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:

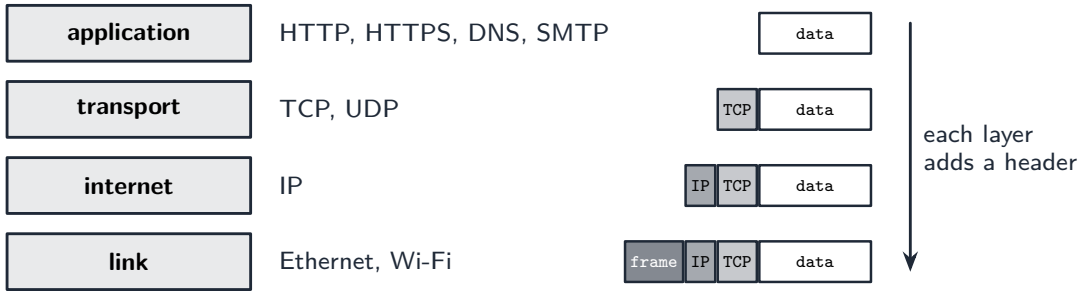
- describe the four layers of the TCP/IP model and **encapsulation**
- choose TCP or UDP for a task, and state the use of HTTP(S), DHCP and **DNS**

- 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.

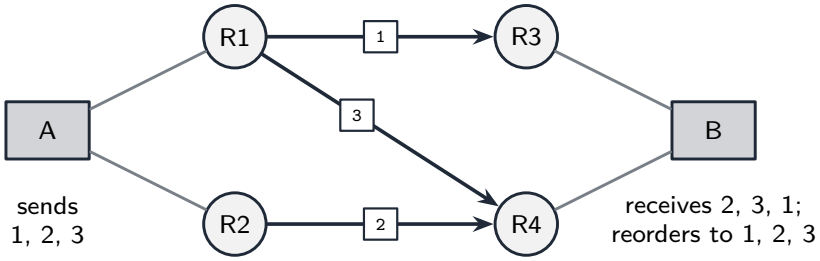
■ Key knowledge: layers and protocols



	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

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

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

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

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

3 Exam-style questions

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]

(b) Describe how the browser finds the server's IP address. [3]

(c) The link is 16 Mbit/s. Calculate the ideal download time. [2]

(d) Explain why the e-book is sent using TCP. [2]

Solutions

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
- $48 \times 10^6 \div 4 \times 10^6 =$ **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
- $192 \times 10^6 \div 16 \times 10^6 =$ **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