CS 494/594: Internetworking Protocols (Combined Homework 4 and Homework 5)
Portland State University Due Date: **6/7/2018**
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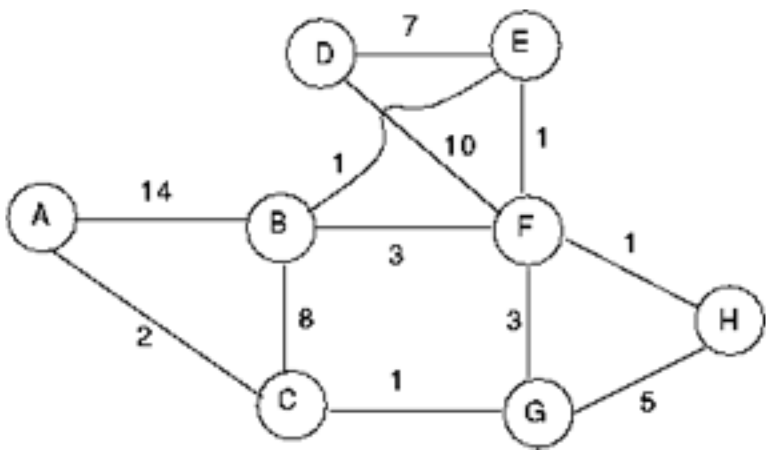
Notes:

- This joint homework submission covers both the network and data link layers.
- The combined homework is worth **200 points.**
- Submit a hard copy IN CLASS, at the beginning of class.
- We plan to release homework solutions on the submission deadline. For this reason, we are unable to offer any extensions. If you have an incomplete homework, turn that in. Budget and plan your time wisely. You are welcome to turn in your homework early.

1. **(60 points) Routing Algorithms**
Consider the network shown below and suppose that each node is running a distributed rout- ing algorithm.



a) Suppose that each node is running Dijkstra's link state routing algorithm. Starting from an empty tree, determine the order in which the nodes are placed in H's shortest path tree. Break ties using the alphabetical order (eg. B before C).

   H -> F -> E -> B -> G -> C -> A -> D

b) Now suppose that each node is running the distributed Distance Vector (DV) routing algorithm. The table below shows how H's distance vector entries get updated from the initial step to step 1, and so on, until final convergence.

H's distance vector

	A	B	C	D	E	F	G	H
Initial	infinity	infinity	infinity	infinity	infinity	1	5	0
Step 1	infinity	4	6	11	2	1	4	0
Step 2	8	3	5	9	2	1	4	0
Step 3	7	3	5	9	2	1	4	0
Step 4	7	3	5	9	2	1	4	0

2. (20 points) Software Defined Networks

Across networking academic research and industry, Software defined networking (SDN) and network function virtualization (NFV) have been transformational. Long-time incumbents such as Intel, Broadcom, Cisco, and IBM have SDN products. Several startups such as Nicira, Contrail have been acquired. SDN solutions have been extensively deployed across enterprises and Google's Wide Area Networks. Finally, SDN is anticipated to transform global-scale carrier networks (such as operated by AT&T, NTT, France Telecom, Deutsche Telekom, and others). To answer this question, you will need to perform some web-based research of your own!

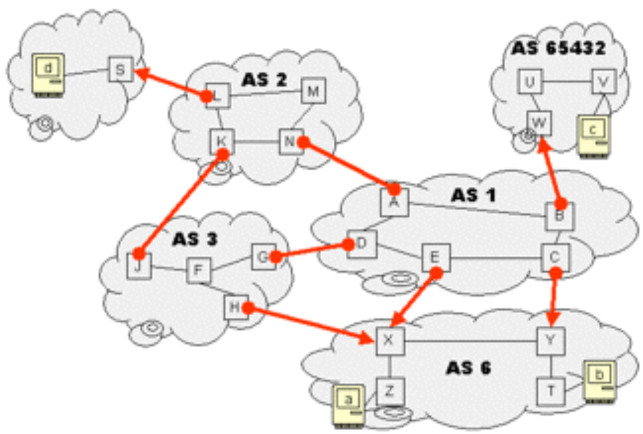
a) Explain how SDN requirements for carrier networks differ from datacenter networks.

The fundamental idea: SDN separates and information and manages as well as programmability of the network NFV transfer network functions from devoted appliance to broad servers.
Area of operations: SDN operates in a site, data centre and cloud environment. NFV targets the service supplier network.
Preliminary application target: SDN software target cloud orchestration in addition to networking. NFV software target routers, firewall, gateway, etc.
Protocols: SDN - open flow. NFV -none.
Supporting organization: SDN: open networking function. NFV: ETS NFV functioning coup.

b) Give one example of a commercial SDN switch that can be deployed in data centers. What functions does it support to manage data center workloads?

The fully virtualized data is automated and managed by intelligent, policy based data center management software, vastly simplifying governance and operations a singly, management platform lets you centrally monitor and administer all applications across hybrid clouds you can replay and manage in physical, virtual and cloud environment with a unified management experience. It become agile, elastic and responsive to a degree before possible.

3. (40 points) BGP
AS1, AS2, and AS3 are ISPs, peering with each other at the links between routers J-K, N-A, and D-G. AS6 is a customer of AS1 and AS3. Two more customer networks are shown. All routers are shown. All links between routers are shown. All networks are running OSPF as their IGP, and all link costs are equal. All providers are running I-BGP. The prefix for AS6 is 12.2.0.0/16. The prefix for AS65432 is 135.207.16.0/20. The prefix for the nameless customer containing router S and host **d** is 192.20.225.0/24. AS1, AS2, and AS3 number their routers out of 1.0.0.0/8, 2.0.0.0/8, and 3.0.0.0/8, respectively. Suppose that AS6 announces the lower half of its address space (12.2.0.0/17) from the Y-C link, and the upper half from the X-H link. Let **a**'s IP address be 12.2.33.65, and **b**'s IP address be 12.2.192.66. For each pair of hosts below, show the path.



Hosts	Path
(a, b)	a-Z-X-Y-T-b
(a, c)	a-Z-X-Y-C-B-W-U-V-c
(a, d)	a-Z-X-H-F-J-K-L-S-d
(c, a)	No path
(d, a)	No path

There is no path between c to a because, the network AS65432 cannot send data to ASI through which AS6 can be connected.
There is no path between d to a because, the anonymous network cannot send data to ASI through which AS6 can be connected.

4. **(40 points)** ISP #1 provides exclusive Internet connectivity to ISP #2 with customers A, B, C, and D. Suppose ISP#1 gives ISP #2 a range of addresses to use from 195.221.0.0 to 195.221.255.255 (Given in prefix/mask notation as 195.221.0.0/16). ISP #2 turns around and allocates the entire range to its 4 customers A, B, C, and D in contiguous, equal-sized chunks. List the four allocations ISP #2 makes to its customers in prefix/mask notation.

Customer	Prefix/Mask
195.221.0.0 to 195.221.127.255	195.221.0.0 | 16
195.221.128.0 to 195.221.191.255	195.221.128.0 | 17
195.221.192.0 to 195.221.223.255	195.221.192.0 | 18
195.221.224.0 to 195.221..255	195.221.224.0 | 19

5. **(40 points) Multiple Access Protocols**
Suppose nodes A and B are on the same 10 Mbps Ethernet segment and the propagation delay between the two nodes is 225 bit times. Suppose A and B send frames at the same time, the frames collide, and then A and B randomly choose their own values of K in the CSMA/CD algorithm. Assuming no other nodes are active, can retransmissions from A and B collide. For our purposes, it suffices to work out the following example. Suppose A and B begin transmission at t=0 bit times. They both detect collisions at t= 225 bit times. They finish transmitting a jam signal at t=225+48=273 bit times. Suppose K_A=0 and K_B=1.

Hints: Note that the random backoff component of scheduling delay is K * 512 bit times. Also note that the minimum Ethernet frame size is 512 bits.

(5 points) At what time does B schedule its retransmission (in bit times)?
A and B begin transmission: 0, A and B detect collision: 225,
A and B finish transmitting jam signal: 273,
B 's last bit arrives at A ; A detects an idle channel: 273+225 = 498.
A starts transmitting: 498+96=594.
B returns to Step2: 273+512 = 785.
B schedules its retransmission: 785+96=881

(5 points) At what time does A begin transmission (in bit times)?
B 's last bit arrives at A ; A detects an idle channel: 273+225 = 498.
A starts transmitting: 498+96=594.

(5 points) At what time does A's signal reach B?
T = 594 + 225 = 819

(5 points) Does B refrain from transmitting?
819 < 881, node B detects the signals sent by node A at t=819.
As a result, node B refrains from transmitting at its scheduled time.
Since node B receives a signal sent by node A before its schedules retransmission time, node B refrains from transmitting until code A finishes its transmission.