

# Computer Networks

A computer network is a set of nodes connected by communication links.

any device capable of sending/receiving data (e.g. data, printer)

Wired link / wireless link.  
(link carries the information.)

Wired link: cable

Wireless link: air.

## Basic Characteristics of Computer Network

- \* Fault Tolerance → continue working despite failures
- \* Scalability → grew based on its needs of service.
- \* Quality of Service (QoS) →
  - Set Priorities
  - Manage data traffic to reduce data loss, delay, etc.
- \* Security →
  - Unauthorized access
  - Misuse
  - Forgery
  - Confidentiality
  - Integrity
  - Availability

## Elements of Protocol

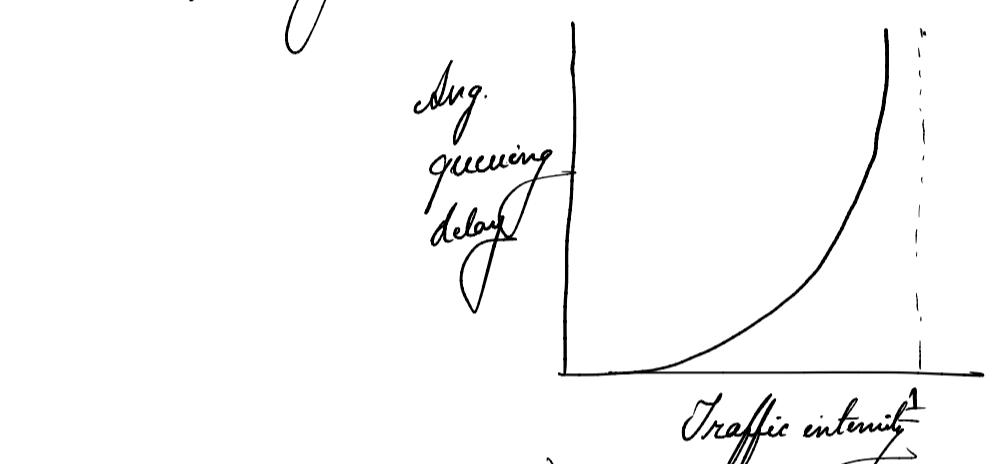
- ① Message Encoding
- ② Message formatting & encapsulation
- ③ Message timing
- ④ Message size
- ⑤ Message delivery option.

## ① Message Encoding



## ② Message Formatting & Encapsulation

Queuing delay



$\frac{La}{R} \sim 0$  (no queuing delay)

$\frac{La}{R} \sim 1$  (large queuing delay)

$\frac{La}{R} > 1$  (the delay gets bigger)

Traffic intensity

$R \leftarrow$  bitrate  
 $a \leftarrow$  avg. packet arrival rate  
 $l \leftarrow$  long. of the packet (bits)

## Protocol layers

- > Networks are complex
- > Layers make it simple to maintain
- > Abstraction
- > Modulation

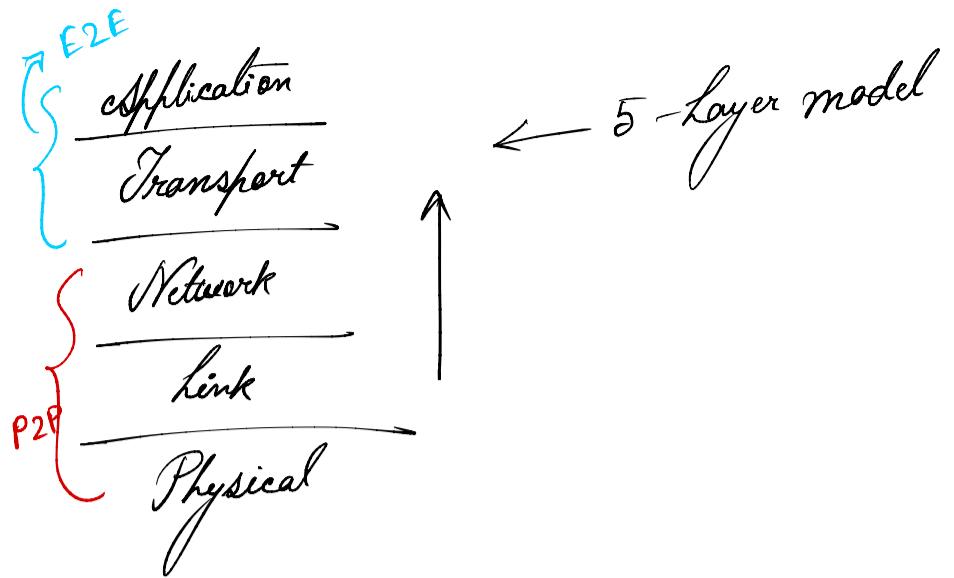
## Divide-and-Conquer

- ① Well-defined Function

- ② Neat Interfaces

- ③ Exchange Minimal Information.

## Internet Protocol Stack



## Link layer (P2P)

### Function

#### Data link layer

> Framing

> Error Control (when packets are corrupted, detect/find)

> Flow Control

Media access Control layer

### Types of Communication entities

- ① End to End (E2E) (only endpoints are active)
- ② Point to Point (P2P) (every nodes in network)

### Application Layer

① End to End

② User Services

- > Web
- > Email
- > File Transfer

### Transport Layer

Checks whether the packets received are corrupted/mining

Responsible for sending packets from application layer.

### Network layer

> Point to Point

### Function

> Addressing

> Routing

> Congestion control

> Administration