COMP90007 Internet Technologies

Semester 1, 2016

Assignment 1 – Suggested Solutions

1 a. The performance of a network application is influenced by two major network characteristics: the bandwidth of the network (number of bits per second that the network can transport) and the latency (the delay experienced by each bit transported).

Give:

i. an example of a network that exhibits high bandwidth but also high latency,

ii. an example of a network that exhibits low bandwidth and low latency.

i. A transcontinental fibre link or a satellite links (their bandwidth is high also they have high latency).

ii. 56-kbps modem and low-end local and personal area wireless technologies such as Zigbee have low bandwidth as well as low delay.

b. A digital signal is transmitted using an 32-level modulation scheme, corresponding to 0, 1, 2, ... , 31 volts. If the baud rate (number of symbols transmitted per second) of the channel is 9600 baud, what is the bit-rate of the channel using this modulation scheme?

A 32 level modulation scheme encodes $\log_2 32 = 5$ bits/symbol.
Hence the bit-rate of the channel is 5 bits/symbol × 9600 symbols/s
= 48000 bits/s

2 a. List two ways in which the OSI reference model and the TCP/IP reference model are the same. Now list two ways in which they differ.

Similarities: Both models are based on layered network principles. Both have a network, transport and application layer. In both models, the transport service can provide a reliable end-to-end byte stream.

Differences: The number of layers is different. The TCP/IP does not have session or presentation layers. The OSI has both connection oriented and connectionless service in the network layer.

b. In a system with n-layer protocol hierarchy, applications generate messages of length M bytes. At each of the layers, an h-byte header is added. What fraction of the network bandwidth is filled with headers?

Assume *n layers and h bytes added per layer.*

The total number of header bytes per message = hn.
Hence the space wasted on headers = hn.
The total message size is then M + nh.
The fraction of bandwidth wasted on headers = hn/(M + hn).

This estimate does not take into account fragmentation (one higher layer message is sent as multiple lower layer messages) or aggregation (multiple higher layer messages are carried as one lower layer message) that may be present. If fragmentation is used, it will raise the overhead. If aggregation is used, it will lower the overhead.

3 a. You have a choice of making a telephone call between Melbourne and Sydney via either a coaxial cable link or a geostationary satellite link. Which would you choose? Briefly explain why.

Coaxial cable – because the delay would be significantly smaller than via a geostationary satellite, and delay is an important factor for interactive services such as telephony

b. An image is 640 × 480 pixels with 3 bytes/pixel. Assume the image is uncompressed. How long does it take to transmit it over 56-kbps model channel? Over a 1-Mbps cable modem? Over a 100 Mbps Ethernet? Over gigabit Ethernet?

# of bytes needed for representing the image: 640 × 480 × 3 bytes = 9,21,600 bytes. This is 73,72,800 bits.

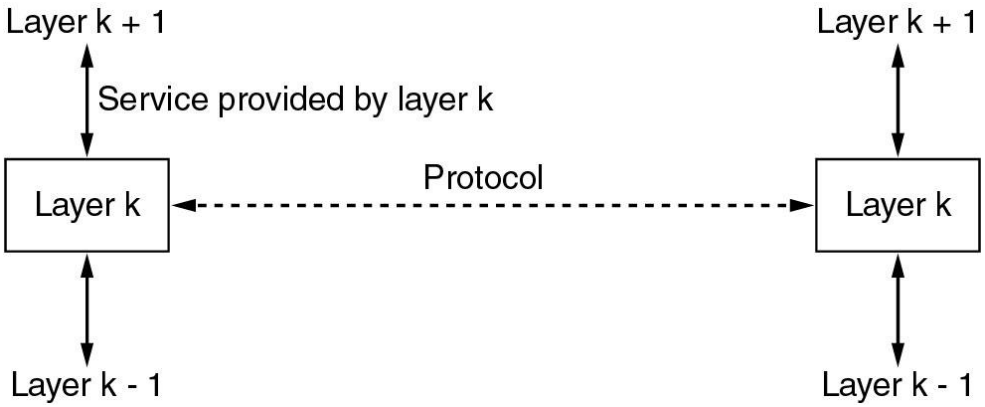
At 56 kbits/sec, it takes about 131.657 sec.
At 1 Mbits/sec, it takes 7.3728 sec.
At 100 Mbits/sec, it takes about 0.074 sec.
At 1 Gbits/sec it takes about 7.4 msec.

4. When a large file is transferred across the network between two computers, two different possible acknowledgement schemes can be used. In the first, the file is divided into smaller packets, which are then individually acknowledged by the receiver as they are received, but the file transfer as a whole is not acknowledged. In the second scheme, the packets are not acknowledged individually, but the entire file is when it arrives at its destination. Discuss these two approaches, also relating to what you may have observed in your Wireshark trace in Lab 2.

Acknowledging each packet separately ensures that in a network where packet loss is high, lost packets can be re-transmitted without re-transmitting the whole file. However, if packet loss is low or negligible, then bandwidth can be saved by not transmitting acknowledgement packets. The price to pay is that if one packet is lost, then the entire file must be retransmitted. Approach 1 is more reliable in a real world situation.

In Lab 2, when the file was being transferred, acknowledgement packets from our computer to the remote host can be seen after every one or two frames that were received.

5 a. Consider the following figure:



In the above figure, a service is shown. Are any other services implicit in the figure? If so, where? If not why not?

The service shown is the service offered by layer k to layer k + 1. Another service that must be present is below layer k, namely, the service offered to layer k by the underlying layer k - 1.

Also Viable:

But, if the algorithm implemented does not conform to the RFC standards then higher layers will be affected as the interface exposing lower layers would have been unsuitable for use in higher layers.

b. Suppose the algorithms used to implement the operations at layer k is changed. How does these impact operations at layers *k – 1* and *k + 1*?

This has no impact on the operations at layers k – 1 or k + 1.

6 a. Describe the functions of each layer in OSI reference model using not more than two sentences.

Please refer to 1.4.1 of Tanenbaum's text. The main intention behind this question is that everyone reads this section and able to extract the summary of functions of OSI layers.

b. Give two disadvantages of using layered protocols.

Information at one layer may not be available to other layers, e.g., the timestamp on a packet. Duplication of functions can occur between layers, e.g., buffering or error control. Optimisation of functions is difficult between layers, e.g., providing error detection at the link or transport layers.

7. Companies who operate and maintain mobile phone networks need to know where the mobile phones of their users are located. Explain different reasons why this may be bad and why this may be good for users.

The architecture of the mobile network and its design in dividing an area into cells allows for the location of each subscriber (or user) to be known to the network company. This is an advantage in situations where the location of a user may need to be known in an emergency or to law enforcement. Disadvantages may include the detriment to privacy, if companies decide to employ location-based marketing techniques.

8. What are the 3 main functions of the Data Link layer? What is a checksum? What is its role in the Data Link layer?

1. provide a well-defined service interface to the network layer
2. handle transmission errors
3. data flow regulation

A checksum is a bit string that is computed from the contents of a frame and attached to the end of the frame. It is used in the Data Link layer as a means of error detection. If the checksum for a received frame does not match the checksum that was received with the frame, then a transmission error has occurred.

9 Which protocol requires more buffer space at the receiver – Go-Back-N or Selective Repeat? Briefly explain why.

Selective Repeat requires more buffer space. If a packet is missing or out of order, Go- Back-N requires all unacknowledged packets to be retransmitted, and they do not need to be buffered at the receiver. Hence Go-back-N only requires a buffer for the most recent packet. Selective Repeat requires a buffer for a complete window of N packets, since it will buffer packets that arrive out of order to avoid retransmission.

10. A stop-and-wait protocol is used on a 100 Mbits/s link. The round-trip propagation time on the link is 300 *micro*seconds. What is the minimum frame size required (in bits) in order to guarantee that the maximum utilization of the link is at least 40%? Assume that transmission is error free, and the length of an acknowledgement frame is negligible.

Max Utilisation = L/(L + bR)
L/(L + bR) > 0.4
L > 0.4L + 0.4bR
0.6L > 0.4bR
L > (bR×0.4)/0.6 = 100 × 10^6 × 300 × 10^{-6} × 0.4 / 0.6
L > 20 kbits