

Introduction To Networks

Prof. Ling Li | Dr. Nadith Pathirage | Lecture 01

Semester 2, 2021

Important Contacts

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Unit Overview

▪ Lecture Component:

- 12 Lectures (1x2 hours)
- 1st week onwards

▪ Tutorial Component:

- 11 Tutorials (1x2 hours)
- Supervised
- 2nd week onwards

▪ Practical Component:

- 12 Lab Sheets (1x2 hours)
- Unsupervised (an online help session every fortnight)
- 1st week onwards

The content will be assessed in the **Final Examination**

Week 1~5: Incremental Task 01
Week 5~8: Incremental Task 02
Week 8~13: Incremental Task 03

Unit Contents

- **Fundamental knowledge on the design and implementation of networks and network protocols**

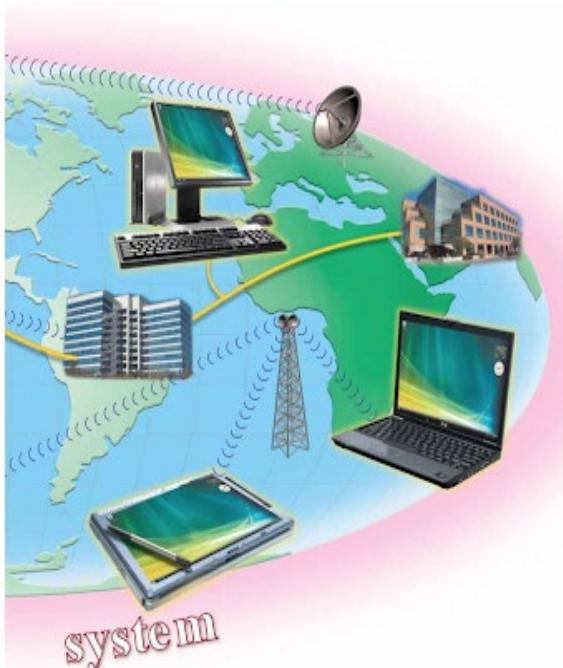
- Types of Network
- Basic Network Components
- Networking Protocols and Standards
- The Internet
- Emerging topics such as Internet of Things, Blockchain etc.



FIGURE 8-1 An example of a communications system. The communications channel consists of telephone and power lines, cable television and other underground lines, microwave stations, and satellites.

Why study Computer Communications

- A **core topic** in the IEEE Body of Knowledge (BoK) for **all** computing related degrees
- **Foundation** for more advanced units in networking and cyber security



Time table

- **Lectures:**

Mondays 10 to 12, Online via Collaborate Ultra

- **Workshops/Tutorials:**

- Tuesdays 8~10 am: B400.R230
- Thursdays 12~2 pm: Online via Collaborate Ultra
- Fridays 10~12 noon: B201.R309
- Fridays 12~2 pm: B212.R107

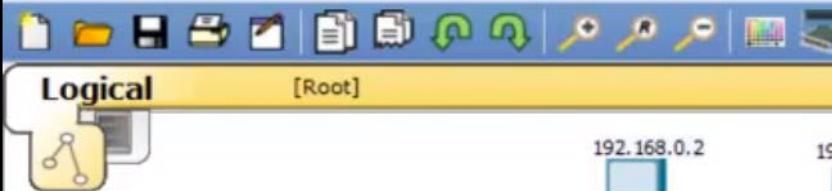


Time table

▪ **Practicals:**

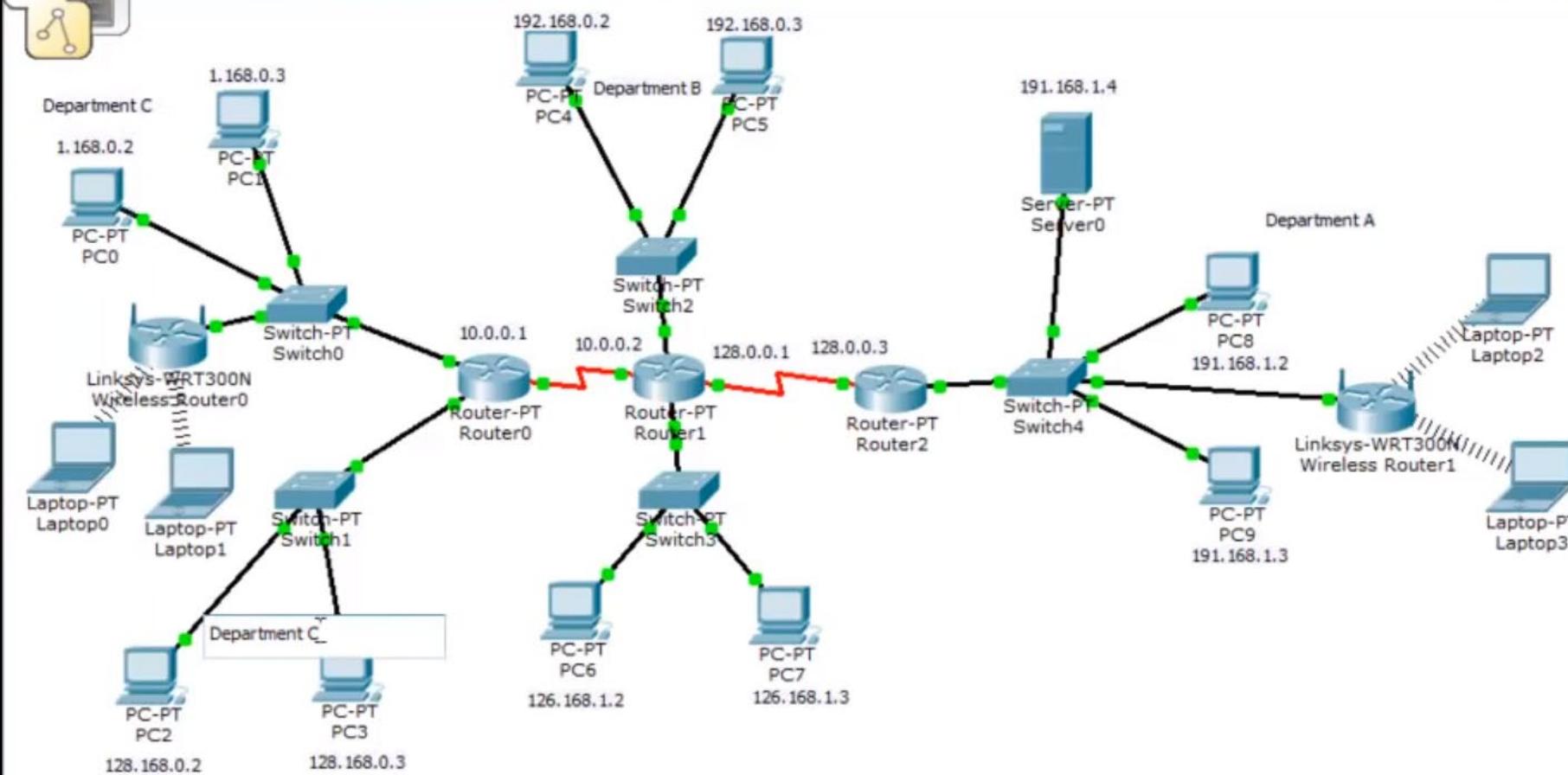
- Practical aspect of networking with simulation tools (Cisco Packet tracer, Wireshark etc.)
- Weekly practical sheets starting from Week 1
- Detailed step-by-step instructions
- **Essential to complete them every week**
- A help session conducted every fortnight (starting from Week 2) at 2 to 4 pm Wednesdays, online via Collaborate Ultra. Please come with your questions.





Logical [Root]

New Cluster Move Object Set Tiled Background Viewport



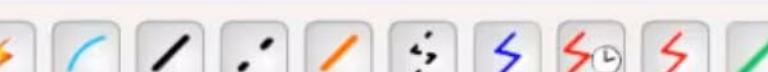
Packet Tracer

- Cross-platform visual simulation tool
- Emulate different network devices
- Simulate networks in action
- Monitor data flow
- Observe operations of protocols
- More & more !

Time: 00:03:42

Power Cycle Devices Fast Forward Time

Realtime



Scenario 0
New Delete
Toggle PDU List Window

Fire	Last Status	Source	Destination	Type	Color	Time (sec)	Periodic	Num

Assessments

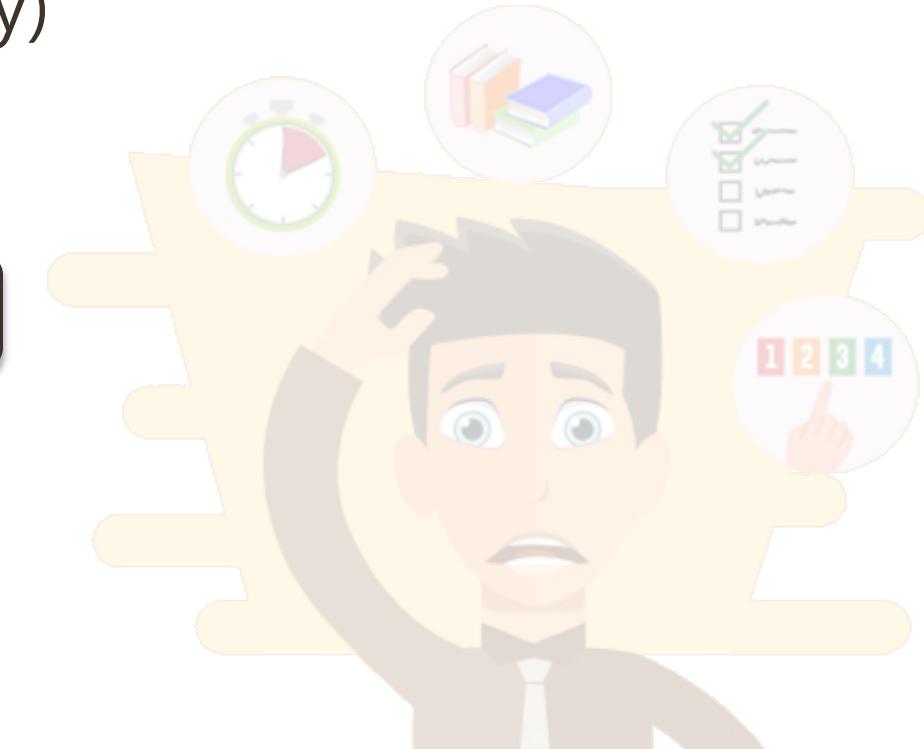
- Practical Incremental Tasks – **50%**
(3 tasks worth 15%, 15%, 20% respectively)
- Final Examination – **50%**

Compulsory conditions to pass the unit

Minimum mark of **40%** in the **Final Examination**

Minimum **overall mark** of **50%**

Must Fulfil all assessment components





Semester Week	Teaching Week	Lecture Name	Tutorial	Lab Sheet	Practical Incremental Tasks			
1	1 (July 26)	01 Introduction to Networks	No Tutorial in Week 1	P0 Packet Tracer Basics	Task No.1 Announced			
2	2 (Aug 02)	02 Physical Layer	T1 Introduction to Networks	P1 Working with Physical Workspace				
3	3 (Aug 09)	03 Data Link I	T2 Physical Layer	P2 Working with Logical Workspace				
4	4 (Aug 16)	04 Data Link II	T3 Data Link I	P3 Networking with Layer 1 Devices, Simulating Internet				
5	5 (Aug 23)	05 Network Layer I	T4 Data Link II	P4 Networking with Layer 2 Devices, VLAN I	Task No.1 due	Task No.2 announced		
6	6 (Aug 30)	06 Network Layer II	T5 Network Layer I	P5 Networking with Routers (IPv4, IPv6, VLAN II, VOIP)	Task No.3 due			
7	(Sep 06)	Tuition Free						
8	7 (Sep 13)	07 Transport Layer I	T6 Network Layer II	P6 Static/Dynamic Routing (RIP, RIPv2, EIGRP, OSPF)				
9	8 (Sep 20)	08 Packet Tracer	T7 Transport Layer I	P7 Networking with TCP (Client-Server)	Task No.2 due	Task No.3 announced		
10	9 (Sep 27)	09 Transport Layer II	Mock Paper Discussion	P8 Networking with UDP (Client-Server)				
11	10 (Oct 4)	10 Application Layer I	T8 Transport Layer II	P9 Networking with Application Layer I (Telnet, FTP, HTTP, Email)				
12	11 (Oct 11)	11 Application Layer II	T9 App Layer I	P10 Networking with Application Layer II (DHCP, DNS, P2P)				
13	12 (Oct 18)	12 Emerging Networking Tech	T10 App Layer II / T11 Emerging Network Tech	P11 Networking with IoT (Internet of Things)				
(Oct 25)		Study Week				Task No.3 due		
		Final Examination						

Color indicate the difficulty

Text, Video and References

- **Official Text:** None
- **Recommended references:**
 - All materials (text, web, video) relevant to the unit are listed on Blackboard under each week.
- **Lecture Slides / Tutorial Sheets / Lab Sheets**
 - Available electronically through Blackboard.



Blackboard

Computer
Communications
(Semester 2 2020 Bentley
Campus - INT[1])

Announcements

Unit Information

Assessments

My Grades

Message Board

Calender

iLecture

Collaborate Ultra

Reading List

Learning Materials

Packet Tracer

Help Me!

Discussion Board

Glossary

Wiki

Help Me! 

Build Content 

Assessments 

Tools 



Discussion Board

 subscribe

This is a place (**discussion forums**) where people can post questions, ideas or thoughts. It's a way of starting a conversation, about something important to you, that you hope other people will engage with and respond to.



Glossary

The important terms found throughout the course of study.

These terms will be helpful in studying for the **Examinations of this Unit**.



Wiki(s)

Wikipedias maintained for the unit.

HELP IS
AVAILABLE





Discussion Board (Forums)

- Unit FAQs Questions on unit assignments, structure, examinations.

- Learning Material FAQs Questions on learning materials, concepts, tutorials (**both Computing and Engineering students**).

- CNCO2000 Practicals FAQs Questions on lab sheets (Packet Tracer) for CNCO2000 (**Computing students only**).

- CMPE2000 Practicals FAQs Questions on CCNA labs, netcad, etc for CMPE2000 (**Engineering students only**).

- 27/07/20 13:07 P3: Networking with Layer 1 Devices, Simulating Internet

- 27/07/20 13:07 P2: Working with Physical & Logical Workspace

- 27/07/20 13:02 P1: Packet Tracer Basics

- 10/07/20 00:17 General

Forum: Learning Material FAQs

In a thread, you can view the post and information abo

Subscribe

- 27/07/20 12:23 L03/T03: Data Link Layer I

- 27/07/20 12:23 L02/T02: Physical Layer

- 27/07/20 12:17 L01/T01: Introduction To Networking

- 10/07/20 00:01 General



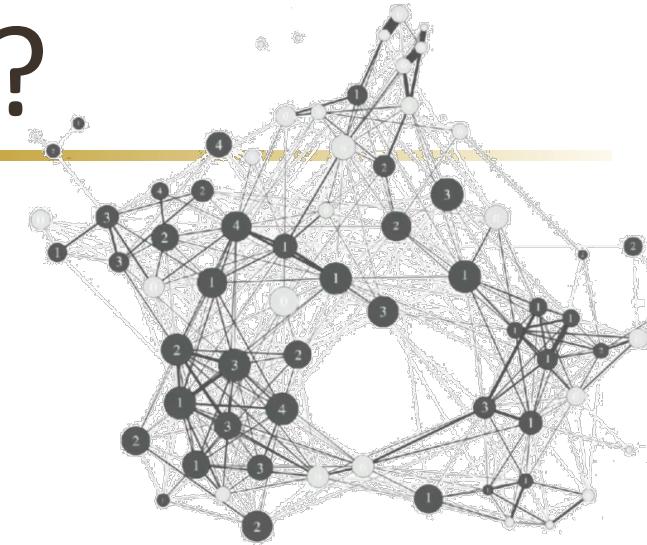
Networking

- What is a network?
- Data network elements
- Transmission Technology
 - Point-2-point (unicast)
 - Multi-point (multicast, broadcast)
- Scales of network
 - LAN, MAN, WAN,
 - WLAN, WMAN, WWAN, WPAN

What is a network?

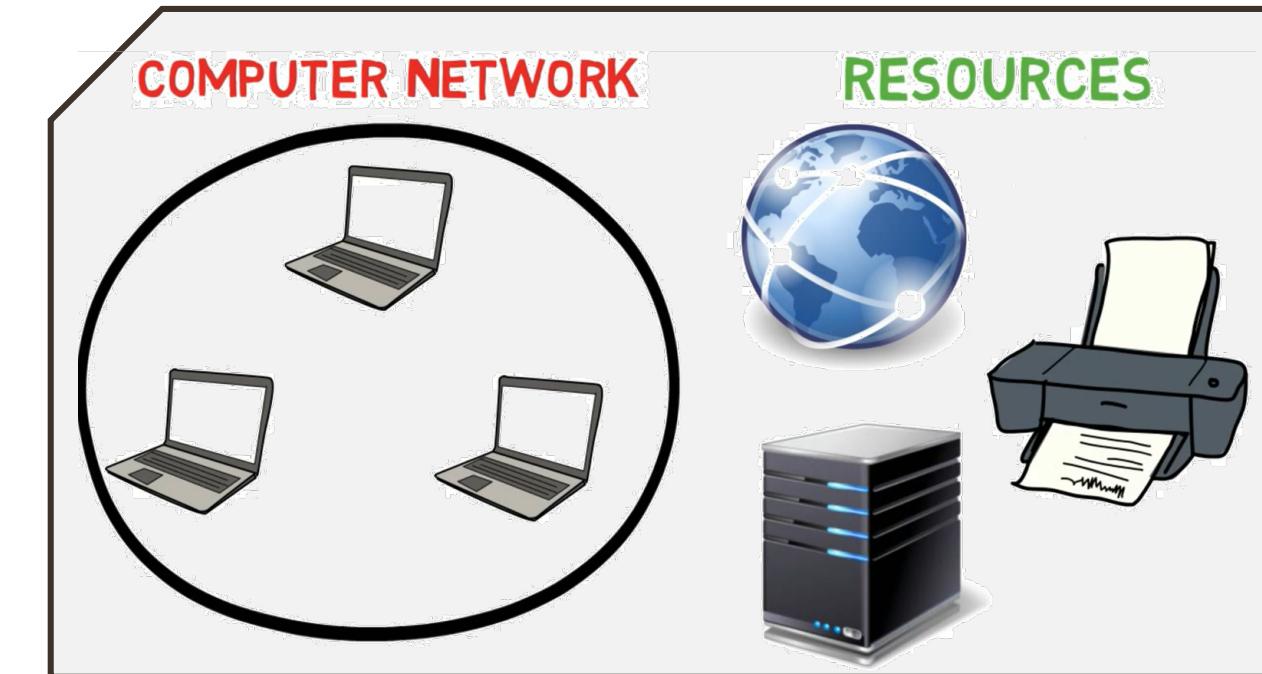
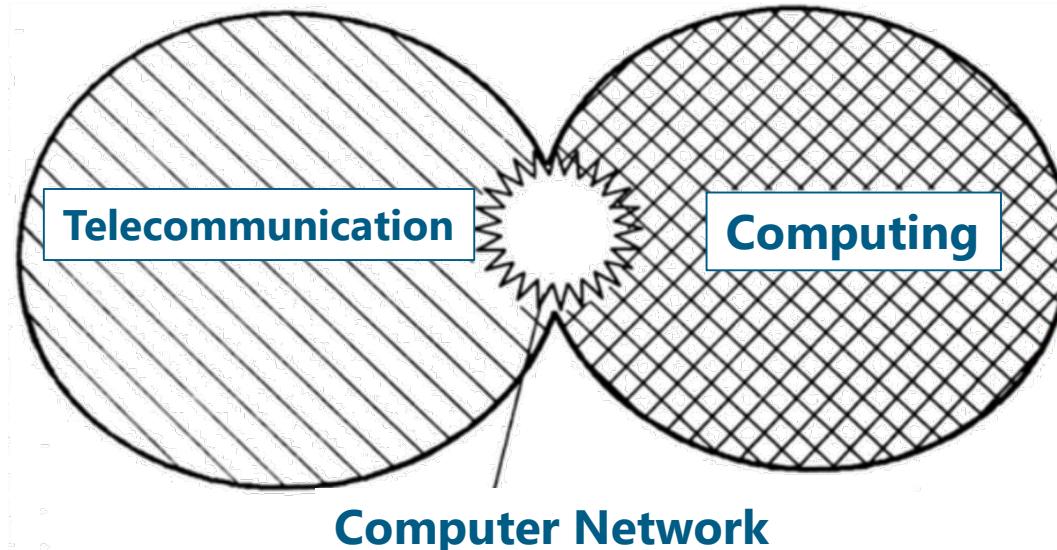
▪ What is a network?

- Group of interconnected things
 - E.g. Water supply system in ancient Rome

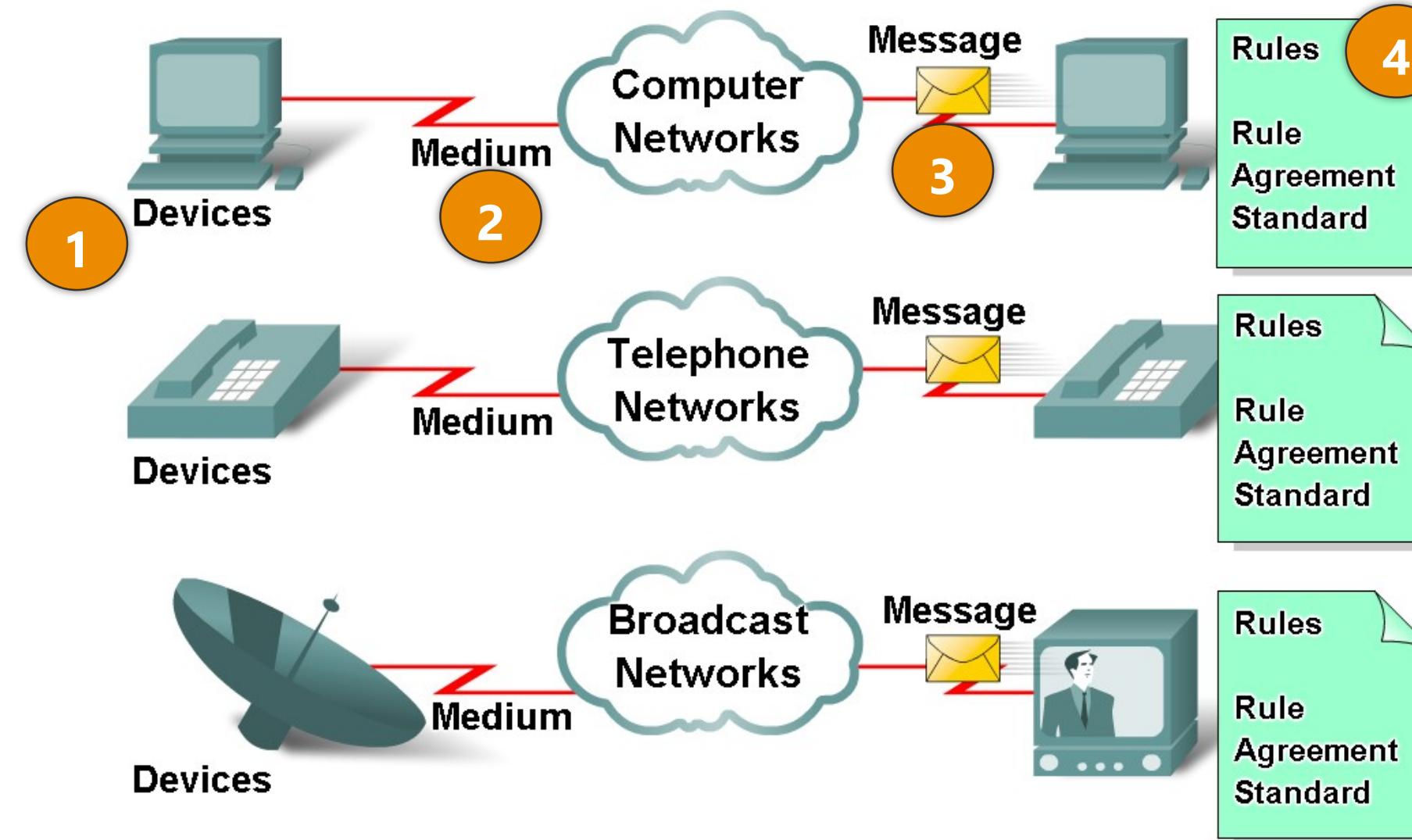


▪ What is a computer network?

- Group of interconnected computers
 - ✓ sharing resources, etc.



Data Networks & Elements



Rules (*protocols*)

- ✓ How messages flow across network
- ✓ How communication between peers will occur

Transmission Technology

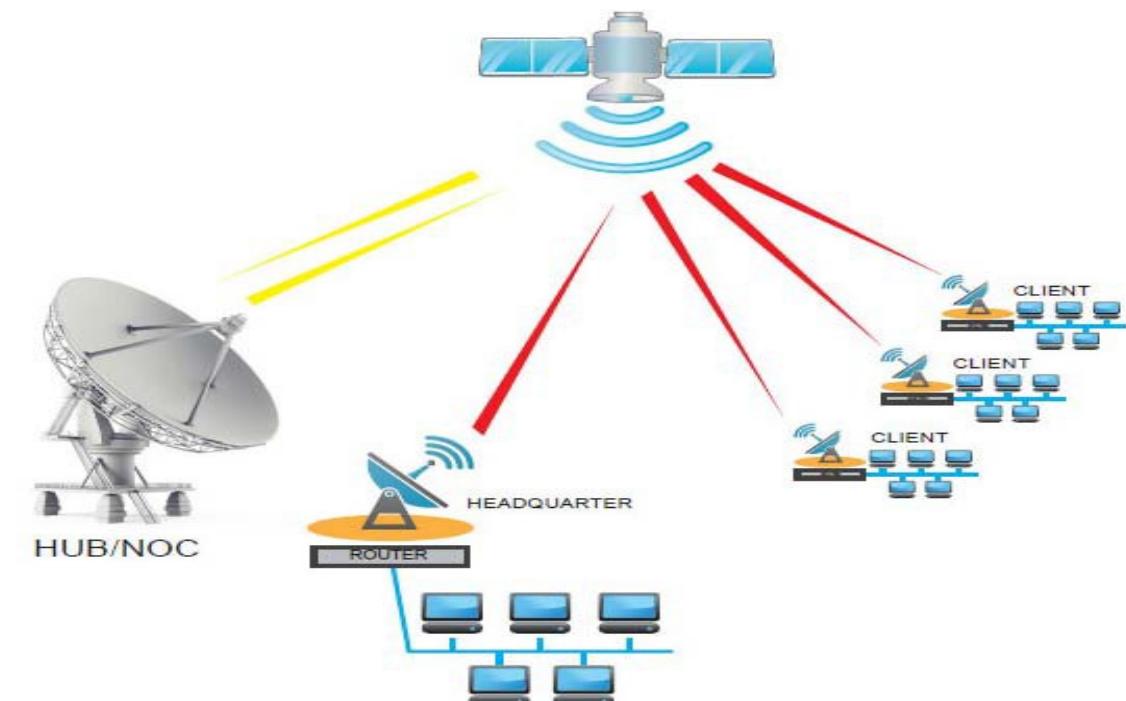
Point-to-point Network

- One sender and one receiver (dedicated links)
- **Unicasting**



Multipoint (Multidrop) Network

- Many nodes share the link capacity
- **Broadcasting, Multicasting**



Scales of Network

A **loosely coupled**
multiprocessor
system

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

Local Area Network (LAN)

- **Privately-owned networks**
- **Restricted in size**
 - within a building or campus.
- **Transmission technology**
 - a **single cable** – 10Mbps/100Mbps/10Gbps (400 Gbps in 2017?)
 - **wireless** transmission – 2Mbps/11Mbps/54Mbps/108Mbps/250Mbps
- Various **topologies** are possible
 - **Bus, Ring and Star**

Metropolitan Area Network (MAN)

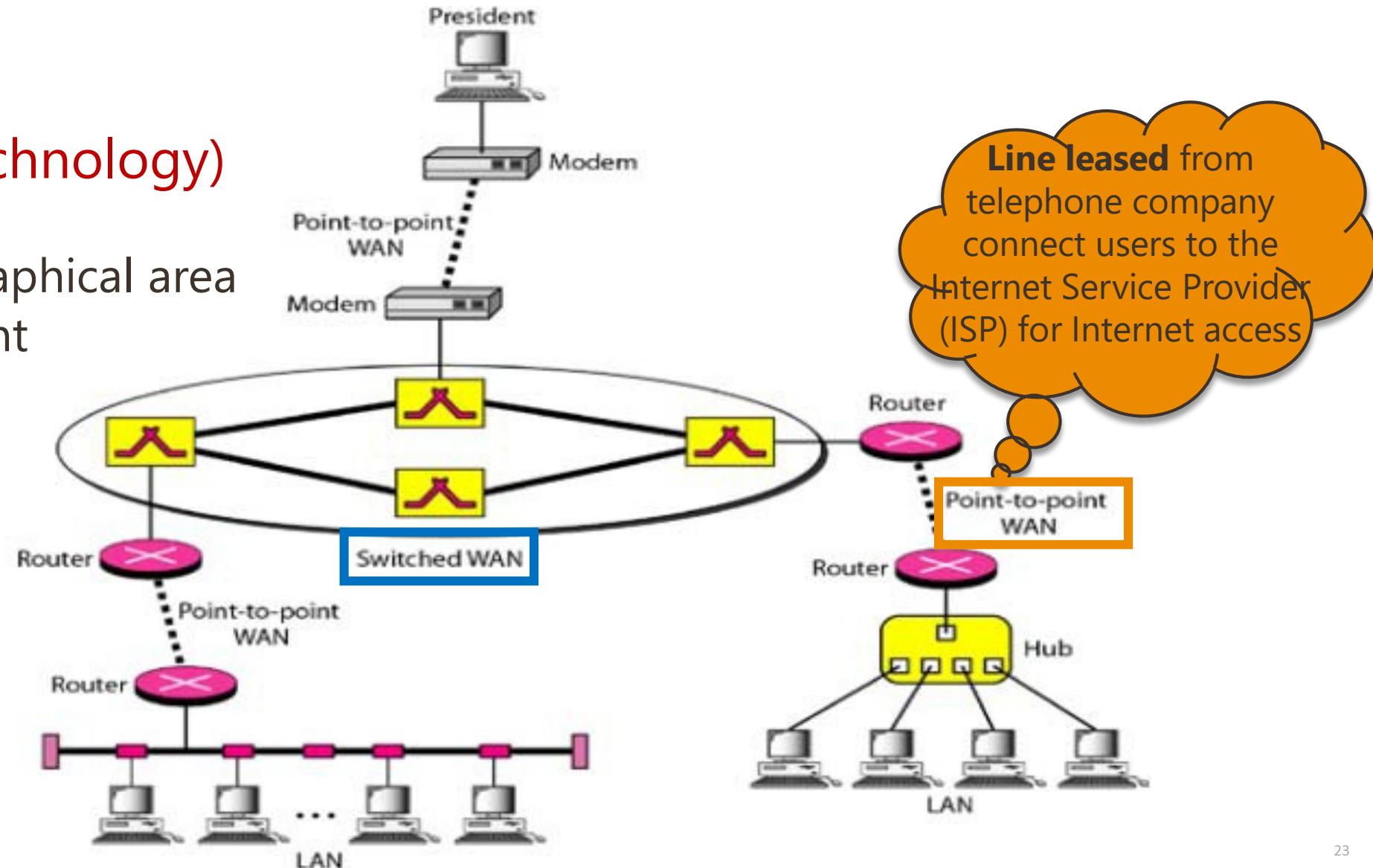
- **LARGE LAN** (uses same LAN technology)
- **Size**
 - Cover a group of nearby corporate office or a city
- **Transmission technology**
 - High-speed backbone linking multiple LAN's
 - ✓ Digital Subscriber Line (DSL)
 - ✓ TV cables
 - ✓ Fiber Distributed Data Interface (FDDI)
 - ✓ Distributed-Queue Dual-Bus (DQDB) network

Wide Area Network (WAN)

LARGE MAN

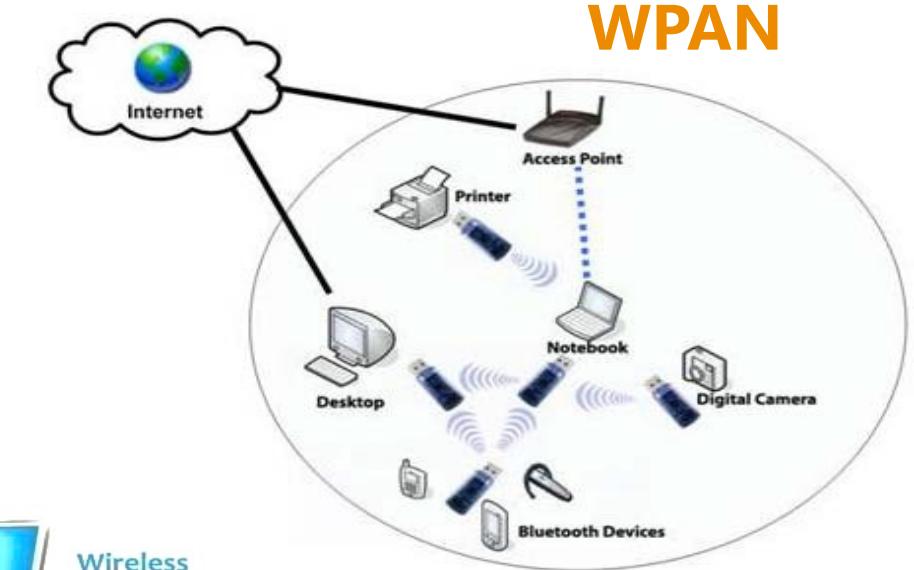
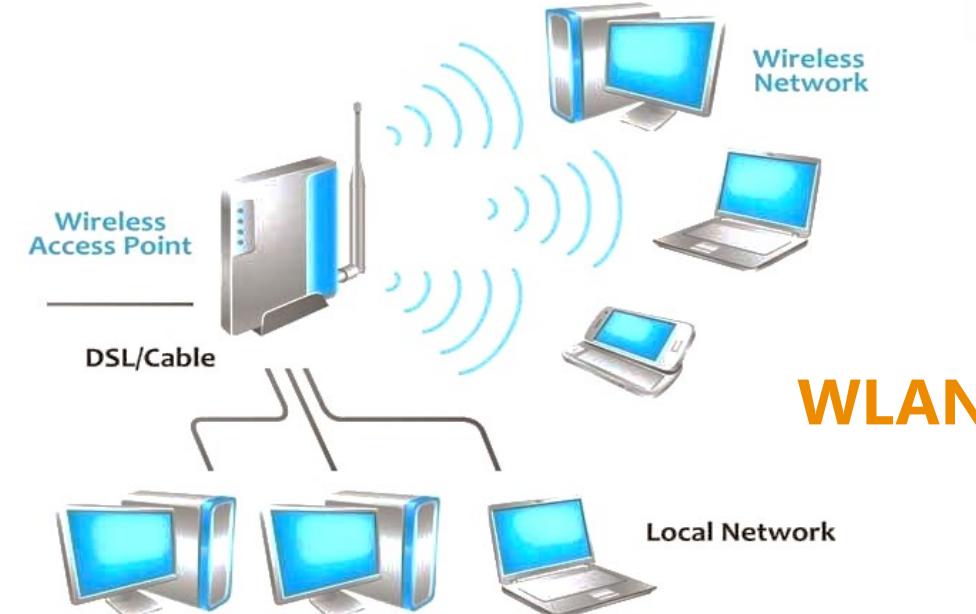
(uses different technology)

Size: A large geographical area
- country or continent



Wireless Networks

- Wireless Personal Area Networks (WPAN)
- Wireless LAN (WLAN)
- Wireless MAN (WMAN)
- Wireless WAN (WWAN)
 - Cellular Networks





Classification Of Networks

- Circuit-switched networks
- Packet-switched networks
 - Datagram networks
 - Virtual Circuit networks

Classification of Networks

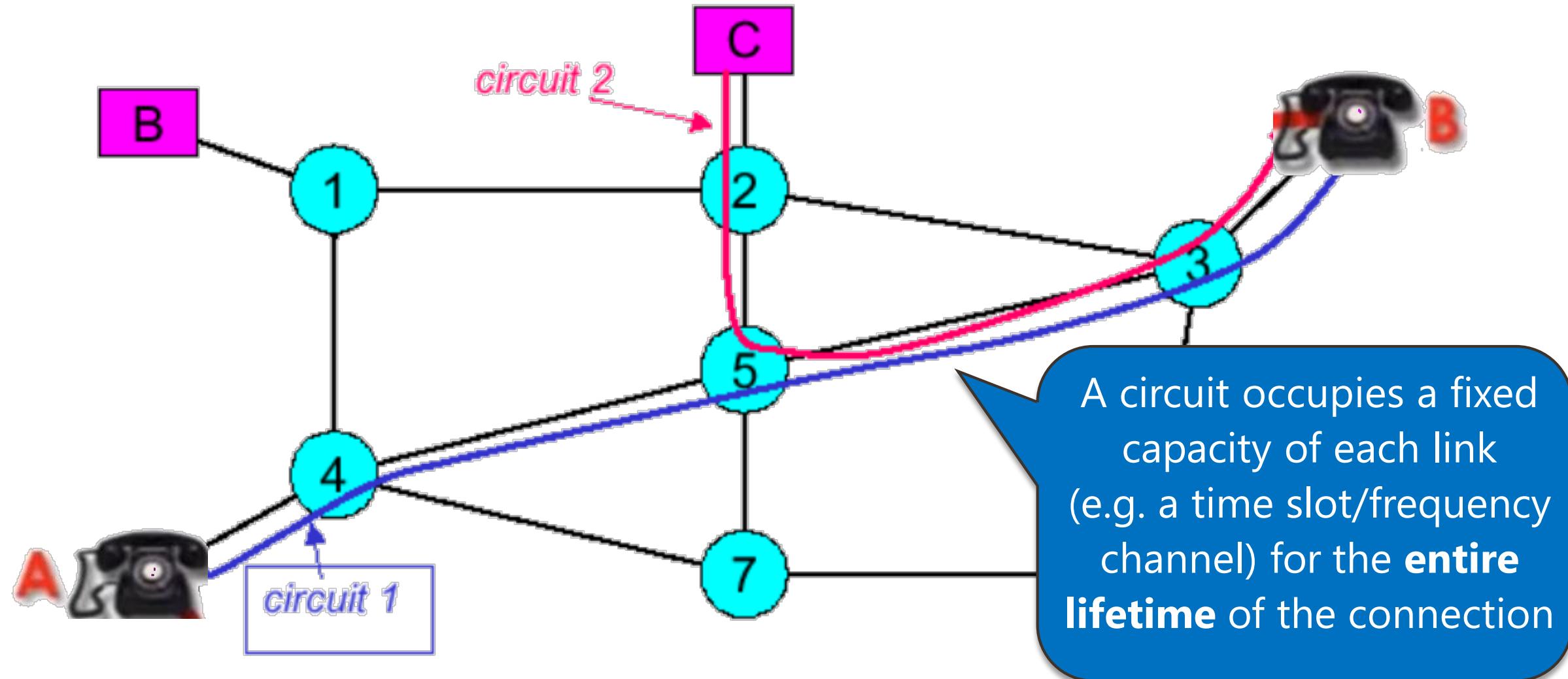
1. **Circuit-Switched** Networks

- ✓ Circuit Establishment
- ✓ Data Transfer
- ✓ Circuit Termination

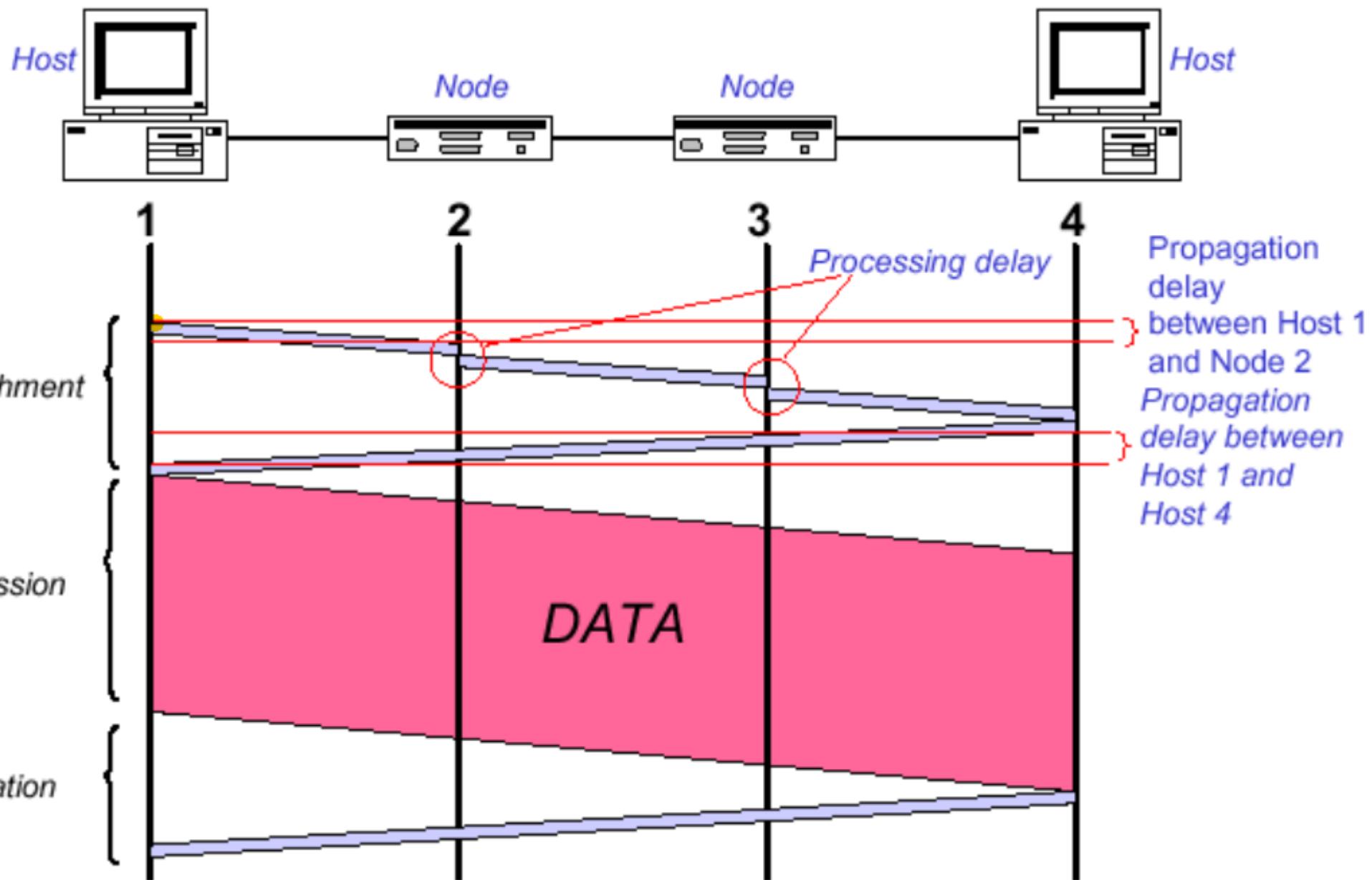
2. **Packet-Switched** Networks

- a) **Datagram** (Packet Switched) Networks
- b) **Virtual Circuit** (Packet Switched) Networks

Circuit Switched Network



Timing in Circuit Switched Network

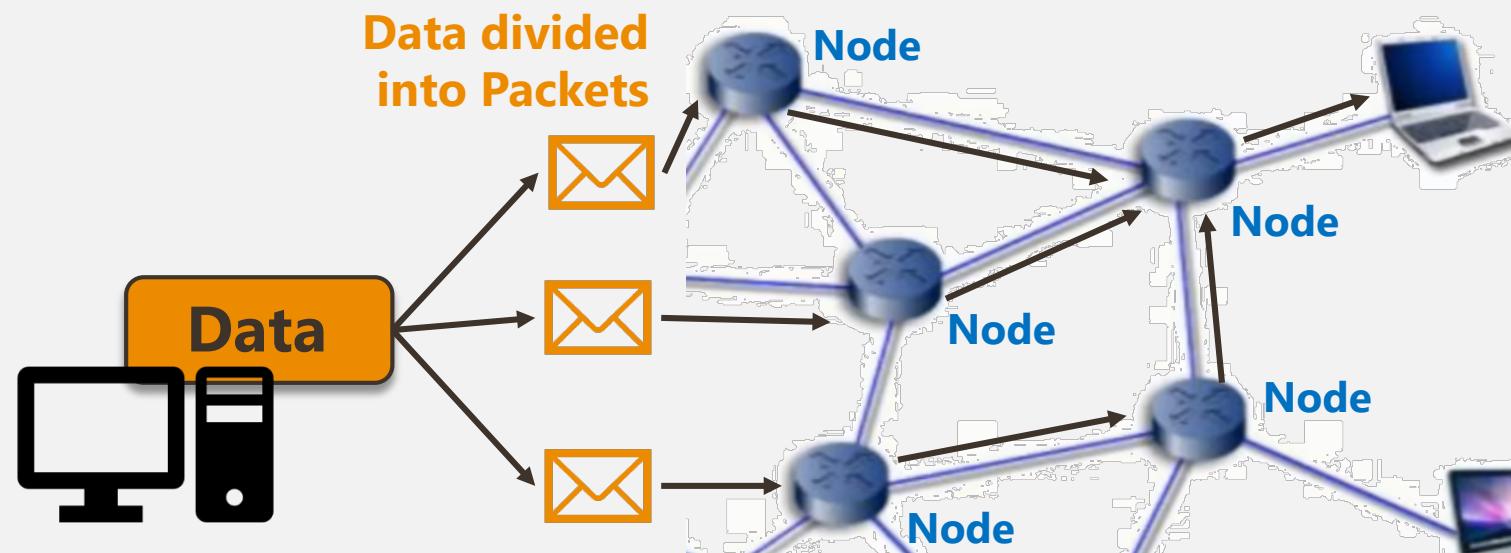


Datagram PS Network

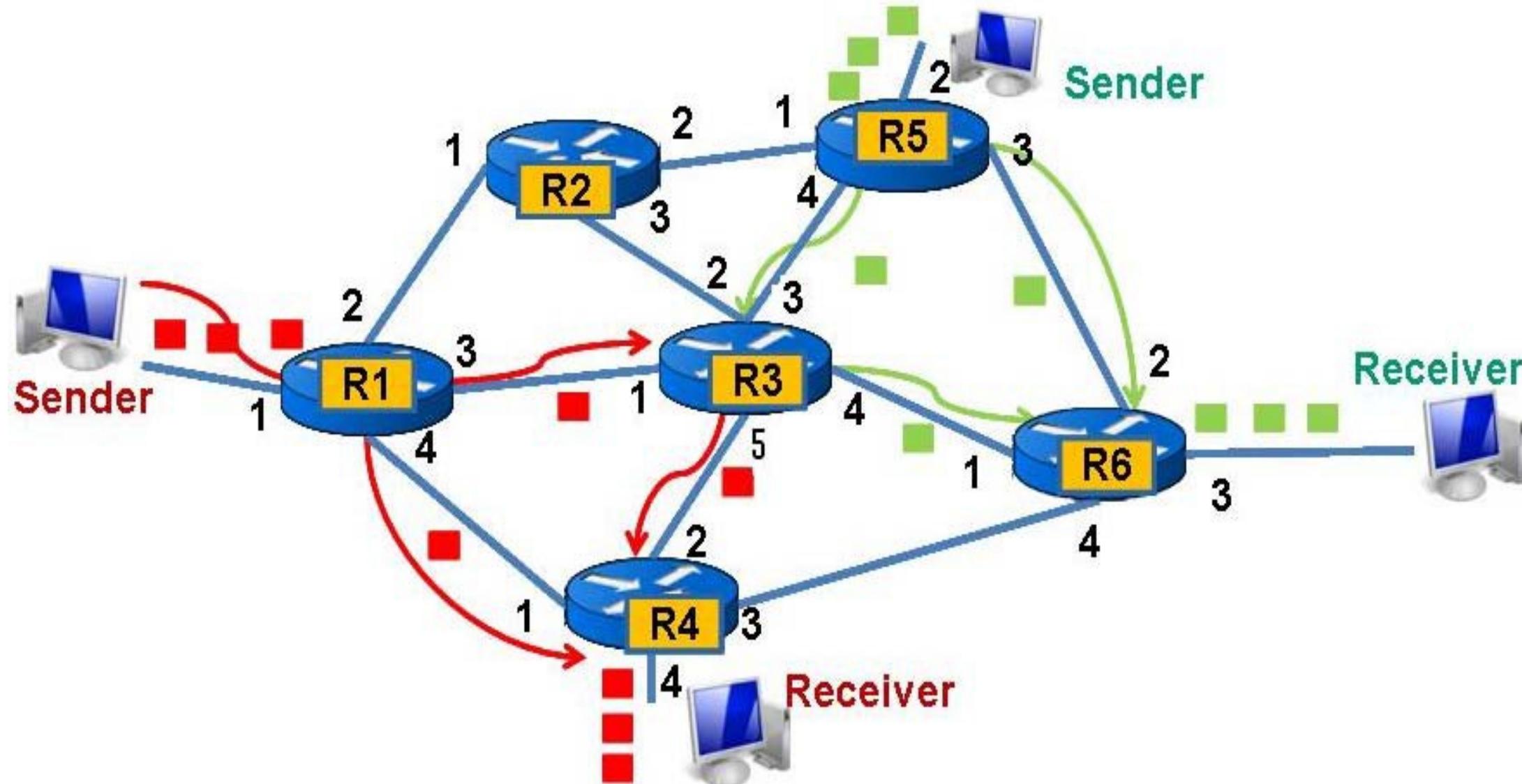
- **At a Node:**

packet stored briefly, and then forwarded to the next node (**store-and-forward**)

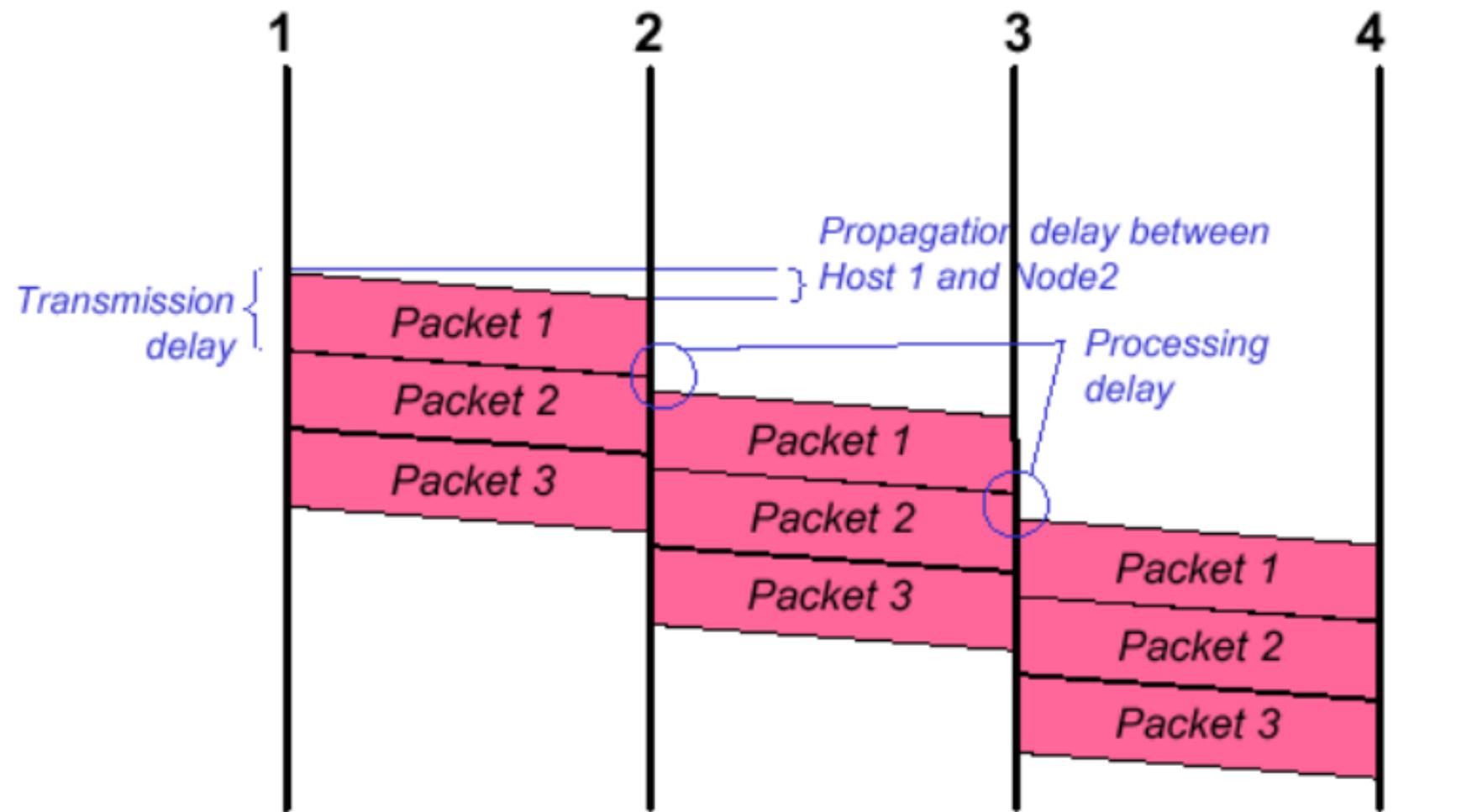
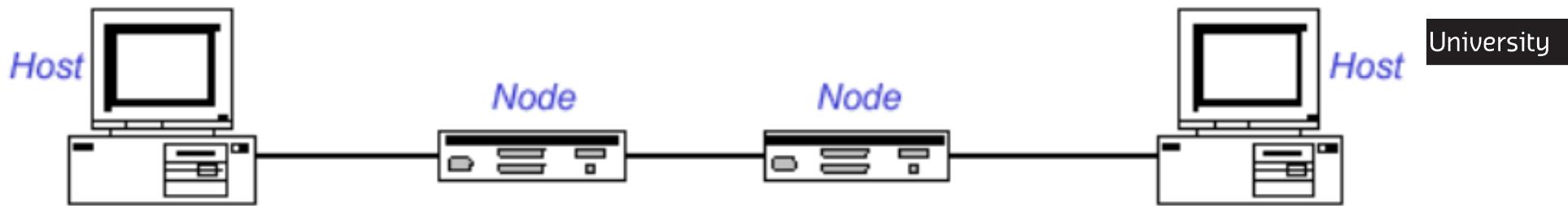
- **No physical capacity is allocated** for packets



Datagram PS Network



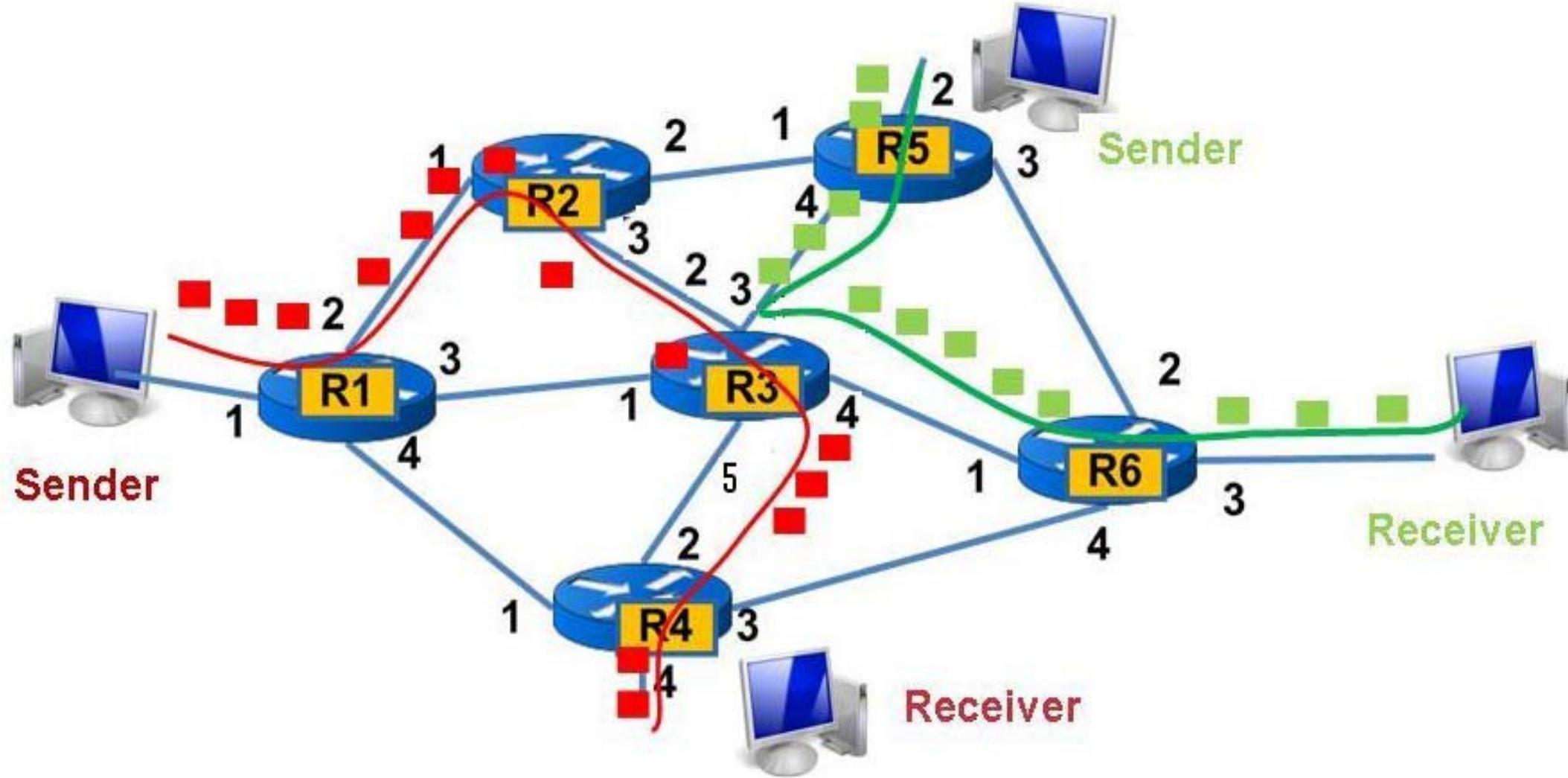
Timing in Datagram (PS) Networks



Virtual Circuit PS Network

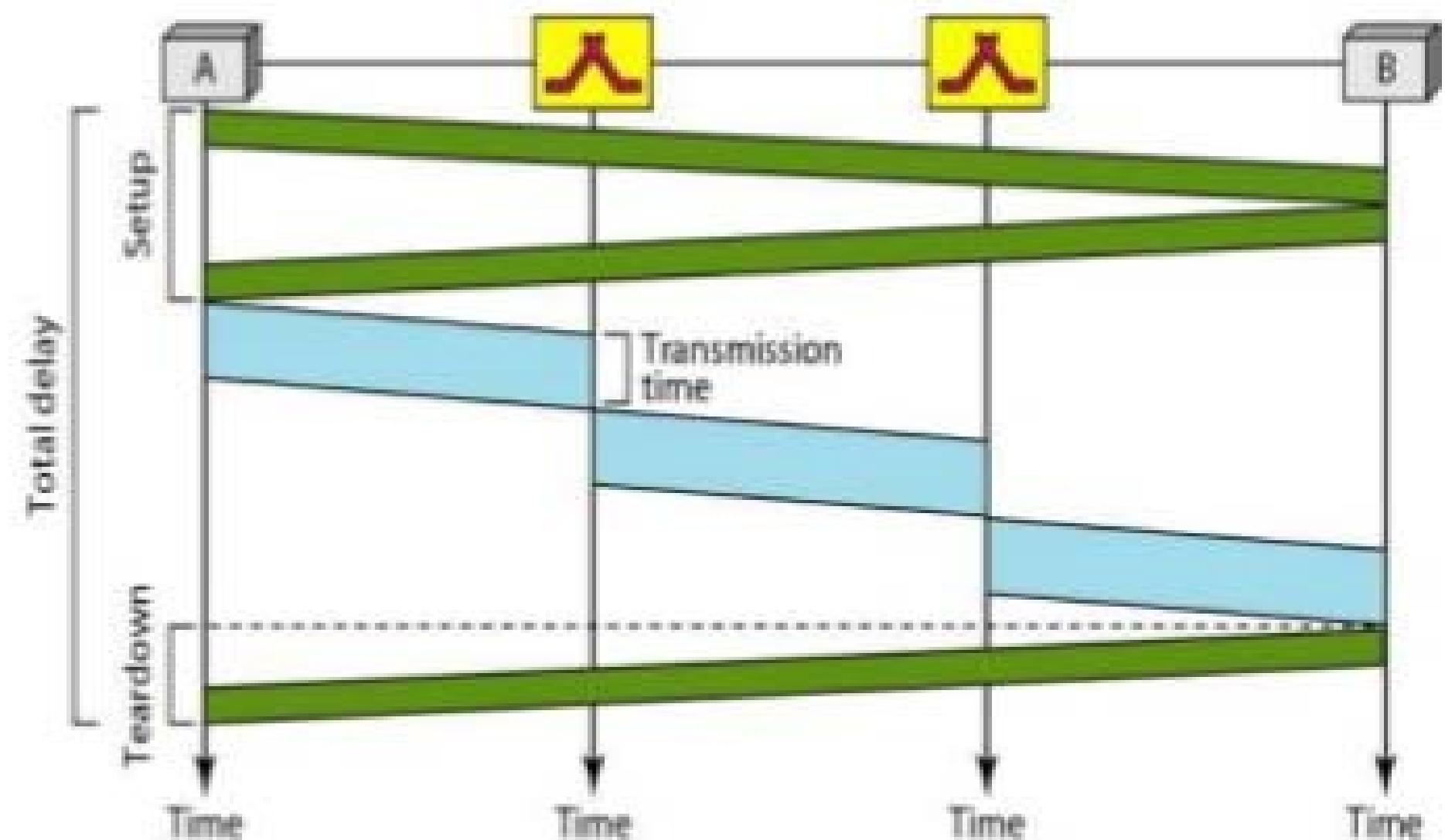
- **Hybrid:**
 - **Packet Switching + Circuit Switching**
- A **preplanned route** (between stations)
- All packets take the **same route**
 - *for the duration of the logical connections*
- **But, No dedicated path** between the two stations

Virtual Circuit PS Network



Virtual Circuit PS Network

Timing in Circuit Switched Network



Circuit Switching	Datagram Packet Switching	Virtual Circuit Packet Switching
Dedicated transmission path	No dedicated transmission path	No dedicated transmission path
Continuous transmission	Transmission of packets	Transmission of packets
Path stays fixed for entire connection	Route of each packet is independent	Path stays fixed for entire connection
Call setup delay	No setup delay	Call setup delay
No queuing delay	Queuing delay at switches	Queuing delay at switches
Busy signal overloaded network	Delay increases in overloaded networks	Delay increases in overloaded networks
Fixed bandwidth for each circuit	Bandwidth shared by all packets	Bandwidth shared by all packets
No overhead after call setup	Overhead in each packet	Overhead in each packet



Common Networking Technologies

- PSTN
- Internet
- ATM

Common Networking Technologies



Public Switched Telephone Networks (PSTN)

- ✓ The largest worldwide computer network, **specialized for voice**
 - ✓ Switching: **Circuit Switching**

The Internet

- ✓ A newer global and public information infrastructure
 - ✓ Switching: Datagram **Packet Switching** (Mostly)



ATM (asynchronous transfer mode; obsolete)

- ✓ **Flexibility** and **low-cost** ~ = Internet
 - ✓ **End-to-end service guarantees** ~ = telephone network
 - ✓ to replace telephone networks and data networks.
 - ✓ Switching: **VC Packet Switching**



Internet

▪ Internet

Network of geographically distributed computers

▪ Collection of interconnected network is known as **internetwork or internet**

- ✓ Common form of internet is a collection of LANs connected by a WAN

▪ End users use the internet via Internet Service providers (ISPs)

▪ History

- Early 1980: First personal computer
- Early 1980: Commercial use of Internet
- 1991: World Wide Web (www)





Layers, Services & Protocols

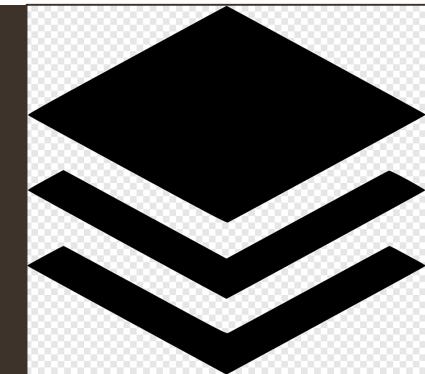
- Layering? Services? Protocol?
- Intro to OSI-7-layer model
- Intro to TCP/IP 5-layer model
- OSI 7-layer model vs TCP/IP 5-layer model

Layering, Services, Protocols

The overall communications process between two or more machines connected across one or more networks is **very complex**

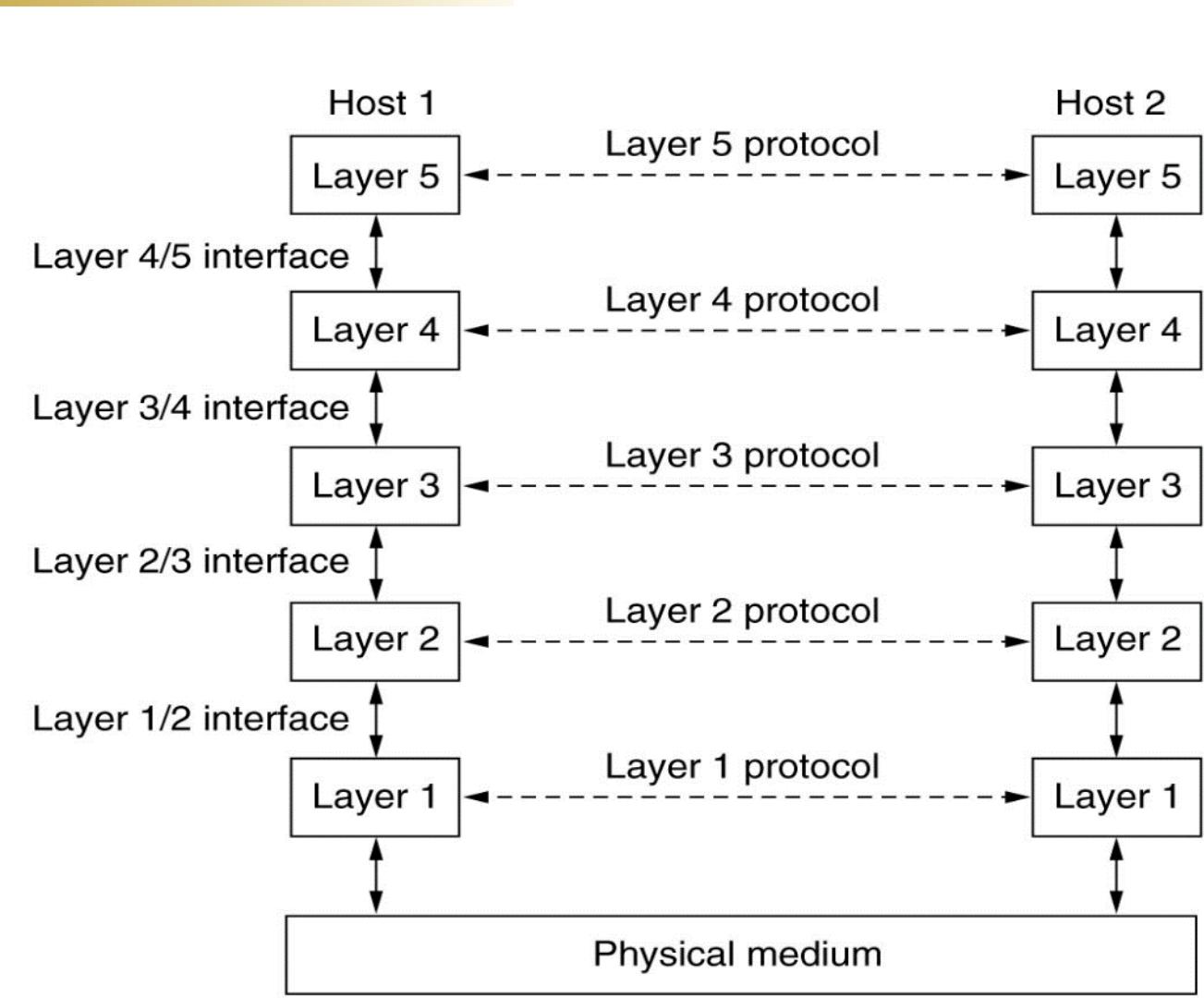


Layering simplifies design, implementation, and testing by partitioning overall communications process into parts



Why Layering?

- Each layer provides a service to the layer above
- Each layer operates according to a **protocol**
- Protocols can be changed without affecting other layers, higher or lower



Network **Protocol** ?

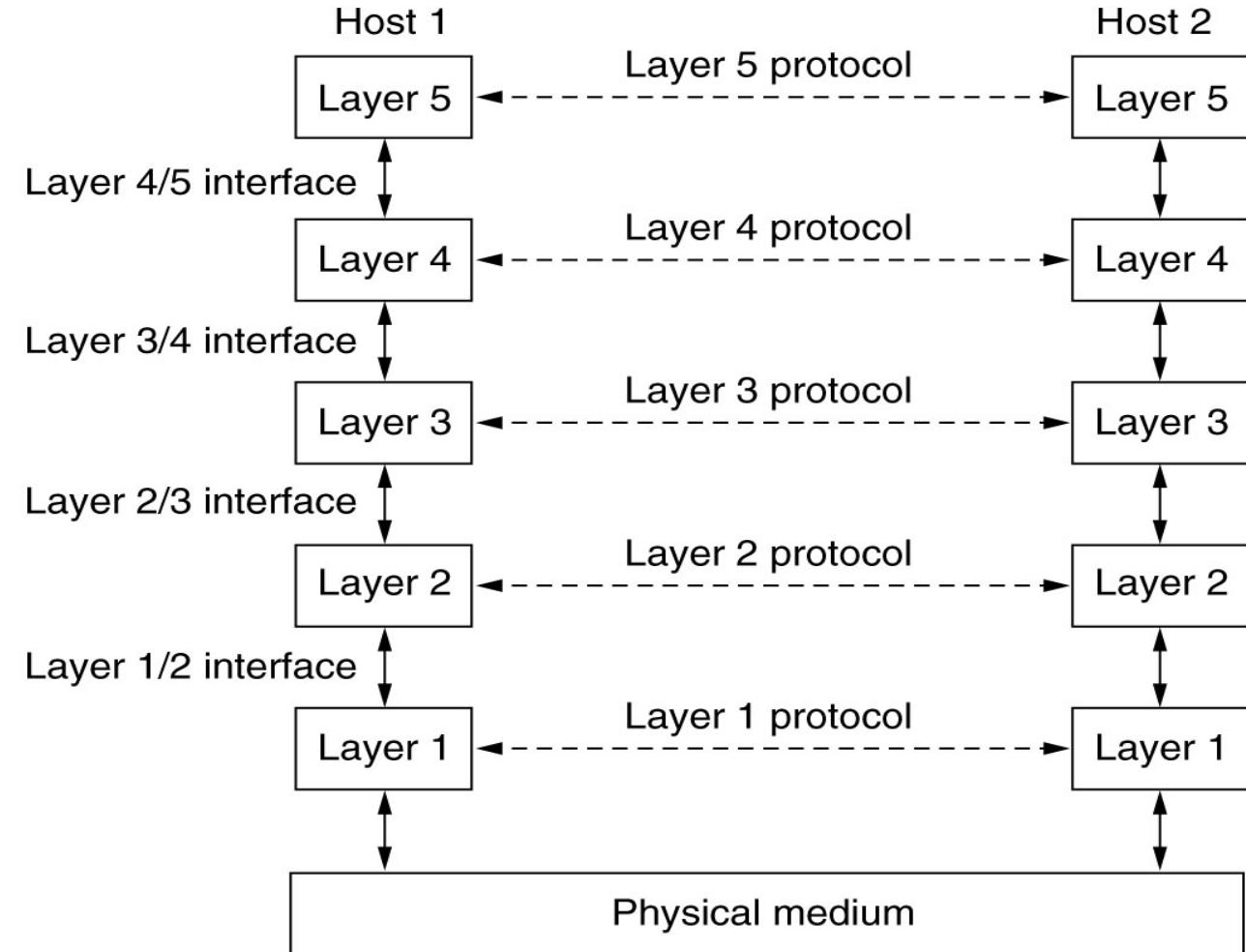
- **Set of rules** and conventions **governs** peer-to-peer **communication**

- **Network Architecture**

- The set of layers of protocols

- Protocol has specific **syntax**

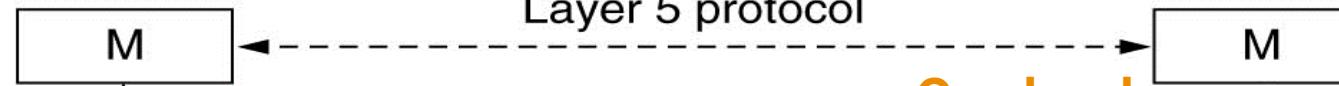
- ✓ Format of the data block
 - ✓ Uses control information for coordination
 - ✓ Sequencing
 - ✓ Speed matching



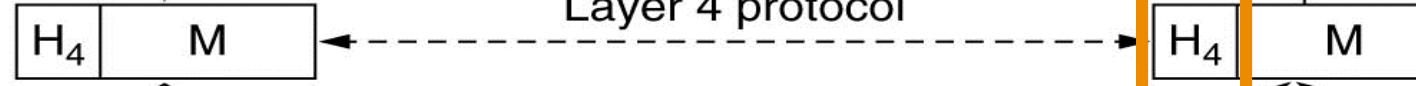
Layer Protocols – cont.

Layer

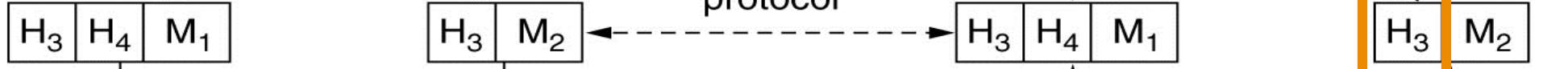
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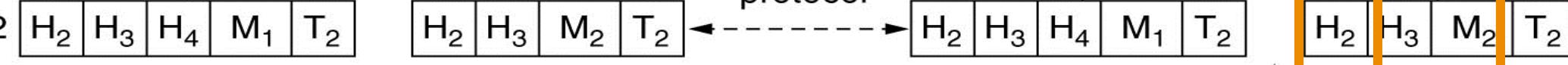
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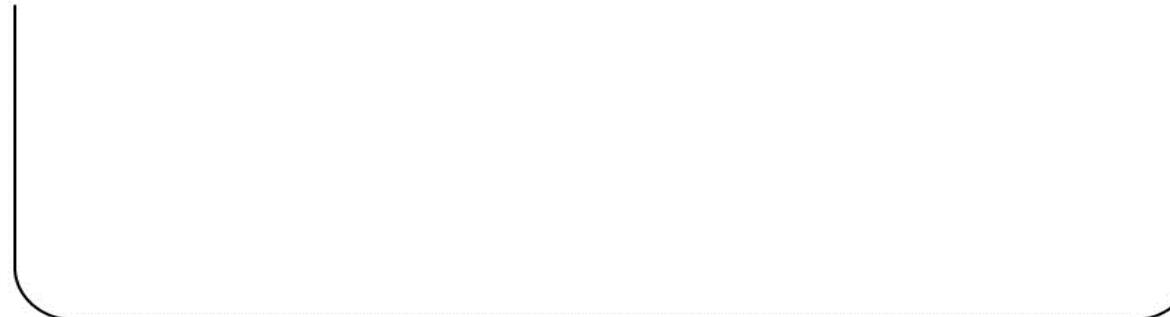
3



2



1



Source machine

Destination machine

OSI Model

▪ Open System Interconnect

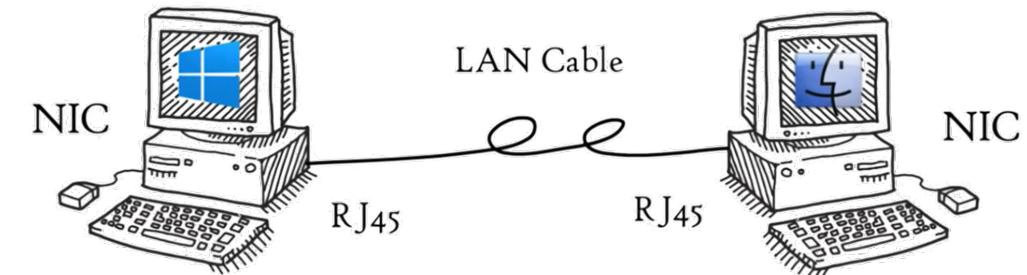
- Introduced by ISO in 1984

▪ Each layer:

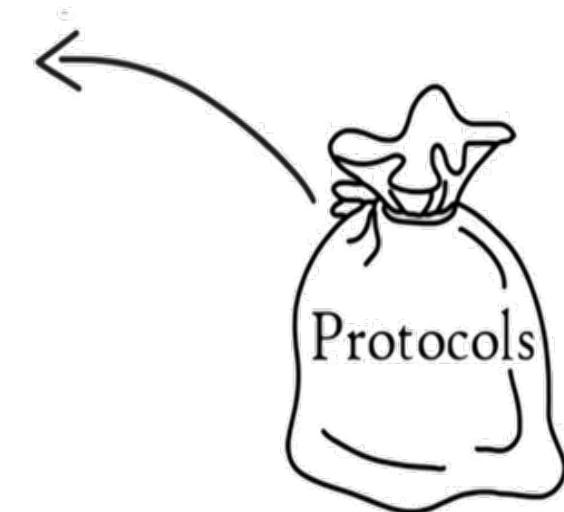
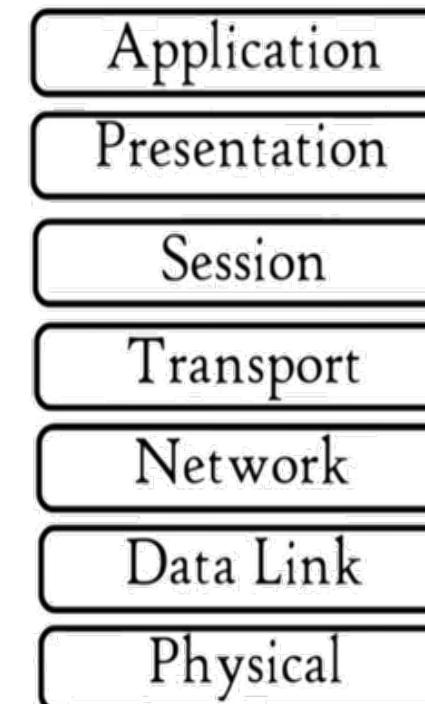
- Package of protocols

▪ 7 Layers

- Please – Physical
- Do - Data Link
- Not – Network
- Throw – Transport
- Sausage – Session
- Pizza – Presentation
- Away – Application

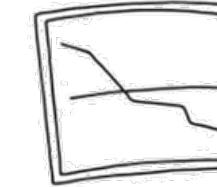
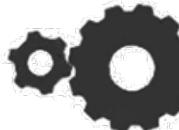


OSI Model



APPLICATION LAYER

Network Applications



HTTP HTTPS FTP
NFS FFTP DHCP
SNMP TELNET
POP3 IRC NNTP



Virtual
Terminals



File Transfer



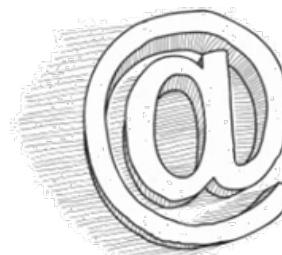
FTP

Web Surfing



HTTP/S

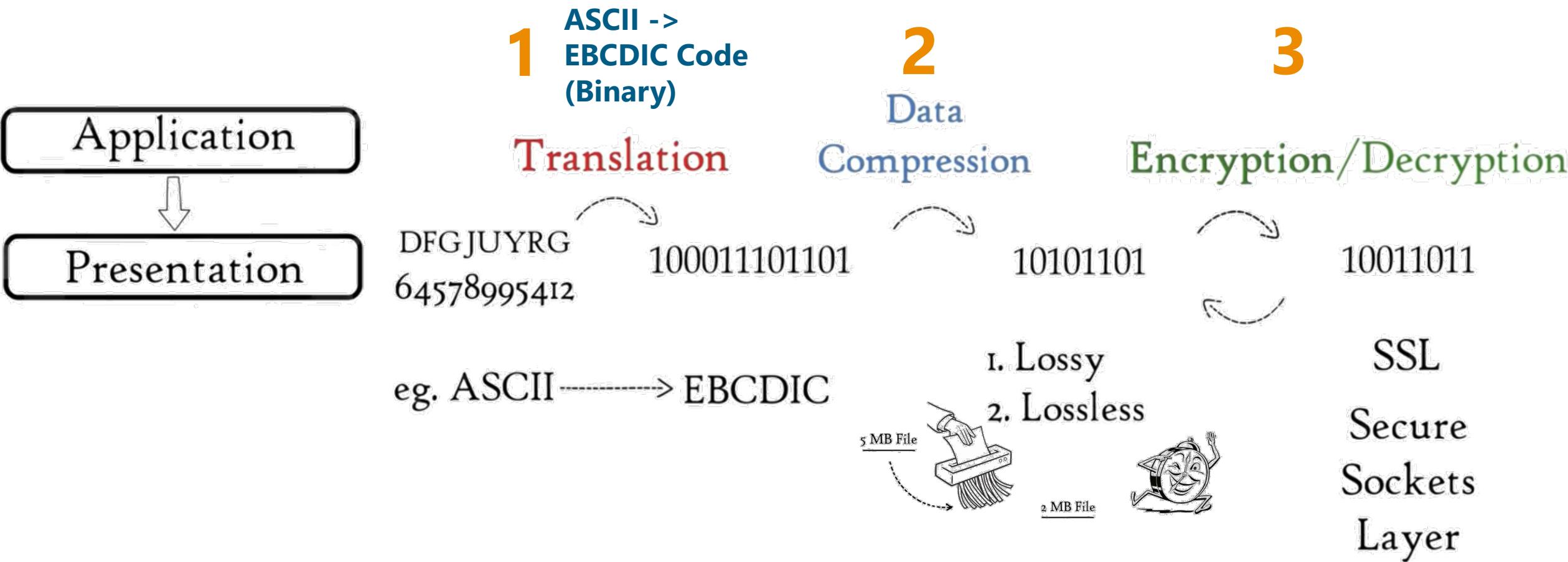
Emails



Telnet

Presentation Layer

- Used by Network Applications



Session Layer

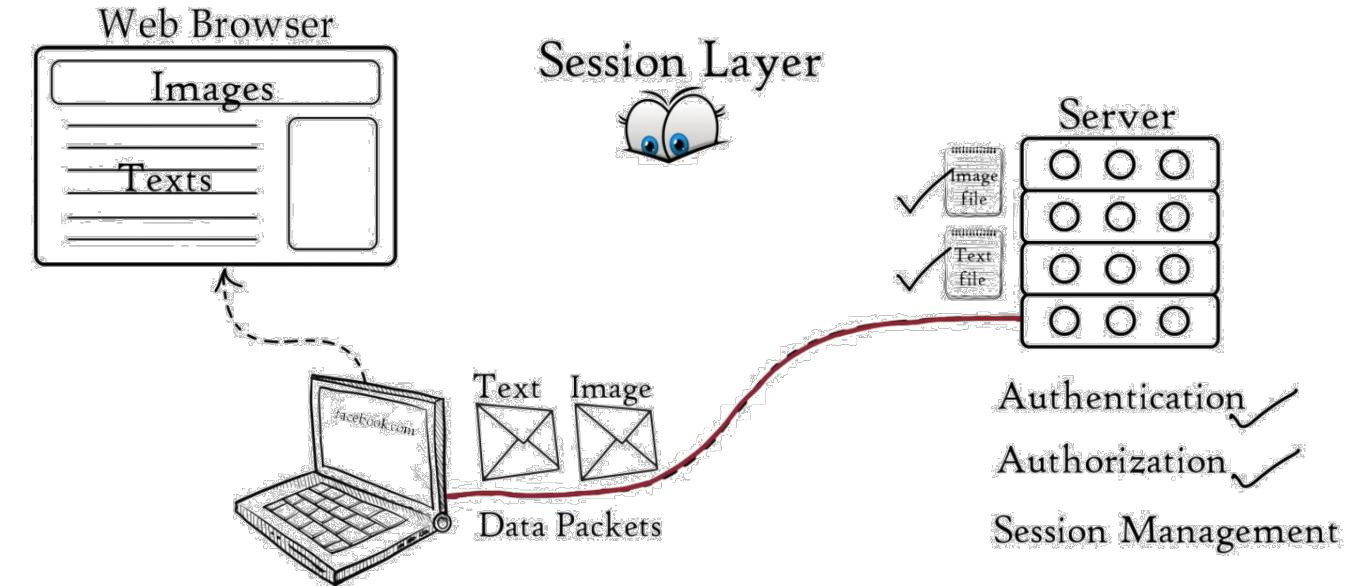
- Setting up and managing connections
- Session Layer Helpers: APIs, NETBIOS
 - Helps applications to communicate with each other

▪ **Session Management**

▪ Authentication, Authorization

▪ **For example,**

- ✓ Web browser performs:
 - Session maintenance across different tabs



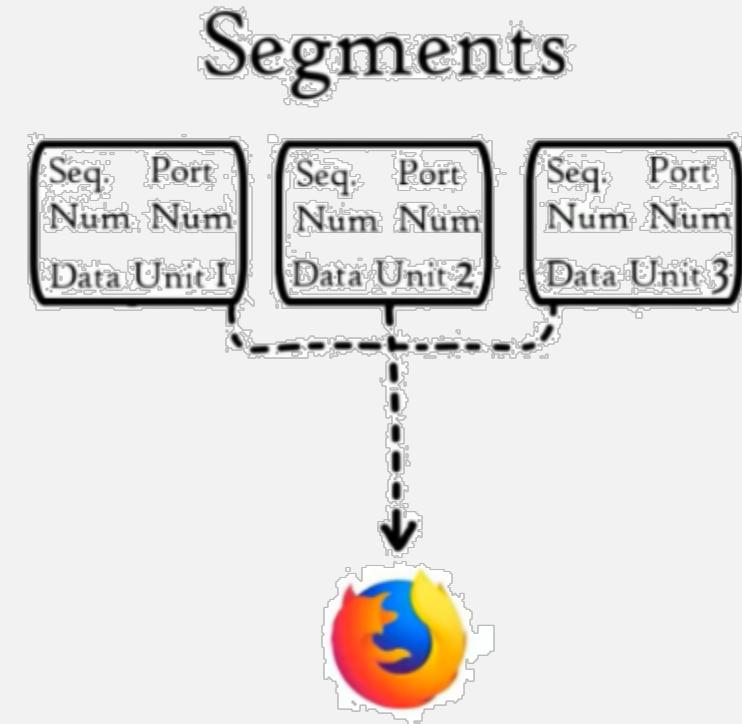
Transport Layer

- Send data from **one application** in a host
to another application in another host



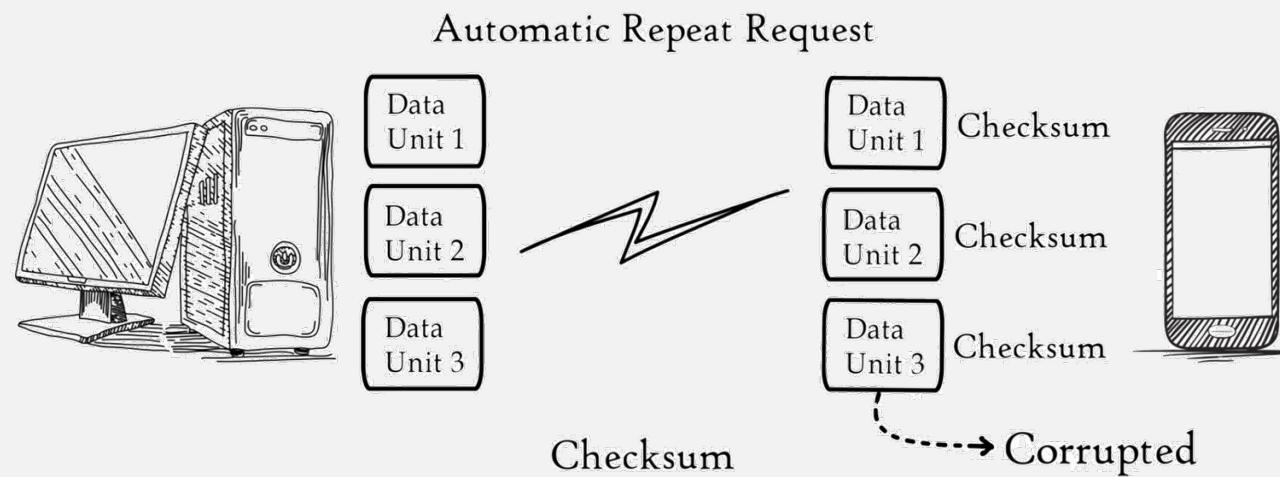
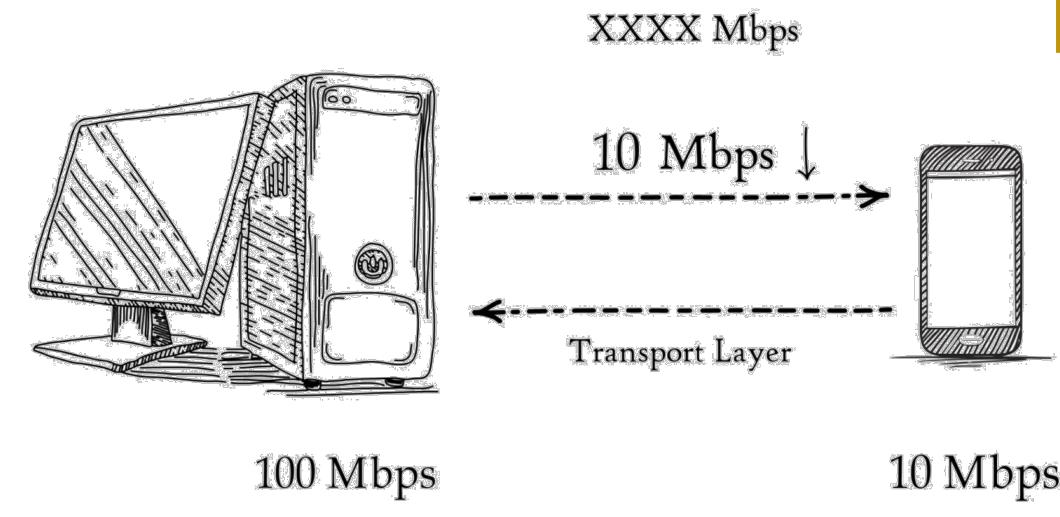
1. Segmentation

- ✓ Data -> segments
- ✓ Segment:
 1. Port number
 2. Seq number
 3. Payload (data)



2. Flow Control

- ✓ Control the amount of data being transmitted

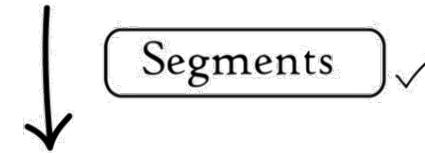


3. Error Control

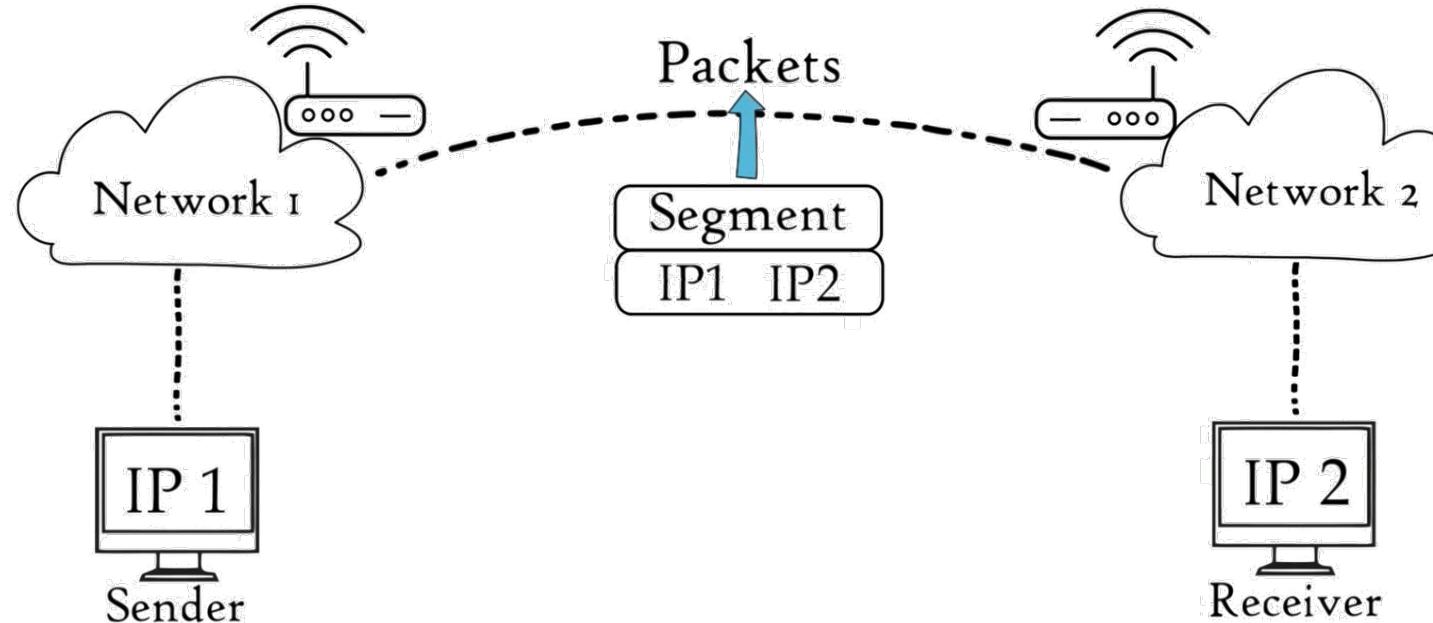
- ✓ Detect errors in data-units
- ✓ Retransmit missing data-units

Network Layer

Transport Layer



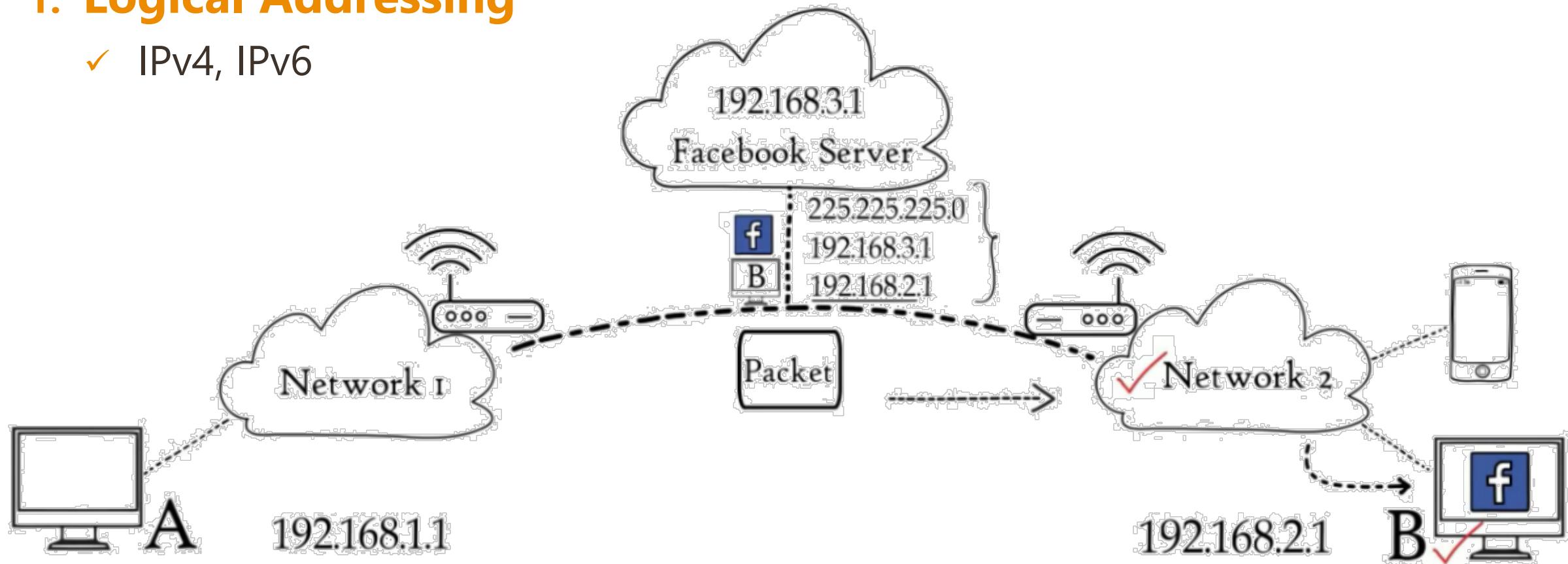
Network Layer



Network Layer – cont.

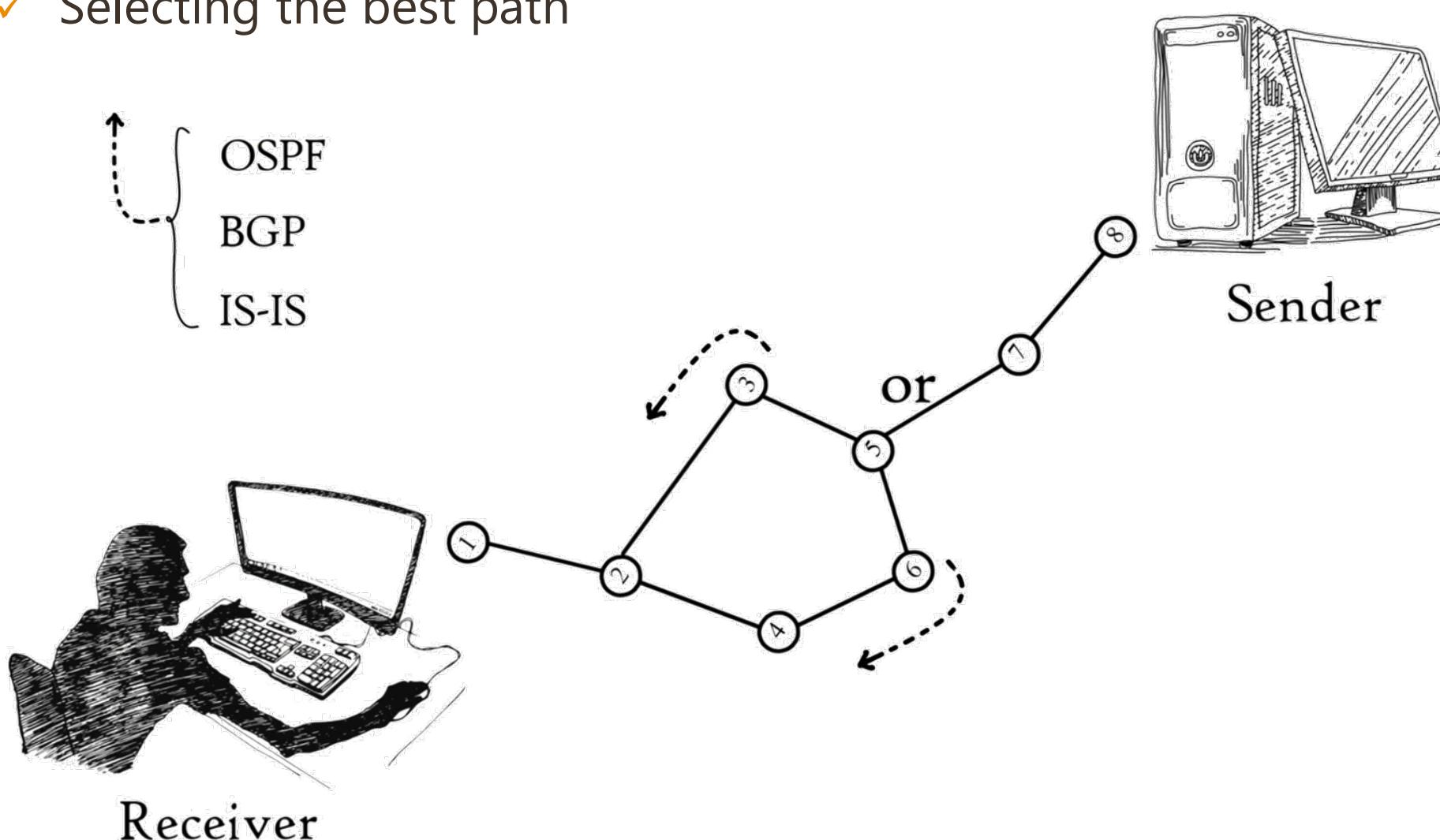
1. Logical Addressing

- ✓ IPv4, IPv6



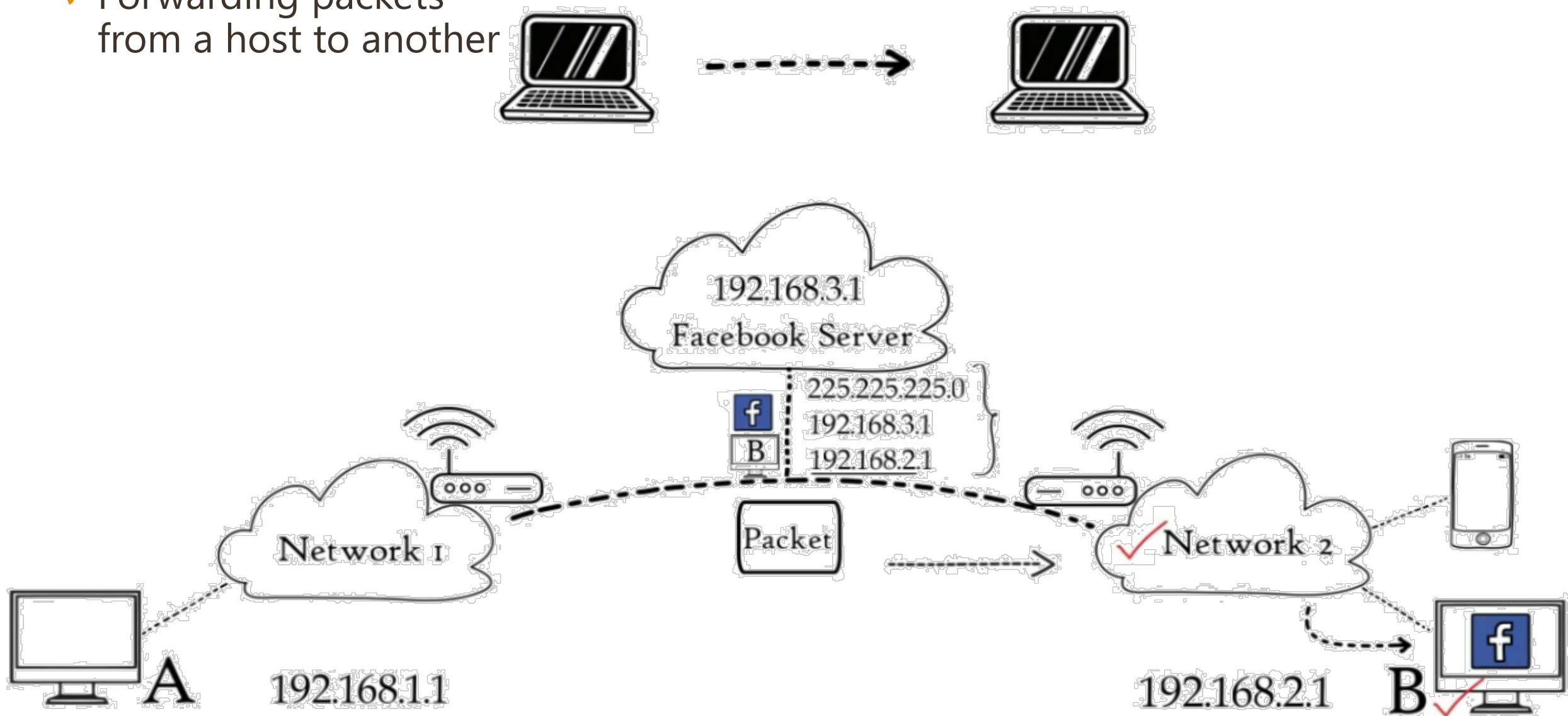
2. Routing

- ✓ Selecting the best path



2. Routing

- ✓ Forwarding packets from a host to another



Data Link Layer

▪ Physical Addressing

- ✓ MAC (Media Access Control) Address
- ✓ Hardcoded by manufacturer to NIC

Two Sub Layers

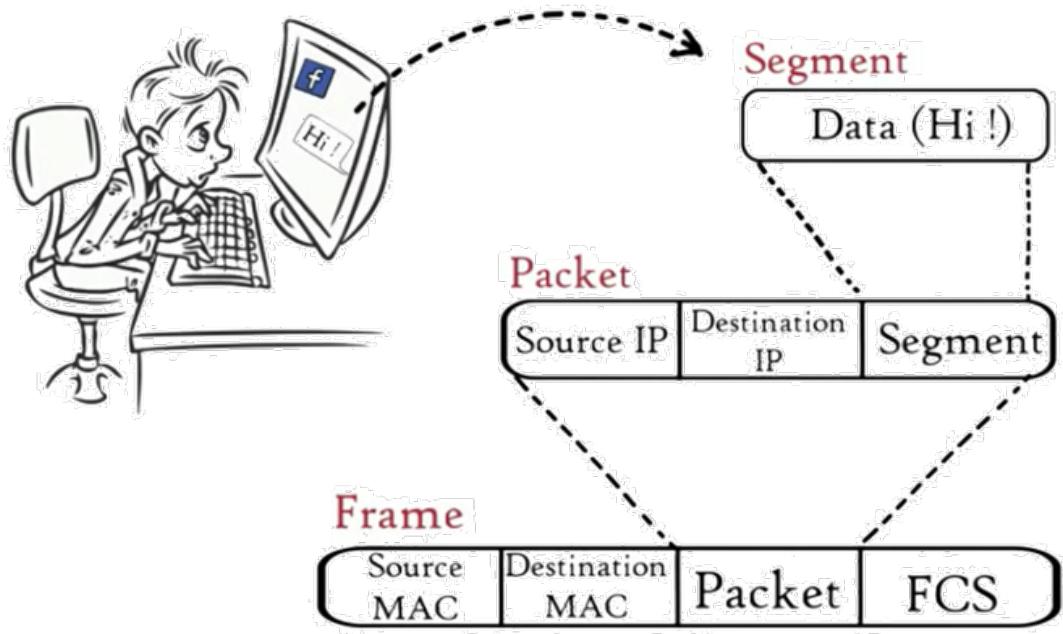
- **Logical Link Control (LLC):**

- ✓ *Error Detection and Correction, etc.*

- **Media Access Control (MAC)**

- ✓ *Framing*
 - ✓ *How the media access is controlled and shared*





TRANSPORT LAYER

NETWORK LAYER

DATA LINK LAYER

APPLICATION LAYER

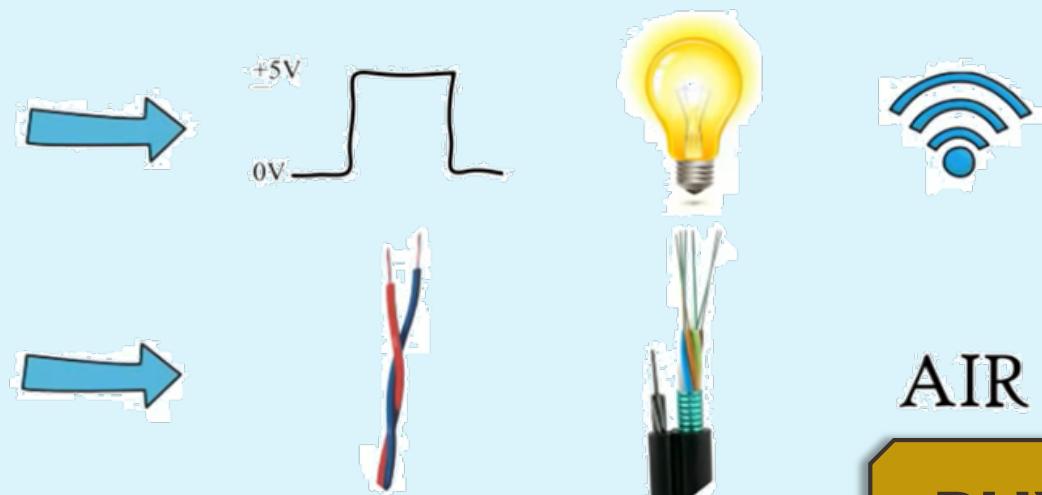
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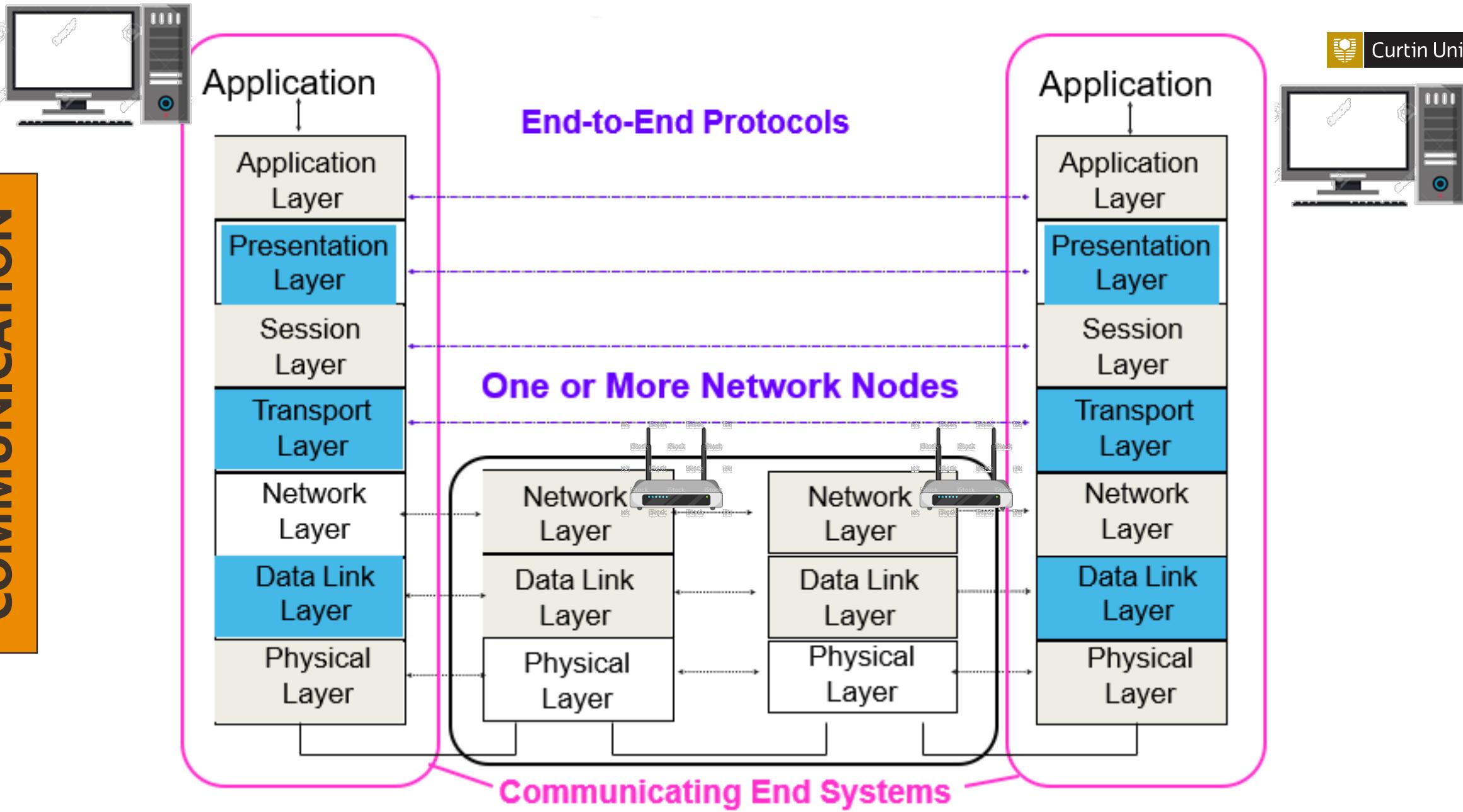
BITS

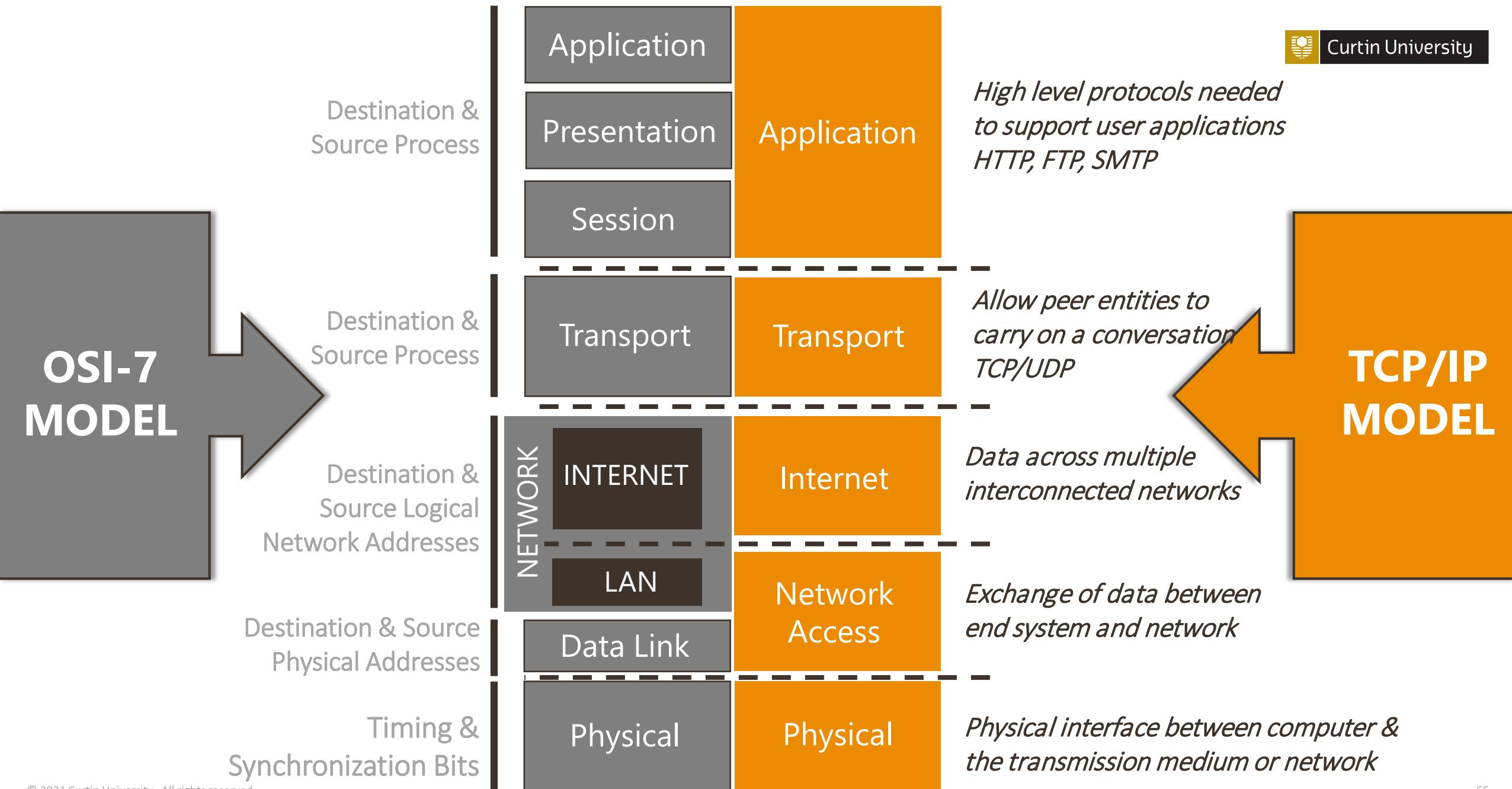
SIGNALS

SIGNALS



COMMUNICATION

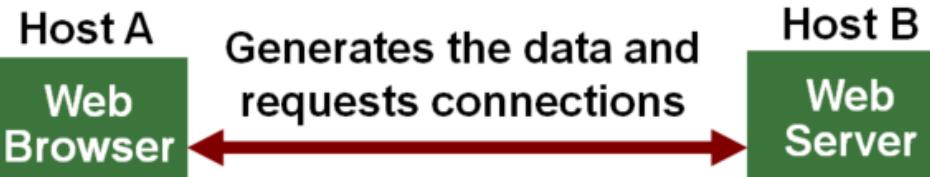






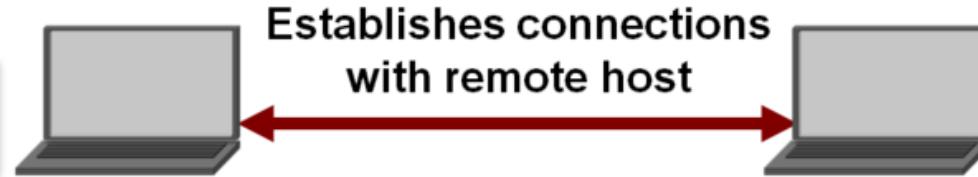
5 Application Layer

The Application layer is the group of applications requiring network communications.



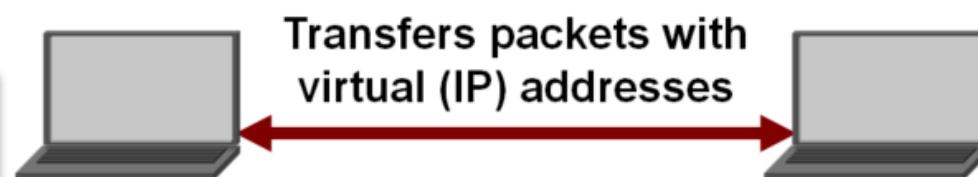
4 Transport Layer (TCP/UDP)

The Transport layer establishes the connection between applications on different hosts.



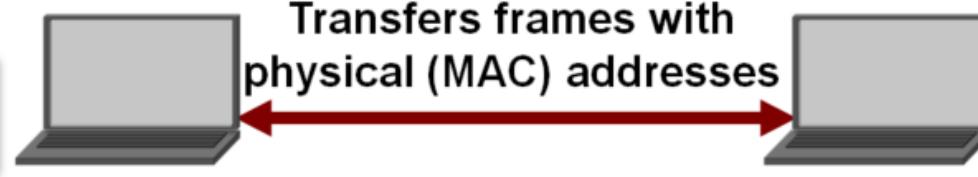
3 Network Layer (IP)

The Network layer is responsible for creating the packets that move across the network.



2 Data Link Layer (MAC)

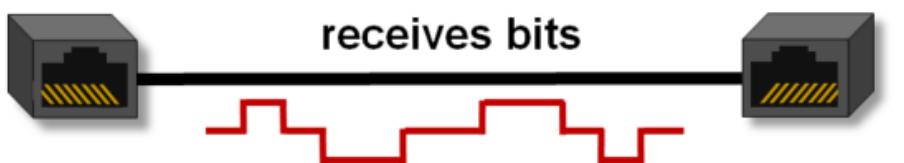
The Data Link layer is responsible for creating the frames that move across the network.



TCP/IP MODEL

1 Physical Layer

The Physical layer is the transceiver that drives the signals on the network.





▪ **Introduction to Networks**

- What is a network?
- Data network elements
- Transmission Technology
 - Point-2-point (unicast)
 - Multi-point (multicast, broadcast)
- Scales of network
 - LAN, MAN, WAN
 - WLAN, WMAN, WWAN, WPAN

▪ **Classification of Networks**

- Circuit-switched networks
- Packet-switched networks
 - Datagram networks
 - Virtual Circuit networks

▪ **Common Networking Technologies**

- Intro. to Telephone Networks (PSTN), Internet, ATM
- Internet

▪ **Layers, Services & Protocols**

- Layering? Services? Protocol?
- Intro to OSI-7-layer model
 - Application Layer Elements / Functions
 - Presentation Layer Elements / Functions
 - Session Layer Elements / Functions
 - Transport Layer Elements / Functions
 - Network Layer Elements / Functions
 - Data Link layer Elements / Functions
 - Physical Layer Elements / Functions
- Intro to TCP/IP 5-layer model
- OSI 7-layer model vs TCP/IP 5-layer model

THANK YOU

Make tomorrow better.