Networks

IB DP Computer Science A2 Networks full package

What happens when you open a web page?

> Every step follows agreed rules.

- Theme A2: types, devices, protocols, addressing, transmission and security.
- Prerequisite: 1 byte = 8 bits.

Types of network

Type	Covers	Example
LAN	one site	a school or office
WAN	a large area, joining LANs	the internet
PAN	one person's devices	phone and earbuds
VPN	private link over a public one	working from home

Name the device by its job

Device	Job
switch	joins devices in a **LAN**; forwards each frame to its port
router	joins networks; forwards packets along a route
access point	lets wireless devices join a wired LAN
modem	turns data into a signal for the line, and back
firewall	checks traffic against rules; blocks the rest

Client-server or peer-to-peer?

Client-server

Servers provide services; clients request them.

Central control - but the server is a single point of failure.

Peer-to-peer

Every device is equal and can share.

No central control - hard to secure and back up.

Star or mesh?

Star

Every device has its own cable to a central **switch**.

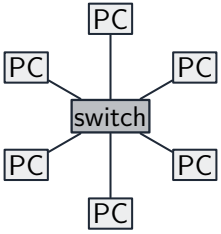
One broken cable affects one device - if the switch fails, all fail.

Mesh

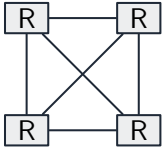
Many paths between devices.

Data routes round a failure - more cables, more cost.

Star and mesh topologies



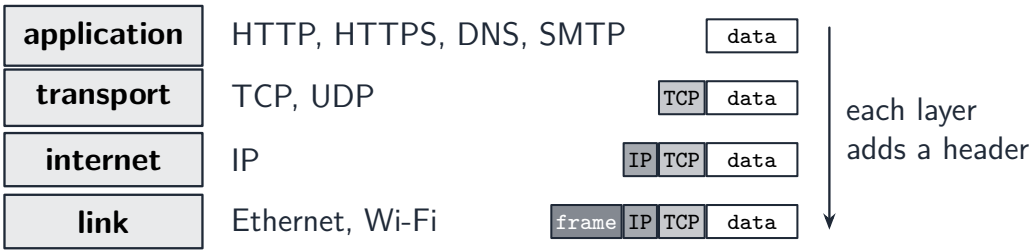
star



full mesh

Mesh is robust but needs many links

The TCP/IP layers



Change one **layer** without changing the others.

Encapsulation

> A browser works the same over Wi-Fi or cable.

- Going down, each **layer** adds control data: a header, sometimes a trailer.
- The receiver removes them going up.

TCP or UDP?

TCP

Numbered segments, acknowledgements, resends.

Every byte must arrive: web pages, files.

UDP

Fast; no delivery or ordering guarantee.

A late **packet** is useless: video calls, games.

IP address or MAC address?

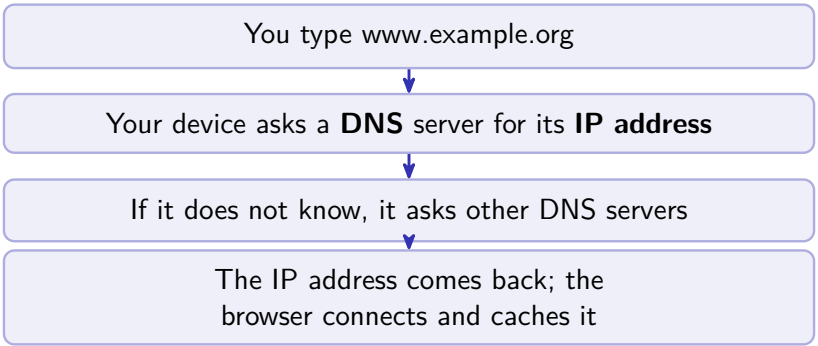
	IP address	**MAC address**
identifies	position on a network	the network card
set by	the network (**DHCP**)	usually the maker
changes?	yes, when it moves	can be randomised
example	192.168.1.24	3C:22:FB:9A:10:07

Why IPv6?

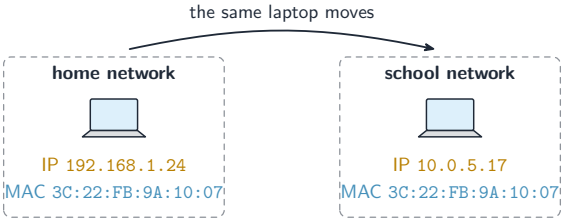
> Four times the bits, vastly more addresses.

- IPv4: 32 bits, about 4.3 billion addresses - too few for every device.
- IPv6: 128 bits, written in hex such as 2001:db8::1.

DNS: finding a server

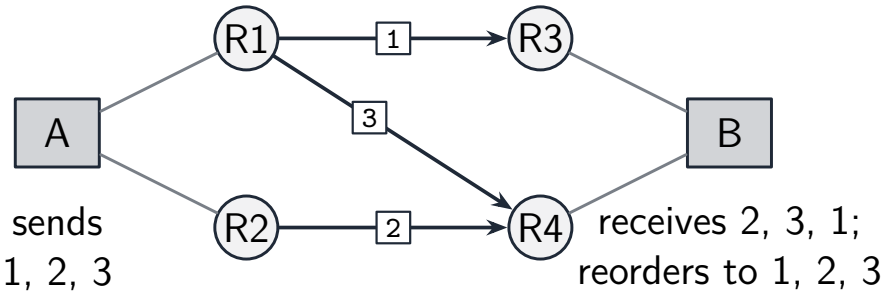


IP and MAC addresses



IP depends on the network; MAC on the hardware

Packet switching



Packets can take different routes and arrive out of order.

Bandwidth, latency, throughput

Term	Meaning	Unit
bandwidth	the most a link can carry	bits/s
latency	the delay before data arrives	ms
throughput	what is actually delivered	bits/s

How long to send it?

1. **To bits** 12 MB x 8 = 96 million bits
2. **Divide** 96 million / 8 million bits per second
3. **Ideal time** 12 seconds

Decision

The real time is longer: **latency** and overhead are added.

Threats

Threat	What happens
malware	a virus or ransomware damages or locks data
phishing	a fake message tricks a user out of a password
interception	data is read as it travels
denial of service	a server is flooded until users cannot reach it

Countermeasures

Match each defence to a threat.

- **Authentication** checks who you are; **authorization** decides what you may do.
- Multi-factor: something you know, have or are.

Symmetric or asymmetric?

Symmetric

One shared secret key.

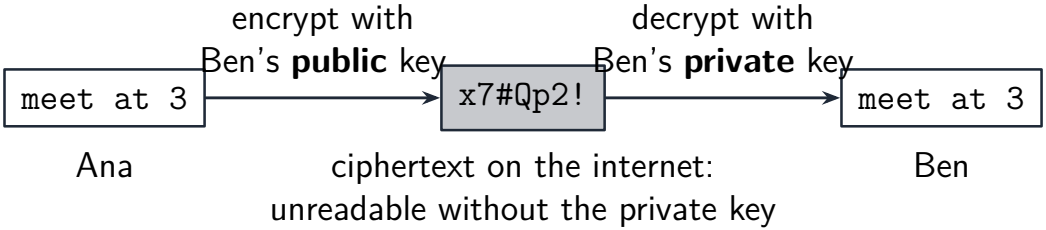
Fast - but the key must be shared safely.

Asymmetric

A public key and a private key.

Slower - the public key can go to anyone.

How HTTPS uses both



> Asymmetric to agree a key, symmetric for speed.

Practice

Your turn

Try these:

A. TCP or UDP for an online game? Explain.
B. Describe how a file crosses the internet.
C. 30 MB on a 20 Mbit/s link: the ideal time?
D. Name the threat in a "confirm your password" e-mail.

Check yourself

