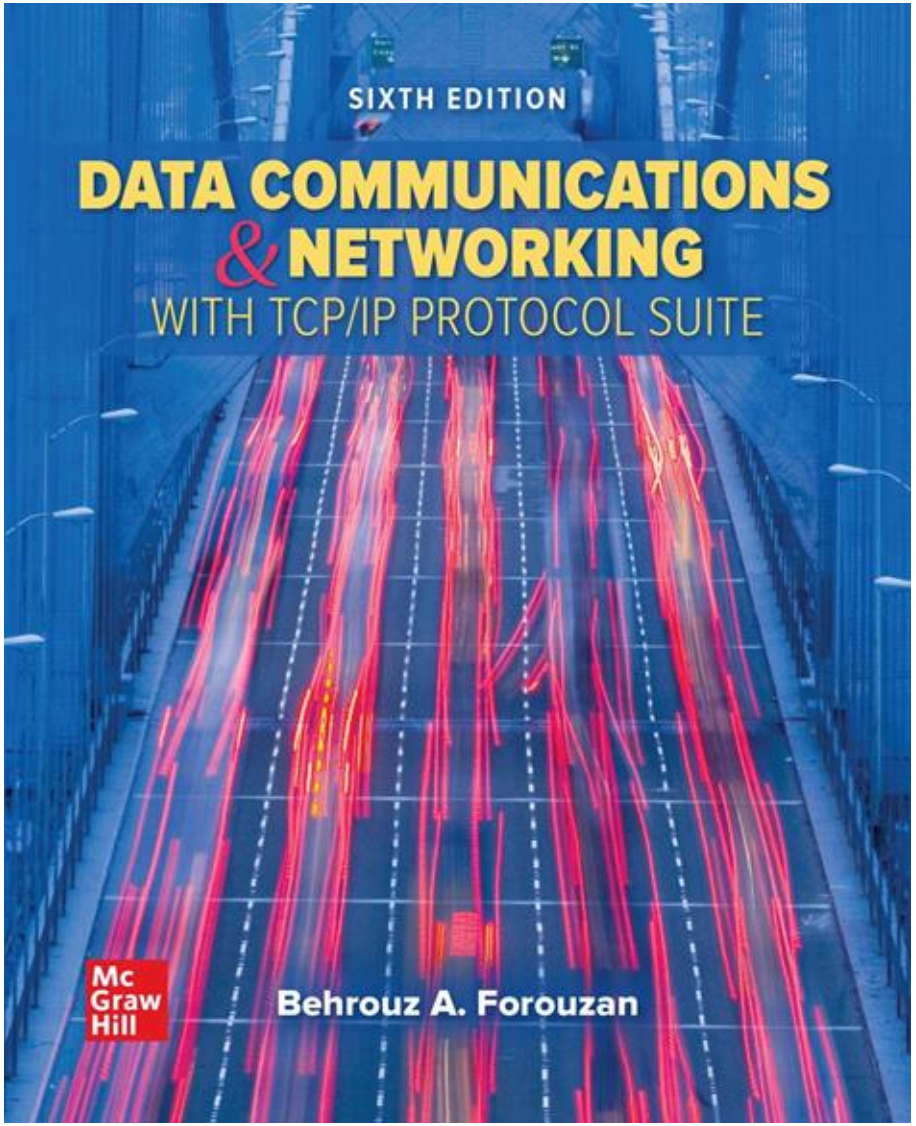
Chapter 01

Introduction

- Data Communications and Networking, With TCP/IP protocol suite Sixth Edition
- Behrouz A. Forouzan



Chapter 1-Part 1: Outline

- 1.1 DATA COMMUNICATIONS
- 1.2 NETWORKS
- 1.3 NETWORK TYPES

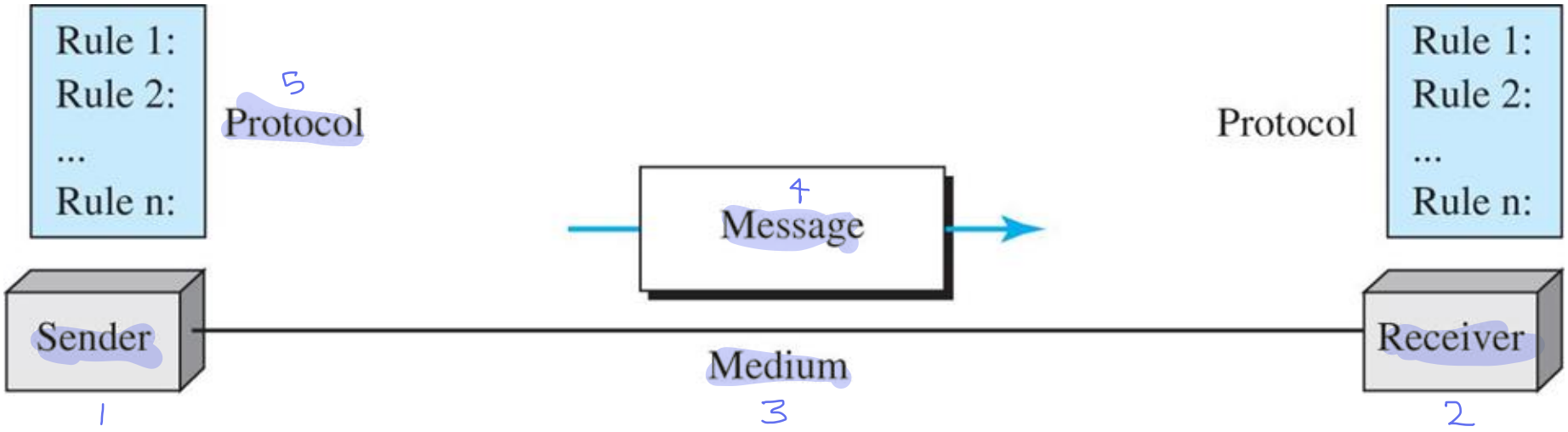
Data Communications

- The exchange of Information between two devices through a transmission medium

① Guided
- Twisted pair
- fiber optics
- coaxial

② Unguided
- Microwave
- Infrared
- Radio

Figure 1.1 Five components of data communication



1.1.2 Message

- Information today comes in different forms such as text, numbers, images, audio, and video.
  - Text is represented as a bit pattern using Unicode.
  - Numbers are represented in binary. 0,1
  - Images are represented as bit patterns
  - Audio refers to the recording or broadcasting of sound or music. of sound/music
  - Video is a series of images displayed in rapid succession.

1.2 Networks

- A network is a set of devices (called **nodes**) connected by **communication links**
  - **Node** can be **host** (a computer, printer, cell phone) or networking devices (routers, switches, modem, etc…)
  - **Link** is a communication **pathway** that transfer data from one device to another
  - Link can be wired or wireless
- Type of network connections
  - Point-to-Point: dedicated link between two devices
  - Multipoint : shared link between more than two devices

- Distributed system vs. Computer networks
- A network must be able to meet a certain **number of criteria**. The most important of these are:
  - **Performance**
    - Depends **on factors** such as:
      - # of users, type of transmission medium, capabilities of Network hardware, Network software efficiency
    - Evaluated by:
      - **Throughput** (**amount of data a user can send**)
      - **Delay** (**measured in transit time, and response time**)
    - To have good performance, we need more throughput and less delay (**contradict each other, because when throughput increases, it means more data arrive to the network, this will increase the delay**

  - **Reliability**
    - Measured by:
      - Frequency of failure
      - Time it takes a link to recover from the failure
  - **Security**
    - Protecting data from unauthorized users, and damage, applying security policies for recovery from breaches and data losses

Figure 1.5 *Point-to-point connection*

Dedicated

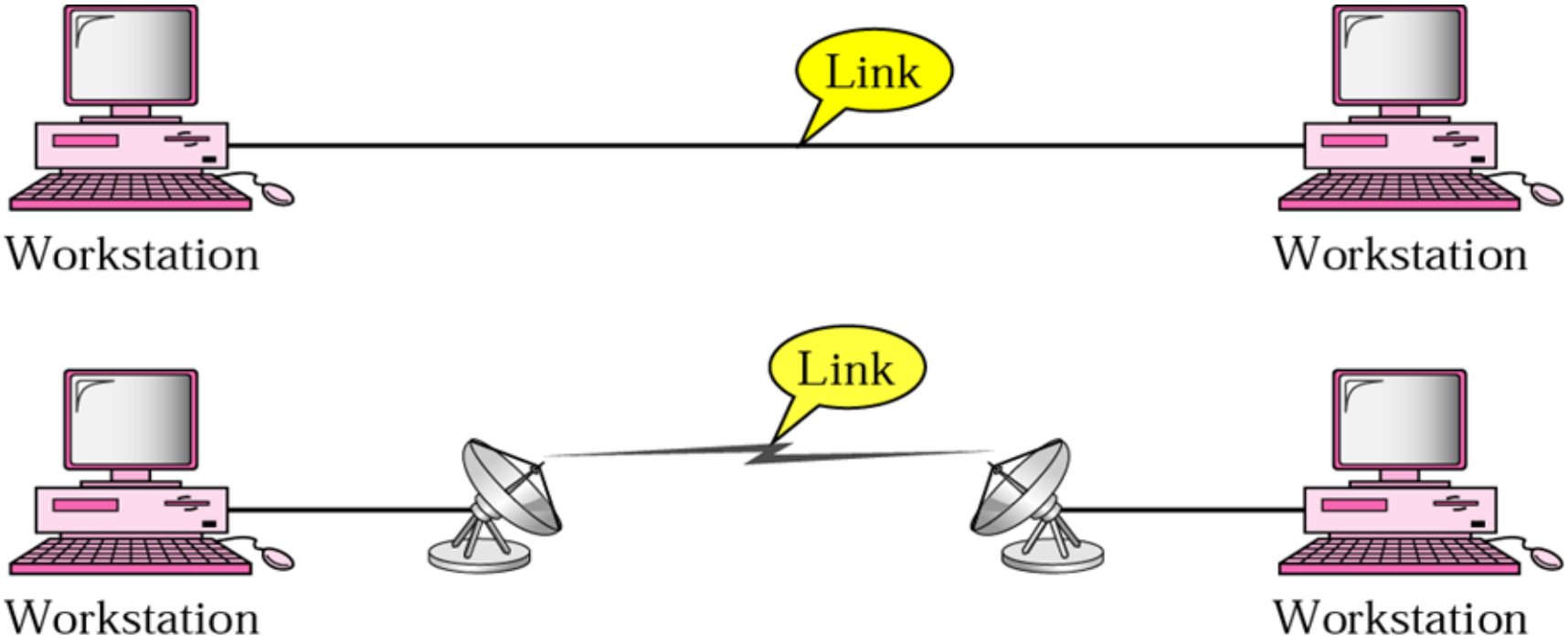
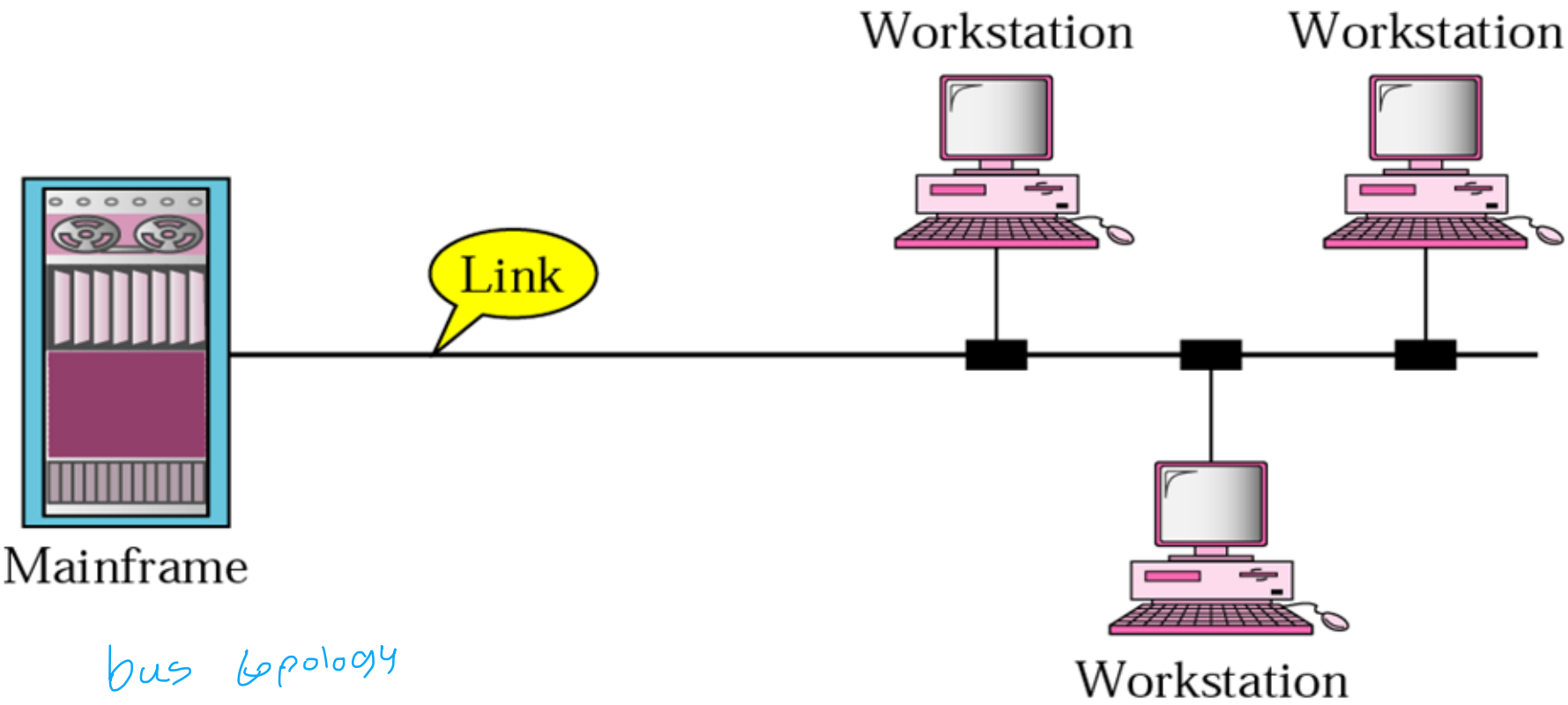


Figure 1.6 *Multipoint connection (shared)*



bus topology

Figure 1.2: *Data flow (direction of data flowing in the link)*

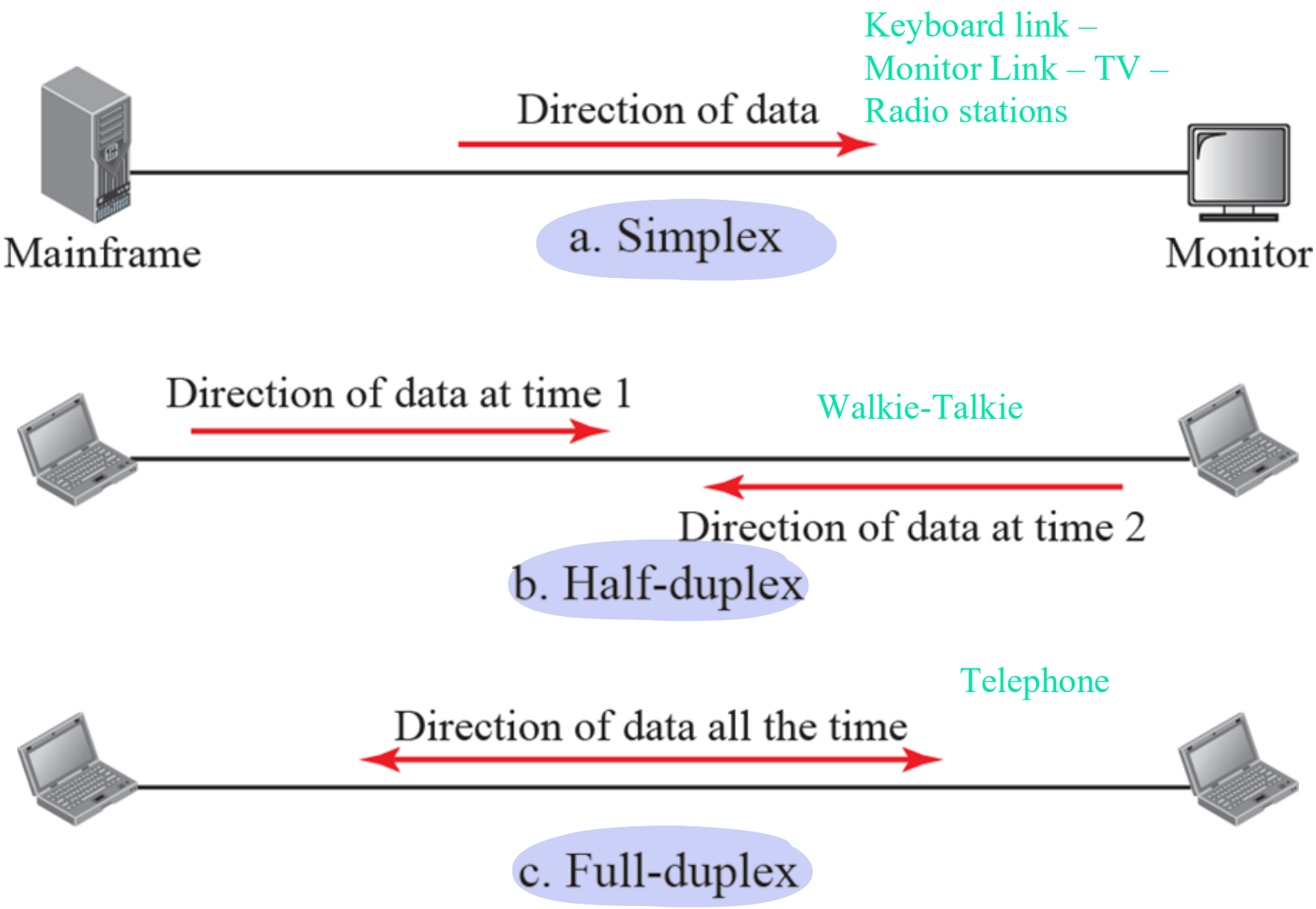
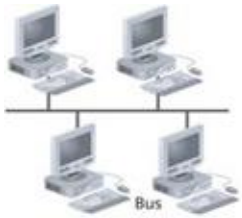
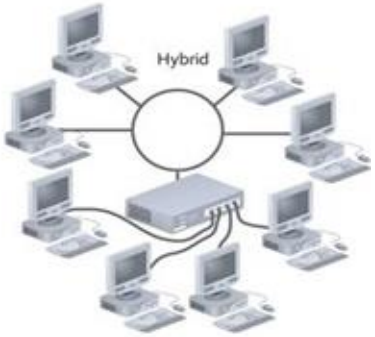


Figure 1.7 *Categories of topology*

Topology: **The way in which a network is physically built or**

The way in which devices interconnect across the network





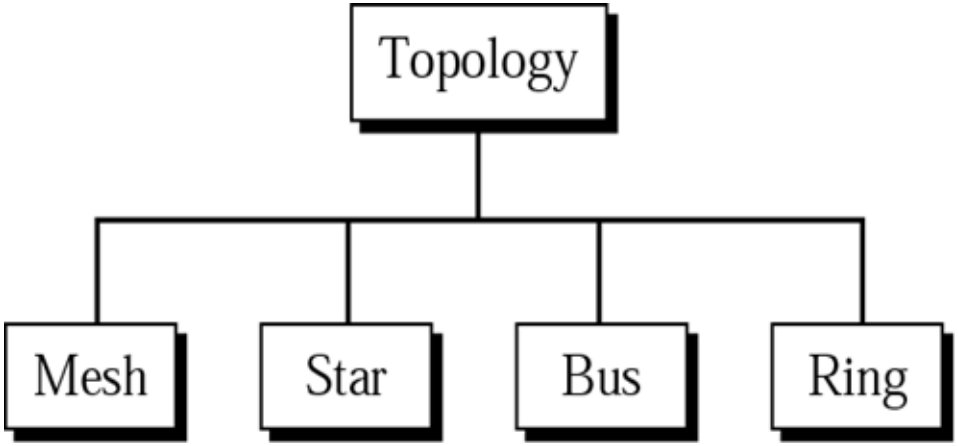


Figure 1.8 *Fully connected mesh topology (for five devices)*

Mesh

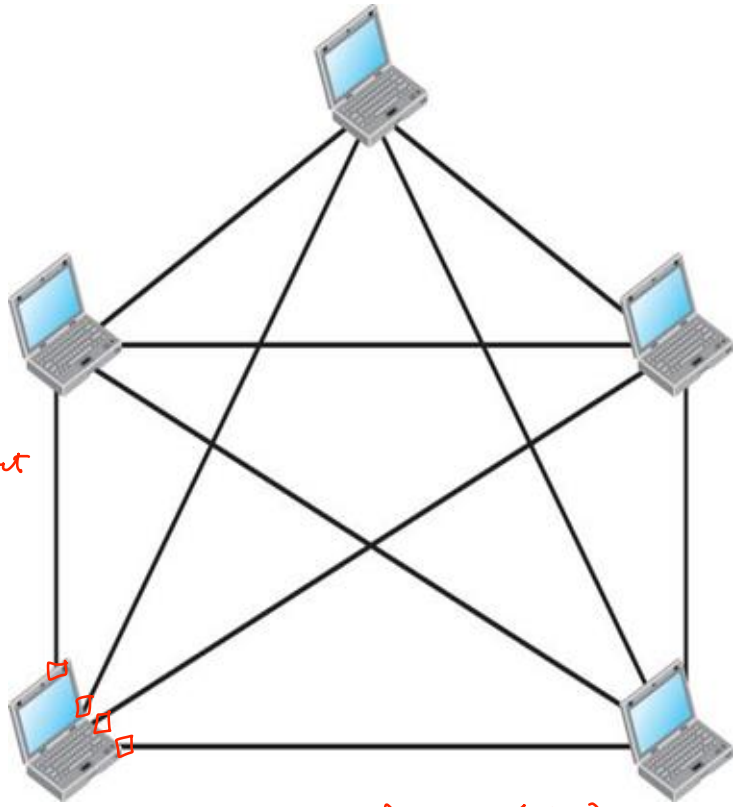
- *Dedicated point-to-point link to every other node*
- Number of links = N(N-1)/2
- Advantages

  n = nodes = devices

  - Dedicated links → secure, no traffic problems (no congestion)
  - Robust: if one link fails, the network will still work
  - Easy to discover faulty links
- Disadvantages?

  only 1 difficult to install

  most wires out of all
  - Difficult to install & update (too much wiring)
  - Expensive (why?) $$ # NIC, # I/O ports = (n-1)/device; # cables/links
  - Number of Network interface cards (NIC) or Number of I/O ports = (N-1)per device
  - Number of cables = Number of links



I/O ports = (n-1)/device → (5-1)/device → 4

Figure 1.9 *Star topology*

- ***Dedicated point-to-point link to a central controller only***
- ***Number of links = N***
- **Advantages**
  - **Less expensive than mesh**
  - **Easy to install**
  - **Easy to add and remove devices**
  - **Robust**
  - **Easy to discover faulty links**
  - **Secure but less than mesh**
- **Disadvantages?**
  - **If the central device failed the whole network will not function**

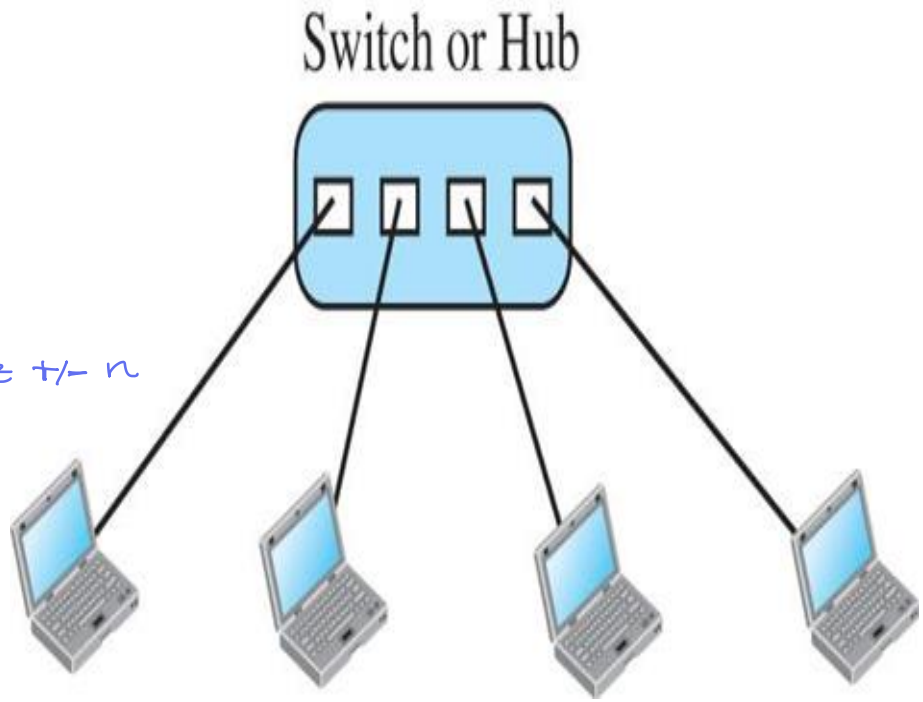
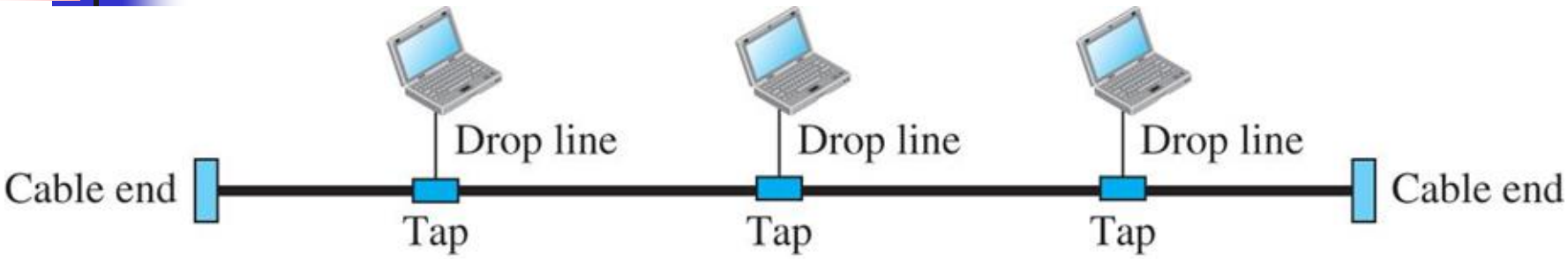


Figure 1.10 *Bus topology*



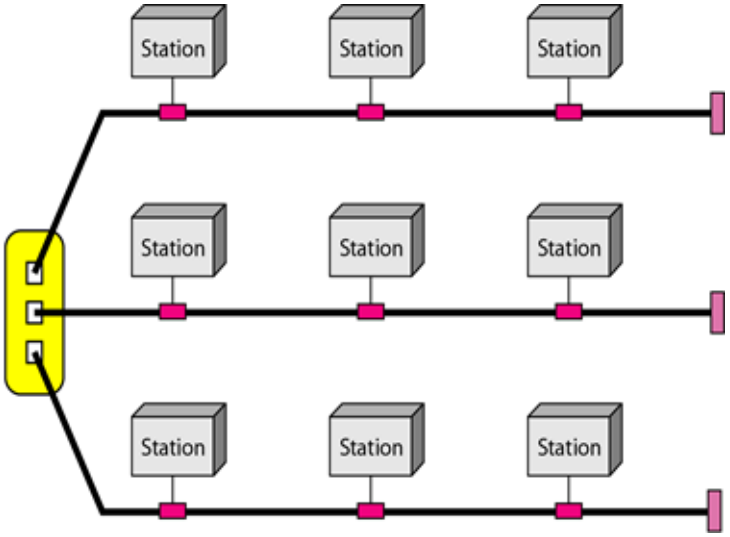
- ***Number of links = 1 Main + N droplines***
- **Advantages**
  - **Easy to install**
  - **less cabling than mesh and hub**
- **Disadvantages?**
  - **Difficult to isolate fault**
  - **Difficult to add new devices**
  - **A break in the bus cable stops all transmission**

Only 1 hard to isolate fault

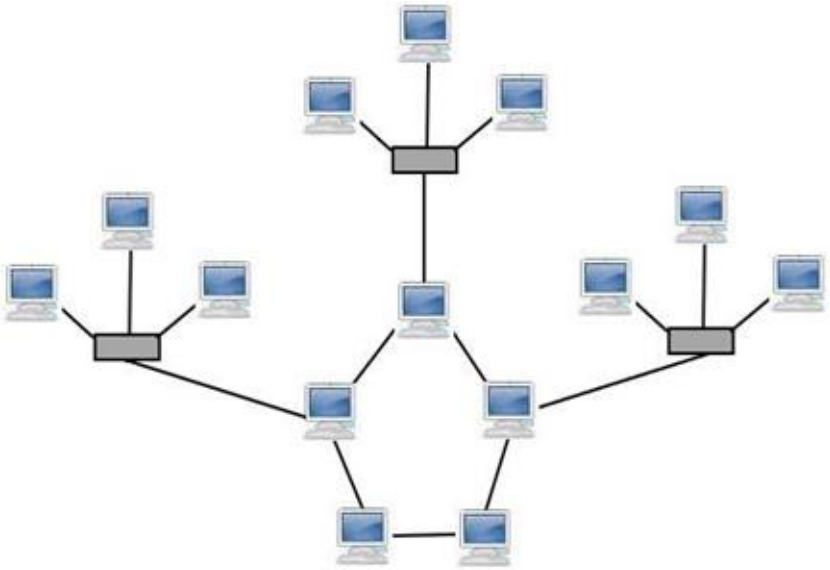
Figure 1.11 *Ring topology*

- **Dedicated point-to-point link between a node and the two nodes on either side of it**
- ***Number of links = N***
- **Advantages**
  - **Easy to install**
  - **less cable**
  - **Easy to add or remove a device** → like star
  - **Fault isolation is easy**
- **Disadvantage?** only 1 not robust
  - **Not robust**

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



Star - Bus



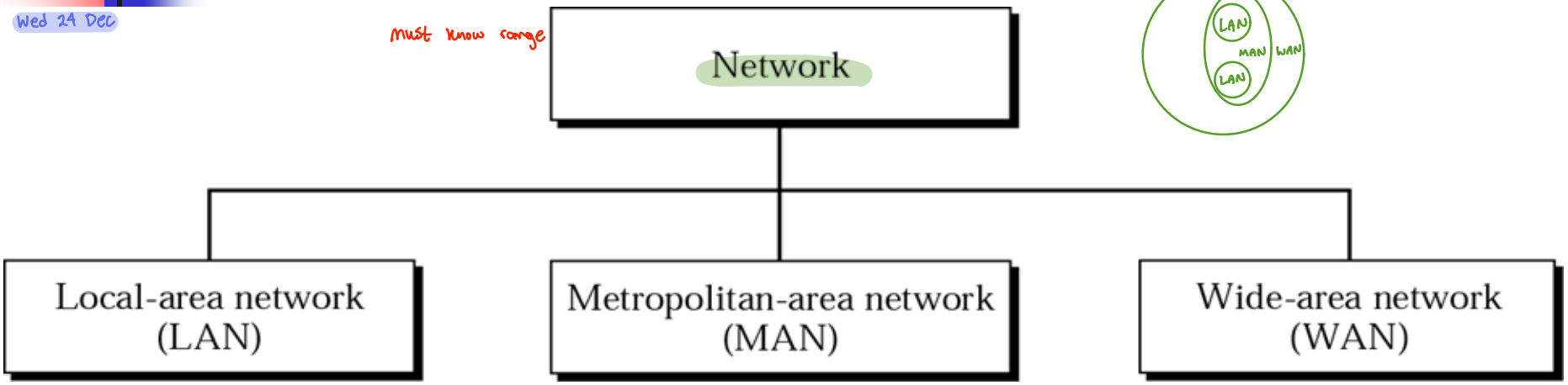
Star - Ring

List more dominant one 1st

Figure 1.12 *Categories of networks*

Wed 24 Dec

must know range

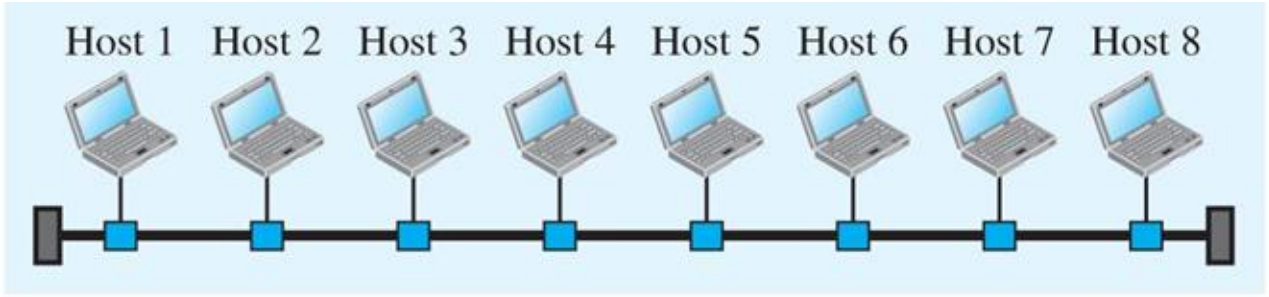


Interprocessor distance	Processors located in same	Example
1 m	Square meter	Personal area network
10 m	Room	Local area network
100 m	Building	
1 km	Campus	
10 km	City	Metropolitan area network
100 km	Country	Wide area network
1000 km	Continent	
10,000 km	Planet	The Internet

even 2 cities is MAN

5km in LAN

Figure 1.8 An isolated LAN in the past and today

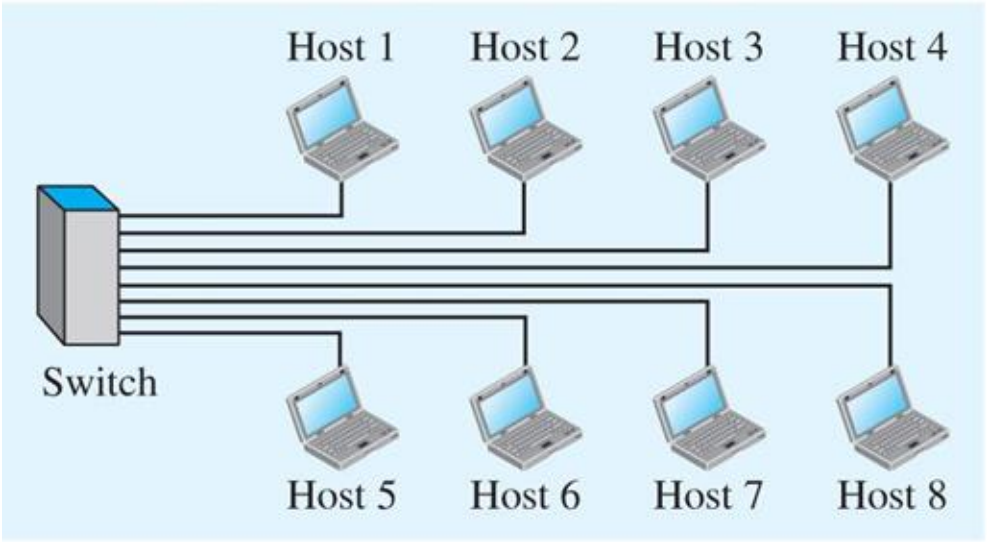


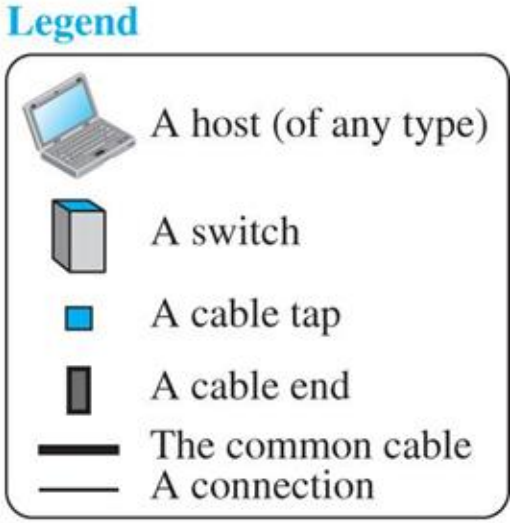
uncommon to use today

1 common LAN

Bus network

a. LAN with a common cable (past)





b. LAN with a switch (today)

Figure 1.14 *MAN*

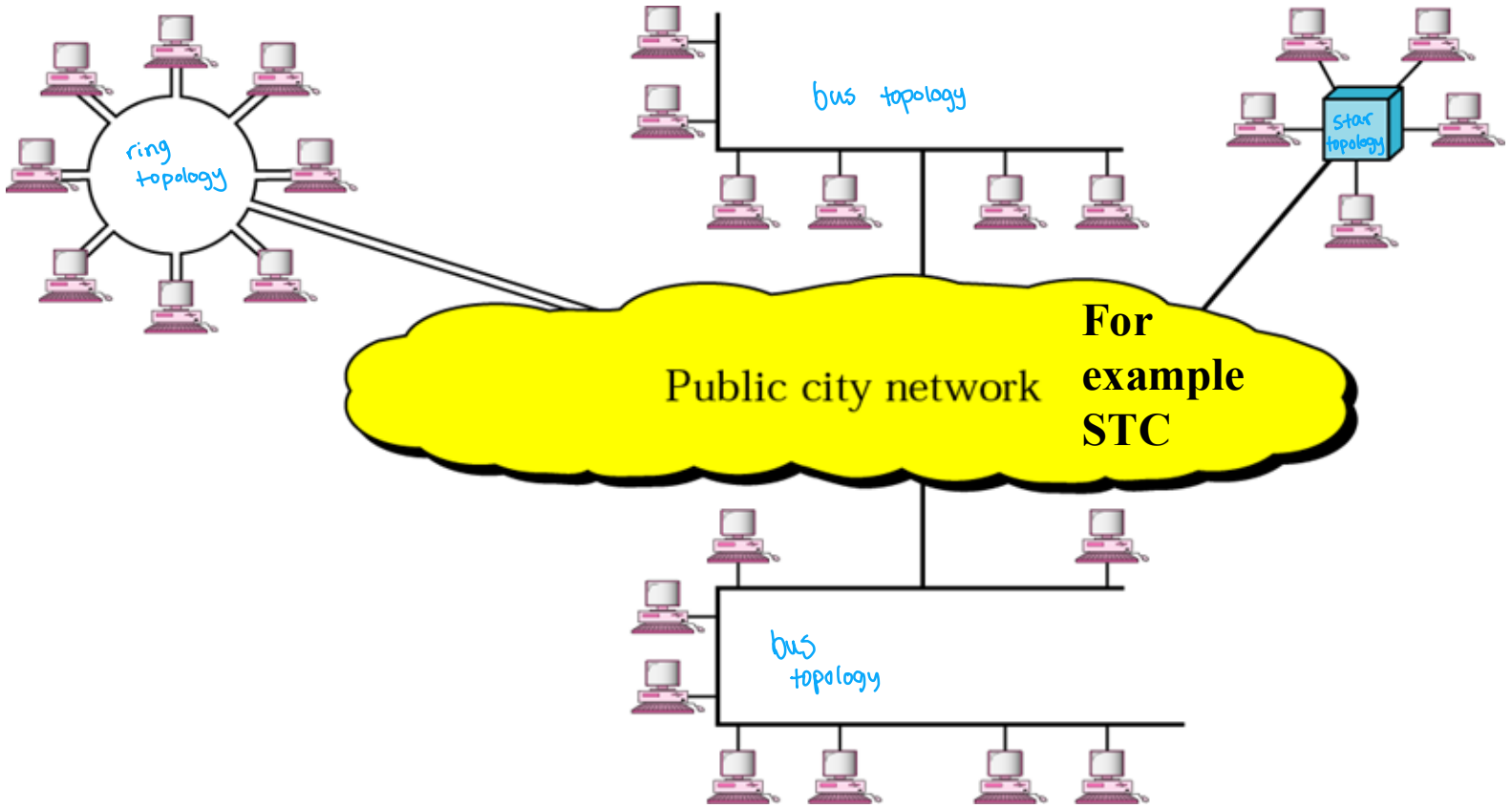


Figure 1.13 *LAN (two buildings)*

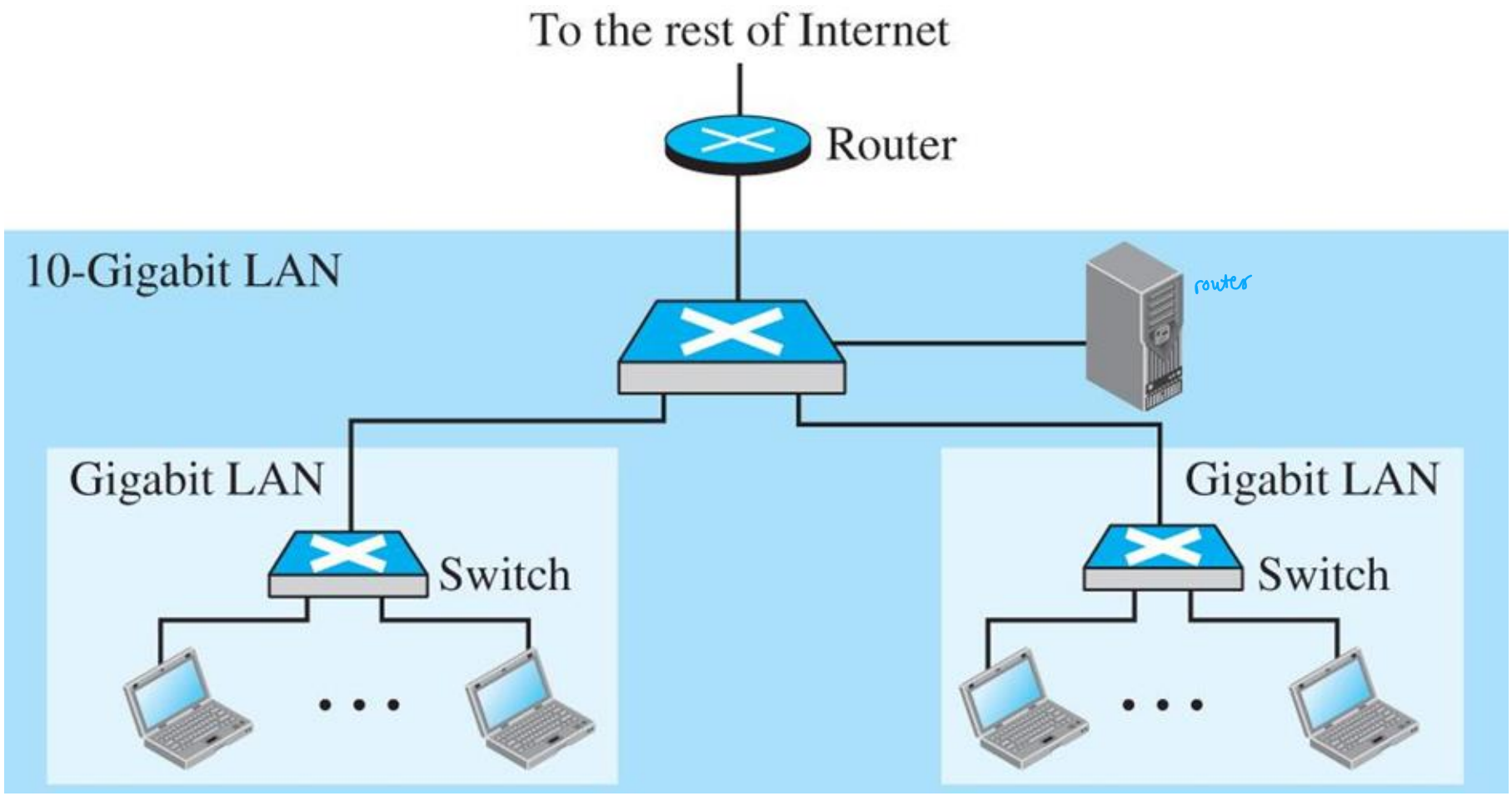


Figure 1.11 An internetwork made of two LANs and one WAN

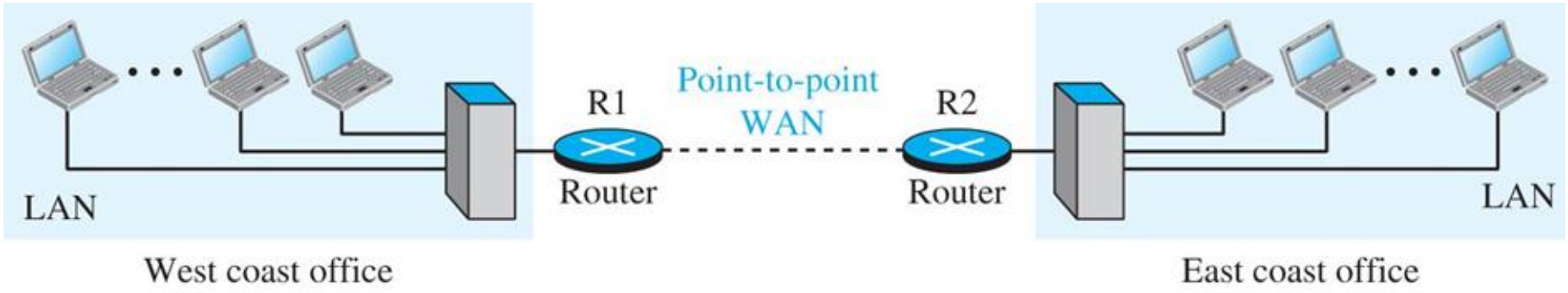


Figure 1.12 A heterogeneous network made of WANs and LANs

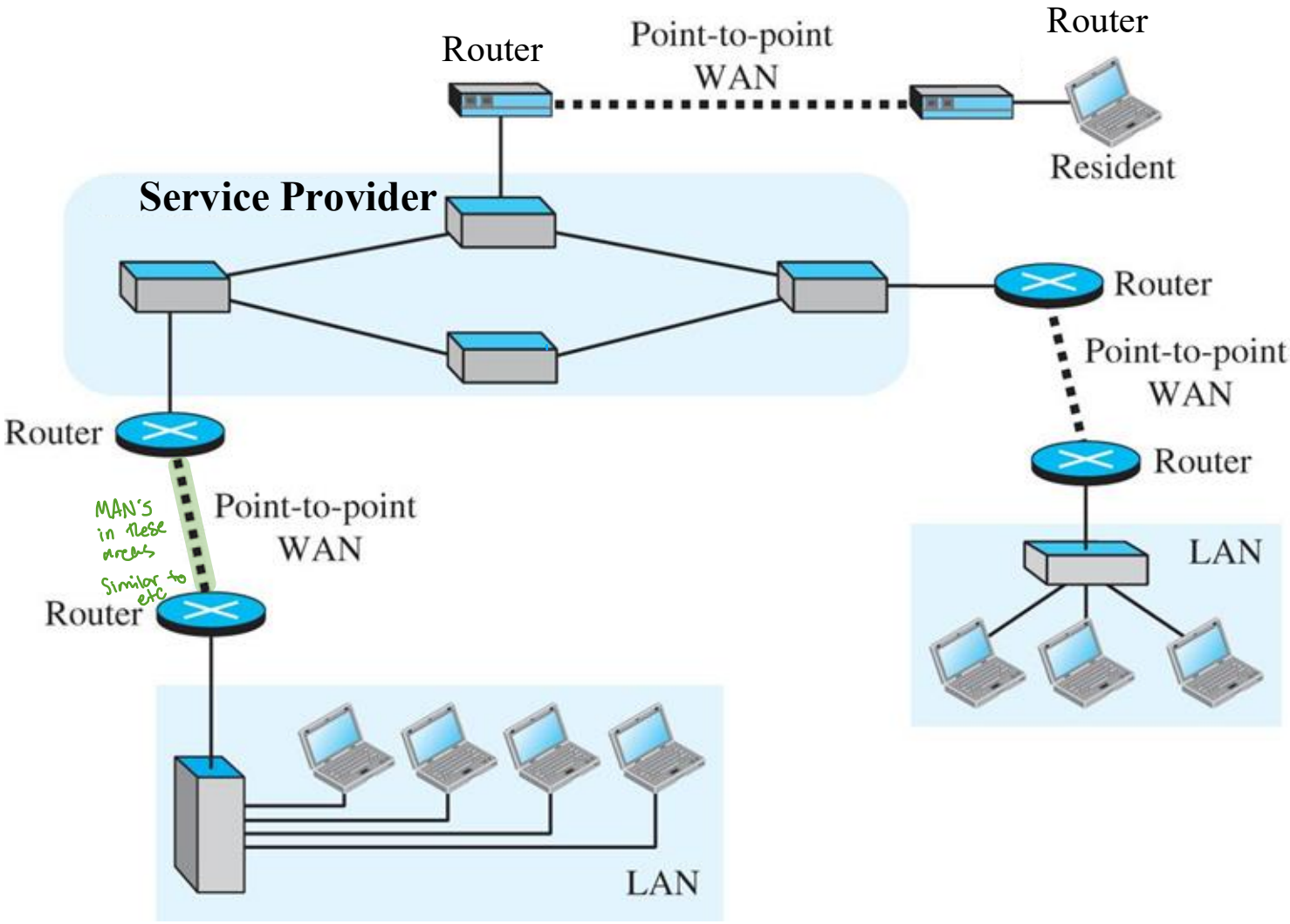
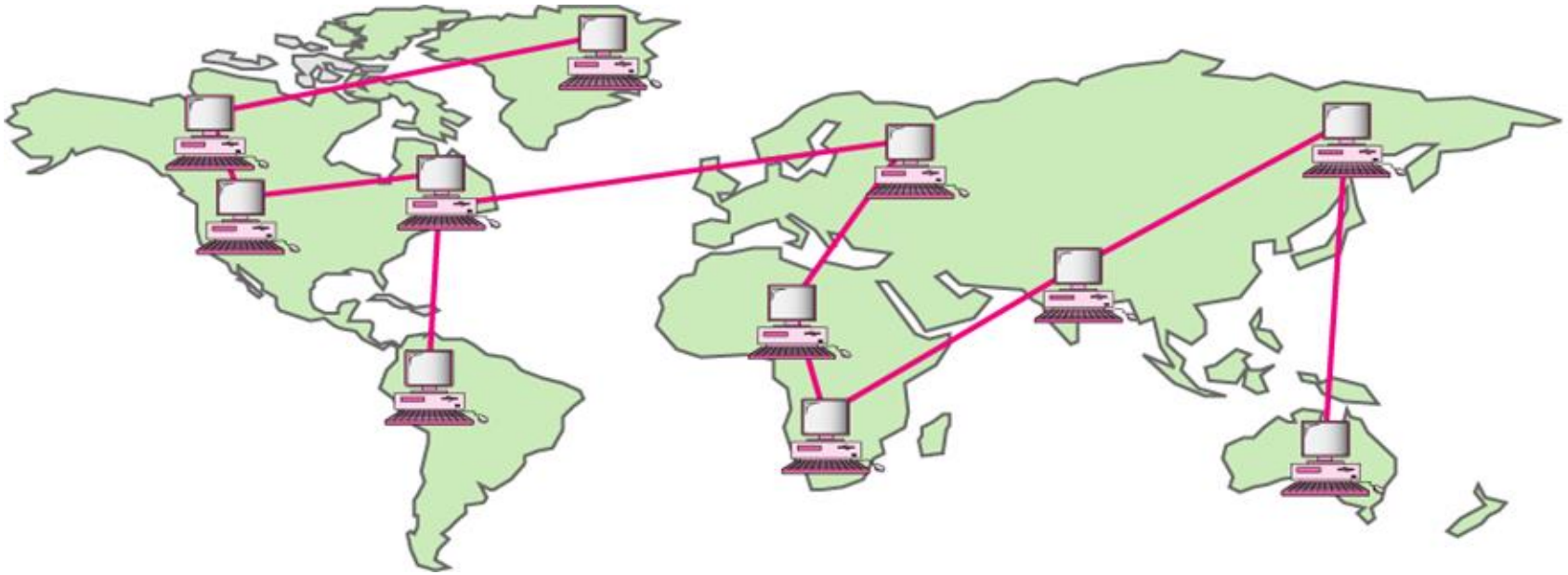


Figure 1.15 *WAN*

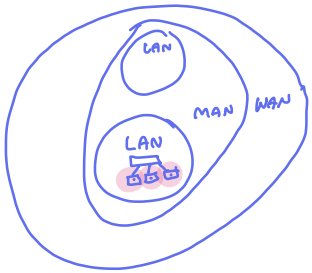
WAN: Provides long-distance transmission of data

11 WAN's
each has LAN
MAN



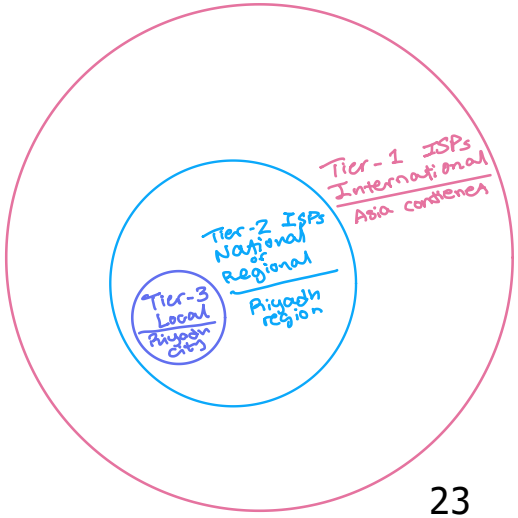
1.3 The Internet

based on previous slide



each device acts as host → connects to service provider

- The Internet is a collection of different networks that run TCP/IP protocols suite — Rules governing our communication between devices → protocols
- It is made of many wide- and local area networks joined by connecting devices and switching stations
- In order to be considered on the Internet, your host machine should
  - run TCP/IP protocol — layered
  - have Internet address
  - be able to send Internet Protocol (IP) packets to other machines on the Internet — knows them by IP address

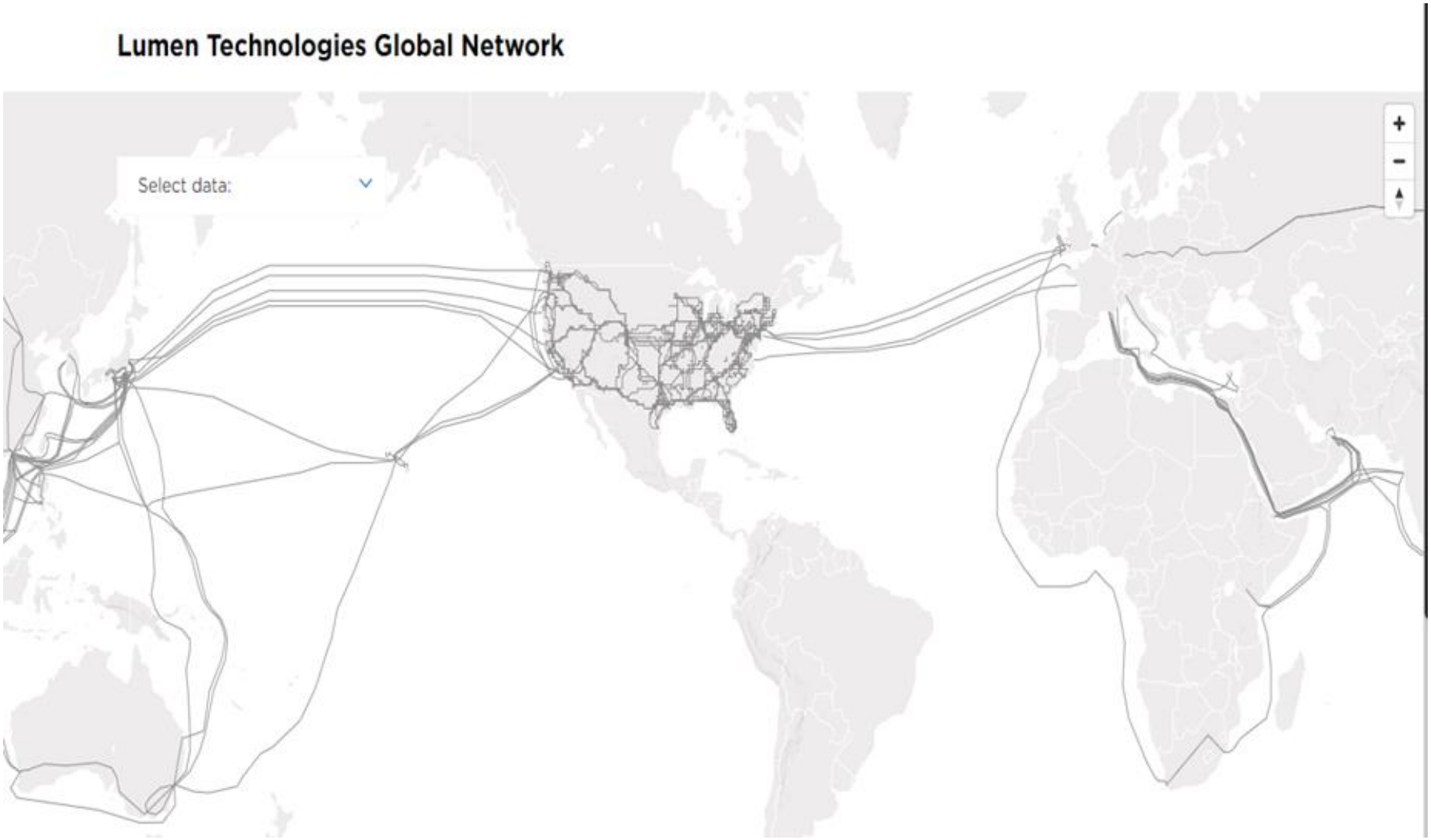


Tiers → providing service
WAN's / LAN's → users

All tiers need each other (domino effect)

Internet Service Providers (ISPs)

- **Backbones:** International Service providers (tier-1 ISPs)
  - International coverage
  - **Called Internet backbone** networks
  - Few number exists
  - **Own links and routers** to connect to other networks:
  - **Connected directly** to other tier-1 ISPs
  - Examples: Sprint, AT&T, LUMEN, etc.
- **Provider networks**: National or regional (tier-2 ISP)
  - Gateways to the international Internet
  - Connected to at least one tier-1 ISPs
  - has a regional or national coverage
  - Example: STC, ITC, Mobily
- Local ISPs (Tier-3)
  - Taking services from National Providers


Lumen Technologies Global Network
Select data:

Internet structure: network of networks

- "Tier-3" ISPs and local ISPs
  - last hop ("access") network (closest to end systems)

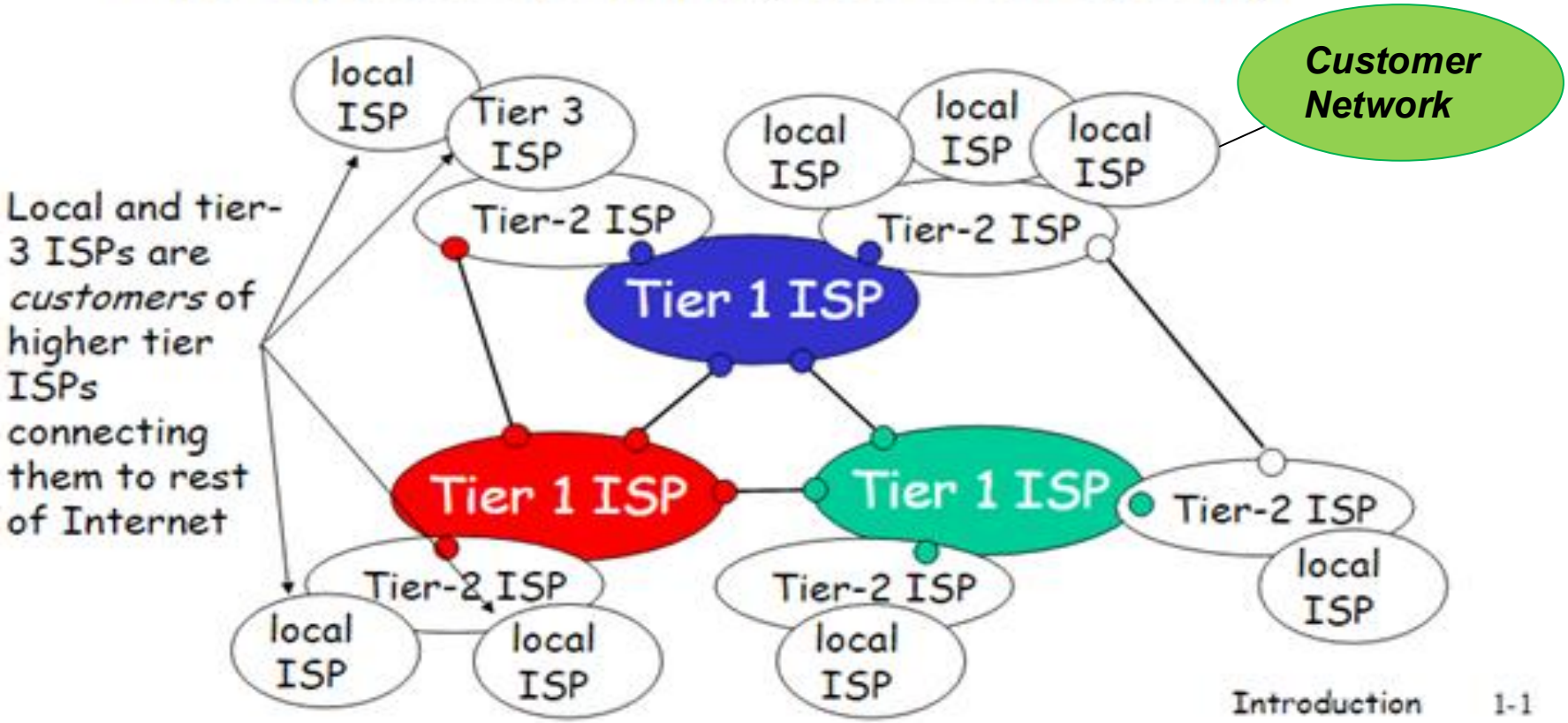
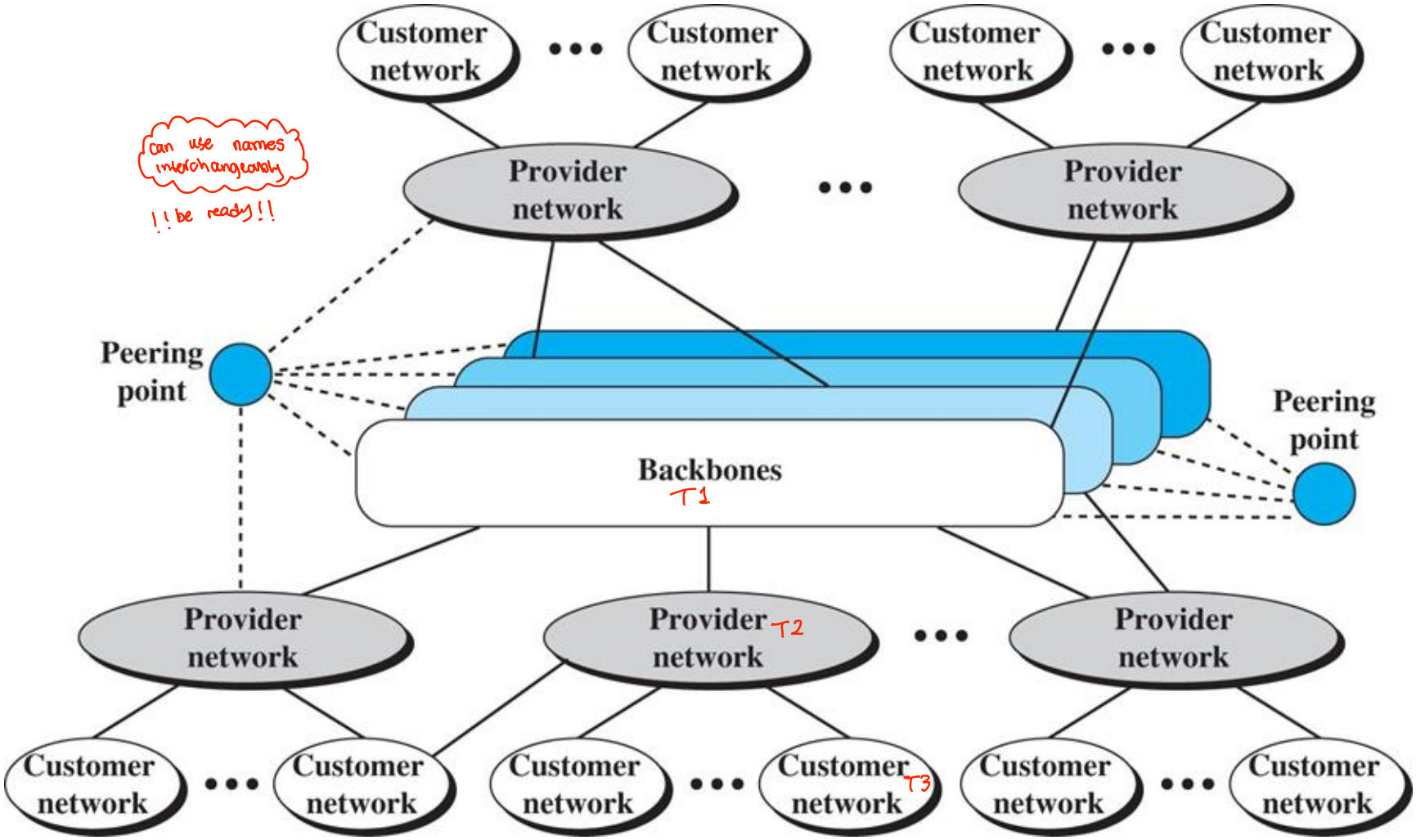


Figure 1.13 The Internet today



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Methods of ISPs InterConnection

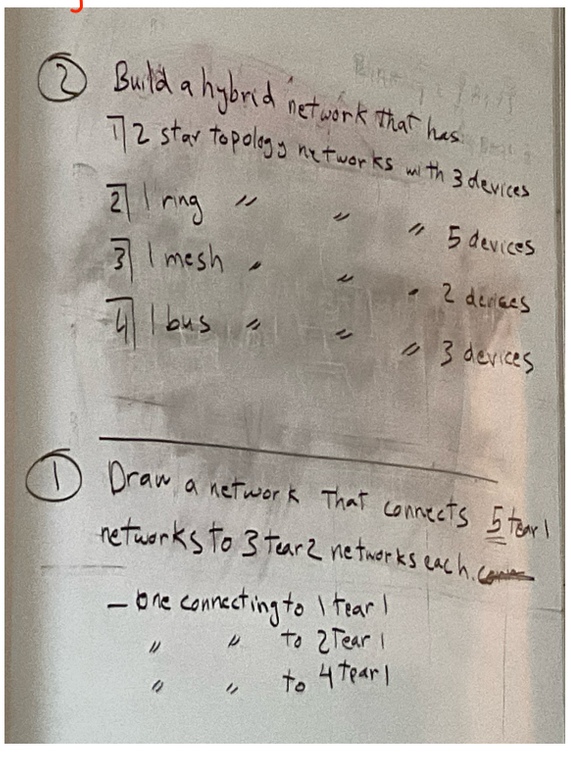
- Peering is the interconnection of networks, allowing those networks to exchange traffic.
- Methods of ISP interconnection (peering):
  1. Private Peering Points (Direct Connection)
     - Points at which one ISP is connected to the others and consist of a **group of routers (devices that connects networks together)**
     - **Private Peering** Points are **owned and operated by ISPs not by a third party telecommunication company**
  2. Internet Exchange Points (IXP) (Public Peering)
     - is a physical infrastructure through which Internet service providers (ISPs) exchange Internet traffic between their networks
     - A public IXP is managed by a **third party** and enables any ISP to connect with any other ISP
     - IXP consists of Complex **high speed switching networks**
     - IXP exchange huge amounts of traffic

Since networks have high speeds of course it has exchange a lot

  3. Current trend for connecting ISP:
     - **International ISPs** connect to each other at **private peering points**
     - National ISPs interconnect using **IXP**

sums it up

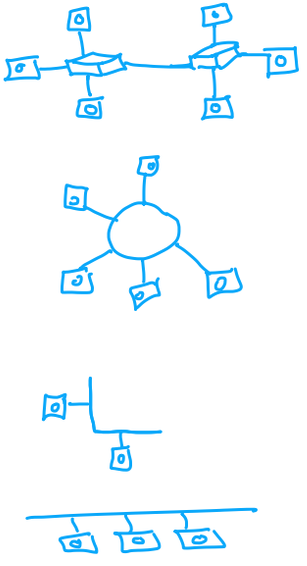
Solving



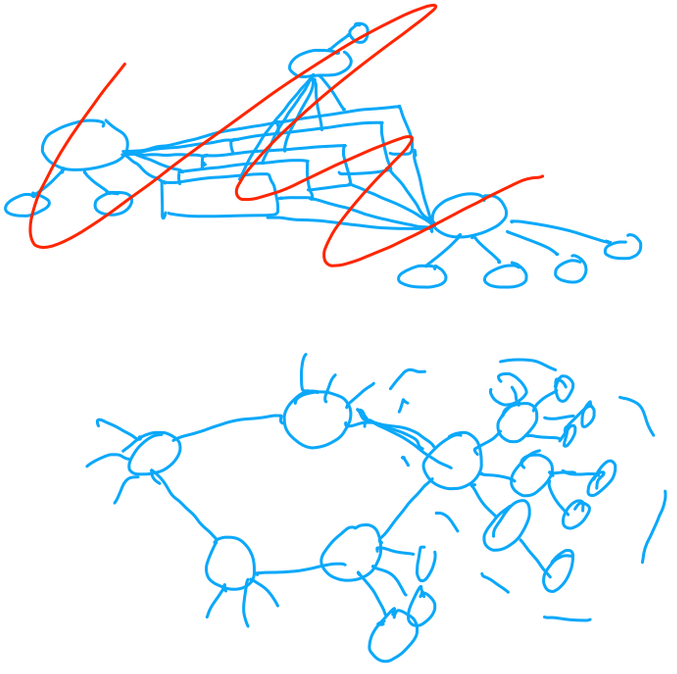
(2) Build a hybrid network that has
1. 2 star topology networks with 3 devices
2. 1 ring " " " 5 devices
3. 1 mesh " " " 2 devices
4. 1 bus " " " 3 devices

(1) Draw a network that connects 5 tear 1 networks to 3 tear 2 networks each.
- one connecting to 1 tear 1
- " " to 2 Tear 1
- " " to 4 tear 1

(2)

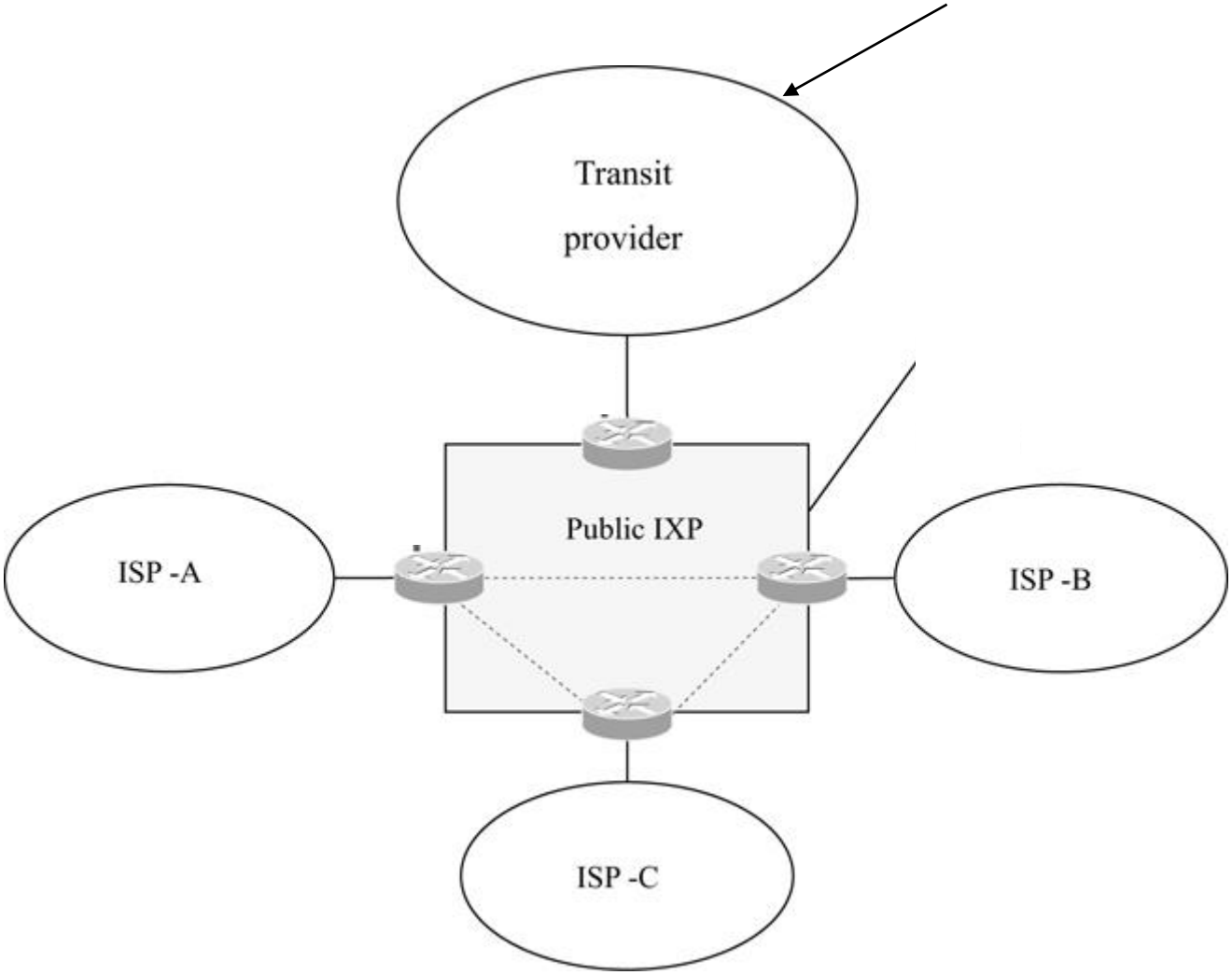


(1)



Internet Exchange Points (IXP)

ISP which provides access to other parts of the Internet



Customers from each ISP can communicate with each others through IXP network

Saudi Arabian Internet Exchange

Sun 28 Dec

1.4 Internet Standards

- In early 1970s, IBM, Digital Equipment and other vendors developed networking architectures that allow only their own computers to operate in **local computer** networks
- Each company network **can't communicate** with other company equipments without using a major **translation software.** MAC w/ MAC only
- **Question: How to allow these different networks communicate with each others easily?**
  - **Answer: Communicating devices *must agree* on a protocol or standards**
- Protocol: **set of rules** controlling the exchange of data between two entities in a system.
  - Entities: **application** that is capable of sending and receiving information (ex: user applications, email,… etc).
  - Systems: computers, terminals, remote sensors

Internet Standards

- Standards and protocols specify **hardware and software** procedures through which computers can **correctly** and **reliably** talk to one another
- Required to allow for **interoperability among equipments** built by different vendors
- **Advantages**
  - Ensures a large market for equipment and software
  - Provide guidelines to manufacturers, vendors, government agencies.
  - Allows products from different vendors to communicate

Agreements must be at many levels ...

- How many volts pulse is a 0 and 1 ?
- How to determine the end of a message ?
- How to handle lost messages ?
- How many bits for different data types ? Integers/Strings, etc.; are ASCII chars ?
- How machines are identified in a network?
- How to find the way to reach a machine ?
- How applications speaks together through the network ?

MUST KNOW?

Standards Organizations

- International Organization for standardization (ISO)
- International Telecommunication Union (ITU-T) – UN Agency
- American National Standards Institute (ANSI)
- Institute of Electrical and Electronic Engineers (IEEE) –specializes in LAN/MAN standards
- World Wide Web Consortium (W3)