CPE348: Introduction to Computer Networks

Lecture #2: Chapter 1.1

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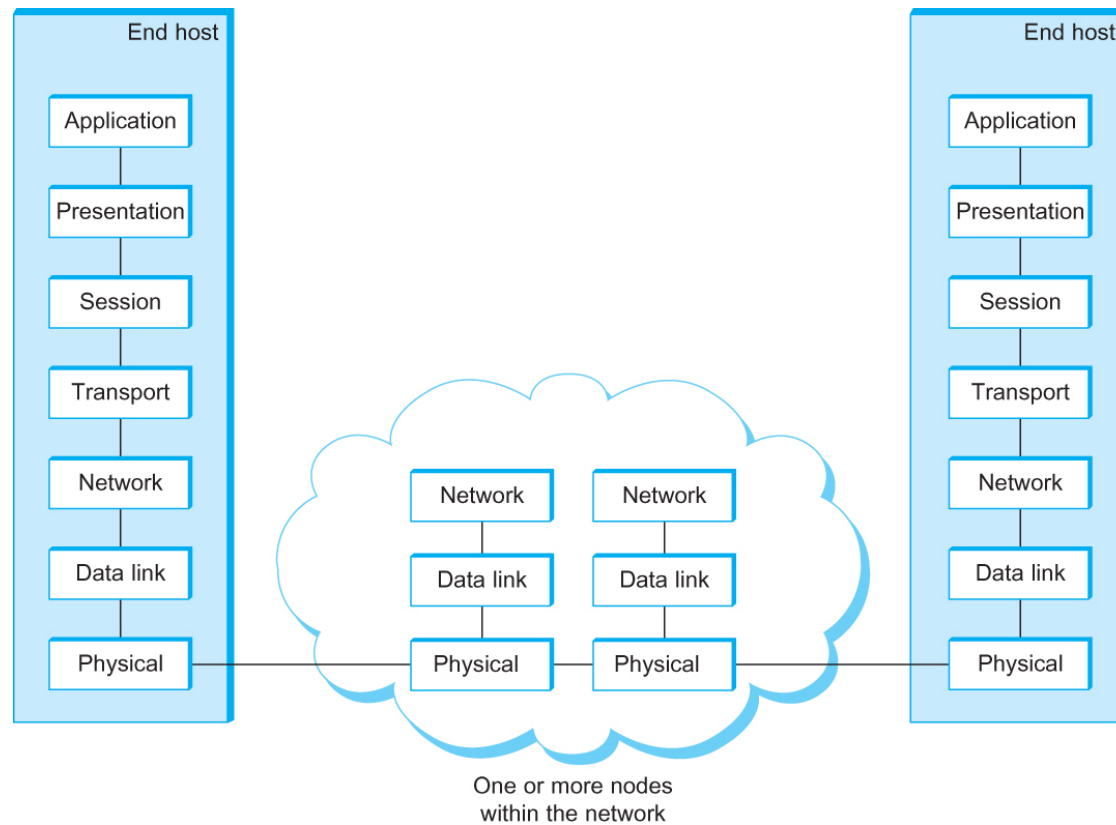
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Chapter Outline

- Network Architecture
- Applications
- Metrics and Performance

Chapter Goal

- Overview of the network architecture

- Briefly explain how to develop a network application following a top-down approach

- Given several metrics that will be used to evaluate the performance of computer network

OSI Model

The OSI 7-layer Model
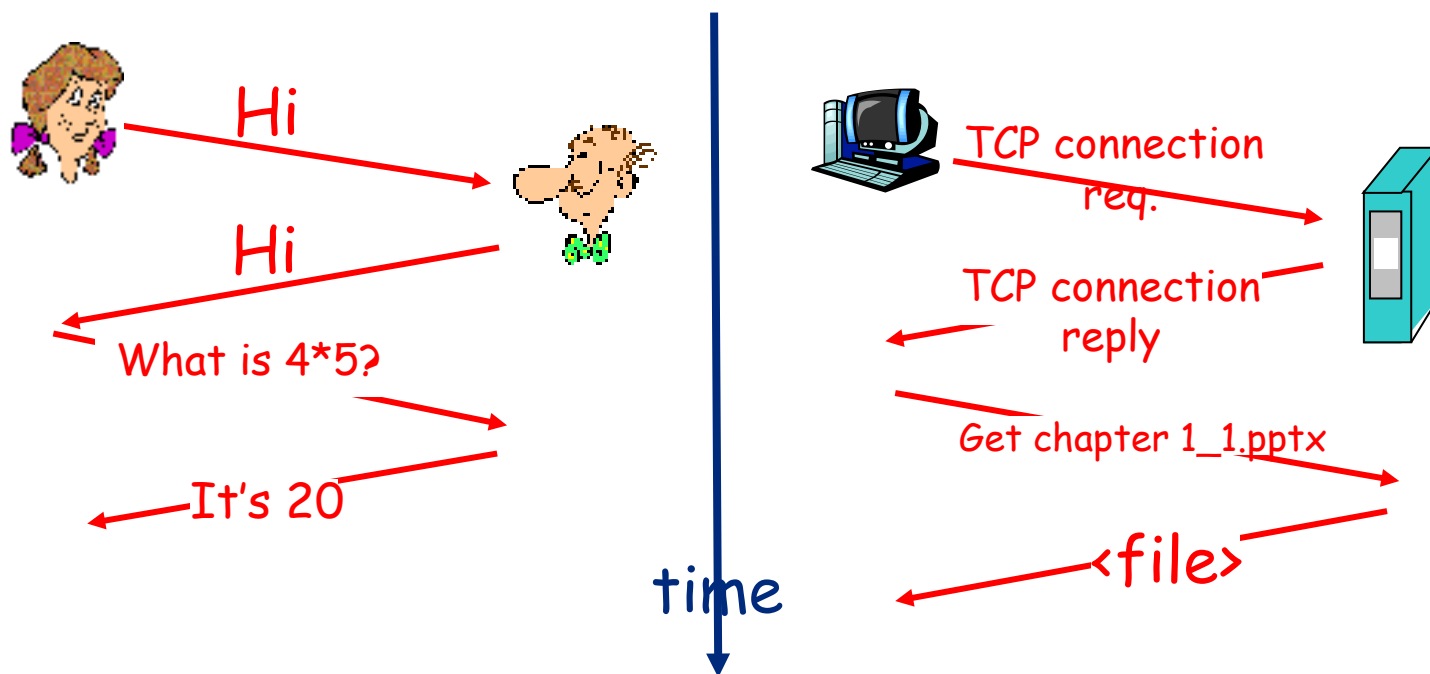
OSI – Open Systems Interconnection

OSI Model

- It is the foundation of any computer network;

- It partitions a computer network into abstraction layers;

- A lower layer serves the layer above it;

- It encompasses a wide range of rules, algorithms and protocols;

OSI model
by layer

7. Application layer [hide]
NNTP · SIP · SSI · DNS · FTP · Gopher · HTTP · NFS · NTP · SMPP · SMTP · SNMP · Telnet · DHCP · Netconf · *more....*

6. Presentation layer [hide]
MIME · XDR · ASN.1

5. Session layer [hide]
Named pipe · NetBIOS · SAP · PPTP · RTP · SOCKS · SPDY

4. Transport layer [hide]
TCP · UDP · SCTP · DCCP · SPX

3. Network layer [hide]
IP (IPv4 · IPv6) · ICMP · IPsec · IGMP · IPX · AppleTalk · X.25 PLP

2. Data link layer [hide]
ATM · ARP · IS-IS · SDLC · HDLC · CSLIP · SLIP · GFP · PLIP · IEEE 802.2 · LLC · MAC · L2TP · IEEE 802.3 · Frame Relay · ITU-T G.hn DLL · PPP · X.25 LAPB · Q.921 LAPD · Q.922 LAPF

1. Physical layer [hide]
EIA/TIA-232 · EIA/TIA-449 · ITU-T V-Series · I.430 · I.431 · PDH · SONET/SDH · PON · OTN · DSL · IEEE 802.3 · IEEE 802.11 · IEEE 802.15 · IEEE 802.16 · IEEE 1394 · ITU-T G.hn PHY · USB · Bluetooth · RS-232 · RS-449
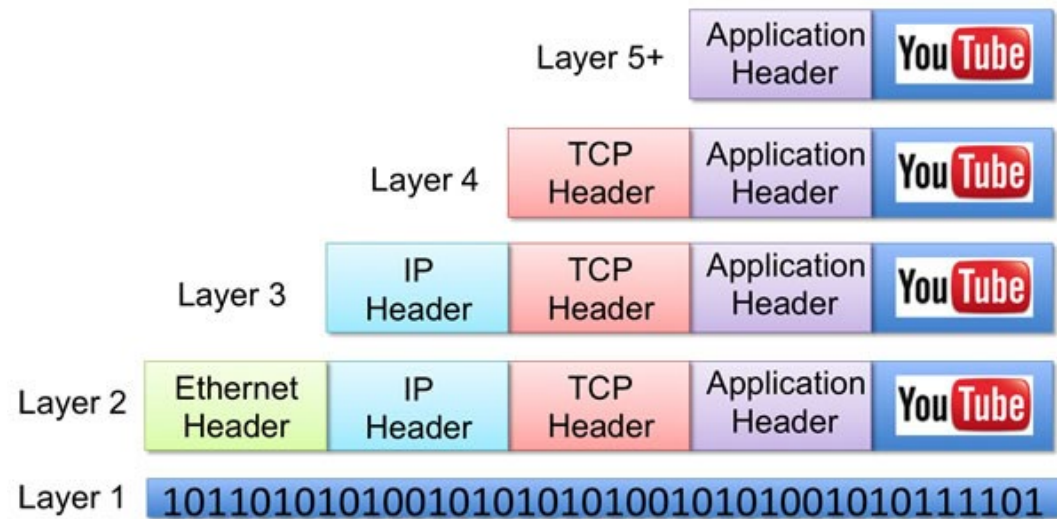
Wiki Screenshot

Rules, Algorithms, Protocols?
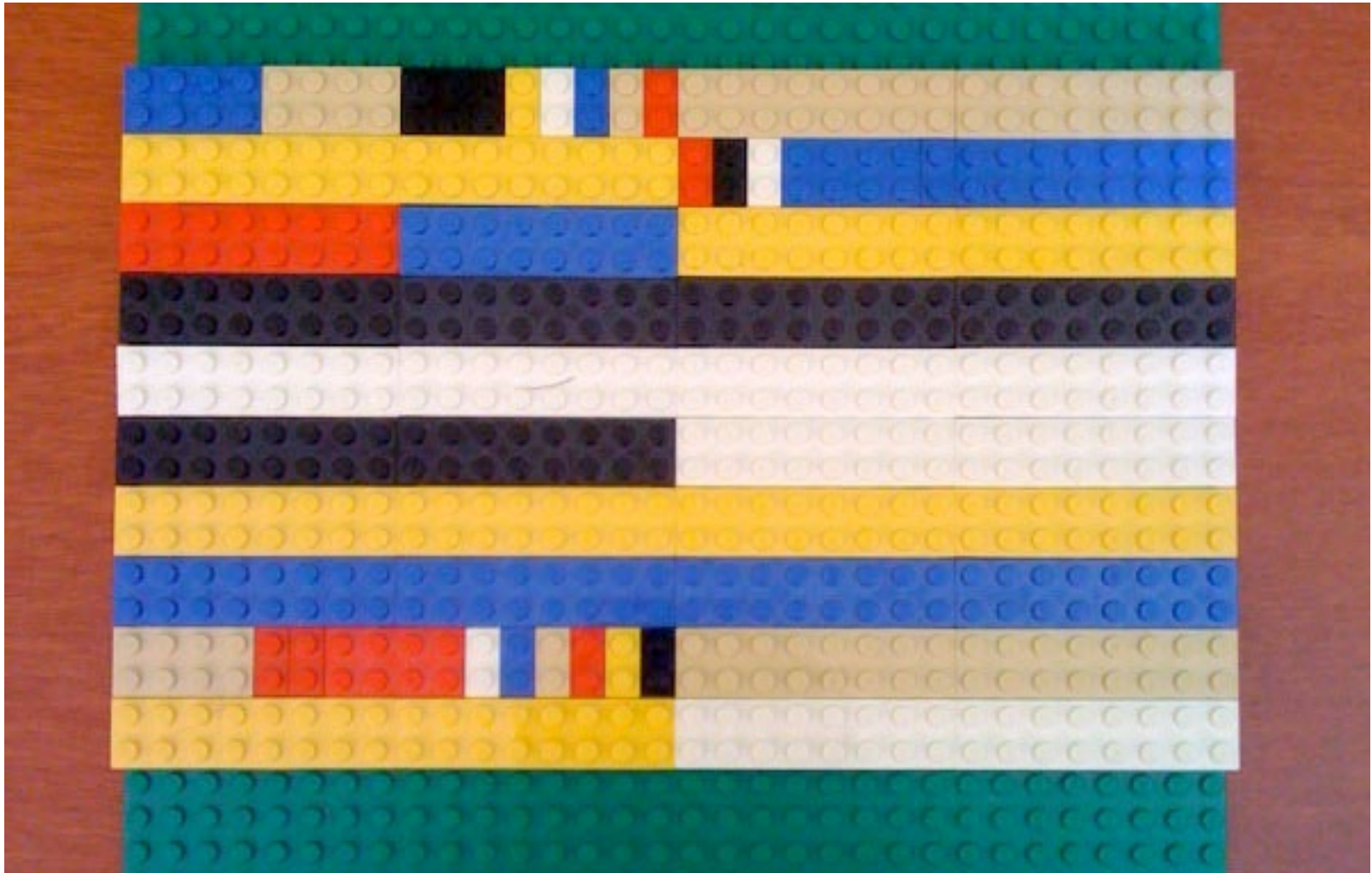
a human conversation and a computer conversation:

Hi

Hi

What is 4*5?

It's 20

TCP connection req.

TCP connection reply

Get chapter 1_1.pptx

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time

- **Rules**: the format, naming, addressing, etc.
- **Algorithms**: functions
- **Protocols**: A collection of agreements, including rules and algorithms, for a conversation

Rules, Algorithms, Protocols?

- **Rules, Algorithms and Protocols**: are specified in the header of each OSI layer;

- **Send host** goes from top to bottom, encapsulates data; whereas **receive host** goes from bottom to top, decapsulates data. (**onion**)

Layer 5+				Application Header	You Tube
Layer 4			TCP Header	Application Header	You Tube
Layer 3		IP Header	TCP Header	Application Header	You Tube
Layer 2	Ethernet Header	IP Header	TCP Header	Application Header	You Tube
Layer 1	1011010101001010101010010101010010101111101

e.g., TCP/IP Header in Lego

Network Architecture

This course is about to study **Rules**, **Algorithms and Protocols of each OSI layer,** using a **bottom-up approach**.

First, let's take an alternative view in terms of developing a **network application**, using a **top-bottom approach**.

Applications

- Most people know about the Internet (a computer network) through applications
    - World Wide Web (www.espn.com)
    - Email (outlook)
    - Online Social Network (facebook)
    - Streaming Video (youtube)
    - File Sharing (dropbox)
    - Instant Messaging (whatsapp)
    - …

Application Protocol

- URL
  - Uniform resource locater
  - http://www.cs.princeton.edu/~llp/index.html
- HTTP
  - Hyper Text Transfer Protocol
- TCP
  - Transmission Control Protocol
- 17 messages for one URL request
  - 6 to find the IP (Internet Protocol) address
  - 3 for connection establishment of TCP
  - 4 for HTTP request and acknowledgement
    - Request: I got your request and I will send the data
    - Reply: Here is the data you requested; I got the data
  - 4 messages for tearing down TCP connection
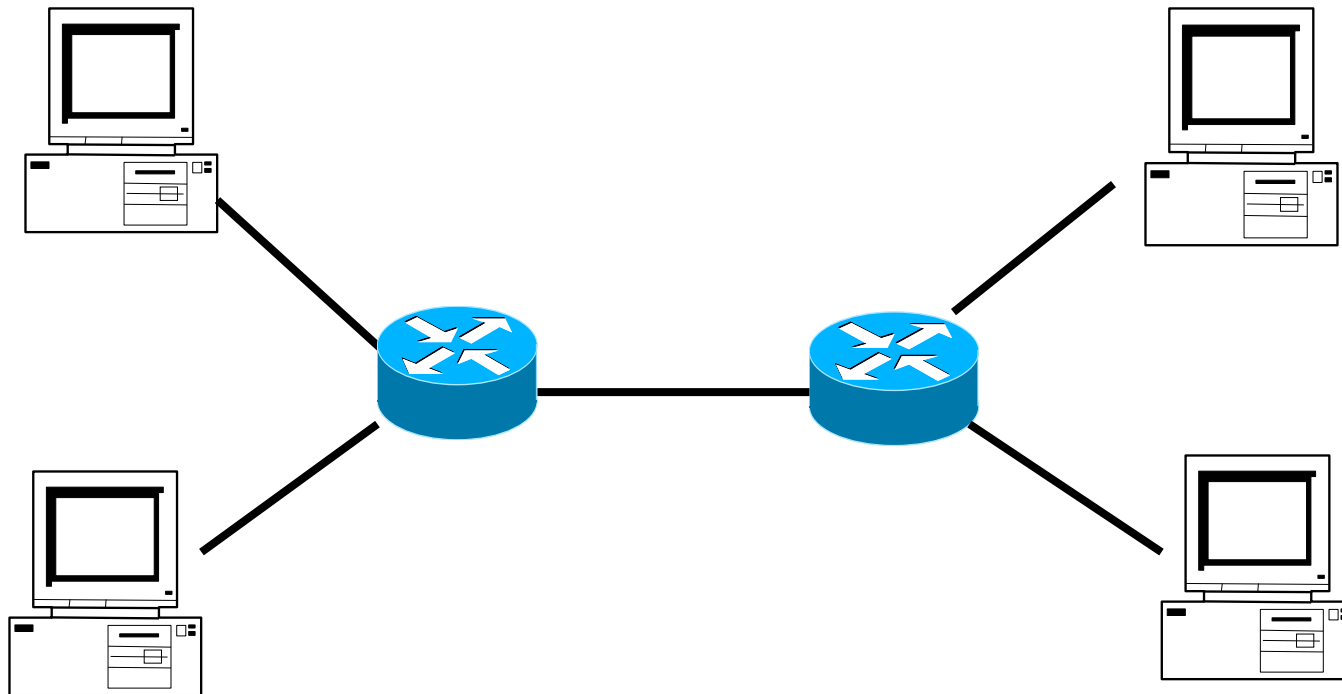
Connectivity

Link

- Fiber optics, ethernet, wireless, cable,…
- Characterized by
    - Capacity or bit-rate (1.5 Mb/s, 100Mb/s, …)
    - Propagation delay (10us, 10ms, 100ms, ..)
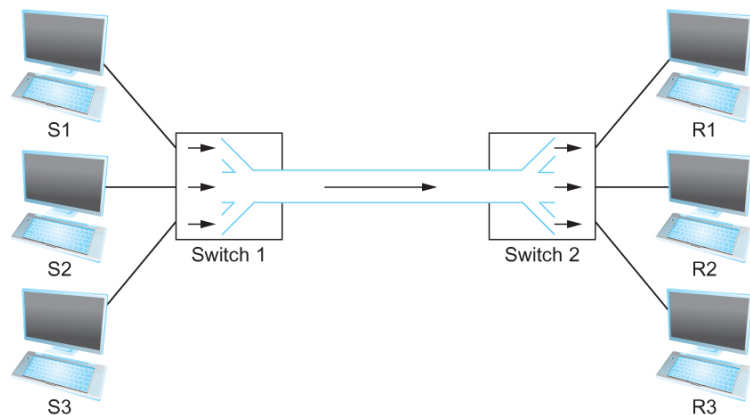   - Transfer time on a link = #bit/bit-rate + propagation delay
    - …

Connectivity
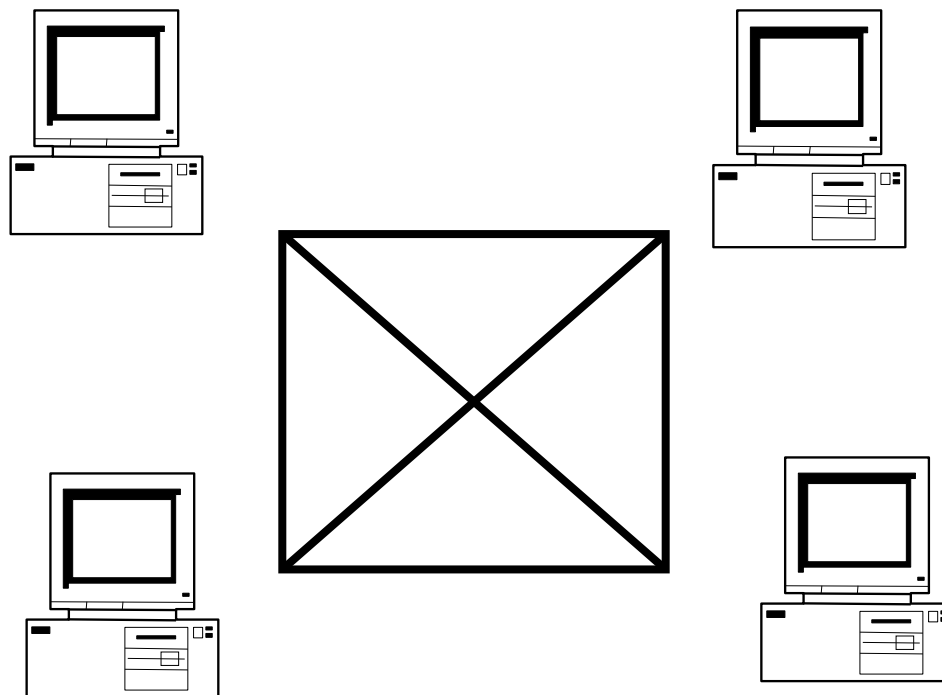
A mesh network requires N^2 connections → too costly

Connectivity
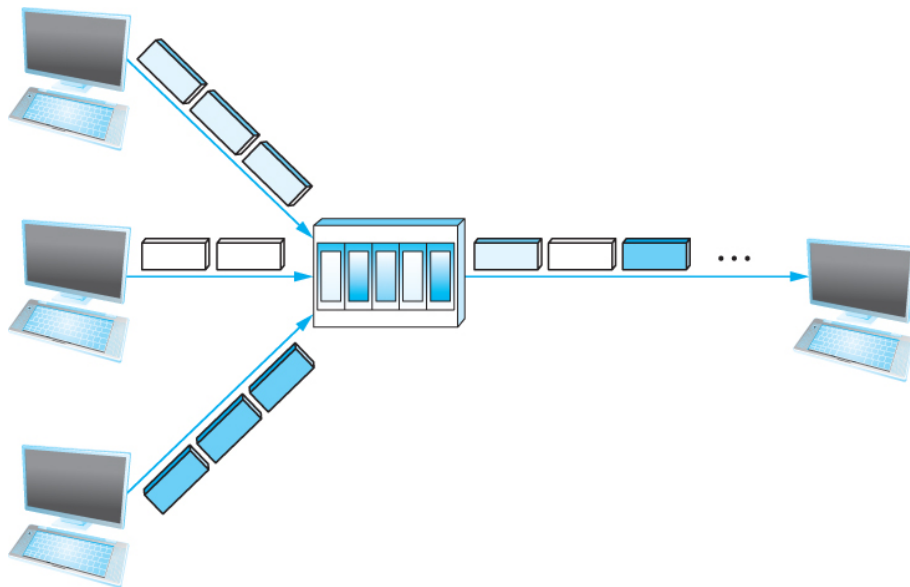

A shared infrastructure

Cost-Effective Resource Sharing

Multiplexing multiple logical flows over a single physical link

- Resource: links and nodes
- How to share a link?
  - Multiplexing
  - De-multiplexing
  - Synchronous Time-division Multiplexing
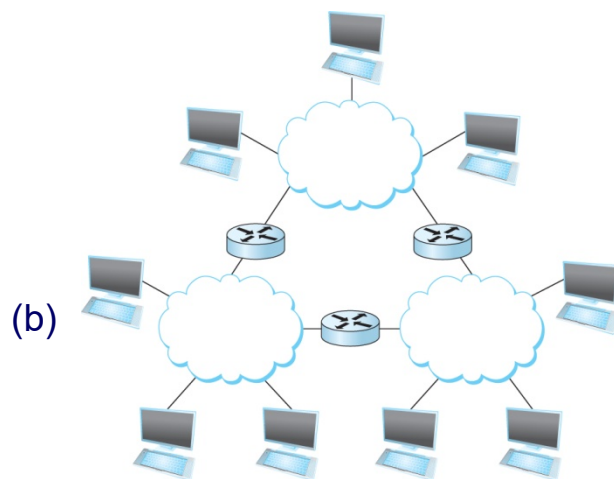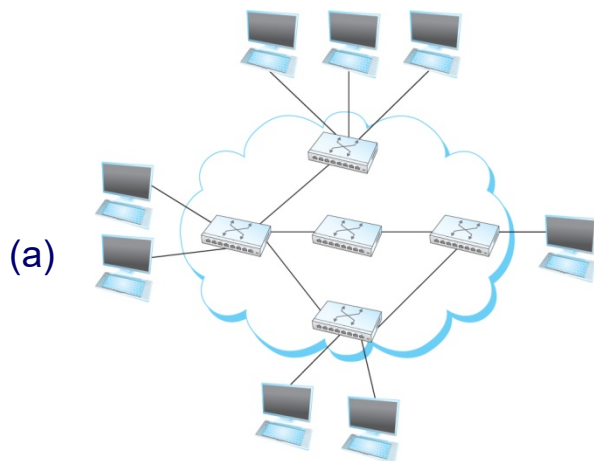   - Time slots/data transmitted in predetermined slots

Cost-Effective Resource Sharing

A switch multiplexing packets from multiple sources onto one shared link

- FDM: Frequency Division Multiplexing
- Statistical Multiplexing
  - Data is transmitted based on demand of each flow.
  - What is a flow?
  - Packets vs. Messages
  - FIFO, Round-Robin, Priorities (Quality-of-Service (QoS))
  - Congested?
- LAN, MAN, WAN
- SAN (System Area Networks

Connectivity

(a)

(b)

- **Terminologies (contd.)**
  - Cloud
  - Hosts
  - Switches
  - internetwork
  - Router/gateway
  - Host-to-host connectivity
  - Address
  - Routing
  - Unicast/broadcast/multicast

(a) A switched network

(b) Interconnection of networks

Support for Common Services

- ## Logical Channels (via TCP)
  - ### Application-to-Application communication path or a pipe
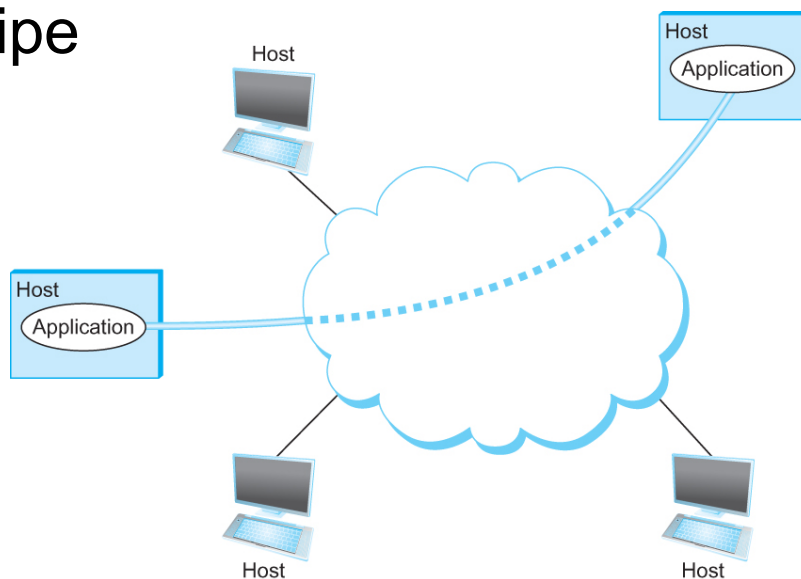
Process communicating over an
abstract channel

Reliability

- Network should hide the errors
- Bits are lost
    - Bit errors (1 to a 0, and vice versa)
    - Burst errors – several consecutive errors
- Packets are lost (Congestion)
- Links and Node failures
- Messages are delayed
- Messages are delivered out-of-order
- Third parties eavesdrop