CSC358H5: Principles of Computer Networking — Winter 2025

Worksheet 10: HTTP, Transport Layer, UDP, TCP

Q0 Knowledge Check

0.a List one advantage and one disadvantage of using a text-based header (as in HTTP) instead of a binary format. Why does IP use a binary format?

0.b Which of the following statements are True? Choose all that apply.

- ☐ HTTP is a stateful protocol that remembers user sessions by default.
- ☐ HTTP operates at the transport layer of the OSI model.
- ☐ HTTP uses request and response messages to facilitate communication between clients and servers.
- ☐ HTTP always ensures data encryption without the need for additional protocols.

0.c In your Wireshark labs, you worked with two application layer protocols that operate over UDP as their transport layer protocols. Name those application layer protocols.

0.d We had seen many protocols and devices in this course that use Soft State. In the following part, specify why using the Soft State is necessary.

0.d.i DHCP Offer Lease Time: In your Wireshark lab, you notices that an offer message from a DHCP server includes a lease time, along with other fields like an IP address, subnet mask, DNS server address, and so on. Why is a lease time necessary?

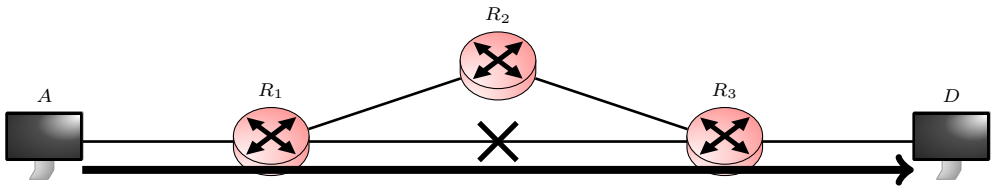
0.d.ii DNS Response Time-to-Live: A DNS response message from a DNS server includes a time-to-live field. Why is this necessary?

0.d.iii IP TTL Field: The IP packet header includes a time-to-live field that is decremented by each router along the path. Why is the time-to-live field necessary?

0.e Why does a TCP sender use a very large retransmission timeout (*e.g.*, several seconds) to detect and retransmit a lost SYN packet?

0.f Considering the TCP implementation that was described in lecture, when does fast retransmit fail to improve the performance?

0.g Suppose two hosts have a long-lived TCP session over a path with a 100 msec round-trip time (RTT). Then, a link fails, causing the traffic to flow over a longer path with a 500 msec RTT. Suppose the router on the left recognizes the failure immediately and starts forwarding data packets over the new path, without losing any packets. (Assume also that the router on the right recognizes the failure immediately and starts directing ACKs over the new path, without losing any ACK packets.) Why might the TCP sender retransmit some of the data packets anyway?



0.h When starting a new TCP connection, why do the sender and receiver each pick a random initial sequence number (ISN)? Why not start every TCP transfer with a sequence number of 0?

0.i In the three-way handshake to open a TCP connection, host A sends a SYN, host B sends a SYN-ACK, and host A sends an ACK. When can the TCP implementation at host A start sending data packets? When can the TCP implementation at host B start sending data packets? Explain why they cannot start sending any sooner.

0.j What happens, at the socket level, when the user clicks "reload" on a Web browser when the data transfer is proceeding slowly? Why does this often lead to a faster download?

Q1 An HTTP response message can include a "Last Modified" time, indicating the last time the requested object was modified. When a user requests an object that resides in the browser cache, the browser generates an HTTP request message with an "If Modified Since" header to ask the server to return a fresh copy only if the object has been modified since the previous request. How is it possible for the "If Modified Since" cache-validation technique to work, even if the two machines have vastly different notions of time *(i.e.*, no clock synchronization)?

Q2 To make an HTTP request, the client establishes a TCP connection and sends an HTTP request message. An HTTP request message has a "Host" header than includes the name of the server (*e.g.*, "Host: www.erfanmeskar.com"). Why is the Host necessary? Wouldn't the server already know its own name?

Q3 Your boss asked you to customize TCP to make it suitable for the specific network of your organization. You were told that the maximum possible rount-trip-time (RTT) in this network is 100 ms. Moreover, the links in this network have a capacity of 1 Gbps. Furthermore, you were told that the **Maximum Segment Lifetime (MSL)** in this network is 30 seconds. MSL defines the maximum time a TCP segment can remain valid in the network. It represents the longest time a TCP segment could be in transit before being discarded.[1]

3.a What is the minimum number of bits that you need for Sequence Number and Advertised Window field in the header of the TCP that you customized for this network?

3.b Among RTT and MSL, which one is more difficult to estimate?

Q4 Suppose two hosts are about to open a TCP connection. The TCP headers used in the communication are only 20 bytes long and regular (*i.e.*, no options) IPv4 is being used.

4.a If the MTU of the link is 1260 bytes, what is the MSS?

4.b When this connection starts, the sender starts with an ISN 19. The initial window for the sender is set to 10 MSS.

4.b.i Given the previously calculated MSS, what ACK number does the sender receive **as part of the TCP handshake**?

4.b.ii After sending the first window of data, what is the first and last ACK number the sender receives for this initial window? (Assume no packets were lost or reordered).

Q5 Consider a Web server that generates and sends HTTP response messages to clients over sockets. The header of an HTTP response message consists of a collection of lines, each ending with a carriage return and line feed. For example,

```
HTTP/1.1 200 OK
Server: Apache/1.2.7-dev
Date: Tue, 07 Jul 1998 18:21:41 GMT
Content-Type: text/html
...
```

Some early Web-server software generated the lines one at a time, and used a separate system call to write (or send) each line to the socket.

5.a Why is this approach inefficient for the end host?

5.b Why is this approach inefficient for the network?

5.c Describe how a programmer implementing the Web server software could fix this problem.

[1] In addition to detirmining the number of bits you need for the Sequence Number filed, MSL is used in TIME-WAIT mechanism of TCP, too. When a TCP connection is closed, the endpoint that performs an active close (sending the final FIN packet) enters the TIME-WAIT state for a duration of $2 \times$ MSL. This ensures that all packets related to the closed connection are either delivered or discarded by the network. [**NOTE:** This footnote won't be covered in your exam]

Q6 This problem is inspired by a question raised by one of the students in class during last week's lecture.

Many of the protocols underlying the Internet rely on end hosts to faithfully implement the protocols correctly, for the greater good. This question explores what happens when they don't.

6.a Consider a multi-access Ethernet where one host has an adapter that does not back off after detecting a collision. Describe how this would affect the communication performance for the other hosts.

6.b Consider a TCP implementation that does not reduce its sending rate in response to packet loss. Describe how this would affect the other TCP traffic sharing the congested link. Also, explain whether/how this non-compliant behavior might hurt the performance of the offending TCP connection.