

18-345

Introduction to Telecommunication Networks

Homework 1 **Solutions**

September 3, 2008

Due: September 10, 2008

1. Discuss the advantages and disadvantages of packet switched networks over circuit switched networks. Name some of the applications for which a packet switched network would be preferred over a circuit switched network.

Solution:

The main advantages of a packet switched network over a circuit switched one are :

Bandwidth conservation – Bandwidth is not dedicated to a particular connection, and can be multiplexed to handle packets from multiple connections

No circuit set-up overhead – Since a dedicated channel need not be established prior to data transfer, the connection set-up and tear-down overhead is not present.

The main disadvantages are:

Since each packet is routed independent of the other, there is a risk of packets getting lost or delayed.

The sharing of network bandwidth leads to problems like network congestion, etc

E-mail, web browsing, etc are a few applications for which packet switched network is preferred to circuit switched networks. For interactive voice communications, such as a telephone conversation, circuit switched networks are preferred.

2. Suppose transmission channels become virtually error-free. Is the data link layer still needed?

Solution:

The data link layer is still needed for flow control over the transmission channel and for framing the data. In a multiple access medium such as a LAN, the data link layer is required to coordinate access to the shared medium among the multiple users.

3. Harry Bovik decides to do away with DNS. Instead he stores the mapping between domain names and IP addresses in a local file that is stored on his computer. He argues that this approach is better since it resolves domain names much faster. What is the problem with this approach?

Solution:

While this approach can be used instead of DNS, practically it will face some problems, such as:

1. The number of entries in the files would be very large since all possible name-IP mapping need to be stored. Most of these entries would be useless for Harry since he is unlikely to visit all those domains. On the other hand, DNS resolution is on-demand which means that from a potential set of billions of entries you only retrieve what you want.
2. Harry's solution is centralized and therefore doesn't scale as well as the distributed DNS. With the current size of Internet, a centralized database would be overwhelmed with the constant updating and additions of new domain name-IP mappings.

In summary, while Harry's approach can work in theory but practically given the current size and nature of the Internet domain names, it is unlikely to work.

4. What protocol (between *UDP* and *TCP*) do the following protocols use? Give reasons accordingly.
 - a) FTP
 - b) HTTP
 - c) DNS

Solution:

FTP and HTTP are protocols running on top of TCP and their corresponding applications such as file transfer and fetching HTML document require the reliable and in order data delivery service provided by the TCP connection.

DNS uses UDP since it is a short request-response kind of protocol. Since DNS is used quite often, its response time is very important. TCP's three way handshake is simply too much of an overhead for a short request and response communication. For fault tolerance, DNS can use multiple servers to retrieve information. Thus, the reliability part is built into the application.

5. Suppose you want to build a new application that requires in-order service but can afford losses. In other words, you don't require all the features of TCP but want more than the simple datagram delivery service provided by UDP. Is it possible to build such an application? Justify your answer.

Solution:

Yes, it is possible to build such an application using UDP as the transport layer protocol. The additional features that is required by the application can be implemented on top of UDP (within the application). Therefore, we don't need to come up with a new transport layer protocol in response to different kinds of application requirements.

6. Suppose an application layer entity wants to send an L byte message to its peer process, using an existing TCP connection. The TCP segment consists of the message plus 20 bytes of header. The segment is encapsulated into an IP packet that has an additional 20 bytes of header. The IP packet in turn goes inside an Ethernet frame that has 18 bytes of header and trailer. What percentage of the transmitted bits ("efficiency") in the physical layer correspond to message information, if $L = 100$ bytes, 500 bytes, 1000 bytes?

Solution:

$L = 100$ bytes, $100/158 = 63\%$ efficiency.

$L = 500$ bytes, $500/558 = 90\%$ efficiency.

$L = 1000$ bytes, $1000/1058 = 95\%$ efficiency.

7. Suppose the population of the world is 6 billion, and that there is an average of 1000 communicating devices per person. How many bits are required to assign a unique host address to each communicating device? Suppose that each device attaches to a single network and that each network on average has 10000 devices. How many bits are required to provide unique network ids to each network?

Solution:

$\log_2 (6 \times 10^9 \times 10^3) = 42.44$. 43 bits are required to assign a unique host address to each communicating device.

$\log_2 ((6 \times 10^9 \times 10^3) / 10,000) = 29.2$. 30 bits are required to provide unique network ids to each network.

8. You are required to reduce the delay for a certain application. The options under consideration are listed below. For each option, explain whether the decision will increase or decrease the packet delay. Moreover, which component of the delay (transmission or propagation) will be affected?

i) Increasing the packet size

ii) Increasing the bit rate of the transmission system from R bits/second to $2R$ bits/second

iii) Moving the two endpoints physically closer (for example, Pittsburgh to New York rather than Pittsburgh to San Francisco)

Solution:

transmission delay = L/R

propagation delay = d/c

L = number of bits in message

R bps = speed of digital transmission system

d = distance in meters

c = speed of light

- i) Increasing the packet length increases the transmission delay since L is increased.
- ii) Increasing the bit rate decreases the transmission delay since R is increased
- iii) Reducing the distance decreases the propagation delay since d is decreased.

9. Suppose regularly spaced PING packets are sent to a remote host. What can you conclude from the following results?

- i) No replies arrive back
- ii) Some replies are lost
- iii) All replies arrive but with variable delays

Solution:

- i) If you can receive from other hosts you can conclude that the remote host is not available or is behind a firewall that does not allow PING replies. If you can not receive from any hosts than something is wrong with your connection
- ii) If some replies are lost you can conclude that there is heavy network traffic and packets are being dropped at some point along the path
- ii) If you receive all packets but they arrive with variable delays you can conclude that each packet is taking a different path through the network.

10. Assume an analog signal in a system has a bandwidth of 10 kHz. If we want to send the signal in digital format, what should be the minimum sampling rate required?

Solution:

In order to recover the sampled signal, the sampling rate has to be greater than $2W$ samples/second, where W is a signal spectrum bandwidth (in term of Hz). [Nyquist Sampling Rate] Therefore, $(2 \times 10 \text{ k}) = 20 \text{ k}$ samples/second is the minimum sampling rate.