Homework 3 (Due: 11/19)

1. Path MTU Games

Here are some alternative possible mechanisms that might be used at routers as the basis for path MTU discovery when a packet encounters a link for which it is too large to be transmitted:

i. Discard the packet and return an error to the source with no indication of the MTU of the next link
ii. Discard the packet and return an error to the source with the MTU of the next link
iii. Discard the packet and return an error to the destination with no indication of the MTU of the next link
iv. Discard the packet and return an error to the destination with the MTU of the next link
v. Truncate the packet and return the truncated packet as an error to the source
vi. Truncate the packet and continue forwarding it to the destination

You should assume that only the given mechanism is used at each router, but you are free to use whatever processing you desire at the ends of the network path (i.e., the source and destination). Compare these designs with a brief analysis that evaluates approximately how many round trip times in the worst case are needed for the source to find the path MTU. Use your evaluation to rank the schemes from best to worst.

2. Mobile Networks

Wireless IP connectivity is everywhere these days, even on airplanes. That certainly sounds like Mobile IP, but it is somewhat different because it is an entire network that is mobile rather than one node. Specifically, neither the computers on the Internet sending to the computers on the plane nor the computers on the plane have been upgraded with Mobile Airplane software. Your job is to build on Mobile IP and sketch a suitable design as guided by the questions below.

a) Explain why Mobile IP does not provide a solution to this scenario in its current form.
b) Describe the simplest design you can that builds on Mobile IP to achieve the Mobile Airplane scenario. (Hint if you are stuck: read about the idea of NAT or Network Address Translation.) A one paragraph answer is all the detail needed.
c) Suppose that a competitor comes up with a solution that does not use Mobile IP at all. Instead, they assign a fixed IP address prefix to the plane, giving customer computers IP addresses with DHCP. Packets sent to the IP prefix are routed by Internet hosts to the company headquarters in Seattle, then go over a wireless satellite link to reach the plane. Does your solution above provide advantages over this solution? Explain why or why not.

3. Where in the World is 140.142.0.0/16?

This question asks you to use publicly available sources of Internet addressing and routing data to explore some real routes. Data on routes to 140.142.0.0/16 has been collected from Route-

Views (http://www.routeviews.org, and telnet://route-views.routeviews.org) and stored in the file rviews.txt. It gives AS paths that different parts of the Internet use to reach 140.142.0.0/16. Many web pages let you query WHOIS databases for the ownership of AS numbers and IP addresses, e.g., http://www.radb.net/, http://www.whois.net/, https://www.arin.net/, http://www.db.ripe.net/whois, http://wq.apnic.net/apnic-bin/whois.pl/apnic-bin/whois.pl/

a) What are ARIN, RIPE and APNIC, and what is their relationship to IANA?
b) Who owns the IP prefix 140.142.0.0/16 and AS73?
c) Draw a single figure showing the tree of AS routes to this prefix from the RouteViews data. Give brief names to the ASes.
d) Some routes repeat an AS number multiple times. Why is this?
e) A customer of the AOL Transit Data Network sends packets to 140.142.0.0/16.What AS do these packets pass through?
f) If we take the routes in the RouteViews data as a representative sample of Internet paths, how many ASes on average does a packet travel through?

4. TCP and Delayed ACKs

Consider a small file of 8 packets that is transferred from one computer to another with TCP. Assume the network is not the bottleneck.

a) Draw a time sequence diagram, including connection setup and teardown for two cases:
    i. A simple slow-start sequence in which no packets are lost.
    ii. Same as the above except that the computers now include TCP Delayed ACKs
b) Roughly by how much do Delayed ACKs slow down this transfer? Is it likely significant?
c) Given the downsides, explain why Delayed ACKs can be useful.

5. ECMP Routing

Read about Equal-Cost Multi-Path routing compared to regular, Single-Path routing. In our version of ECMP, each router splits traffic equally over the N>=1 next-hops of the multiple paths that are found. Consider the network of Figure 5-23 and the scenario that each link has a cost of 1, can carry 1 unit of traffic capacity, and there is much traffic to be sent from A to G.

a) For Single-Path routing, what are the possible paths from A to G that will be found by OSPF?
b) For Single-Path routing, what is the most traffic that can be sent from A to G with any setting of link weights?
c) With ECMP, what fraction of the traffic from A to G will flow along each of the West-to-East links CF and EI?

d) For ECMP, give a simple set of changes to the link weights so that 2 units of traffic can flow from A to G, or explain why this cannot be done. Give the paths and amount of traffic flowing along each path.
e) For ECMP, give a simple set of changes to the link weights so that 1 unit can from B to C at the same time that 2 units can flow from A to G, or explain why this cannot be done. Give the paths and amount of traffic flowing along each path.
f) For ECMP, give a simple set of changes to the link weights so that 1 unit can from A to C at the same time that 2 units can flow from A to G, or explain why this cannot be done. Give the paths and amount of traffic flowing along each path.

6. Textbook

Questions 3.28, 5.30, 5.33, 5.35, 6.14, and 6.32

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