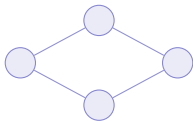


Computer Systems & Networks

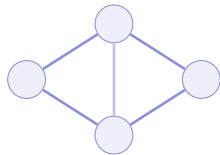
AP Computer Science Principles ■ Unit 4

AP Computer Science Principles



What we will cover

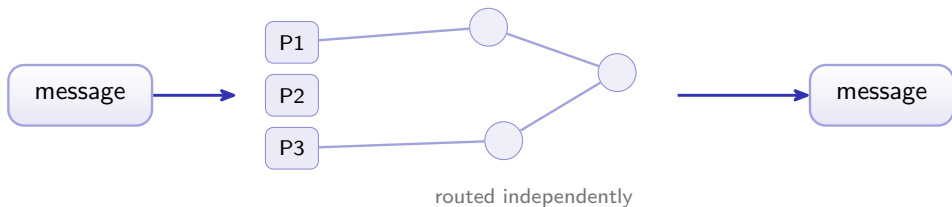
- 1 The Internet
- 2 Fault tolerance
- 3 Parallel & distributed computing



1

The Internet

Data travels as packets



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

Single point of failure 单点故障

one part whose failure stops everything

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 **proces-**
sors 处理器,
one machine

Distributed 分布式计算

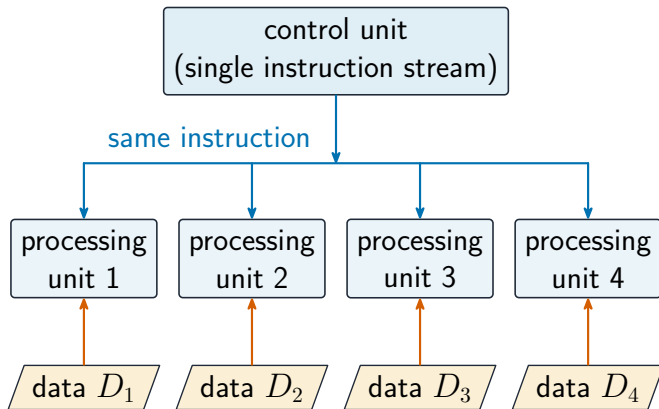
many sepa-
rate machines

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



*Distributed systems run
across many machines*

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**

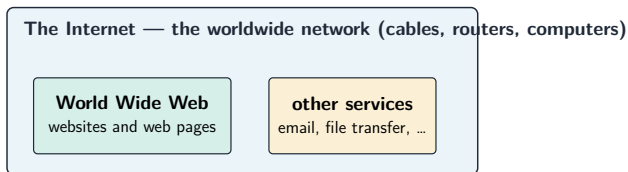
Parallel = one machine;
distributed = many

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

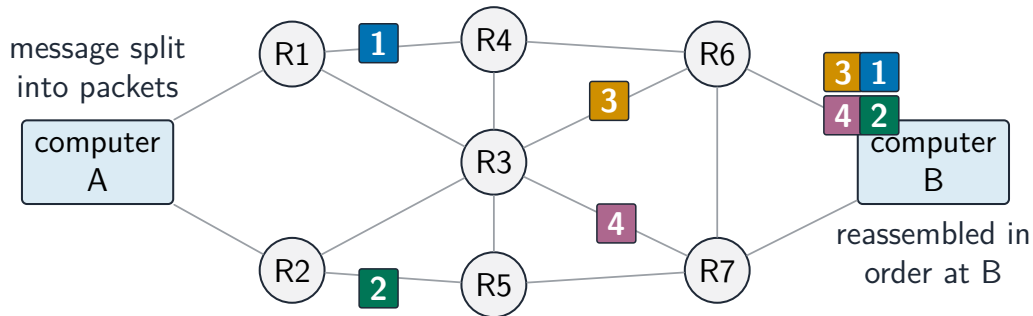
Worked example – the limit of parallelism

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

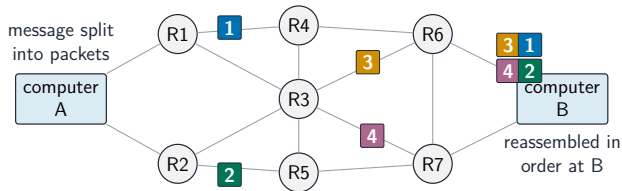
4

Terms

bandwidth vs latency; DNS name-
to-address

Check yourself

- 1 Is the Web the same thing as the Internet?
- 2 A 40 s sequential part: can 1000 processors beat 40 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