Exercise walk-through

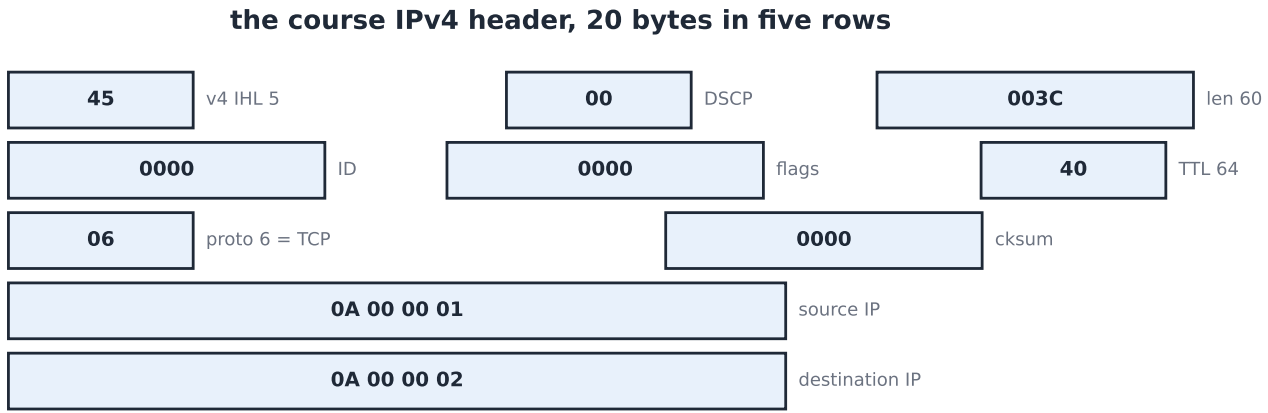
9.2
Link layer and IP

University Computer Science

Link and IP: neighbour versus stranger

1. **Frame** Ethernet: 6-byte destination and source MACs, type, payload, **CRC** - the CRC guards the whole frame **link** by link.
2. **Header** 45 00 003C ... 40 06: IHL 5 words = 20 bytes, total length 60 (20 + 40 payload), **TTL** 64, protocol 6 = TCP.
3. **Scope** The IP checksum guards only the header: routers rewrite TTL but never touch the data.

Packet header layout



IHL 5 counts 32-bit words: 5 x 4 = 20 header bytes; total length 60 = 20 header + 40 payload

MAC names a neighbour; IP names the stranger

The IPv4 header decoded field by field: total length 60, **TTL** 64, protocol 6.

Exercises 2.1·2.3

2.1 IHL = 7: how many header bytes? [3]

2.2 Total length $0x0050$, IHL 5: how many payload bytes? [3]

2.3 What does the IP checksum cover, and why not the payload? [3]

Exercises 2.1·2.3

2.1 IHL = 7: how many header bytes? [3]

2.1

- $7 \times 4 = 28$ bytes ✓.

2.2 Total length $0x0050$, IHL 5: how many payload bytes? [3]

2.2

- $0x50 = 80$ total $- 20$ header $= 60$ payload bytes ✓.

2.3 What does the IP checksum cover, and why not the payload? [3]

2.3

- Only the header – routers rewrite the header (TTL), never the data; the frame CRC already guards the whole frame link by link ✓.

Exercise 3.1

3.1 Decode this course-style header field by field:

```
46 00 00 78 0000 0000 20 11 0000 C0 A8 01 01 C0 A8 02 02
```

State the version, IHL (in words and bytes), total length, TTL and protocol number with its name. Compute the payload bytes. State the two addresses in dotted decimal. Verify the arithmetic that links total length, IHL and payload. [8]

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3.1

- Version 4; IHL 6 $\Rightarrow$ 24 header bytes ✓.
- Total length $0x0078 = 120$; TTL $0x20 = 32$; protocol 17 = UDP ✓.
- Payload $= 120 - 24 = 96$ bytes ✓.
- Addresses: source `192.168.1.1`, destination `192.168.2.2` ✓.
- Arithmetic: total length = IHL bytes + payload, $24 + 96 = 120$ ✓.

Exercise 3.2

3.2 A packet crosses 3 routers from host H to server S.

State how many frames it rides and how many distinct destination MAC addresses appear, with a one-line reason. State what chooses each next-hop MAC. State what the TTL is at H and by how much each router changes it, and what happens at zero. [7]

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3.2

- 4 frames (one per hop), 4 distinct destination MACs – each frame is addressed only to the next hop ✓.
- The next-hop MAC is chosen from the routing decision made on the destination IP ✓.
- TTL starts at H's sending value (e.g. 64); each router decrements by 1 ✓.
- At zero the router drops the packet and reports (time exceeded) – the TTL bounds a packet's lifetime in hops ✓.