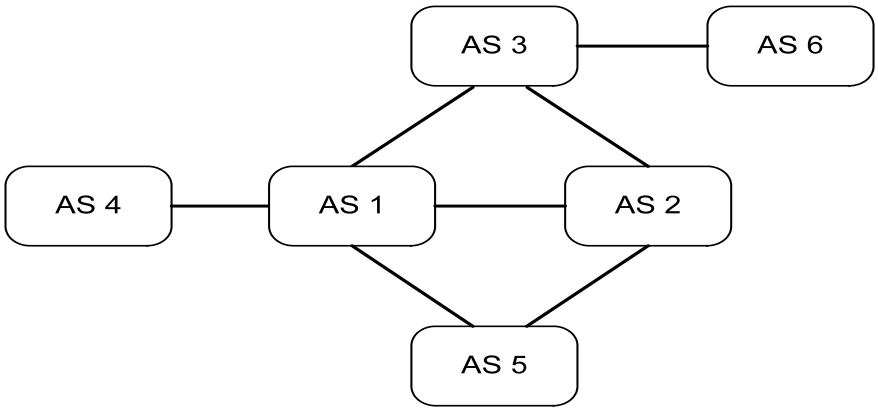
ECE 461 – Internetworking
Fall 2009

Problem Set 7
Solutions

Problem 1. Policy Based Routing in BGP

The figure shows a network with six autonomous systems. AS4 "owns" the prefix 10.0.1.0/24 and sends an advertisement to AS1 with the following prefix, and ORIGIN and AS-PATH attributes: *10.0.1.0/24, ORIGIN{AS4}, AS-PATH{AS4}.*



a. Assume that no routing policies are employed (i.e., no advertised routes are selectively ignored and all known routes are advertised). Explain how the other autonomous systems process and disseminate the advertisement for prefix 10.0.1.0/24. Indicate which autonomous systems advertise the prefix to their neighboring autonomous systems. Provide the ORIGIN and AS-PATH attributes used in the advertisements.

b. Now consider that autonomous systems AS1, AS2, and AS3 are transit networks, and AS4, AS5, and AS6 are stub networks. For each autonomous system, explain how the processing and advertisement for prefix 10.0.1.0/24 should be changed (compared with your answer to (a)).

a. (revised on Dec 10,2009)

AS-4 to AS 1: 10.0.1.0/24, ORIGIN{AS4}, AS-PATH{AS4}

AS-1 to AS-3, AS-1 to AS-2, AS-1 to AS-5: 10.0.1.0/24, ORIGIN{AS4}, AS-PATH{AS4, AS1}

AS-3 to AS-2, AS-3 to AS-6: 10.0.1.0/24, ORIGIN{AS4}, AS-PATH{AS4, AS1, AS3}

AS-2 to AS-3, AS-2 to AS-5: 10.0.1.0/24, ORIGIN{AS4}, AS-PATH{AS4, AS1, AS2}
AS-5 to AS-2: 10.0.1.0/24, ORIGIN{AS4}, AS-PATH{AS4, AS1, AS5}

AS-2 to AS-3: 10.0.1.0/24, ORIGIN{AS4}, AS-PATH{AS4, AS1, AS5,AS2}
AS-2 to AS-5: 10.0.1.0/24, ORIGIN{AS4}, AS-PATH{AS4, AS1, AS3,AS2}
AS-3 to AS-6: 10.0.1.0/24, ORIGIN{AS4}, AS-PATH{AS4, AS1, AS5,AS2,AS3}

AS-3 to AS-6: 10.0.1.0/24, ORIGIN{AS4}, AS-PATH{AS4, AS1,AS2,AS3}

b. Policies are added:
AS 5 → a stub network does not advertise any network other than those originating in AS 5
AS 2 → as transit networks with peering relationships it should not advertise to AS 3 that it can carry traffic to AS 1.
AS 3 → as transit networks with peering relationships it should not advertise to AS 2 that it can carry traffic to AS 1.

AS-4 to AS 1: 10.0.1.0/24, ORIGIN{AS4}, AS-PATH{AS4}

AS-1 to AS-3, AS-1 to AS-2, AS-1 to AS-5: 10.0.1.0/24, ORIGIN{AS4}, AS-PATH{AS4, AS1}

AS-3 to AS-6: 10.0.1.0/24, ORIGIN{AS4}, AS-PATH{AS4, AS1, AS3}
AS-2 to AS-5: 10.0.1.0/24, ORIGIN{AS4}, AS-PATH{AS4, AS1, AS2}

b)
AS-4 to AS 1: 10.0.1.0/24, ORIGIN{AS4}, AS-PATH{AS4}

AS-1 to AS-3, AS-2 and AS-5: 10.0.1.0/24, ORIGIN{AS4}, AS-PATH{AS4, AS1}

AS-3 to AS-6: 10.0.1.0/24, ORIGIN{AS4}, AS-PATH{AS4, AS1, AS3}
AS-2 to AS-5: 10.0.1.0/24, ORIGIN{AS4}, AS-PATH{AS4, AS1, AS2}

Problem 2.
Explain Hot-Potato Routing and where it is used. Discuss an advantage and a disadvantage of Hot-Potato routing.

Solutions:

Hot-Potato routing = route packet to closest exit point when there is more than one route to destination.

- Advantages:
  - Simple decision criteria
  - Minimizes resource consumption

- Disadvantages:
  - Forward and backward path are asymmetric.
  - May select a suboptimal path (example in lecture slides)

Additional sensible answers are valid.

Problem 3.
Suppose a BGP router sees the following two advertisements for destination network 10.0.1.0/8:

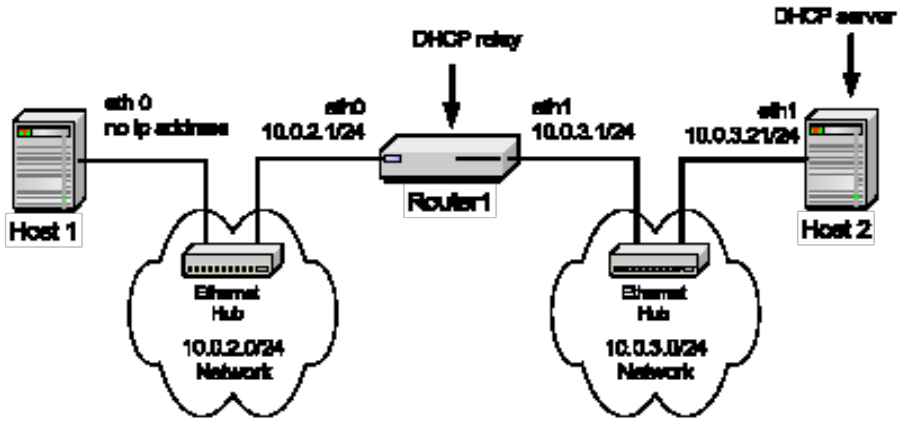
10.0.1.0/8, AS-PATH { 202, 101, 89, 59}
10.0.1.0/8, AS-PATH { 876, 32}

Explain how the second advertised AS-PATH could result in a ~~shorter~~ longer route.

Solution:

The answer should explain that the number of AS's that are traversed is no indication of the number of IP routers that are traversed. So, the path AS876 → AS32 may have more IP routers than the path AS202→AS101→AS89→AS59.

Problem 4. *(10 points)* In the figure below, Host1 is a DHCP client, Host 2 is a DHCP server. Router 1 is an IP router (i.e., IP forwarding is enabled), that is also configured as DHCP relay server.



a. *(4 Points)* Explain why Router1 needs to be configured as a DHCP relay server.

b. *(3 Points)* Describe how the relay server processes and directs a DHCP Request from Host 1 and the DHCP Reply to Host 1. Does the DHCP relay server modify the IP headers of the DHCP packets?

c. *(3 Points)* List the IP source and destination addresses in the DHCP Request and the DHCP Response. If the addresses are changed at Router1, show the original and the modified addresses.

The following steps describe how a DHCP relay agent works:

1. The DHCP client broadcasts a DHCPDISCOVER packet.
2. The DHCP relay agent on the client's subnet forwards the DHCPDISCOVER message to the DHCP server by using unicast.
3. The DHCP server uses unicast to send a DHCPOFFER message to the DHCP relay agent.
4. The DHCP relay agent broadcasts the DHCPOFFER packet to the DHCP client's subnet.
5. The DHCP client broadcasts a DHCPREQUEST packet.
6. The DHCP relay agent on the client's subnet forwards the DHCPREQUEST message to the DHCP server by using unicast.
7. The DHCP server uses unicast to send a DHCPACK message to the DHCP relay agent.
8. The DHCP relay agent broadcasts the DHCPACK to the DHCP client's subnet.