BLG433E-Computer Communications,Fall2013

Instructor: Prof.Dr.Sema Oktuğ (oktug@itu.edu.tr), **Classroom:** 5203

Schedule: Thr.15:30-17:30, **Assistant:** Sıla Özen

Course Type: Engineering Design, Credits: 2 (3 ECTS credits)

Description:

Introduction to International Standards Organization Open SystemInterconnection (ISO-OSI) reference model, design issues and protocolsin the physical layer, data link layer and network layer, architectures and control algorithms of point-to-point networks and local-area networks, standards in network access protocols and models of network interconnection.

Objectives:

1. To provide a unified view of data and computer communications.
2. To discuss principles and practice of computer networking
3. To teach software principles involved in computer networks.
4. To ensure that students have the necessary networking skills to design, implement, and analyze communication networks.

BLG433E-Computer Communications

Learning Outcomes:

1. Knowledge of the fundamentals of data communication and communication networks,
2. capability of designing and analyzing data transmission protocols and data link control protocols,
3. Knowledge of routing algorithms/techniques for different network types.

Textbook:

A. S. TANENBAUM AND D.J. WETHERALL , *COMPUTER NETWORKS*, 5TH EDITION, PRENTICE HALL, 2011

Assessment Criteria:

Midterm Exam	25%	(Nov. 6, 2014)
Poster	10%	
Projects (2)	30%	
Final Exam	35%	

In order to join the FINAL EXAM, the weighted average of the midterm exam and the projects must be min 30 (Naturally, 70% attendance is compulsory)

Course Plan

Weeks	Topics	Course Outcomes
1	Introduction. Protocols and layered structure. OSI Reference Model.	1
2	Physical Layer. Data transmission. Transmission media.	1
3	Mobile Telephone System	1
4	Data Link Layer. Framing. Error detection and correction.	2
5	Sliding window protocols. Medium access sublayer. IEEE 802.3. (Project#1 will be announced, Oct.9, 2014)	2
6	Wireless LANs. IEEE 802.11	2
7	Bridges, spanning tree bridges, switches, virtual LANs.	1
8	Routing algorithms-I.	1-2
9	Midterm Exam (Nov.6, 2014)	1
10	Routing algorithms-II.	1
11	IP, IP addressing. (Project#2 will be announced, Nov.20, 2014)	3
12	TCP, UDP.	2
13	Poster Presentation	3
14	Poster Presentation	3

Chapter 1

Introduction

Confusion BETWEEN a Distributed System and a Computer Network

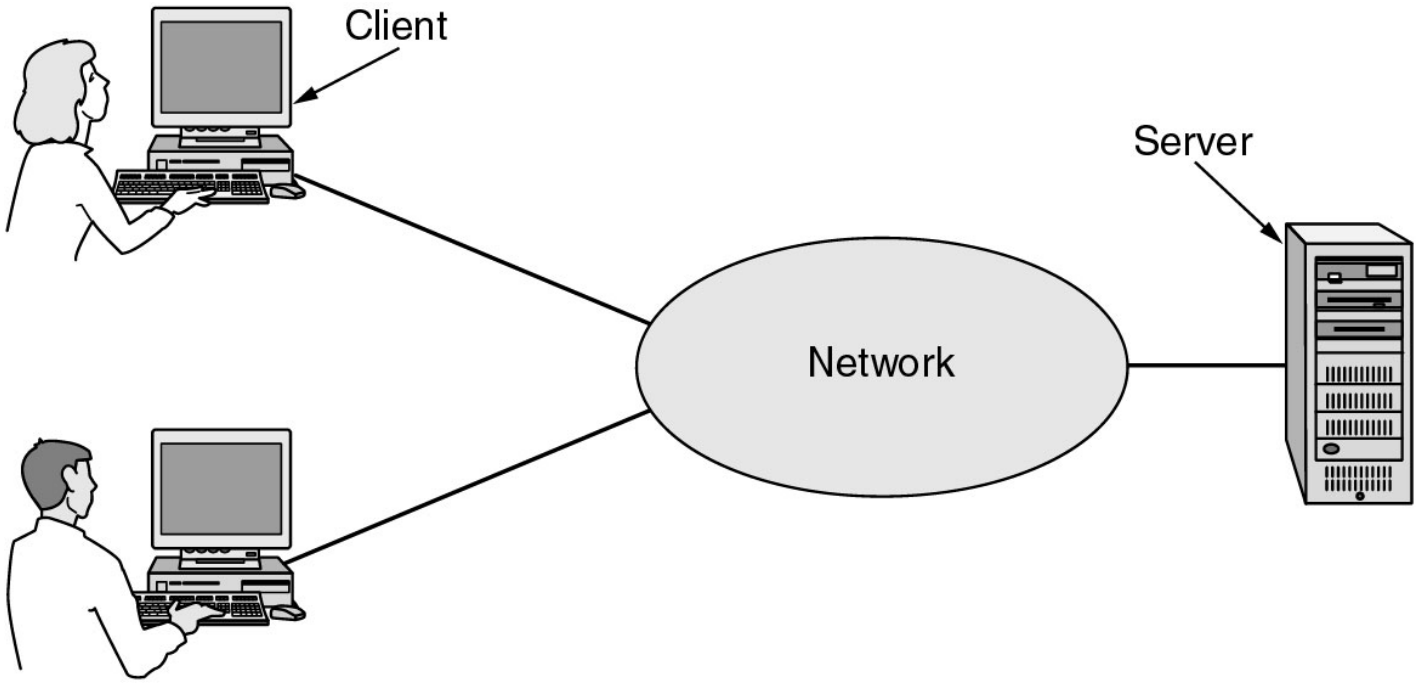
In a Distributed System , a collection of independent computers appears to its users as a single coherent system. Often a layer of software on top of the operating system, called middleware, is responsible to implement this model.

In a Computer Network, this coherence, model, and software are absent. Users are exposed to the actual machines, without any attempt by the system to make the machines look and act in a coherent way.

Uses of Computer Networks

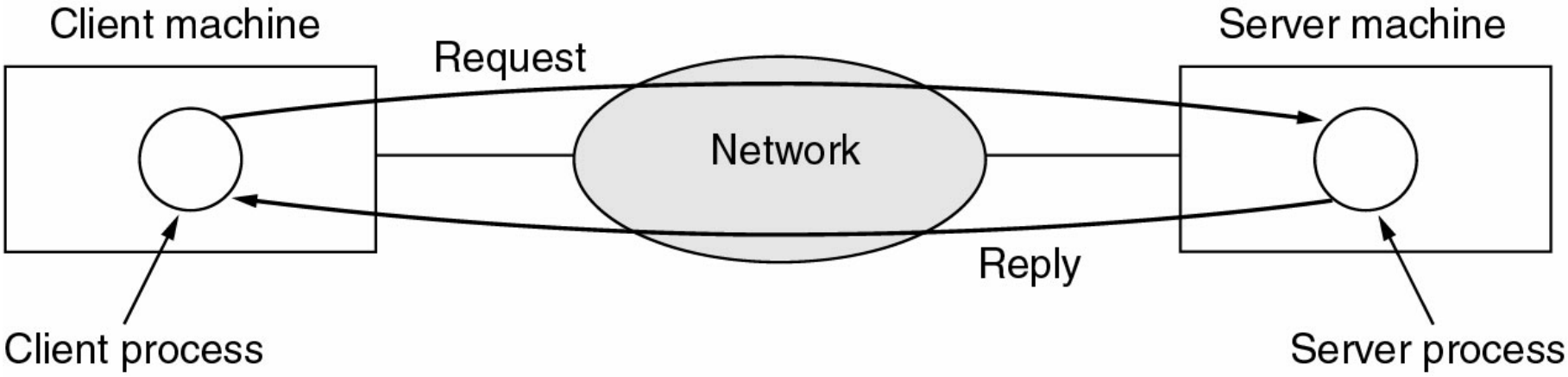
- Business Applications
- Home Applications
- Mobile Users
- Social Issues

Business Applications of Networks



A network with two clients and one server (resource sharing).

Business Applications of Networks (2)

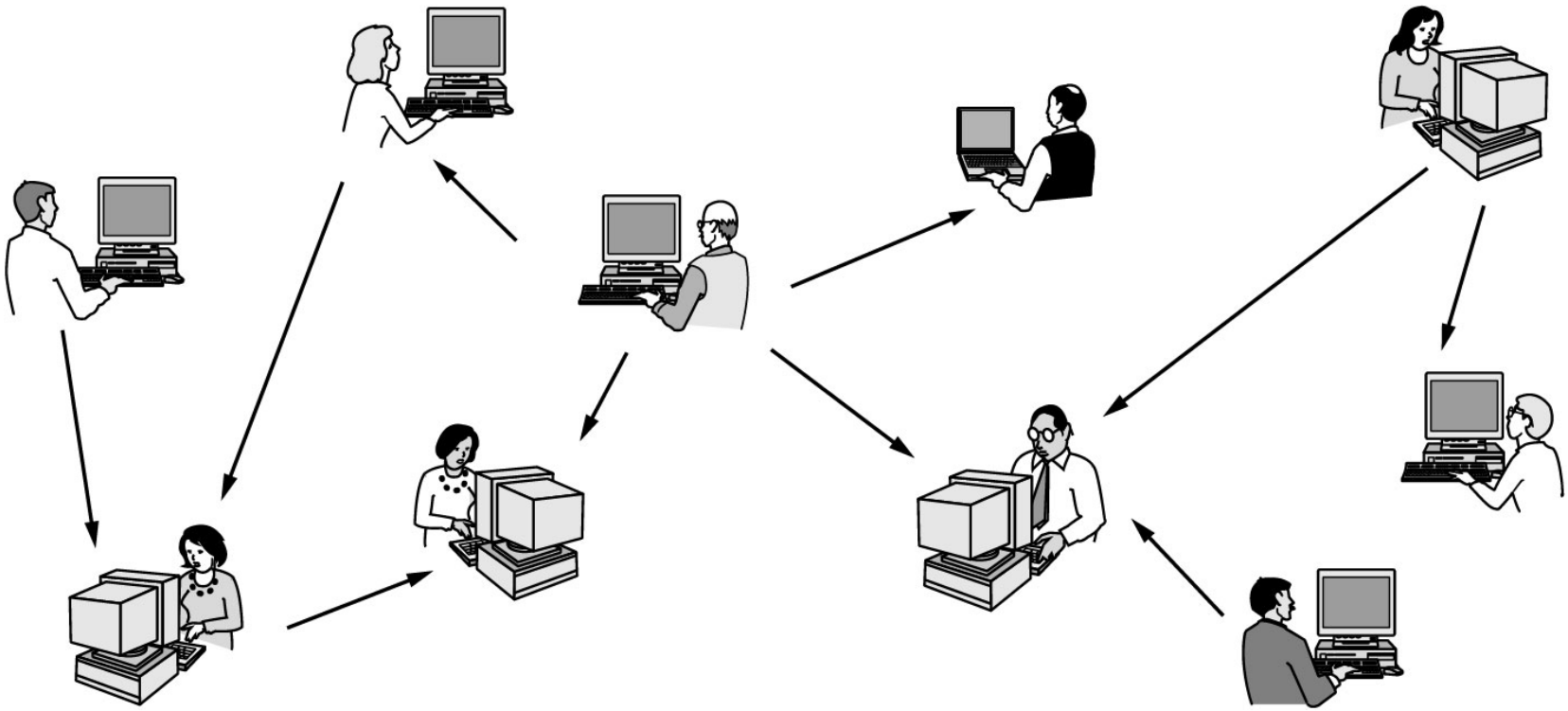


The client-server model involves requests and replies.

Home Network Applications

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

Home Network Applications (1)



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

Home Applications (2)

Tag	Full name	Example
B2C	Business-to-consumer	Ordering books online
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 online
P2P	Peer-to-peer	Music sharing

Some forms of e-commerce

Mobile Users

Wireless	Mobile	Typical applications
No	No	Desktop computers in offices
No	Yes	A notebook computer used in a hotel room
Yes	No	Networks in unwired buildings
Yes	Yes	Store inventory with a handheld computer

Combinations of wireless networks and mobile computing

Social Issues

The widespread introduction of networking has introduced new social, ethical, and political problems:

- Some people have sued network operators, claiming that they are responsible for the contents of what they carry
- Employee rights vs employer rights
- Government vs citizen. Snooping all incoming and outgoing e-mail for nuggets of interest
- A lot of problems could be solved if the computer industry took computer security seriosly

Social Issues

- Network neutrality
- Digital Millennium Copyright Act
- Profiling users
- Phishing

Network Hardware (1)

- Personal area networks
- Local area networks
- Metropolitan area networks
- Wide are networks
- The internet

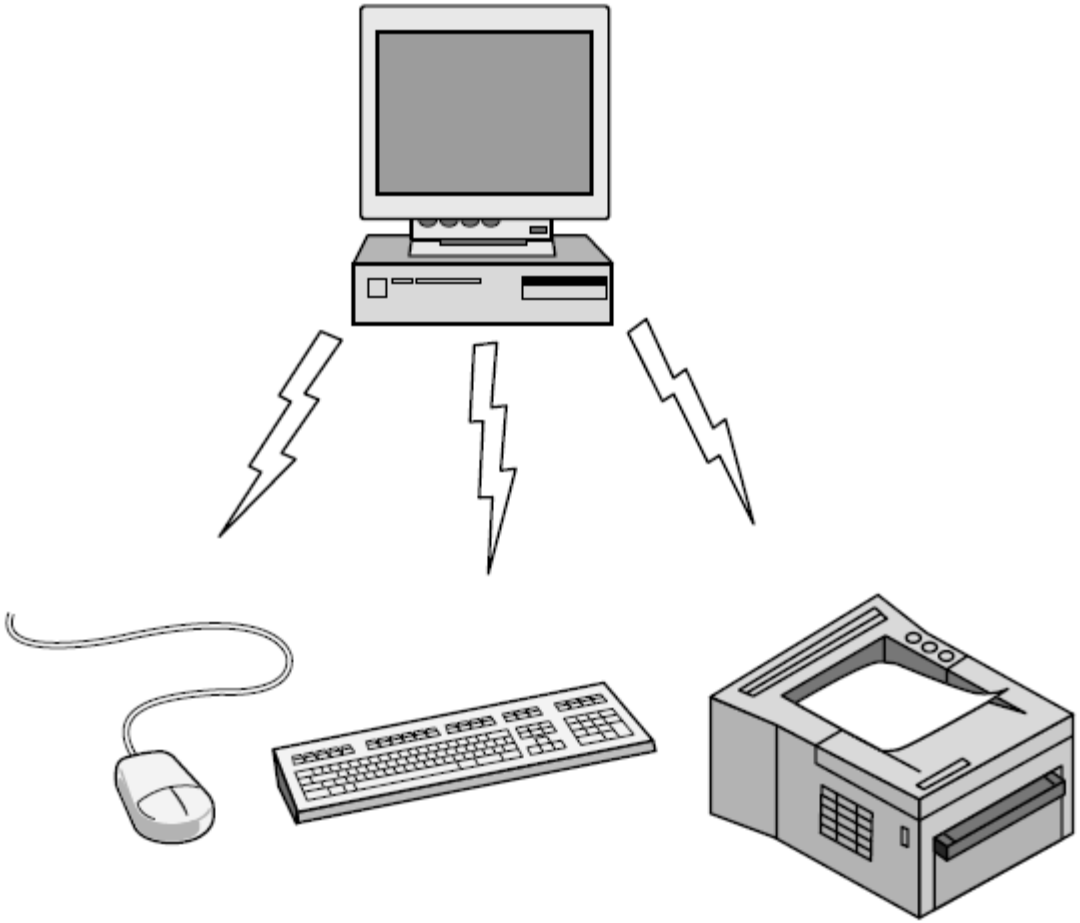
Network Hardware (2)

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

Classification of interconnected processors by scale.

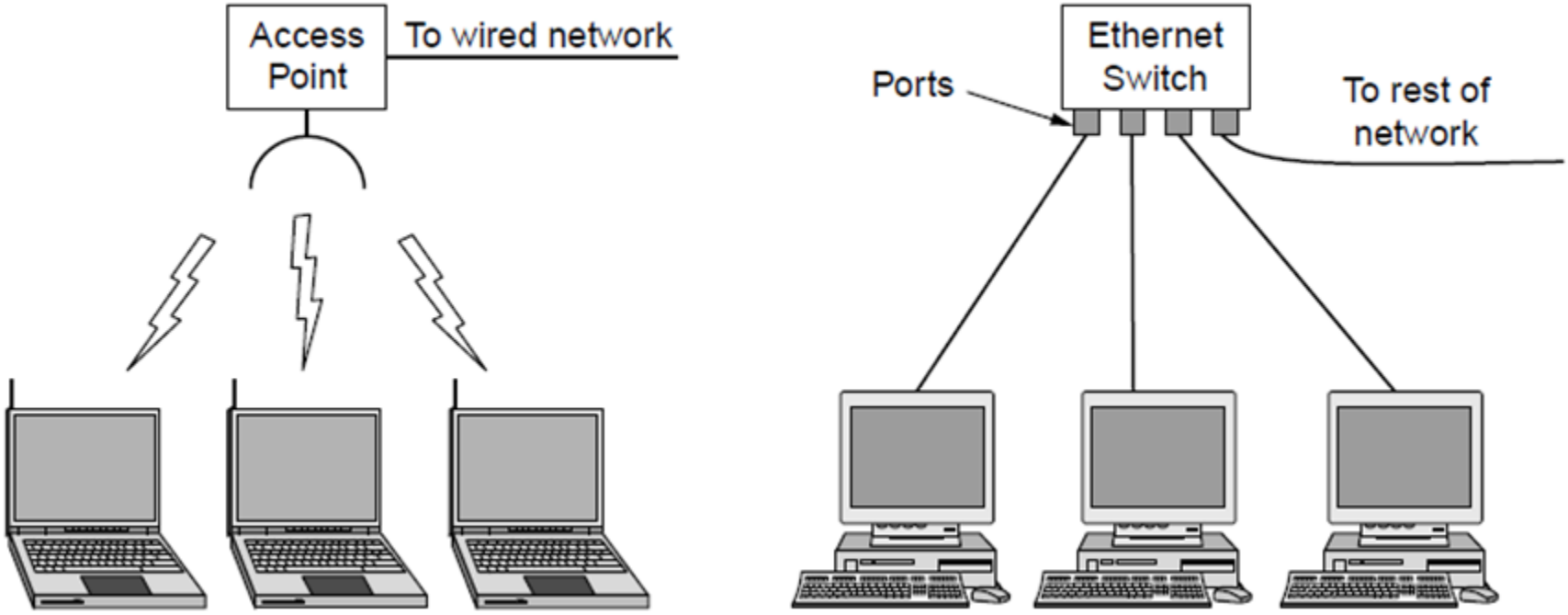
- Broadcasting
- Multicasting
- Unicasting
- Anycasting

Personal Area Network



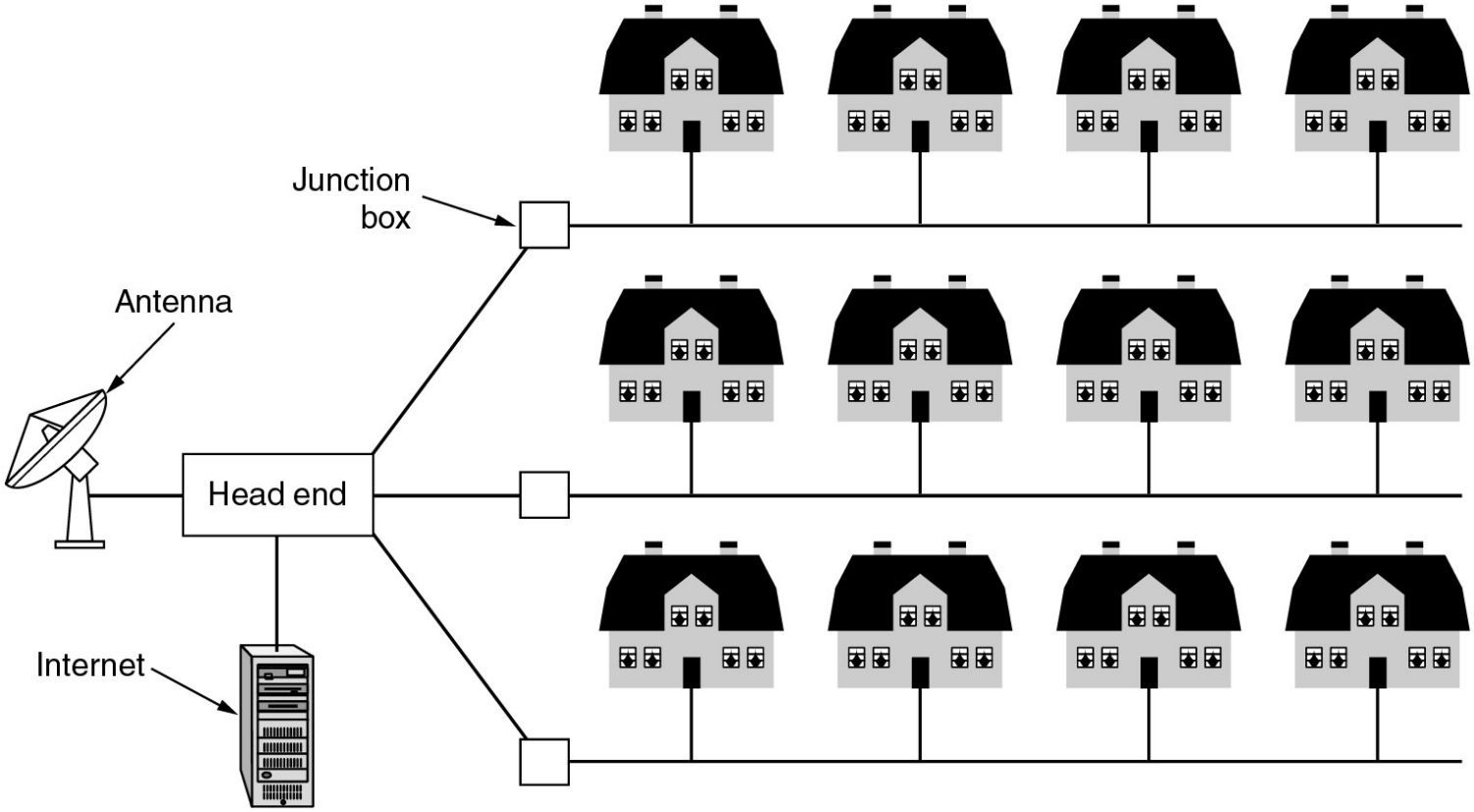
Bluetooth PAN configuration

Local Area Networks



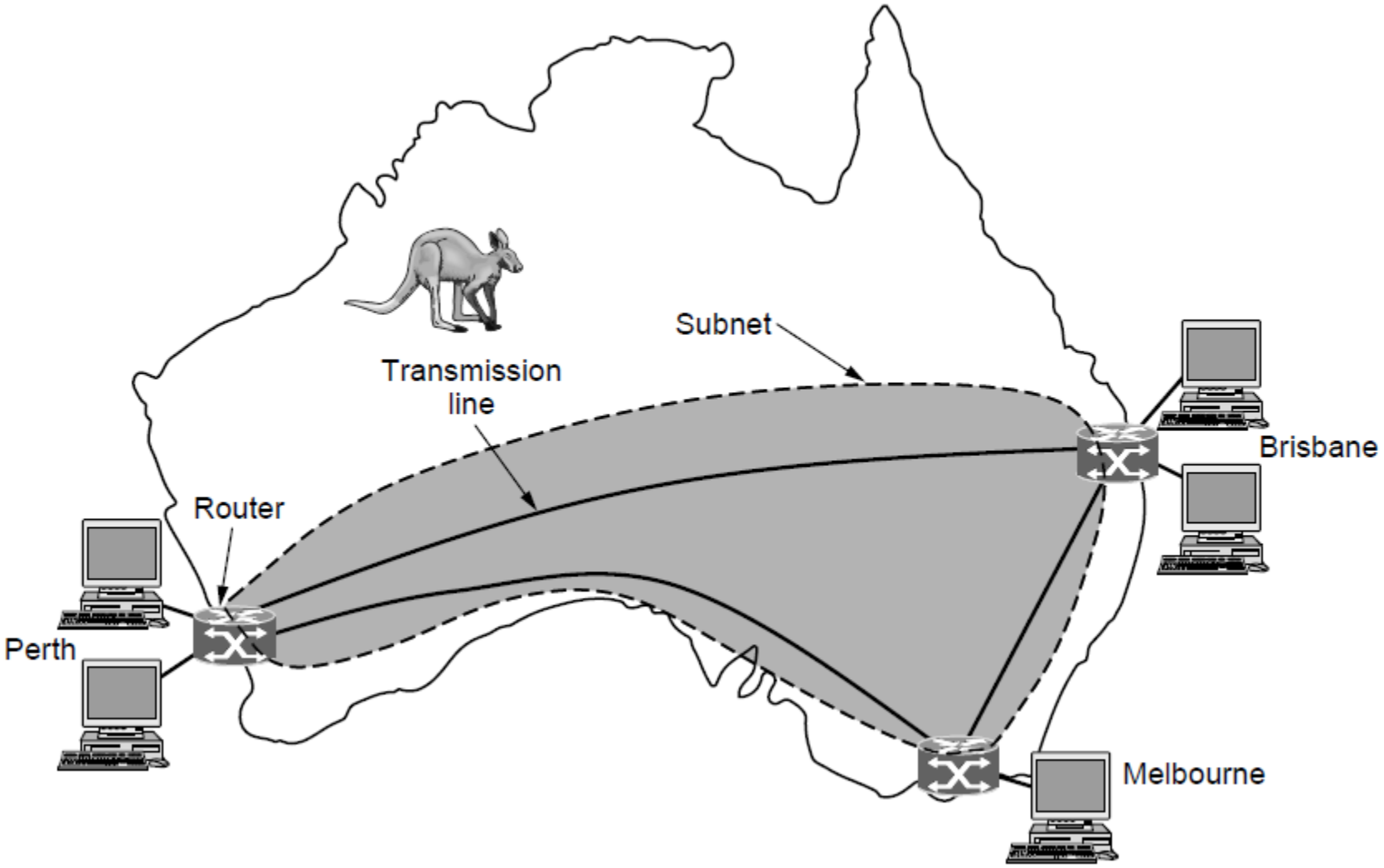
Wireless and wired LANs. (a) 802.11. (b) Switched Ethernet.

Metropolitan Area Networks



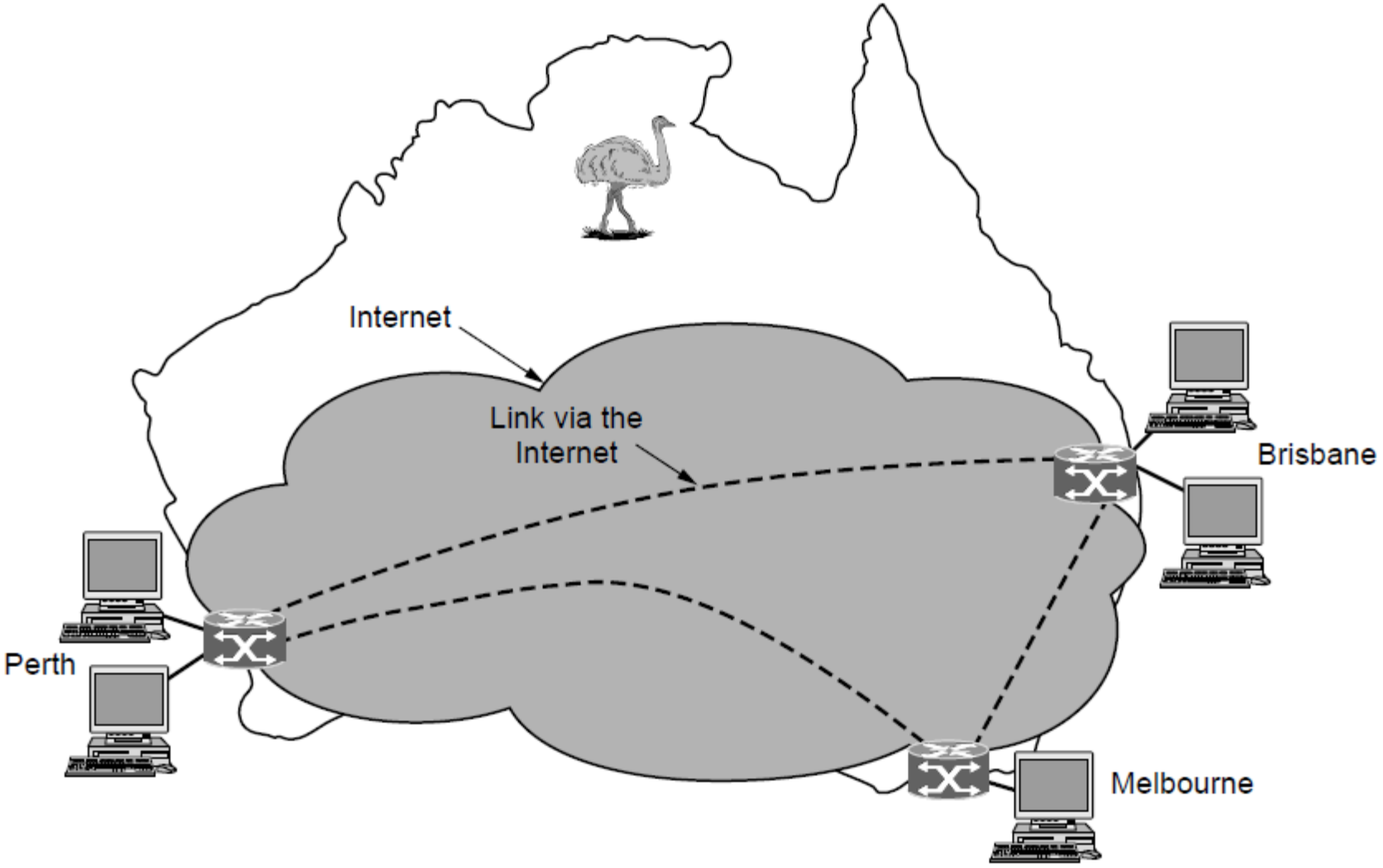
A metropolitan area network based on cable TV.

Wide Area Networks (1)



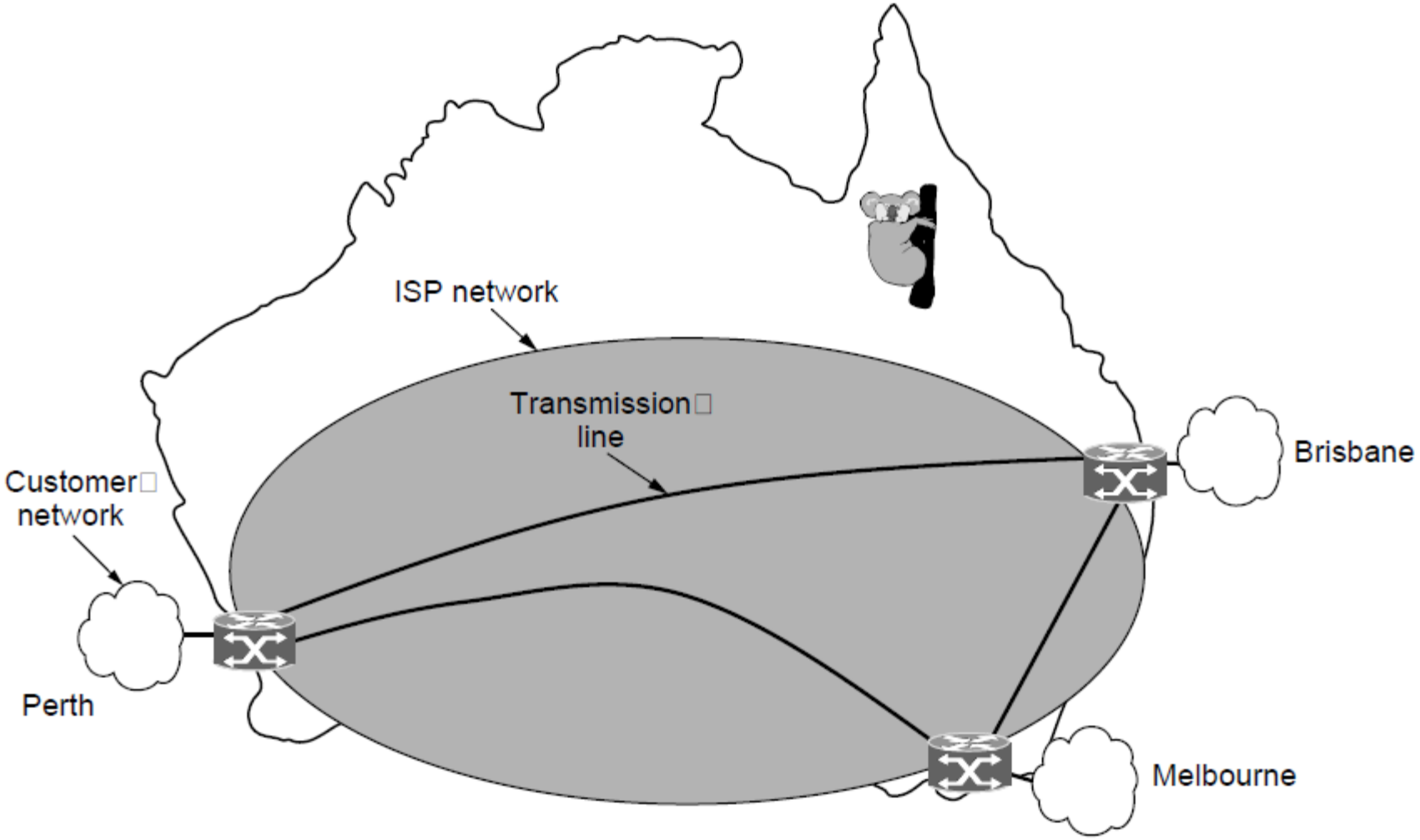
WAN that connects three branch offices in Australia

Wide Area Networks (2)



WAN using a virtual private network.

Wide Area Networks (3)

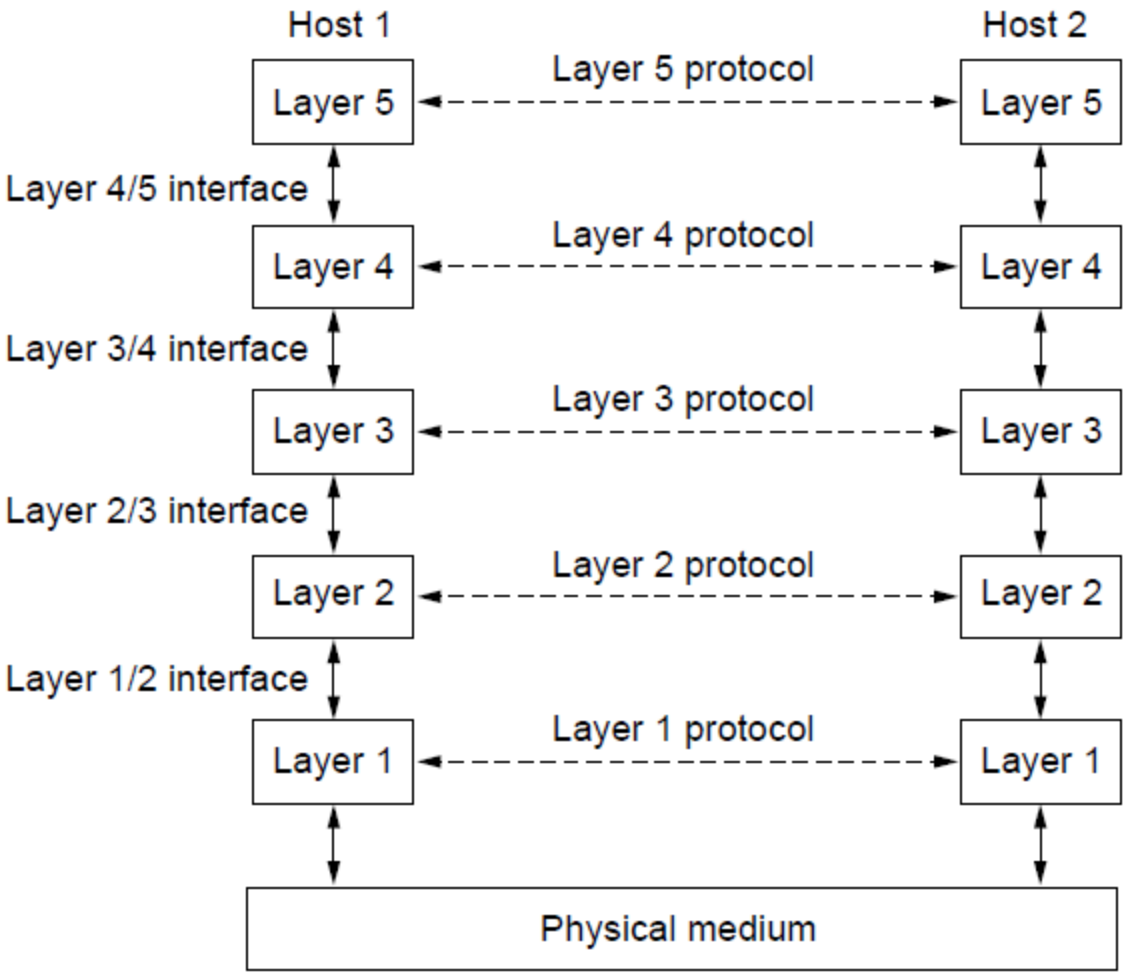


WAN using an ISP network.

Network Software

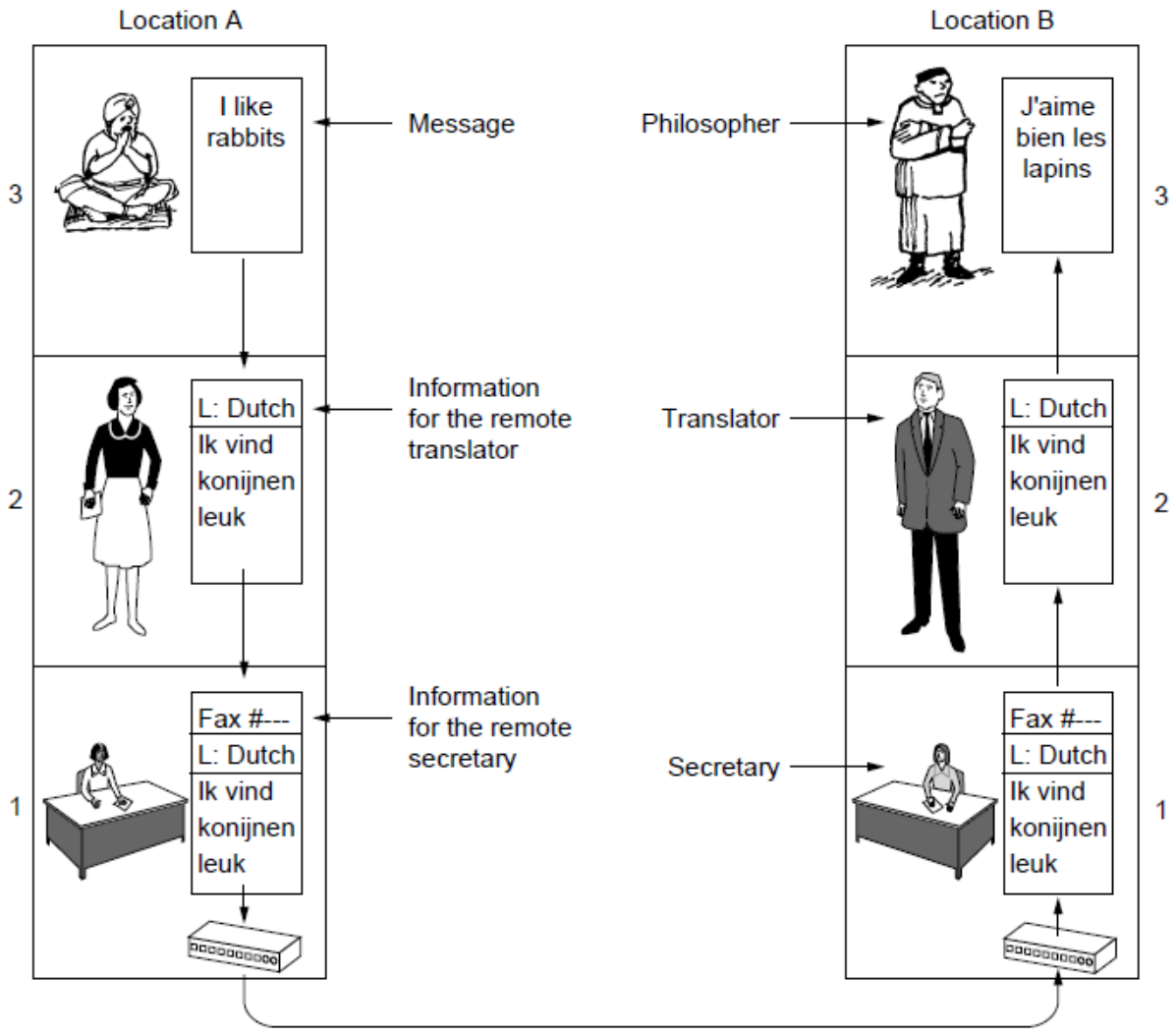
- Protocol hierarchies
- Design issues for the layers
- Connection-oriented versus connectionless service
- Service primitives
- Relationship of services to protocols

Protocol Hierarchies (1)



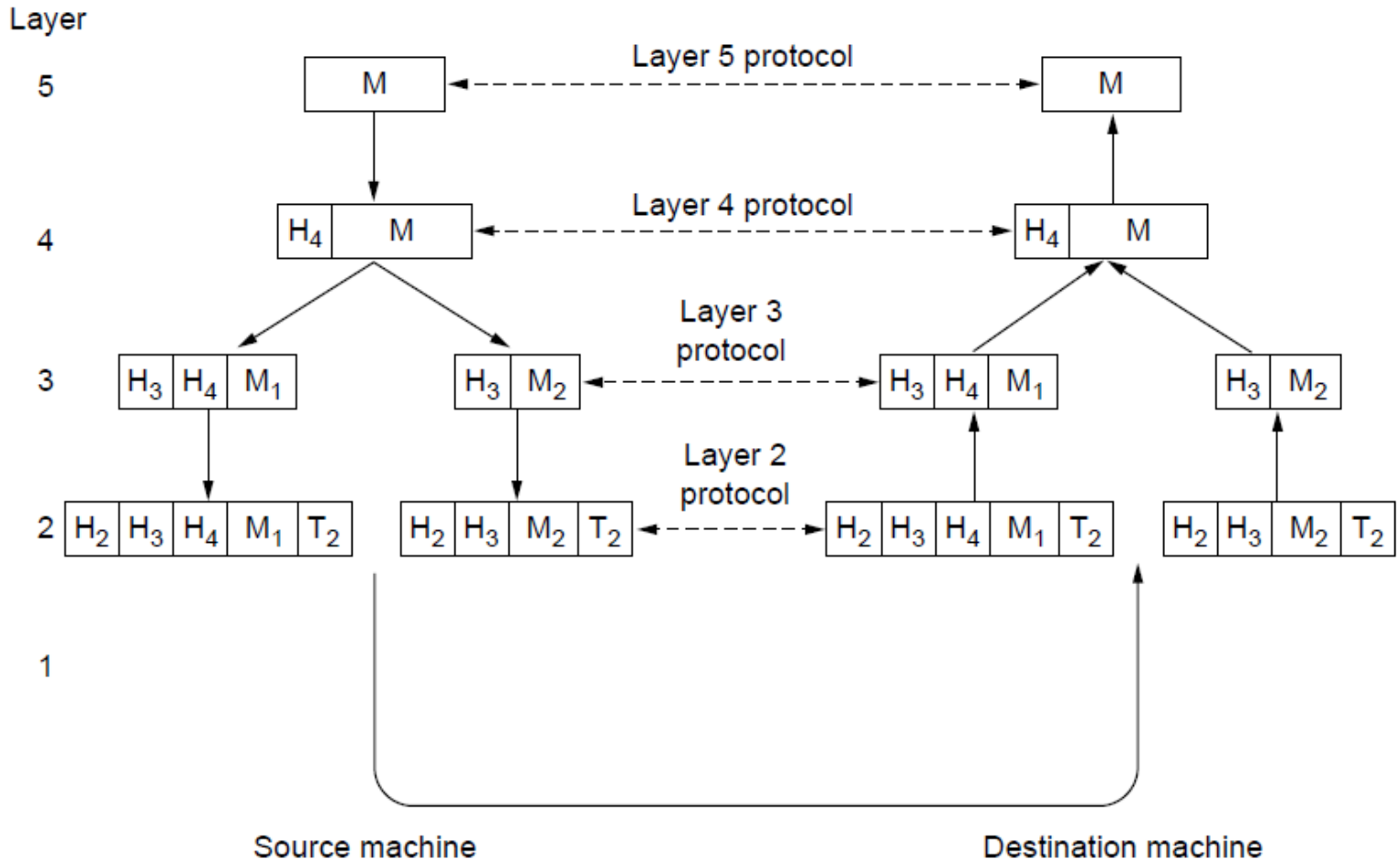
Layers, protocols, and interfaces.

Protocol Hierarchies (2)



The philosopher-translator-secretary architecture

Protocol Hierarchies (3)



Example information flow supporting virtual communication in layer 5.

Connection-Oriented Versus Connectionless Service

	Service	Example
Connection-oriented	Reliable message stream	Sequence of pages
	Reliable byte stream	Movie download
	Unreliable connection	Voice over IP
Connectionless	Unreliable datagram	Electronic junk mail
	Acknowledged datagram	Text messaging
	Request-reply	Database query

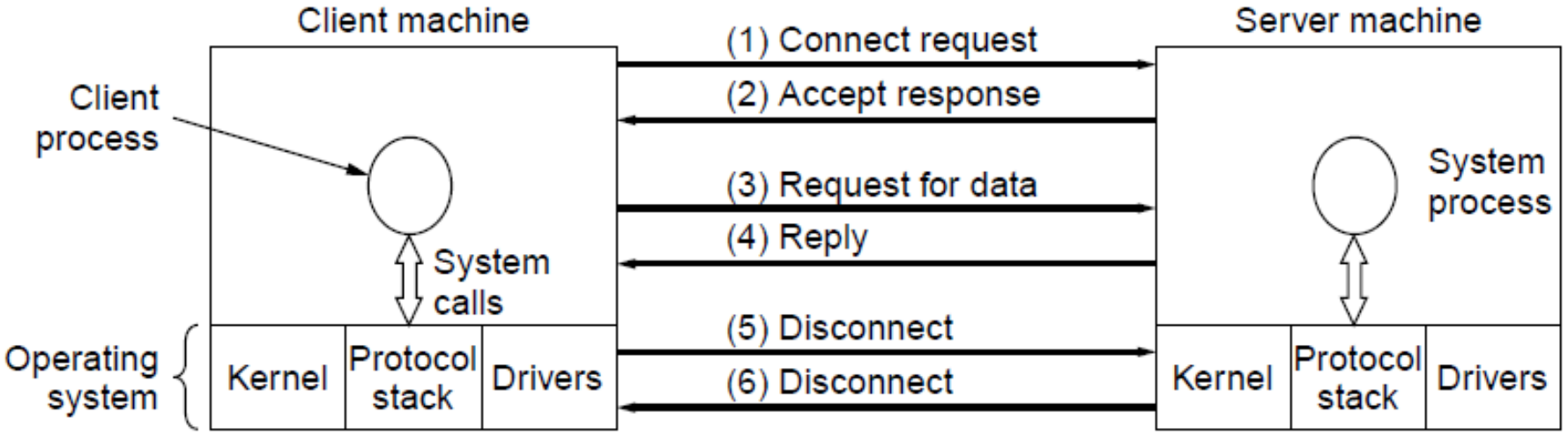
Six different types of service.

Service Primitives (1)

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

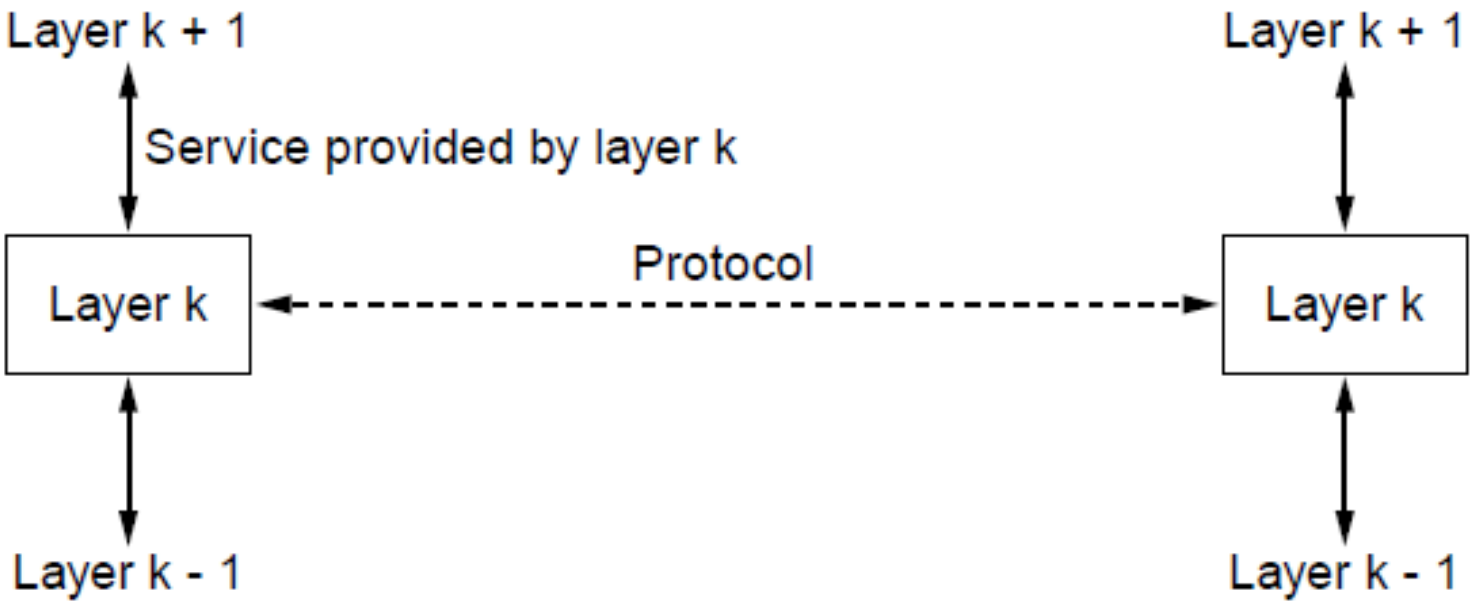
Six service primitives that provide a simple connection-oriented service

Service Primitives (2)



A simple client-server interaction using acknowledged datagrams.

The Relationship of Services to Protocols



The relationship between a service and a protocol.

Reference Models

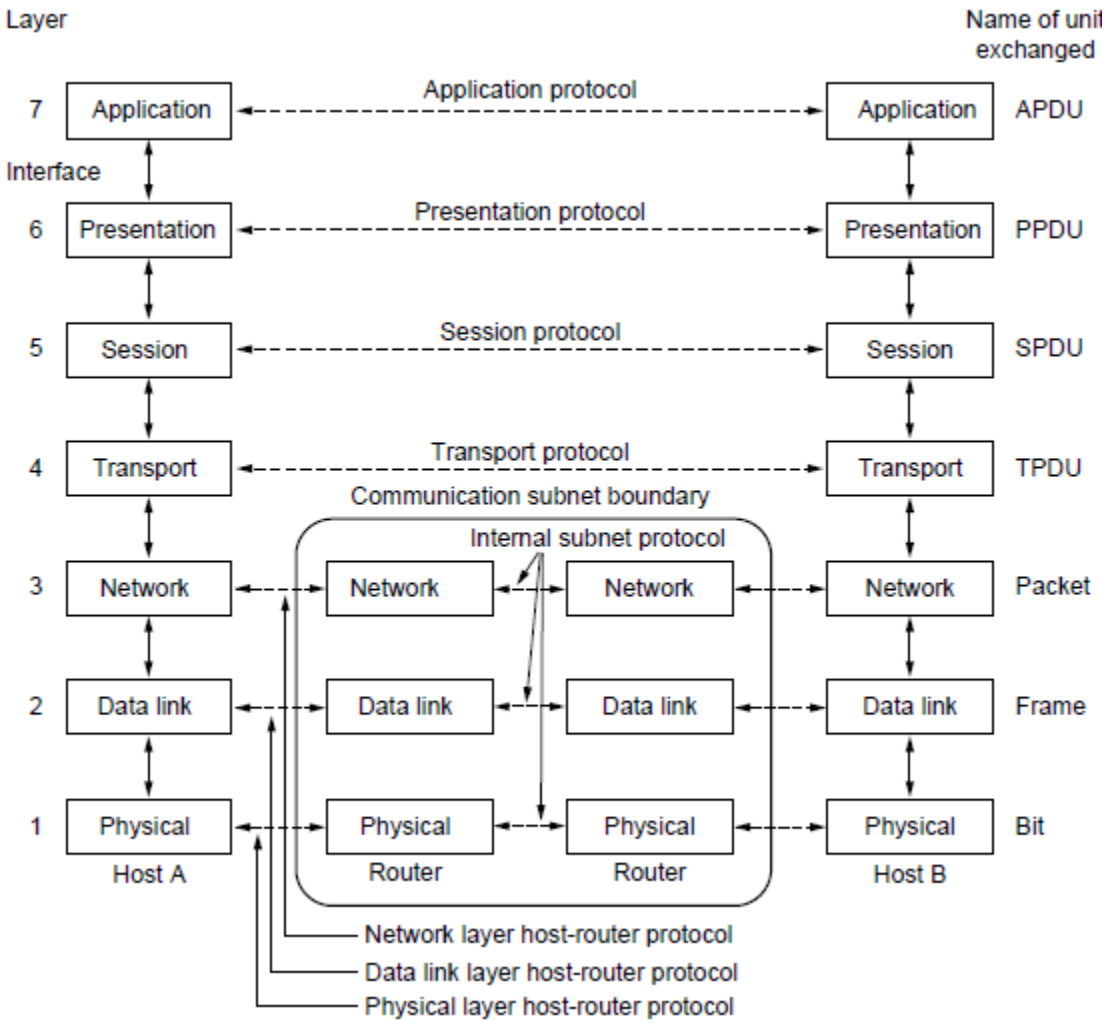
- OSI reference model
- TCP/IP reference model
- Model used for this text
- Comparison of OSI and TCP/IP
- Critique of OSI model and protocols
- Critique of TCP/IP model

The OSI Reference Model

Principles for the seven layers

- Layers created for different abstractions
- Each layer performs well-defined function
- Function of layer chosen with definition of international standard protocols in mind
- Minimize information flow across interfaces between boundaries
- Number of layers optimum

The OSI Reference Model



The OSI reference model

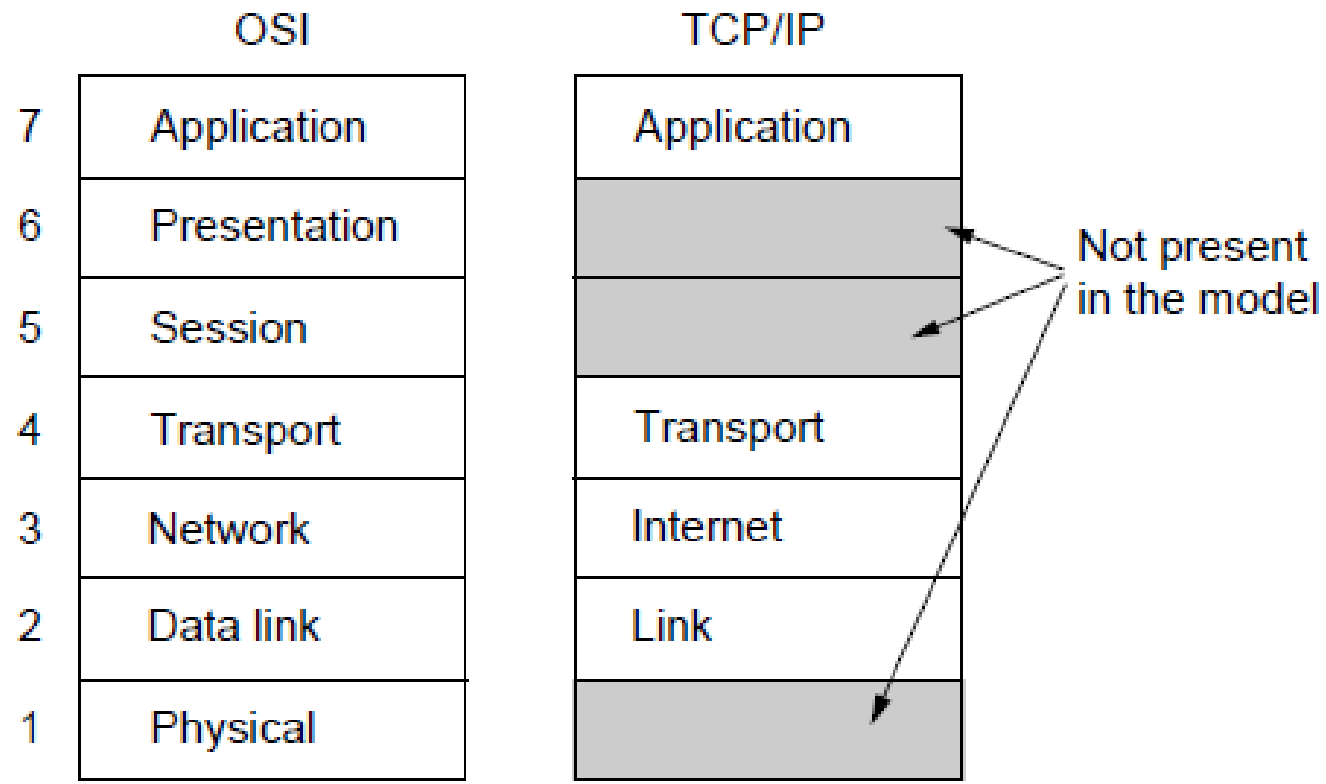
OSI Reference Model Layers

- Physical layer
- Data link layer
- Network layer
- Transport layer
- Session layer
- Presentation layer
- Application layer

The TCP/IP Reference Model Layers

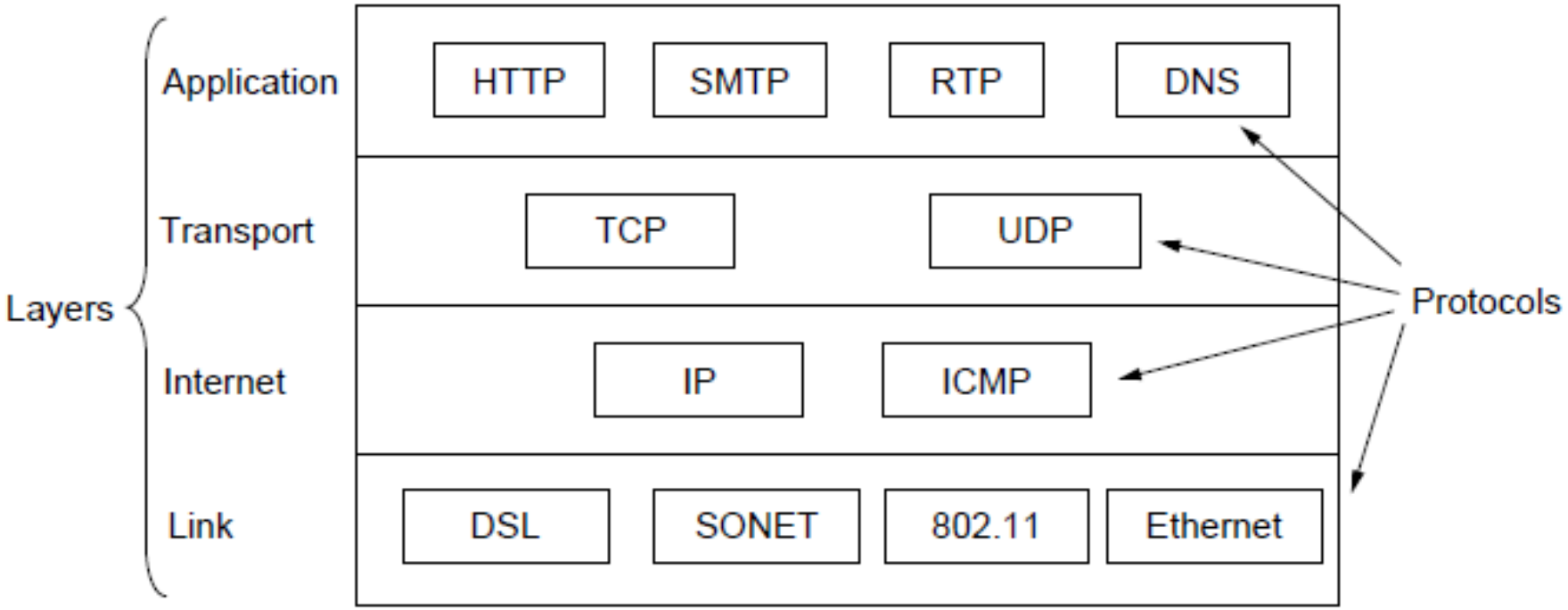
- Link layer
- Internet layer
- Transport layer
- Application layer

The TCP/IP Reference Model (1)



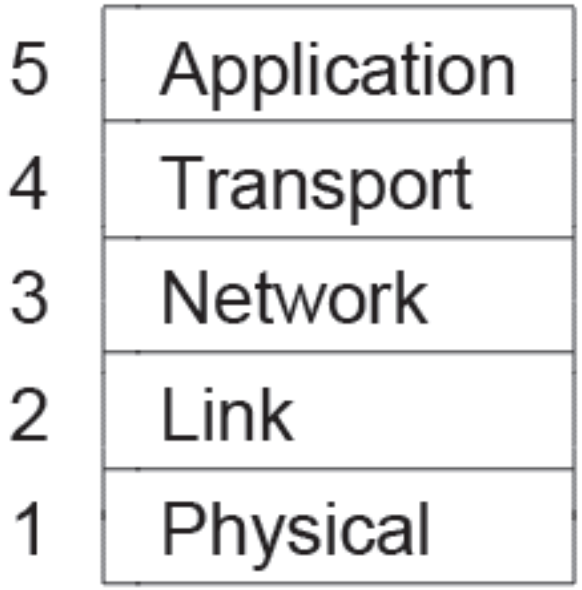
The TCP/IP reference model

The TCP/IP Reference Model (2)



The TCP/IP reference model with some protocols we will study

The Model Used in this Book



The reference model used in this book.

Comparison of the OSI and TCP/IP Reference Models

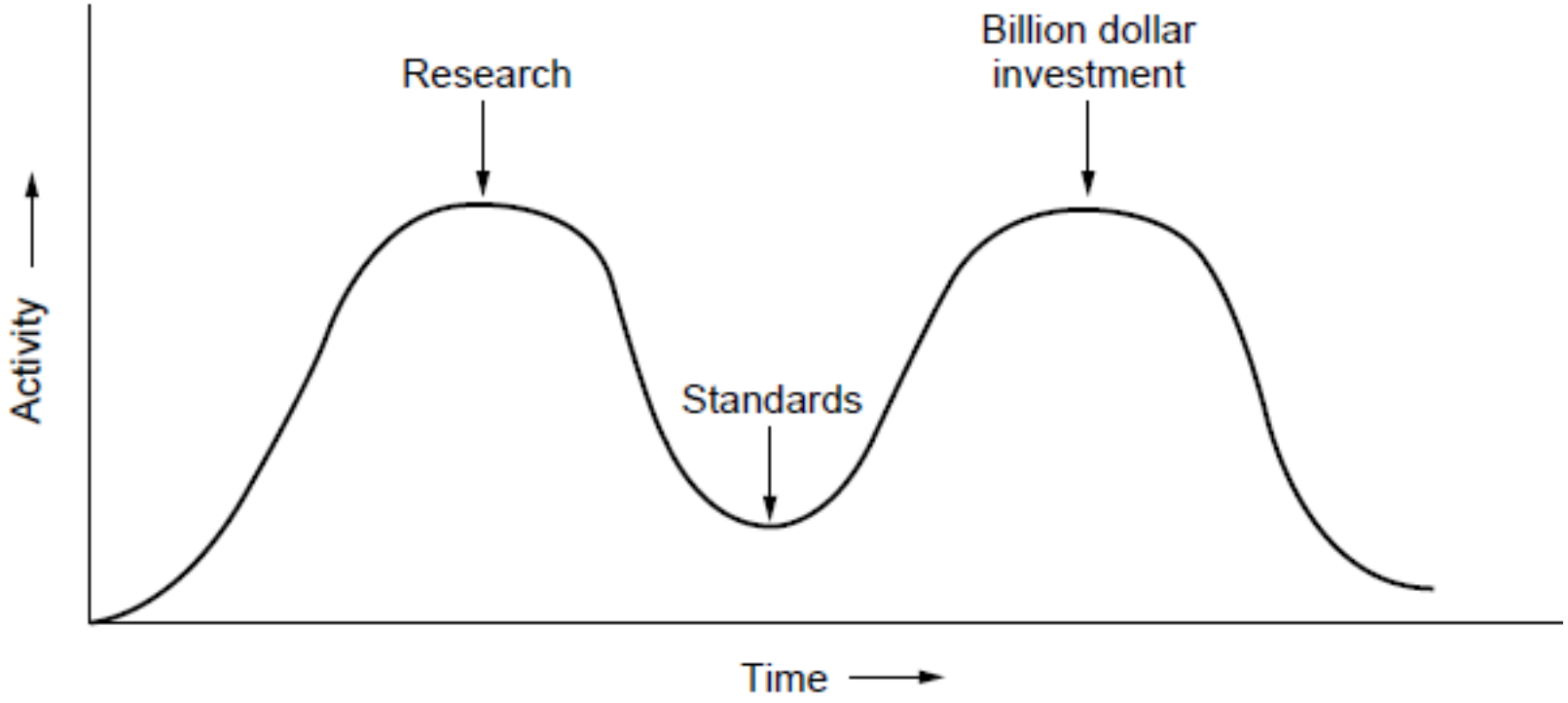
Concepts central to OSI model

- Services
- Interfaces
- Protocols

Critique of the OSI Model and Protocols

- Bad timing.
- Bad technology.
- Bad implementations.
- Bad politics.

OSI Model Bad Timing

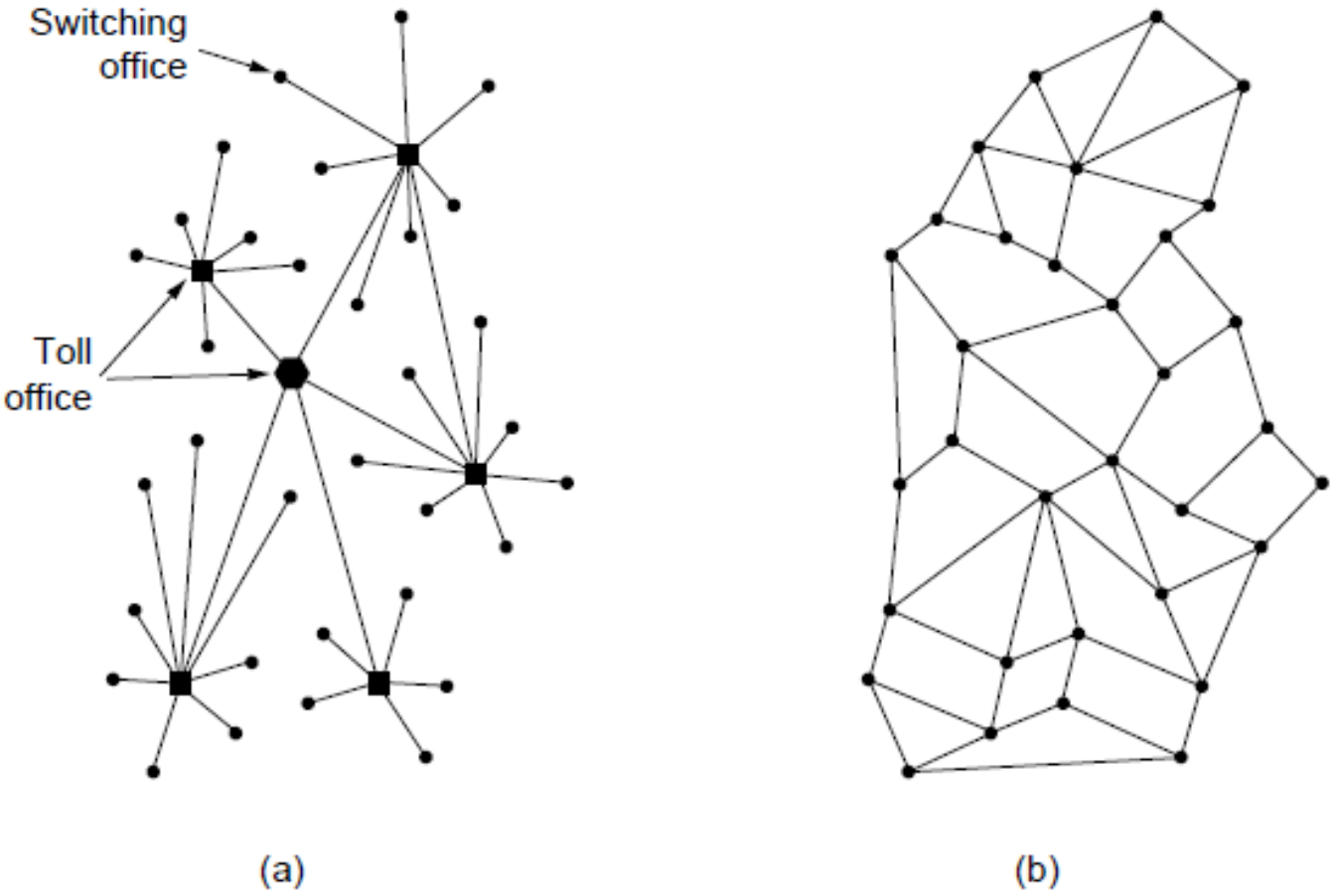


The apocalypse of the two elephants.

Example Networks

- Internet
- ARPANET
- NSFNET
- Third-generation mobile phone networks
- Wireless LANs: 802.11
- RFID and sensor networks

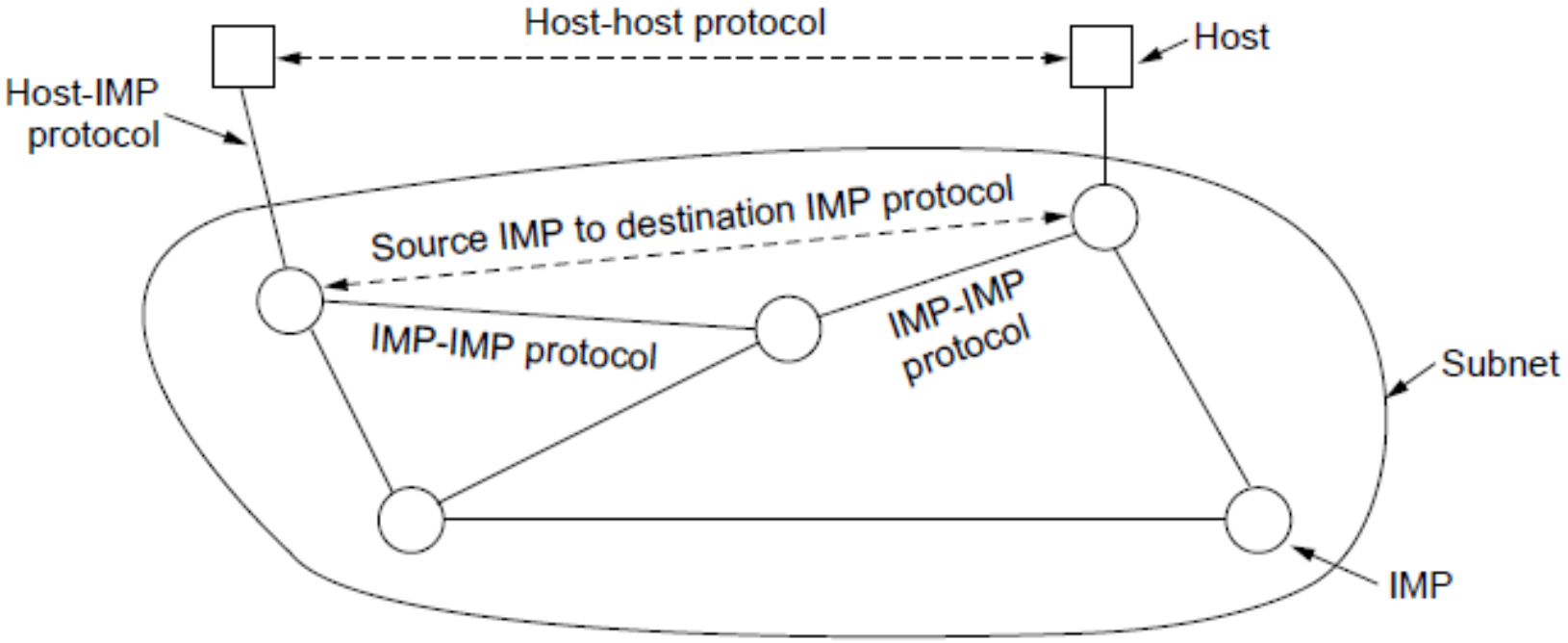
The ARPANET (1)



a) Structure of the telephone system.

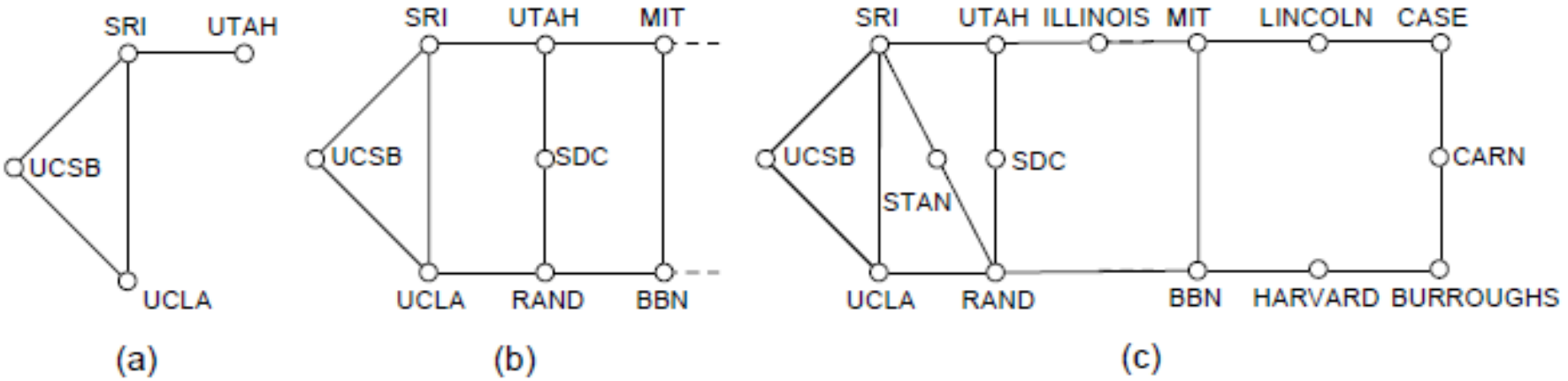
b) Baran's proposed distributed switching system.

The ARPANET (2)



The original ARPANET design

The ARPANET (3)



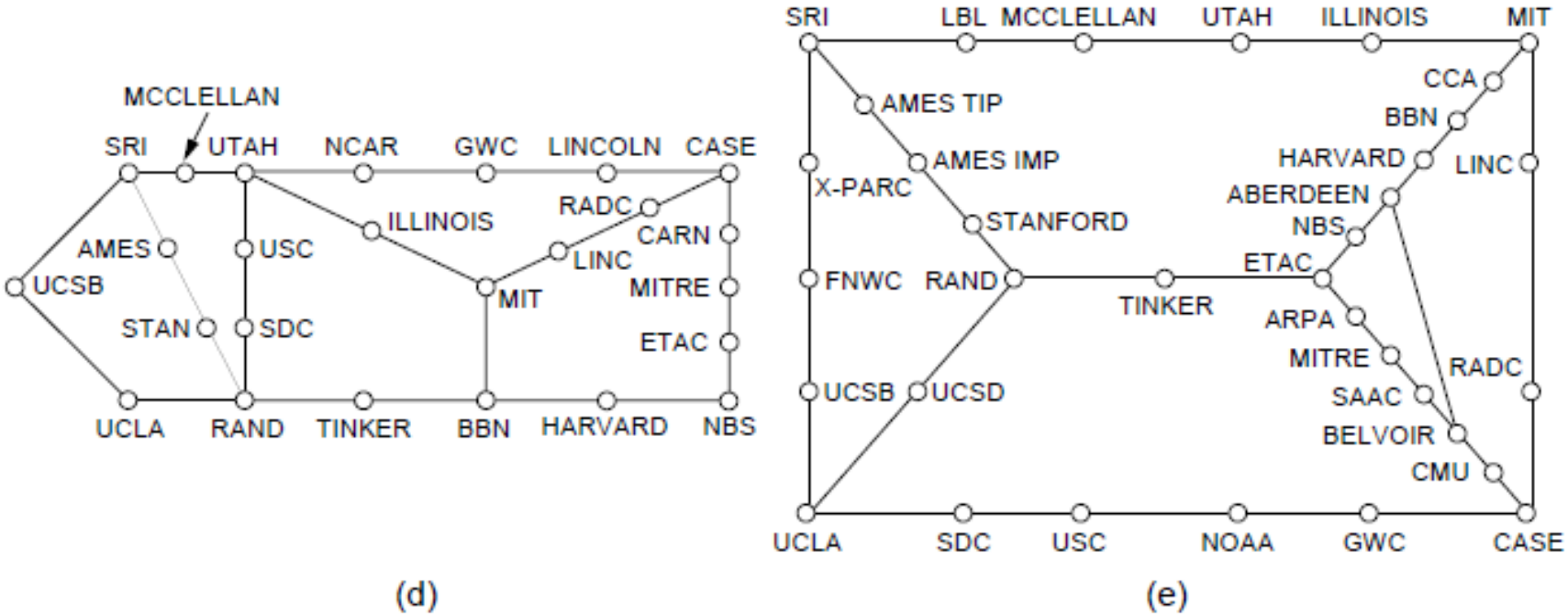
Growth of the ARPANET.

a) December 1969.

b) July 1970.

c) March 1971.

The ARPANET (4)

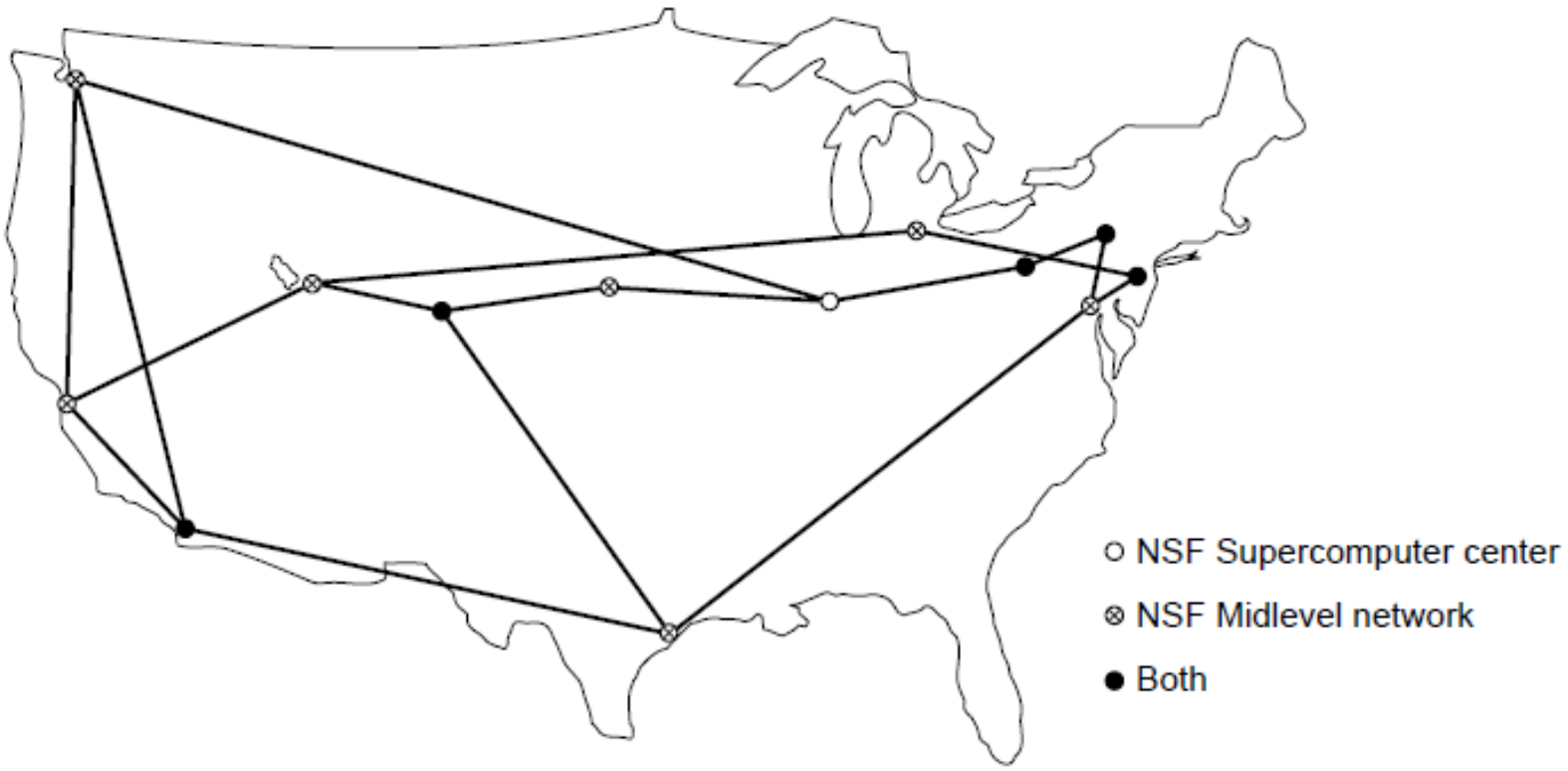


Growth of the ARPANET.

d) April 1972.

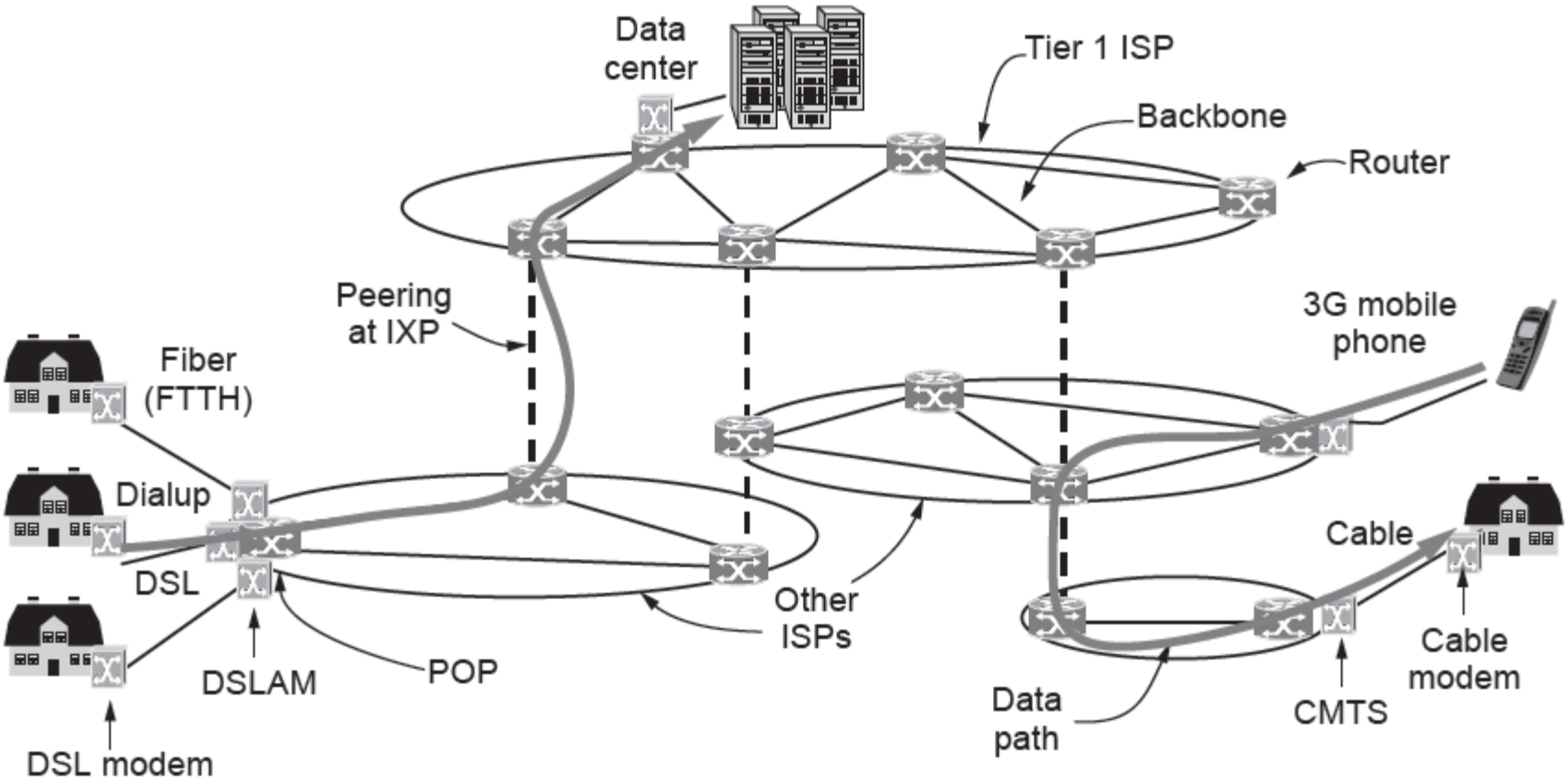
e) September 1972.

NSFNET



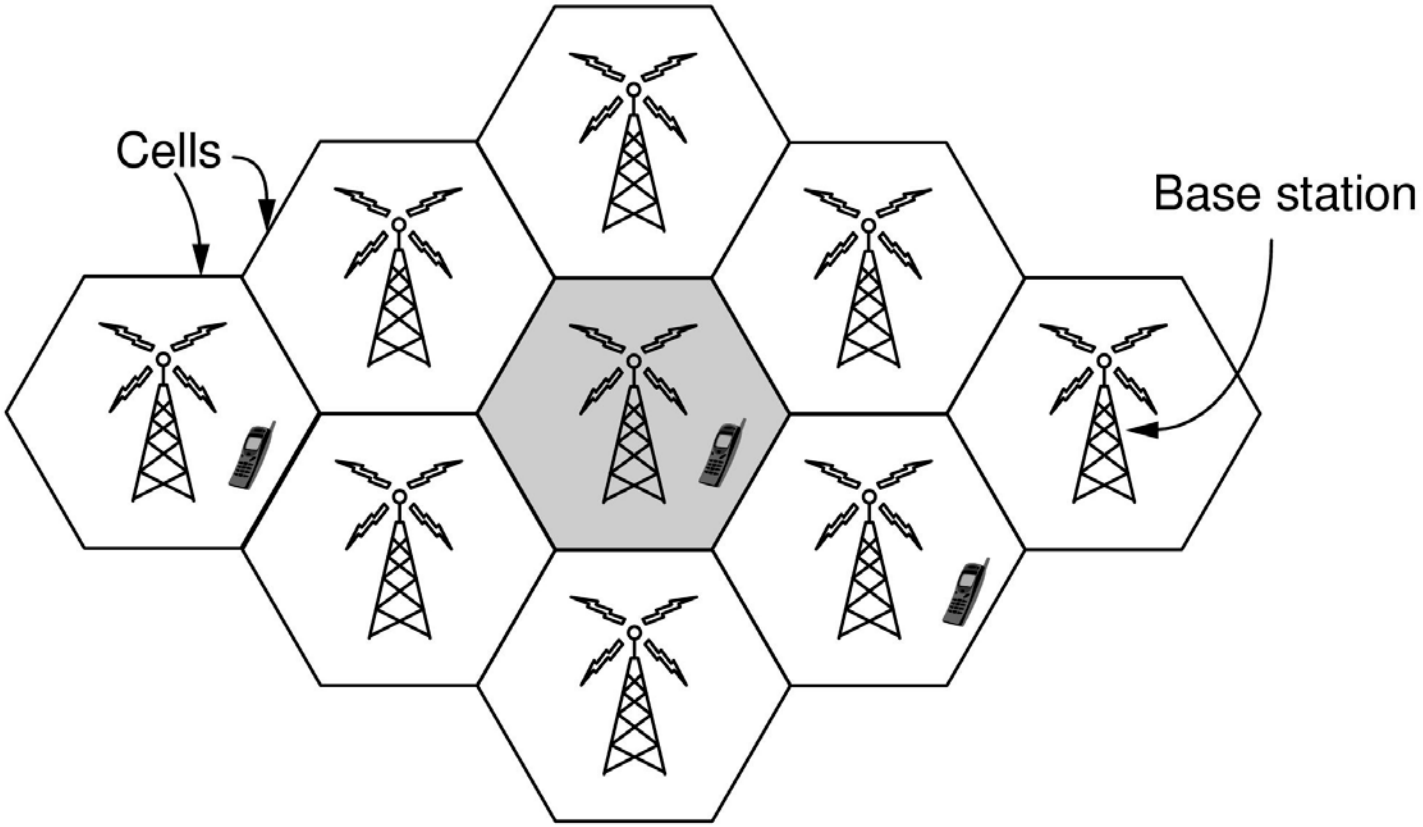
The NSFNET backbone in 1988.

Architecture of the Internet



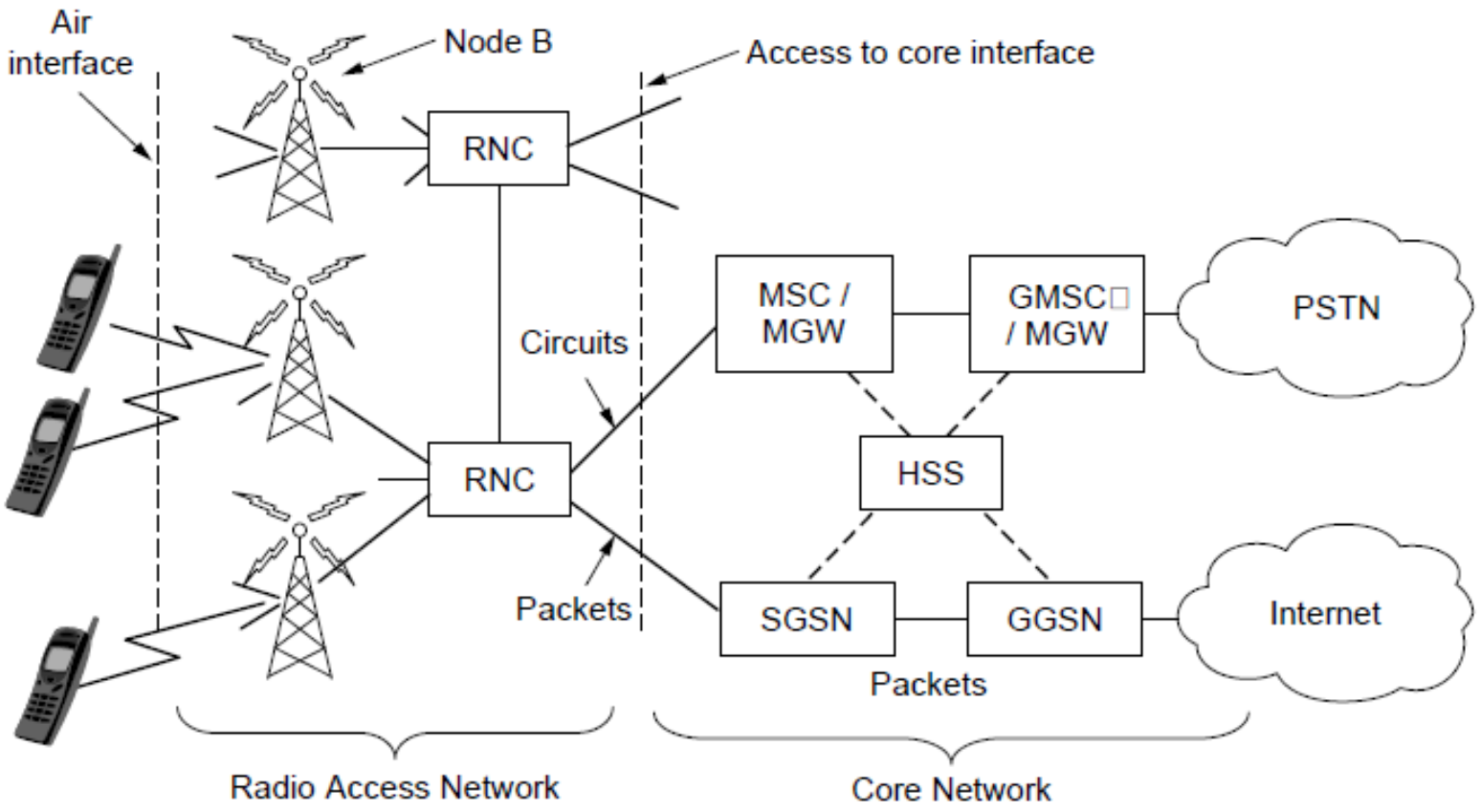
Overview of the Internet architecture

Third-Generation Mobile Phone Networks (1)



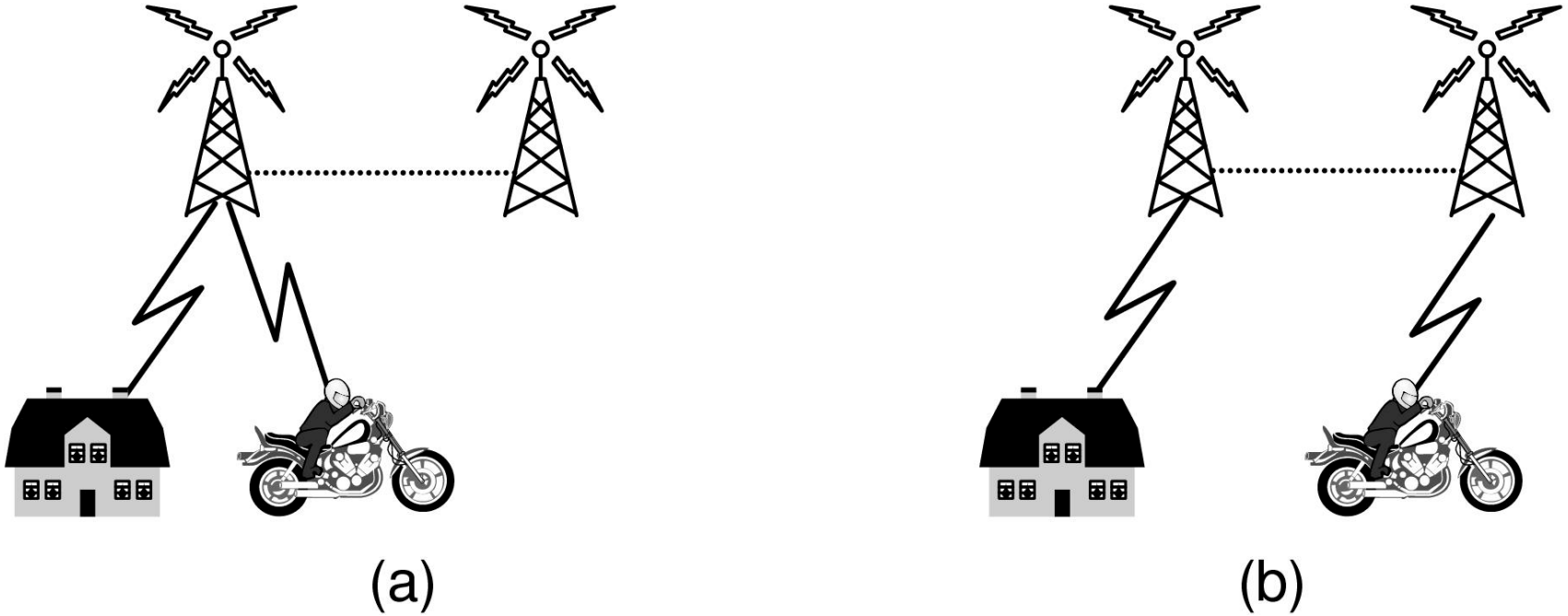
Cellular design of mobile phone networks

Third-Generation Mobile Phone Networks (2)



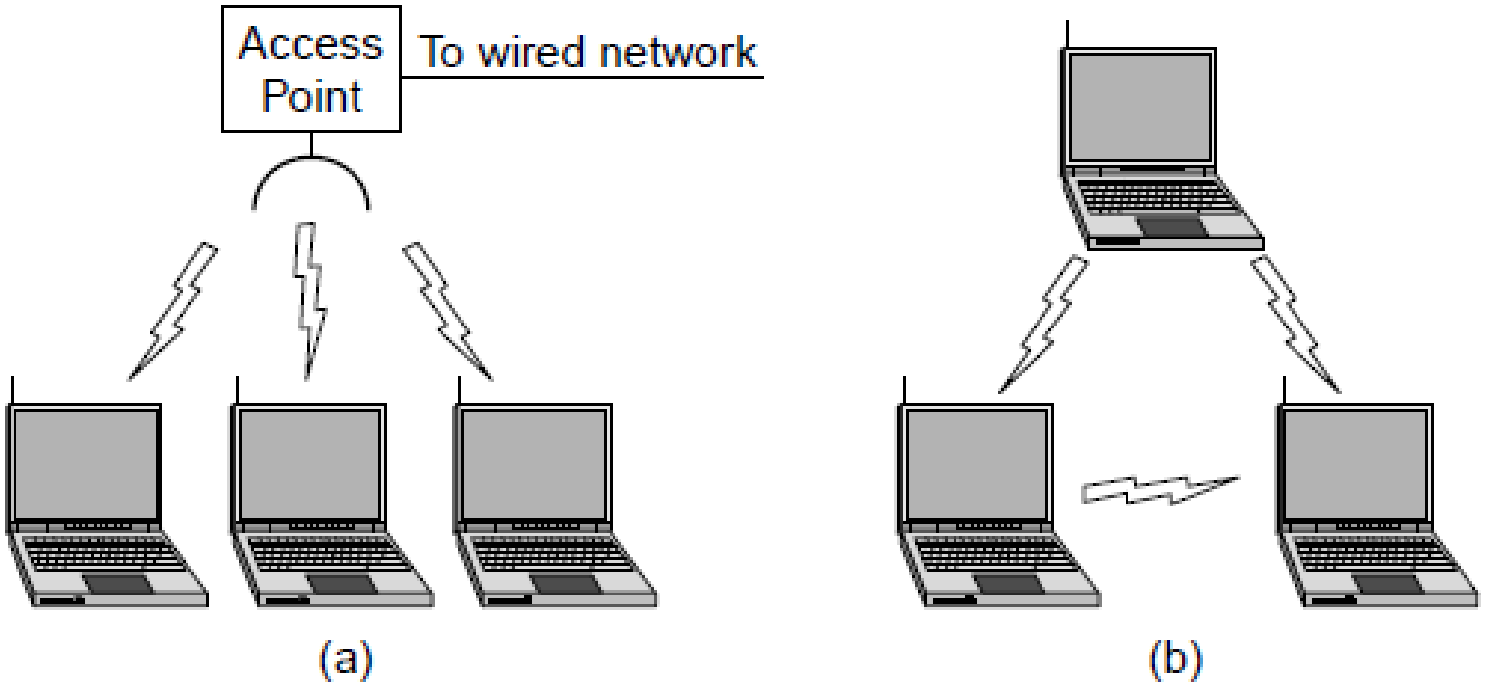
Architecture of the UMTS 3G mobile phone network.

Third-Generation Mobile Phone Networks (3)



Mobile phone handover (a) before, (b) after.

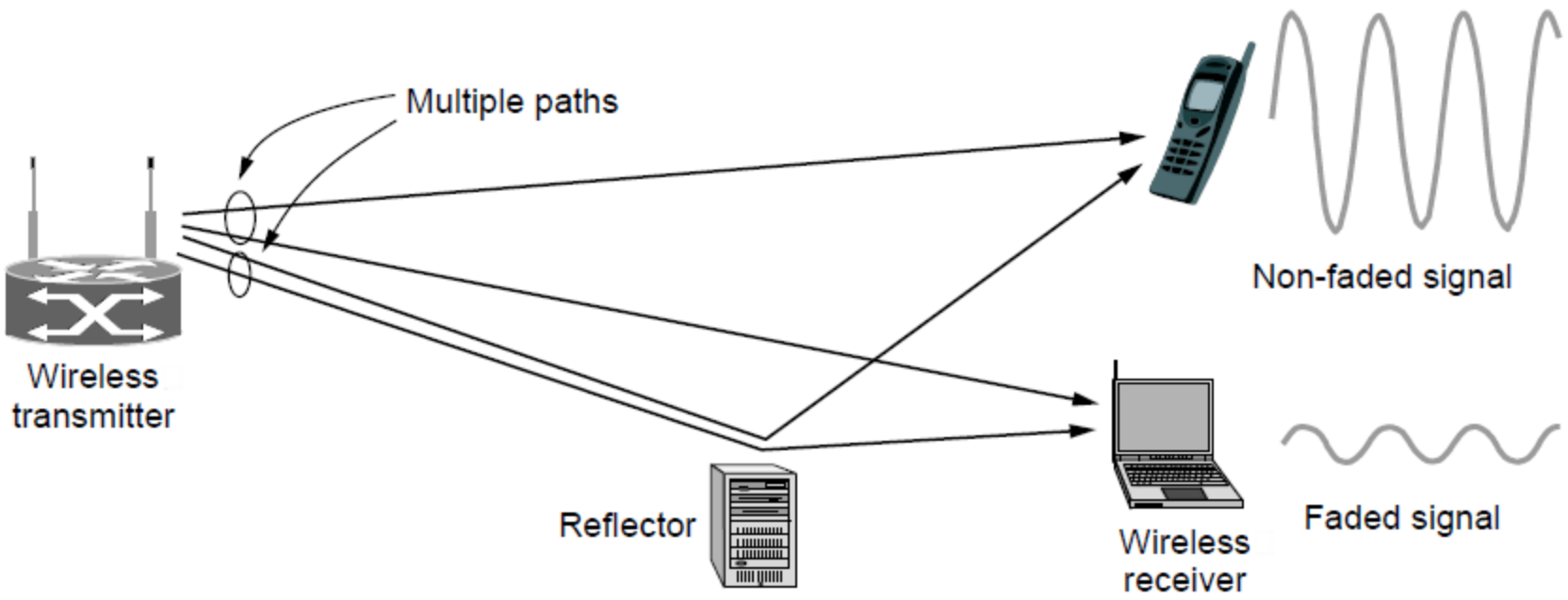
Wireless LANs: 802.11 (1)



(a) Wireless network with an access point.

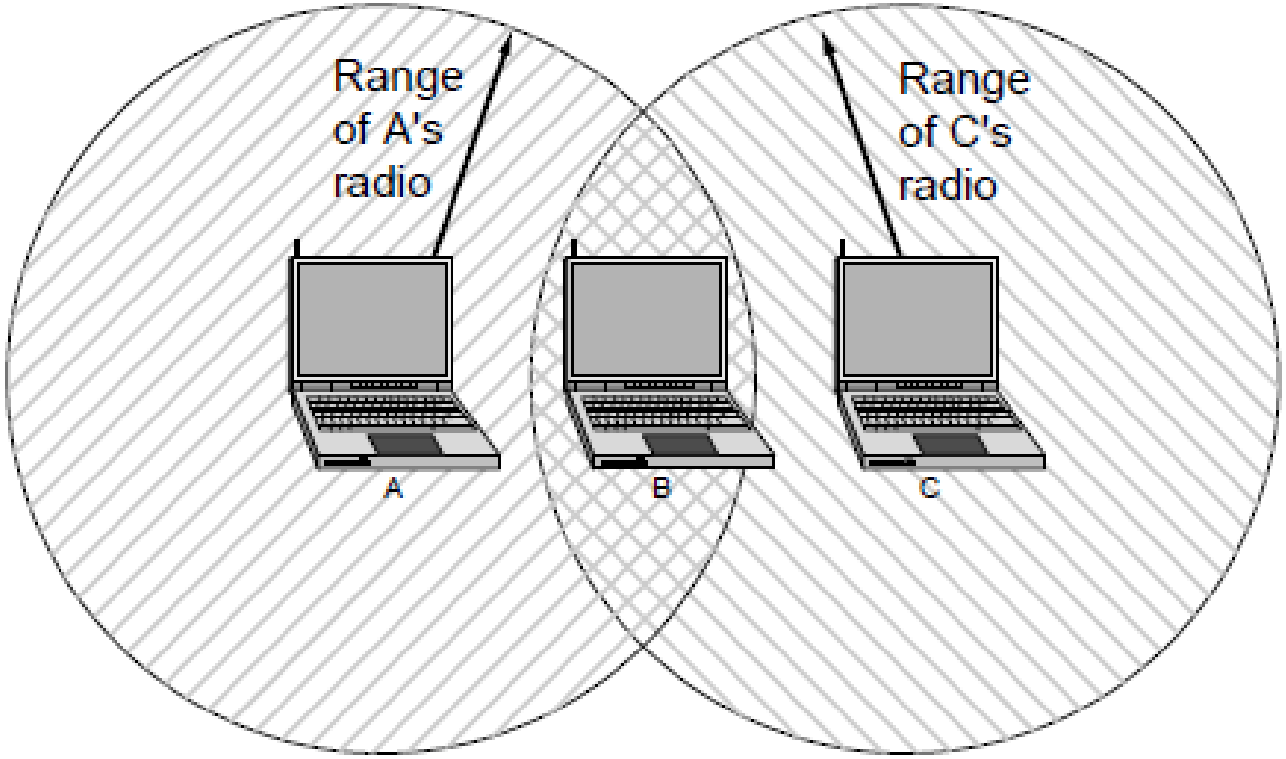
(b) Ad hoc network.

Wireless LANs: 802.11 (2)



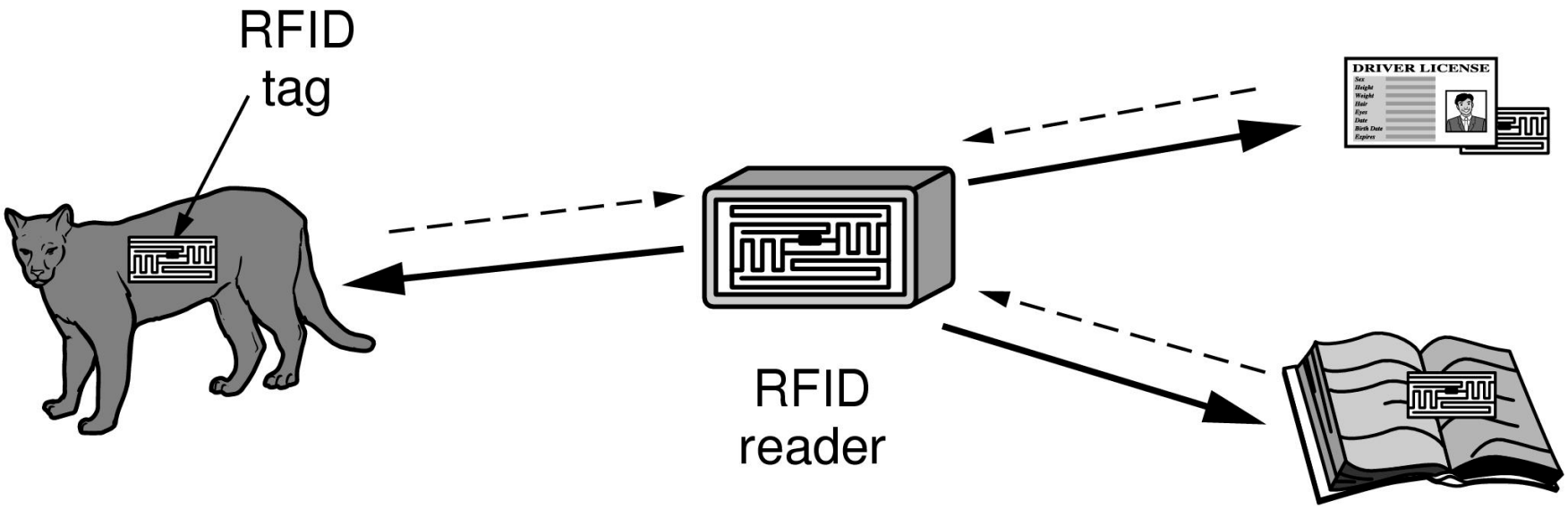
Multipath fading

Wireless LANs: 802.11 (3)



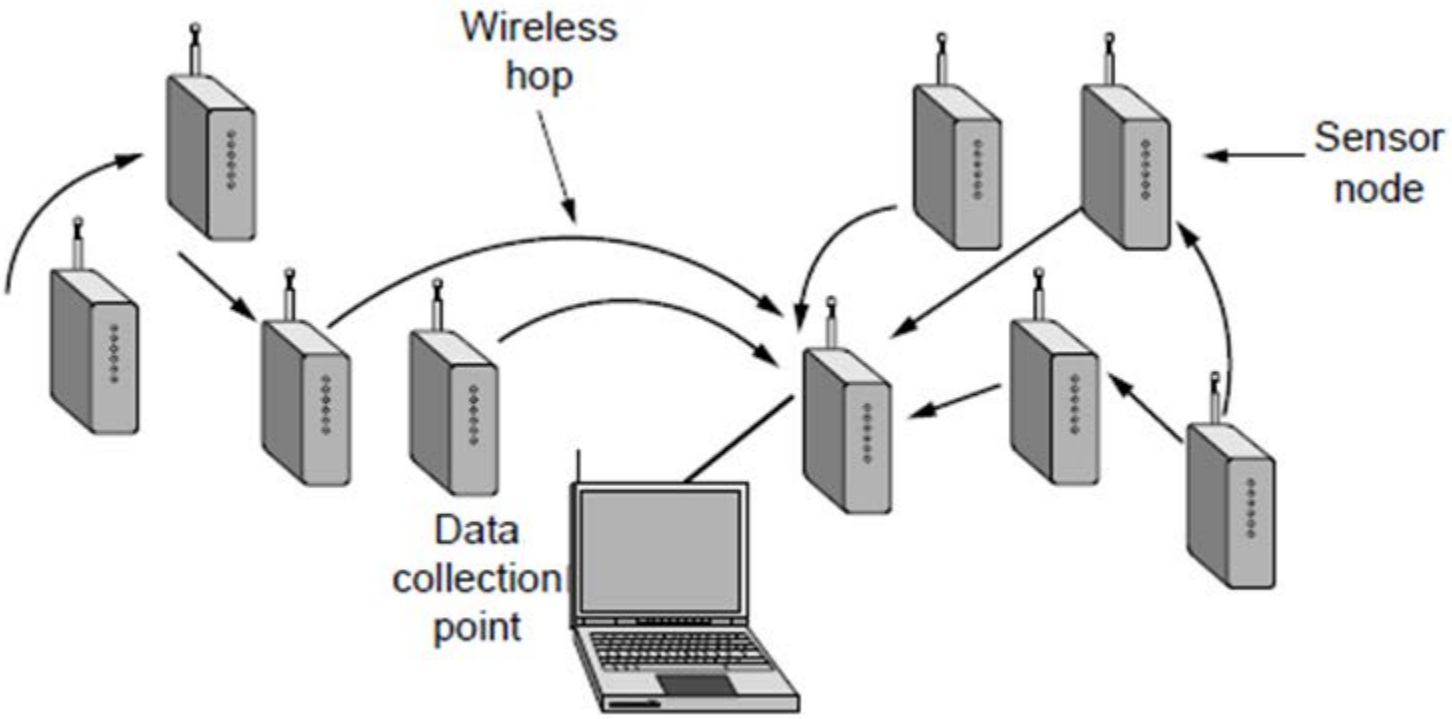
The range of a single radio may not cover the entire system.

RFID and Sensor Networks (1)



RFID used to network everyday objects.

RFID and Sensor Networks (2)



Multihop topology of a sensor network

Network Standardization

- Who's Who in telecommunications
- Who's Who in international standards
- Who's Who in internet standards

Who's Who in International Standards (1)

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 (WiFi)
802.12 ↓	Demand priority (Hewlett-Packard's AnyLAN)

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

Who's Who in International Standards (2)

802.13	Unlucky number; nobody wanted it
802.14 ↓	Cable modems (defunct: an industry consortium got there first)
802.15 *	Personal area networks (Bluetooth, Zigbee)
802.16 *	Broadband wireless (WiMAX)
802.17	Resilient packet ring
802.18	Technical advisory group on radio regulatory issues
802.19	Technical advisory group on coexistence of all these standards
802.20	Mobile broadband wireless (similar to 802.16e)
802.21	Media independent handoff (for roaming over technologies)
802.22	Wireless regional area network

The 802 working groups. The important ones are marked with *.

The ones marked with ↓ are hibernating. The one marked with † gave up and disbanded itself.

Metric Units (1)

Exp.	Explicit	Prefix
10^{-3}	0.001	milli
10^{-6}	0.000001	micro
10^{-9}	0.000000001	nano
10^{-12}	0.000000000001	pico
10^{-15}	0.000000000000001	femto
10^{-18}	0.000000000000000001	atto
10^{-21}	0.000000000000000000001	zepto
10^{-24}	0.000000000000000000000001	yocto

The principal metric prefixes

Metric Units (2)

Exp.	Explicit	Prefix
10^3	1,000	Kilo
10^6	1,000,000	Mega
10^9	1,000,000,000	Giga
10^{12}	1,000,000,000,000	Tera
10^{15}	1,000,000,000,000,000	Peta
10^{18}	1,000,000,000,000,000,000	Exa
10^{21}	1,000,000,000,000,000,000,000	Zetta
10^{24}	1,000,000,000,000,000,000,000,000	Yotta

The principal metric prefixes

End

Chapter 1