Computer Networks

Introduction to data communication & Computer networks

About Me

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Books and Relevant Content

- Data communications and networking by Behrouz A. Forouzan
- Data and Computer Communications by William Stallings
- Computer Networking: A Top-Down Approach Featuring the Internet by Kurose and Ross, Sixth Edition
- Software Defined Networks
- Reading materials and Articles
- Reference Slide at the end of every lecture to make your life easier

Evaluations

Assessment	Weightage (%age)
Assignments / Case Studies	10
Quizzes	10
Project	10
Sessional 1	15
Sessional 2	15
Finals	40

Introduction

- What is Internet?
- What is networks?
- Its importance
- Major areas of Application
- Industry Application/usage
- Softwares used
- Major Research Areas.

Data Communication

Networks exist so that data may be sent from one place to another.

Telecommunication network that allows computers to exchange data.

Connection between the exchanging devices can be wired or wireless.

Best known Computer network is Internet.

- A system containing any combination of computers, computer terminals, printers, audio or visual display devices, or telephones interconnected by telecommunication equipment or cables: used to transmit or receive information
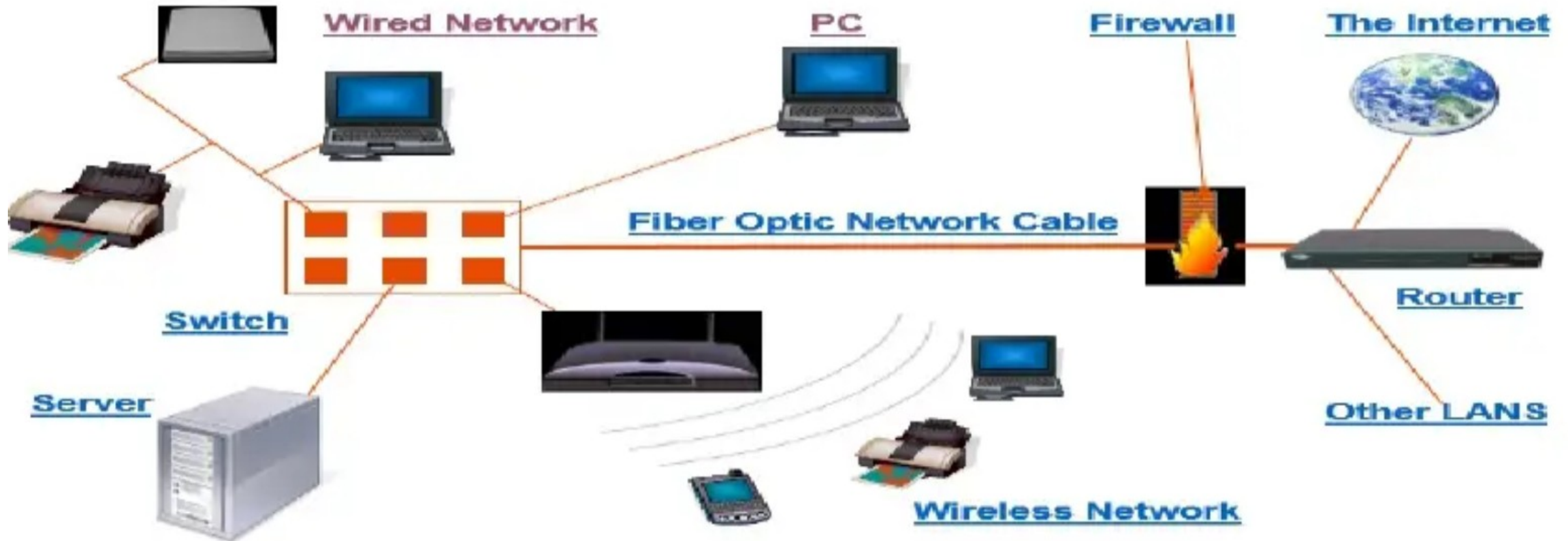
Data Communication

When we communicate we share information

Local Communication, if Face to Face

Remote (*tele*), if through Telephone, Telex, television etc

Data

Information presented in any form that is agreed upon by communicating parties.

- Text, Image, Video, Audio

- Exchange of data between two devices via some form of transmission medium such as a wire or wireless
- Data Communication is the exchange of information from One entity to another using a transmission medium

- Keywords
  - Exchange
  - Information
  - Entity
  - Transmission medium

Internet

- How it works?
- Principals and Structure
- Large number of users and devices
- Nuts and bolts of internet(Hardware & Software elements involved)
- Internet in terms of networking infrastructure
- Provide services to the distributed applications

Nuts and Bolts of Inte

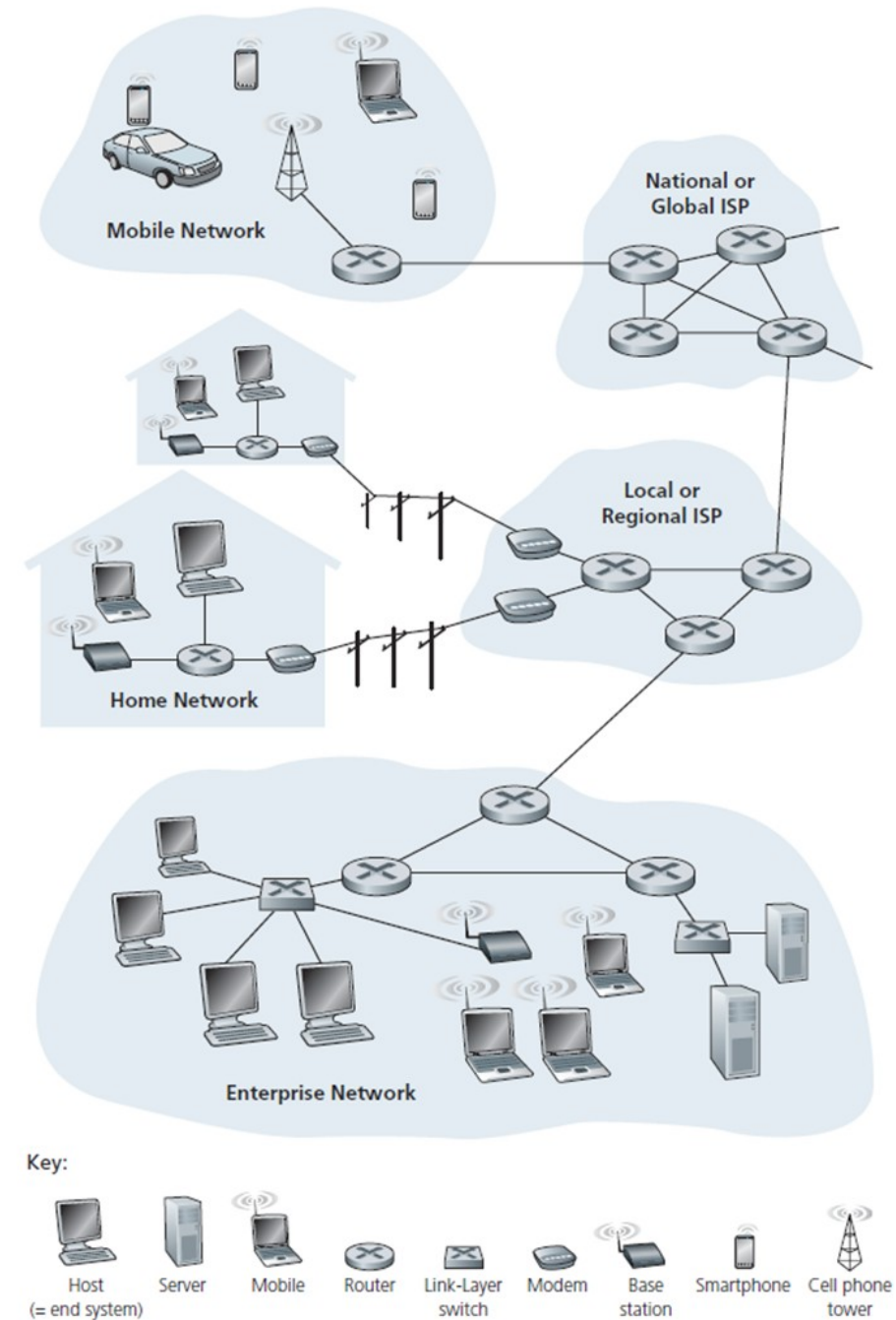- End Devices
- Communication Links
- Packets
- Packet Switches

Figure 1.1 ♦ Some pieces of the Internet

End Devices

- laptops, smartphones, tablets, TVs, gaming consoles, Web cams, automobiles, environmental sensing devices,picture frames, and home electrical and security systems are being connected to the Internet

- More than 2 billion internet users

Communication Links

- End systems are connected by a network of communication links and packet switches.
- Many types of physical media are used for communication
  - Coaxial Cable
  - Twisted Pair
  - Copper Wire
  - Optical Fiber
  - Radio Spectrum
- Different links can transmit data at different rates, with the **transmission rate** of a link measured in bits/second.

**Single core coaxial cable**

Multi-core coaxial cable

Coaxial cables in computer networks

Twisted Pair

- The twisted-pair cable was primarily developed for computer networks. This cable is also known as Ethernet cable. Almost all modern LAN computer networks use this cable.

- This cable consists of color-coded pairs of insulated copper wires. Every two wires are twisted around each other to form pair. Usually, there are four pairs. Each pair has one solid color and one stripped color wire. Solid colors are blue, brown, green, and orange. In stripped color, the solid color is mixed with the white color.

- Based on how pairs are stripped in the plastic sheath, there are two types of twisted-pair cable; UTP and STP.
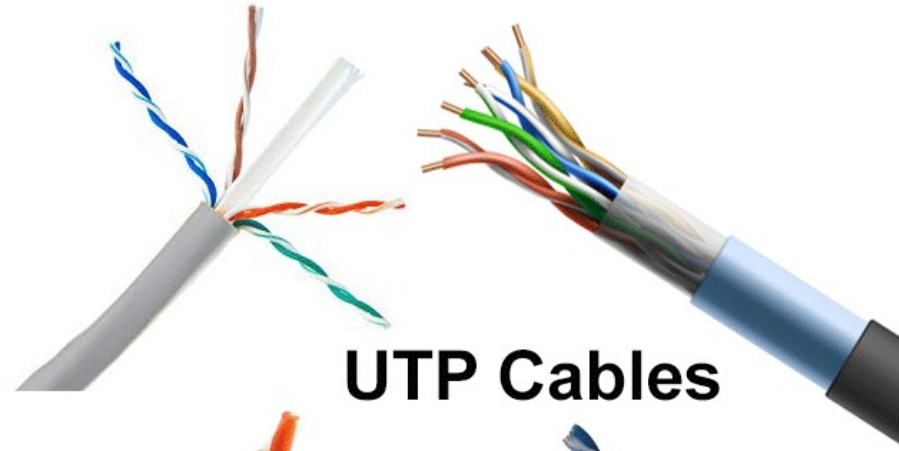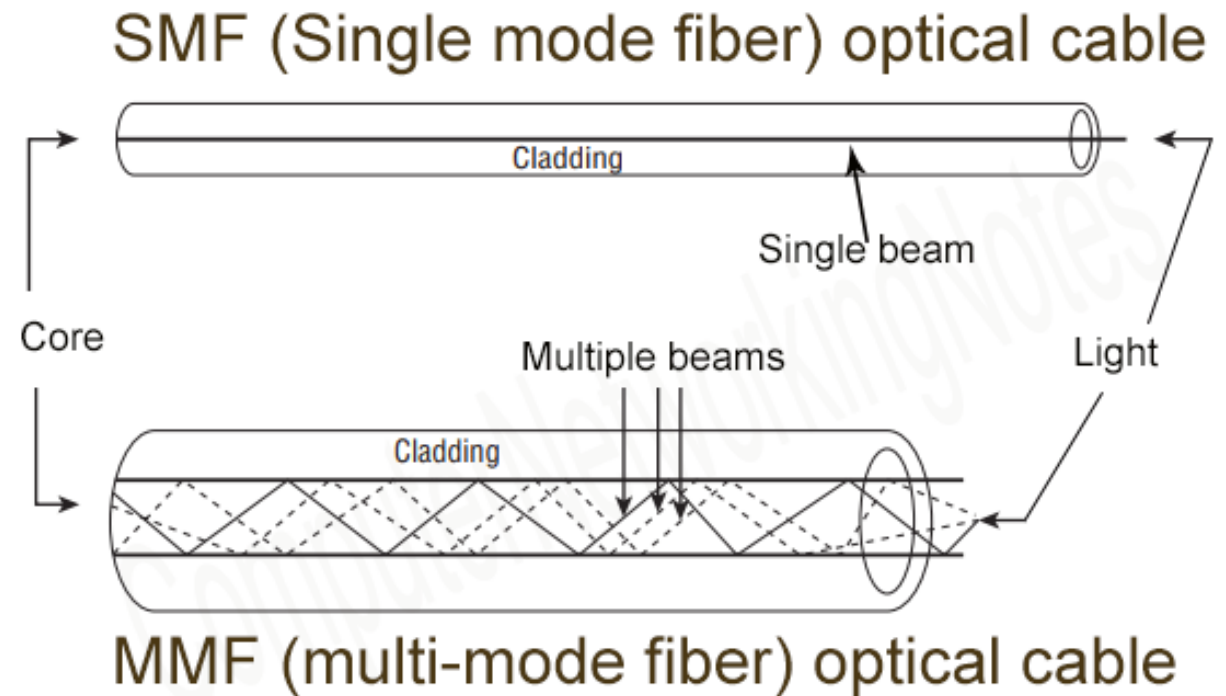
UTP Cables

STP Cables

ETHERNET CABLE PERFORMANCE SUMMARY

CATEGORY	SHIELDING	MAX TRANSMISSION SPEED (AT 100 METERS)	MAX BANDWIDTH
Cat 3	Unshielded	10 Mbps	16 MHz
Cat 5	Unshielded	10/100 Mbps	100 MHz
Cat 5e	Unshielded	1000 Mbps / 1 Gbps	100 MHz
Cat 6	Shielded or Unshielded	1000 Mbps / 1 Gbps	>250 MHz
Cat 6a	Shielded	10000 Mbps / 10 Gbps	500 MHz
Cat 7	Shielded	10000 Mbps / 10 Gbps	600 MHz
Cat 8	Shielded	25 Gbps or 40Gbps *	2000 MHz

Optical Fiber Cable

- This cable consists of a core, cladding, buffer, and jacket. The core is made from thin strands of glass or plastic that can carry data over a long distance. The core is wrapped in the cladding; the cladding is wrapped in the buffer, and the buffer is wrapped in the jacket.

SMF (Single mode fiber) optical cable

Cladding

Single beam

Core

Multiple beams

Light

Cladding

MMF (multi-mode fiber) optical cable

Packets and Packet Switches

- Data to be transmitted and Headers called Packets
- Various types of Packet Switches
  - Router
  - Hubs
  - Link Layer Switches
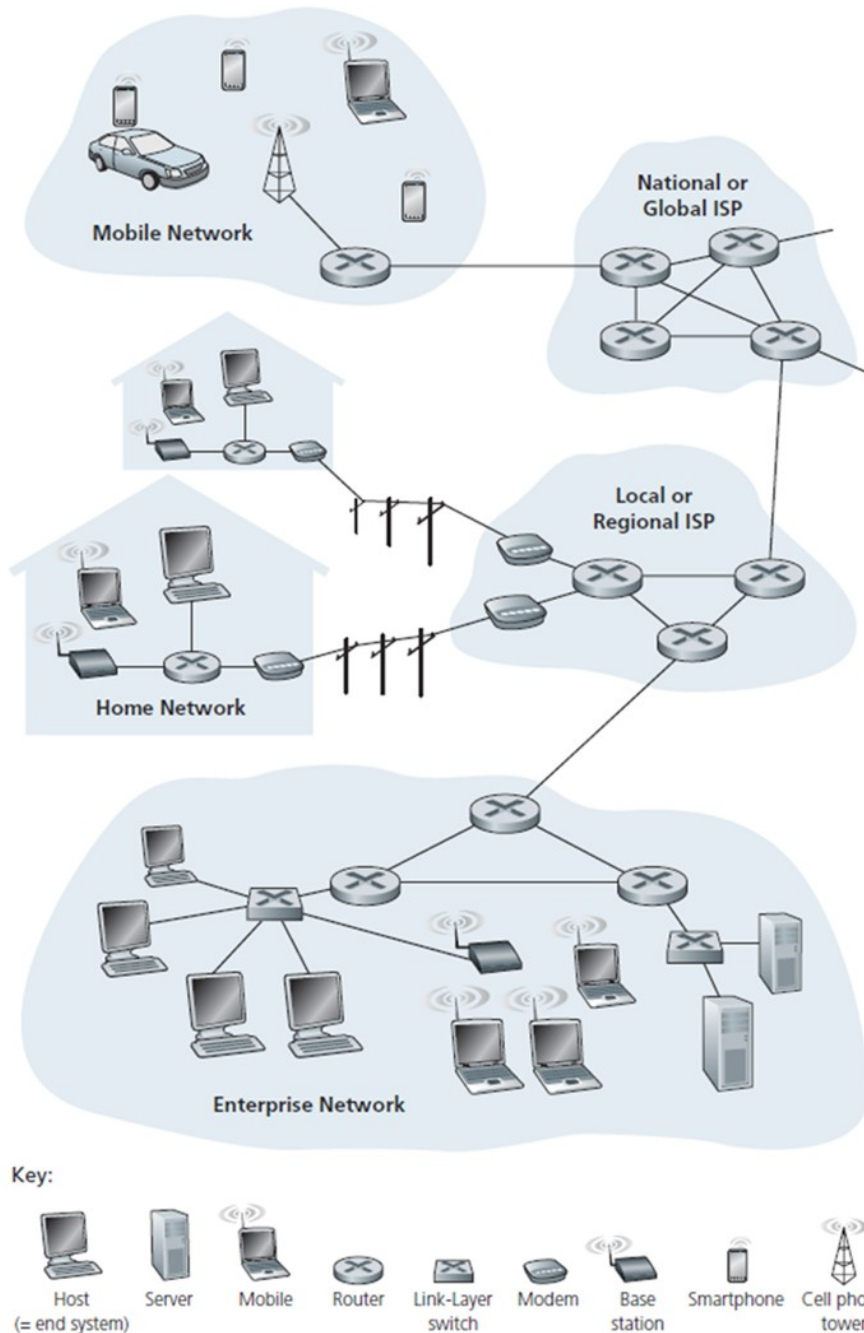- Packet switches facilitate the exchange of data among end systems

Figure 1.1 ♦ Some pieces of the Internet

ISPs

- Internet Service Providers
- Types
  - Residential(Local Cable and Telephone Companies)
  - Corporate (University, Enterprise etc)

- The Internet is all about connecting end systems to each other, so the ISPs that provide access to end systems must also be interconnected.
- These lower-tier ISPs are interconnected through national and international upper-tier ISPs such as Level 3 Communications, AT&T, Sprint, and NTT.
- An upper-tier ISP consists of high-speed routers interconnected with high-speed fiber-optic links.
- Each ISP network, whether upper-tier or lower-tier, is managed independently, runs the IP protocol and conforms to certain naming and address conventions.
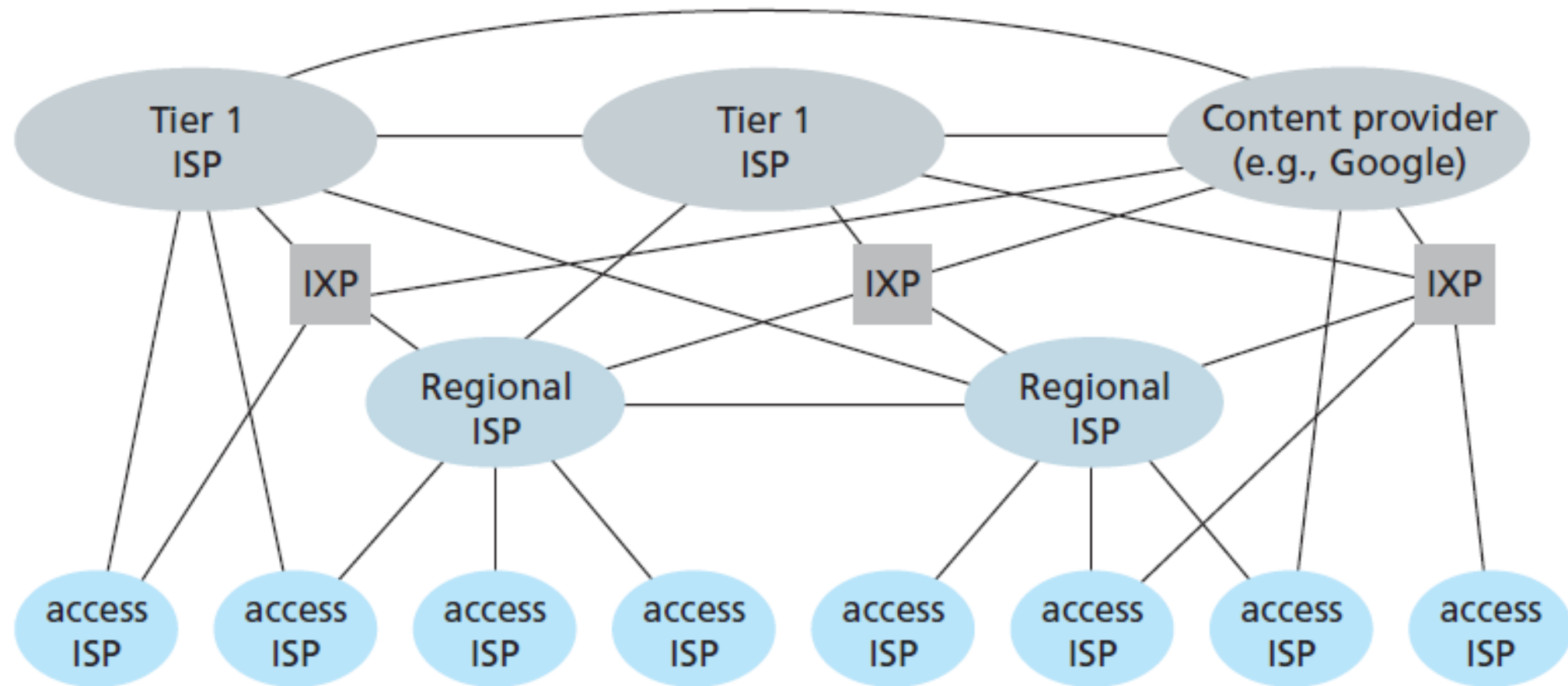
Components

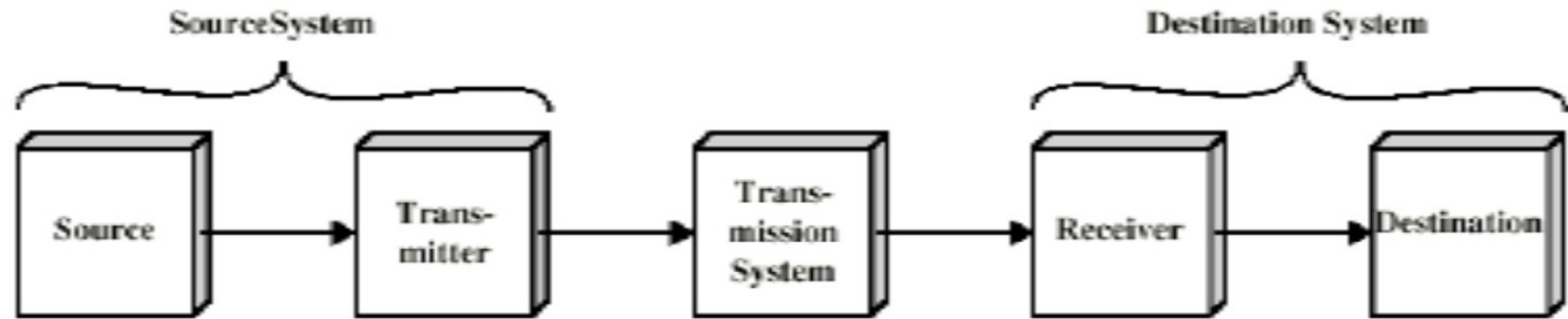## Five basic Components of data communication

- Message
- Sender
- Reciever
- Transmission medium
- Protocol

- **Message:** The message is the information (data) to be communicated.
- **Sender/ Receiver:** The sender/receiver is the device that sends/receives the data message.
- **Transmission medium:** The transmission medium is the physical path by which a message travels from sender to receiver.
- **Protocol:** A protocol is a set of rules that govern data communications.

Rule 1:
Rule 2:
...
Rule n:

Protocol

Sender

Message

Medium

Protocol

Rule 1:
Rule 2:
...
Rule n:

Receiver
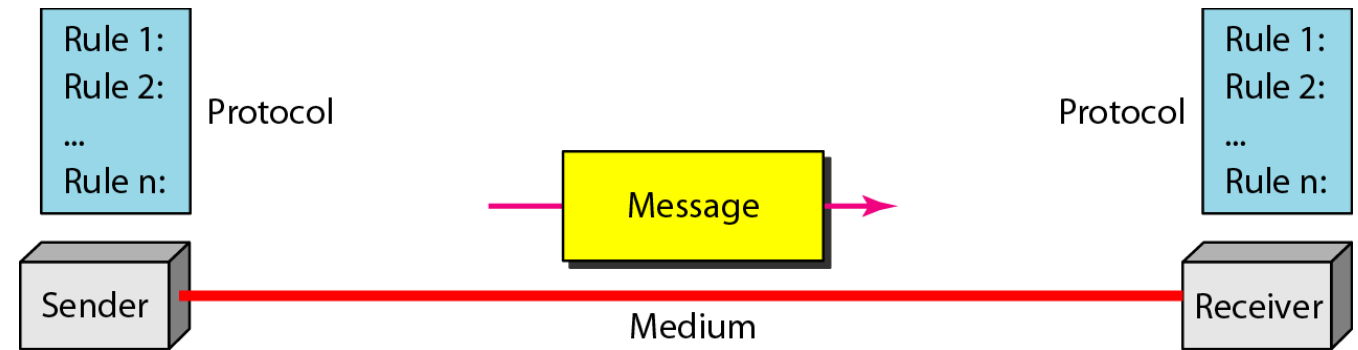
Communication Model

(a) General block diagram

(b) Example

Parts of Communication Model

Source

- Generates data to be transmitted
  - Telephone, Mic, Computer, Web Cam, Scanner, Digital Camera

Transmitter

- Data produced can not be transmitted directly
- Data should be converted to signals
- Transmitter converts data into transmittable signals
  - Modem converts Data Bits into Signals
    - Modulation

Parts of Communication Model

Transmission System

- It carries data from one party (sender) to another (receiver)
- Can be Wired / Wireless medium
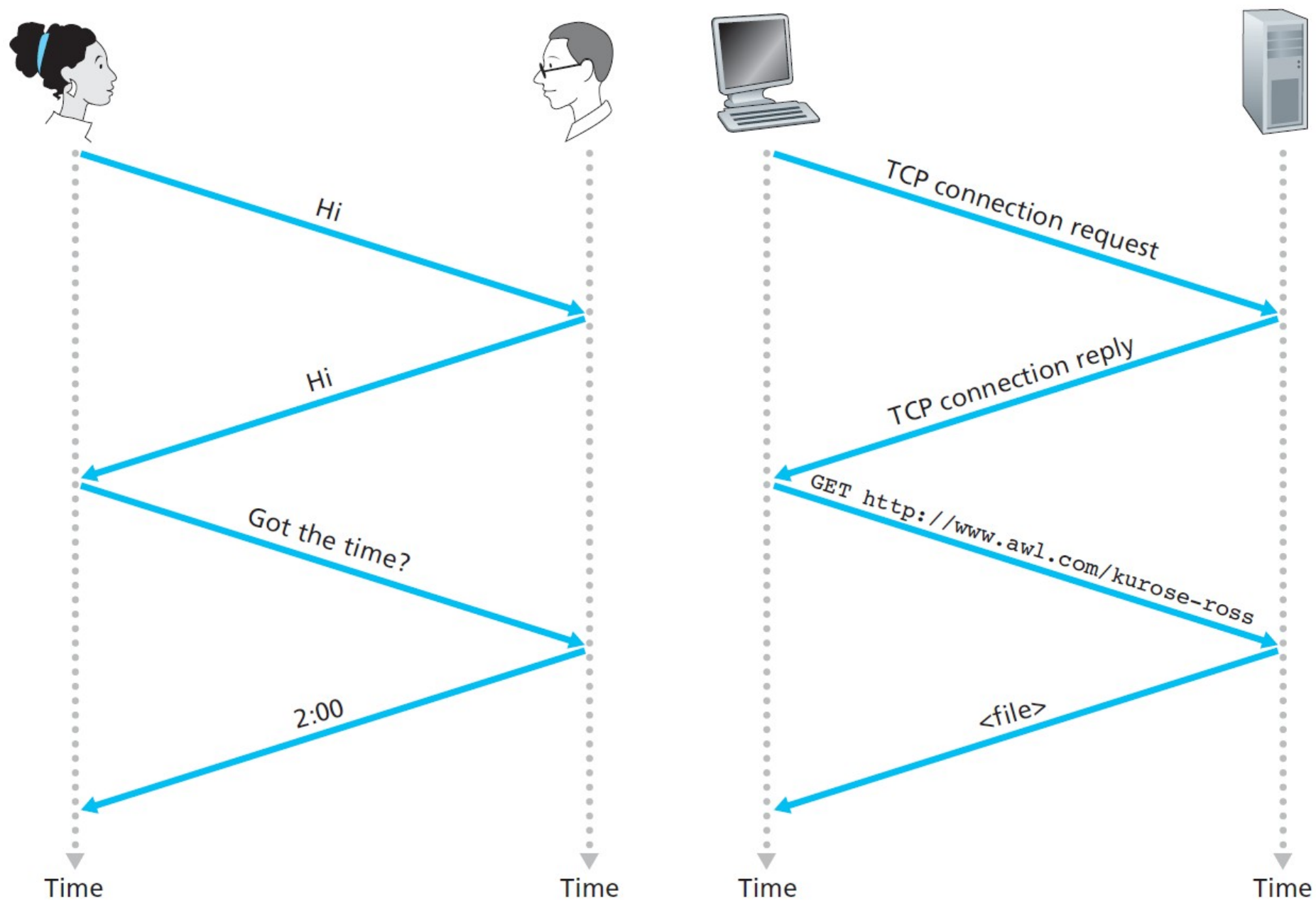- Can be complex network like Internet

Receiver

- It receives signal
- Converts received signal into data (bits)
  - Modem (demodulation)

Destination

- Takes incoming data from receiver.
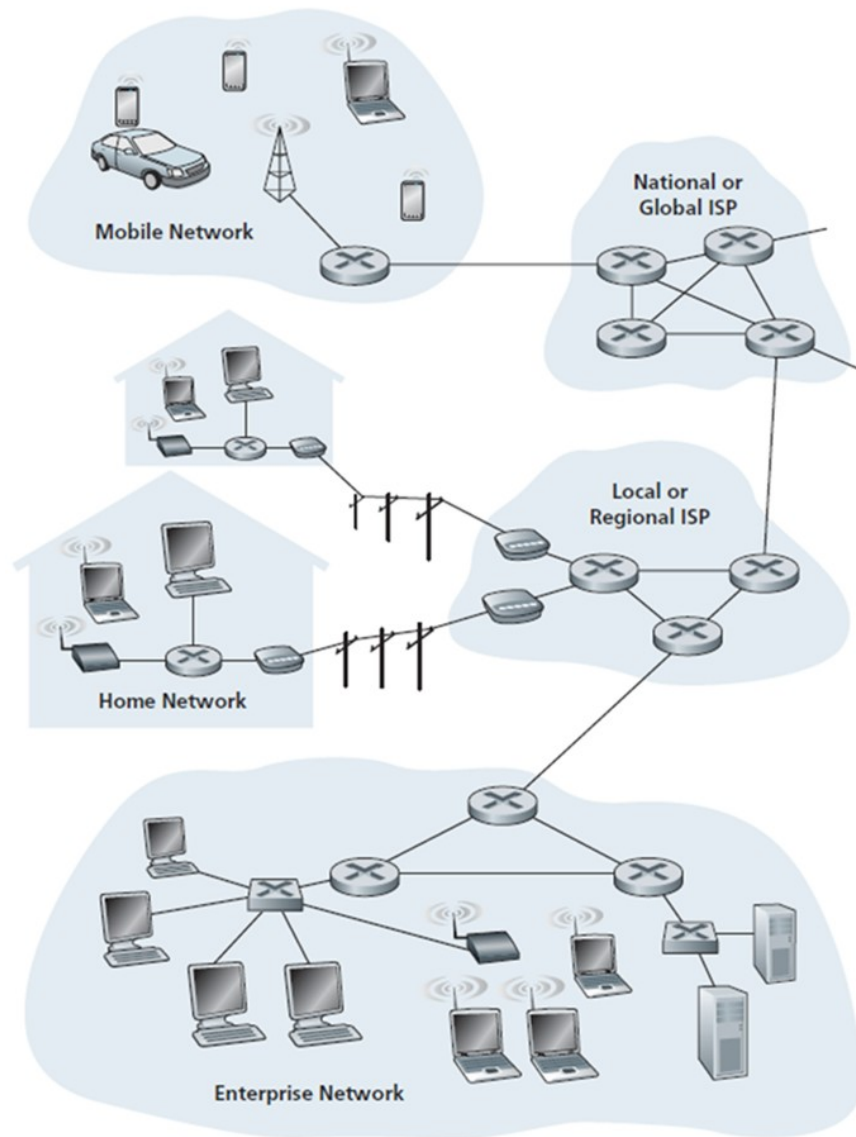
Protocols

- Set of rules that drives the packets across the internet.
- Examples:
    - IP
    - TCP
    - UDP
    - SMTP
    - HTTP

- *A protocol defines the format and the order of messages exchanged between two or more communicating entities, as well as the actions taken on the transmission and/or receipt of a message or other event.*

Figure 1.2 ♦ A human protocol and a computer network protocol

Mobile Network

National or Global ISP

Local or Regional ISP

Home Network

Enterprise Network

Key:

Host (= end system)   Server   Mobile   Router   Link-Layer switch   Modem   Base station   Smartphone   Cell phone tower

Figure 1.1 ♦ Some pieces of the Internet

Services

- Internet is an infrastructure that provides services to applications
- Examples:
    - electronic mail, Web surfing, social networks, instant messaging, Voiceover-IP (VoIP), video streaming, distributed games, peer-to-peer (P2P) file sharing, television over the Internet, remote login, and much, much more.
- Called distributed applications, since they involve multiple end systems that exchange data with each other.
- Applications run on the end systems and not on the switches.

- Application Programming Interface APIs

A DIZZYING ARRAY OF INTERNET END SYSTEMS

Not too long ago, the end-system devices connected to the Internet were primarily traditional computers such as desktop machines and powerful servers. Beginning in the late 1990s and continuing today, a wide range of interesting devices are being connected to the Internet, leveraging their ability to send and receive digital data. Given the Internet's ubiquity, its well-defined (standardized) protocols, and the availability of Internet-ready commodity hardware, it's natural to use Internet technology to network these devices together and to Internet-connected servers.

Many of these devices are based in the home—video game consoles (e.g., Microsoft's Xbox), Internet-ready televisions, digital picture frames that download and display digital pictures, washing machines, refrigerators, and even a toaster that downloads meteorological information and burns an image of the day's forecast (e.g., mixed clouds and sun) on your morning toast [BBC 2001]. IP-enabled phones with GPS capabilities put location-dependent services (maps, information about nearby services or people) at your fingertips. Networked sensors embedded into the physical environment allow monitoring of buildings, bridges, seismic activity, wildlife habitats, river estuaries, and the weather. Biomedical devices can be embedded and networked in a body-area network. With so many diverse devices being networked together, the Internet is indeed becoming an "Internet of things" [ITU 2005b].
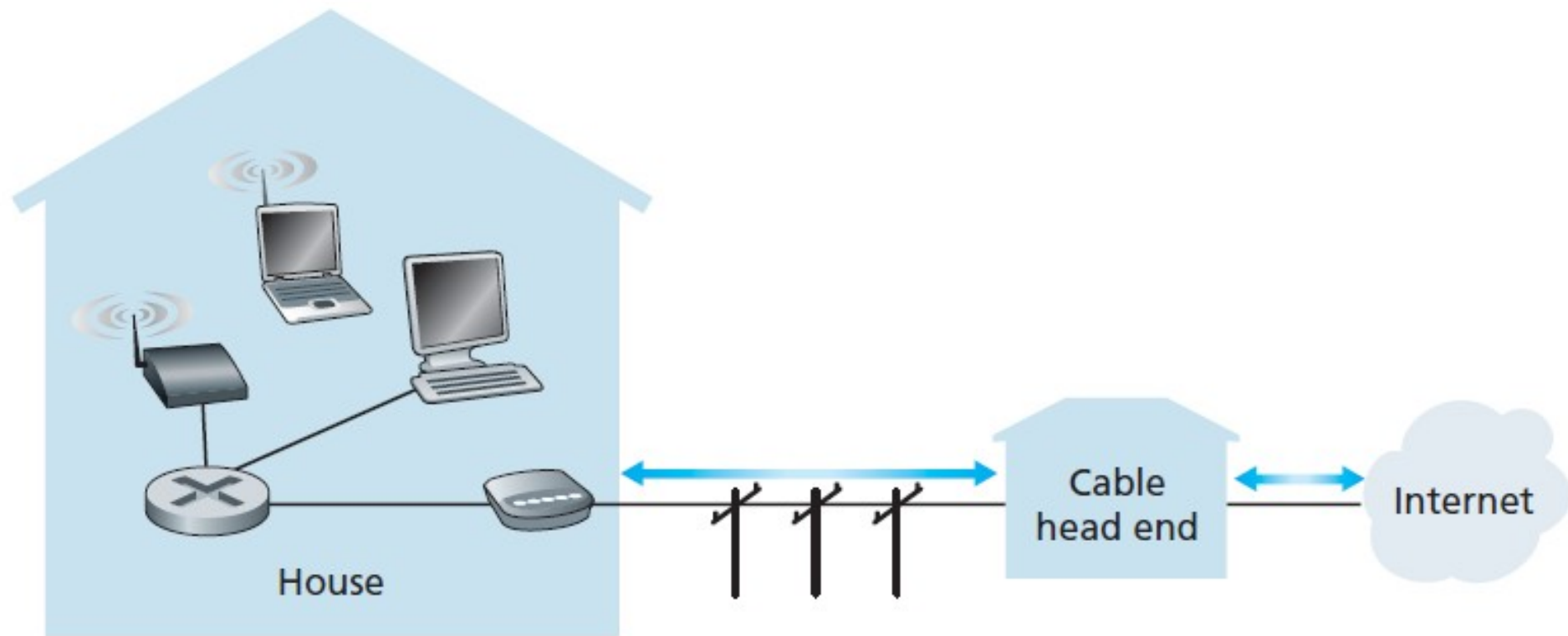
Network Edge

- Hosts/ End Nodes
- Client-Servers/ Peers
- Access Network
  - the network that physically connects an end system to the first router (also known as the "edge router") on a path from the end system to any other distant end system.
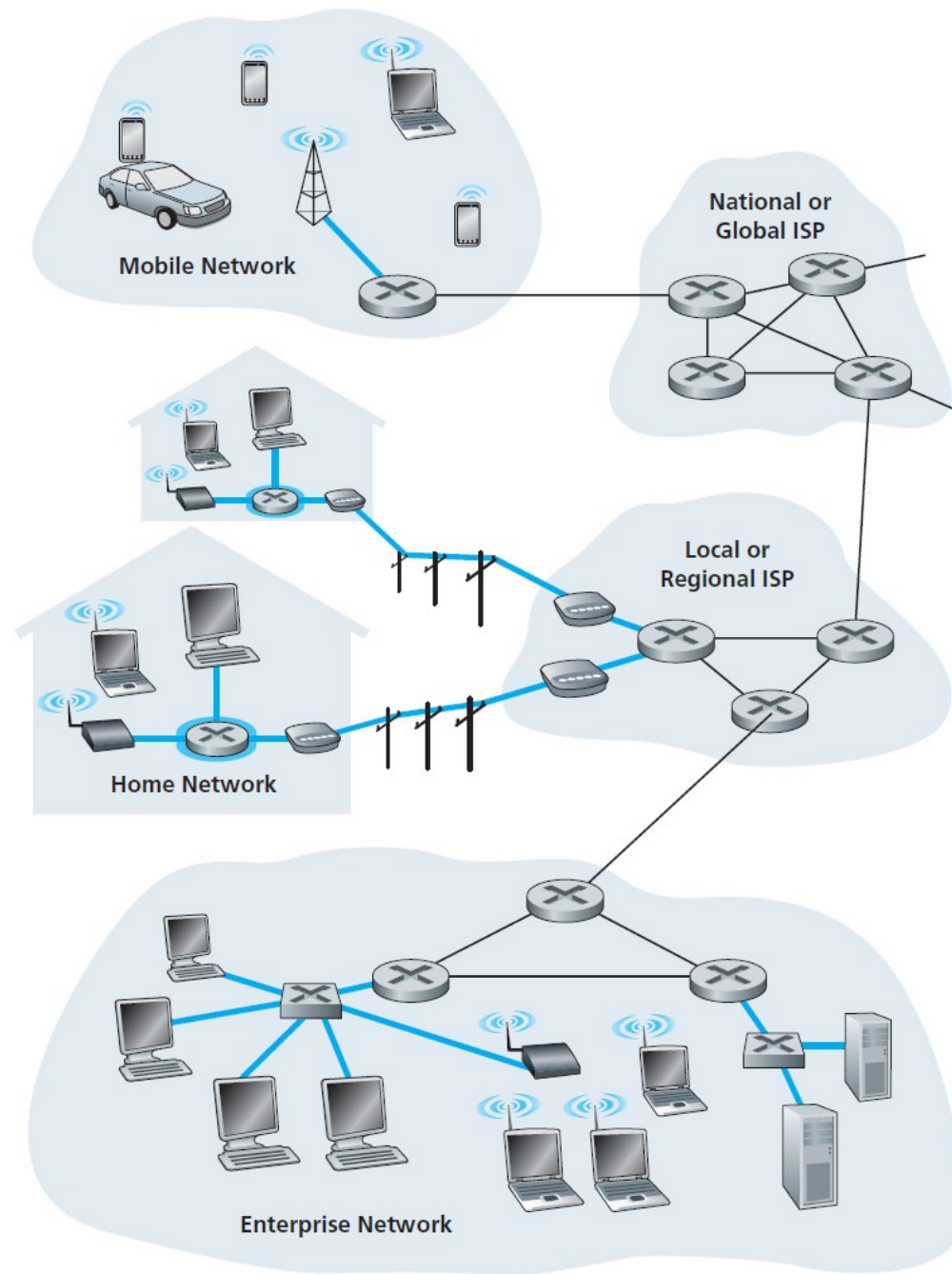
Figure 1.4 ♦ Access networks
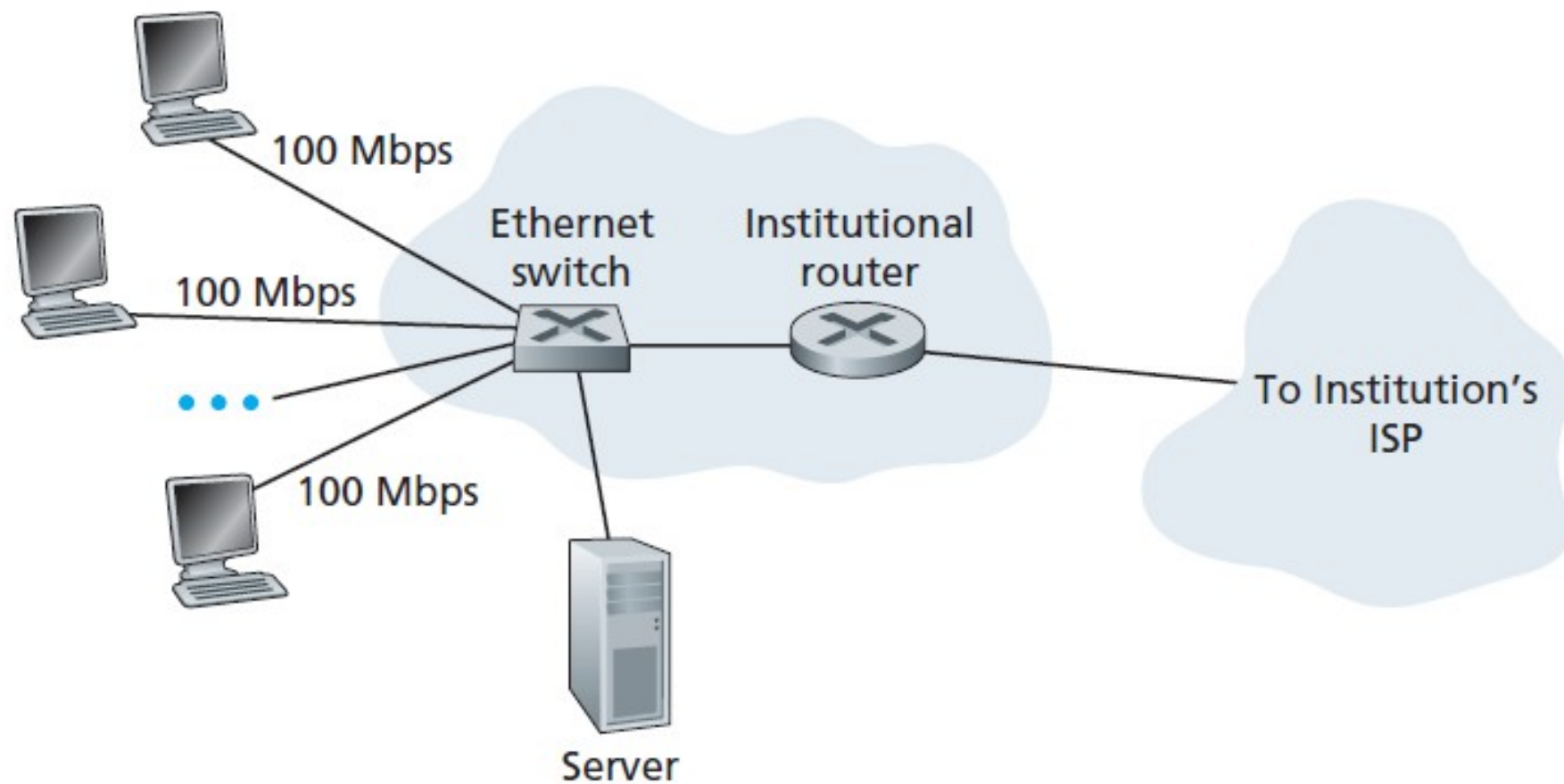
Figure 1.8 ♦ Ethernet Internet access

Figure 1.9 ♦ A typical home network

Wide-Area Wireless Access

- Mobile Networks
- 3G, 4G, 5G, LTE

References

- https://www.computernetworkingnotes.com/networking-tutorials/network-cable-types-and-specifications.html