CS 536 (Park) **Final** **Apr. 30 (Tue.), 2024**

Remarks: Please keep the answers compact, yet precise and to-the-point. Long-winded answers that do not address the key points are of limited value. Binary answers that give little indication of understanding are not good either. Time is not meant to be plentiful. Make sure not to get bogged down on a single problem.

PROBLEM 1 (45 pts)

(a) Describe the main features of RIP that distinguish it from OSPF. Which one is commonly used for intra-domain routing in large networks, and why? What benefit does IS-IS bring? What is the main distinguishing factor between LAN packet forwarding and intra-domain routing? Explain your reasoning.

(b) What is the rationale behind the Fast Retransmit feature of TCP congestion control? What is the rationale behind Slow Start? What part of the Congestion Avoidance feature does TCP CUBIC aim to improve, and how? How is congestion collapse related to exponential backoff? Explain your reasoning.

(c) Upon receiving an HTML file from a HTTP GET request, a number of objects pointed to by hyperlinks may need to be fetched through additional GET requests. What is HTTP head-of-line (HOL) blocking, and how has HTTP evolved to address the problem? What is an end system solution to HOL that does not require changes to the HTTP protocol? What is its main drawback? What is a second HOL problem that is addressed by QUIC in HTTP 3? What is the approach followed by QUIC?

PROBLEM 2 (36 pts)

(a) Fading is the main feature that distinguishes wireless from wired communication. How is fading effected by multi-path propagation in indoor environments? What impact can it have on performance? Suppose a user at a fixed location indoors within line-of-sight from an AP is receiving poor signal strength. What minor adjustment can the user make to potentially improve signal strength? What action can the AP take to improve the user's signal strength? What benefit can OFDM (i.e., single-user, not OFDMA) combined with FEC bring in WLANs to mitigate the effects of fading? Explain your reasoning.

(b) A significant part of Internet traffic is comprised of file transfers mediated by TCP. How does the workload property of TCP in terms of file size affect its two congestion control features, Slow Start and Congestion Avoidance? Explain your reasoning. For the stop-and-wait protocol we noted that throughput is inversely proportional to RTT. For a fixed packet size, network utilization declines the higher RTT and the higher the bandwidth of its links. How does TCP mitigate performance degradation in wide-area network environments with long RTT and high bandwidth links?

PROBLEM 3 (19 pts)

We discussed how application layer infrastructure such as distributed caching in CDNs and advertisement of an Internet-wide service accessible through a single IP address (e.g., 1.1.1.1) is made possible by utilizing the features of intra- and inter-domain routing. Explain using two hosts—one in California, the other in New York—that both use 1.1.1.1 as their DNS server address how DNS requests to 1.1.1.1 to resolve domain names (e.g., translate www.purdue.edu to an IP address) are speedily resolved, despite the hosts being on opposite coasts. Assume the two hosts belong to stub autonomous systems A and B, respectively, 1.1.1.1 belongs to C, and the three autonomous systems are customers of tier-1 transit autonomous system D. C being a large service provider has servers at major POPs where D operates. A and B provide Internet access in large metropolitan areas.

BONUS PROBLEM (10 pts)

In lab5, we utilized congestion control method D to support audio streaming. What was the objective that method D was trying to achieve to facilitate high quality audio playback? What was the throughput, γ, of the streaming client/server system? How can quality of video playback be improved by reconfiguring system resources/parameters? What is its drawback?