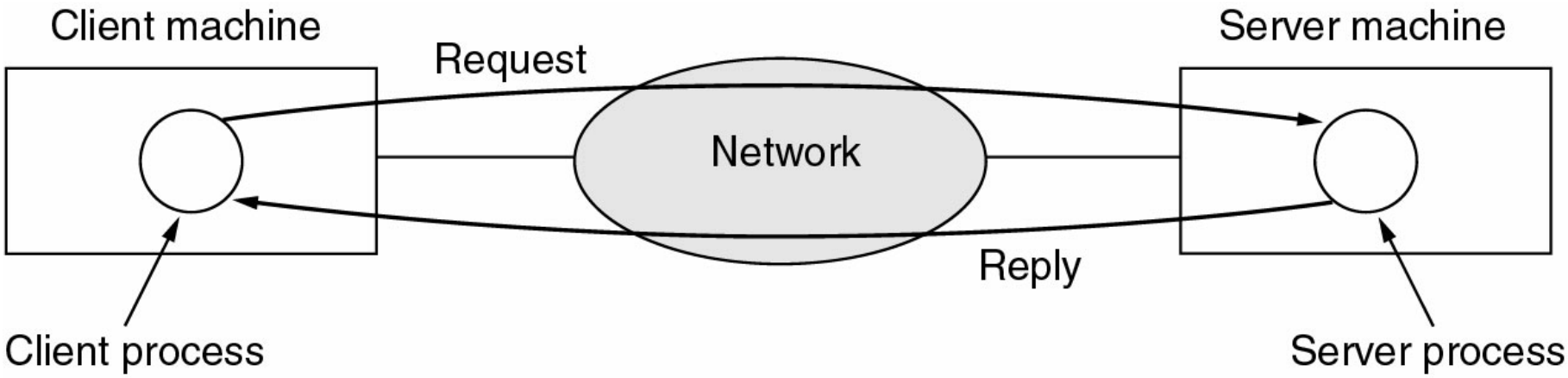
INTRODUCTION

Uses of Computer Networks

- Business Applications
- Home Applications
- Mobile Users
- Social Issues

Business Applications of Networks

- The client-server model involves requests and replies.



Network Applications

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

Types of Network Applications

- 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

Typical 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

Broadcast Networks

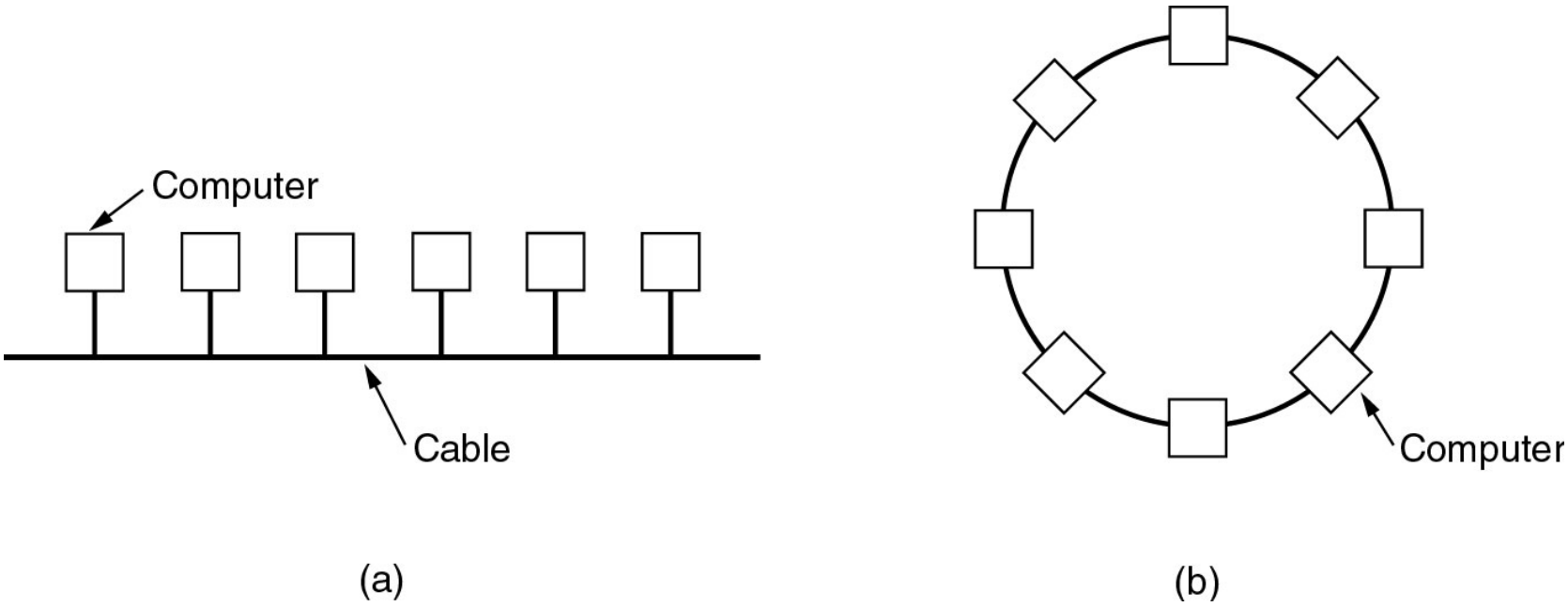
- Types of transmission technology
  - Broadcast links
  - Point-to-point links

Broadcast Networks - Definitions

- 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

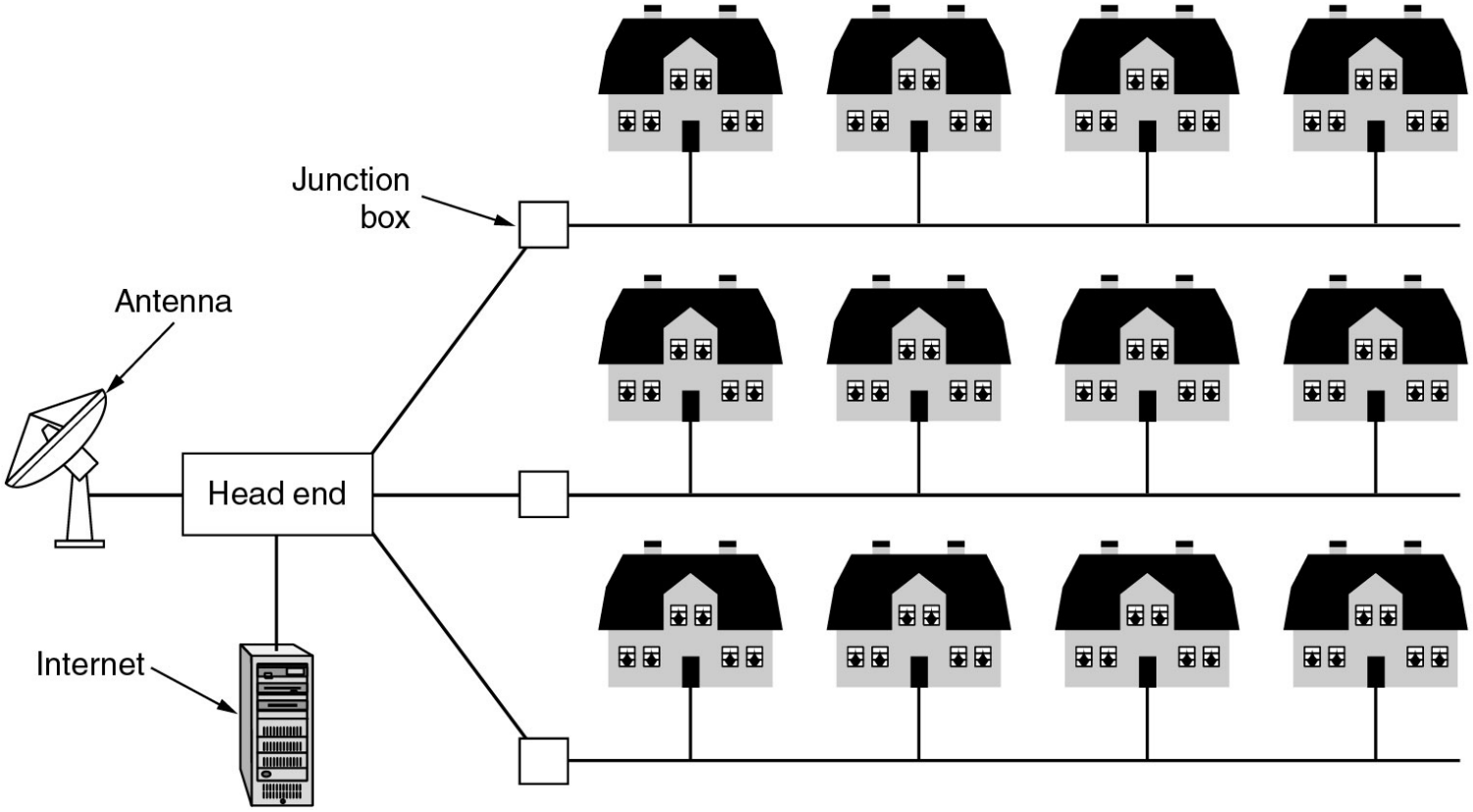
Local Area Networks



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

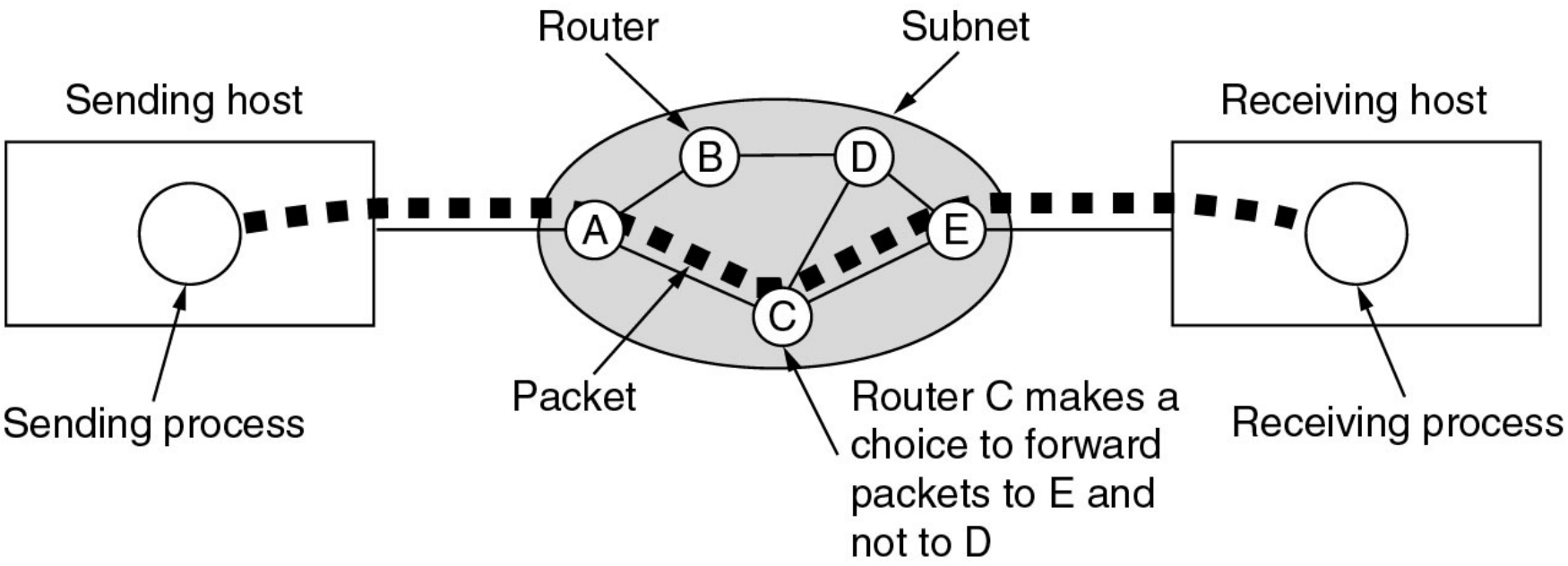
Metropolitan Area Networks

- A metropolitan area network based on cable TV.



Wide Area Networks

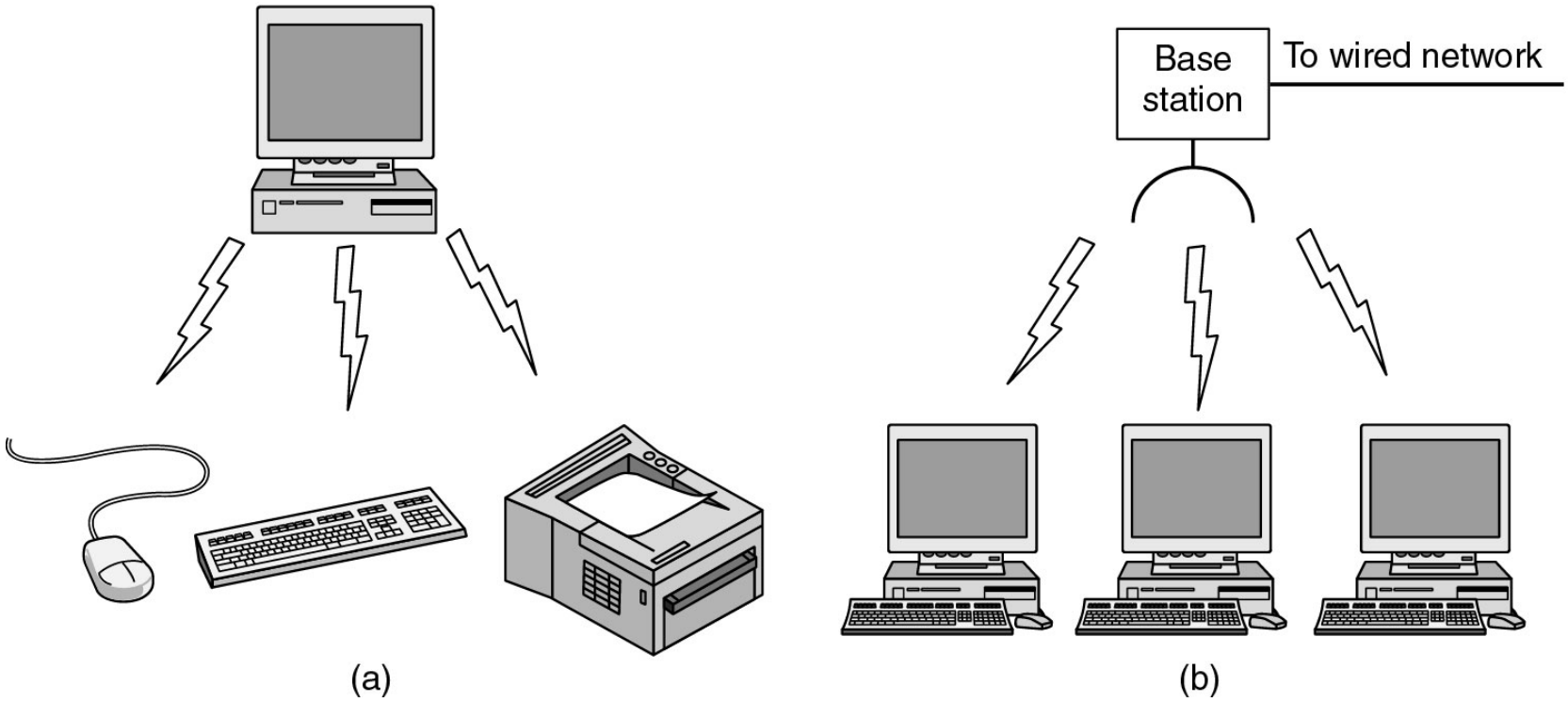
- A stream of packets from sender to receiver.



Wireless Networks

- Categories of wireless networks:
  - System interconnection
  - Wireless LANs
  - Wireless WANs

Types of Wireless Networks



(a) Bluetooth configuration
(b) Wireless LAN

Home Network Categories - IoT

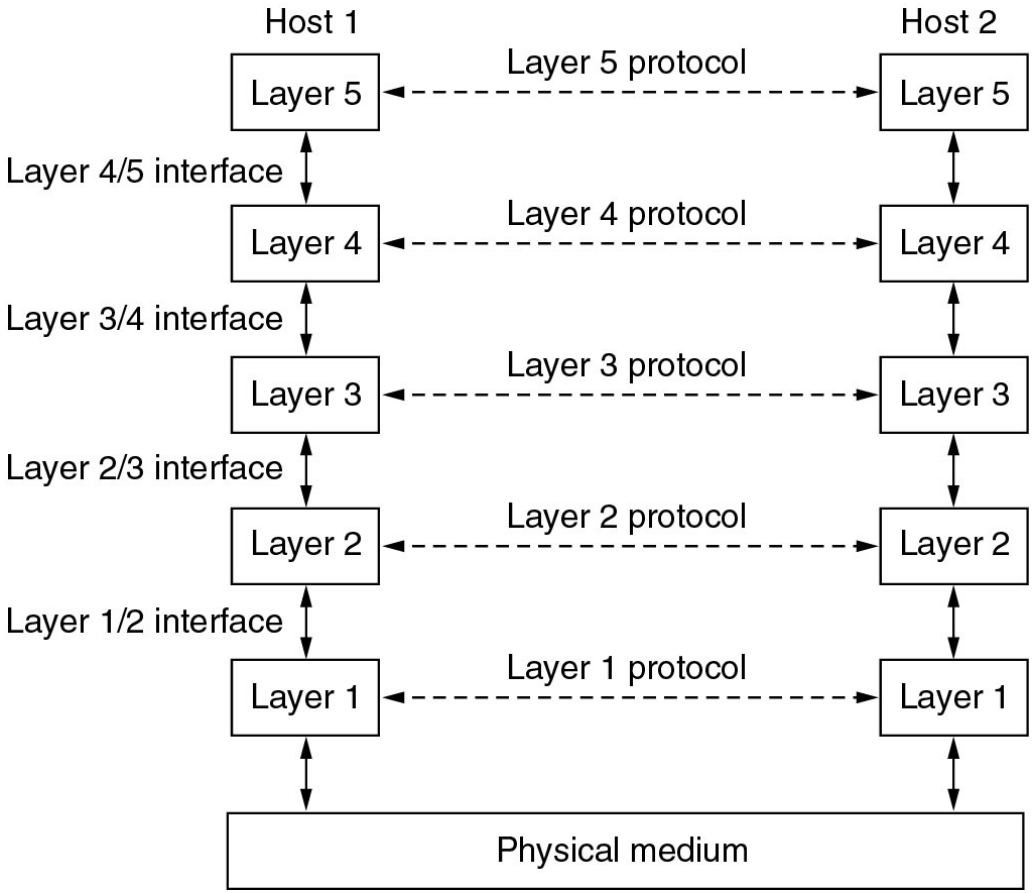
- Computers (desktop PC, PDA, shared peripherals
- Entertainment (TV, DVD, VCR, camera, stereo, MP3)
- Telecomm (telephone, cell phone, intercom, fax)
- Appliances (microwave, fridge, clock, furnace, aircon)
- Telemetry (utility meter, burglar alarm, babycam).

Network Software

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

Network Software

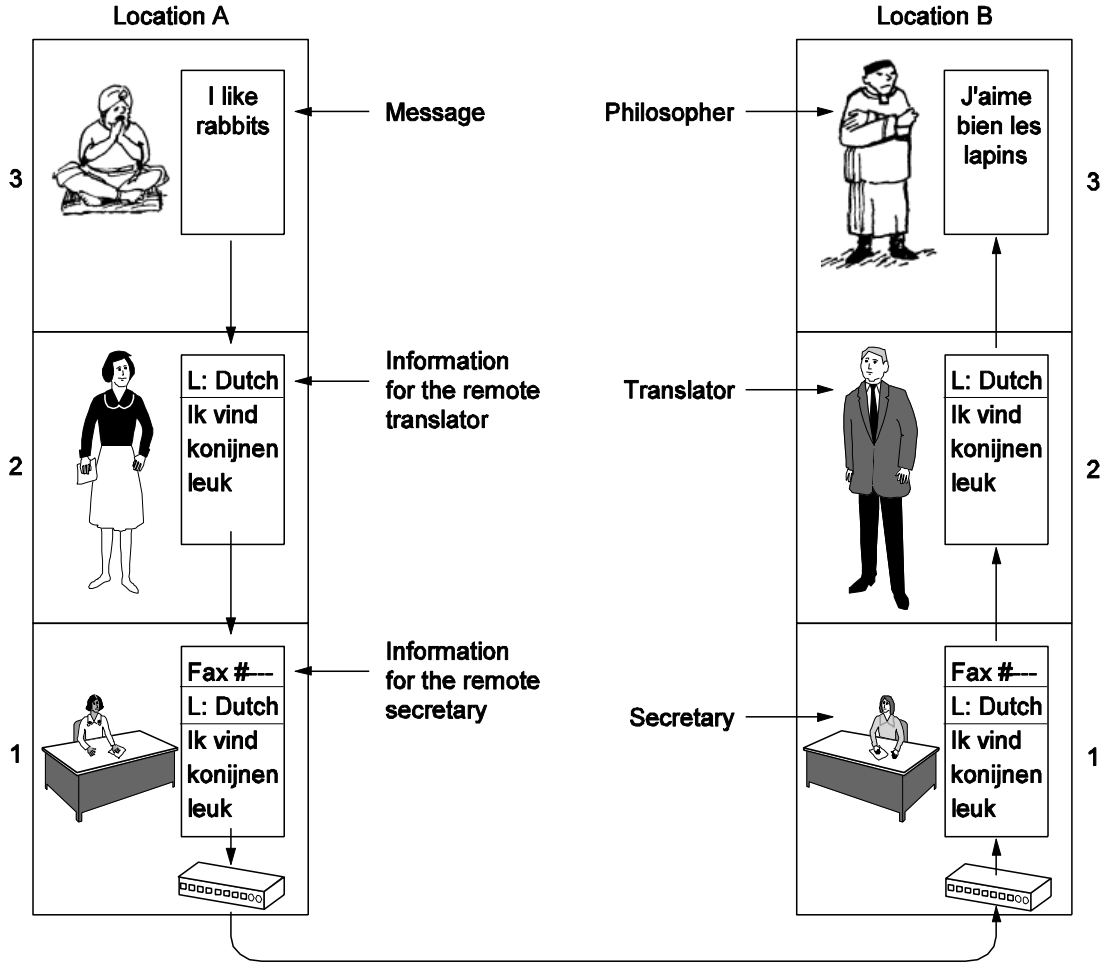
Protocol Hierarchies



- Layers, protocols, and interfaces.

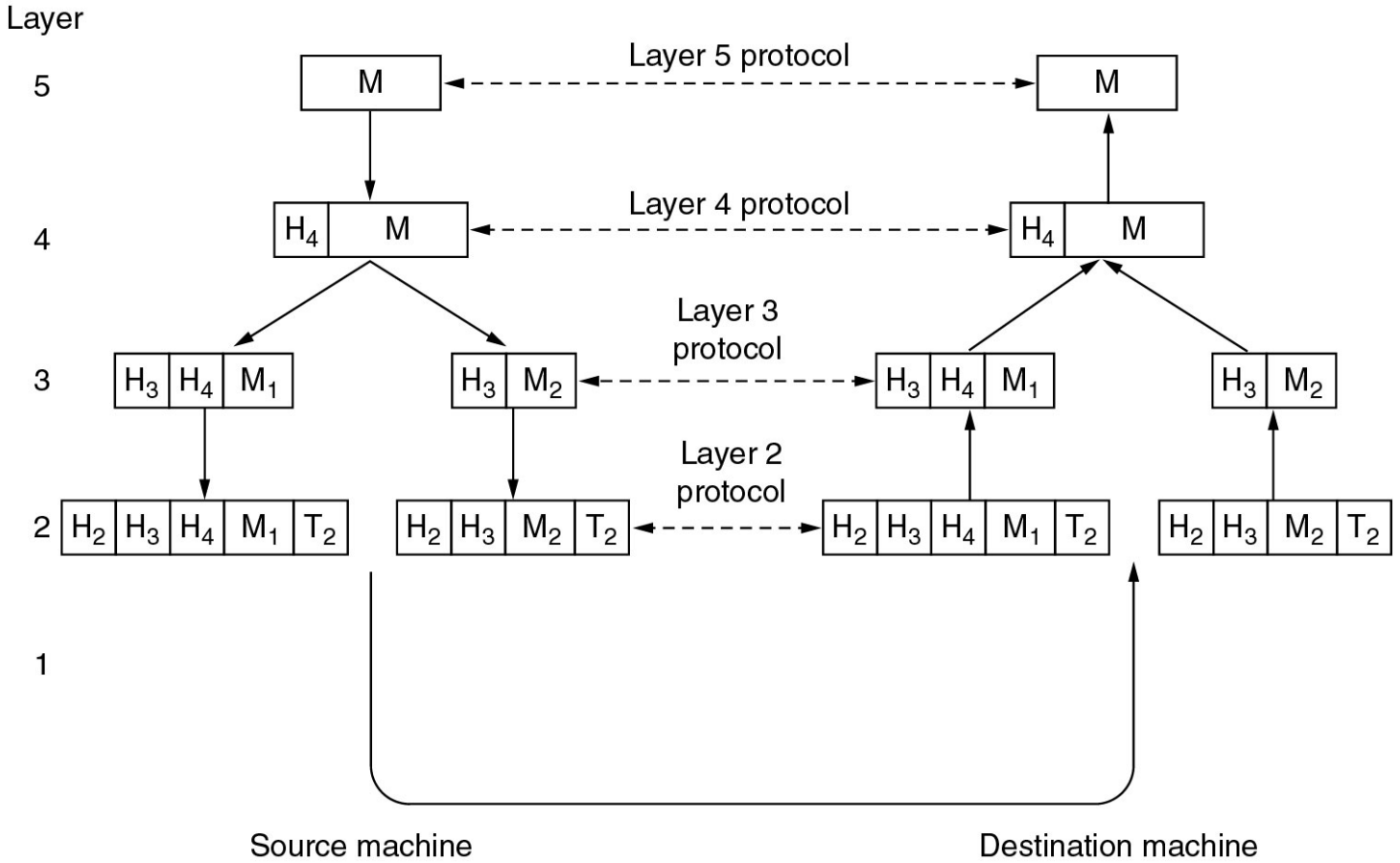
Protocol Hierarchies (2)

- 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.

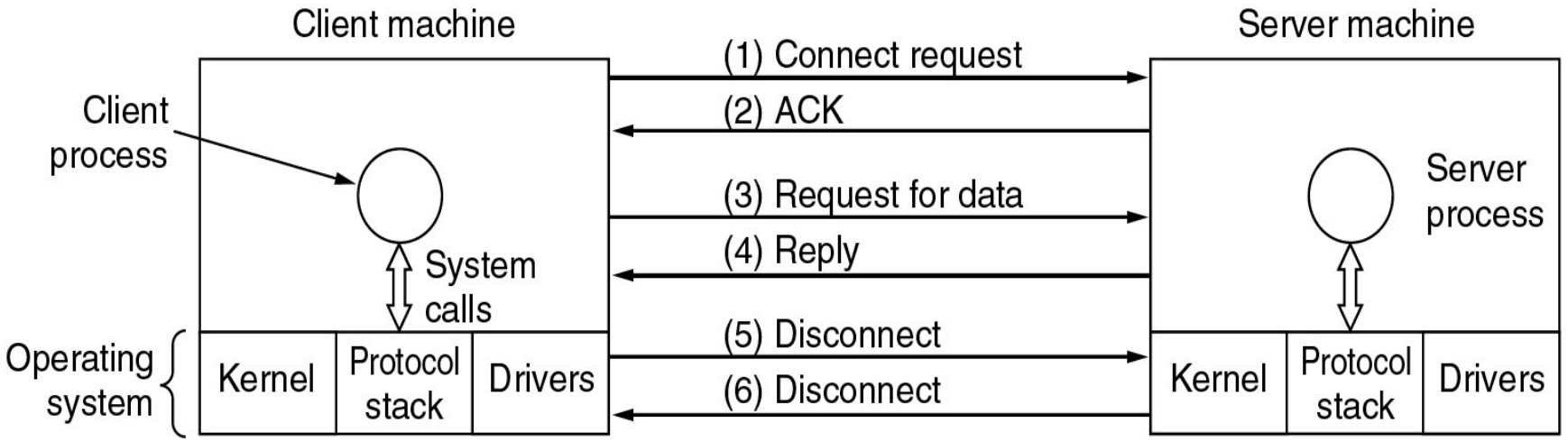
	Service	Example
Connection-oriented	Reliable message stream	Sequence of pages
	Reliable byte stream	Remote login
	Unreliable connection	Digitized voice
Connectionless	Unreliable datagram	Electronic junk mail
	Acknowledged datagram	Registered mail
	Request-reply	Database query

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.

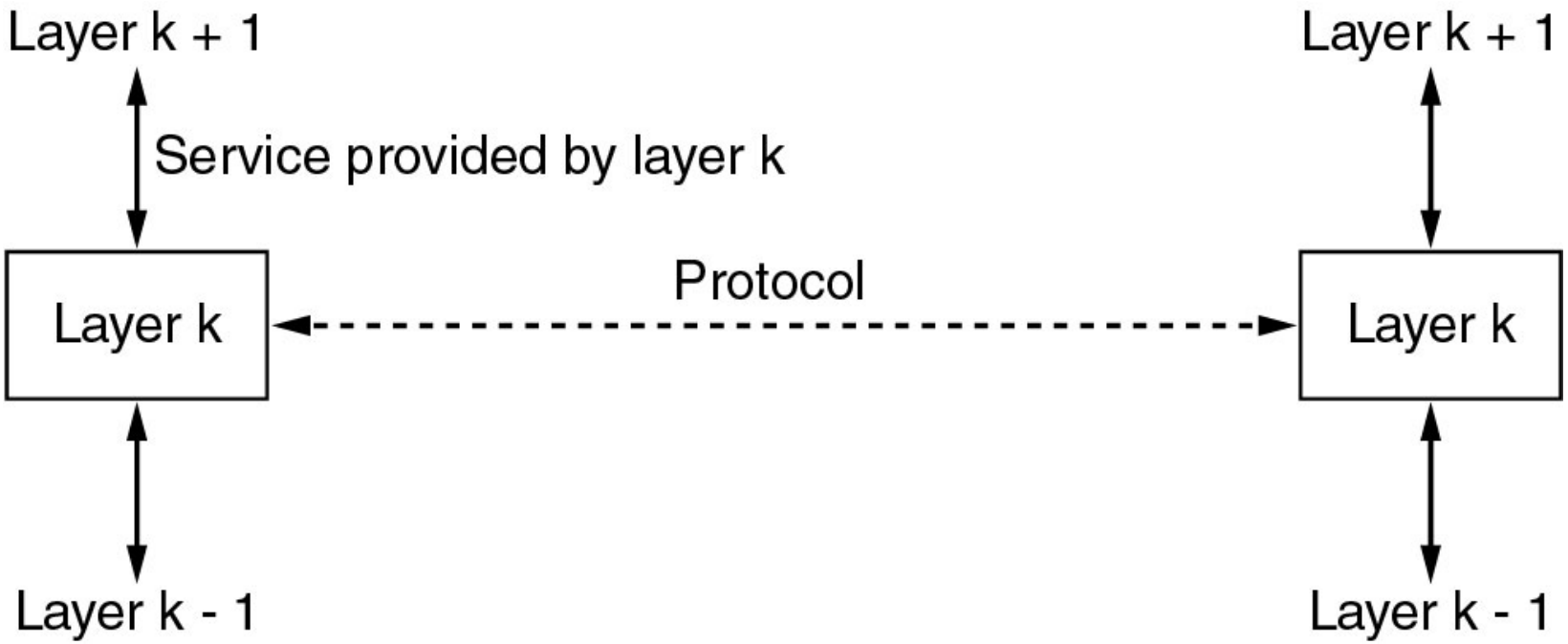
Service Primitives (2)



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

Services to Protocols Relationship

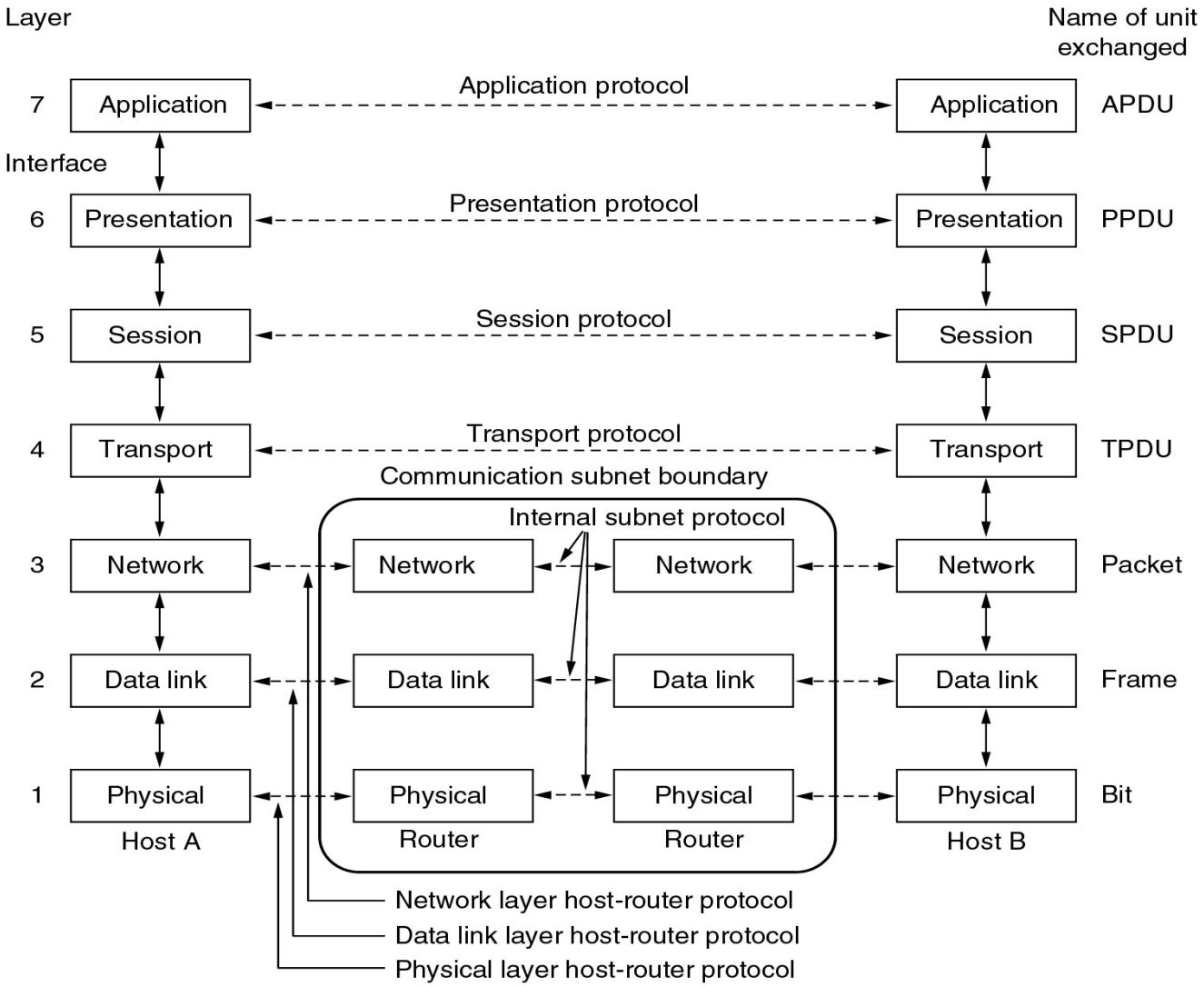
- The relationship between a service and a protocol.



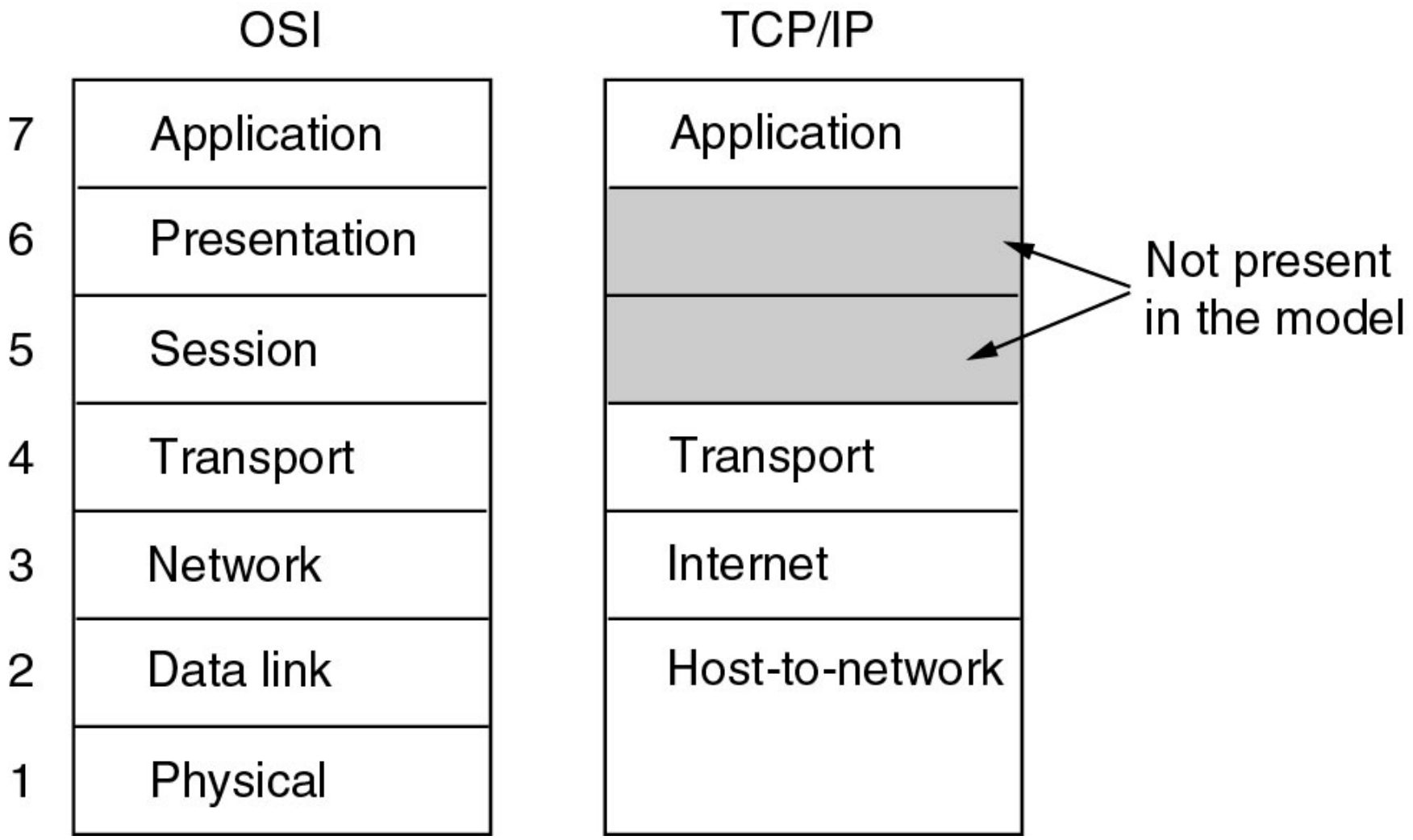
Reference Models

- 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

Reference Models - OSI



Reference Models - TCP/IP



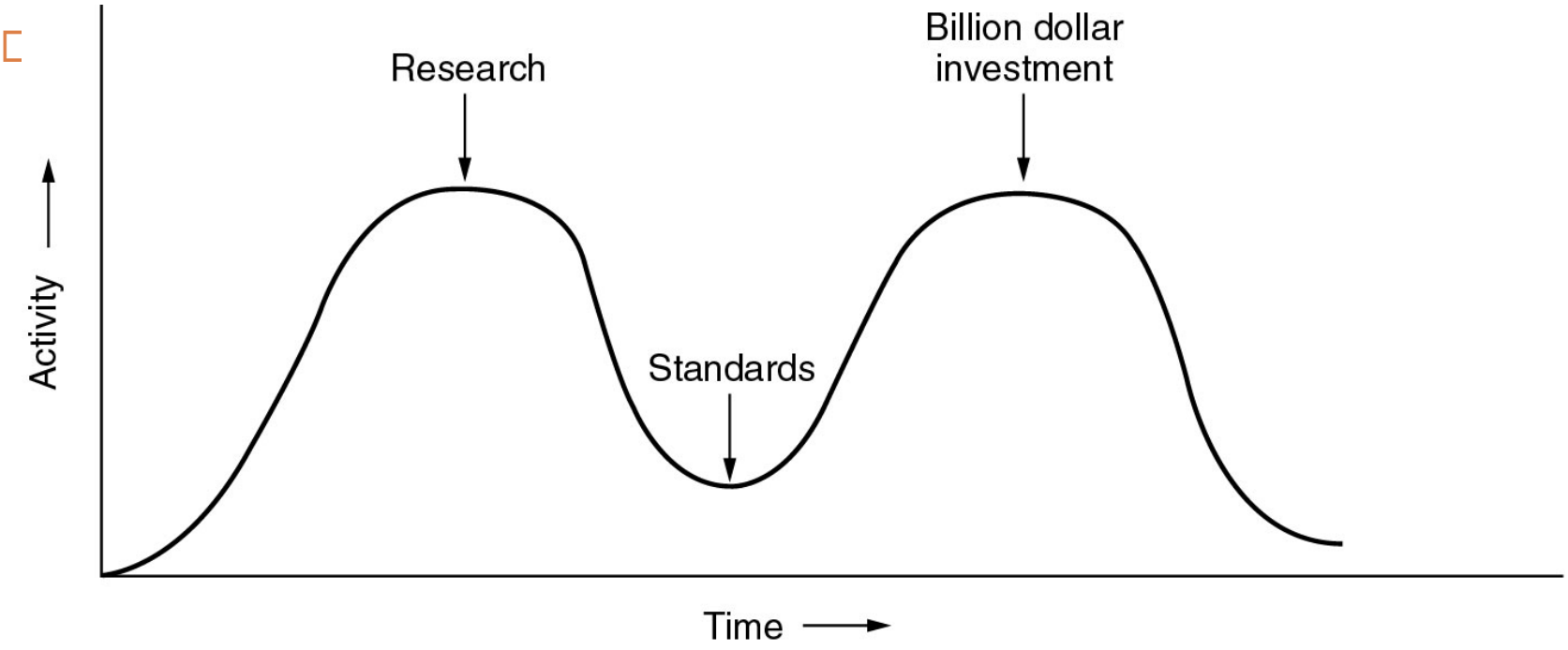
Comparing OSI and TCP/IP Models

- 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

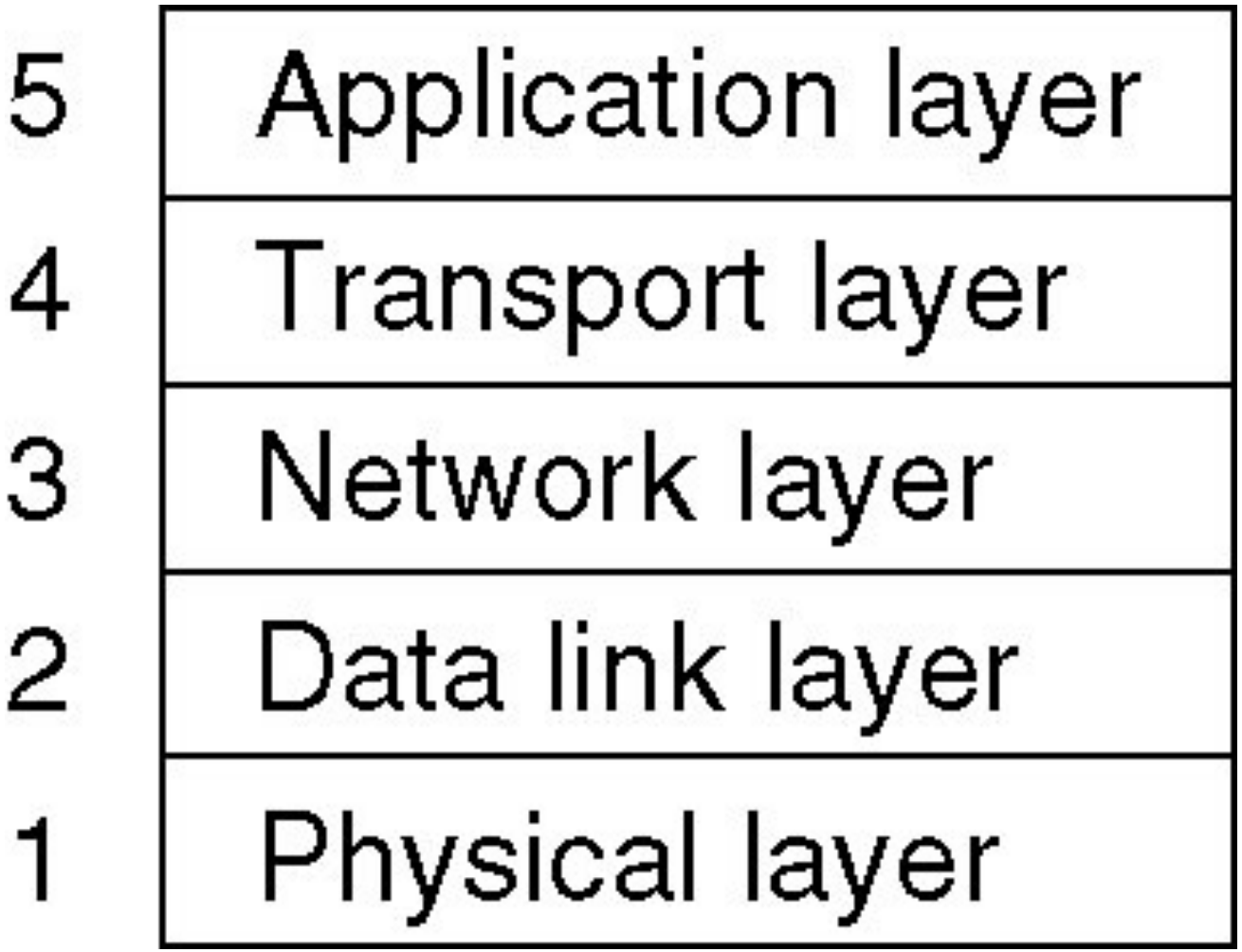
Bad Timing


Research
Billion dollar investment
Standards
Activity
Time

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

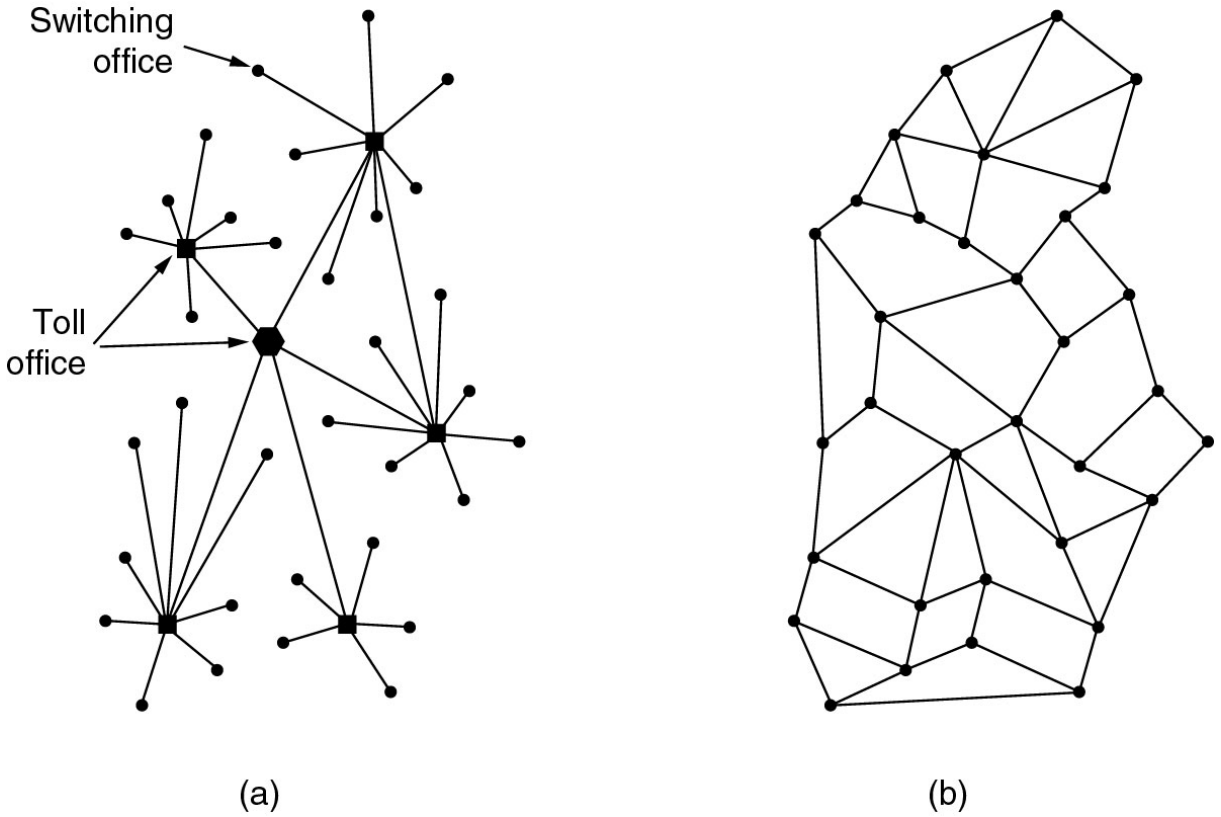
Hybrid Model



Example Networks

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

The ARPANET



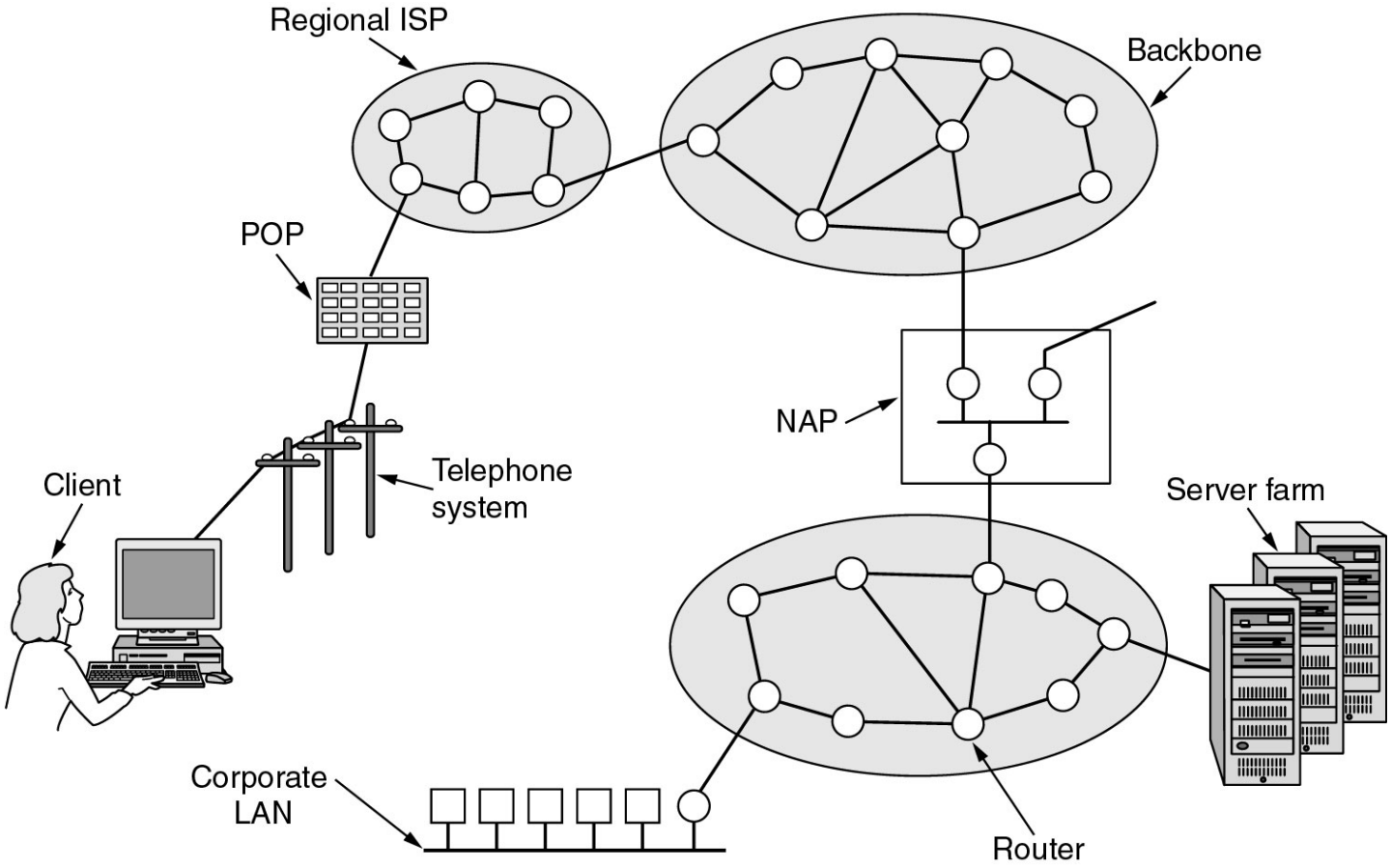
(a) Structure of the telephone system.
(b) Baran's proposed distributed switching system.

Internet Usage

- Traditional applications
  - E-mail
  - News, RSS feeds & Twitter etc
  - Remote login
  - File transfer

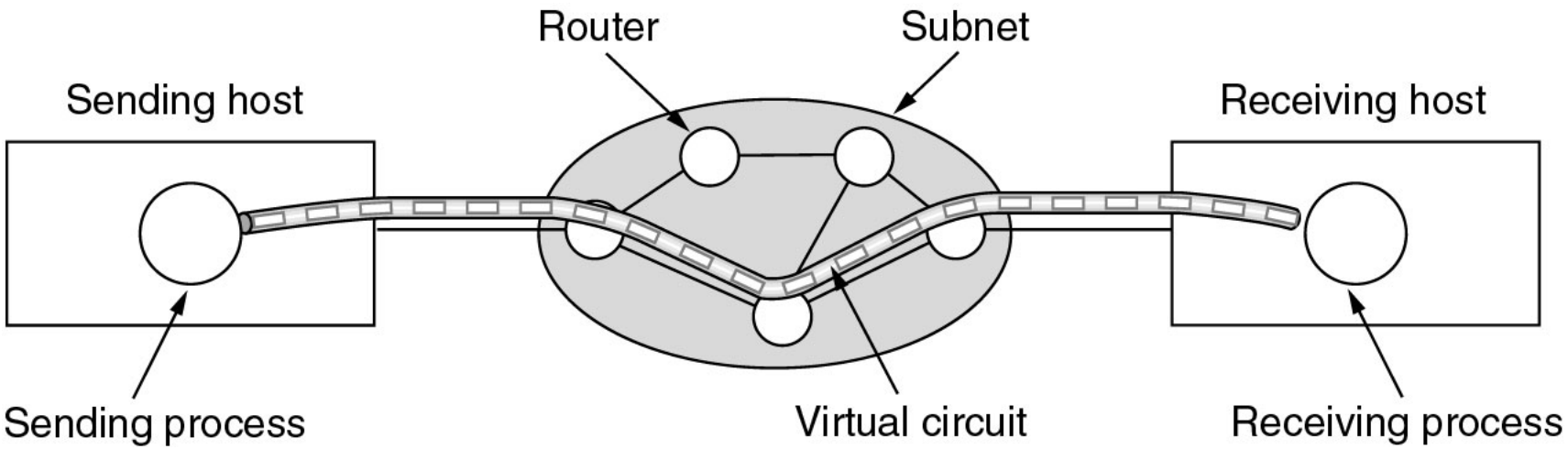
Architecture of the Internet

- Overview of the Internet.



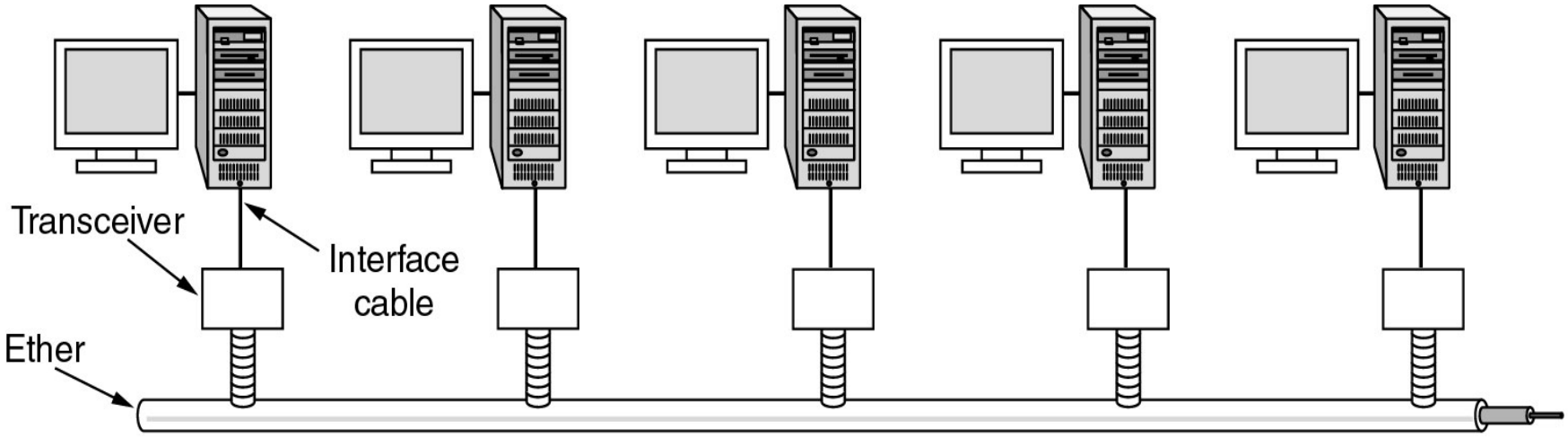
ATM Virtual Circuits

- A virtual circuit.

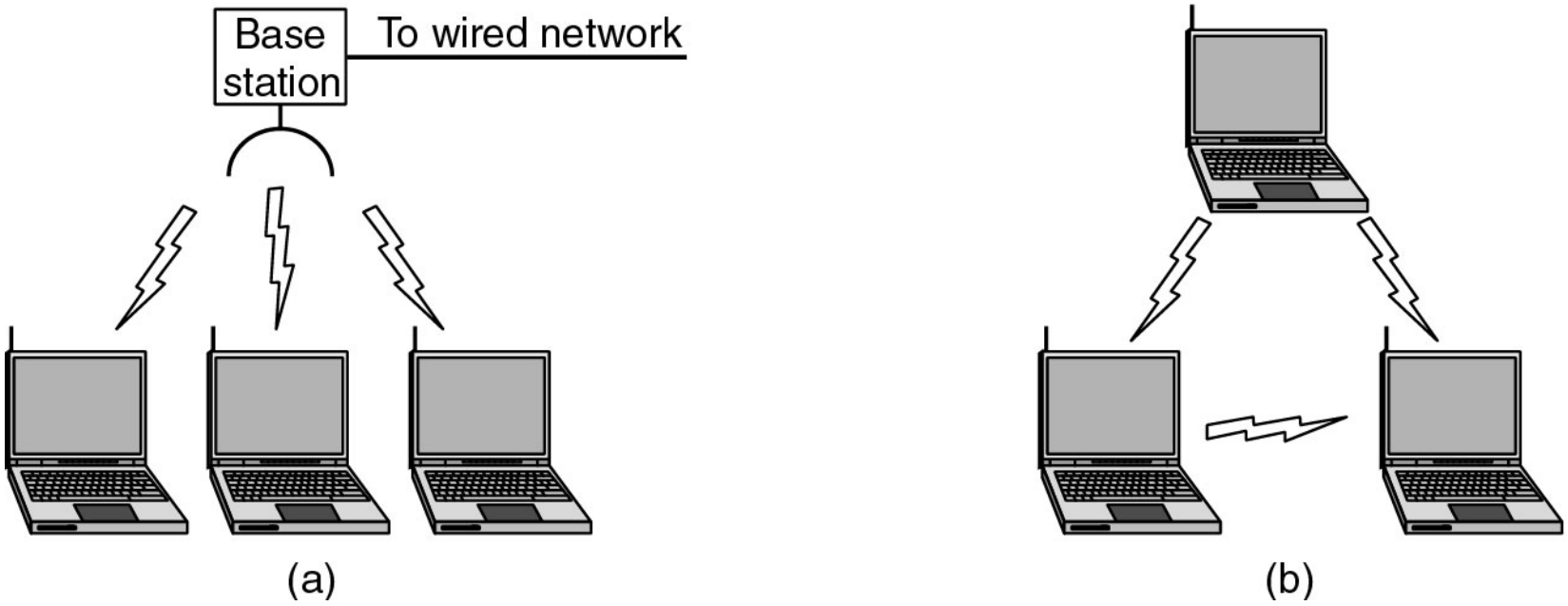


Ethernet

- Architecture of the original Ethernet.



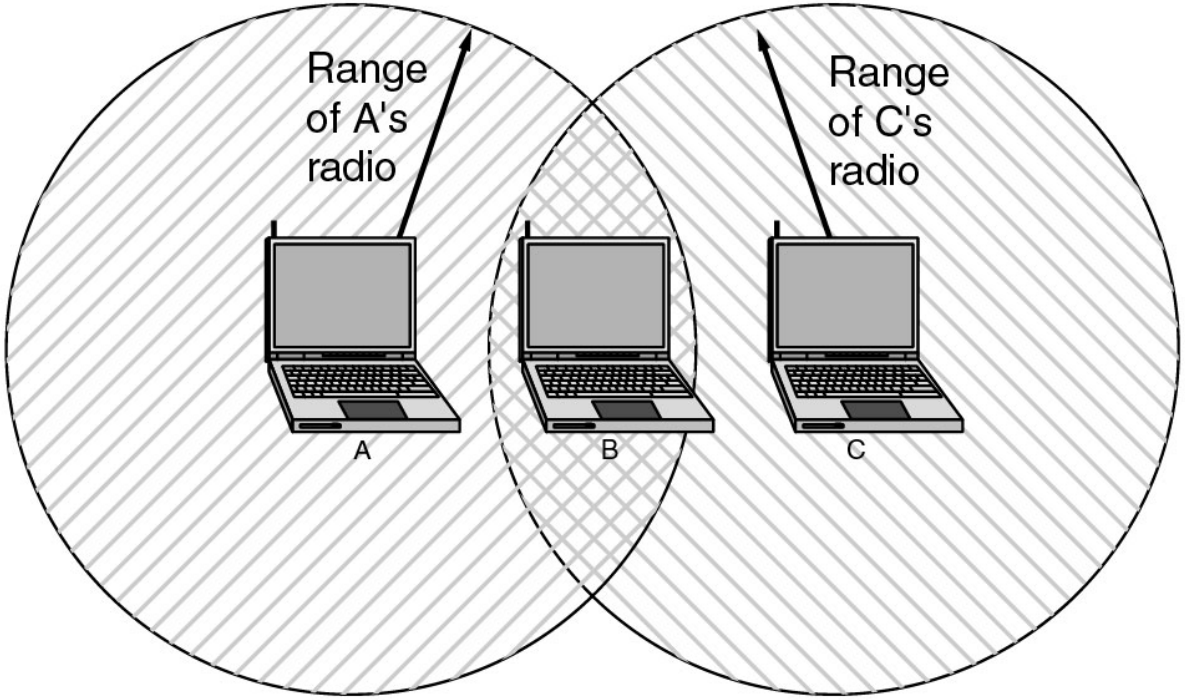
Types of Wireless LANs



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

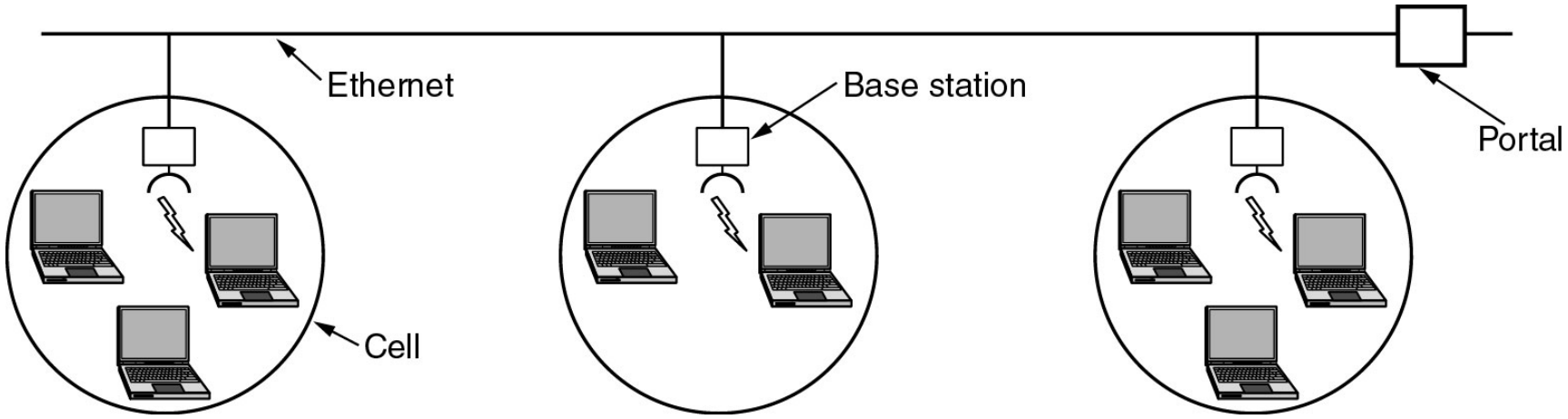
Wireless LANs - Range

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



Complex Wireless LANs

- 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

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}	0.000000000000001	femto	10^{15}	1,000,000,000,000,000	Peta
10^{-18}	0.000000000000000001	atto	10^{18}	1,000,000,000,000,000,000	Exa
10^{-21}	0.000000000000000000001	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

- The principal metric prefixes.