Exercise walk-through

Protocols ▪ 14.1

eXercise

You must be able to

- explain why a **protocol** is essential, and the benefit of a **layered** model
- describe the four layers of the **TCP/IP** suite
- state the purpose of **HTTP, FTP, SMTP, POP3, IMAP, BitTorrent** and compare **TCP**/**UDP**

Method — Why protocols, and layers

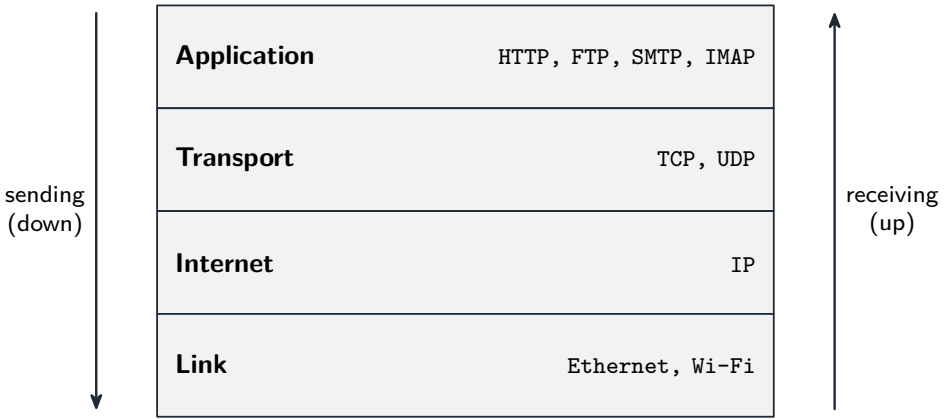
A **protocol** is an agreed **set of rules** for communication — the data **format**, the **order** of messages, their **meaning**, **timing** and **error handling**. Both ends must follow the same rules or the bytes are meaningless.
Networking is split into **layers**, each with one job, talking only to the layers above and below. Benefits: **modularity** (swap one layer without touching the others), **standardisation**, and **abstraction**.
Each layer has one job:

- **Application** — provides network services to programs (HTTP for the web, SMTP for email).
- **Transport** — splits the data into **packets** and provides reliable, in-order delivery (TCP) or fast send-and-forget (UDP); adds **port numbers**.
- **Internet** — adds **IP addresses** and **routes** the packets across networks.

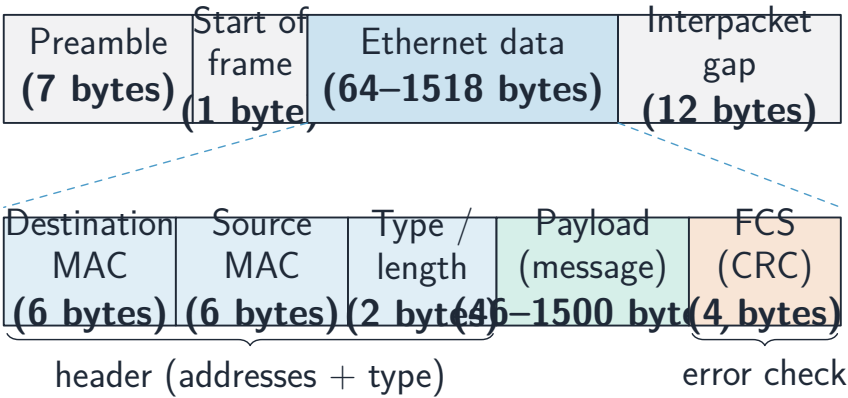
Method — Why protocols, and layers

- **Link** — sends the bits over the physical connection (Ethernet, Wi-Fi) using **MAC addresses**.

Method — Why protocols, and layers



Method — Why protocols, and layers



An Ethernet frame carries the protocol data

Method — TCP vs UDP (transport layer)

- **TCP** — **connection-oriented**: reliable, in-order delivery, retransmits lost packets (HTTP, email). Higher overhead.
- **UDP** — **connectionless**: send-and-forget, no ordering or acknowledgements (streaming, gaming, DNS). Low overhead.

Method — Application protocols

Protocol	Purpose
HTTP	fetch web pages
FTP	transfer files
SMTP	**send** email
POP3 / IMAP	**retrieve** email (IMAP keeps it on the server)
BitTorrent	peer-to-peer file sharing

Practice 2.1 ▪ 1 mark

State what a **protocol** is.

Solution 2.1

Worked steps

An agreed **set of rules** governing how devices communicate (format, order, meaning, timing, errors) B1.

Practice 2.2 ▪ 1 mark

State **one** benefit of using a **layered** model for networking.

Solution 2.2

Worked steps

Any one: **modularity** (change one layer without the others); standardisation/interoperability; abstraction (hide details) B1.

Practice 2.3 ▪ 2 marks

Name the **four** layers of the TCP/IP suite, **from top to bottom**.

Solution 2.3

Method: Why protocols, and layers

Worked steps

Application → Transport → Internet → Link B1 B1 *layers, correct order.*

Practice 2.4 ▪ 1 mark

State which protocol is used to **send** an email.

Solution 2.4

Worked steps

SMTP B1.

Exam-style 3.1 ▪ 2 marks

State **two** differences between **TCP** and **UDP**.

Solution 3.1

Worked steps

Any two: TCP is **connection-oriented**, UDP **connectionless**; TCP **guarantees delivery and order**, UDP does not; TCP **retransmits** lost packets, UDP does not; TCP has higher overhead B1 B1.

Exam-style 3.2 ▪ 3 marks

State the purpose of each protocol: **HTTP**, **FTP**, **SMTP**.

Solution 3.2

Method: Application protocols

Worked steps

HTTP — request/transfer **web pages**; **FTP** — transfer **files**; **SMTP** — **send** email B1 B1 B1.

Exam-style 3.3 ▪ 2 marks

Explain why a protocol is **essential** for communication between two computers.

Solution 3.3

Method: Why protocols, and layers

Worked steps

Without an agreed protocol the two computers have no shared rules for **format/order/meaning** B1, so each side cannot interpret the other's data and communication **fails** B1.

Exam-style 3.4 ▪ 2 marks

State **one** difference between **POP3** and **IMAP**.

Solution 3.4

Worked steps

POP3 usually **downloads and removes** mail from the server; **IMAP keeps** mail on the server and syncs across devices B1 B1.

Exam-style 3.5 ▪ 4 marks

Describe the purpose of the **Application layer** and the **Transport layer** of the TCP/IP suite.

Solution 3.5

Method: Why protocols, and layers

Worked steps

Application layer — provides network services to the user's programs (e.g. HTTP, SMTP) and formats the data B1 B1. **Transport layer** — splits the data into packets and provides reliable, in-order delivery (TCP) using port numbers B1 B1.

Exam-style 3.6 ▪ 3 marks

A company's staff use email and a web application over the internet.
(a) **Explain** why protocols are essential for communication between computer systems.
(b) **Complete** the table by naming the protocol used for each task.

task	**protocol**
retrieving email, deleting it from the server	_____
sending email to a mail server	_____
transferring a large file to a server	_____
requesting a web page securely	_____

Exam-style 3.6 ▪ 3 marks

(c) **Describe** two ways in which **packet switching** ensures a complete message arrives correctly, even though the packets may travel by different routes.
(d) **State** the layer of the TCP/IP model at which each of the following operates: an IP address, a port number, and HTTP.
(e) **Explain** why the layered model makes it easier to introduce a new application protocol.

Solution 3.6

Method: Why protocols, and layers

Worked steps

(a) A protocol is an agreed **set of rules** for the exchange B1, covering the format of the data, the order of the messages, the speed, and how errors are handled B1. Without agreement on all of that, two systems from different manufacturers could not interpret each other's bits at all B1.
(b) Retrieving and deleting email — **POP3** B1; sending email — **SMTP** B1; transferring a large file — **FTP** B1; a secure web page — **HTTPS** B1.
(c) Any two, developed: each packet carries a **sequence number**, so the receiver can reassemble them in the right order however they arrive B1 B1. Each packet carries a

Solution 3.6

checksum or error check, and a packet that fails it is **re-requested** from the sender B1 B1. Also acceptable: the receiver sends acknowledgements and the sender retransmits anything unacknowledged within a timeout.
(d) An IP address — the **internet (network)** layer B1; a port number — the **transport** layer B1; HTTP — the **application** layer B1.
(e) Each layer only has to work with the layer directly above and below it through a defined interface B1, so a new application protocol can be added at the top without changing the transport, internet or link layers, or any of the hardware B1.