LANs, WANs and network performance

Computer systems (Paper 1) · revision notes

What a LAN and a WAN are, how they differ, and the factors that make a network faster or slower. Expect 1 to 2 mark definitions, 'describe the differences' questions and 'explain why the network is slow' questions set in a scenario such as a school, café or office.

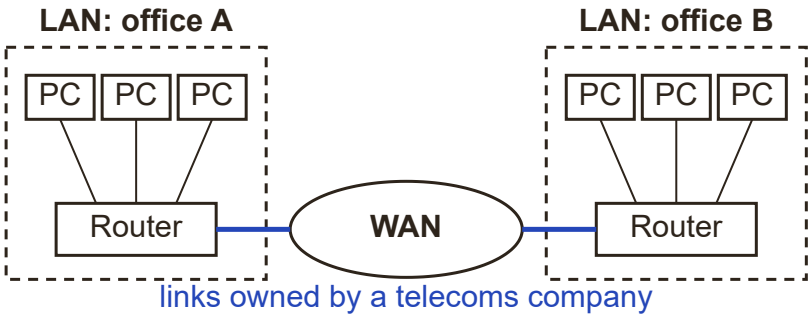
Key facts

- LAN = Local Area Network: small area, hardware owned by the organisation
- The Internet is the largest WAN
- Latency = delay before data arrives (measured in milliseconds, ms)
- Errors → packets re-sent → less useful bandwidth and more delay
- WAN = Wide Area Network: large area, third-party infrastructure; often connects LANs
- Bandwidth = amount of data transferred per second (bits per second, e.g. Mbps)
- Performance factors: bandwidth, number of users, transmission media, error rate, latency, interference
- Grade 6+ only Shared bandwidth: each device's share ≈ total bandwidth ÷ number of active devices

Notes

LANs and WANs

- A **LAN** (Local Area Network) covers a **small geographical area**, such as a home, a school or one office building.
- The hardware in a LAN (cables, switches, access points) is usually **owned and managed by the organisation** that uses it.
- A **WAN** (Wide Area Network) covers a **large geographical area**, such as between towns, cities or countries. It is often used to connect LANs together.
- A WAN uses infrastructure owned by **third parties**, such as telecommunications companies (e.g. leased lines, cables and satellite links). The organisation pays to use it.



Each LAN covers one site; the WAN joins the LANs across a large area using third-party links

- The **Internet** is the largest WAN in the world.

Factors that affect performance

- **Bandwidth**: the amount of data that can be transferred in a given time, measured in bits per second (e.g. Mbps). More bandwidth means more data can be sent each second.
- **Number of users**: the bandwidth is shared, so the more devices transferring data at the same time, the smaller each one's share and the more congestion there is.
- **Transmission media**: fibre optic cable generally has the highest bandwidth, then copper cable; wireless connections are usually slower and less reliable.
- **Error rate**: packets that arrive damaged must be sent again, which wastes bandwidth and adds delay.
- **Latency**: the delay between data being sent and being received. It increases with distance and with the number of devices (such as routers) the data passes through.
- **Interference**: wireless signals are weakened by walls, distance and other wireless networks, which causes more errors.

Bandwidth, latency and improving performance

- Bandwidth is a capacity. If a 100 Mbps connection is shared by 20 devices all downloading at once, each gets roughly 5 Mbps. Grade 6+ only
- More bandwidth lets more data through each second, but it does not make a single packet arrive sooner. For online games and video calls, which send small amounts of data many times a second, **latency** is often the bigger problem. Grade 7+ only
- To improve performance: use wired connections for devices that do not move, upgrade to a higher-bandwidth connection, reduce interference (e.g. move the wireless access point), or schedule large downloads for quieter times.

How to answer each type of question

Describe the differences between a LAN and a WAN — 2 to 4 marks — Grade 4

1. Compare the size of the geographical area covered.
2. Compare who owns the infrastructure.
3. Make every point a comparison: say what the LAN is like AND what the WAN is like.

Example. Describe **two** differences between a LAN and a WAN. [4]

Model answer. A LAN covers a small geographical area such as a single building (1), whereas a WAN covers a large geographical area such as several countries (1). The hardware in a LAN is usually owned by the organisation (1), whereas a WAN uses infrastructure owned by third parties such as telecommunications companies (1).

Explain why a network is slow (scenario) — 2 to 4 marks — Grade 5

1. Pick a factor that fits the scenario, e.g. many users at a busy time.
2. Say what it causes: shared bandwidth, congestion, errors or delay.
3. Finish with the effect: data takes longer to transfer.
4. For 'two reasons', give two different factors, each with its own explanation.

Example. A café offers free Wi-Fi. Customers say it is slow when the café is busy.
Explain **two** reasons why. [4]

Model answer. More customers' devices are connected at busy times, so the bandwidth is shared between more devices (1), and each device gets a smaller share, so downloads take longer (1). Many wireless devices close together cause more interference (1), so more packets are corrupted and have to be re-sent, which adds delay (1).

Use data to identify the cause of poor performance 2 to 4 marks **Grade 7**

1. Check each measurement: is the bandwidth almost fully used? Is the latency high? Are many packets re-sent?
2. Name the one factor that stands out and quote its figure.
3. Match the improvement to that factor: more bandwidth, a closer server, or less interference.
4. Say why the other improvements would not help.

Example. Video calls between a company's office and a partner office on another continent keep lagging. The network team takes these measurements during a call:

Measurement	Value
Bandwidth in use	35%
Latency	240 ms
Packets re-sent	0.2%

(a) Identify the factor causing the problem. Use the data to justify your answer. [2]
(b) Explain why buying more bandwidth would not solve the problem. [2]

Model answer.

(a) Latency (1). 240 ms is a long delay, whereas only 35% of the bandwidth is in use and very few packets are re-sent (1).
(b) The connection is not full, so there is already enough bandwidth for the calls (1). More bandwidth lets more data be sent each second but does not reduce the time each packet takes to travel the long distance (1).

Don’t lose marks

- Saying a WAN is 'the Internet'. The Internet is one example of a WAN; a company can have its own WAN linking its offices.
- Defining a LAN by the number of computers. It is about the size of the area and who owns the hardware.
- Calling bandwidth 'speed'. Bandwidth is the amount of data that can be transferred per second.
- Writing 'more users slow it down' without saying why: the bandwidth is shared, so each device gets less.
- Giving two reasons that are really the same factor (e.g. 'interference' and 'other Wi-Fi signals') when two different reasons are asked for.

More tips

Memory tricks

- LAN = Local = Little area.
  WAN = Wide = World-wide.
- Performance factors: 'BUT LIE' = Bandwidth, Users, Transmission media, Latency, Interference, Errors.
- Bandwidth is like the number of lanes on a motorway (how much traffic fits at once); latency is how long the journey takes.
- Sense check: if the data shows the connection is nowhere near full, more bandwidth will not help.

Exam technique

- In 'describe the differences' questions, write matched pairs: 'A LAN… whereas a WAN…'.
- Use the scenario: a school network at lunchtime is pointing you to the number of users.
- For 'explain' marks, give the factor AND its effect, joined with 'so' or 'because'.
- Use the right units: bandwidth in bits per second (e.g. Mbps), latency in milliseconds (ms).

What each grade needs

What you need to be able to do, from the first marks up to the top grade.

Grade 3

State what LAN and WAN stand for
Local Area Network and Wide Area Network.

Grade 4

Describe the differences between a LAN and WAN
A LAN covers a small area such as one site and uses hardware the organisation owns; a WAN covers a large area and uses infrastructure owned by other organisations.

Grade 4

Name factors that affect network performance
Bandwidth, number of users, transmission media, error rate, latency and interference.

Grade 5

Define bandwidth and latency
Bandwidth is the amount of data that can be transferred per second; latency is the delay before data arrives.

Grade 6

Explain why a busy network slows down
Link the cause to the effect, e.g. more users share the bandwidth, so each gets less and transfers take longer.

Grade 7

Use data to identify the limiting factor
Decide from measurements whether bandwidth, latency or errors are causing poor performance, and justify a matching improvement.

Grade 8

Explain why more bandwidth may not fix lag
When small amounts of data are sent many times a second, the delay (latency) matters more than the bandwidth.

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