CS4450 Problem Set #4

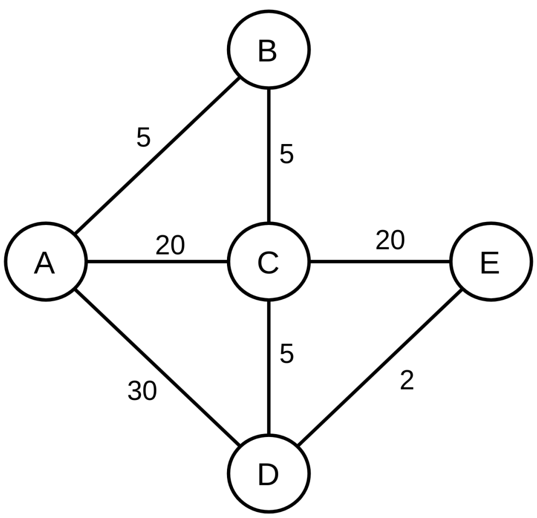
April 13, 2018

1 Distance Vector Routing

The number on a link between any pair of nodes is the latency between the two nodes (equal to the propagation delay for both data packets and control packets). We will use latency, cost and distance interchangeably in this problem.

- Assume distance-vector routing and that at time t = 0, each node knows the distance only to its immediate neighbors.
- Assume that all nodes send their current distance vectors to all neighbors at every 10 seconds, starting at t = 0.
- Assume the nodes' clocks are perfectly synchronized.
- Assume that transmission time is 0 for both data packets and control packets
- Assume that processing a received distance vector and updating the routing/forwarding tables takes time 0.
- Assume that if the entry to a particular destination has cost/latency/distance equals to ∞, then a packet to that destination is dropped.

Given the above assumptions, below is node A's routing/forwarding table at t = 0.



A's Forwarding Table at t=0

Destination	Next Hop	Cost
B	B	5
C	C	20
D	D	30
E	-	∞

(a) Fill in A's forwarding table at the following times.

t = 6s

Dest.	Next hop	Cost
B		
C		
D		
E		

t = 16s

Dest.	Next hop	Cost
B		
C		
D		
E		

t = 26s

Dest.	Next hop	Cost
B		
C		
D		
E		

(b) Suppose three packets destined to E arrive at A, one packet p_1 at time t = 6s, another packet p_2 at time t = 16s and finally another packet p_3 at time t = 26s. Show the paths taken by and the end-to-end latency for each of the packets (ignoring transmission time). Also give reasons for the correctness of the paths computed for the packets.

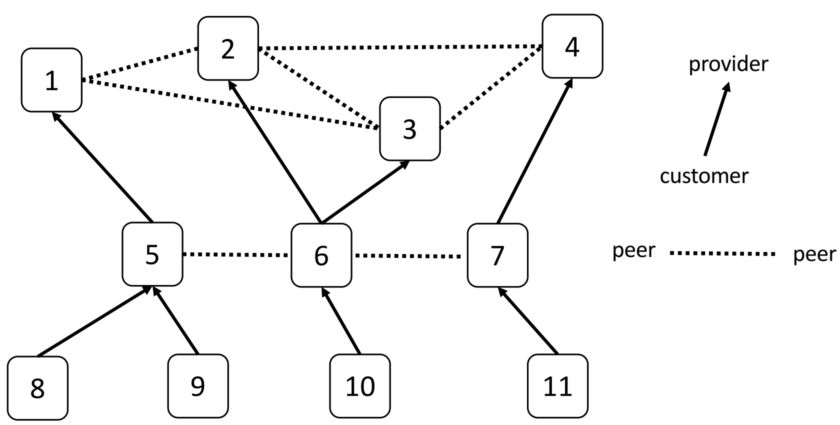
2 BGP

Recall that in BGP routing a valley-free path is a path that follows a sequence of zero or more provider links, followed by at most one peer link, followed by a sequence of customer links.

(a) Using the local preference to enforce valley-free paths, please fill in whether a route imported from a neighbor of a given type should be sent to another neighbor of a given type or not. Answer by Yes or No.

Route received from	**Route sent to**		
	Customer	**Provider**	**Peer**
Customer			
Provider			
Peer			

(b) Consider the diagram below of ASes shown in the diagram below. Arrows point from customer up towards a provider, dashed lines connect peers.



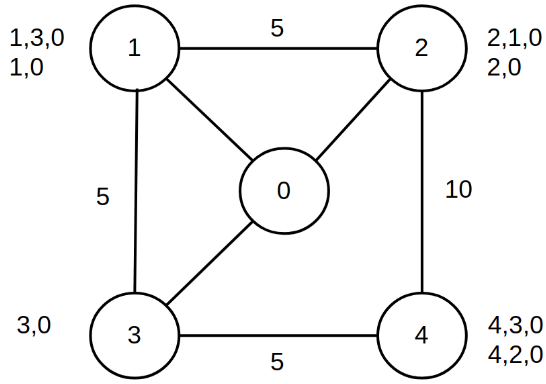
i. What possible valley-free paths are there from AS11 to AS10?

ii. Which path will be used for sending traffic from AS11 to AS10?

3 BGP

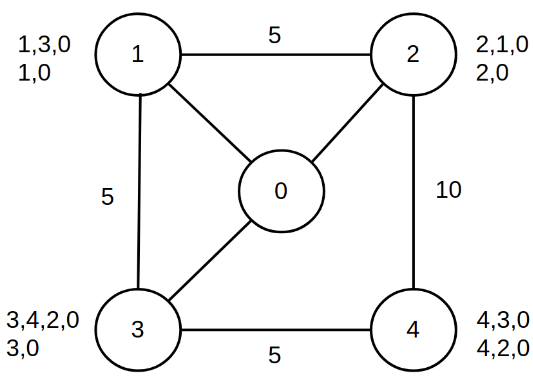
Consider the network below. Next to each Node 1-4, the possible paths from that node to Node 0 are listed. If there are multiple paths available, the nodes choose the path that is on the top. The numbers next to the links represent the propagation delay between the nodes that are connected. Ignore transmission delays.

Assume at time $t = 0$ any node that has a direct path to Node 0 chooses the direct path, and starts runnning BGP.

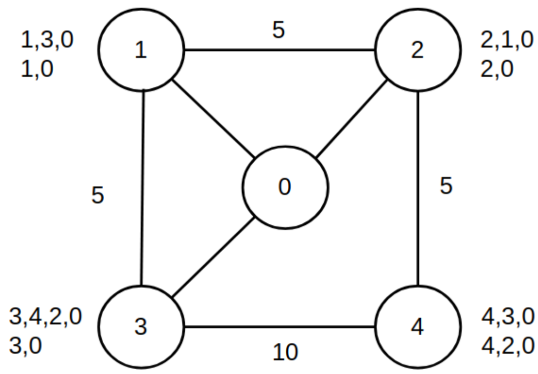


(a) Write down each message that is sent along with their timestamp. Write down the path choices of each node after the network converges (if it converges).

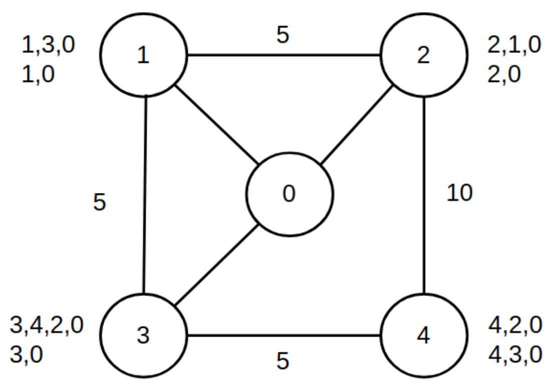
(b) Assume we add another possible path from Node 3 to Node 0 to obtain the below network. Write down each message that is sent along with their timestamp. Write down the path choices of each node after the network converges (if it converges).



(c) Assume we update the latencies to obtain the below network. Write down each message that is sent along with their timestamp. Write down the path choices of each node after the network converges (if it converges).



(d) Assume we update the latencies and Node 4's preference list to obtain the below network. Write down each message that is sent along with their timestamp. Write down the path choices of each node after the network converges (if it converges).



4 Addressing and Switching

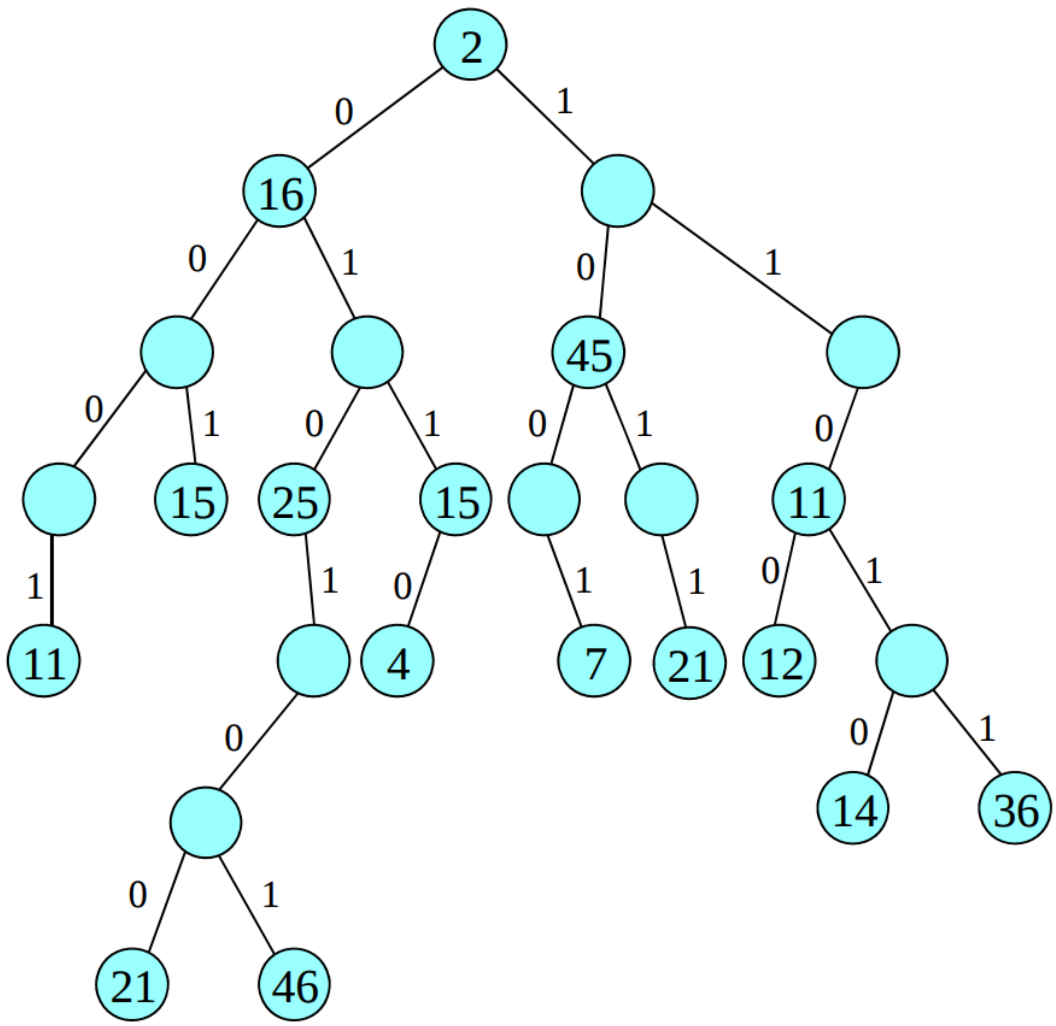
(a) What is the 32-bit binary equivalent of the IP address 223.1.3.27?

(b) Consider a datagram network using 8-bit host addresses. Suppose a router uses longest prefix matching and has the below forwarding table. For each of the four interfaces, give the associated range of destination host addresses and the number of addresses in the range.

Prefix Match	Interface
00	0
010	1
011	2
10	2
11	3

5 Longest Prefix Matching

(a) The figure below shows a data structure for IP address lookup using a TRIE. In the figure, the nodes containing numbers correspond to valid address prefixes and the numbers are the output ports that should be used by packets for which a given prefix is the best match.



i. What output ports should the following destination addresses be forwarded on?

- 1010 0011 1011 0010 1111 1111 0111 0101
- 0011 0010 1111 1110 1100 1101 1001 0001
- 0111 0010 0101 1100 1101 0100 0000 0001

ii. Change the the data structure to include a new prefix 101101* with next hop 22 and a new prefix 01001* with next hop 17.

(b) Draw the TRIE tree for the routing rule set below.
P1 = 0000*
P2 = 0001*
P3 = 0010*
P4 = 001*
P5 = 01*
P6 = 1*
P7 = 110*
P8 = 111*