

## 2.2 Protocols and data transmission

Name: \_\_\_\_\_ Class: \_\_\_\_\_ Date: \_\_\_\_\_

Total: 20 marks

**KEY WORDS** encapsulation • DNS • packet switching  
• bandwidth • throughput • latency

### Objective

Build the skills to answer exam questions on **protocols and data transmission** – the TCP/IP layers, TCP and UDP, IP addressing, DNS, packet switching and transmission time.

**You must be able to:**

- describe the four layers of the TCP/IP model and **encapsulation**
- choose TCP or UDP for a task, and state the use of HTTP(S), DHCP and **DNS**
- compare IPv4 with IPv6, and public with private and static with dynamic addresses
- describe **packet switching**
- calculate an ideal transmission time, and tell **bandwidth** from **throughput** and **latency**

### 1 Key knowledge and worked examples

Study these first. Each one shows the method for a question type used later.

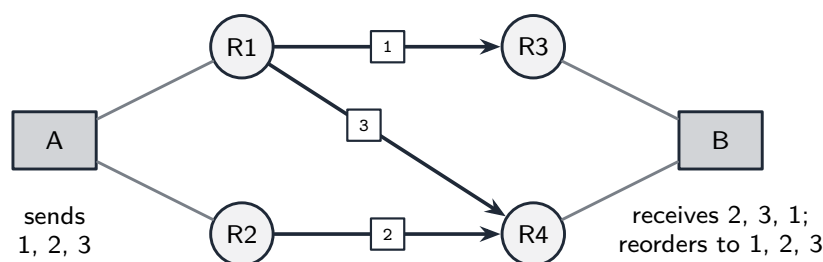
#### ■ Key knowledge: layers and protocols



|          | TCP                        | UDP                      |
|----------|----------------------------|--------------------------|
| delivery | checked, in order, resends | no checks                |
| speed    | slower                     | faster                   |
| suits    | web pages, files, e-mail   | calls, games, live video |

- IPv4: 32 bits, about 4.3 billion addresses. IPv6: 128 bits.
- DHCP lends a device an IP address; DNS turns a domain name into an IP address.

#### ■ Worked example: packet switching



Describe how a photo is sent by packet switching. (4 marks)

1. The photo is split into packets.
2. Each packet has a header: source and destination IP addresses and a sequence number.
3. Routers forward each packet separately by the best route available; packets may take different routes.
4. The receiver puts the packets back in order by sequence number, and asks again for any that are missing.

#### ■ Worked example: transmission time

A 45 MB file is sent over a 15 Mbit/s link.

$$\text{time} = \frac{\text{data size in bits}}{\text{rate in bits per second}}$$

$$\text{time} = \frac{45 \times 10^6 \times 8}{15 \times 10^6} = \frac{360 \times 10^6}{15 \times 10^6} = 24 \text{ s}$$

The real time is longer: latency, headers, other users and resends make the throughput lower than the bandwidth.

## 2 Practice

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**2.1** State the layer of the TCP/IP model at which each works: (i) IP; (ii) HTTP; (iii) TCP. [3]

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**2.2** State whether TCP or UDP suits: (i) sending an e-mail; (ii) a live sports stream. [2]

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**2.3** Calculate the ideal time to send a 6 MB file over a 4 Mbit/s link. [2]

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**2.4** Explain why a web server needs a static IP address. [1]

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## 3 Exam-style questions

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**3.1** What does DNS do? [1]

- ☐ **A** gives a device an IP address  
☐ **B** turns a domain name into an IP address  
☐ **C** encrypts web pages  
☐ **D** splits data into packets

**3.2** Why was IPv6 introduced? [1]

- ☐ **A** IPv4 has too few addresses  
☐ **B** IPv4 cannot be routed  
☐ **C** IPv6 addresses are shorter  
☐ **D** IPv6 needs no router

**3.3** Which statement about throughput is true?

[1]

☐

**A** it is always equal to the bandwidth

**B** it is the delay before data arrives

**C** it is the data actually delivered per second, at most the bandwidth

**D** it is measured in milliseconds

**3.4** A student joins the school Wi-Fi and opens `www.school-library.org` to download a 24 MB e-book.

(a) Describe how the student's laptop gets an IP address.

[2]

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(b) Describe how the browser finds the server's IP address.

[3]

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(c) The link is 16 Mbit/s. Calculate the ideal download time.

[2]

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(d) Explain why the e-book is sent using TCP.

[2]

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## Solutions

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Each answer shows the steps, then the **result**.

### 2.1

- (i) **internet**
- (ii) **application**
- (iii) **transport**

### 2.2

- (i) **TCP**: every part must arrive
- (ii) **UDP**: speed matters more than a lost packet

### 2.3

- $6 \times 10^6 \times 8 = 48 \times 10^6$  bits
- $48 \times 10^6 \div 4 \times 10^6 = \mathbf{12\ s}$

### 2.4

- its address must not change, so DNS can always point clients to it

### 3.1 B

- name to address

### 3.2 A

- 32 bits give only about 4.3 billion

### 3.3 C

- other traffic and errors reduce it

### 3.4

(a)

- the laptop asks for an address when it joins; a DHCP server replies
- it lends a free private IP address for a time

(b)

- the browser asks a DNS server for the IP address of **www.school-library.org**
- if it does not know, that DNS server asks other DNS servers
- the IP address is returned and the browser connects to it

(c)

- $24 \times 10^6 \times 8 = 192 \times 10^6$  bits
- $192 \times 10^6 \div 16 \times 10^6 = \mathbf{12\ s}$

(d)

- every byte of the file must arrive, in the right order
- TCP numbers the data, checks it arrived and resends missing parts