Department of Computer Science and Engineering, National Sun Yat-Sen University
Second Semester of 2005 PhD Qualifying Exam
Computer Networks

Problem 1. (Totally, 20 points)

(1) What are the major differences between TCP and UDP in terms of services provided for the upper layer?

(2) Explain what is "three-way handshaking" in the context of TCP connection setup. Why not use "two-way handshaking" or "four-way handshaking"?

(3) Explain the congestion control algorithm that is used in TCP. Why it might be a good solution for congestion control? Why don't we simply use a window of constant size?

(4) The major reason for packet loss in wireless networks is different from that in the wired Internet. What are the major reasons for packet loss in wireless networks and wired networks, respectively? Why the original TCP does not work well over a wireless link.

Problem 2. (Totally, 10 points)

Let G be the total network traffic load. Typically, the network throughput is a function of G.

(1) When the ALOHA is used, the network throughput equals $f_1(G) = G \cdot e^{-2G}$. Draw the function $f_1(G)$ and use Calculus to find the maximum value of $f_1(G)$.

(2) When the slotted ALOHA is used, the network throughput equals $f_2(G) = G \cdot e^{-G}$. Draw the function $f_2(G)$ and use Calculus to find the maximum value of $f_2(G)$.

Problem 3. (Totally, 20 points)

Video applications typically run over UDP rather than TCP.

(1) Could you explain why TCP is not suitable for video applications?

Therefore, video applications are not constrained by TCP's congestion control algorithm.

(2) What impact does this have on TCP traffic? Be specific about the consequences.

Fortunately, these video applications often use RTP, which results in RTCP "receiver reports" being sent

back from the sink back to the source. These reports are sent periodically and include the packet loss probability.

(3) Describe how the source might use this information to adjust its rate in a TCP-compatible way.

Timestamps are usually used in multimedia transmissions.

(4) Explain the jitter problem that arises in multimedia transmissions over the Internet. List two techniques that are widely used to mitigate the jitter problem.

Problem 4. (Totally, 20 points)

(1) What is multicast? Explain how multicast is used to reduce bandwidth consumption in the Internet backbone and the Ethernet-based local area networks.

(2) List the advantages and the disadvantages of layer-3 multicast and layer-7 multicast.

(3) In IGMP, is it necessary for multicast router to know how many hosts join in a multicast group? Please justify your answer.

(4) Briefly explain two multicast routing algorithms.

Problem 5. (Totally, 10 points)

(1) What are the major differences between the symmetric key encryption scheme and the public key encryption scheme?

(2) Use public key encryptions to design a scheme that assures privacy and integrity for a communication session from Jane to Michael over an insecure Internet.

Problem 6. (Totally, 10 points)

Consider a M/M/1 queueing system. Let $a(t) = \lambda e^{-\lambda t}$ be the probability density function for the inter-arrival times and $b(t) = \mu e^{-\mu t}$ be the probability density function of the service times. Let $X(t)$ be the system size of the queueing system at time t. In addition, $X(0) = 0$.

(1) Let $p_n = \lim_{t\to\infty} P\{X(t) = n\}$, $\forall n \geq 0$. Derive p_n's, where $n \geq 0$.

(2) Derive the average system delay W and the average queueing delay W_q.

Problem 7. (Totally, 10 points)

(1) Carrier sensing is a popular technique used in medium access control schemes. However, carrier sensing does not assure collision-free transmissions. Explain the hidden terminal problem and the exposed terminal problem that arise in a multi-hop wireless local area network.

(2) Binary exponential backoff is another popular technique used in medium access control schemes. Briefly explain how it works. Why don't we simply pick up an optimal value for contention window size in advance?