PRINCE OF SONGKLA UNIVERSITY
FACULTY OF ENGINEERING

Midterm Examination: Semester II
Date: Dec 22, 2009
Subject: 210-555 Modern Communication Networks

Academic Year: 2009
Time: 13.30-16.30
Room: S201

Instructions:

a. Allow a student to bring his/her own note (**one A4-size paper**) into a room during the exam

b. Allow the student to use his/her own calculator and dictionary

Answer all problems

1. What is the peak throughput achievable by a source employing stop-and-wait flow control when the maximum packet size is 1000 bytes, and the network spans **(a)** 10 km, **(b)** 5000 km? Assume a direct fiber-optic line between endpoints.

(10 points)

2. Compute the optimal window size when packet size is 53 bytes, the RTT is 60 ms, and bottleneck bandwidth is **(a)** 1.5 Mbps (the standard T1 trunk speed), **(b)** 155 Mbps (the standard OC-3 trunk speed).

(10 points)

3. In a test of integrated circuits there is a probability p that each circuit is rejected. Let Y equal the number of tests up to and including the first test that discovers a reject. What is $P\{Y=y\}$?

(10 points)

4. Discuss about the end-to-end argument

(10 points)

5. On-off flow control

In on-off flow control, the receiver sends the transmitter an *On* signal when it can receive data, and an *Off* signal when it can accept no more data. The transmitter sends as fast as it can when it is in the On state, and is idle when it is in the Off state. "On-off flow control is effective when the delay between the receiver and the sender is small"

Discuss the reason why on-off flow control works poorly when the delay between the sender and receiver is large.

(10 points)

6. Packet-pair flow control

This flow control estimates the bottleneck capacity in the network. Also, it predicts the future service rate in the network and corrects for incorrect past predictions. These allow it to maintain a certain number of packets in the bottleneck queue precisely (its *set point*) despite variations in the bottleneck service rate.

The packet-pair flow control is based on this concept: The probing lemma allows a source to determine the bottleneck service rate by sending two packets at a rate faster than the bottleneck service rate, and measuring the inter-ack spacing. Thus, when two packets belonging to the same connection enter a server back-to-back, an interval that is inversely proportional to the connection's service rate at the bottleneck separates them when they leave as shown in Figure 1. Note that the separation is largest at the bottleneck server. Thus, if the receiver measures the packet separation (or if the source measures the acknowledgement separation), the receiver (or source) can directly determine the bottleneck service rate. A packet-air source sends all packets as pairs (except if the source only has a single packet to send). Thus, a source can update its estimate of the bottleneck service rate with every pair of acks it receives. If the bottleneck service rate changes with time, the source automatically detects and adapts to the change.

Assume that all packets are the same size. Let $u(k)$ be the bottleneck service rate detected by the kth ack pair.

(a) Use the exponential averaging of the time series $u(1), u(2), \ldots, u(k)$ to predict $\tilde{u}(k+1)$. Write the expression of $\tilde{u}(k+1)$ in terms of $\tilde{u}(k)$, $u(k)$ and the averaging factor α, where $0 < \alpha < 1$.

(10 points)

(b) Given the round-trip **propagation** delay R and the number of packets outstanding (that is, transmitted, but not acknowledged) S, estimate the number of packets in the bottleneck buffer (X).

(10 points)

(c) If the set point is B, then the packet-pair source adjusts the actual transmission rate so that it reaches the set point in approximately one round-trip time. Determine the transmission rate $\lambda(k+1)$.

(10 points)

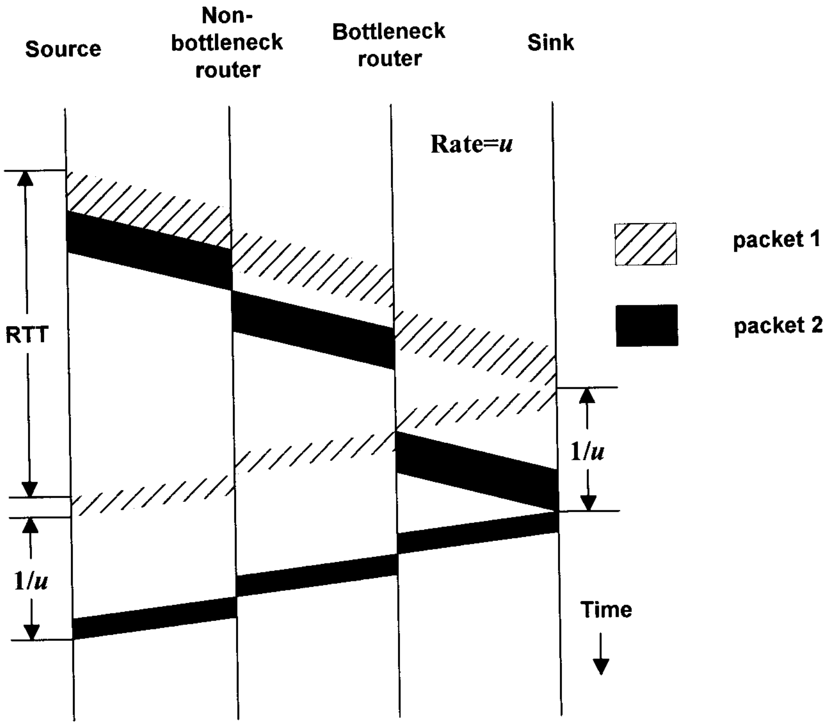

Figure 1 Packet-pair flow control