L1

computer networks

A computer network is a **set of nodes** that are connected together by **communication links**.

Set of nodes：

Computers, switches（交换机）, routers, hubs（集线器）, printers, and servers, smart phone, tablet（平板电脑）

Communication links：

Fiber optics（光纤）, Coaxial pair cable（同轴电缆）, copper（铜）, radio wave, micro wave

Basic components

Server, Client, Hub,Router, Data cable, Peers

Server:

A server is a computer or system that provides resources, data, services, or programs to other computers. Types: File server, Domain Name System(DNS) server, web server, print server, mail server etc.**

Client:

Client is a computer that accesses a service made available by a server

Hub:

Hub is a device that splits分割 a network connection into multiple computers.

Router：

A Router is a networking device that **receives and forwards data packets between computer network**.

Data cable: 数据电缆

Data cables are used to transmit the information from a source to a destination.

Peers: 对等点

Peer is a computer that accesses a service made available by a server

Components of data communication system in computer networks

- Sender, Receiver, Message
- Transmission Medium 传输媒介
- Protocol （数据传输）协议

Types of data communication

- Simplex Mode 单工
- Half-Duplex Mode 半双工
- Full-Duplex Mode 双工

Data communication ways 传播方式

Unicast：单播

Unicast is the term used to describe communication where a piece of information is sent from one point to another point. In this case there is just one sender, and one receiver.

Broadcast：广播

- Broadcast is the term used to describe communication where a piece of information is sent from one point to all other points.
- In this case there is just one sender, but the information is sent to all connected receivers.

Multicast：多播

- Multicast is the term used to describe communication where a piece of information is sent from one point to a set of other points.
- In this case, the information is distributed to a set of receivers

Protocols 协议

Network protocols：

A network protocol is an established set of rules that determine how data is transmitted between different devices in the network.

Network edge

The network edge refers to endpoints of a networks.

End systems 端系统:

The computers and other devices connected to the Internet are often referred to as end systems

access networks：接入网络

is a network that connects subscribers to a particular service provider(DSL, cable networks)

Links：连接

physical media 物理媒介: wired, wireless communication links

Access network:

digital subscriber line DSL 数字用户线路

DSL is a technology for transmitting digital information at a high bandwidth **on existing phone lines** to homes and businesses

cable network：有线电视网络

unlike DSL, which has dedicated access to central office

Physical media

- Wired communication links: - twisted pair 双绞线, - coaxial cable, - fiber optics - Wireless communication links: - micro wave - radio wave - infrared 红外

Types of physical media

Guided：有引导的线路

Twisted pair cable:

- least expensive and most commonly used
- copper wire
- wired connections from the telephone handset to the local telephone switch

分为 1. Shielded（有屏蔽层的）2.Un-shielded（无屏蔽层的）

Coaxial Cable: 同轴电缆

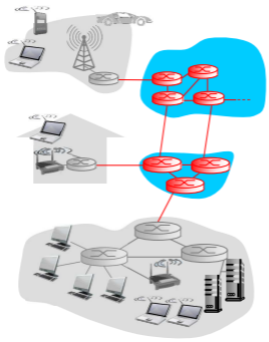
- used in cable Television networks

Fiber optic cables：光纤

Unguided Media：无引导的可以四处发散的

- Radio waves
- Unguided or Wireless Media Microwaves 无线电波
- Infrared signals 红外信号

Network Core



Functions:

1. routing: determines source□destination route taken by packets(by routing algorithms)
2. forwarding: move packets from router ’s input to appropriate router output

Circuit switching 电路交换 ★

优点：Real-time, low delay, low exchange cost

缺点：Low line utilization, long circuit connection time, low communication efficiency, different types of terminal users can not communicate with each other.

Circuit switching is suitable for communication between fixed users with large amount of information and long messages.

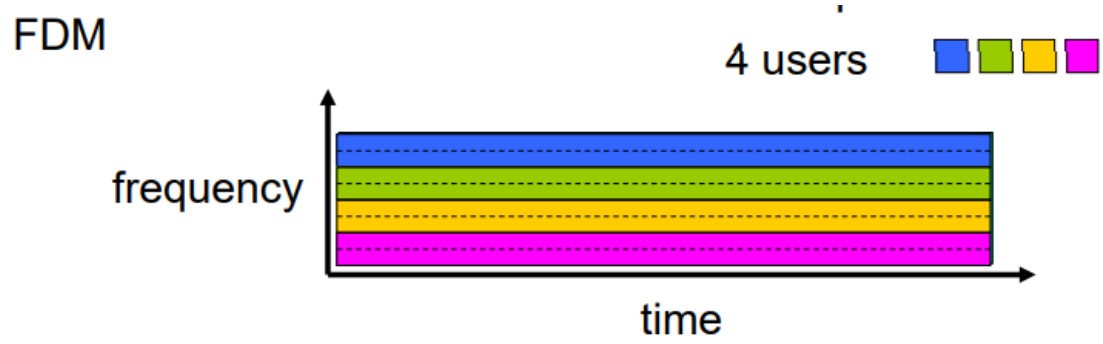
线路利用低，电路接续时间长，通信效率低，不同类型终端用户之间不能通信等缺点。
电路交换比较适用于信息量大、长报文，经常使用的固定用户之间的通信。

Packet switching 分组交换 ★

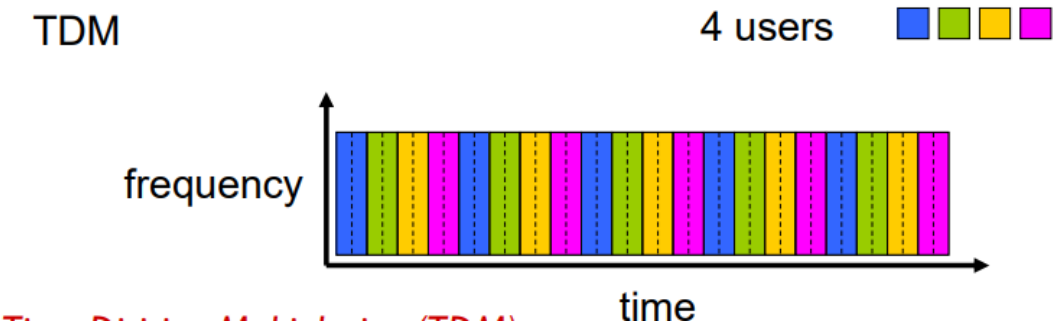
Packet switching has higher circuit **utilization rate** than circuit switching

分组交换比电路交换的电路利用率更高

Frequency Division Multiplexing (TDM) 分频多路复用



Time Division Multiplexing (TDM) 时分多路复用



Packet-switching: 分组交换

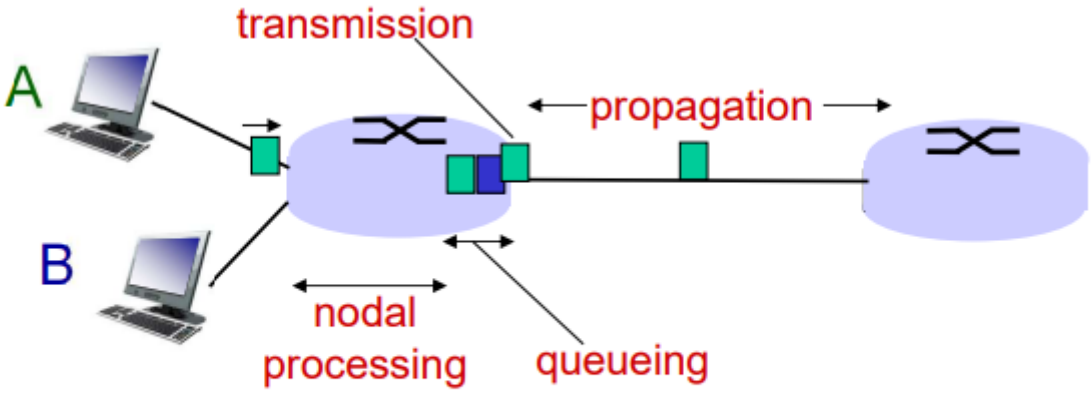
packet switching is a switching technique in which the packets are transferred from a source end system to a destination end system

- Store-and-Forward Transmission 存储转发传输（拥有缓存）

  Most packet switches use store-and-forward transmission at the inputs to the links

★ Delay 迟延

往返时延RTT



$$d_{total} = d_{proc} + d_{queue} + d_{trans} + d_{prop}$$

Processing Delay 处理: The time required to examine the packet's header and determine where to direct the packet is part of the processing delay.

PS：**处理时延**（检错，找出口）

d_{proc}: processing delay
- check bit errors
- determine output link

Queueing delay 排队: At the queue, the packet experiences a queuing delay as it waits to be transmitted onto the link. The length of the queuing delay of a specific packet will depend on the number of earlier-arriving packets that are queued and waiting for transmission onto the link.

PS：**排队时延**

d_{queue}: queueing delay
- time waiting at output link for transmission
- depends on congestion level of router

Transmission delay 传输: This is the amount of time required to transmit the packet bits from the node into the out link buffer. The transmission delay is L/R.

PS：对标**发送时延（传输时延）**，计算机开始发送分组，数据量/带宽

d_{trans}: transmission delay:
- L: packet length (bits)
- R: link *bandwidth (bps)*
- $d_{trans} = L/R$

Propagation delay 传播: Once a bit is transmitted into the link, it needs to propagate to router B. The time required to propagate from the beginning of the link to router B is the propagation delay. 在链路上传播

PS：**传播时延**

d_{prop}: propagation delay:
- d: length of physical link
- s: propagation speed in medium ($\sim 2 \times 10^8$ m/sec)
- $d_{prop} = d/s$

Packet loss

- Since the amount of buffer space is finite, an arriving packet may find that the buffer is completely full with other packets waiting for transmission
- In this case, packet loss will occur—either the arriving packet or one of the already-queued packets will be dropped

type of switching

Circuit-switching: 电路交换
 Does not need to be broken into packets
 Connection establishment is required to start transmission
 It is not a store and forward technique
Packet switching: 分组交换
 Data are broken into pieces, called packets
 Connection establishment is not required to start transmission
 It is a store and forward technique

Throughput 吞吐量 bits/sec

- **instantaneous:** rate at given point in time
- **average:** rate over longer period of time

去类比水管

Networks types

- LAN(Local Area Network) 局域网
- PAN(Personal Area Network) 个人区域网
- MAN(Metropolitan Area Network) 城域网
- WAN(Wide Area Network) 广域网

Topology type

Network topology 网络拓扑

Bus topology 总线拓扑

Star Topology 星型拓扑

Ring topology 环形拓扑

Tree topology 树形拓扑

五层模型

- application layer
- transport layer
- network layer
- link layer
- physical layer