MPCS 54001, Winter 2021

Homework 5 - Solutions

Due: February 25 at 5:30 pm

Submit your assignment to Gradescope. This work must be entirely your own. If you need help, post questions to Ed Discussion and/or visit the staff during office hours. As a reminder, if you make a public post on Ed Discussion, please don't give away the answer!

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1. Compare and contrast link-state and distance-vector routing algorithms. Also, for each routing algorithm category, name one example protocol along with its corresponding RFC. (25 points)

   Link-state algorithms: Computes the least-cost path between source and destination using complete, global knowledge about the network. An example of a link-state protocol is Open Shortest Path First (OSPF), which is defined in RFC 2328 (also accept RFC 1131 or RFC 5340).

   Distance-vector routing: The calculation of the least-cost path is carried out in an iterative, distributed manner. A node only knows the neighbor to which it should forward a packet in order to reach given destination along the least-cost path, and the cost of that path from itself to the destination. An example of a distance-vector protocol is the Routing Internet Protocol (RIP) defined in RFC 2453 (also accept RFC 1058).

2. Consider a network with the following five nodes: V, W, X, Y, and Z. Using distance vector routing, fill out the entries in V 's routing table immediately after receiving the following updates from its neighbors. V 's current costs to its neighbors are also shown below. (25 points)

   <u>Routing Updates from V 's Neighbors</u>
   W: [(V, 6), (W, 0), (X, 2), (Y, 5), (Z, 11)]
   X: [(V, 7), (W, 2), (X, 0), (Y, 3), (Z, 9)]

<u>V 's Link Cost to Its Neighbors</u>

W : 6

X : 7

In addition to filling out the routing table entries, be sure to show the Bellman-Ford equations that you used to derive the routing table.

$D_V(W)$ = min { W : c (V, W) + $D_W(W)$, X : c (W, X) + $D_X(W)$ }

= min { W : 6 + 0, X : 7 + 2 }

= min { W : 6, X : 9 } = W : 6

$D_V(X)$ = min { W : c (V, W) + $D_W(X)$, X : c (W, X) + $D_X(X)$ }

= min { W : 6 + 2, X : 7 + 0 }

= min { W : 8, X : 7 } = X : 7

$D_V(Y)$ = min { W : c (V, W) + $D_W(Y)$, X : c (W, X) + $D_X(Y)$ }

= min { W : 6 + 5, X : 7 + 3 }

= min { W : 11, X : 10 } = X : 10

$D_V(Z)$ = min { W : c (V, W) + $D_W(Z)$, X : c (W, X) + $D_X(Z)$ }

= min { W : 6 + 11, X : 7 + 9 }

= min { W : 17, X : 16 } = X : 16

V's Routing Table

Destination	*Cost*	*Next Hop*
W	6	W
X	7	X
Y	10	X
Z	16	X

3. Answer the following questions about the Border Gateway Protocol (BGP).
   a. What is the purpose of BGP? (5 points)

      BGP is the standard inter-domain routing protocol that enables routing between autonomous systems (AS). Unlike interior gateway protocols (e.g., OSPF, RIP), BGP prioritizes AS policy when making routing decisions.

   b. What is the difference between iBGP and eBGP? (5 points)

      Internal BGP (iBGP) is used to propagate reachability information among the routers within a single AS. External BGP (eBGP) is used to propagate reachability information across neighboring ASes.

   c. Do autonomous systems always advertise all reachable destinations? Explain your answer. (5 points)

      No, BGP supports policy-based routing, which means that BGP reachability information could be suppressed according to AS policy. For example, an export policy might suppress reachability information from a neighboring AS with whom it does not have a business agreement.

   d. Is it possible to detect BGP routing loops? If so, then explain how. If not, then explain why not. (10 points)

Yes, since the AS-PATH attribute contains a list of the ASes through which a prefix advertisement has already passed, it would be straightforward to drop an advertisement if your AS already appears in the AS-PATH attribute.

4. Suppose that an ISP decides to switch from OSPF to a new routing algorithm. Would the transition be easier with a traditional monolithic routing infrastructure or with a software-defined network? Explain your answer. (25 points)

   The transition would be easier with a software-defined network (SDN). To make the transition in an SDN, the network administrator would need to update the software in the SDN controller to start using the new routing algorithm rather than OSPF. The SDN controller would perform computations using the new algorithm and push forwarding tables (e.g., OpenFlow tables) to the routers. The change would be transparent from the router's perspective because it will continue to receive forwarding tables as usual.

   At a minimum, making the transition in a traditional monolithic routing infrastructure would require updating the configuration of each router to switch from OSPF to the new routing algorithm. In some cases, it might be necessary to install new software to support the new routing algorithm. In the worst case, it might be necessary to switch router vendors and deploy brand new hardware (if the current router vendor does not support the new routing algorithm).