab work = No assignment mark



Lecture 1: Introduction to Computer Networks

Reference:

Chapter 1 - “*Computer Networks*”,
Andrew S. Tanenbaum, 4th Edition, Prentice Hall, 2003.



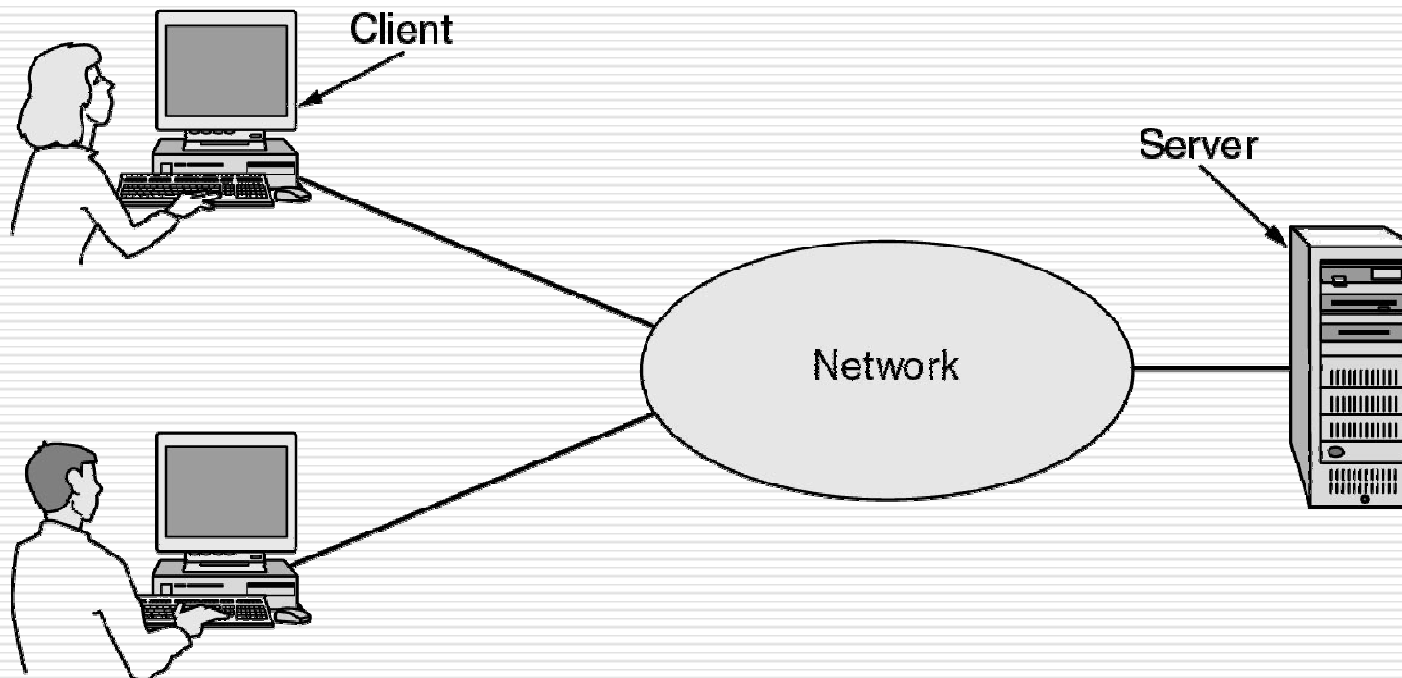
Uses of Computer Networks

- ❑ Business Applications
- ❑ Scientific Applications
- ❑ Home Applications
- ❑ Mobile Users



Business Applications of Networks (1)

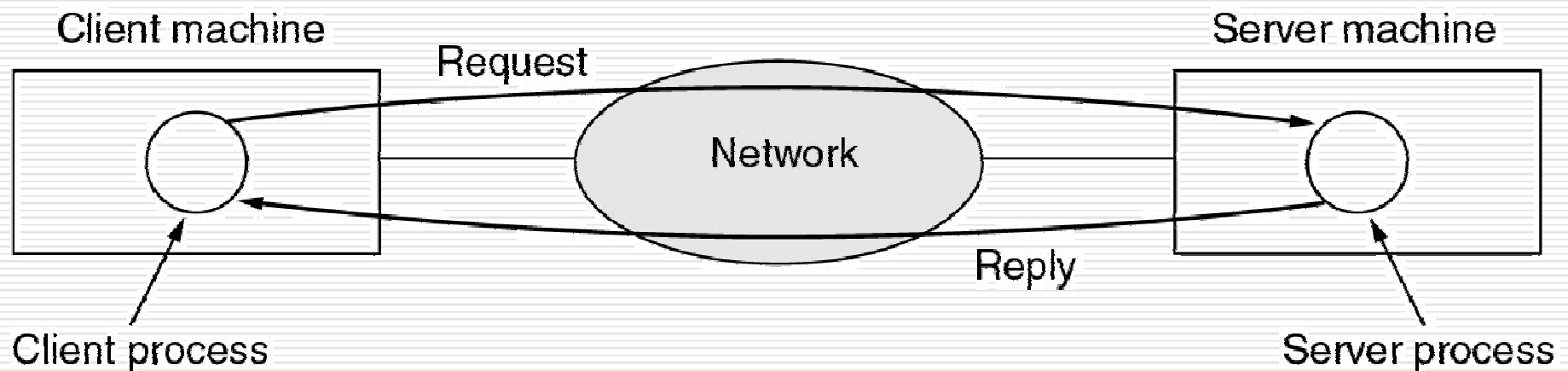
- A network with two clients and one server.





Business Applications of Networks (2)

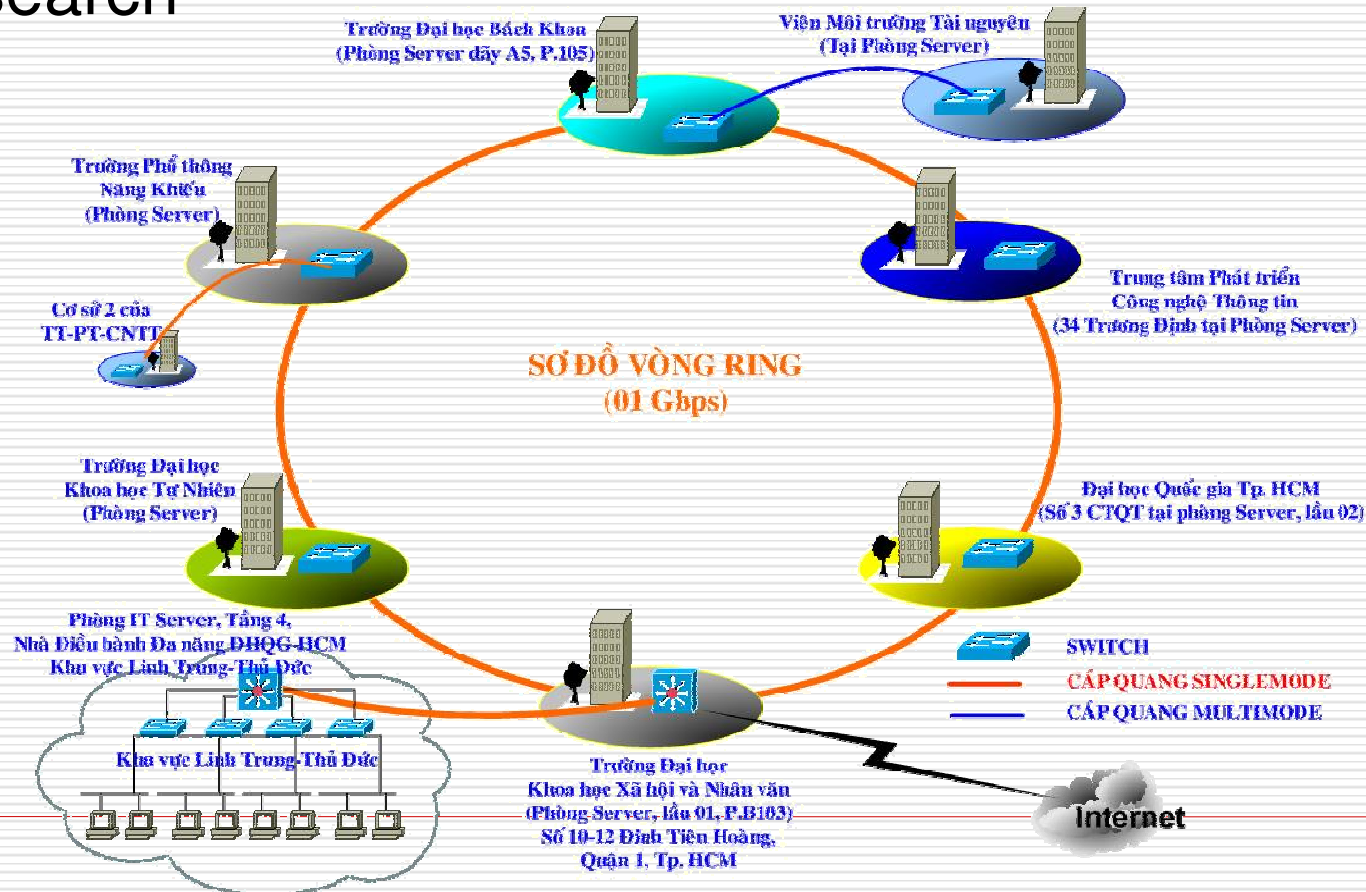
- The client-server model involves requests and replies.





Scientific Applications

- Grid computing infrastructure to support scientific research





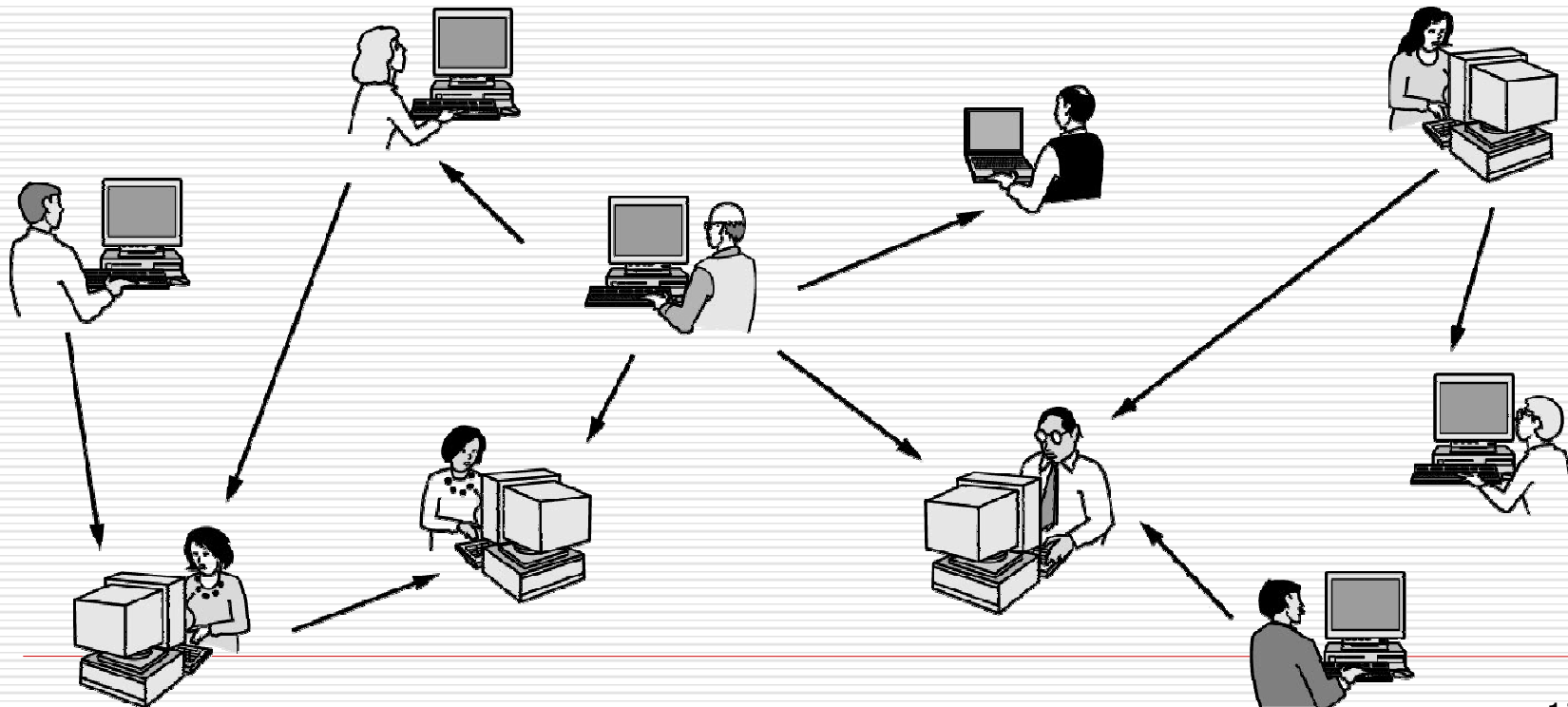
Home Network Applications (1)

- Access to remote information
- Person-to-person communication
- Interactive entertainment
- Electronic commerce



Home Network Applications (2)

- In peer-to-peer system there are no fixed clients and servers.





Home Network Applications (3)

- Some forms of e-commerce.

Tag	Full name	Example
B2C	Business-to-consumer	Ordering books on-line
B2B	Business-to-business	Car manufacturer ordering tires from supplier
G2C	Government-to-consumer	Government distributing tax forms electronically
C2C	Consumer-to-consumer	Auctioning second-hand products on-line
P2P	Peer-to-peer	File sharing



Mobile Network Users

- Combinations of wireless networks and mobile computing.

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



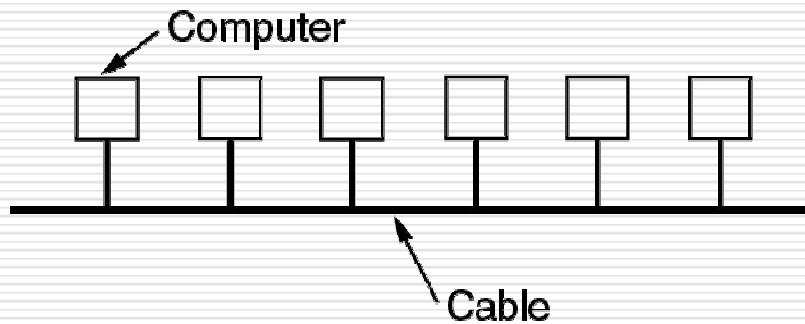
Network Hardware

- ❑ Local Area Networks
- ❑ Metropolitan Area Networks
- ❑ Wide Area Networks
- ❑ Wireless Networks
- ❑ Home Networks
- ❑ Internetworks

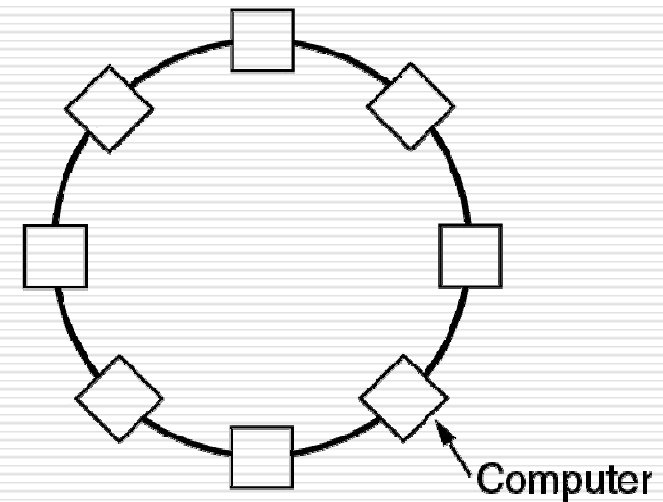


Local Area Networks

- Two broadcast networks
- (a) Bus
- (b) Ring



(a)

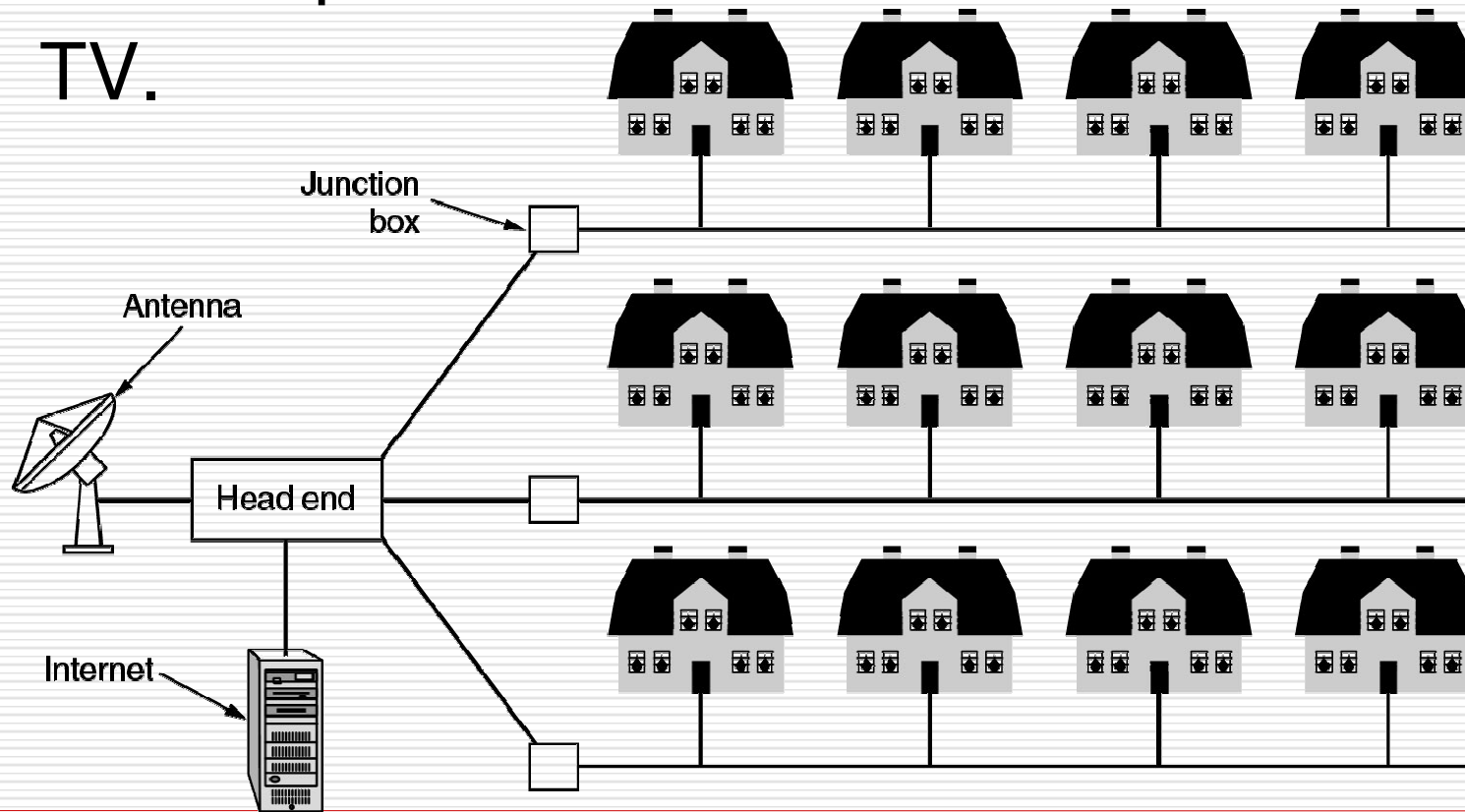


(b)



Metropolitan Area Networks

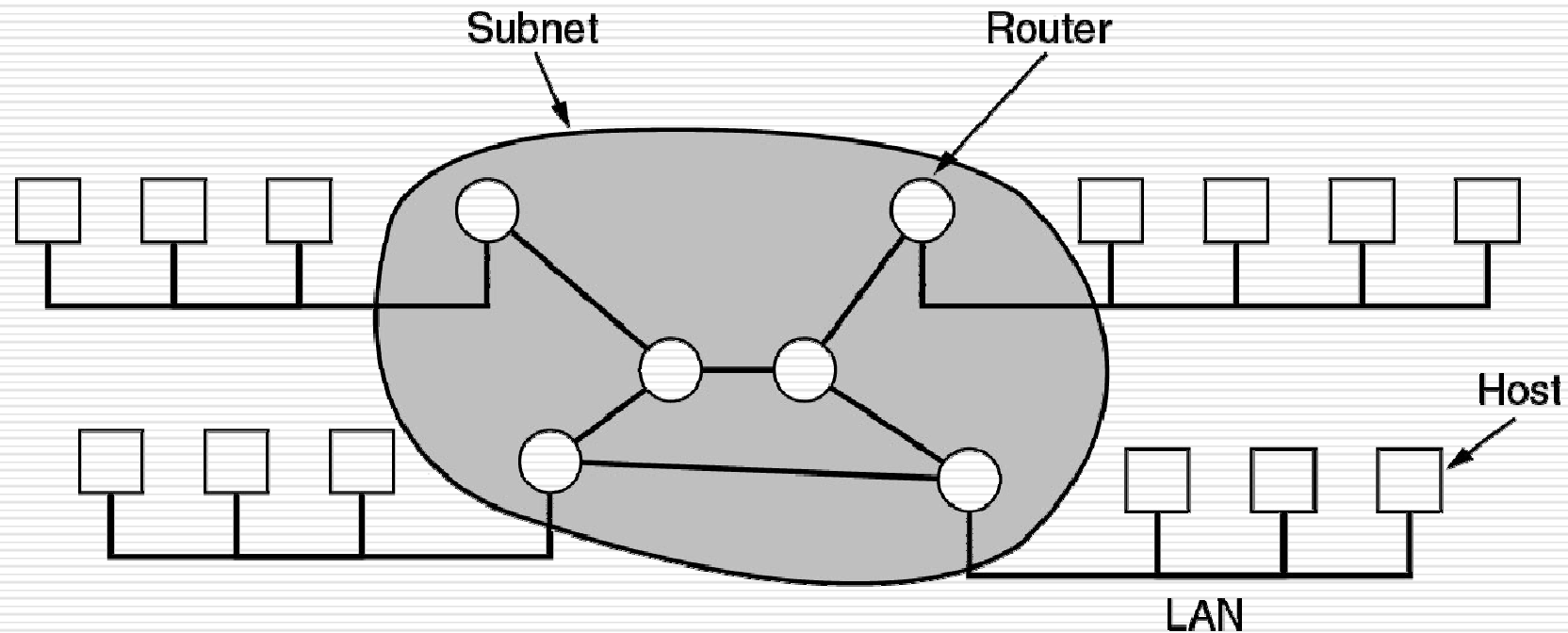
- A metropolitan area network based on cable TV.





Wide Area Networks (1)

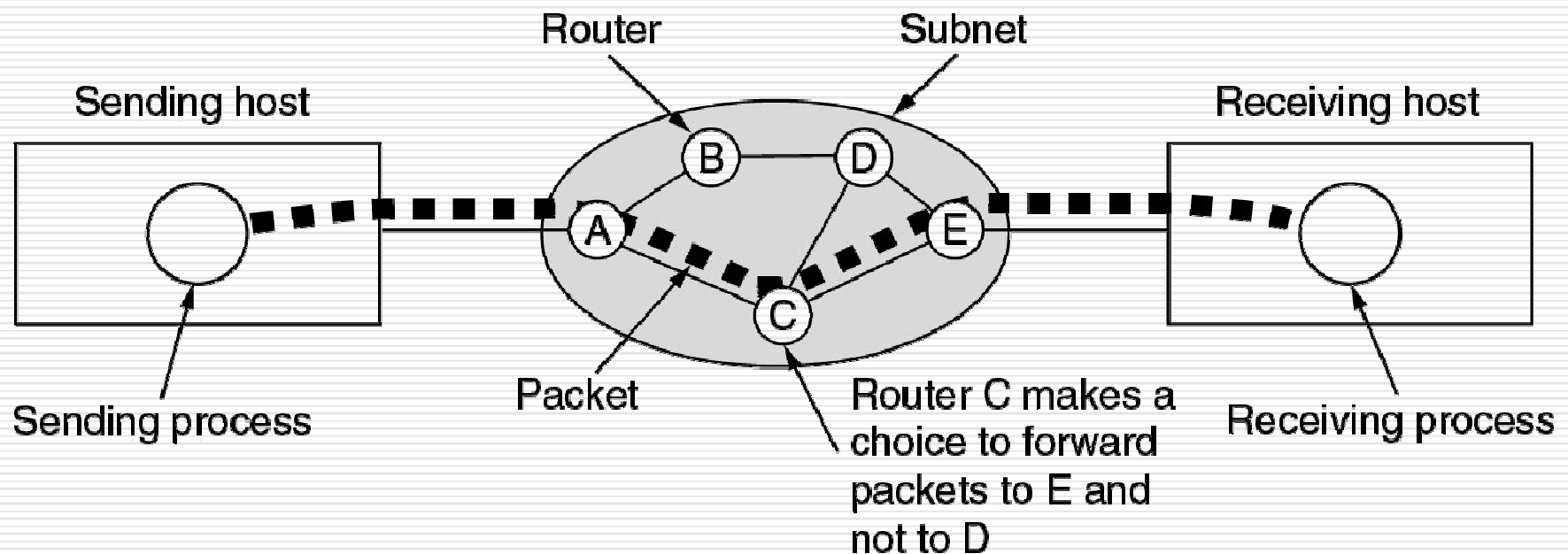
- Relation between hosts on LANs and the subnet.





Wide Area Networks (2)

- A stream of packets from sender to receiver.





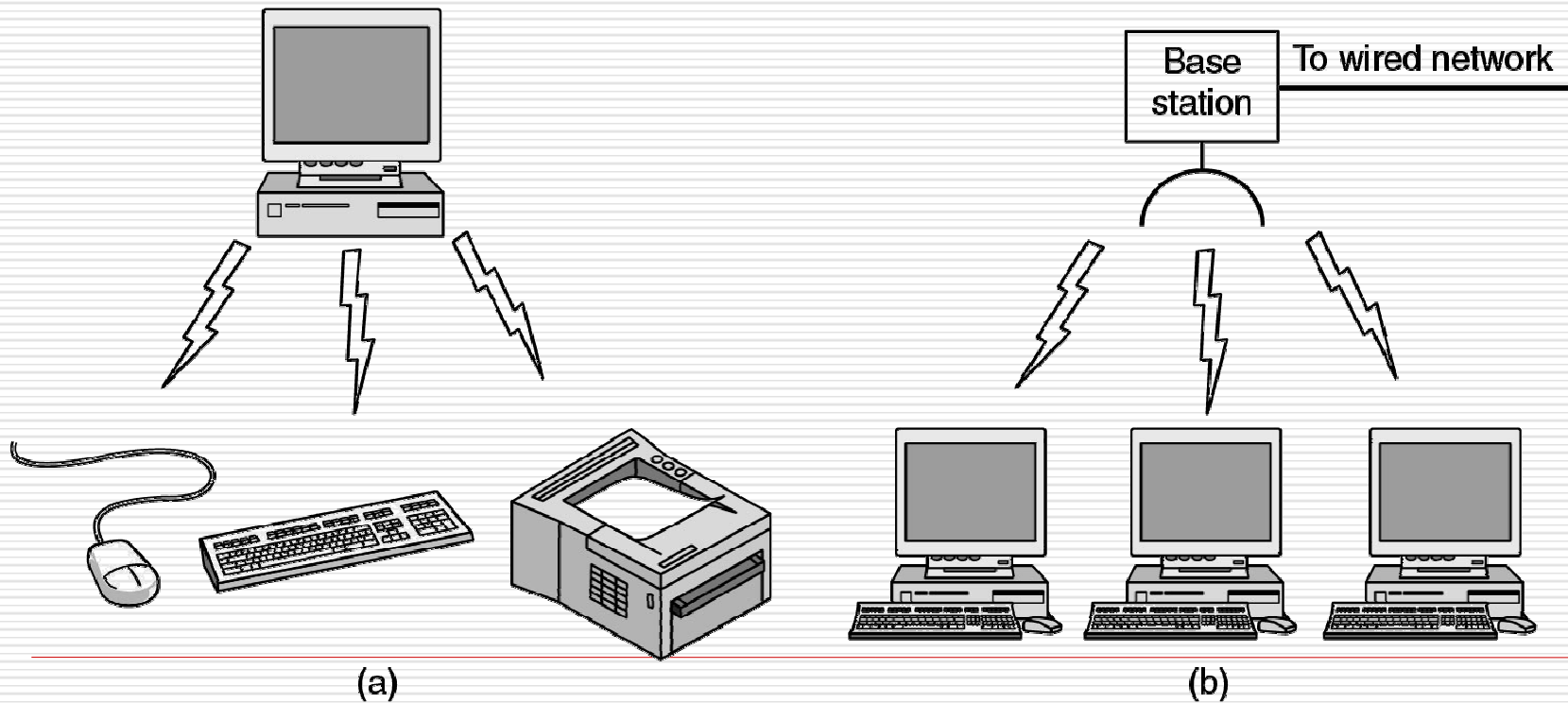
Wireless Networks (1)

- Categories of Wireless Networks
 - System interconnections
 - Wireless LANs
 - Wireless WANs



Wireless Networks (2)

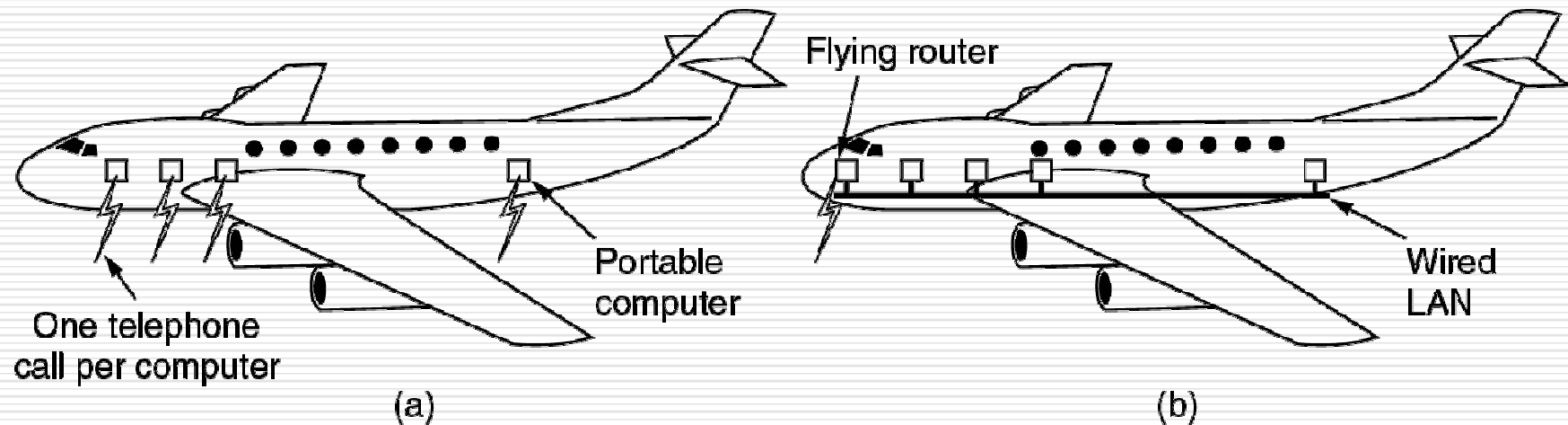
- (a) Bluetooth configuration
- (b) Wireless LAN





Wireless Networks (3)

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





Home Network Categories

- ❑ Computers: desktop PC, PDA, shared peripherals
- ❑ Entertainment: TV, DVD, VCR, camera, MP3
- ❑ Telecomm: telephone, cell phone, intercom, fax
- ❑ Appliances: microwave, fridge, clock, aircon
- ❑ Telemetry: utility meter, burglar alarm, babycam



Network Software

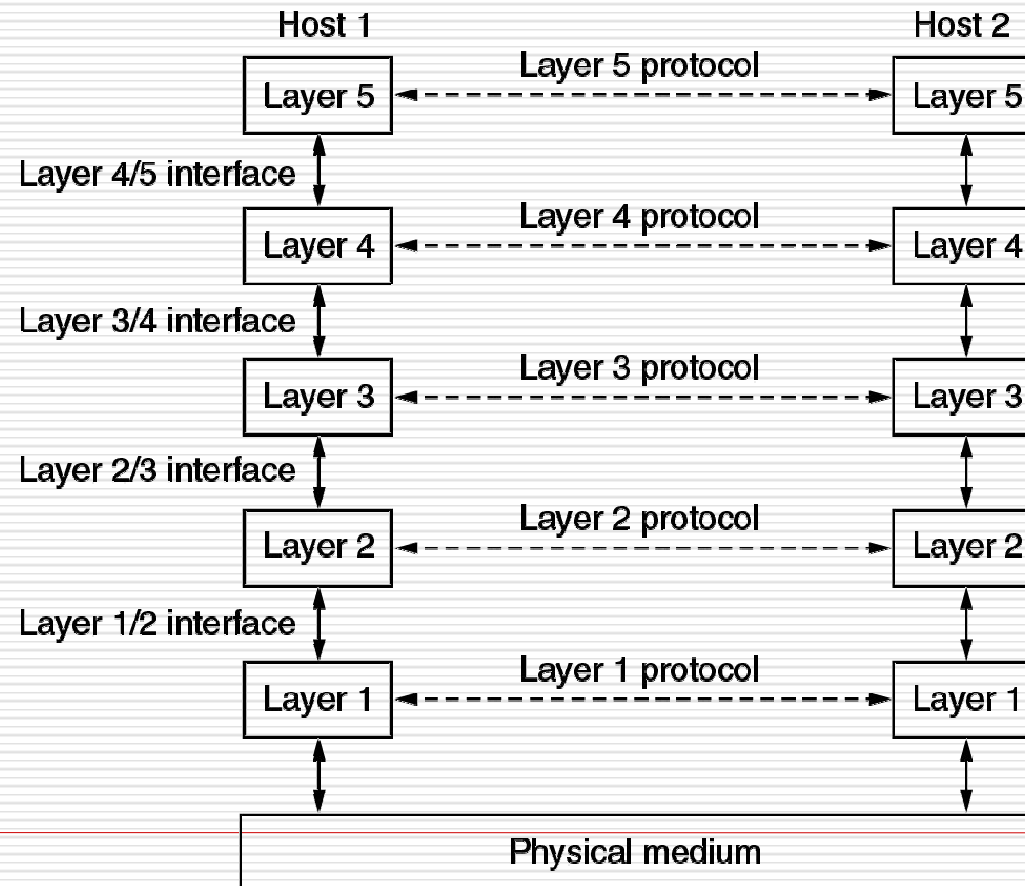
- Protocol Hierarchies
- Design Issues for the Layers
- Connection-Oriented and Connectionless Services
- Service Primitives
- The Relationship of Services to Protocols



Network Software

Protocol Hierarchies

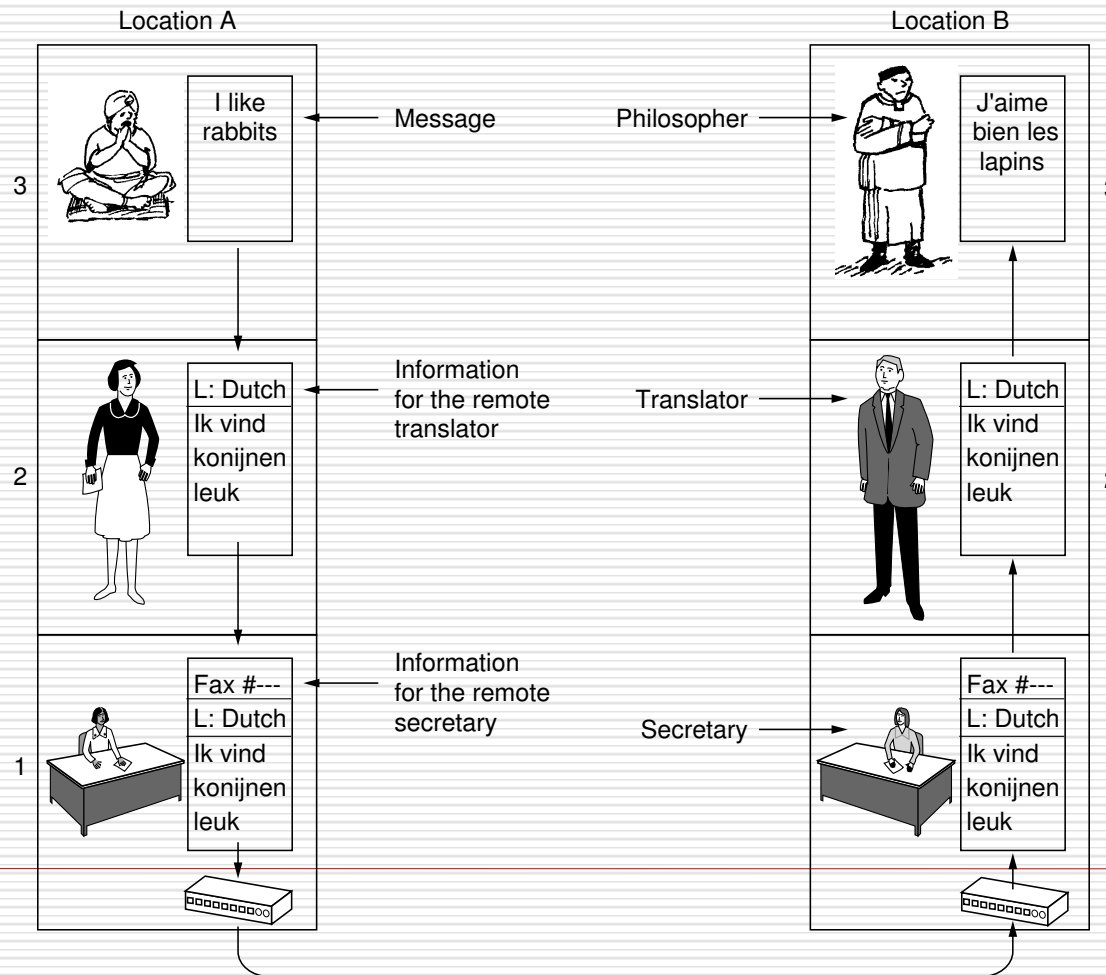
- Layers, protocols, and interfaces.





Protocol Hierarchies (2)

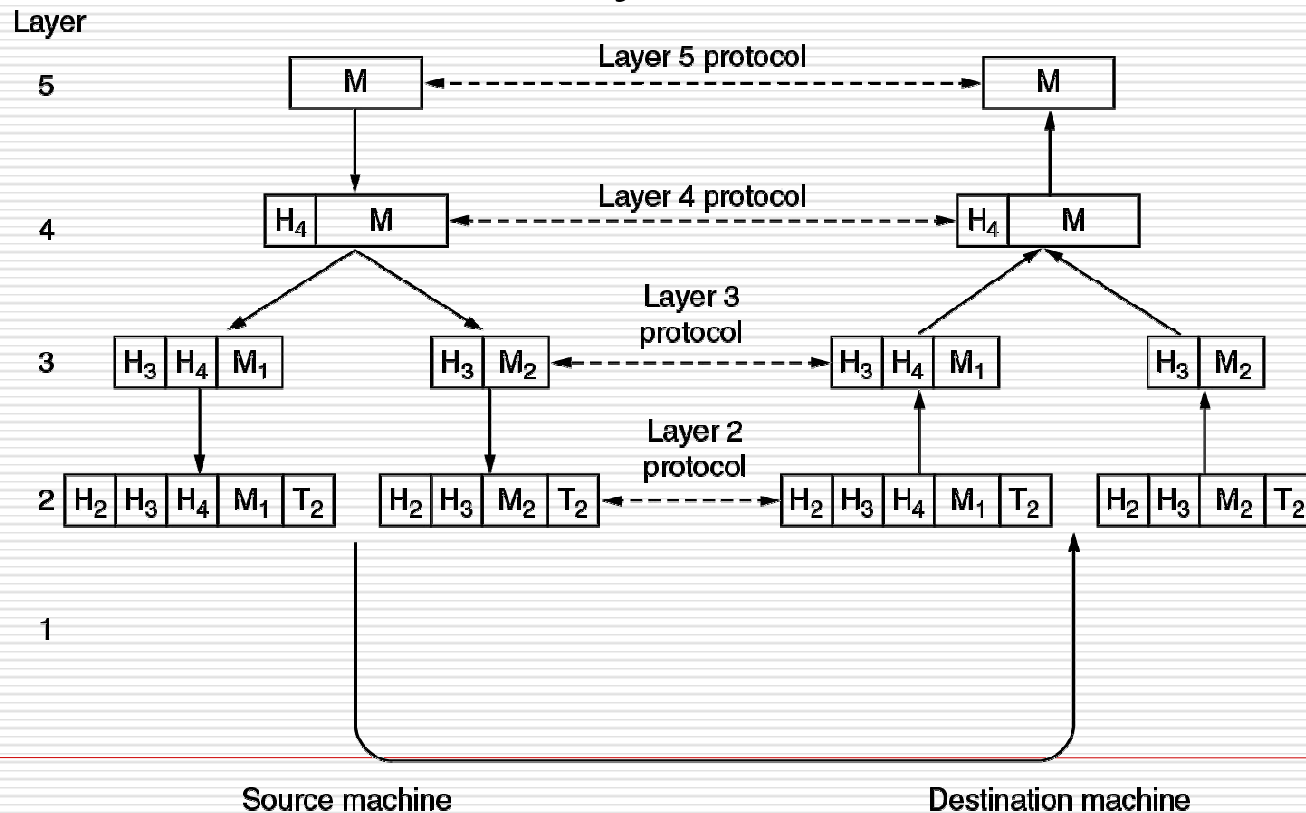
- The philosopher-translator-secretary architecture.





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

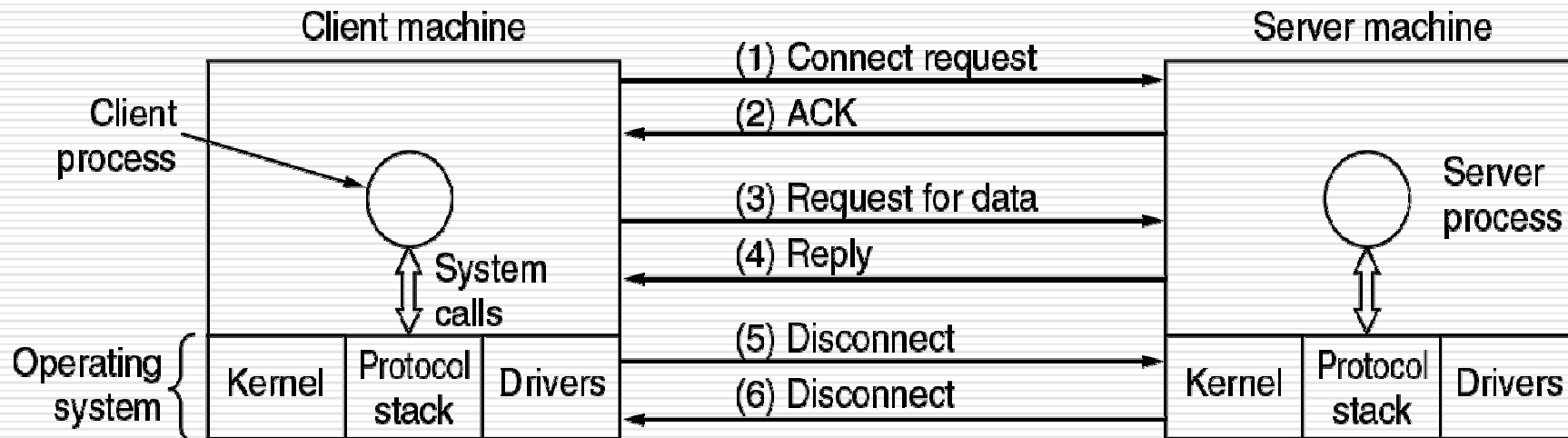
- Five service primitives for implementing a simple connection-oriented service.

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



Service Primitives (2)

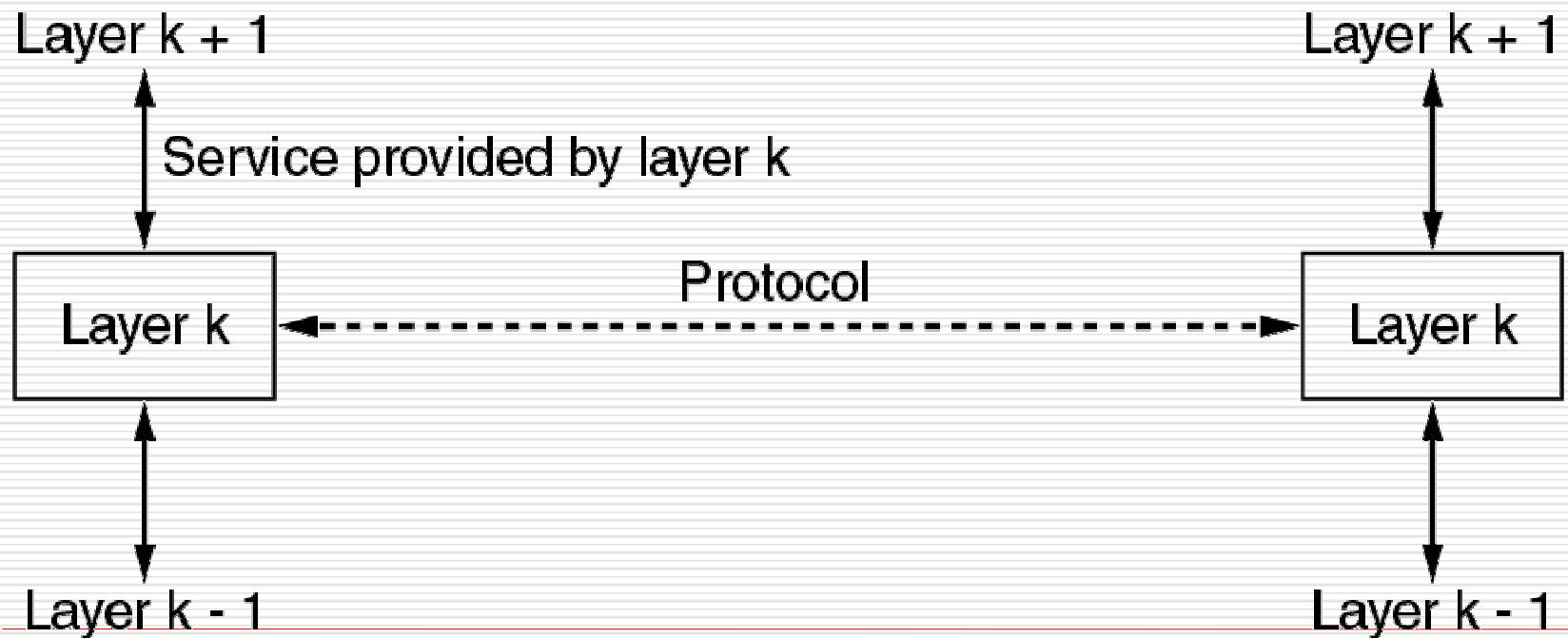
- Packets sent in a simple client-server interaction on a connection-oriented network.





Services to Protocols Relationship

- The relationship between a service and a protocol.





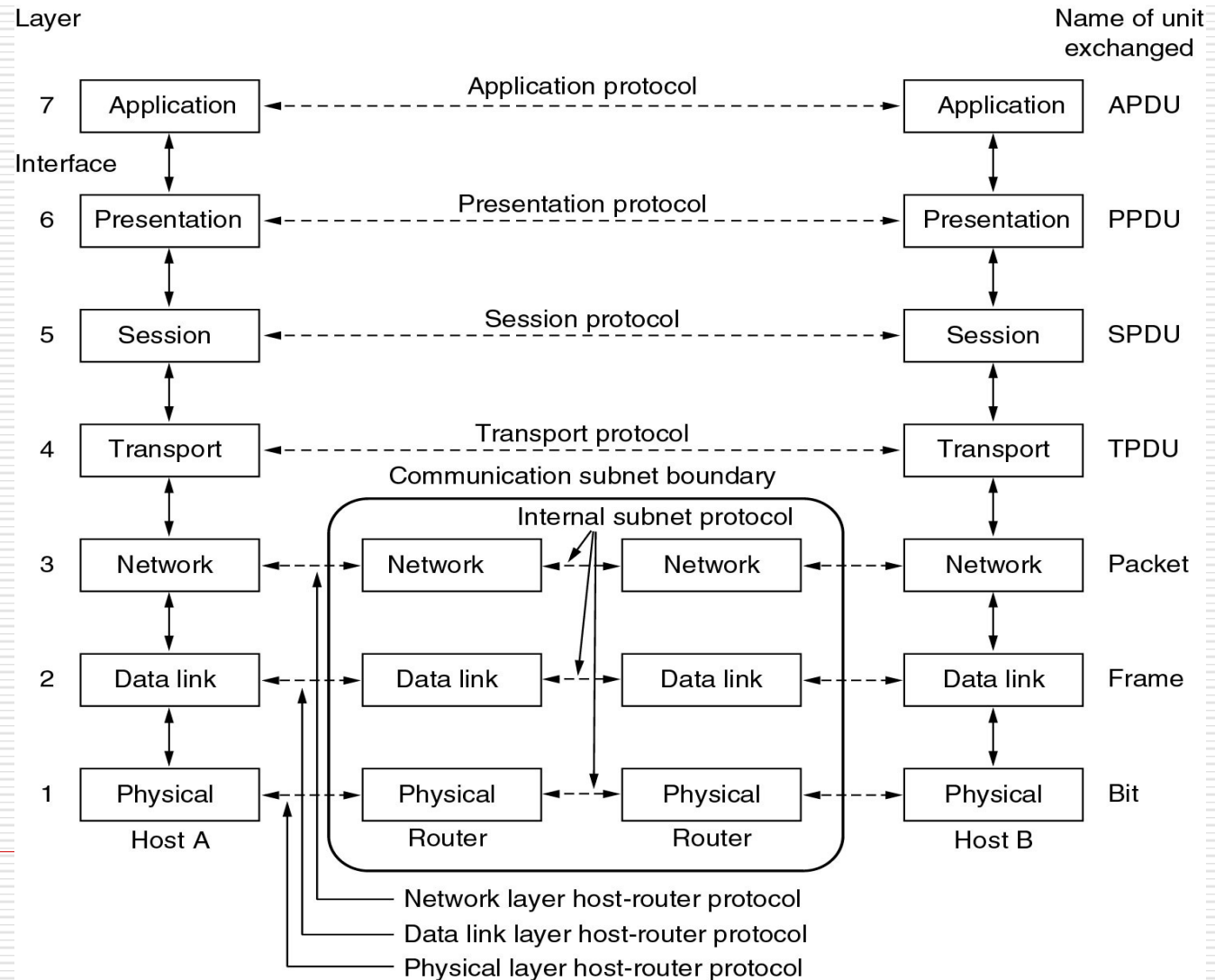
Reference Models

- The OSI Reference Model
- The TCP/IP Reference Model
- A Comparison of OSI and TCP/IP
- A Critique of the OSI Model and Protocols
- A Critique of the TCP/IP Reference Model



OSI Reference Model

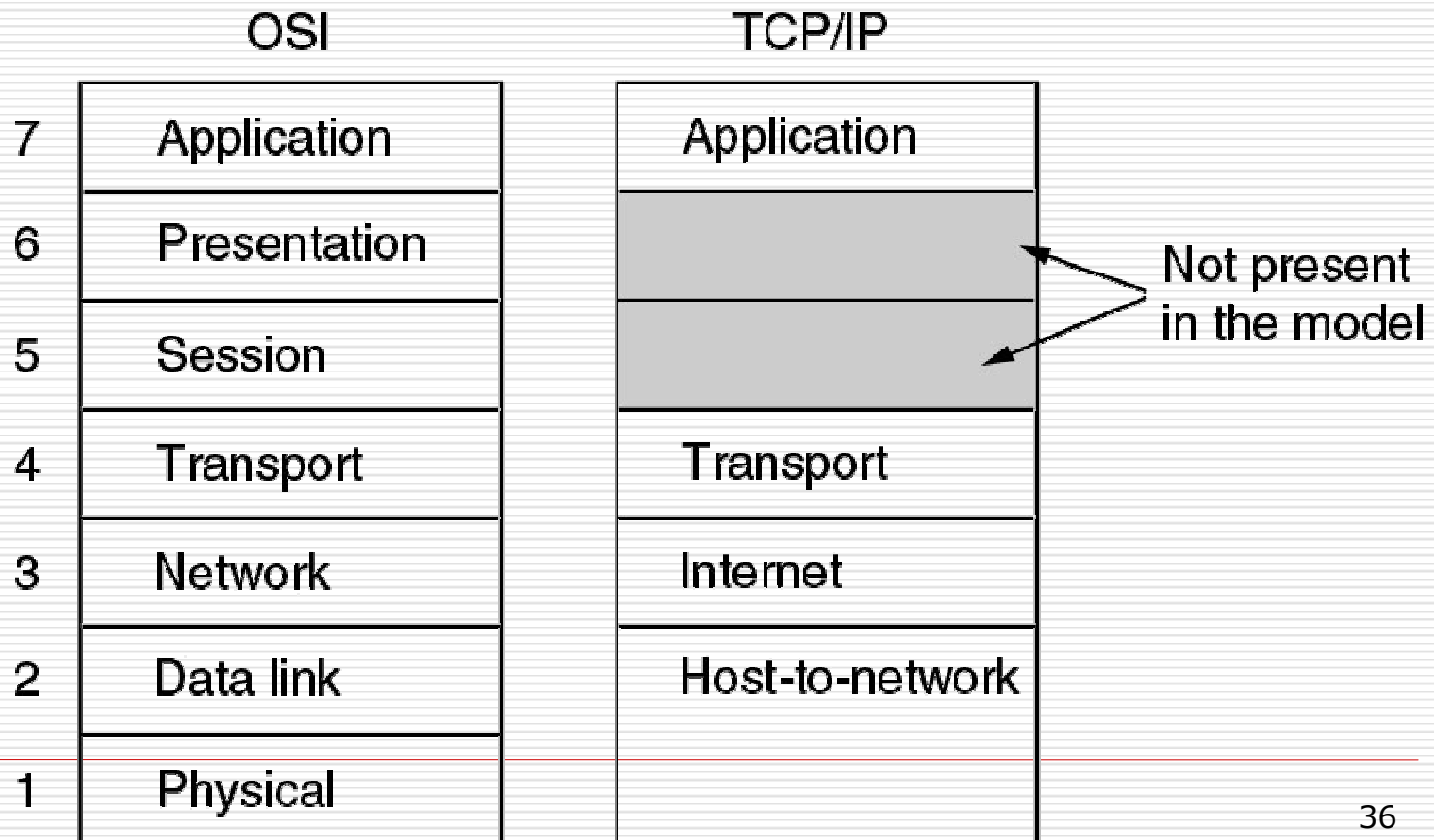
The OSI reference model.





TCP/IP Reference Models (1)

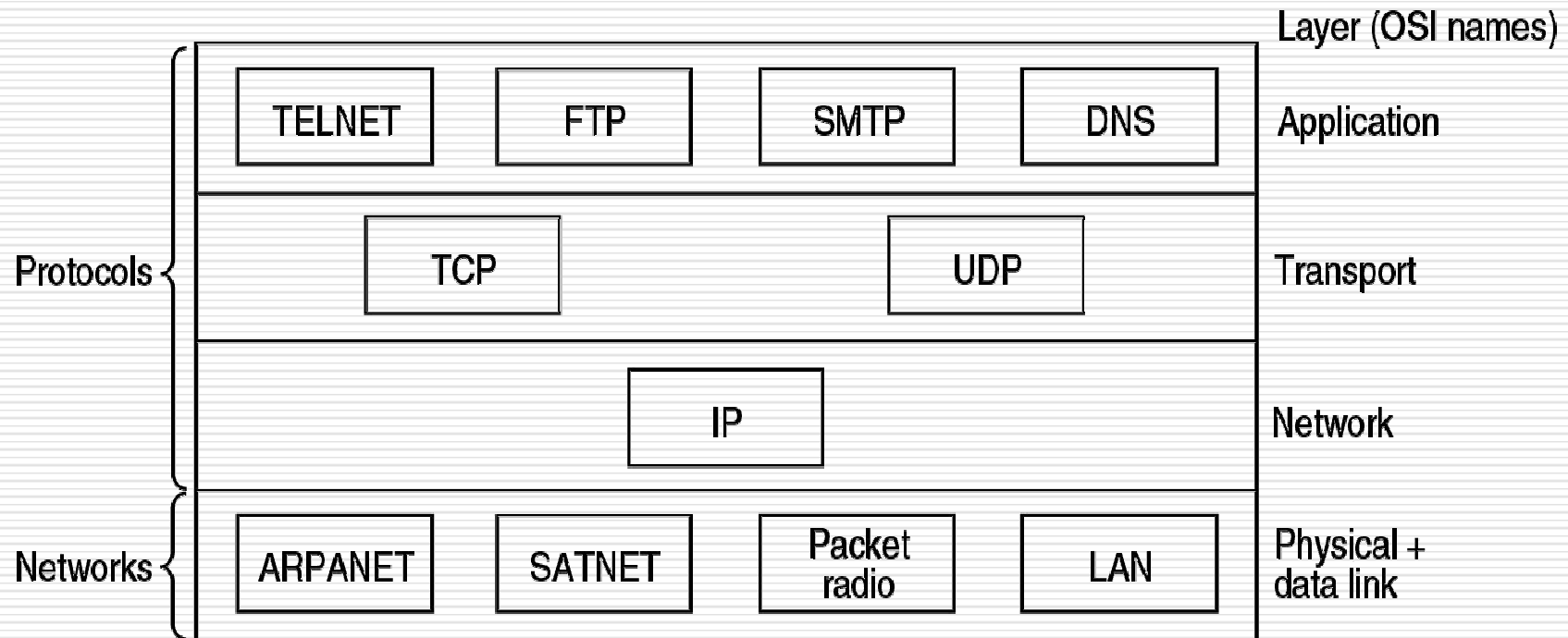
- The TCP/IP reference model.





TCP/IP Reference Model (2)

- Protocols and networks in the TCP/IP model initially.





Comparing OSI and TCP/IP Models

- ❑ Concepts central to the OSI model
- ❑ Services
- ❑ Interfaces
- ❑ Protocols



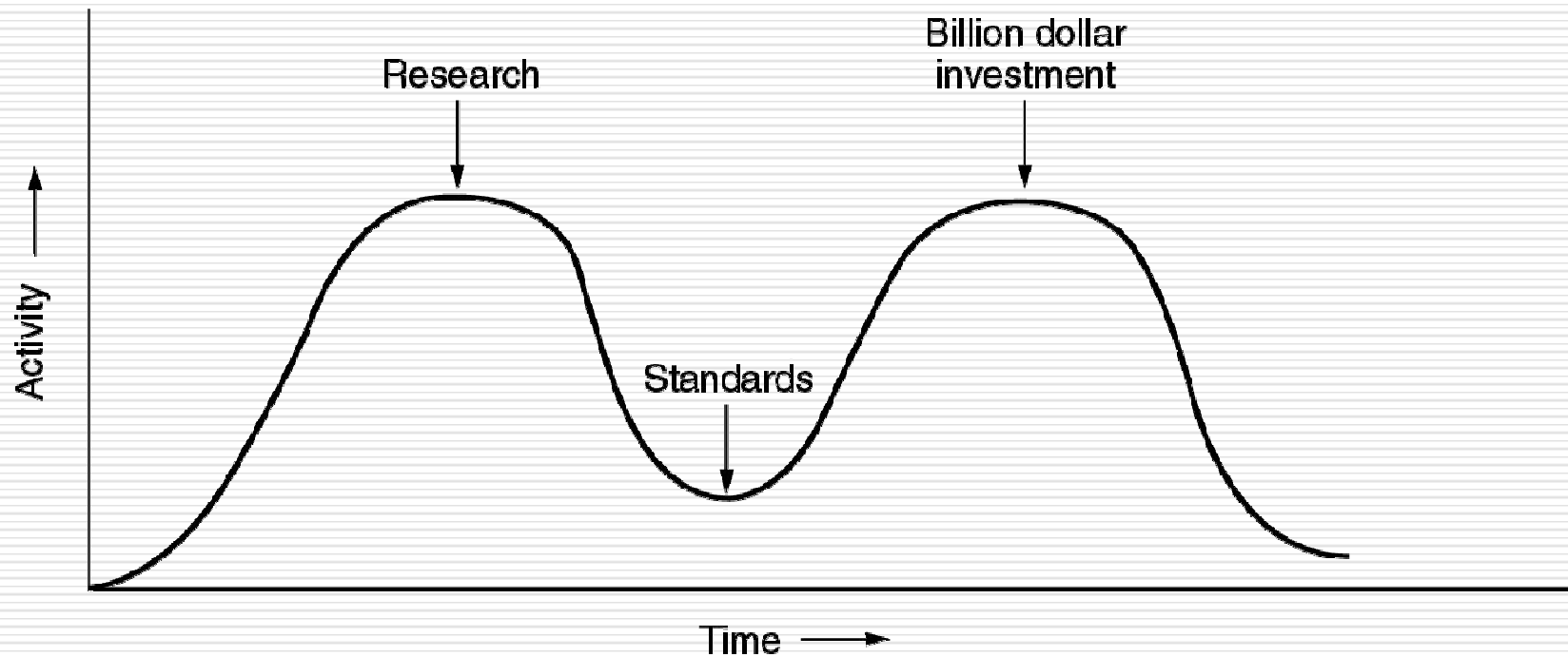
A Critique of the OSI Model and Protocols

- Why OSI did not take over the world
 - Bad timing
 - Bad technology
 - Bad implementations
 - Bad politics



Bad Timing

- The apocalypse of the two elephants.





A Critique of the TCP/IP Reference Model

- Problems:
 - Service, interface, and protocol not distinguished
 - Not a general model
 - Host-to-network “layer” not really a layer
 - No mention of physical and data link layers
 - Minor protocols deeply entrenched, hard to replace



Hybrid Model

- The hybrid reference model to be used in this book.

5	Application layer
4	Transport layer
3	Network layer
2	Data link layer
1	Physical layer



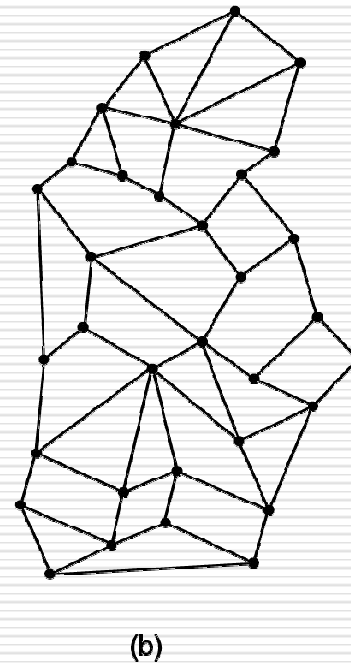
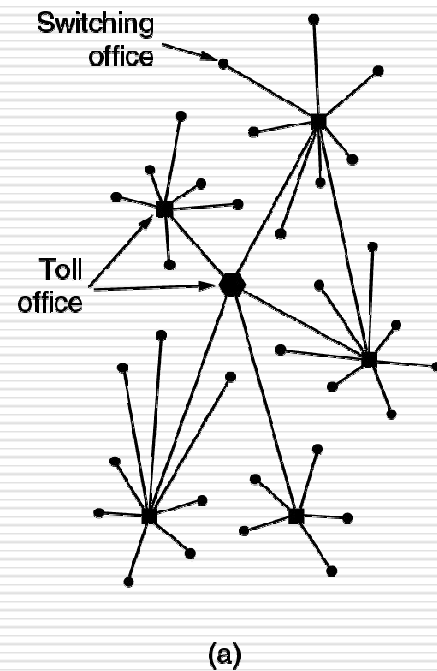
Example Networks

- The Internet
- Connection-Oriented Networks:
X.25, Frame Relay, and ATM
- Ethernet
- Wireless LANs: 802:11



The ARPANET (1)

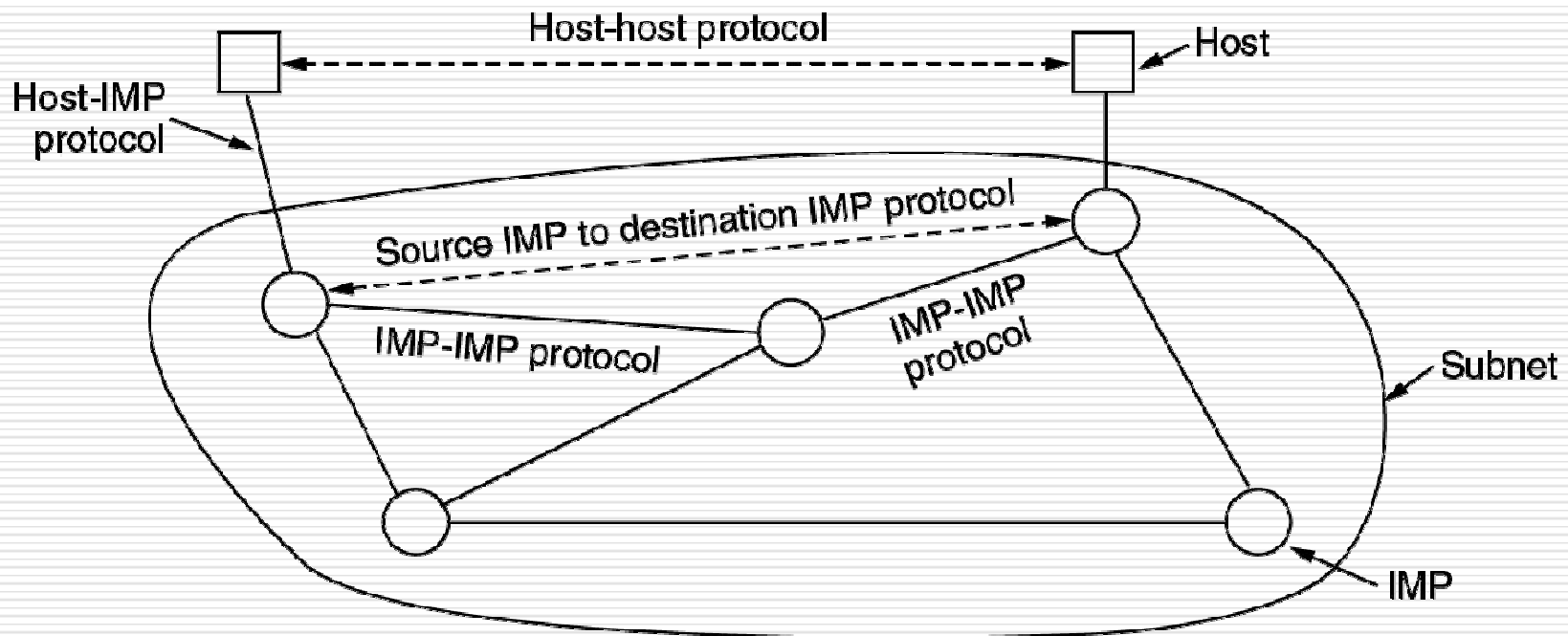
- (a) Structure of the telephone system.
- (b) Baran's proposed distributed switching system.





The ARPANET (2)

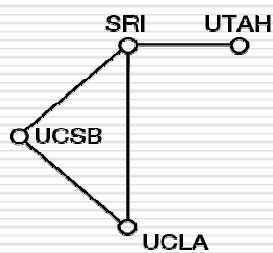
- The original ARPANET design.



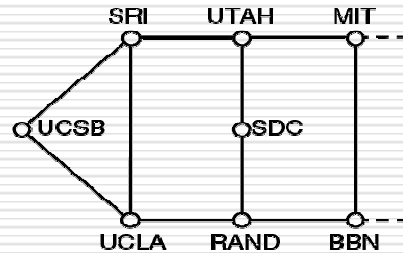


The ARPANET (3)

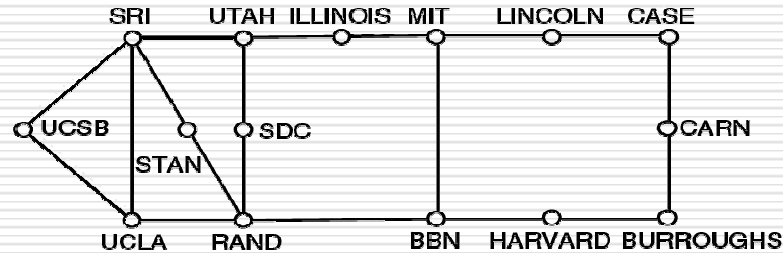
- Growth of the ARPANET (a) December 1969. (b) July 1970.
- (c) March 1971. (d) April 1972. (e) September 1972.



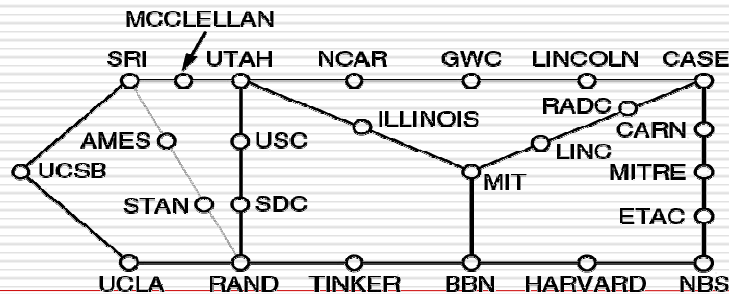
(a)



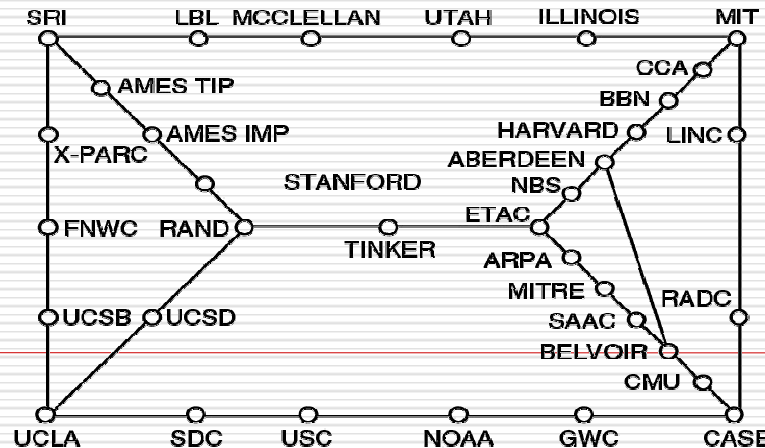
(b)



(c)



(d)

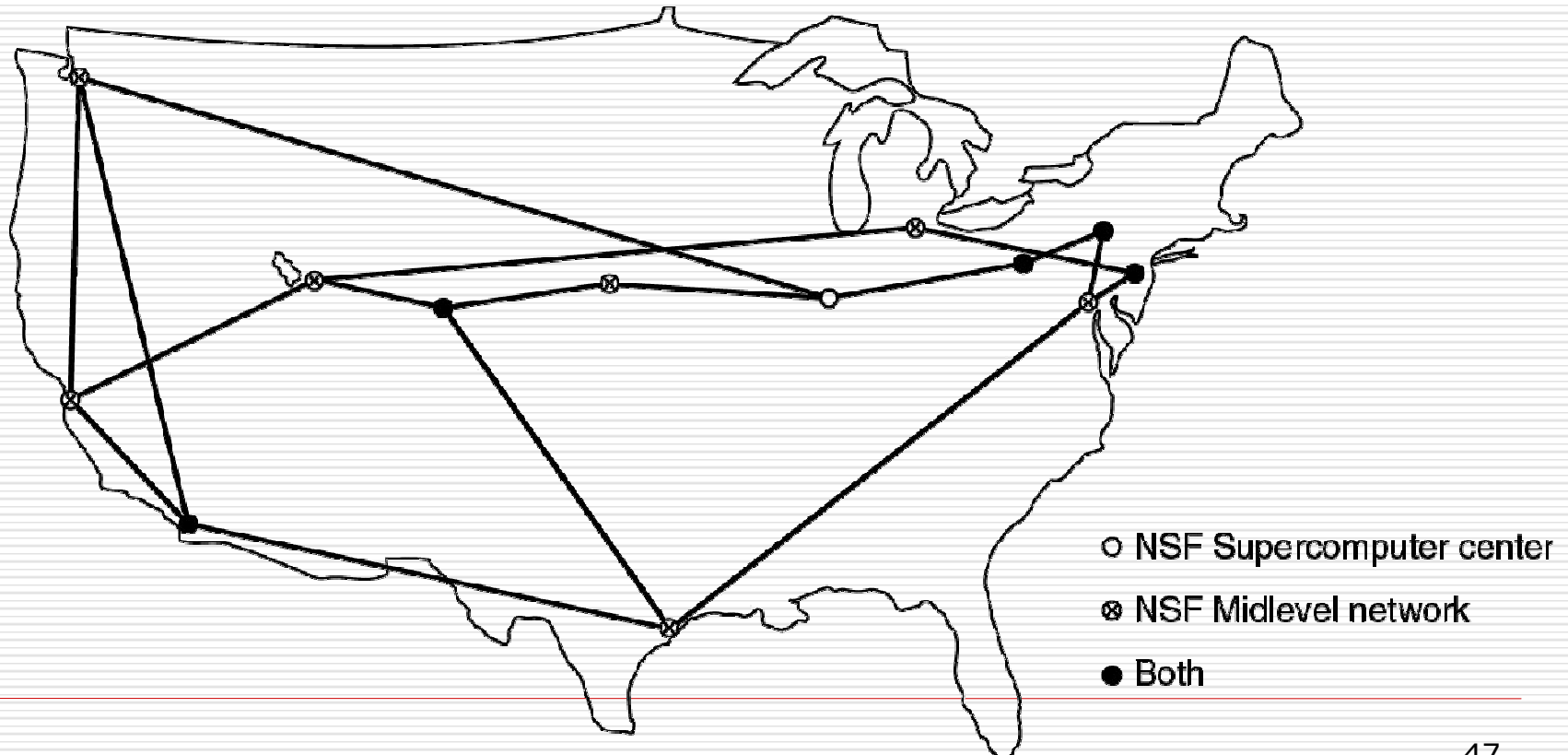


(e)



NSFNET

- The NSFNET backbone in 1988.





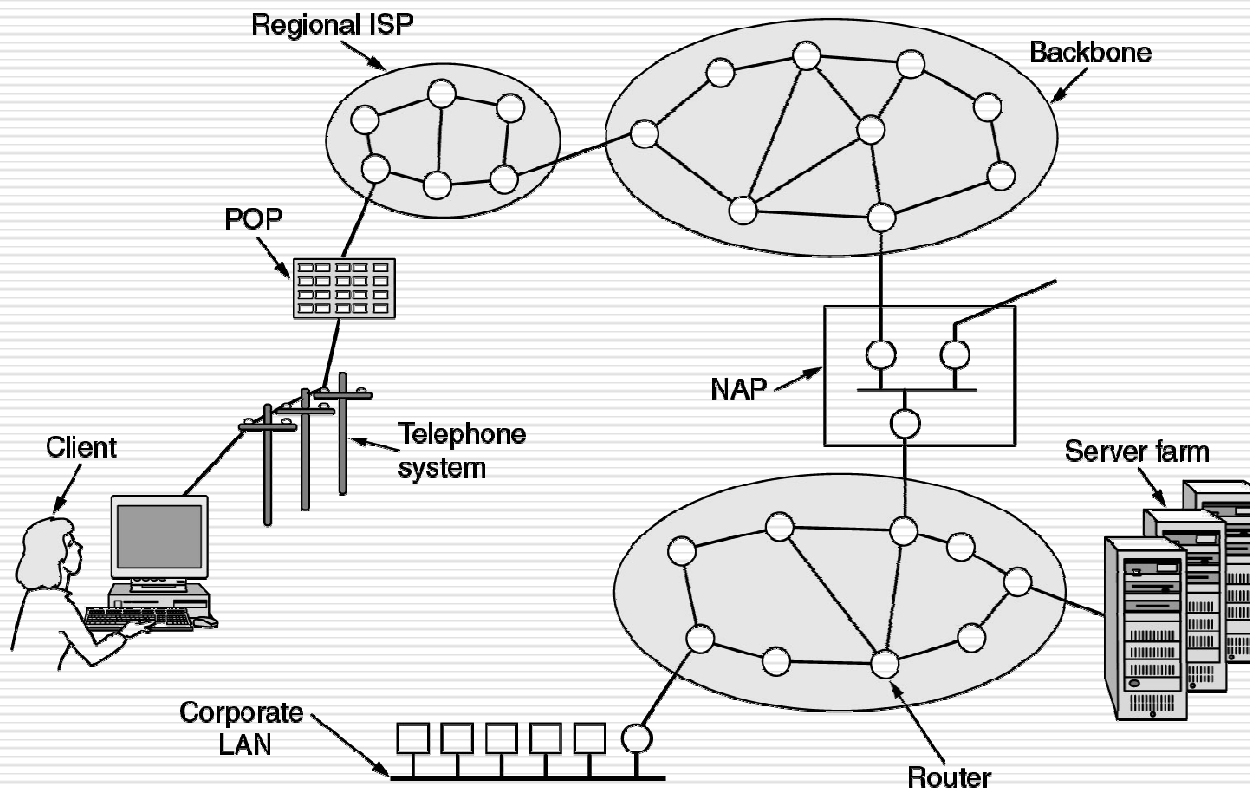
Internet Usage

- Traditional applications (1970 – 1990)
 - E-mail
 - News
 - Remote login
 - File transfer



Architecture of the Internet

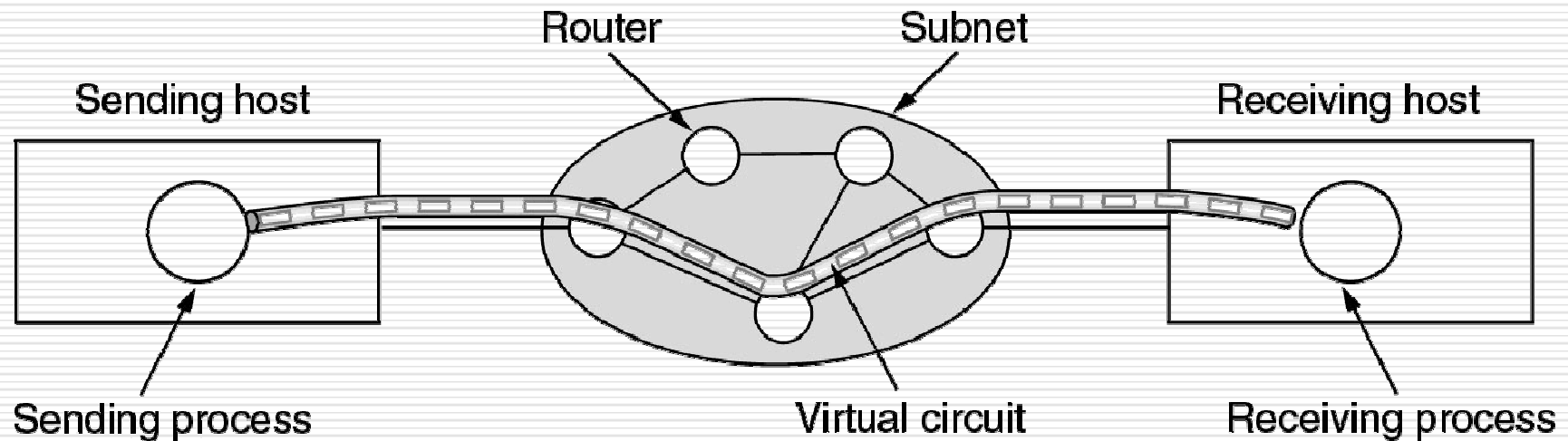
□ Overview of the Internet.





ATM Virtual Circuits

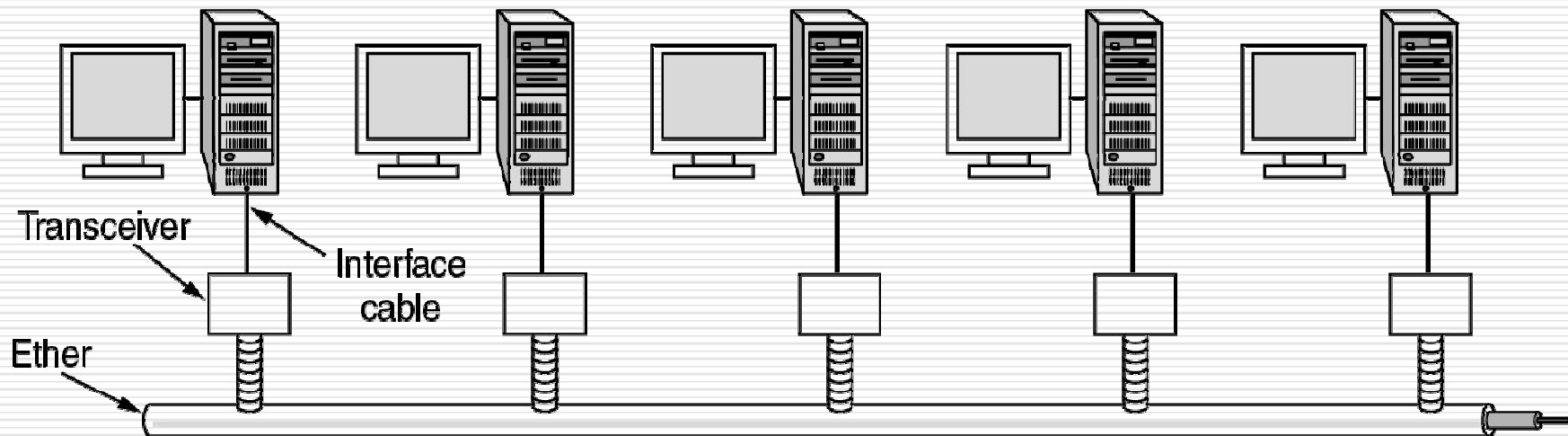
- A virtual circuit.





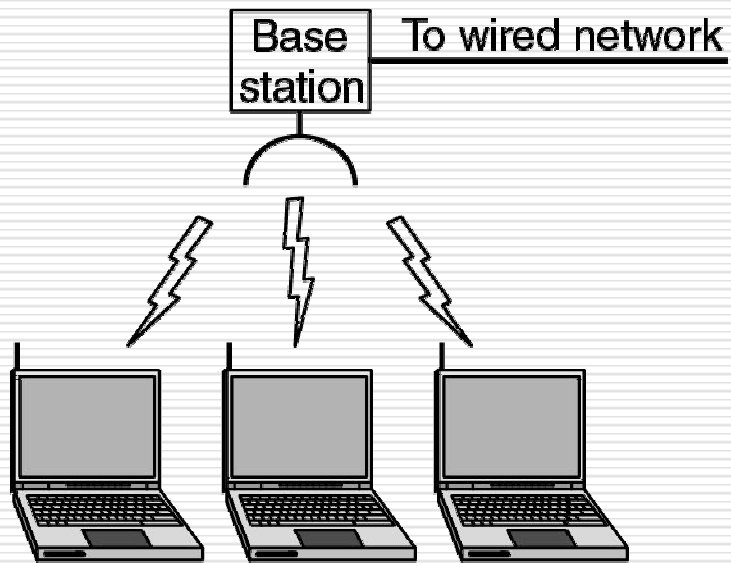
Ethernet

- Architecture of the original Ethernet.

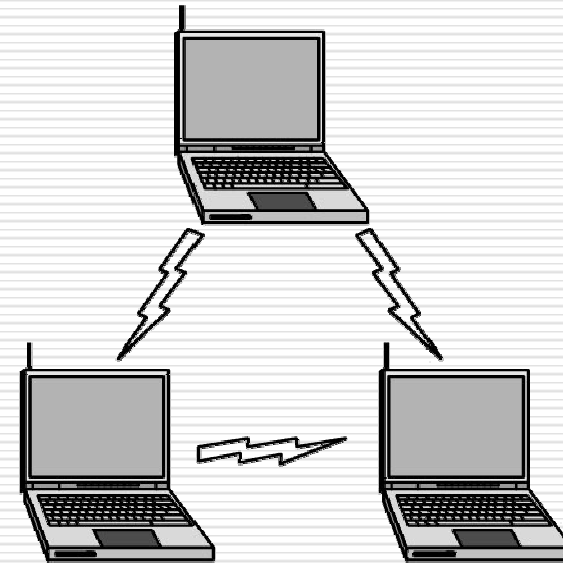




Wireless LANs (1)



(a)



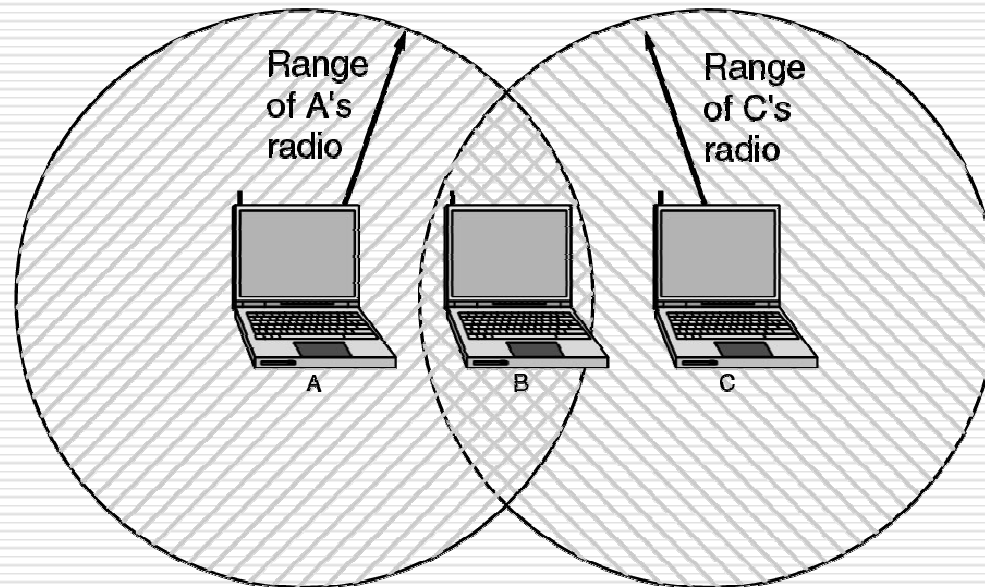
(b)

- ❑ (a) Wireless networking with a base station.
- ❑ (b) Ad hoc networking.



Wireless LANs (2)

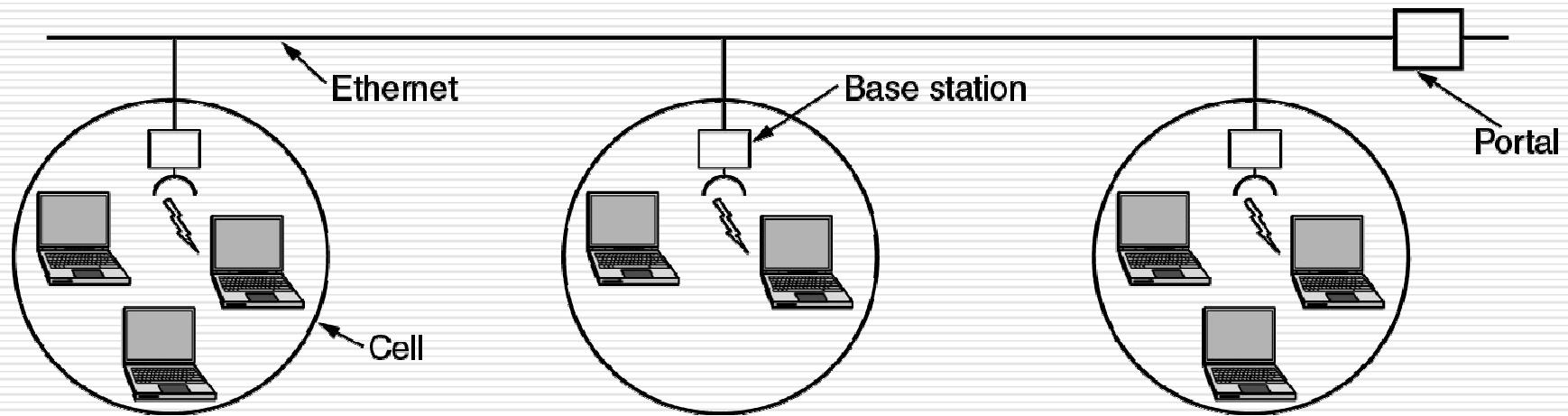
- The range of a single radio may not cover the entire system.





Wireless LANs (3)

- A multicell 802.11 network.





Network Standardization

- Who's Who in the Telecommunications World
- Who's Who in the International Standards World
- Who's Who in the Internet Standards World



ITU

□ Main sectors

- Radiocommunications
- Telecommunications Standardization
- Development

□ Classes of Members

- National governments
 - Sector members
 - Associate members
 - Regulatory agencies
-



IEEE 802 Standards

Number	Topic
802.1	Overview and architecture of LANs
802.2 ↓	Logical link control
802.3 *	Ethernet
802.4 ↓	Token bus (was briefly used in manufacturing plants)
802.5	Token ring (IBM's entry into the LAN world)
802.6 ↓	Dual queue dual bus (early metropolitan area network)
802.7 ↓	Technical advisory group on broadband technologies
802.8 †	Technical advisory group on fiber optic technologies
802.9 ↓	Isochronous LANs (for real-time applications)
802.10 ↓	Virtual LANs and security
802.11 *	Wireless LANs
802.12 ↓	Demand priority (Hewlett-Packard's AnyLAN)
802.13	Unlucky number. Nobody wanted it
802.14 ↓	Cable modems (defunct: an industry consortium got there first)
802.15 *	Personal area networks (Bluetooth)
802.16 *	Broadband wireless
802.17	Resilient packet ring

The 802 working groups. The important ones are marked with *. The ones marked with ↓ are hibernating. The one marked with † gave up.



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}	0.000000000001	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}	0.00000000000000000000001	zepto	10^{21}	1,000,000,000,000,000,000,000	Zetta
10^{-24}	0.0000000000000000000000001	yocto	10^{24}	1,000,000,000,000,000,000,000,000	Yotta

- The principal metric prefixes.