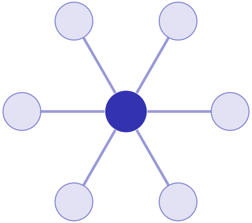
Communication

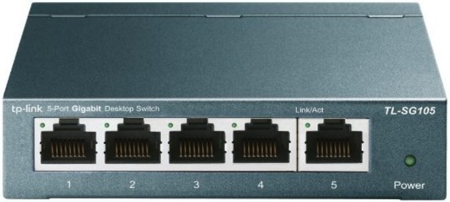
AS Computer Science ▪ Topic 2

A-Level Computer Science



What we will cover

1. Networks: types & models
2. Topologies & cloud
3. Hardware & routing
4. Ethernet & streaming
5. Internet, IP & DNS
6. Recap



1 Networks and types

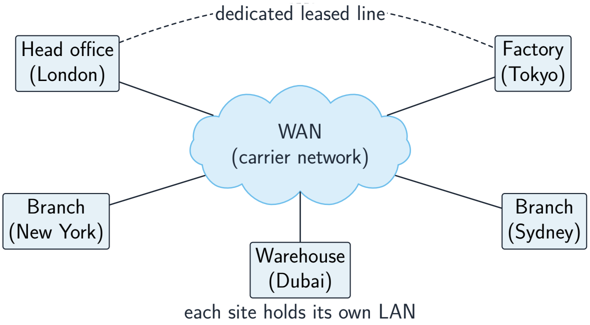
Why use a network?

A **network** 网络 connects devices to communicate and share:

- share resources (printers, files, internet)
- central management & backup
- communication & remote access

Ethernet rj45

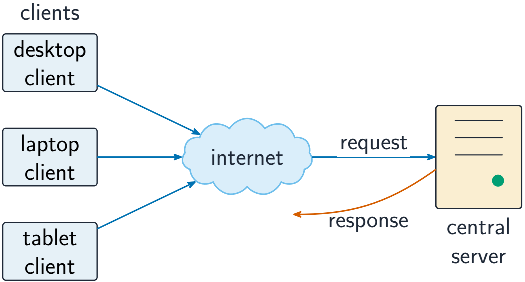
LAN vs WAN

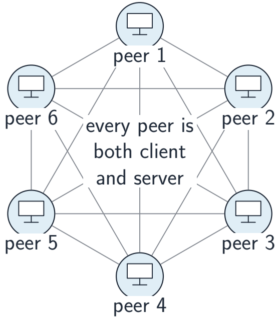


- **local area network** 局域网 (LAN) – small area, one owner, fast, low **latency** 延迟
- **wide area network** 广域网 (WAN) – large area, over **public switched telephone network** 公共交换电话网 links, telecom links, slower; joins LANs

A LAN is usually owned by the organisation itself; a WAN leases telecom links. The internet is the largest WAN.

Client-server and peer-to-peer





client-server 客户端-服务器: *central*

peer-to-peer 对等网络: *equal peers*

Server: easy to manage but a single point of failure. P2P: robust but harder to secure.

Thin vs thick clients

thin client 瘦客户端

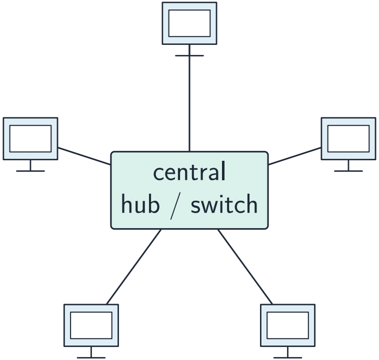
little local processing/storage
relies on a powerful server
(web terminal, remote desktop)

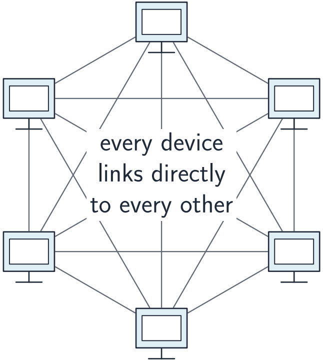
thick client 胖客户端

strong local processing/storage
runs full applications itself
(a normal desktop PC)

2 Topologies and cloud

Network topologies (1)



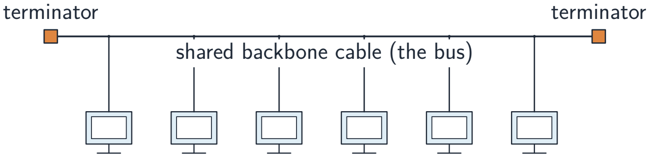


star *星形: a central switch (most common)*

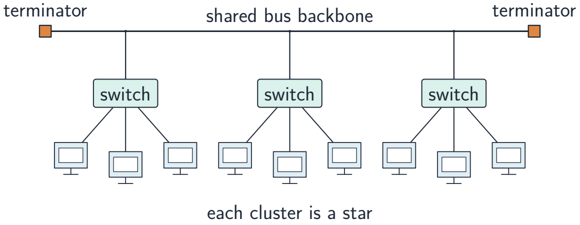
mesh *网状: many paths,* ***fault-tolerant*** *容错*

In a star one cable fault affects one device – but the switch is a single point of failure.

Network topologies (2)



bus *总线: one shared cable – cheap, but one break stops everyone*



Cloud computing and wired vs wireless

Cloud computing 云计算: services over the internet, hosted by a third party.

- + **scalability** 可扩展性, low cost, anywhere
- − needs internet; data held by others

Wired (**Ethernet** 以太网 over **twisted-pair** 双绞线 or **fibre-optic** 光纤): faster, lower latency, fewer errors, more secure. **Wireless** (Wi-Fi, Bluetooth, cellular): mobile and cable-free, but slower and open to interference and eavesdropping.

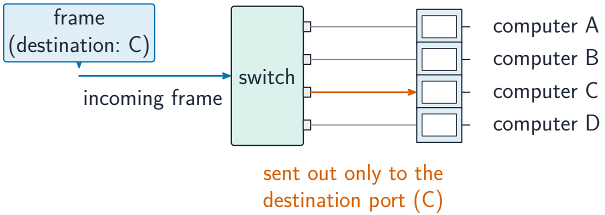
wired: faster, safer, lower latency

wireless: mobile, no cables, but slower

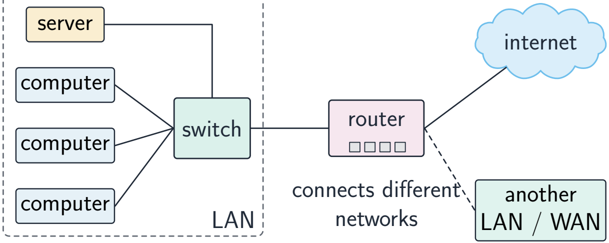
3 Hardware and routing

LAN hardware

- **network interface card** 网络接口卡 (NIC) – sends/receives; unique **MAC address** MAC 地址
- **switch** 交换机 – forwards a frame to the right port only
- **hub** 集线器 – copies to all ports (obsolete)
- **wireless access point** 无线接入点 (WAP) – joins **wireless network interface card** 无线网卡 clients to a wired LAN
- cabling – twisted-pair for short runs, fibre for longer ones



Routers

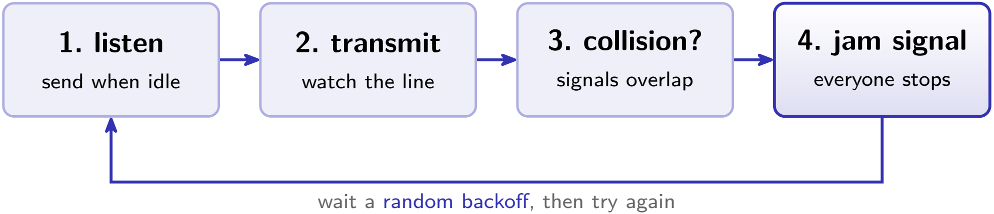


A **router** 路由器 connects different networks:

- forwards **packets** 数据包 by IP (routing table)
- **network address translation** 网络地址转换 (NAT), **DHCP** 动态主机配置协议, and a **firewall** 防火墙 to block unwanted incoming traffic

Ethernet and CSMA/CD

On shared media a **collision** 冲突 can happen – **CSMA/CD** 载波侦听多路访问:



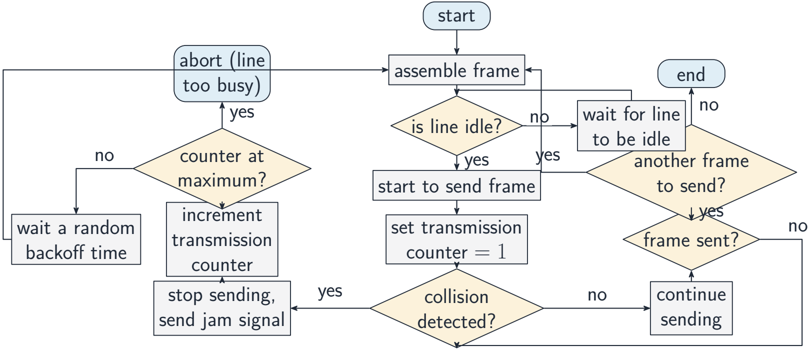
Modern **full-duplex** 全双工 switches avoid collisions altogether.

Wired against wireless, and how Ethernet shares a wire

for the same generation	wired wins on speed and reliability; wireless wins on convenience
1. carrier sense	listen first – if the medium is busy, wait
2. multiple access	any station may transmit when it hears silence
3. collision detection	keep listening while sending; a clash is a collision
4. back off	stop, wait a random time, and try again
why random	if both waited the same time they would collide again immediately

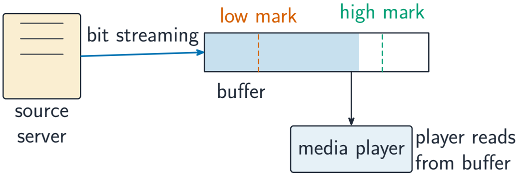
> Wireless cannot detect a collision while transmitting, which is why Wi-Fi uses collision *avoidance* instead of detection.

The CSMA/CD process for handling collisions on



Listen first, and if two stations still transmit together, both stop and wait a random time before retrying – random, so they do not collide again.

Bit streaming



Bit streaming 流式传输: play media as it arrives.

- real-time (live): low latency, no rewind
- on-demand: **buffer** 缓冲 ahead, can pause

The pipeline: capture and sample $\rightarrow$ encode with **lossy** 有损 compression $\rightarrow$ send $\rightarrow$ the receiver buffers briefly and plays, dropping any late packet – a live stream cannot wait – the encoded stream must fit the available **bandwidth** 带宽.

Bit streaming, and why it must be lossy

real-time streaming	live: the data is played as it arrives and not stored
on-demand streaming	the file exists on a server and is buffered as you watch
the buffer	a store filled ahead of the play point, so a brief slowdown does not stop playback
lossy 有损 compression	used here because moving pictures hide small losses, and the stream must be small enough to fit the bandwidth
the requirement	bit rate must be no greater than the available bandwidth, or the buffer empties
the trade	more compression means lower quality but fewer interruptions

Everything here is bandwidth against quality. Naming the buffer and what it protects against is what the question is asking for.

Worked example: how long to download?

A 600 MB video over an 80 Mbit/s connection – how many seconds?

1. size in bits
$600 \times 8 = 4800$ Mbit

→

2. divide by bit rate
$4800 \div 80$

→

time
$= 60$ s

File sizes are in bytes (MB); connection speeds are in bits per second (Mbit/s). Multiply by 8 first – forgetting it is the classic exam slip.

4 Internet, IP and DNS

Internet vs World Wide Web

Internet 互联网

the global network of networks (TCP/IP)

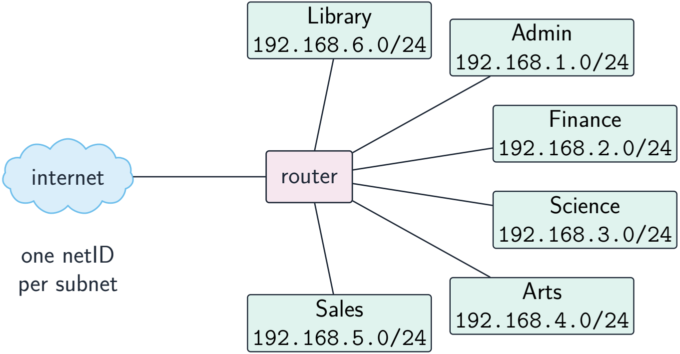
World Wide Web 万维网

one service on it: linked pages via HTTP

> The Internet is the physical network – cables, routers, addresses. The Web is one service running on top of it. Email and file transfer are other internet services, and are not part of the Web.

IP addresses and subnetting

- IPv4: 32-bit (`192.168.1.10`)
- IPv6: 128-bit, far more addresses
- **subnet** 子网: split by a **subnet mask** 子网掩码 (`255.255.255.0`)



Address kinds

private vs public

private: inside a LAN; public: globally routable (from **ISP** 互联网服务提供商)

static vs dynamic

static: fixed (servers); dynamic: from **DHCP** 动态主机配置协议, may change

NAT protection

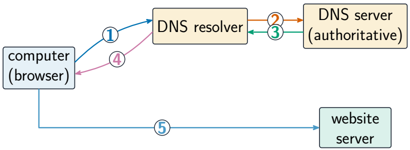
devices behind NAT are not directly reachable from the internet

IP addresses, subnets and the URL

IPv4	32-bit, four denary numbers 0–255 – about 4.3×10^9 addresses, now exhausted
IPv6	128-bit, eight hexadecimal groups – effectively unlimited
a subnet 子网	the mask splits the address into a network part and a host part
the mask	`255.255.255.192` keeps 26 network bits, leaving 6 for hosts – 64 addresses per subnet
a URL 统一资源定位符	locates a resource on the WWW: protocol, domain name, then the path to the file
DNS	resolves the domain name to an IP address, asking successively higher name servers until one answers

> AND the address with the mask to get the network. `192.168.10.130` and `192.168.10.200` under /26 are on different subnets – 128 and 192.

URL and DNS



1 computer asks the resolver for the IP **2** resolver queries a DNS server
3 server returns the IP address **4** resolver passes the IP back to the computer
5 browser connects to that IP and requests the page

A **URL** 统一资源定位符 names one resource:

```
protocol://domain/path
```

- `https` – the **protocol** 协议
- `example.com` – the **domain name** 域名
- `/notes/1` – the path on that server

> The **domain name system** 域名系统 (DNS) turns the domain name into an IP address before the browser connects.

Worked example – which subnet is this host on?

A host has IP `192.168.10.130`, mask `255.255.255.192`. Which network is it on, and is `192.168.10.200` on the same one?

- The mask's last octet 192 is `11000000`, so the first **26** bits are the network part.
- Subnets step in blocks of $256 - 192 = 64$: `.0`, `.64`, `.128`, `.192`.
- 130 falls in the block from `.128`: the network is `192.168.10.128/26`, hosts `.129`–`.190`, broadcast `.191`.
- 200 falls in the *next* block, so it is on a different subnet – and traffic between them must pass through a router.

Work in the last octet only. The block size is 256 minus the mask value, and every subnet starts at a multiple of it.

Exam tips

- Distinguish **LAN vs WAN** and **client-server vs peer-to-peer** by who stores and controls the resources.
- Match each **topology** (bus, star, mesh) to its advantages and drawbacks (cost, reliability, collisions).
- Know the job of each device: a **switch** directs within a LAN by MAC address, a **router** routes between networks by IP.
- Explain **bit streaming** and why buffering is needed (data arrives at a different rate from playback).
- Distinguish **IPv4 vs IPv6** and public vs private addresses; DNS turns a URL into an IP address.

5 Recap

Topic 2 – key takeaways

1 Types

LAN vs WAN; client-server vs peer-to-peer

2 Topologies

bus, star, mesh, hybrid

3 Hardware

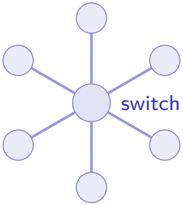
switch forwards by MAC; router by IP

4 Internet

Web is a service on it; DNS maps name to IP

Check yourself

1. Which device forwards frames by MAC address?
2. In a star topology, what fails if the switch fails?
3. What does DNS convert?
4. Internet or Web: which is the service?



Answers **1.** a switch **2.** the whole network **3.** domain name $\rightarrow$ IP address **4.** the Web