COMP 30650 Exercise Sheet 1
The Physical Layer

Units, Latency and Bandwidth Delay Product

Exercises

1. A bike is travelling along at a constant speed of 8 km per hour. How far will it travel in 45 minutes? **6KM**

2. An image is 1600 × 1200 pixels with 3 bytes/pixel. Assume the image is uncompressed. How long does it take to **transmit (*put it on the wire*)** it:

    a) Over a 56-kbps modem channel? **56000 bits per second**
    b) Over a 1-Mbps cable modem? **1000000 bits per second**
    c) Over a 10-Mbps Ethernet? **10000000 bits per second**
    d) Over 100-Mbps Ethernet? **100000000 bits per second**
    e) Over gigabit Ethernet? **1000000000 bits per second**

    Data size = 1600*1200 = 1920000 pixels * 3 bytes per pixel = 5760000 bytes
    8 bits in a byte so data is 5760000 *8 = 46080000 bits.
    Transmission time = data size/ speed (all in bits).

3. Two computers are communicating over a 60000 km satellite link by using 4000-bit frames at a transmission rate of 100 kbps. Assuming errorless transmission, and taking the signal speed as 2×10^8 m/sec, calculate:
    a) The time required to transmit a frame (***put it on the wire***). **Bits/rate = ~40 msec**;
    b) The propagation delay. **Length/speed = 60000000/2×10^8 = 0.3 secs**
    c) The latency. **a + b = 0.3 + .04= .34 seconds.**

4. Two computers are communicating over a 10 km fiber optic link by using 500-byte frames at a transmission rate of 100 Mbps. The propagation speed as 2×10^8 m/sec. Assuming errorless transmission, calculate:
    a) The time required to transmit a frame (***put it on the wire***). **~5 micro seconds**;
    b) The propagation delay. **Length/speed**
    c) The latency. **a + b**

5. Two computers are communicating over a 39000 km satellite link by using 1920-bit frames at a transmission rate of 64 kbps. The propagation speed as 2×10^8 m/sec. Assuming that no error occurs in transmission, calculate:
    a) The time required to transmit a frame (***put it on the wire***). 30 **msec**;
    b) The propagation delay. **Length/speed**
    c) The latency. **a + b**

6. Two computers are communicating over a 3000 km fiber optic link by using 1500-byte frames at a transmission rate of 1 Mbps. The propagation speed as 2×10^8 m/sec. Assuming errorless transmission, calculate:
    a) The time required to transmit a frame (***put it on the wire***). **1.5 msec;**
    b) The propagation delay. **Length/speed**
    c) The latency. **a + b**

7. Calculate the Bandwidth Delay Product for the following situations
    a) ADSL2 20 Mbit with 50 ms round trip time. **125000 bytes**
    b) Gigabit LAN Interface with 1 ms round trip time: **125000 bytes**

8. Imagine that you have trained your Dog to carry a box of three 8-mm tapes instead of a flask of brandy. These tapes each contain 7 gigabytes of data. The dog can travel to your side, wherever you may be, at 18 km/hour. For what range of distances does the dog have a higher data rate than a transmission line whose data rate (excluding overhead) is 150 Mbps?
   How does your answer change if
    a) The dog's speed is doubled; **The distance also doubles**
    b) Each tape capacity is doubled; **The distance doubles**
    c) The data rate of the transmission line is doubled. **The distance is halved**

ANSWER: The dog can carry 3 X 7 Gigabytes = 21 Gigabytes 1 Gigabyte = 8 Gigabits (*storage 8 bits in a byte) 21 Gigabytes = 168 Gigabits
18Km/hr = 0.005km/sec (divide by 3600)
We want the dog's data transfer rate
Line has a rate of 150 Mbps Rate = Data transferred/time take Time = distance/speed dkm/0.005 = 200d sec
Rate = 168/200dGbps = 168000/200dMbps = 840/d Mbps (dog's rate)
So anything less than 5.6km the dog has a higher rate of data transfer.

9. You need to share 80 Gibagbytes of data with your friend. You can share the file via the network at a rate of 150 Mbps or you can drive the disk to your friend's house (100km away) at a speed of 72km/hr. Which is the faster method?

ANSWER: 80 Gigabytes = 640 Gigabits = 640000 Megabits 72Km/hr = 0.02km/sec
Time = Distance/Speed Time = 100/0.02 = 5000 secs Rate = Data transferred/time take
Rate = 640000/5000 = ~128 Mbs/sec