UNIVERSITY COMPUTER SCIENCE • EXERCISE SHEET

9.2 Link layer and IP

Name: _____ Class: _____ Date: _____ **Total: 24 marks**

KEY WORDS IP address IP • MAC address MAC

Objective

Decode IPv4 headers byte by byte and keep the two address scopes apart.

1 Key knowledge and worked examples

■ **The course header**

`45 00 00 3C … 40 06 …`: version 4, IHL 5 (20 bytes), total length $0x003C = 60$, TTL 64, protocol 6 = TCP ✓.

■ **Worked example: scopes**

Across 3 routers a packet rides 4 frames with 4 different destination MACs; the destination IP never changes ✓.

2 Practice

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]

3 Exam-style questions

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]

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]

Solutions

2.1

- $7 \times 4 = 28$ bytes ✓.

2.2

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

2.3

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

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, $24 + 96 = 120$ ✓.

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 ✓.