

Exercise walk-through

9.1

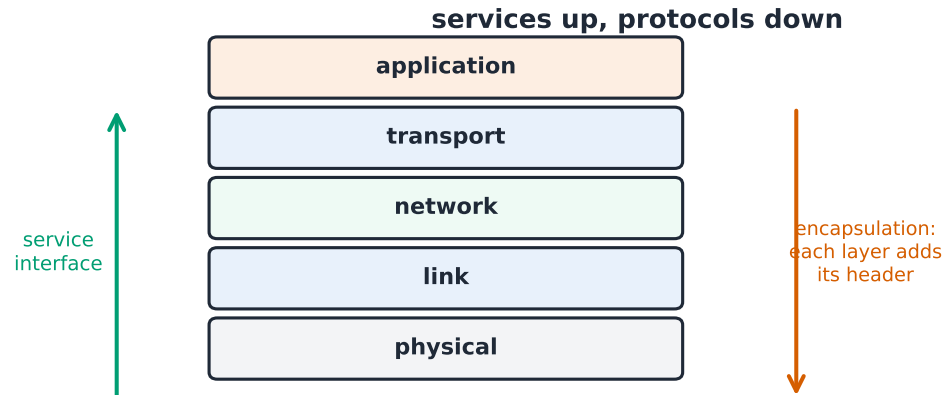
Layering and architecture

University Computer Science

Layering: services up, protocols down

- 1 **Stack** **Physical**, **link**, network, **transport**, application - each offers a service up and consumes one down.
- 2 **Bytes** A 100-byte payload leaves with 54 bytes of headers: $14 + 20 + 20$, one per layer crossed.
- 3 **Shape** Narrow waist (IP), wide top and bottom: applications changed and links changed; IP did not.

Layer stack



a 100-byte payload leaves the application as 54 bytes of headers around it: $14 + 20 + 20$

the hourglass: one narrow waist (IP), wide top, wide bottom

Each layer adds a header going down and strips it coming up.

Exercises 2.1-2.3

2.1 Name the layer that moves frames between neighbours, and the one that moves packets between strangers. [3]

2.2 A message crosses 3 layers going down. How many headers does it gain? [3]

2.3 What does a service interface guarantee the layer above? [3]

Exercises 2.1-2.3

2.1 Name the layer that moves frames between neighbours, and the one that moves packets between strangers. [3]

2.1

- Link (frames, neighbours); network (packets, strangers) ✓.
-

2.2 A message crosses 3 layers going down. How many headers does it gain? [3]

2.2

- Three headers – one per layer crossed ✓.
-

2.3 What does a service interface guarantee the layer above? [3]

2.3

- The promised service, unchanged – whatever the layer does below ✓.

Exercise 3.1

3.1 An application message of 200 bytes is sent over Ethernet carrying IPv4 and TCP.

Compute the bytes on the wire (headers + payload). Compute the fraction of the frame that is header. State which layer strips which header at the receiver, in order. Explain in one line why replacing Ethernet with a new link technology need not change TCP, naming the principle. [8]

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3.1

- Wire bytes: $14 + 20 + 20 + 200 = 254$ ✓.
- Header fraction: $54/254 \approx 21.3\%$ ✓.
- Strips: NIC strips the 14-byte Ethernet header; the IP layer strips 20; TCP strips its 20 – each layer sees only its own promise ✓.
- The link service interface (best-effort frames) held, so TCP never noticed – the principle of layer independence ✓.

Exercise 3.2

3.2 A colleague proposes reading the IP TTL field inside the browser to detect bad routes.

Name the violation. State what happens to that browser when the network stack below changes. Give the correct layer for TTL logic and the interface it should respect. State the hourglass argument for why IP itself should stay narrow. [7]

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3.2

- Violation: a leaky interface – the application reading a network layer header below it ✓.
- When the stack changes, that browser breaks: it was written against an implementation detail, not a service ✓.
- TTL belongs in the network layer (routers decrement it); anything needing it should sit at or below that layer's interface ✓.
- The hourglass: one narrow waist protocol (IP) lets every application above run over every link below – widening the waist multiplies the combinations nobody can maintain ✓.