Exam - Midterm

Due: 11:50am, 15 Mar 2011

Closed Book. Maximum points: 100

NAME:

1. Sending Data - [12 pts]

a. If TCP provides reliable, in-order delivery of bytes end-to-end, why would you want to use UDP? Give an application that might be better off using UDP. [4 pts]

b. Why is packet switching preferred over circuit switching on the Internet? [4 pts]

c. Give an example of when you might want to use the following service models in IP: [4 pts]

(a) Anycast

(b) Broadcast

(c) Multicast

(d) Unicast

2. Link Layer / Ethernet - [12 pts]

a. If the maximum delay between two nodes on a shared medium Ethernet is d, what is the minimum transmission time for any frame? Why is this important? [4 pts]

b. Ethernet uses Manchester encoding to send its frames. Recall that Manchester encoding encodes a 1 as a transition from 1 to 0, and a 0 as a transition from 0 to 1. What feature of this encoding makes it easier to detect collisions in Ethernet? Explain. [4 pts]

c. Ethernet uses exponential backoff as a distributed mechanism to deal with collisions in the shared medium. What is the Capture Effect? Give an example of how it can happen between two nodes A and B connected to the same shared-medium Ethernet. [4 pts]

d. On a shared-medium Ethernet it is easy for an attacker to sniff packets, i.e., to receive packets destined to other nodes. This is considerably harder on a switched Ethernet, but still possible. Using your knowledge of how a learning Ethernet bridge works, given an attacker connected to one port of such a bridge, how can the attacker use the fact that there is only a limited number of entries in the bridge cache to sniff packets destined to a specific MAC address? (The victim must not notice the attack, and thus the attacker cannot simply use the same MAC address as the victim.) [bonus 7pts]

3. Routing - [15 pts] The fundamental reason for which loops form in a Distance Vector protocol is that a A node decides to use a neighbor B as the next hop for a destination based on routing information that was, at some point, propagated by A itself.

a. Give an example (draw a simple topology, break a link, and show a sequence of updates) using standard Distance Vector that shows this is the case. [4 pts]

b. In an attempt to remove loops from the Distance Vector protocol, a guy named Charles proposed the following change to DV. In addition to the cost to reach a destination, he added a sequence number to the update. Sequence numbers are per destination, and are only incremented by the destinations themselves. They are copied in advertisements if the node forwarding the information is not the destination.

For example, node A advertises A:(A, 0, 32) to say that it can reach node A (itself), with cost 0, and this is its update number 32. Node B, directly connected to A, can accept this and install in its routing table the entry B:(A, A, 1, 32), meaning it can reach A, through A, at cost 1, based on A's update number 32.

When receiving an update for a destination, a node will:

(a) update the routing information if the sequence number is newer, or

(b) update the routing information if the sequence number is the same as it currently has, but the metric is better than it currently has.

Did Charles succeed in avoiding loops with this addition? Argue why loops can or cannot form towards a destination when nodes choose routes based on both rules (a) and (b) above. [7 pts]

c. Give one advantage that Link State has over Distance Vector, and one disadvantage. [4 pts]

4. BGP - [15 pts] The Border Gateway Protocol that we studied is a path vector protocol among run by Autonomous Systems (ASs) on the Internet for inter-domain routing.

a. Give two advantages of using path vector routing as the routing algorithm underlying BGP. [4 pts]

b. What are the components in a BGP path? What are the destinations in BGP tables? [4 pts]

c. In 2008, Pakistan was able to prevent about two thirds of the Internet from reaching a slice of YouTube's addresses, by *hijacking part of YouTube's prefix*. What does this mean? Explain how preference for more specific routes makes this easier. [7 pts]

5. IP on Ethernet - [12 pts] You fire up Wireshark and you see the following Ethernet frames interpreted to you:

Time	Origin	Destination	Interpreted Contents
191.5	00:0e:0c:05:86:f7	00:00:00:00:00:00	"Who has 128.148.34.7? Tell 128.148.34.6"
191.6	00:0c:76:b2:84:08	00:03:0c:05:86:f7	"128.148.34.7 is at 00:0c:76:b2:84:08"

a. What protocol is this?[4 pts]

b. What is it used for?[4 pts]

c. 00:00:00:00:00:00 is the Ethernet local broadcast address. Why is the first packet sent to a broadcast address, but the second isn't?[4 pts]

6. Traceroute - [8 pts] `traceroute` is a popular tool for listing hops in the path between two IP hosts. It works between an origin and a destination, and will work for paths of up to 30 hops in length.

a. How does `traceroute` work? Be specific, talk about the packet(s) the origin sends and the packet(s) that it receives. If it sends multiple packets, what varies between successive packets? [4 pts]

b. Does the sequence of hops returned by `traceroute` represent true paths taken by packets? If not, give two reasons for which it might not be the case. [4 pts]

7. Congestion Control - [26 pts] Son and Osmar are frustrated with the Slow Start algorithm used in TCP, saying that it takes too long to fully utilize the bandwidth of a path, and that for short files the link utilization is not good.

a. Let us help them substantiate this complaint by examining this on a simple scenario. Suppose you have two nodes, A and B, connected by a dedicated link with bandwidth of 2^{23} bits per second ($\approx$ 1MBps), and that it takes 125ms (2^{-3}s) for a packet of 1024 bytes to reach the other node and for an ACK to come back. (*Hint: use powers of two for the calculations.*)

   (a) What is the window size, in packets, for a sliding window protocol to fully utilize the link? [5 pts]

   (b) If A is sending data to B and uses TCP's Slow Start algorithm, in how many round trip times does A grow the window to the ideal window size for this link, which you found in (a)? How many total packets will A have sent by the end of this last round trip time? [5 pts]

(c) What is the throughput (in bytes per second) if you have to send a file that has the size of the number of packets you computed in part (b) using Slow Start? What then is the link utilization (throughput / bandwidth) ? (*It is fine if you leave the answers in terms of powers of two.*) [5 pts]

b. QuickStart: Really unhappy with this situation, Son and Osmar decide to implement an alternative algorithm to Slow Start, **QuickStart**. The idea is to quickly find the window size that leads to full utilization.

Here's what QuickStart does: when starting, the sender sends packets as fast as the link will let them, until it receives the first acknowledgment. It then sets the number of packets sent up to that point as the window size, and proceed normally from there.

(a) In the same scenario as in the previous part (single dedicated link), does Quick Start work, assuming the first packet and its acknowledgment are not lost? Explain. [4 pts]

(b) Son and Osmar then decide to test the approach on a real network (paths with multiple links, potentially multiple simultaneous flows), with the hope of writing a new RFC for TCP and gaining worldwide fame. Unfortunately, the approach does not work. Give one example scenario in which Quick Start would grossly overestimate the window size. [7 pts]