LAKIREDDY BALI REDDY COLLEGE OF ENGINEERING

(AUTONOMOUS)

ACCREDITED BY NAAC & NBA (CSE, IT, ECE, EEE&ME)

APPROVED BY AICTE, NEW DELHI AND AFFILIATED TO JNTUK, KAKINADA

L.B.REDDY NAGAR, MYLAVARAM-521230, KRISHNA DIST., ANDHRA PRADESH, INDIA

Data Communication and Computer Networks

Dr. P. Lachi Reddy

Professor in ECE,

Lakireddy Bali Reddy College of Engineering, Mylavaram

Books

TEXT BOOKS

Tanenbaum and Wetherall, “Computer Networks”, Pearson Education, Fifth Edition.

Behrouz. A. Forouzan, “Data Communication and Networking”, Fourth Edition, Tata McGraw-hill, New Delhi, 2006

REFERENCE BOOKS

S.Keshav,” An Engineering Approach to Computer Networks”, Pearson Education, 2nd Edition,

W.A.Shay,”Understanding communications and Networks”, Cengage Learning, 3rd Edition

Chwan-Hwa (John) Wu, J. David Irwin,” Introduction to Computer Networks and Cyber Security”, CRC Press.

L.L.Peterson and B.S.Davie,” Computer Networks”, ELSE VIER, 4th edition.

Course Outcomes

- **Understand** the functions of the OSI, TCP/IP reference models.
- **Summarize** design issues for layer protocols.
- **Examine** the routing algorithms to find shortest paths for packet delivery.
- **Interpret** the operations of application layer protocols.

UNIT - 1

- Introduction
- Physical Layer

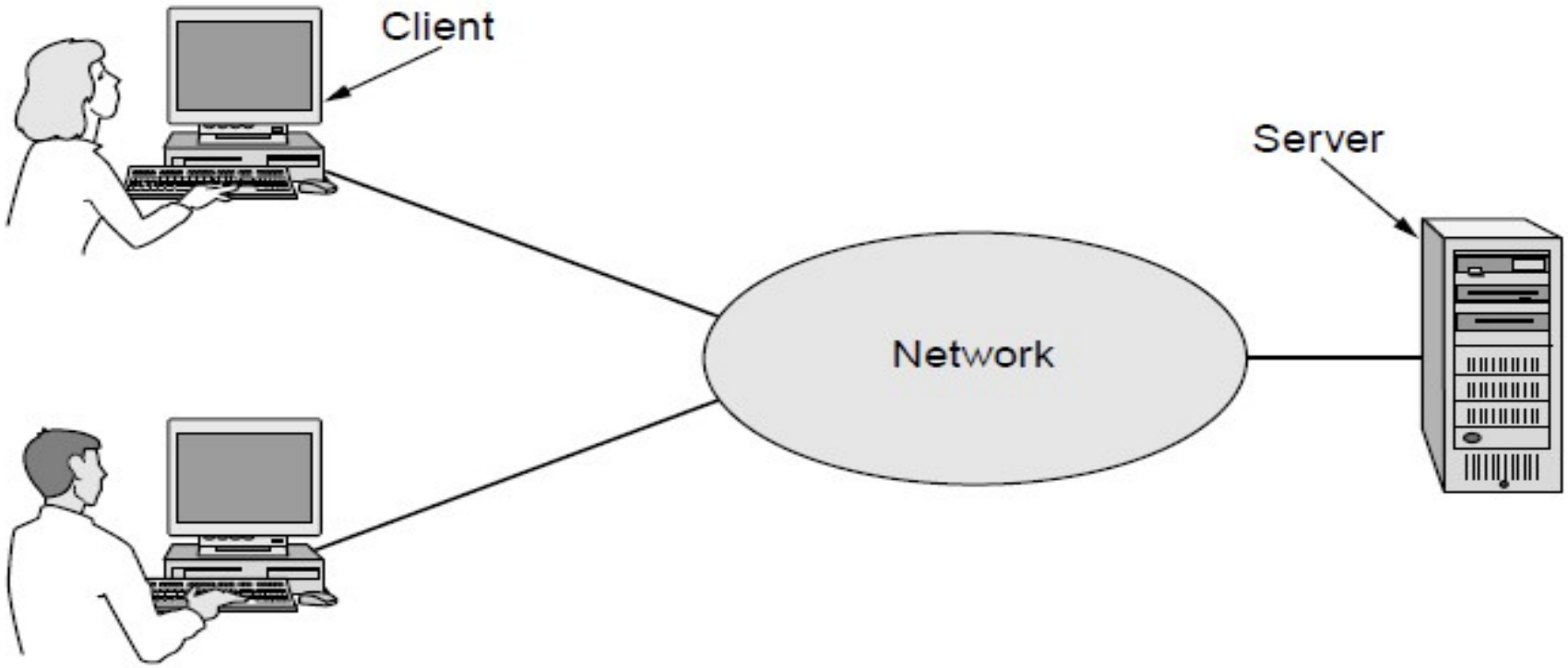
Introduction

- Uses of Computer Networks
- Network Hardware
- Network Software
- Reference Models
- OSI Reference Model
- TCP/IP Model
- Comparison between OSI and TCP/IP
- Critique of the OSI Reference Model and TCP/IP Model

Uses of Computer Networks

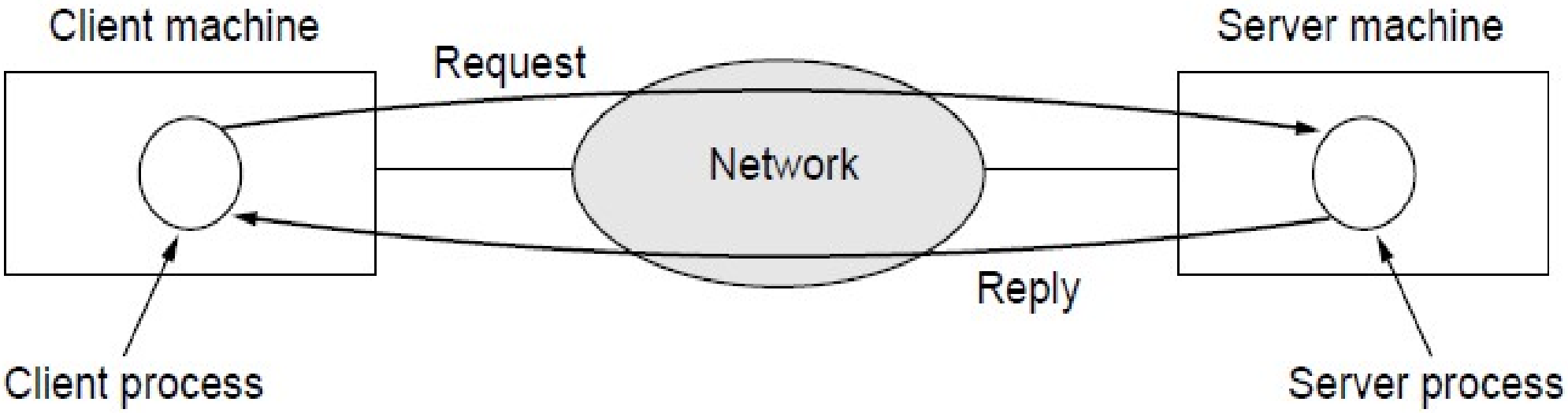
- Business Applications
- Home Applications
- Mobile Users
- Social Issues

Business Applications (1)



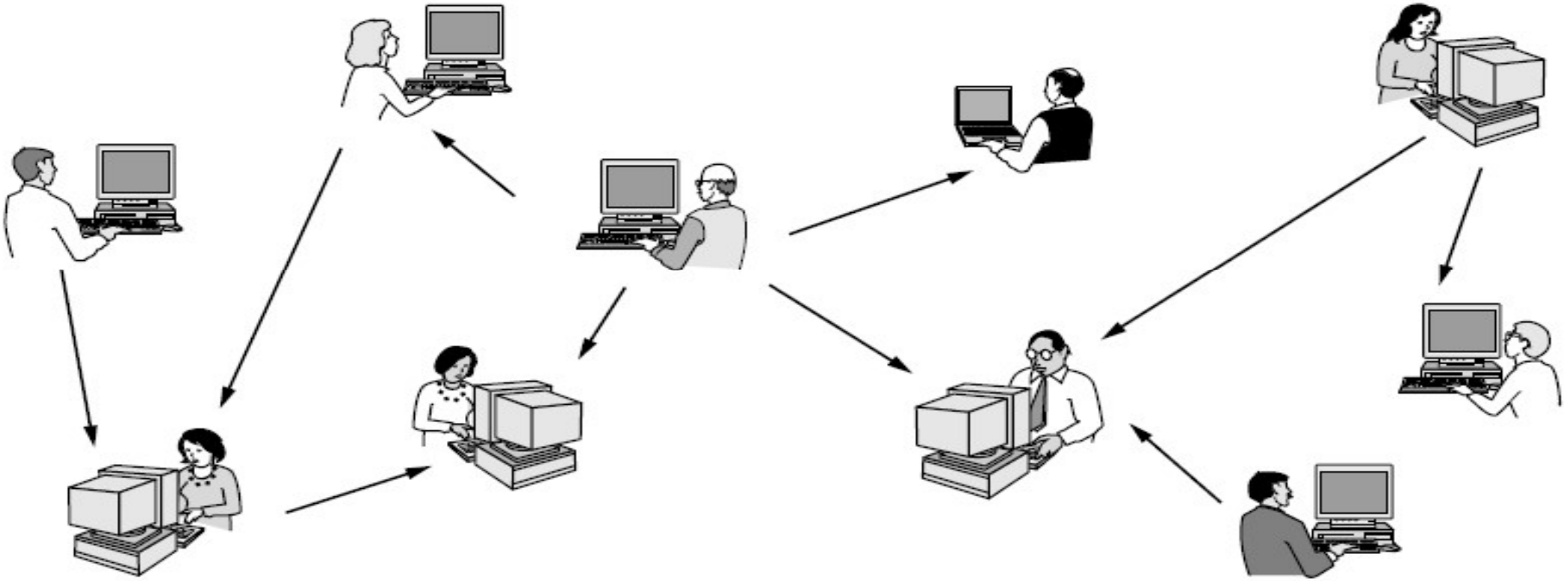
A network with two clients and one server

Business Applications (2)



The client-server model involves requests and replies

Home Applications (1)



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

Home Applications (2)

Tag	Full name	Example
2C	Business-to-consumer	Ordering books online
2B	Business-to-business	Car manufacturer ordering tires from supplier
G2C	Government-to-consumer	Government distributing tax forms electronically
2C	Consumer-to-consumer	Auctioning second-hand products online
2P	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

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

Network Hardware (1)

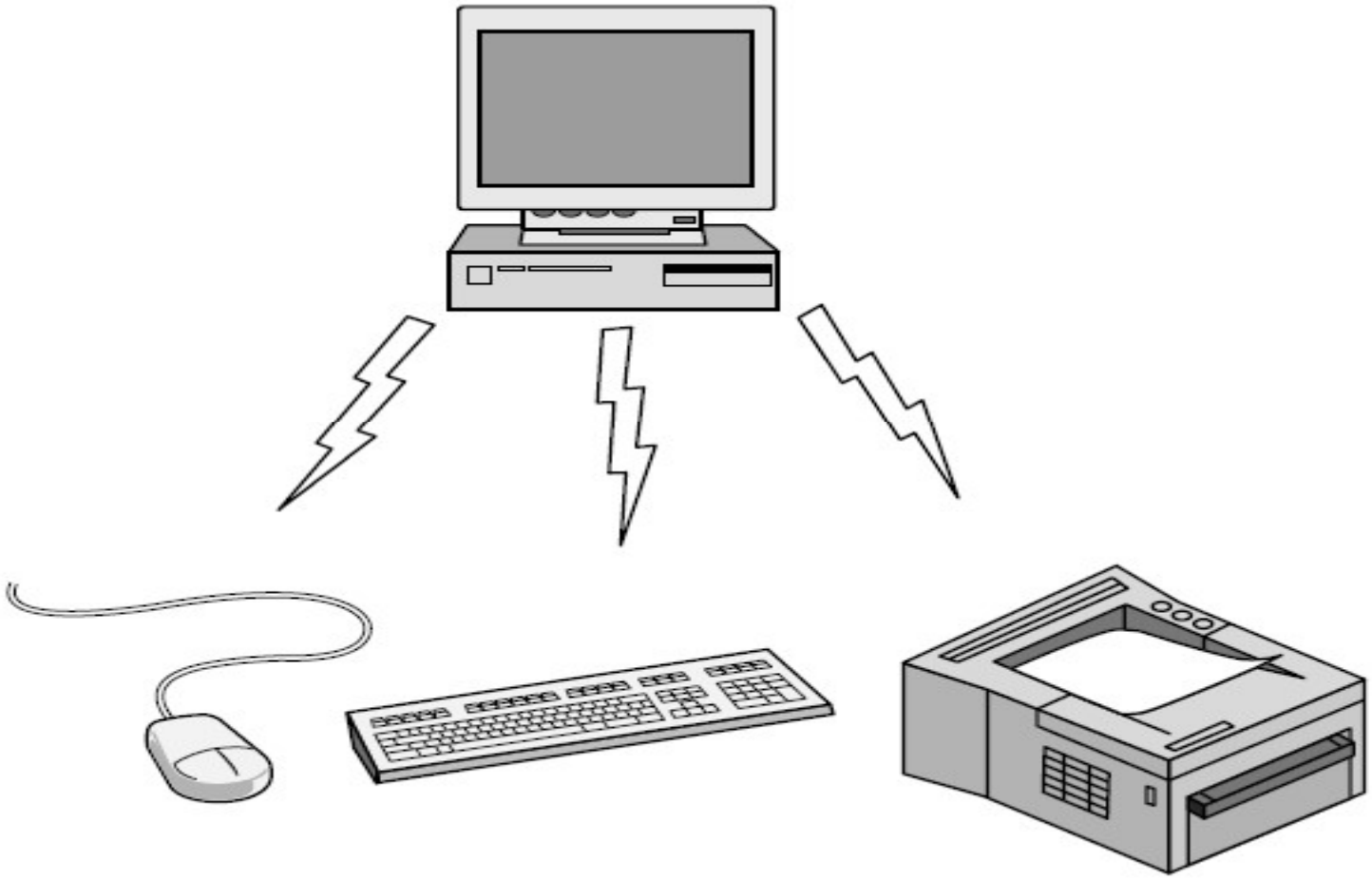
- Personal area networks
- Local area networks
- Metropolitan area networks
- Wide area networks
- The internet

Network Hardware (2)

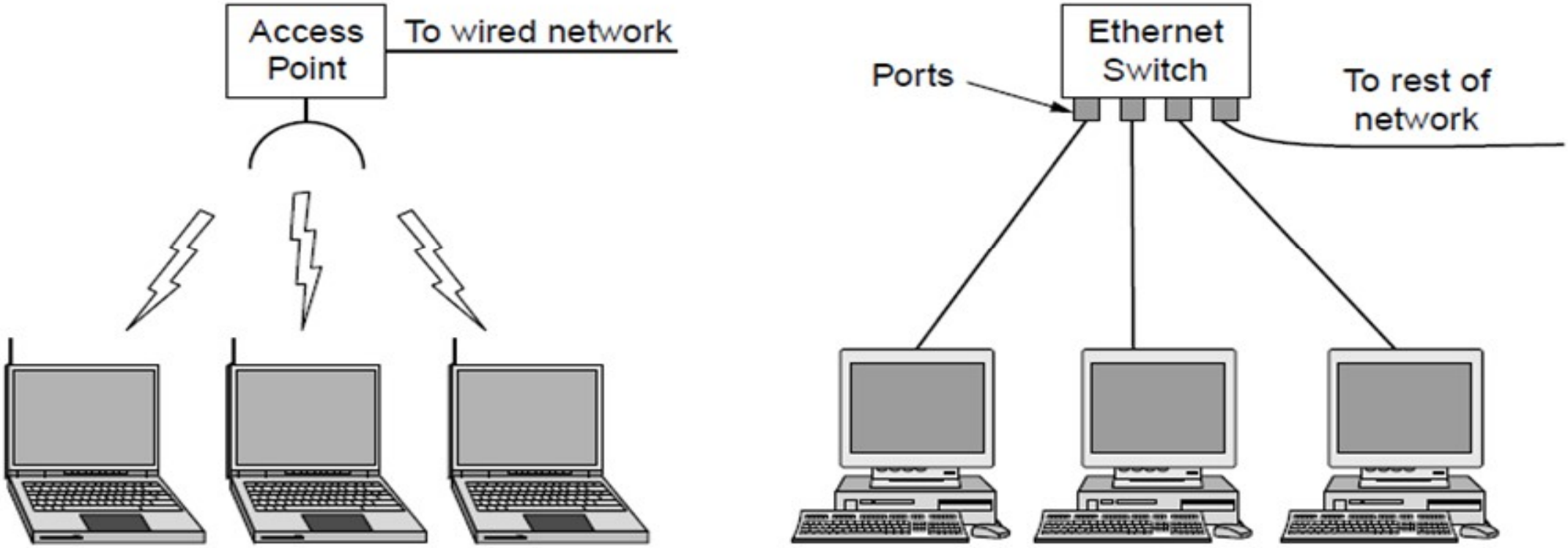
Classification of interconnected processors by scale.

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

Personal Area Network

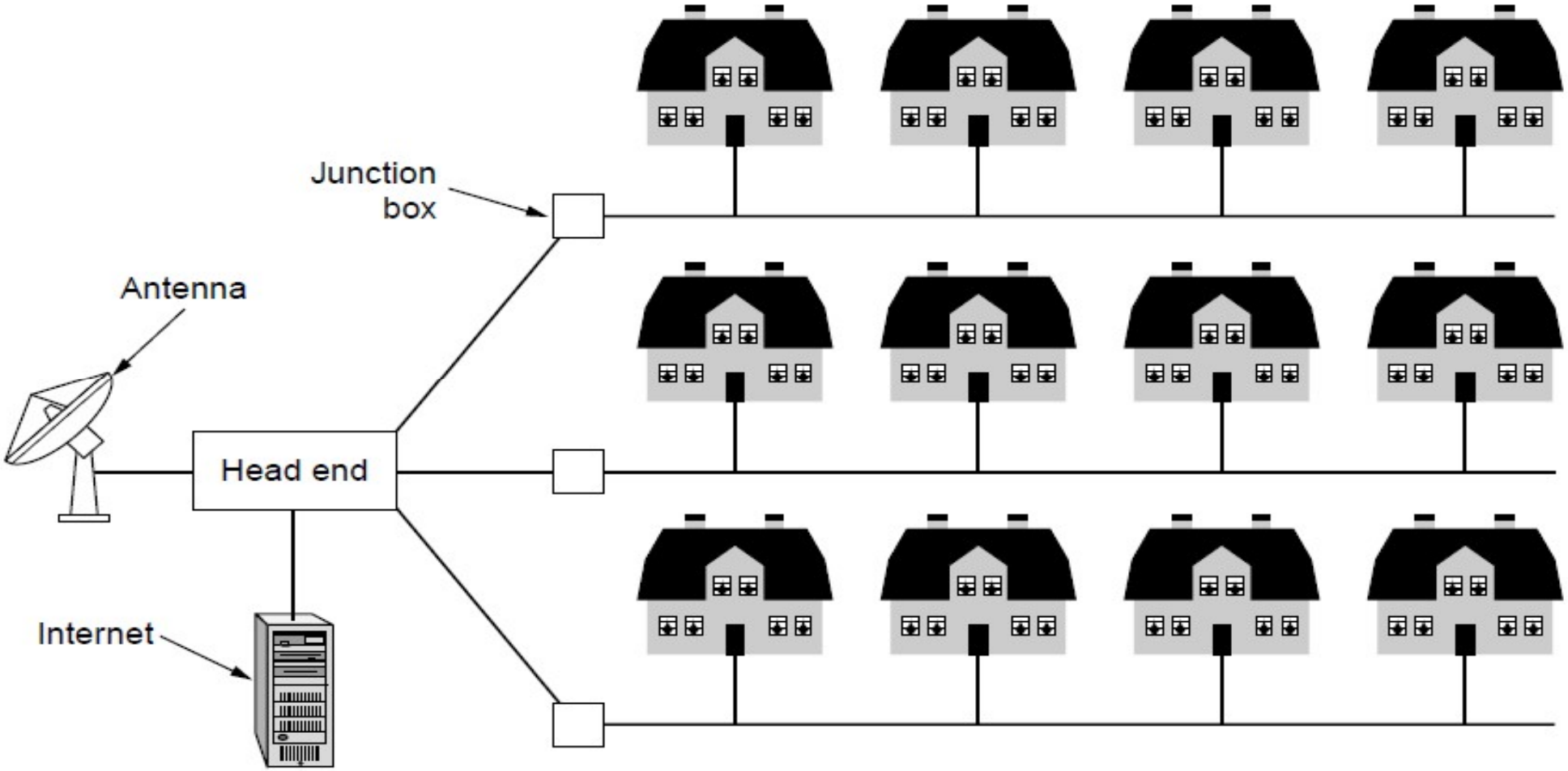


Local Area Networks



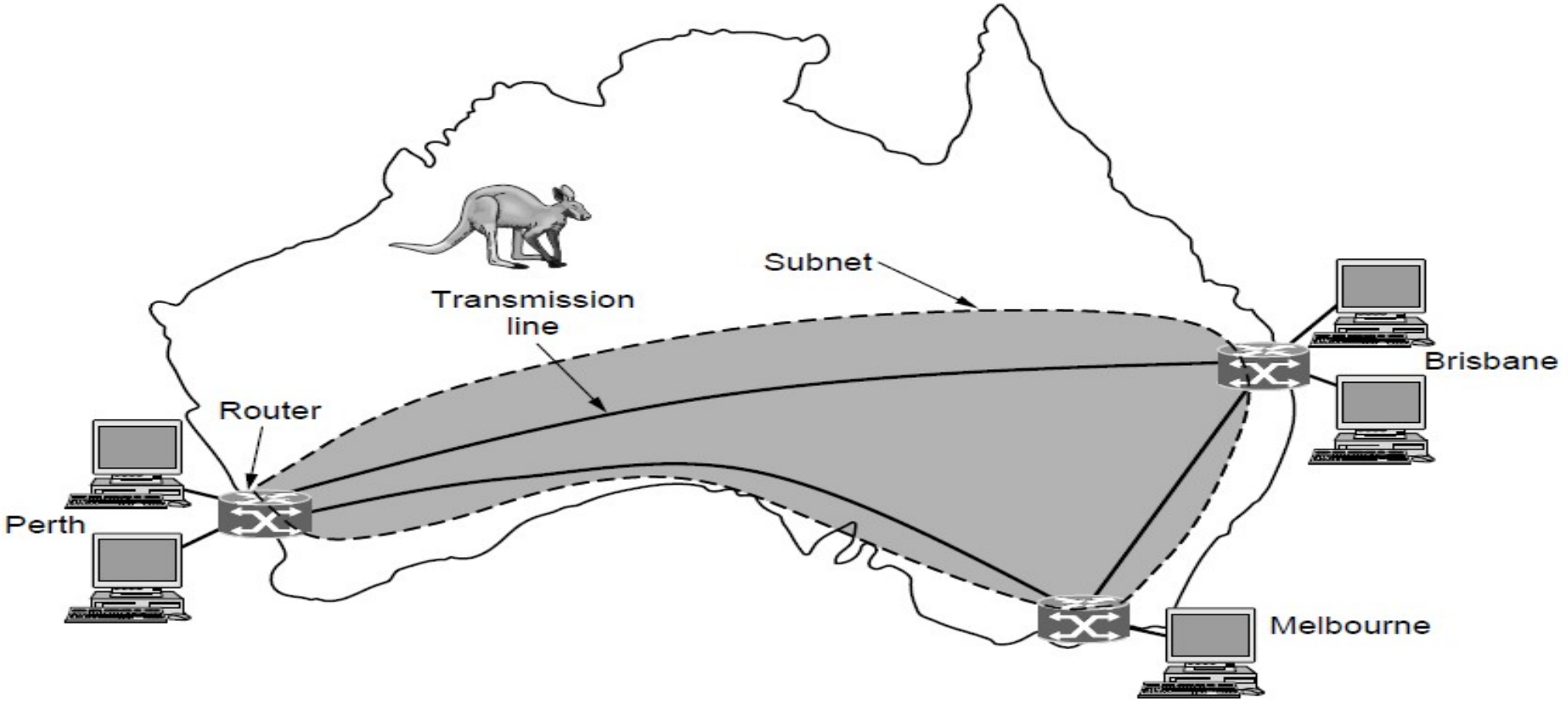
Wireless and wired LANs. (a) 802.11. (b) Switched Ethernet.

Metropolitan Area Networks



A metropolitan area network based on cable TV.

Wide Area Networks

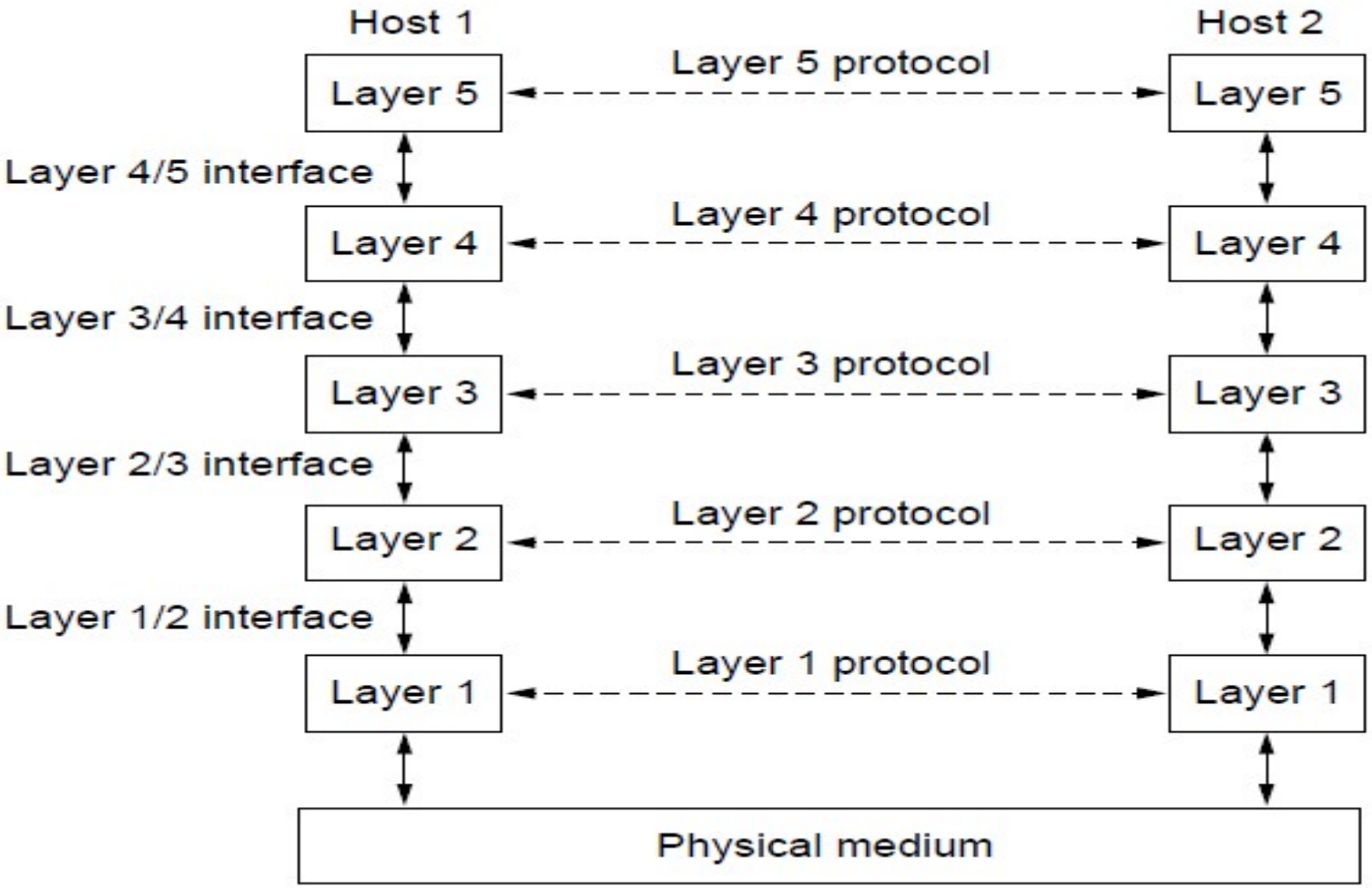


WAN that connects three branch offices in Australia

Network Software

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

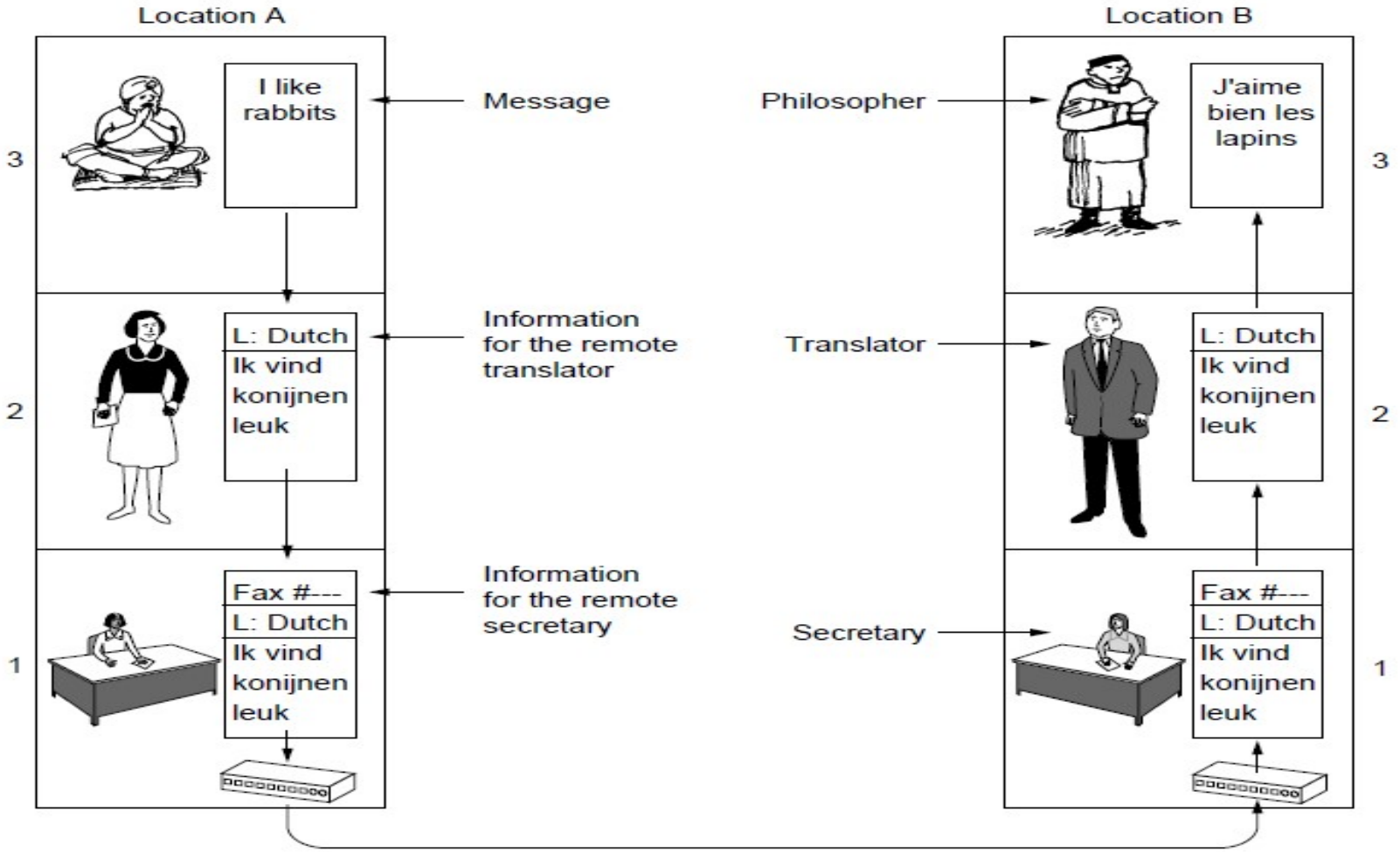
Protocol Hierarchies (1)



Layers, protocols, and interfaces.

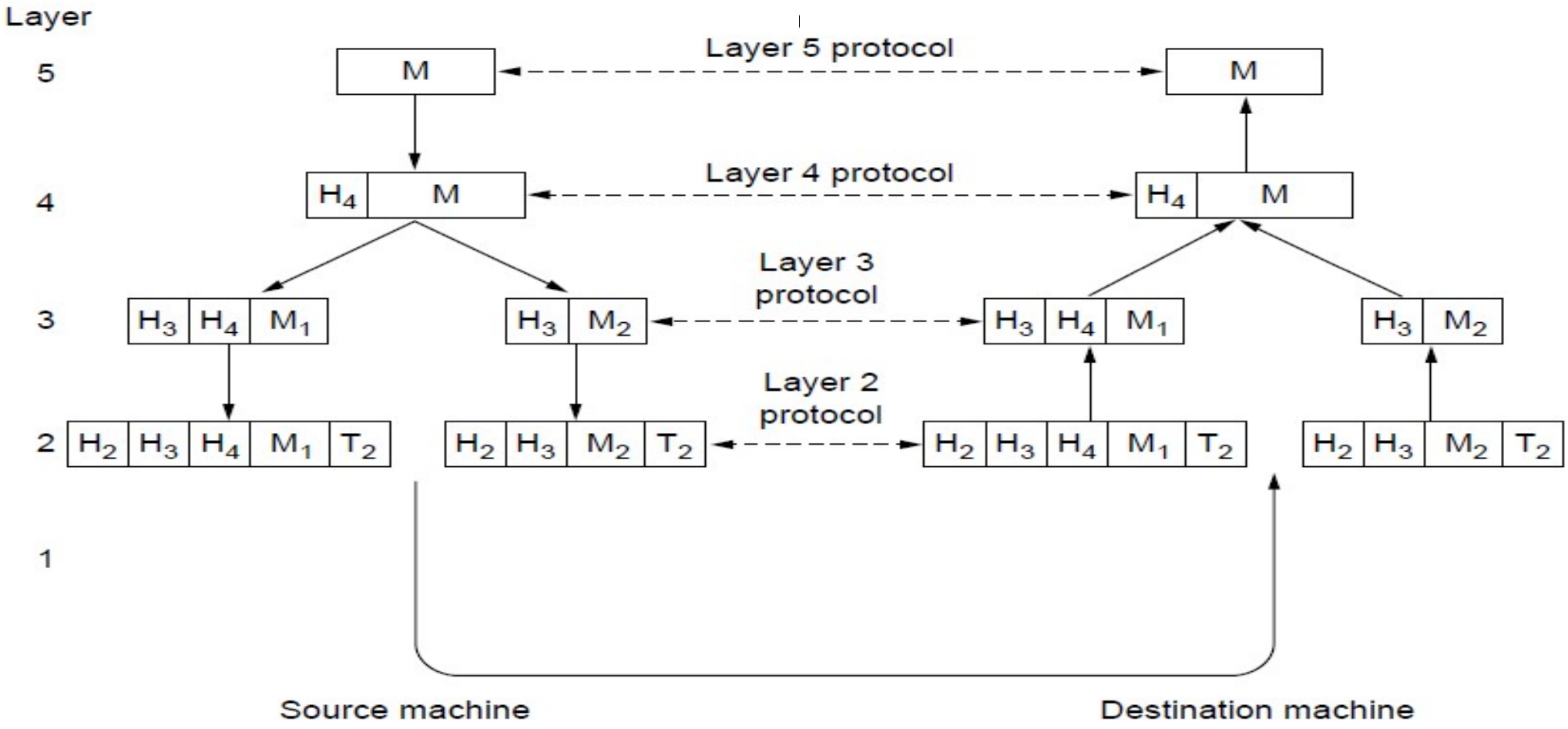
Protocol Hierarchies (2)

The philosopher-translator-secretary architecture



Protocol Hierarchies (3)

Example information flow supporting virtual



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
Connection-less	Unreliable datagram	Electronic junk mail
	Acknowledged datagram	Text messaging
	Request-reply	Database query

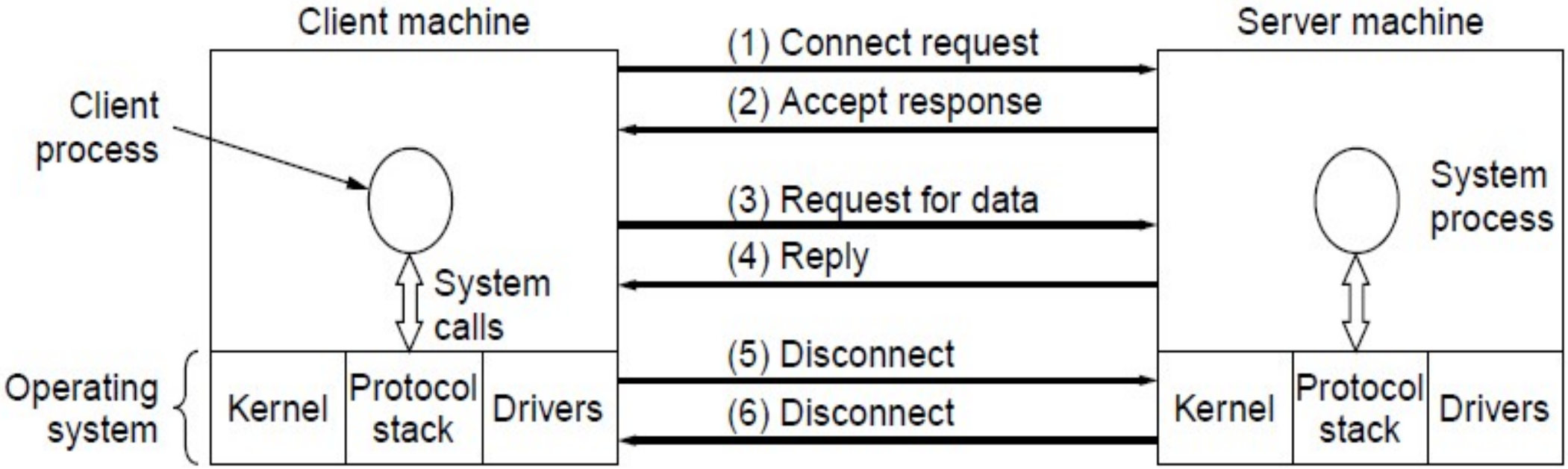
Six different types of service.

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

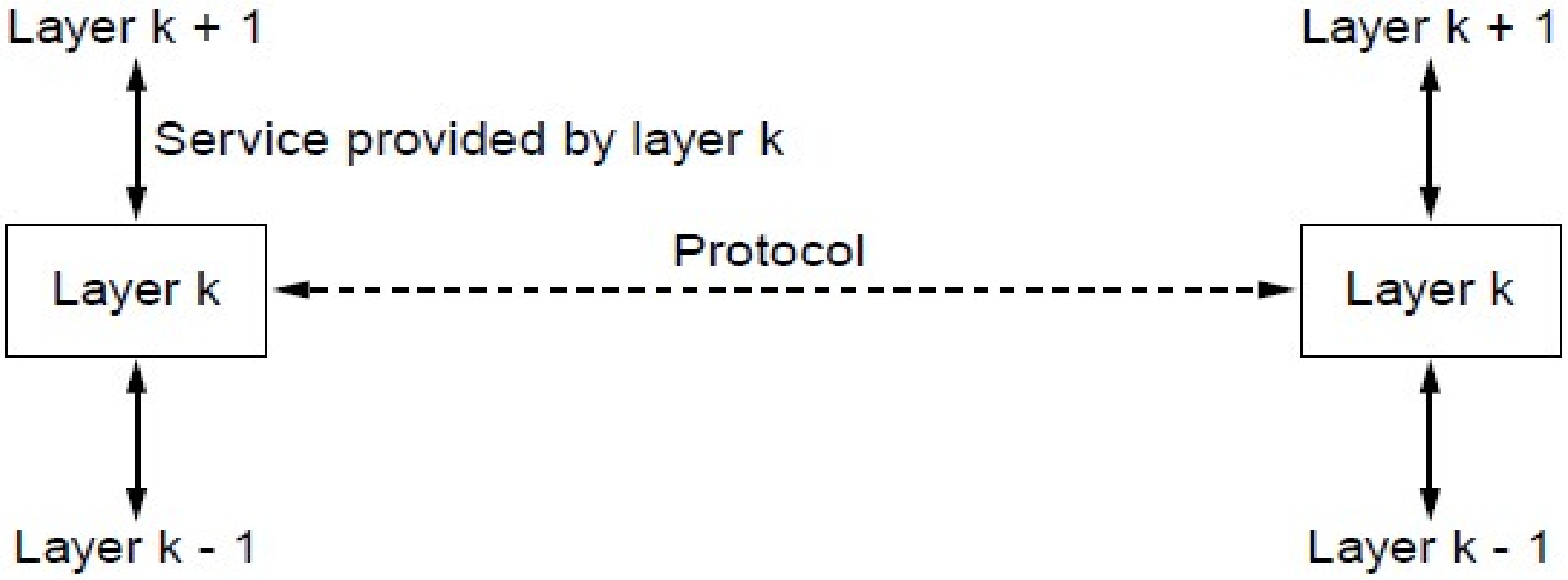
Six service primitives that provide a simple connection-oriented service

Service Primitives (2)



A simple client-server interaction using acknowledged datagrams.

The Relationship of Services to Protocols



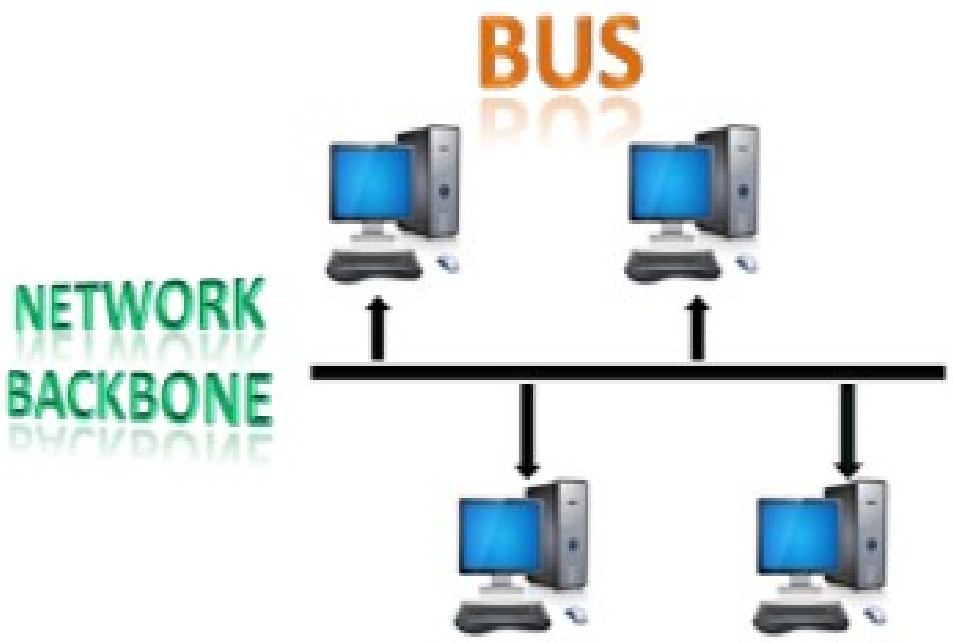
The relationship between a service and a protocol.

Network Topologies

- Bus Topology
- Star Topology
- Tree Topology
- Ring Topology
- Mesh Topology
- Hybrid Topology

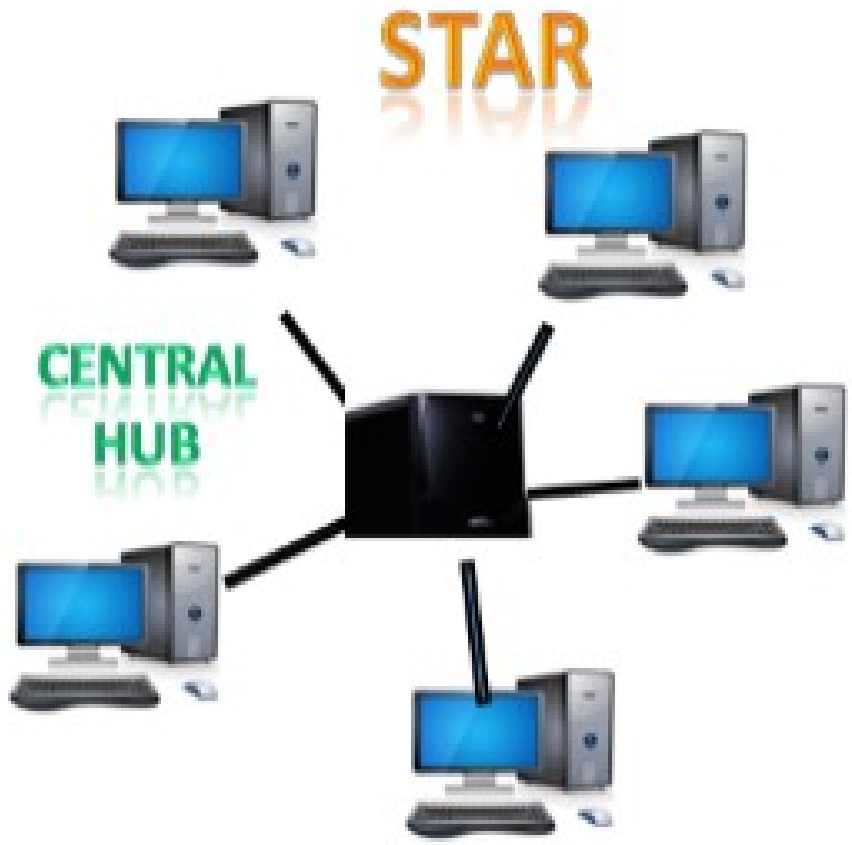
BUS TOPOLOGY

- Advantages:
  - Low cost
  - Familiar Technology
  - Node failure will not affect the other nodes
- Disadvantages:
  - Difficult Troubleshooting
  - Reconfiguration



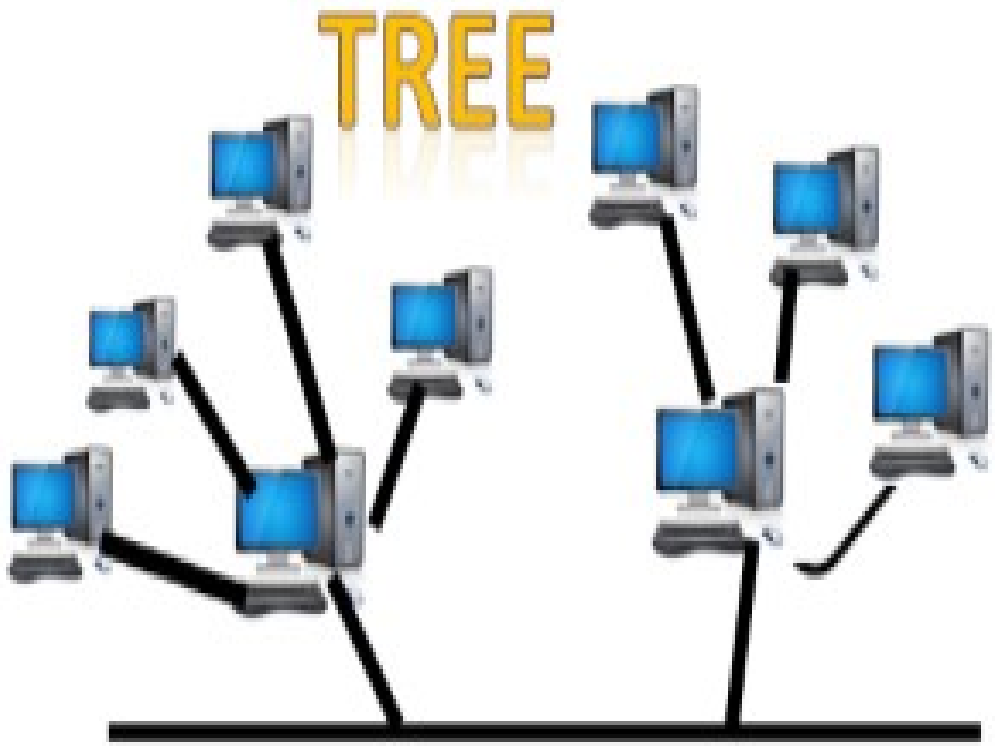
STAR TOPOLOGY

- Advantages:
  - Easy Troubleshooting
  - Familiar Technology
  - Easy Reconfiguration
  - High Data Speed
- Disadvantages:
  - Central point failure
  - More cost compared to Bus topology



TREE TOPOLOGY

- Advantages:
  - Easy expansion
  - Limited failure
- Disadvantages:
  - Difficult Troubleshooting
  - High cost

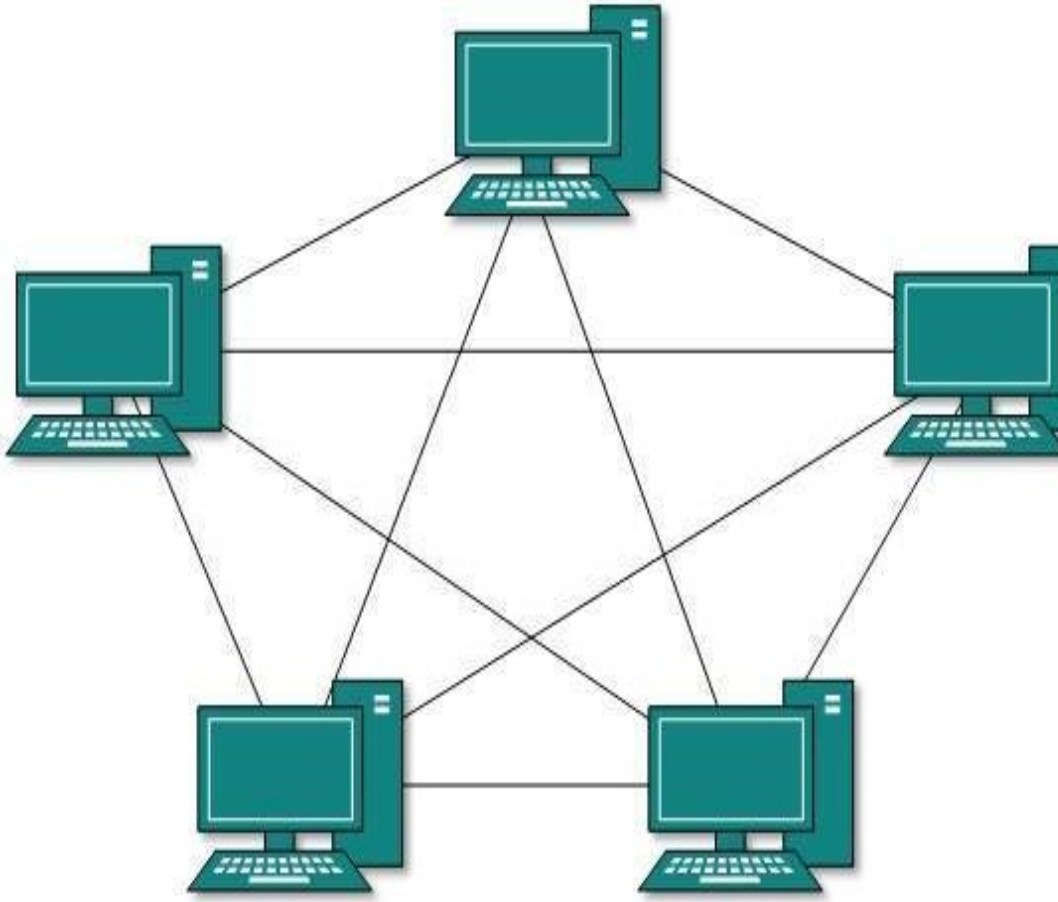


RING TOPOLOGY

- Advantages:
  - Low cost
  - No collisions
- Disadvantages:
  - Difficult Troubleshooting
  - Reconfiguration
  - Delay

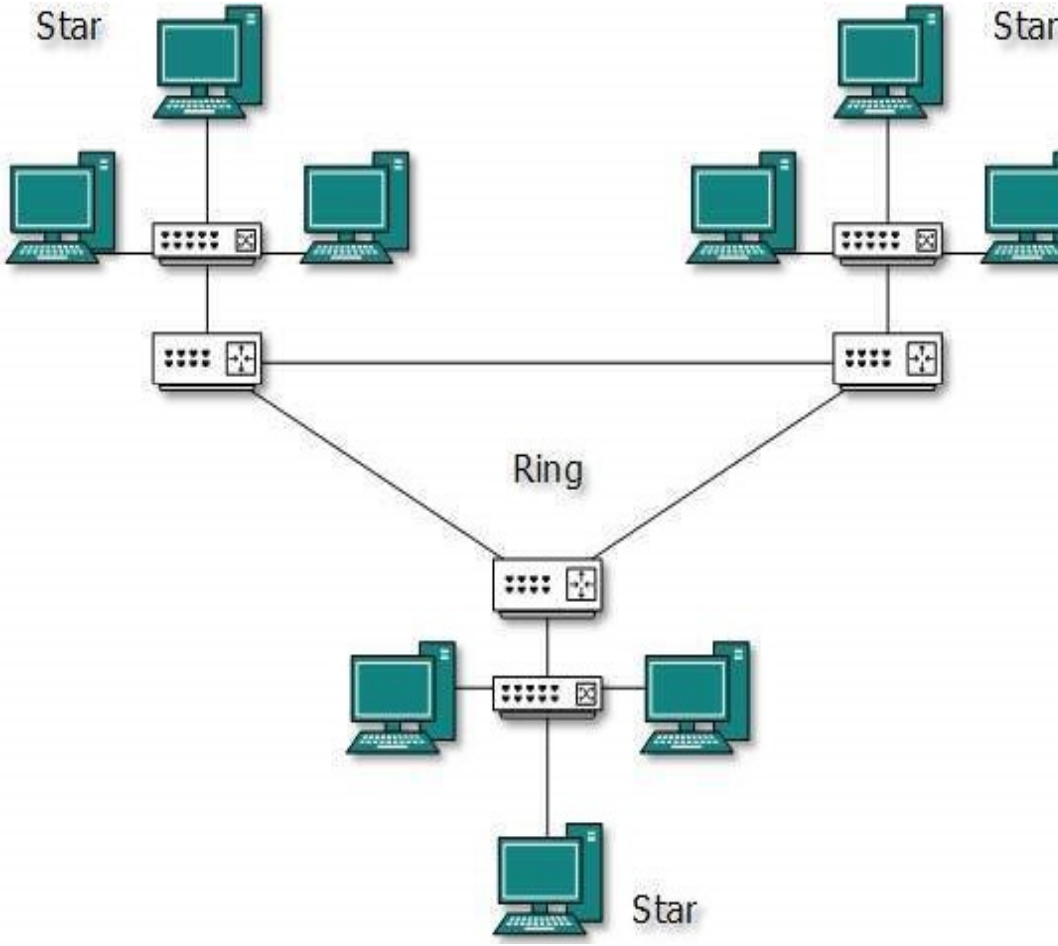
MESH TOPOLOGY

- Advantages:
  - Reliable
  - Fast communication
- Disadvantages:
  - High cost
  - Difficult Management
  - N*(N-1) ports are needed
  - N*(N-1)/2 links are needed



HYBRID TOPOLOGY

- Advantages:
  - Flexible
  - Easy Scalable
- Disadvantages:
  - High cost
  - Complex Design



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

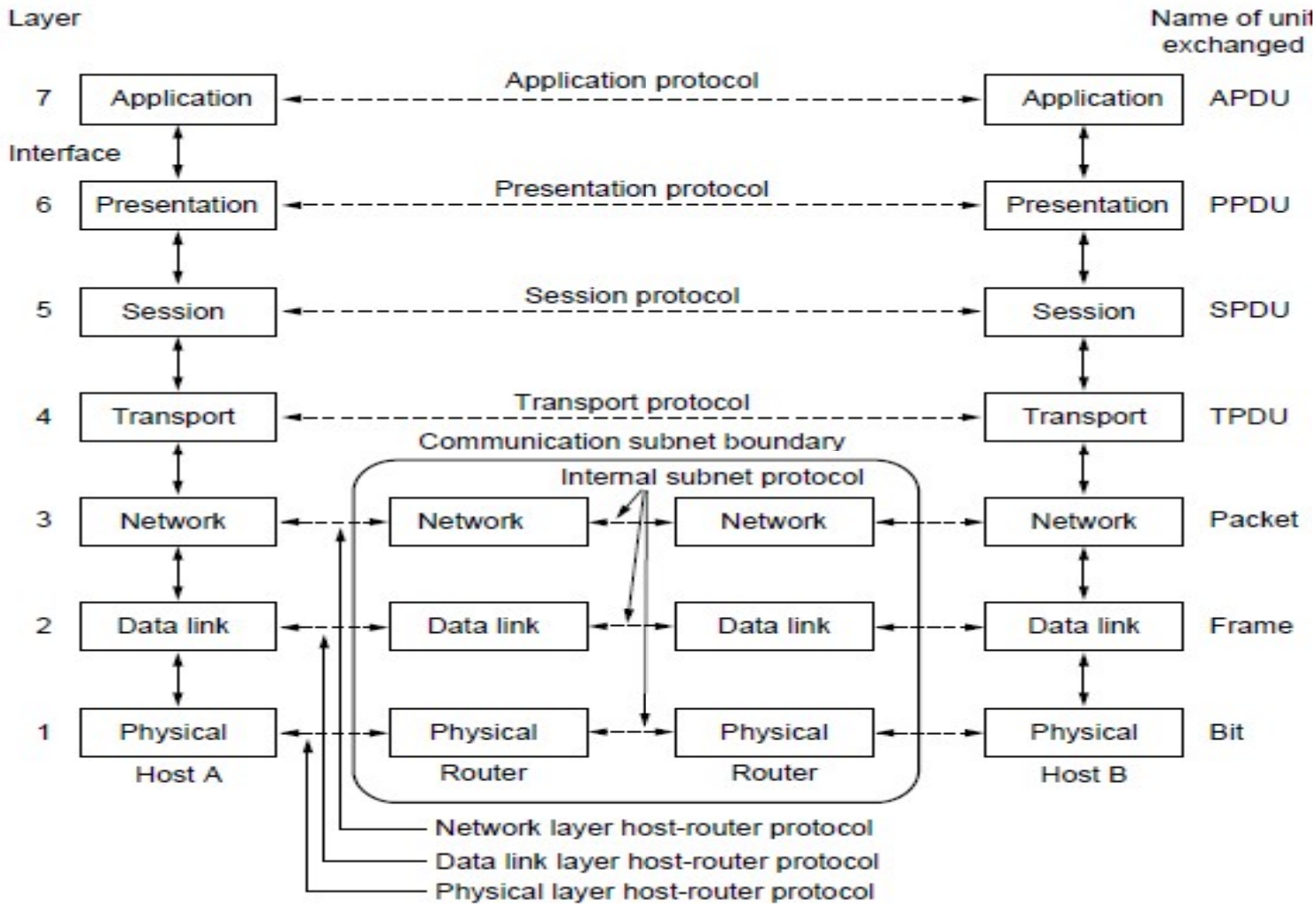
Principles for the seven layers

- 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

OSI Reference Model Layers

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

The OSI Reference Model



The OSI reference model

Physical Layer

- Information is transmitted as bit stream.
- Deals with Electrical and Mechanical properties of the devices.

Data Link Layer

- Information in terms of Frames
- 48 bit MAC or Physical Address
- Acknowledgement
- Flow Control
- Error Control

Network Layer

- Packets
- IPv4: 32 bit IP Address
- IPv6: 128 bit IP Address
- Routing: Static, Dynamic
- Circuit Switching – Connection oriented
- Packet Switching – Connectionless

Transport Layer

- Datagrams
- 16 bit Port Address
- Sequencing
- Flow Control
- Error Control

Session Layer

- Session Management:
  - Session duration
  - Amount of data exchanged
- Token Management

Presentation Layer

- Format Translations
- Encoding and Decoding

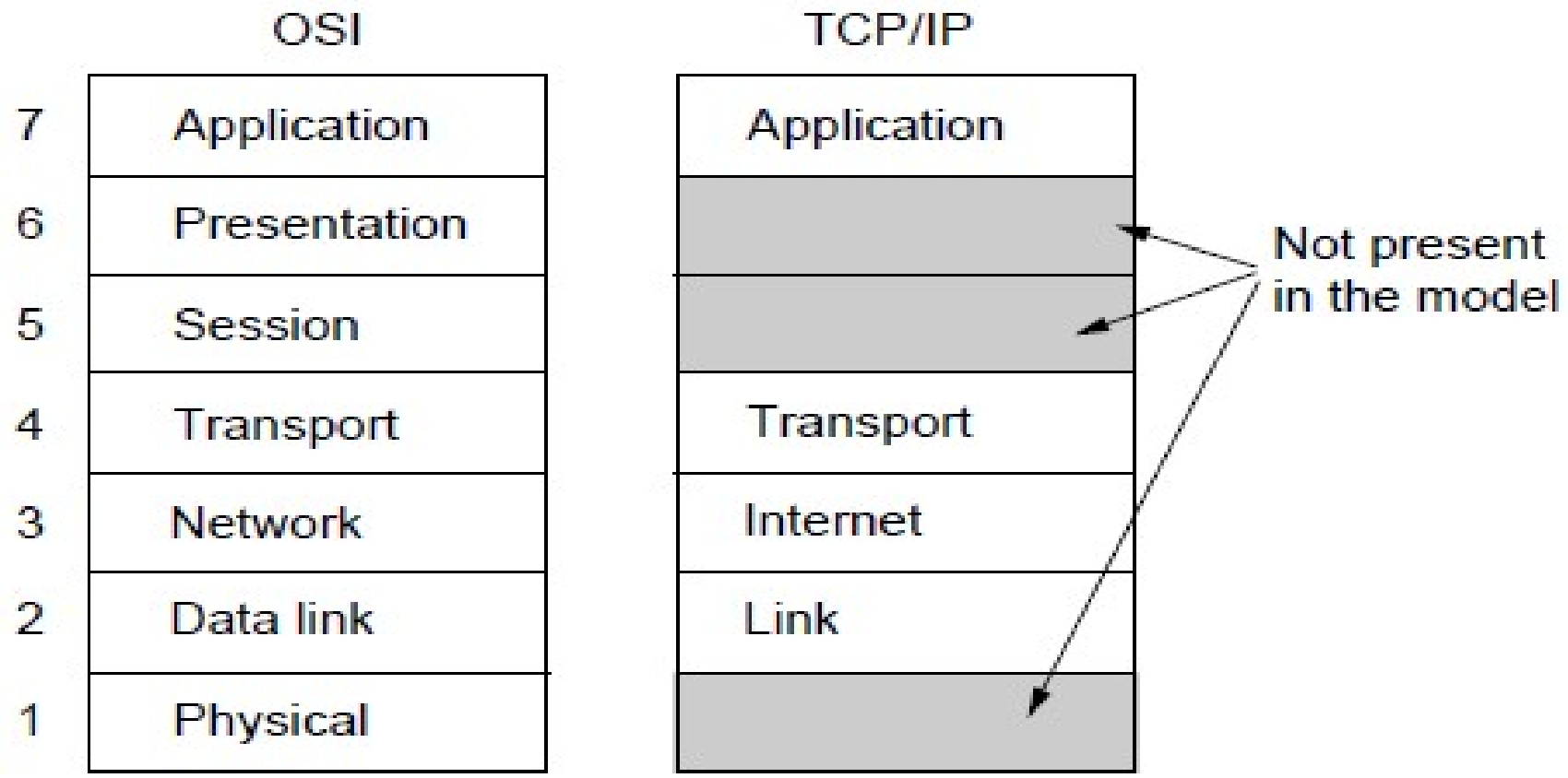
Application Layer

- Data creation, manipulation
- Access to Web page
- Uploading/Downloading a file

The TCP/IP Reference Model Layers

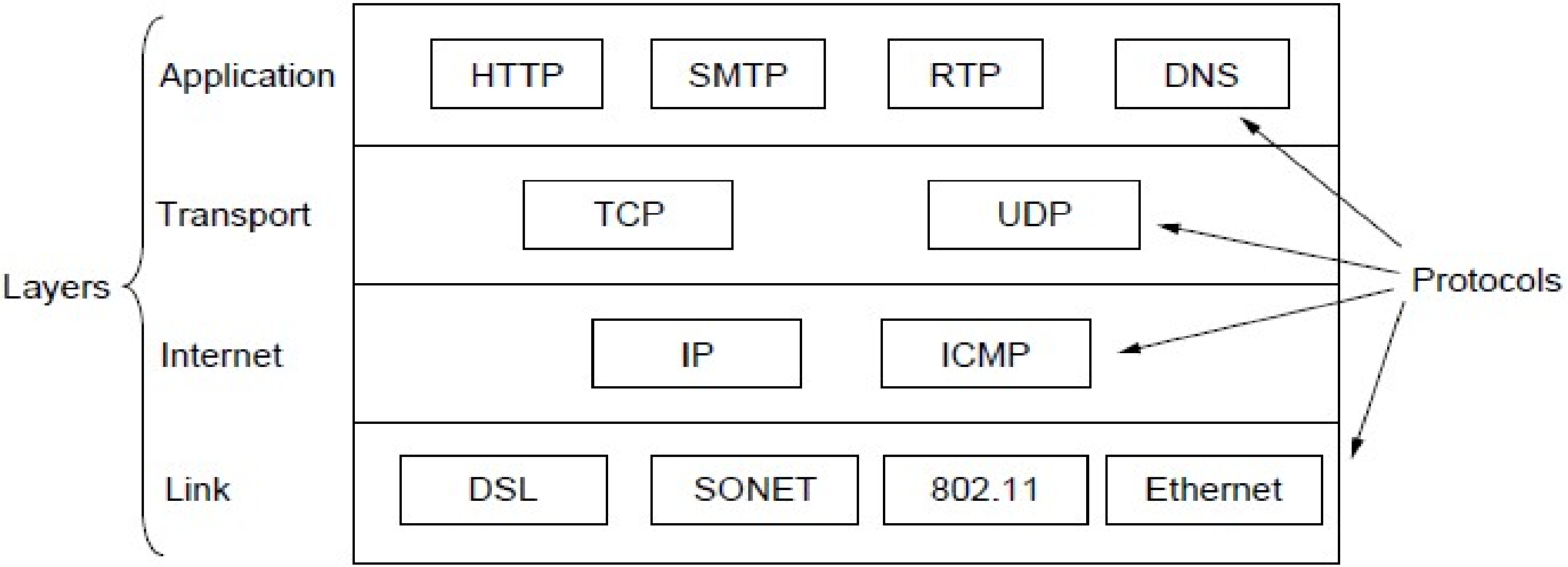
- Link layer
- Internet layer
- Transport layer
- Application layer

The TCP/IP Reference Model (1)



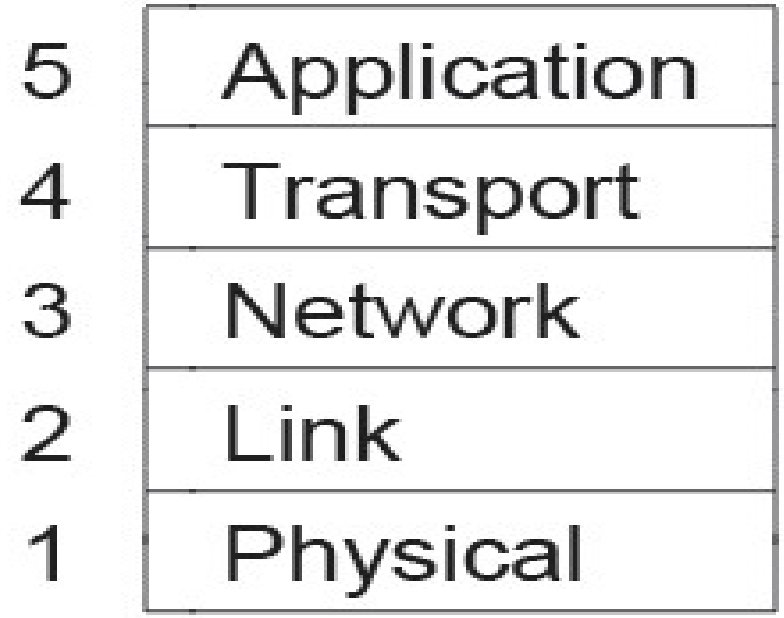
The TCP/IP reference model

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

Services

- Each layer performs some services for the layer above it.
- The service definition tells what the layer does, not how entities above it access it or how the layer works.

Interfaces

- A layer's interface tells the processes above it how to access it.
- It specifies what the parameters are and what results to expect.
- It also says nothing about how the layer works inside.

Protocols

- The peer protocols used in a layer are the layer's own business.
- It can use any protocols it wants to, as long as it gets the job done.
- It can also change them at will without affecting software in higher layers.

OSI vs TCP/IP

- The OSI reference model was devised before the corresponding protocols were invented.
- TCP/IP the reverse was true: the protocols came first, and the model was really just a description of the existing protocols.
- There was no problem with the protocols fitting the model
- The only trouble was that the model did not fit any other protocol stacks.

OSI vs TCP/IP

- The OSI model supports both connectionless and connection-oriented communication in the network layer, but only connection oriented communication in the transport layer.
- The TCP/IP model has only one mode (connectionless) in the network layer but supports both modes in the transport layer.

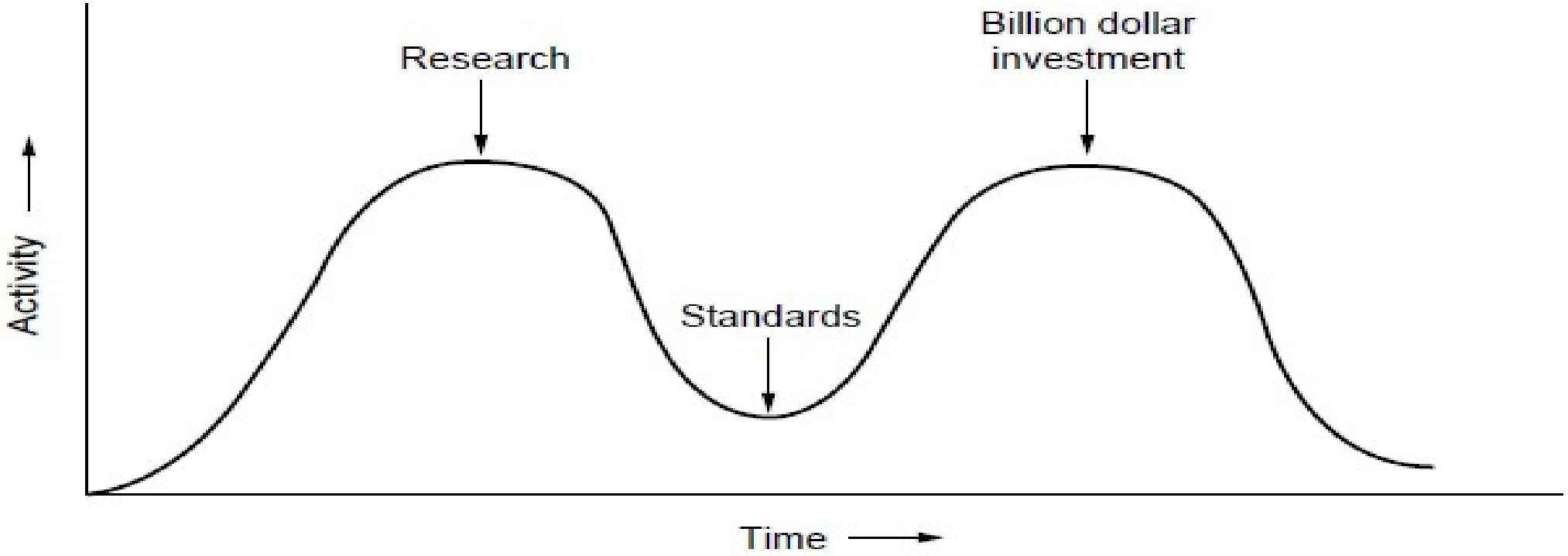
Lack of OSI model's success

- OSI model couldn't compete with TCP/IP model, and failed in getting wider acceptance. One of the main reasons behind the failure of OSI model and wider acceptance of TCP/IP model was because global networks like internet started running on TCP/IP protocol suite.
- The OSI model does not have any special mechanism for providing a reliable and secure connection for data transmission.
- On the other hand, the TCP/IP model has a 3-way handshake mechanism for providing a reliable and secure connection link on the network.

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.

Internet

The network formed by the co-operative interconnection of millions of computers, linked together is called Internet. Internet comprises of :

People : People use and develop the network.

Resources : A collection of resources that can be reached from those networks.

A setup for collaboration : It includes the member of the research and educational committees worldwide.

Intranet

It is an internal private network built within an organization using Internet and World Wide Web standards and products that allows employees of an organization to gain access to corporate information.

Extranet

It is the type of network that allows users from outside to access the Intranet of an organization.

The Physical Layer

- Guided Transmission Medium
- Wireless Transmission Medium

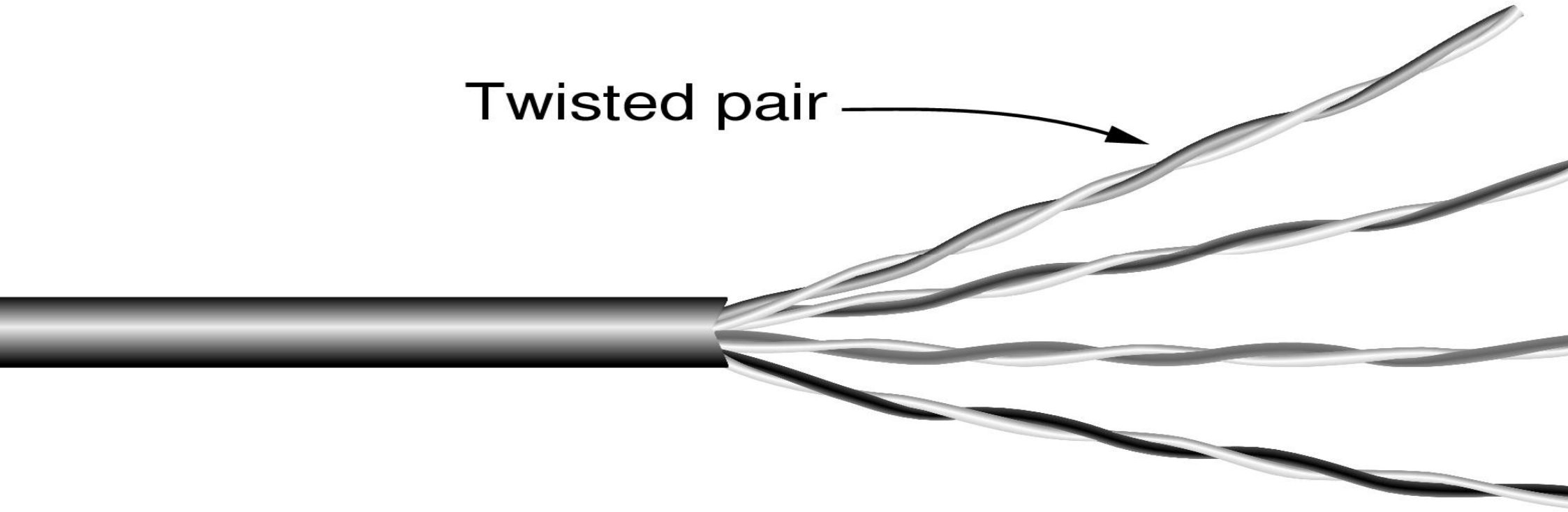
Guided Transmission Media

- Magnetic media
- Twisted pairs
- Coaxial cable
- Power lines
- Fiber optics

Magnetic Media

- Write data onto magnetic media
  - Disks
  - Tapes
- Data transmission speed
  - Never underestimate the bandwidth of a station wagon full of tapes hurtling down the highway.

Twisted Pairs



Category 5 UTP cable with four twisted pairs

Twisted Pairs

Category 5 : Used in local area network. It support upto 100 Mbps data transmission speed.

Category 4 : It support transmission speed of 16 Mbps and three twist per foot.

Category 3 : It support data transmission speed upto 10 Mpbs. At least three twist per feet and used in telephone system.

Category 2 : It support data transmission speed upto 4 Mbps and suitable for voice data transmission.

Category 1 : Mostly used in telephone system. Cat1 is suitable for voice and low speed data communication.

Shielded Twisted Pairs

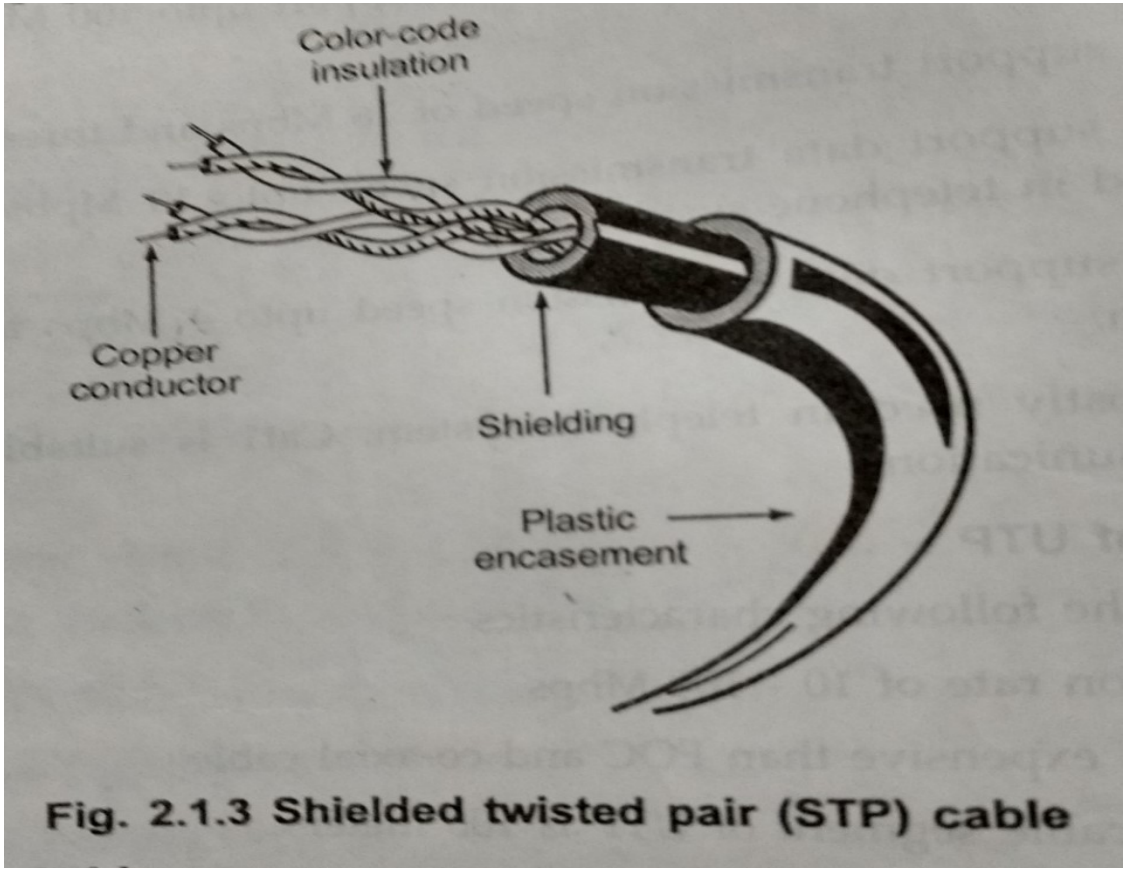


Fig. 2.1.3 Shielded twisted pair (STP) cable

Applications of TP Cable

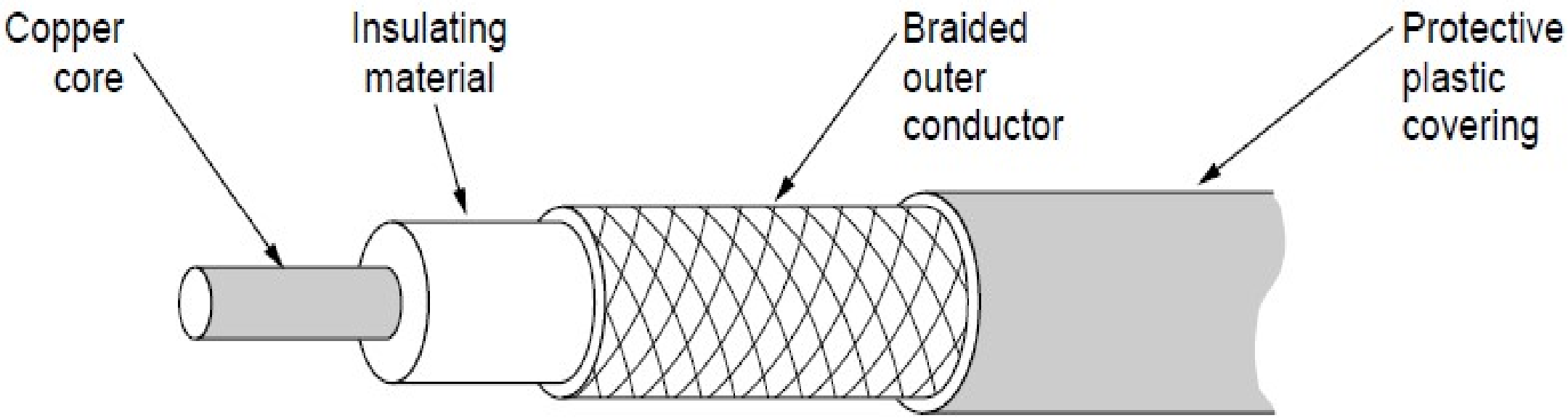
1.Twisted pair cable used for both analog and digital signals
2. Twisted pair cable are used in telephone network
3. In LAN,TP wires are mainly use for low cost, low performance applications

Comparison of UTP and STP

Comparison of UTP and STP

Sr. No.	Parameter	UTP	STP
1.	Data rate	10-100 Mbps	150 Mbps
2.	Cable length	100 meters max.	500 meters max.
3.	Electrical interference	Most susceptible to interference or cross-talk	Less susceptible to interference or corss-talk
4.	Installation	Easy to install	Very easy to install
5.	Cost	Lowest	Little costly

Coaxial Cable



A coaxial cable

Coaxial Cable

- It has better shielding than twisted pairs, so it can span longer distances at higher speeds.
- Two kinds of coaxial cable are widely used. One kind, 50- ohm cable, is commonly used when it is intended for digital transmission from the start.

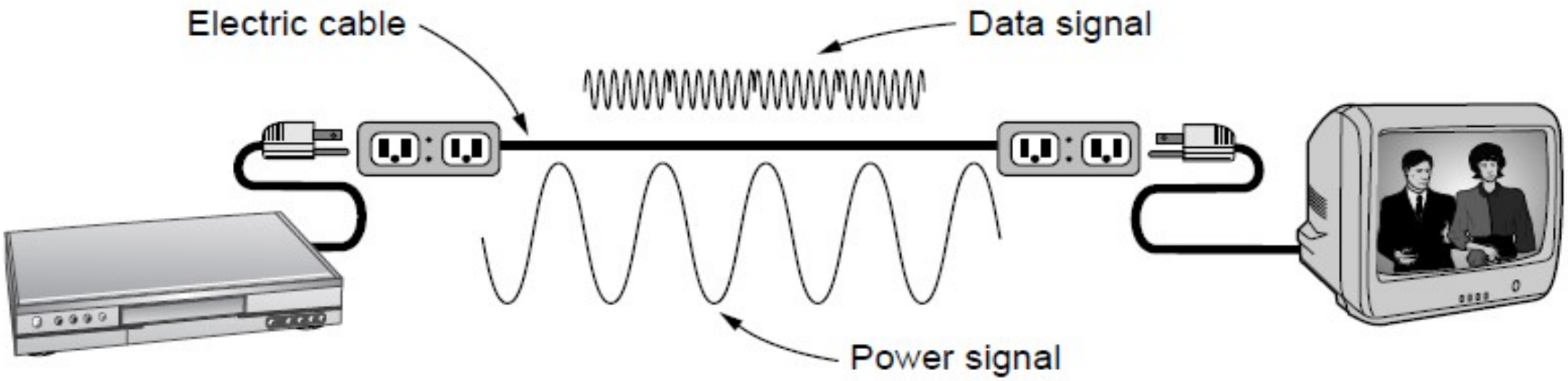
- The other kind, 75-ohm cable, is commonly used for analog transmission and cable television .

- A coaxial cable consists of a stiff copper wire as the core, surrounded by an insulating material.
- The insulator is encased by a cylindrical conductor, often as a closely-woven braided mesh.
- The outer conductor is covered in a protective plastic sheath.

Coaxial Cable

- The construction and shielding of the coaxial cable give it a good combination of high bandwidth and excellent noise immunity.
- The bandwidth possible depends on the cable quality, length, and signal-to-noise ratio of the data signal.
- Modern cables have a bandwidth of close to 1 GHz.
- Coaxial cables used to be widely used within the telephone system for long-distance lines

Power Lines

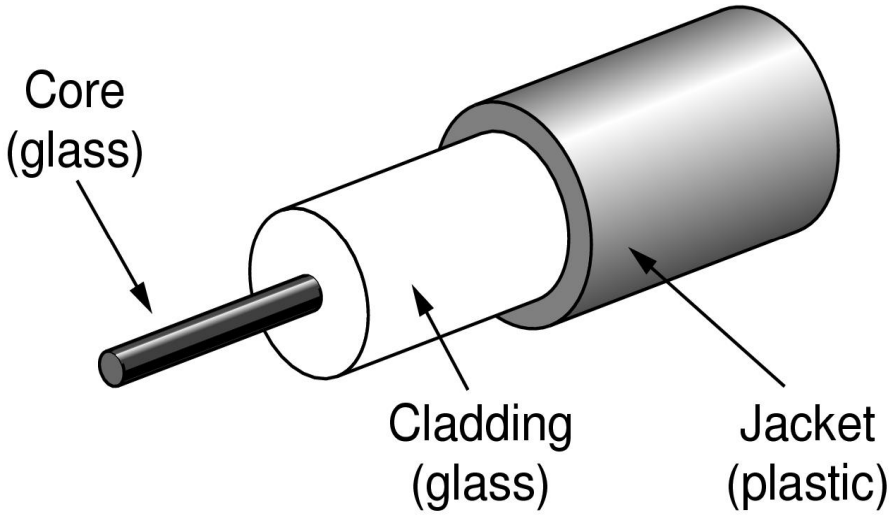


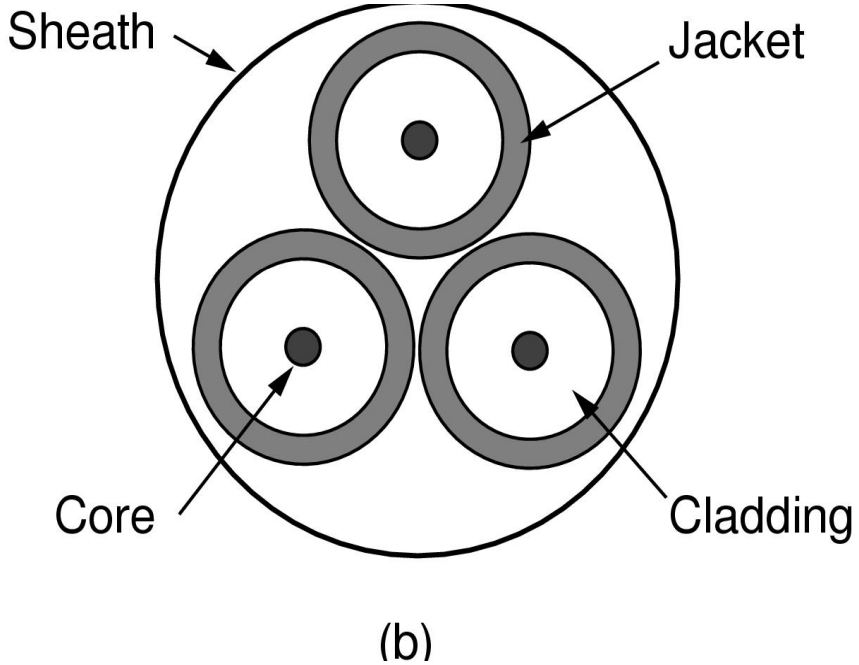
A network that uses household electrical wiring.

Fiber Optical Cable (FOC)

- A fiber cable is a light pipe which is used to carry light beam from one place to another
- Light is an EM signal and can be modulated by information since the frequency of light is extremely high hence it can accommodate wide bandwidths of information.
- Modulated light travel along the fiber and the far end, are converted to an electrical signal by means of photo electrical cell. Thus the original input signal is recovered at far end.
- FOC transmits light signals rather than electrical signals. Each fiber has a inner core of glass or plastic that conducts light. The inner core is surrounded by cladding, a layer of glass that reflects the light back into core.
- A cable may contain single fiber, but often fibers are bundled together the centre of the cable.

Fiber Cables (1)





Views of a fiber cable

Fiber Cables (2)

Item	LED	Semiconductor laser
Data rate	Low	High
Fiber type	Multi-mode	Multi-mode or single-mode
Distance	Short	Long
Lifetime	Long life	Short life
Temperature sensitivity	Minor	Substantial
Cost	Low cost	Expensive

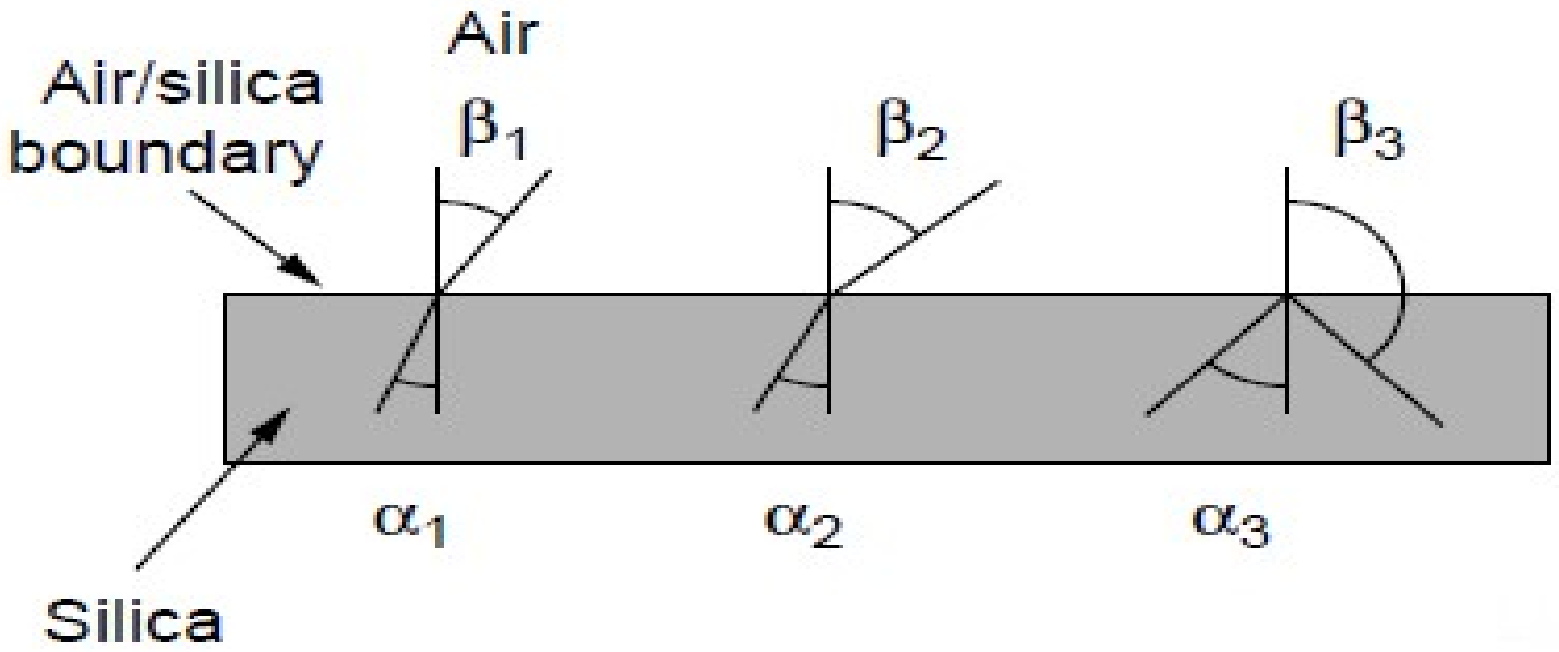
A comparison of semiconductor diodes and LEDs as light sources

Fiber Cables (3)

Types of fiber

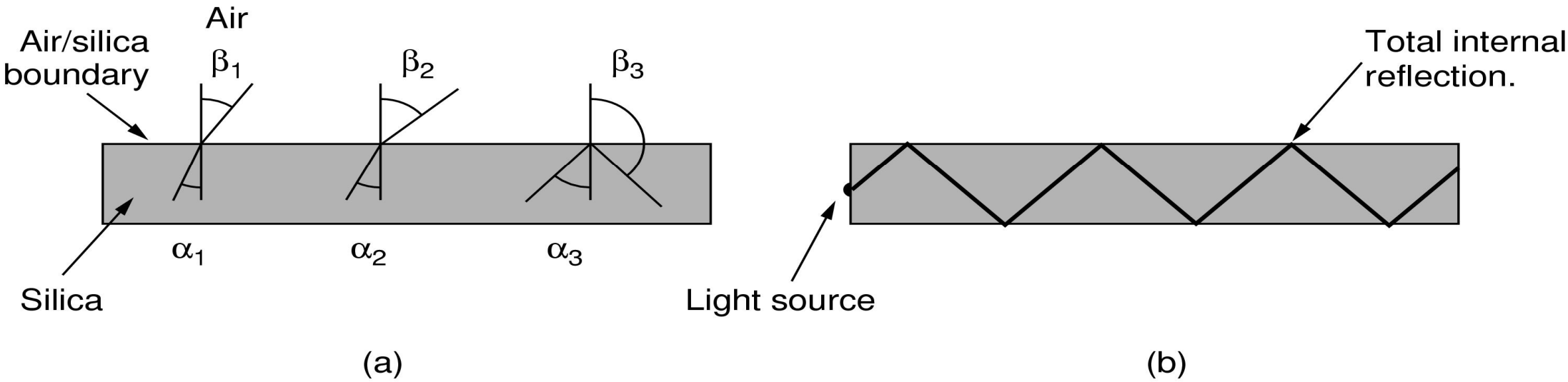
- Plastic core and cladding
- Glass core with plastic cladding(PCS, fiber, plastic-clad silica)
- Glass core and glass cladding(SCS, silica-clad silica)

Fiber Optics (1)



Three examples of a light ray from inside a silica fiber impinging on the air/silica boundary at different angles.

Fiber Optics (2)



Light trapped by total internal reflection.

Plastic core and cladding

- Plastic fibers have several advantages over glass fibers. First, plastic fibers are more flexible and consequently more rugged than glass
- Easy to install, withstand stress, less expensive and weight aprox 60% less than glass

- Disadvantages of plastic fibers is their high attenuation
- Do not propagate light as efficiently as glass
- Used for short distances such as single building

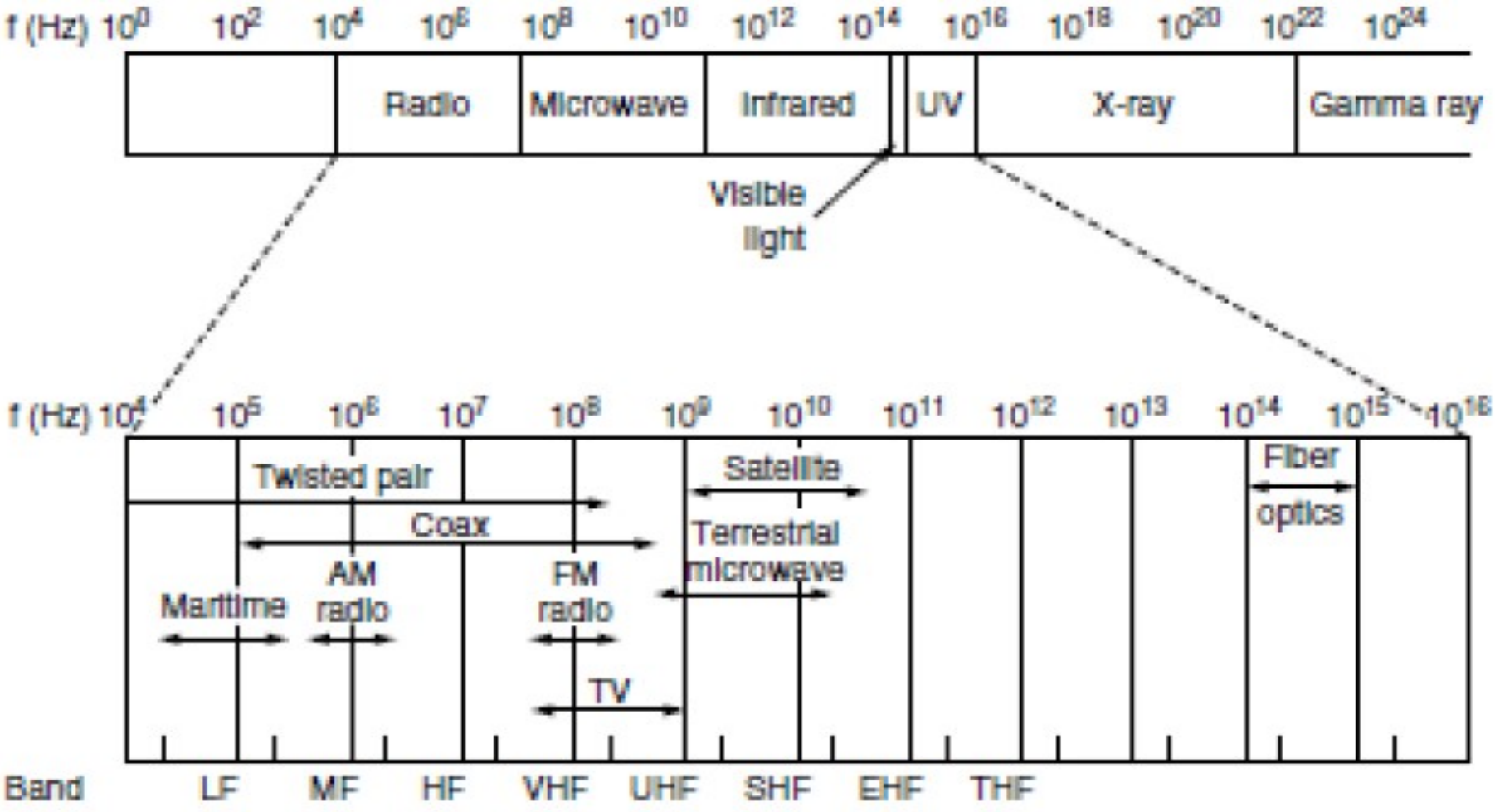
Characteristics of FOC

- Transmission rate of 100 Mbps
- Not affected by the electrical interference
- Most expensive cable
- FOC support cable length of 2 km or more
- It supports voice, video and data
- It provides most secured media
- Backbones between buildings and token ring networks
- Not very flexible difficult to work

Wireless Transmission

- Radio waves
- Microwaves
- Infrared
- Laser

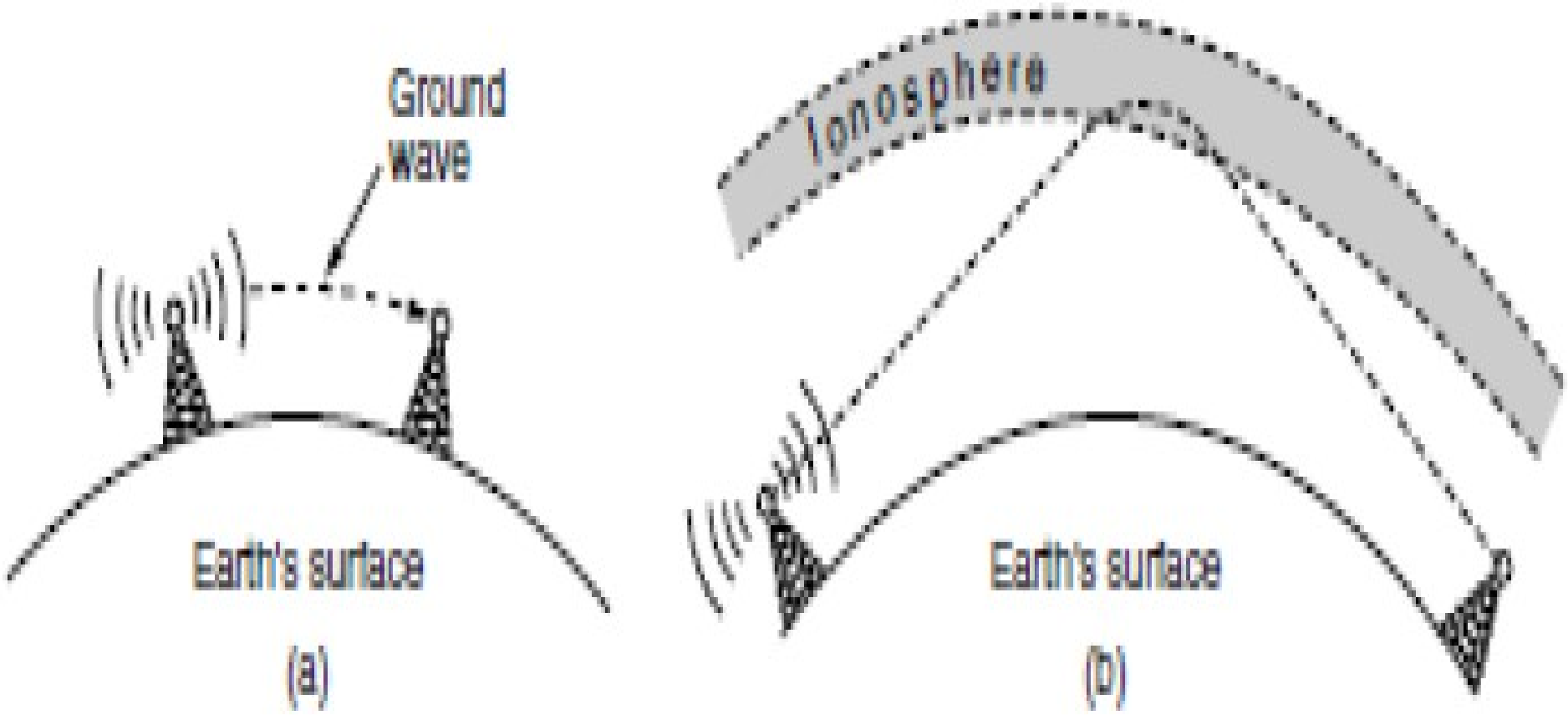
Electromagnetic Spectrum



Radio Transmission

- Radio waves are easy to generate, can travel long distances, and can penetrate buildings easily, so they are widely used for communication, both indoors and outdoors.
- In the VLF, LF, and MF bands, radio waves follow the ground, as illustrated in Fig. (a). These waves can be detected for perhaps 1000 km at the lower frequencies, less at the higher ones.
- AM radio broadcasting uses the MF band, which is why the ground waves from Boston AM radio stations cannot be heard easily in New York.
- In the HF and VHF bands, the ground waves tend to be absorbed by the earth. However, the waves that reach the ionosphere, a layer of charged particles circling the earth at a height of 100 to 500 km, are refracted by it and sent back to earth, as shown in Fig. (b).

Radio Transmission



Microwave Transmission

- Above 100 MHz, the waves travel in nearly straight lines and can therefore be narrowly focused.
- Concentrating all the energy into a small beam by means of a parabolic antenna (like the familiar satellite TV dish) gives a much higher signal-to-noise ratio, but the transmitting and receiving antennas must be accurately aligned with each other.

Microwave Transmission

- Unlike radio waves at lower frequencies, microwaves do not pass through buildings well.
- In addition, even though the beam may be well focused at the transmitter, there is still some divergence in space.
- Some waves may be refracted off low-lying atmospheric layers and may take slightly longer to arrive than the direct waves. The delayed waves may arrive out of phase with the direct wave and thus cancel the signal. This effect is called multipath fading and is often a serious problem.

Microwave Transmission

- Multipath fading
- Frequency band

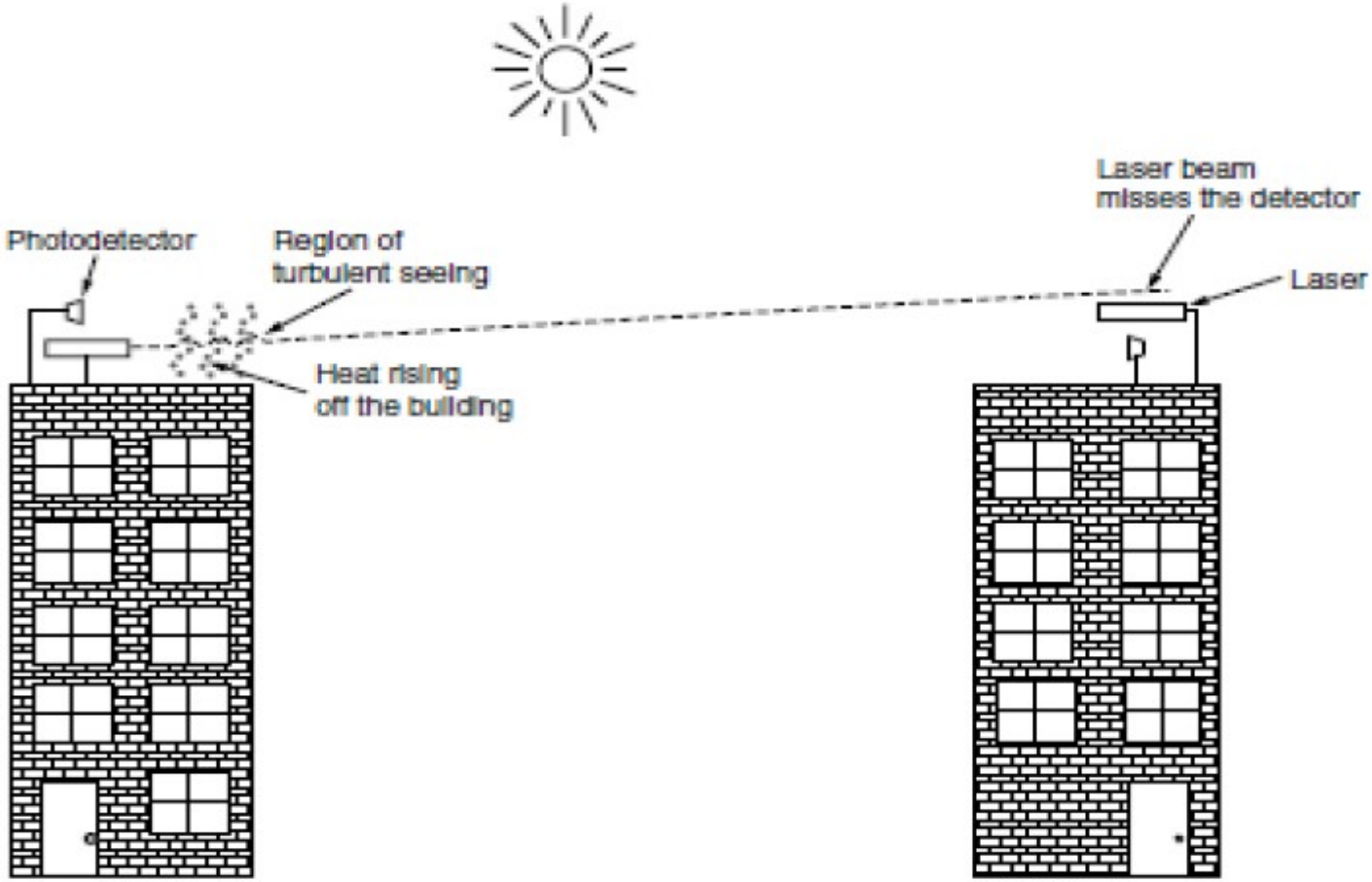
  900 Mhz – 802.11

  2.4 Ghz – 802.11b/g

Infrared Transmission

- Short range communication
- Remote controlled based devices
- Cannot pass through solid objects
- Govt. license is not needed

Light Transmission



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Thank You