Computer Architecture (Sheet #1)

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1. If we ignore the time it takes to write/read data to/from the USB drive, a pigeon has a data rate of 0.08Gbps. 13 pigeons therefore have a higher data rate than a direct 1 Gbps Ethernet connection.

2. The extra overhead of the circuit switched network is the setup time, s. The extra overhead of the packet switched network is the delay incurred by store-and-forward: if each node takes d to buffer the message, then the overhead is kd. So packet switching is faster when $kd < s$.

3. There are 22 hops from my computer to CERN according to traceroute, so the total delay would be 1.1ms, which is insignificant. For reference, the actual RTT to CERN is 18ms.

4. Depends on the checksum. Assuming CRC with a reasonable polynomial, any one bit error in the payload should fail CRC. If a flag byte is corrupted, a frame would become longer than intended (and therefore the checksum will be some garbage after the original end of the frame), but it is very unlikely the resulting frame would pass CRC.

   A one bit error could also create a flag byte in the middle of the frame, which would make the frame shorter. The resulting frame would also be very unlikely to pass CRC.

5. The main disadvantage is that a damaged frame would be propagated by such a switch, whereas a store-and-forward switch would drop it.

6. If 4 bits in a square are flipped, the error will not be detected. If 4 bits at random are flipped, the probability they form a square is $1 \cdot \frac{1}{n} \cdot \frac{1}{k} \cdot \frac{1}{nk} = \frac{1}{n^2k^2}$. This ignores the possibility of parity bits being flipped.

7. If it was placed in the header then the sender would need to buffer the whole payload, compute the CRC, then send the header and the payload. By putting it in the trailer it can be computed on-the-fly, without having to buffer the payload.

8. 802.3 Manchester encoding is 10 10 10 01 01 01 10 01 10 01 01
   Diff. Manchester encoding is 01 10 01 01 01 01 10 10 01 01 01

9. 0111 1110 0000 0010 1111 0000 1010 1111 10001 1111 01111 10111 0111 1110

10. Poly is $(x^{10} + x^9 + x^6 + x^3) \bmod (x^3 + 1) = (x + 1)$.

    If we flip the leftmost bit, the calculation becomes $(x^9 + x^6 + x^3) \bmod (x^3 + 1) = 1$, which is different from $x + 1$.

11. Speed of signal in coax cable is around 2e8 m/s. If we transmit at 10Mbps, 10Mb of signal has length 2e8m. This gives 19m per bit, so 9.77km per minimum length frame. At 1Gbps, this is 100 times shorter, so 98m per minimum length frame.

12. Assume the side of the cube is n units. Then for a single coax cable we need about one unit per office, so n^3 units.

    If we had cables from each office to a central switch, the length of each cable would be the manhattan distance from the center of the office to (n/2,n/2,n/2). The total amount of cabling is therefore $\theta(n^4)$.

    Hence much less cabling is needed if we use a single long coax cable.