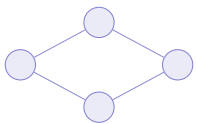
Computer Systems & Networks

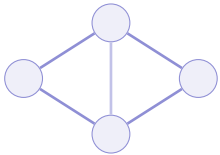
AP Computer Science Principles ▪ Unit 4

AP Computer Science Principles



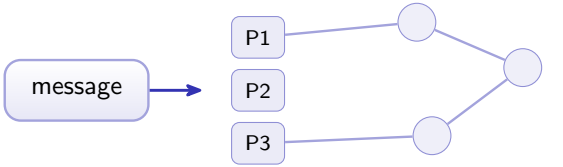
What we will cover

1. The Internet
2. Fault tolerance
3. Parallel & distributed computing



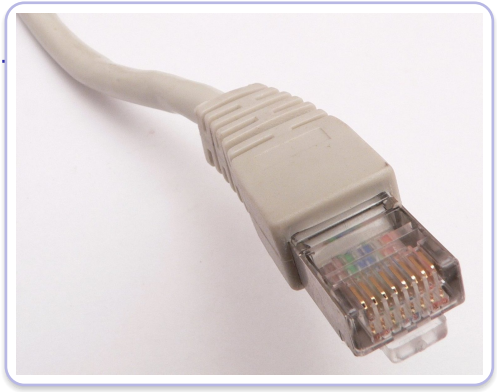
1 The Internet

Data travels as packets



routed independently

The **Internet** 互联网 is a network of networks cooperating through shared **protocols** 协议. Data splits into **packets** 数据包, each addressed by an **IP address** 网际协议地址 and reassembled in order. The **World Wide Web** 万维网 is one service on top.



Packets carry data across networks

Protocols, and the two properties of the Internet's design

protocols 协议	agreed rules for communication – without them two machines cannot interpret each other's bits
IP	Internet Protocol: addresses and routes packets toward a destination
TCP	reassembles packets in order and re-requests any that were lost
open 开放	built on standards anyone can use – no permission needed to join or build on
scalable 可扩展	it keeps working as billions of devices join; **bandwidth 带宽** is the bits per second a connection carries

Openness and scalability are design decisions, not accidents. Both are exam answers to "why has the Internet grown as it has?"

2 Fault tolerance

Fault tolerance

Fault tolerant 容错的

redundancy 冗余: extra paths/copies, a backup takes over

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The Internet is fault tolerant because many routes mean a broken link is bypassed. Redundancy costs money, so designers weigh it against reliability.

Routers forward packets toward their destination

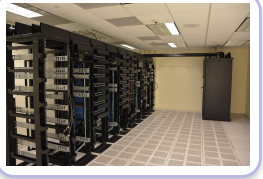
3 Parallel & distributed

Parallel & distributed computing

Sequential 顺序计算
one step at a time

Parallel 并行计算
several **processors** 处理器, one machine

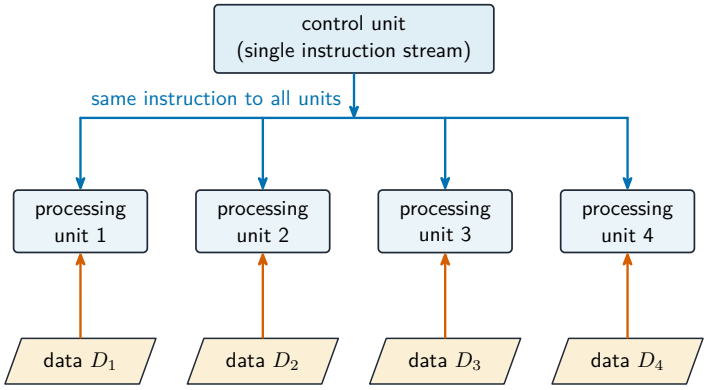
Distributed 分布式计算
many separate machines



Distributed systems run across many machines

Speedup 加速比 $= \dfrac{\text{one-processor time}}{\text{many-processor time}}$. The **sequential part** caps it – a 100 s task with 20 s sequential can never beat $5\times$.

Parallel computing



Parallel computing: many processors work at the same time

Speedup, and the limit on it

sequential computing 顺序计算	one step after another, on one processor
parallel computing 并行计算	several steps at the same time, on several processors
speedup 加速比	the sequential time divided by the parallel time
the limit	parts that must run in sequence cannot be sped up by adding processors, so speedup is bounded by that fraction
the consequence	a task that is 30% sequential can never exceed a speedup of about 3.3, however many processors you add

Doubling the processors never halves the time. Say *why* – the sequential portion – and the mark is yours.

Key points

The **Internet** routes independent **packets** via protocols

Redundancy makes a system **fault tolerant**

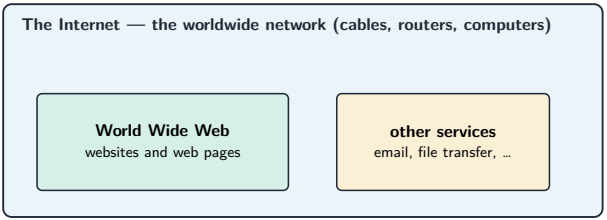
Parallel = one machine; **distributed** = many

The **sequential part** caps parallel speedup

The Internet is not the Web

The **Internet** 互联网 is the network of networks – the wires, routers and protocols. The **World Wide Web** 万维网 is one service running on top of it.

> Email, video calls and games also ride the Internet without touching the Web.



one is the road, the other is one kind of traffic

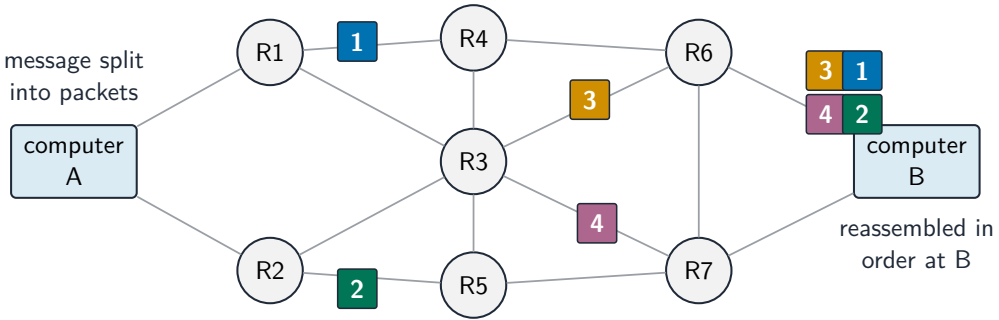
Worked example – the limit of parallelism

A 40 s sequential part + a 60 s parallelizable part

On one processor: $40 + 60 = 100$ s. Spread the parallel part over 3 processors: $\frac{60}{3} = 20$ s, so the total is $40 + 20 = 60$ s and the speedup is $\frac{100}{60} \approx 1.67$.

The 40 s sequential part is a floor: even with infinitely many processors the task can never finish in under 40 s.

Check yourself, in detail



Packet switching sends packets by independent routes, so the network tolerates a failed link

Exam tips

- Describe how data travels in **packets** over a redundant, fault-tolerant network of independent routers.
- Know that **protocols** (IP, TCP, HTTP) are agreed rules, and that open standards let different systems interoperate.
- Explain **scalability** and how the Internet grows without central control.
- Contrast **bandwidth** (rate) with **latency** (delay), and describe the **DNS** name-to-address lookup.
- Discuss the **digital divide** and security basics (encryption, authentication) in plain terms.

4 Recap

Unit 4 – key takeaways

1 Packets

redundant, fault-tolerant network of routers

2 Protocols

IP, TCP, HTTP – open standards interoperate

3 Scale

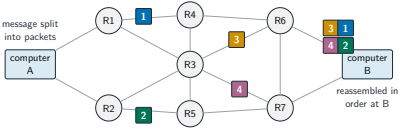
Internet grows without central control

4 Terms

bandwidth vs latency; DNS name-to-address

Check yourself

1. Is the Web the same thing as the Internet?
2. A $40\,\mathrm{s}$ sequential part: can 1000 processors beat $40\,\mathrm{s}$?
3. Why does packet switching make the Internet fault tolerant?
4. What is redundancy in a network?



Answers **1.** no – the Web is one service on the Internet **2.** no – it is a floor **3.** packets reroute around a failure **4.** more than one path between two points