Solution notes

Digital Communication II 2005 – Paper 7 Question 2 (JAC)

(*a*) *Explain the role of the checksum mechanisms in layers 2, 3 and 4 of the Internet Protocols.* [9 marks]

Link layer uses CRC to protect (and correct small amounts of) against noise in transmission. IP layer uses header only checksum to protect against s/w errors in forwarding (and consequent waste of resources); TCP layer uses data+head checksum for user data integrity. Link layer can't be used globally as circumstances vary (i.e. heterogeneity) so it would be too little some places, overkill in others. 3 marks for each, or 1 for getting general tradeoffs of hop v. e2e.

(*b*) *An ARM assembly code implementation of the IP/TCP checksum function appears below. Annotate this with comments that explain the code.* [6 marks]

```
        sub     r3, r3, #16
loop:
        ldmia   r2!, {r6-r9}
        adds    r4, r4, r6
        adcs    r4, r4, r7
        adcs    r4, r4, r8
        adcs    r4, r4, r9
        adcs    r4, r4, #0
        adc     r4, r4, #0
        subs    r3, r3, #16
        bxx     loop
        add     r3, r3, #16
```

So key comments would include:

it's in assembler as it better go fast as it's computed over all bytes in all packets, and might need to fit in instruction cache so it isn't slower than the data access to run the code! 2ndly, can do multiple "parallel" adds due to 16 bit add w/ carry. thirdly, need to round loop.

2 marks for each point, and any extra thoughts get a bonus mark in case

Strictly speaking, the part (a) here is part of Digicom I, but the idea of where to put functionality was discussed in first 2 lectures of Digicom II.

Checksums were discussed and x86/arm code is in notes, including annotation/rationale.

(*c*) *traceroute is a commonly used diagnostic tool in the Internet. Explain how it works, making reference to its use of the TTL Expiry facility of ICMP, and the circumstances under which it might generate misleading or incorrect output.*

So traceroute emits packets deliberately with too low a TTL, eliciting ICMP errors from intermediate routers; it increments the TTL then iterates. If the route changes during the process (which takes order n RTTs for n hops), or the route is asymmetric (and they were told about BGP asymmetric routing) then the results will be misleading obviously.

5 marks cover the basic operation (2) and 1 each for route things...and 1 bonus for anything (e.g. ICMP rate limiting) extra

ICM was discussed in lectures – traceroute was described.