1403322 Computer Communication Systems

Dr Imran Tasadduq

Textbook

- Data Communications & Networking by Behrouz A. Forouzan (5th Edition)

Class Schedule

	Sunday	Monday	Tuesday	Wednesday	Thursday
8:00 am to 8:50 am				**Lecture (6ح)**	
9:00 am to 9:50 am				**Lecture**	
10:00 am to 10:50 am					
11:00 am to 11:50 am					
1:00 pm to 1:50 pm					
2:00 pm to 2:50 pm		**Lecture (8ح)**			

Course Material

- Lecture slides will be available through Dropbox
- Important announcements will be made through emails
- Students should bring the original text book with them in the class room and also a calculator

Marking Scheme

Lab	Mid-Term	Project	Final	Total
25	25	10	40	100

Do not miss the mid term. There will be no make up exam

Attendance

- Students are required to be punctual in lectures
- A student will get two points of attendance in a two hour class and one point in a one hour class if he arrives before the attendance call
- A student **coming late or leaving early** will get only one point of attendance in a two hour class and half point in a one hour class
- More than 25% absence is not allowed and according to the rules any student with more than 25% absence will get "meHroom" grade
- In other words, if you are absent for more than three weeks, you will get "meHroom"

Penalties

- You will receive "–1" mark in ALL of the following cases:
  - —You are "handling" a mobile phone during the lecture
  - —You are talking during the lecture
  - —You are sleeping during the lecture
  - —You are doing something else, e.g., doing homework of other courses

Why study Computer Communication Systems?

- An extremely important and fast growing area of Computer Engineering
- Nowadays there is no computing without being online, e.g.,
  - — You cannot access email
  - — You cannot browse the internet
  - — You cannot access your student record at UQU
  - — You cannot register for courses
  - — …
- Other areas of computing that require communication and networks are:
  - — Video Conferencing
  - — Voice over IP (VoIP)
  - — File sharing
  - — Print sharing
  - — Distributed computing
  - — Online backup and storage
  - — Cellular communication
  - — Global Positioning System (GPS)
  - — Online banking
  - — …

Why study Computer Communication Systems?

- If you would like to do a graduation project based upon computer networks, wired or wireless communications then you need to know how computers communicate

What this course will cover?

- An introduction to basic communication
- How computers communicate
- How the information is transmitted from one point to the other
- How information is converted into signals before transmission
- How various senders can communicate using a single channel

Prerequisites



Course Learning Outcomes (CLOs)

- CLOs are the abilities that students will gain by the end of the course
- For example, once you complete a basic course in communication, you should have the following abilities:
  - "an ability to design a communication system"
  - "an ability to convert an analog signal into a digital signal"

CLOs of Computer Communication Systems

1. An ability to comprehend the fundamentals of data communications.
2. An ability to apply mathematical foundations to solve problems involving digital and analog signals.
3. An ability to comprehend analog and digital transmission.
4. An ability to apply knowledge of multiplexing and spectrum spreading.
5. An ability to understand the fundamentals of transmission media.
6. An ability to design different types of switches.
7. An ability to highlight the challenges/issues of modern communication systems through a technical report/presentation
8. An ability to design and conduct experiments in the area of communications

CLOs of Computer Communication Systems

- At the end of the course, you will tell us how much did you learn these CLOs
- For this purpose, you will fill a form

Student Outcomes (SOs)

- These are general abilities that students should attain by the time they graduate
- There are 11 abilities that are called "a" to "k" outcomes as defined by ABET
- Usually, a single course cannot cover all the outcomes. Some outcomes are covered by a group of courses while others are covered by other courses.

Student Outcomes (SOs)

- This course covers following six student outcomes:
  - (a) an ability to apply knowledge of mathematics, science and engineering
  - (b) an ability to design and conduct experiments, as well as to analyze and interpret data
  - (i) a recognition of the need for, and an ability to engage in life-long learning
  - (j) a knowledge of contemporary issues
  - (k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

Relationship between CLOs and SOs

Student Outcomes – Mapped to Course Learning Outcomes											
CLOs	**(a)**	**(b)**	**(c)**	**(d)**	**(e)**	**(f)**	**(g)**	**(h)**	**(i)**	**(j)**	**(k)**
1	1										
2	1				1						
3	1										
4	1				1						
5	1										
6			1								
7						1	1			1	
8		1									1

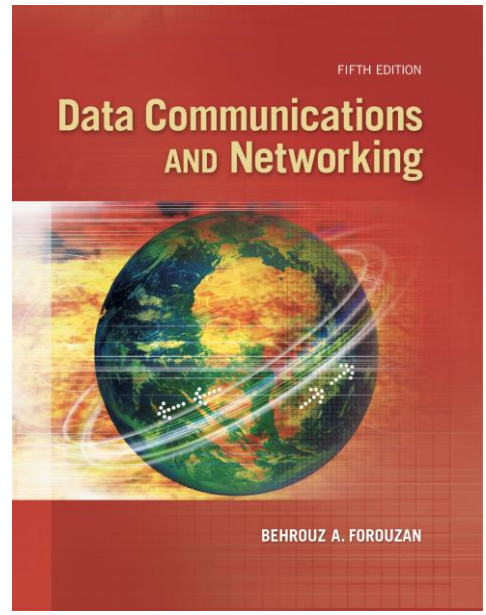
Teaching Plan

	Chapters	Hours	Weeks
1	Introduction	3	1
2	Network Models	6	2
3	Introduction to Physical Layer	9	3
4	Digital Transmission	6	2
5	Analog Transmission	6	2
6	Bandwidth utilization: Multiplexing and spreading	6	2
7	Transmission Media	3	1
8	Switching	9	3
	Total	48	16

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Chapter 1

Introduction



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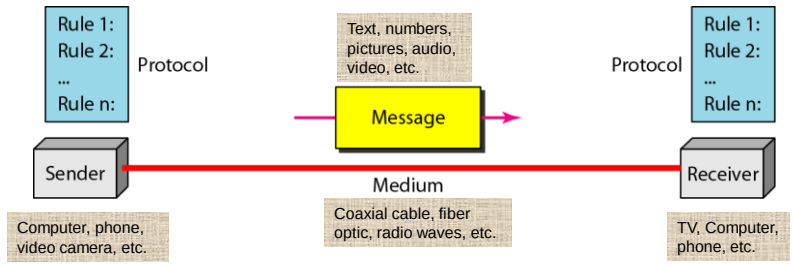
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1-1 DATA COMMUNICATIONS

- ***Data communications** is the exchange of data between two devices via some form of transmission medium such as a wire cable.*

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Figure 1.1 *Five components of data communication*



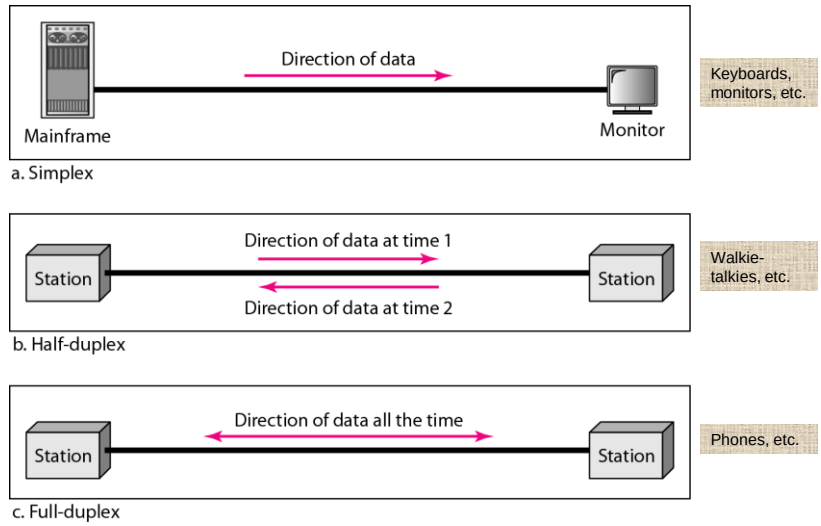
1.24

Data Representation

- Information today comes in different forms such as text, numbers, images, audio, and video.
- Read pages 5 and 6 of the textbook for a review of data representation

1.25

Figure 1.2 *Data flow (simplex, half-duplex, and full-duplex)*



1.26

1-2 NETWORKS

A network is a set of devices (often referred to as nodes) connected by communication links.

A node can be a computer, printer, a mobile device, or any other device capable of sending and/or receiving data generated by other nodes on the network.

1.27

Network Criteria

- **Performance:** Performance of a network depends on a number of factors. For example,
  - Number of users
  - Type of transmission medium
  - Hardware used
  - Software used
- Performance is evaluated by
  - Throughput (the average rate of successful message delivery over a communication channel)
  - Delay

1.28

Network Criteria

- **Reliability:** It is measured by,
  - Frequency of failure
  - Time to recover from a failure
- **Security:**
  - Protecting data from unauthorized access
  - Protecting data from damage
  - Implementing procedures for recovery from data losses

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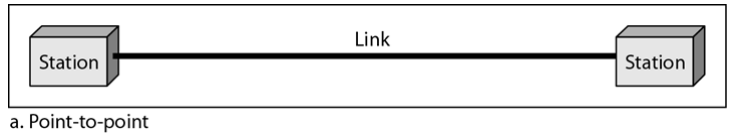
Physical Structure of Networks

- **Link:** A network is formed by connecting two or more devices through "links". A link is a communication pathway that transfers data from one device to another. There are two main types of links or connections:
  - Point-to-point
  - Multipoint

1.30

Point-to-Point Connection

- It is a dedicated link between two devices.
- The entire capacity of the link is reserved for transmission between those two devices.

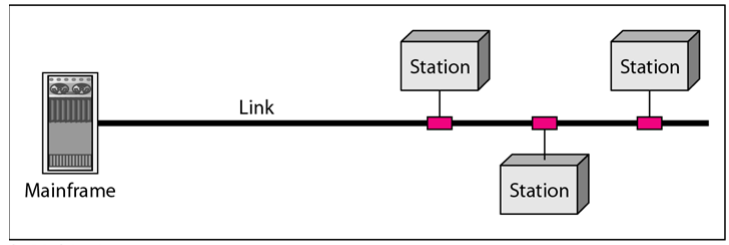


a. Point-to-point

1.31

Multipoint Connection

- More than two devices share a single link. See the diagram below:



b. Multipoint

1.32

Physical Topology

- This is the actual physical layout of a network.
- Two or more devices connect to a link; two or more links form a topology
- Four basic topologies are:
  - Mesh
  - Star
  - Bus
  - Ring

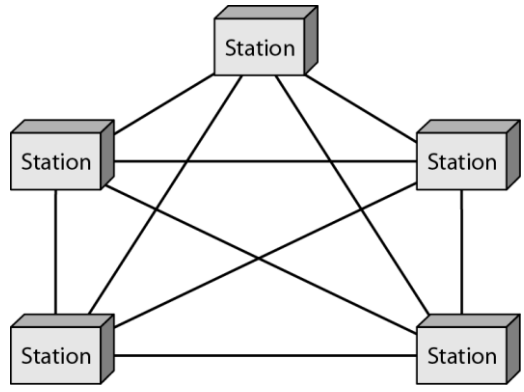
1.33

Mesh Topology

- Every device has a dedicated point-to-point link to every other device
- Dedicated means that the link carries traffic only between the two devices it connects

1.34

Figure 1.5 *A fully connected mesh topology (five devices)*



1.35

Mesh Topology

- Since every node is connected to every other node, if there are five nodes, we need 5 x 4 = 20 physical links
- If each physical link allows duplex communication, the number of links are to be divided by 2, i.e.,

  (5 x 4)/2 = 20/2 = 10 physical links are needed for five nodes.
- In general, if there are n nodes, in a mesh topology, we would require $n(n-1)/2$ duplex mode links
- Read advantages and disadvantages of Mesh Topology from the textbook (page 10)

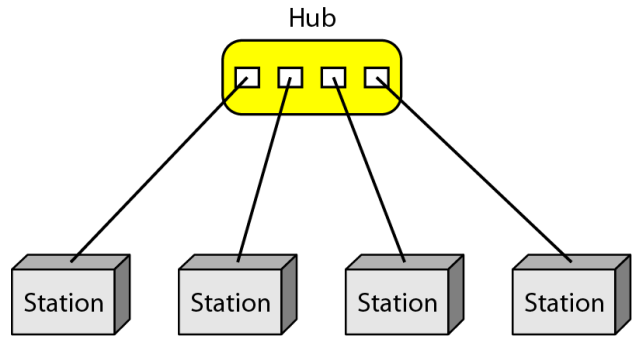
1.36

P1-7. Assume eight devices are arranged in a mesh topology. How many cables are needed? How many ports are needed for each device?

(A computer **port** is a type of electronic, software- or programming-related docking point through which information flows from a program on your computer or to your computer from the Internet or another computer in a network.)

1.37

Figure 1.6 *A star topology connecting four stations*



(Read advantages and disadvantages of Star Topology on pages 10-11)

1.38

Hub

- Data is "broadcast" to every one of its ports.
- It doesn't matter that the data is only destined for one port. The hub has no way of distinguishing which port data should be sent to.
- Passing it along to every port ensures that it will reach its intended destination.
- This places a lot of traffic on the network.

1.39

Switch

- A switch keeps a record of addresses of all the devices connected to it.
- With this information, a switch can identify which system is sitting on which port.
- When data is received, it knows exactly which port to send it to, without significantly increasing network response times.

1.40

Router

- Routers job is to route data to other networks until that data ultimately reaches its destination.
- A router is typically connected to at least two networks, commonly two Local Area Networks (LANs) or Wide Area Networks (WAN).
- Routers are located at gateways, (the places where two or more networks connect).
- Using headers and forwarding tables, routers determine the best path for forwarding the data.

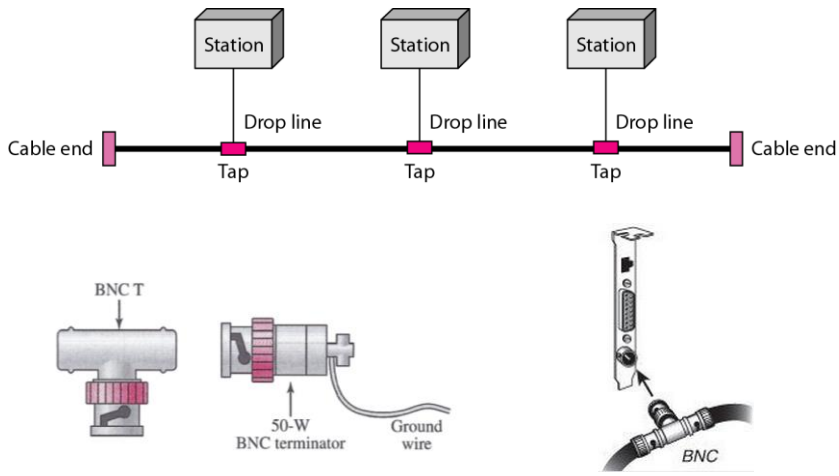
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Star Topology

- A star topology does not allow direct traffic between devices
- The controller (hub) acts as an exchange: If one device wants to send data to another, it sends the data to the controller which then relays the data to the other connected device
- It is less expensive than mesh because each device needs only one link and one I/O port to connect it to any number of users
- Far less cabling is needed
- If one link fails, only that link is affected. All other links remain active

1.42

Figure 1.7 *A bus topology connecting three stations*



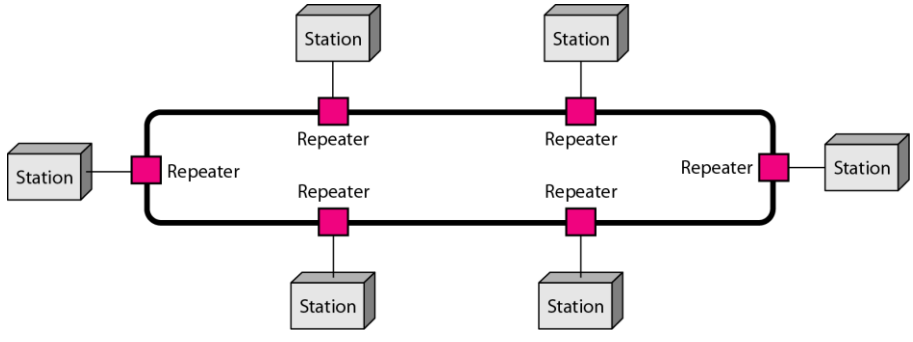
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Bus Topology

- As a signal travels along the backbone, it becomes weaker and weaker. Therefore, there is a limit on the number of taps a bus can support and on the distance between those taps.
- Requires less cabling
- Difficult to isolate faults
- Difficult to add new devices
- A fault or break in the backbone (bus cable) stops all transmission
- Read more about Bus Topology from the textbook (pages 11 & 12)

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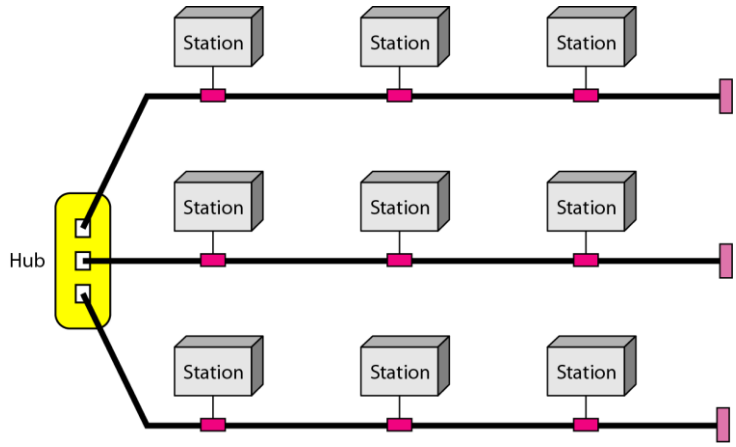
Figure 1.8 *A ring topology connecting six stations*



Read more about Ring Topology on page 12

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Figure 1.9 *A hybrid topology: a star backbone with three bus networks*



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P1-6. For each of the following four networks, discuss the consequences if a connection fails.

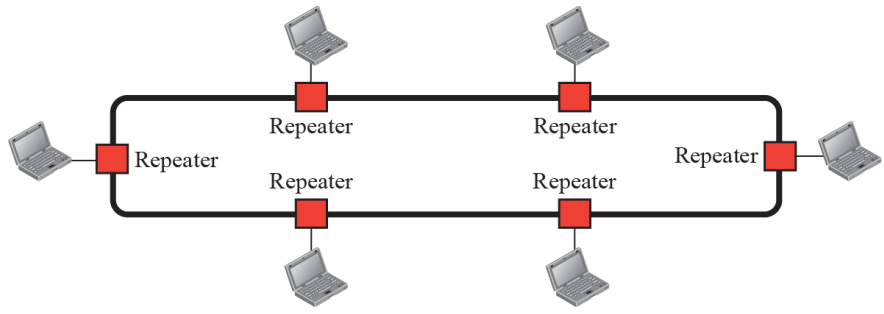
a. Seven devices arranged in a mesh topology

b. Seven devices arranged in a star topology (not counting the hub)

c. Seven devices arranged in a bus topology

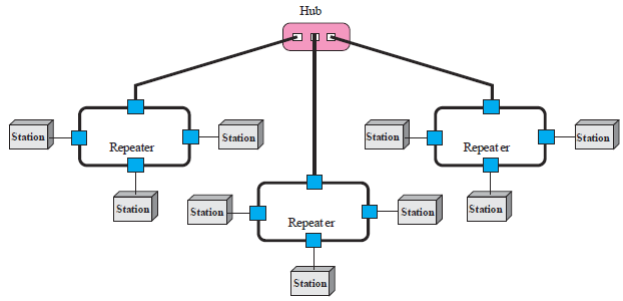
d. Seven devices arranged in a ring topology

P1-10. In the ring topology in Figure 1.7, what happens if one of the stations is unplugged?



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21. Draw a hybrid topology with a star backbone and three ring networks.



P1-8. Performance is inversely related to delay. When we use the Internet, which of the following applications are more sensitive to delay?

a. Sending an e-mail

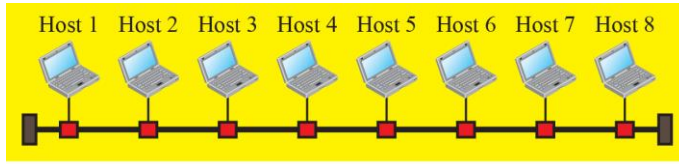
b. Copying a file

c. Surfing the Internet

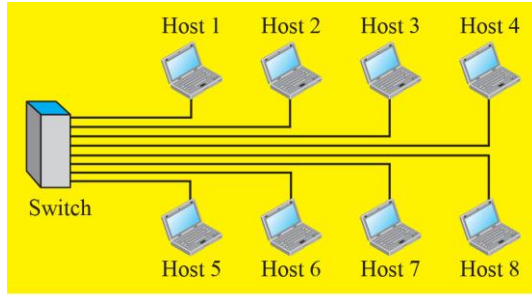
Network Categories

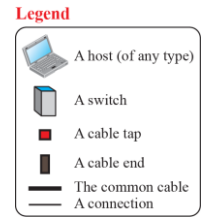
- Local Area Network (LAN)
  - It is usually privately owned and links the devices in a single office, building, or campus
  - A LAN can be as simple as two PCs and a printer in someone's home office or it can extend throughout a company
  - The network in UQU is a LAN

Figure 1.8: ***An Isolated LAN in the past and today***



a. LAN with a common cable (past)





b. LAN with a switch (today)

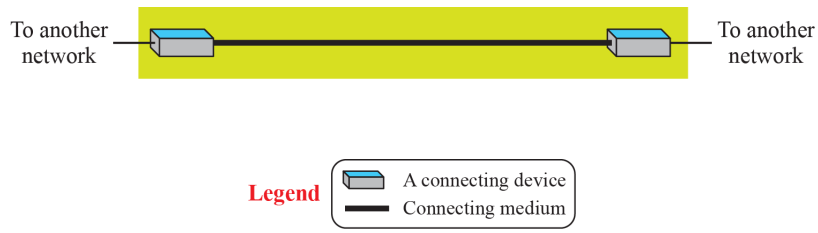
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Network Categories

- Wide Area Network (WAN)
  - It provides long-distance transmission of information over large geographic areas that may comprise a country, a continent, or even the whole world
  - A point-to-point WAN is a network that connects two devices through a transmission medium.
  - A switched WAN is a network with more than two ends.

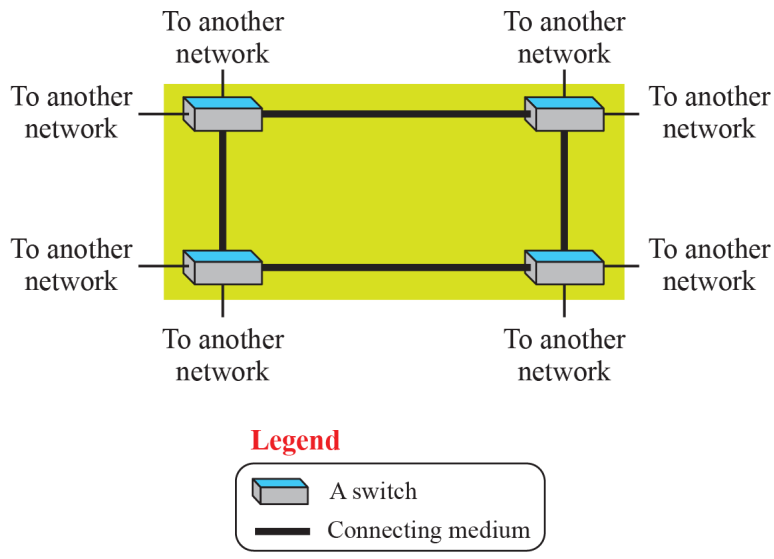
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Figure 1.9: *A Point-to-Point WAN*



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Figure 1.10: *A Switched WAN*



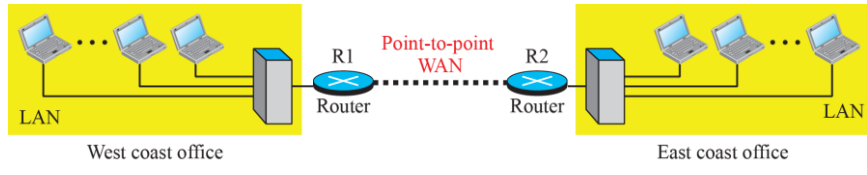
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Internetwork

- When two or more networks are connected, they become an "internetwork" or "internet" (note the small alphabet "i" in internet)
- For example, the UQU LAN in Aziziyah campus and the one here in Abdiyah are connected together. This is an internetwork
- Another example is shown on the next slide

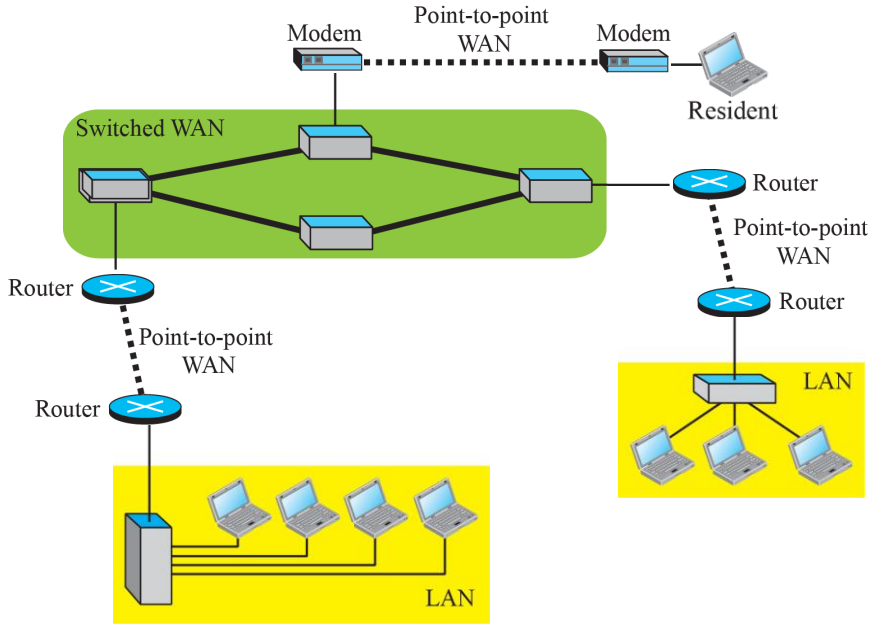
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Figure 1.11: ***An internetwork made of two LANs and one WAN***



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Figure 1.12: *A heterogeneous network made of WANs and LANs*



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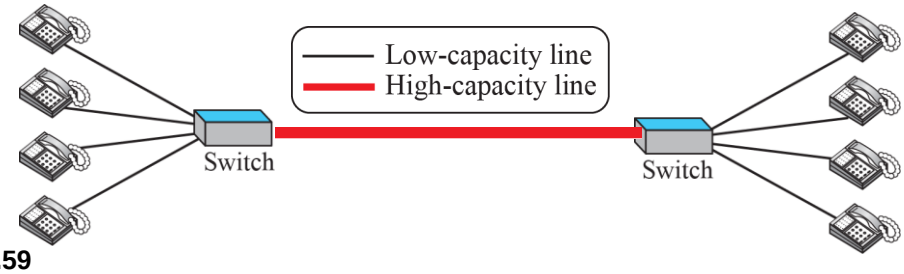
1.3.3 Switching

- *An internet is a switched network in which a switch connects at least two links together.*
- *A switch needs to forward data from a network to another network when required.*
- *The two most common types of switched networks are circuit-switched and packet-switched networks. We discuss both next.*

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Circuit-Switched Network

- In this type of network, a dedicated connection, called a circuit, is always available between the two devices



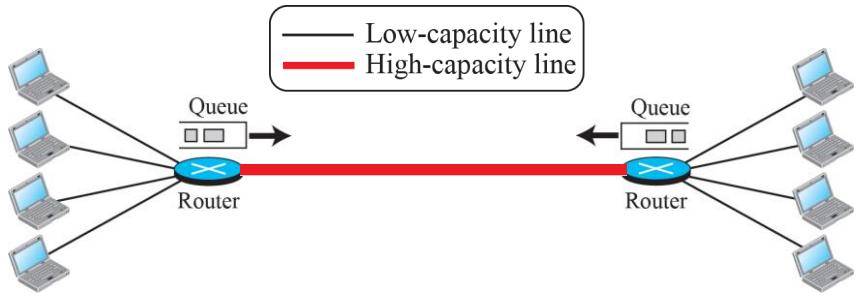
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Circuit-Switched Network

- Case 1: Assume all telephone sets are busy on both sides
  - the capacity of the thick line is fully used
- Case 2: only one telephone set at one side is connected to a telephone set at the other side
  - Only one-fourth of the capacity of the thick line is used.
- This means that circuit switched network is efficient only when it is working at its full capacity
- Most of the time it is inefficient

1.60

Packet-Switched Network



- Communication is done in blocks of data called packets
- Routers store and forward packets
- Capacity of the red link does not have to be four times

1.61

1.3.4 The Internet

- ***As we discussed before, an internet (note the lowercase i) is two or more networks that can communicate with each other.***
- ***The most notable internet is called the Internet (uppercase I), and is composed of thousands of interconnected networks.***

1.62

1.3.5 Accessing the Internet

- *The Internet today is an internetwork that allows any user to become part of it.*
- *The user, however, needs to be physically connected to an ISP.*
- *The physical connection is normally done through a point-to-point WAN.*
- *Read pages 17 – 19 for further details*

1.63

1-4 INTERNET HISTORY

Read this section from the textbook on pages 19 to 22

1-5 STANDARDS AND ADMINISTRATION

Read this section from the textbook on pages 22 to 25

1.64

Problems

- Solve problems P1-1, P1-3, P1-4, P1-6 to P1-10
- Solve the quiz on book's website: http://www.mhhe.com/forouzan
  1. Click on the textbook (5th Edition)
  2. Click on "Student Resources" on the left
  3. Choose Chapter from the menu on the left
  4. Click "Quizzes"