Homework 5 assignment for ECE671

Posted: 04/27/2021

Due: 05/04/2021

Note: *In all written assignments, please show as much of your work as you can. Even if you get a wrong answer, you can get partial credit if you show your work.* If you make a mistake, it will also help the grader show you where you made a mistake.

Problem 1 (25 Points): CDN

a. In class we have looked at a case study for Netflix. As we have seen, Netflix owns very little infrastructure. What other infrastructure and service providers does it make use of? What services are provided by these 3rd parties?

b. For this problem consider the network shown in Figure 1. Assume an average object size of 1Mbits, an average request rate of 15/sec, an average rate to browsers of 150Mbps, RTT from institutional router to any origin server of 2 sec, and an access link capacity of 15Mbps. What are the overall LAN and access link utilization? What is the total delay?

c. Now the access link capacity is increased to 100Mbps. What are the overall LAN and access link utilization? What is the total delay?

d. Now consider the network shown in Figure 2, where a cache is added to the institutional network. Suppose the cache hit rate is 40%. All other parameters for that network are similar to the ones given in b. What is the access link utilization? What is the total delay?

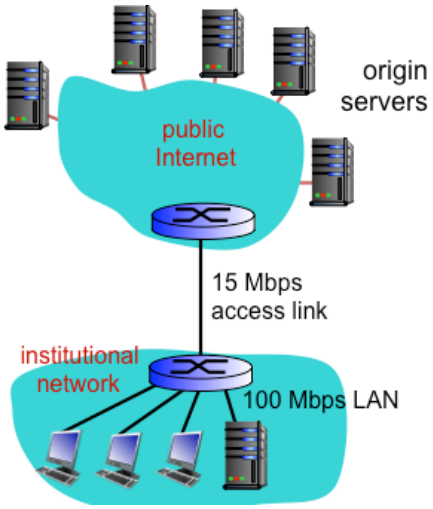

Figure 1: Network without cache

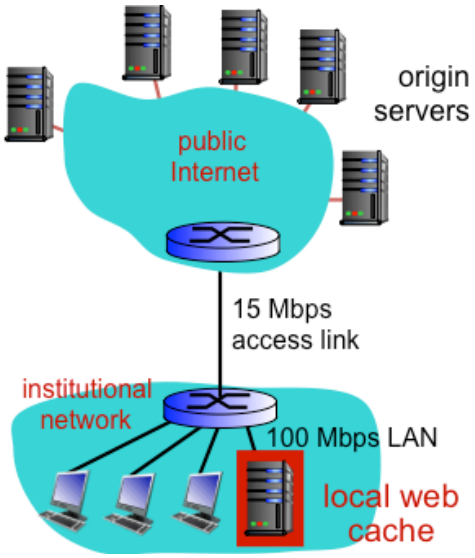

Figure 2: Network with cache

Problem 2 (25 Points): NDN

In this problem we take a look at the Named Data Networking approach, an instantiation of the Information Centric Networking paradigm, which is a candidate for the future Internet architecture.

- **a.** Describe the actions that are taken once an Interest packet arrives at a router. Described the alternatives for the case that (a) the requested content is currently cached in the content store or (b) it is currently NOT cached in the content store.
- **b.** Assume a scenario in which two clients are connected to the same router. Client A requests contents content */com/netflix/video123* at time t_1 and client B requests the same content at time t_2 ($t_2 > t_1$). Show a snapshot of the routers pending interest table (PIT) after the request from client B has arrived (assuming the content is neither cached nor has it arrived from an upstream router or custodian).
- **c.** Now assume the content has arrived before the request from client B arrives. How will the PIT look in this case?
- **d.** Explain the function of the content store (CS). What happens if the content store is full (no additional storage space at the router) and a content arrives at the router?
- **e.** Give an example for a forwarding information base (FIB) in NDN and explain the differences to a FIB in IPv4.
- **f.** Consider a live streaming event like the Super Bowl. Explain the advantages of NDN over TCP/IP in this specific scenario.

Problem 3 (20 Points): DASH

Answer the following questions assuming Dynamic Adaptive Streaming over HTTP (DASH) is used for video streaming.

a. When using DASH for streaming, does this require a dedicated streaming server or can a regular HTTP server be used? Why or why not?
b. Give a brief explanation of the manifest file that's stored on the server in addition to each video.
c. Explain the client behavior in the case where the highest possible quality of the stream is currently transmitted to the client and the buffer fill has fallen below the minimum threshold.
d. Assuming a 5-minute video should be offered in 5 different quality versions and the DASH segment length is 10 seconds. How many individual files will have to be stored on the server if AVC encoding is assumed?

Problem 4 (15 Points): Security

Suppose Alice wants to send an email to Bob. Bob has a public-private key pair (K^+_B, K^-_B), and Alice has Bob's certificate. But Alice does not have a public, private key pair. Alice and Bob (and the entire world) share the same hash function H(.).

a. In this situation, is it possible to design a scheme so that Bob can verify that Alice created the message? If so, show how with a block diagram for Alice and Bob.
b. Is it possible to design a scheme that provides confidentiality for sending the message from Alice to Bob? If so, show how with a block diagram for Alice and Bob.

Problem 5 (15 Points): MultiPath TCP

a. Explain why there has been a recent effort to split a TCP session in one or more subflows that are routed over different paths? Why was this not considered in TCP's original design?
b. Figure 3 illustrates the session setup for two subflows of a multipath TCP session. In the blank parts of this figure fill out the messages that are exchanged between the two end nodes. Also, briefly explain why this method for linking subflows is required.
c. Fill out the blanks in Figure 4 and explain why multipath TCP makes use of two levels of sequence numbers.
d. What is the shortcoming of multipath TCP in comparison to QUIC when it comes to packet losses?
e. Explain what happens in the case of *i)* a fast retransmit, *ii)* timeout expiration, and *iii)* of loss of a subflow.

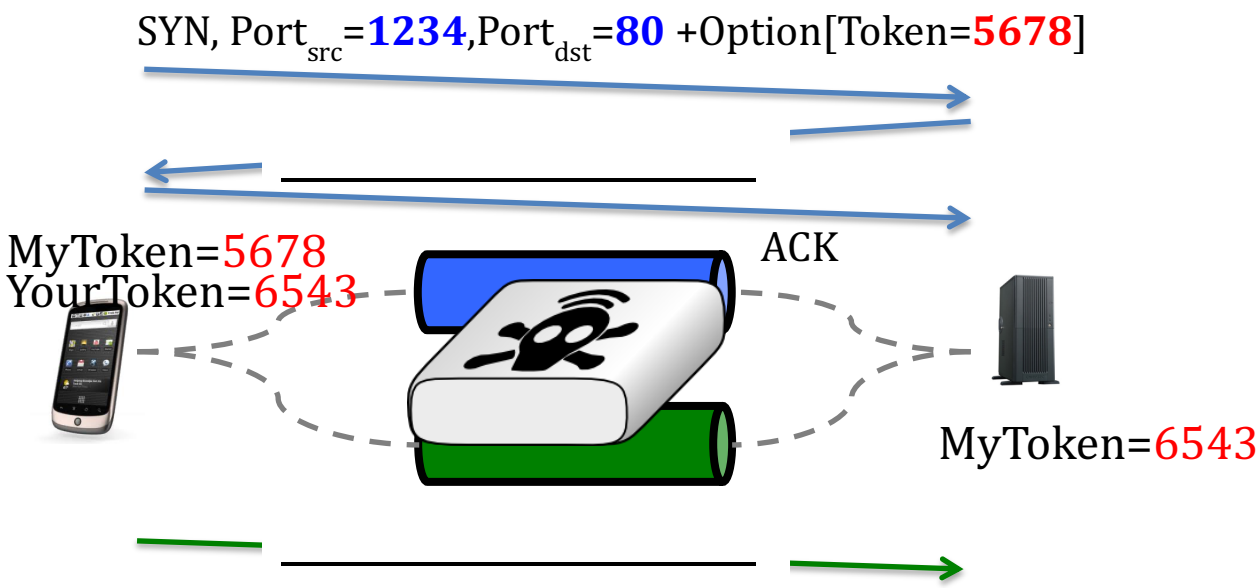

Figure 3

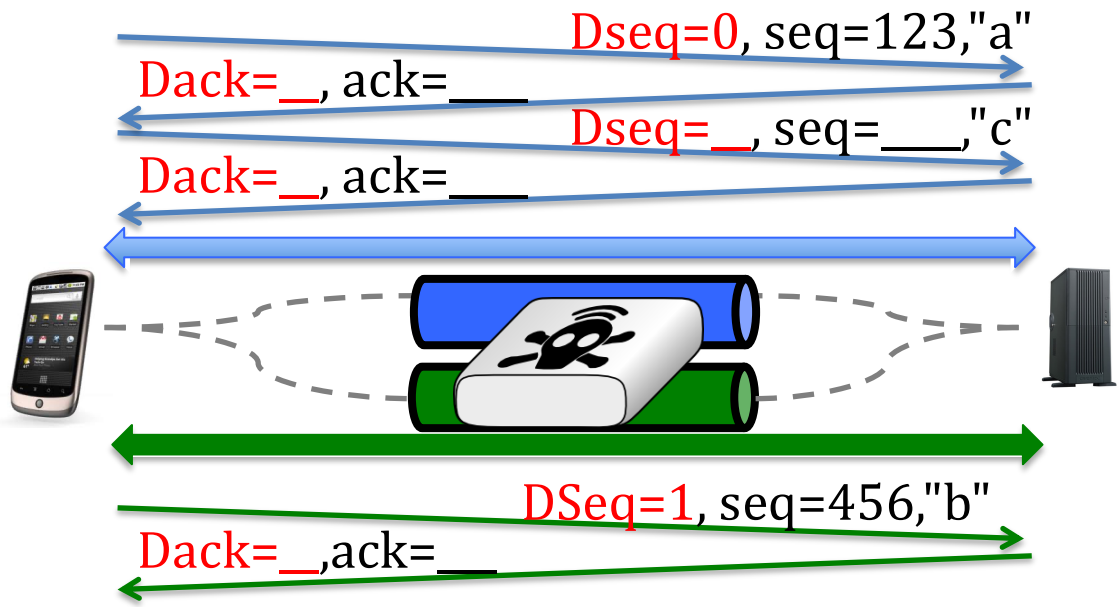

Figure 4