Chapter1 - Introduction

Topics:

- What's Computer Network?
- protocol layers, service models
- basic concepts of data transmission: bandwidth, delay, throughput, multiplexing, switching
- What's the Internet
- network edge: hosts, access net, physical media
- network core: packet/circuit switching, Internet structure

What's Computer Network

1- definition and classification

A collection of computers and devices interconnected by communication channels that facilitate communications among users and allows users to share resources.

- wired & wireless
- broadcast & point-to-point
    - broadcast : a single communication channel
    - point-to-point: for each pair, there is a connection
- different topology: bus, star, ring, tree
- different network scale (from personal area network to the Internet)
    - local area networks (LAN): broadcast + simple topologies
    - metropolitan area network: based on cable TV
    - wide area networks(WAN): network edge <-> core <-> network edge
    - Internet: connecting LANs with each other using WAN

2- components

Computer Network contains **hardware** and **software**.

hardwares: network interface cards/ network adapter; repeaters; bridges; switches; routers; firewalls

softwares: protocols, services, interfaces

protocol layers, service models

complex communications and tasks make Internet protocols complex.

1- Definition

Protocol: two parties at different sites, at the same level, agree on how they will exchange information.

One party will use the resources offered by layers underneath, and the layers underneath will offer interfaces.

2- Why we need protocol layers

- easy to design
- independent
- flexibility

3- Services type

- connection-oriented(link established then sending,like phone model) & connectionless
- reliable(no bit error, no data loss, no disorder) & unreliable e.g. TCP- connection-oriented and reliable, UDP - connectionless & unreliable

4- OSI & TCP/IP

"Hourglass philosophy": IP bridges different applications over different networks

OSI: bad timing, bad technology, bad implementations, yet exceptionally useful for discussing computer networks.

Layer	Data Unit	trait
application	message	programs using computer networks
transport	segment	support end-end data transfer
network	datagram/packet	send packets over multiple networks
link	frame	data transfer between neighboring network nodes
physical	bit	send bits 'on the wire'

For switch: link,physical

For router: network, link, physical

The network is **edge-weighted**.

Basic concepts of data transmission

1- concepts

In a communication system:

source -> transform -> channel -> transform -> destination

- signals

  while transmitting, happens:

  - delay
  - distorted
  - attenuated
  - noise to error
- bandwidth & throughput
  - bandwidth: information carrying capacity, bits/sec
  - throughput: the real data rate, instan or average. According to **bottle-neck**, edge connection is always the bottle-neck.
- baud rate & bit rate
  - baud rate: number of samples/symbols per second
  - amount of information per second

    $$bit\ rate = baud\ rate * bits/symbol$$
    $$bits/symbol < -decoding$$

    δ : 10^k is used here for rates.
  - Nyquist's theorem(noiseless channel)

    $$Maximum\ data\ rate = 2Hlog_2V$$

    δ : H for bandwidth, V for discrete levels of the signals
  - Shannon's theorem(noise channel)

    $$Maximum\ data\ rate = Hlog_2(1 + S/N)$$
    $$S/N(dB) = 10log_{10}S/N$$

  δ : H for bandwidth, S/N for signal-to-noise rate
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- synchronous/asynchronous communication
- serial/parallel communication
  - serial: send a bit over a time
  - parallel: send multiple bits over multiple lines
- data encoding
  - digital data -> analog signal(modulation)

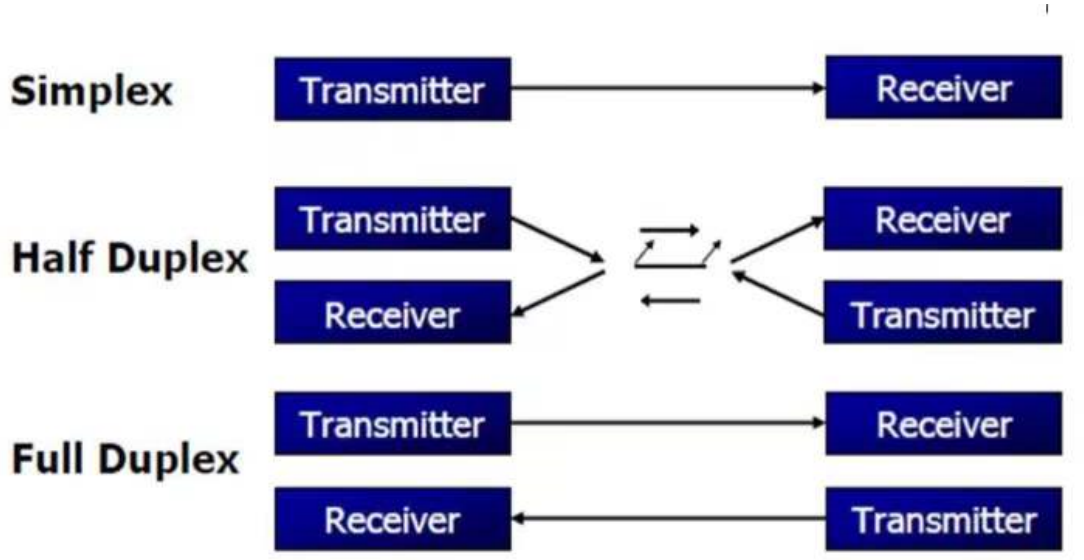
    containing amplitude modulation(振幅), frequency modulation(频率) and phase modulation(相位).
  - digital data -> digital signal

    (differential) Manchester encoding.

    - analog data -> digital signal

      Pulse Code Modulation: sampling, quantifying, encoding.

- duplex



- multiplexing

  FDM,TDM and CDMA

- switching
    - circuit switching -> connection oriented
    - packet switching(virtual circuit switching) -> connectionless
    - message switching
- delay and loss
    - delay may come from: d_process + d_queue + d_trans + d_prop

$$D_{end-end} = \sum nodal_i$$

$$D_{end-end} = d_{end-end-first} + \sum d_{trans_i}$$

    - Bandwidth-Delay Product(RxD): the amount of data in a link

What's the Internet

1- Internet structure

network edge - access networks+physical media + network core

network-edge

end systems(hosts)

- client/server model
- peer-peer model

network-core

Tier1- ISP

Tier2-ISP

Tier3-ISP and local ISP