Iowa State University
Department of Electrical and Computer Engineering
Cpr E 489: Computer Networking and Data Communications
Lab Experiment #6
IPv4 Routing Assignment
(Total Points: 100)

Objective

To get familiar with the static routing protocol, and manually update the routing tables.

Pre-Lab

Complete steps a-g of the Procedure section and remind yourself how to SSH into Nodes as in Lab 5,

    a. Go to https://portal.geni.net/ press the **Use GENI** button and from the **Drop-Down** menu select your institution.

    b. Join a project through GENI portal and create a slice
            (use **<YourLastName>-lab6** as the name),

    c. Generate and use a private SSH key.

Lab Expectations

Work through the lab and let the TA know if you have any questions. After the lab, write up a lab report with your partner. Be sure to

- **summarize what you learned in a few paragraphs. (20 points)**
- **include your answers for all questions, with screenshots**. **(80 points)**

Your lab report is due at the beginning of the next lab.

Procedure:

    a. Create a slice and name it: **<YourLastName>-lab6**.

    b. On the slice page, click on your slice and then click on the **Add Resources** button placed at the top part of the screen.

    c. In the **Choose RSpec** section, choose **URL** and use the following address:

        https://raw.githubusercontent.com/GENI-NSF/geni-tutorials/master/IPRouting/EG-3nodes-mesh.rspec

        After copying this address into the box, press select and you should see NodeA, NodeB, and NodeC appear in the diagram.

    d. You will need to choose an aggregate where you want this topology to be instantiated. Click on the Site 1 box and a panel on the left side of the canvas will appear. Choose any aggregate with **ExoGENI** in its name.

    e. Click on the **Reserve Resources** button on the bottom left part of the screen.

    f. Wait while your resources are being reserved. **This will take several minutes so be patient.** The node statuses on the Home→Slice→Details screen will turn green (READY) to signify that your resources are ready.

Take a screenshot of your slice when all the nodes are ready and include it in your report. (10 points)

g. Setup the routing:

1) The downloaded network is connected as indicated in Figure 1.

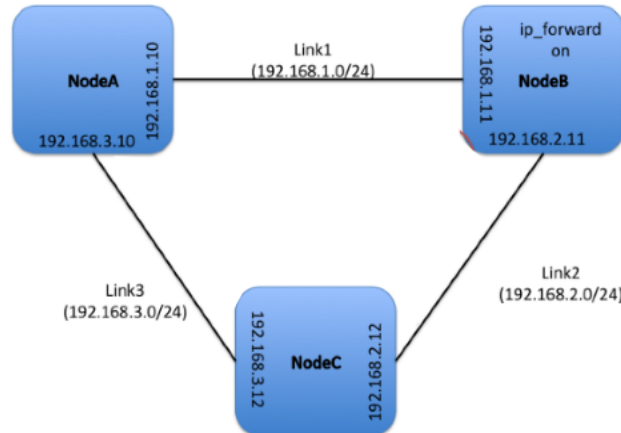Figure 1 Topology and routing

2) Open a terminal

3) Run *ssh* for all three Nodes and enter your passphrase when prompted.

    ```
    ssh -i <private key location> <username>@<hostname> -p <port>
    ```

    i.   To get the information you need, you can load your slice in the portal, and from the Home tab locate your slice and click on it to load it.
    ii. Under the topology canvas, click the Details button. This page should have all the information you need.

4) Execute the `route` command in each of the three nodes to show their respective routing tables **Include a screenshot of the tables in your lab write up. (10 points)**

5) From node A, try to ping the other addresses of nodes B&C (two IP addresses for each node). **Include a screenshot of the ping outputs and explain the results. (10 points)**

6) **What happens when you traceroute from A to IP address 192.168.2.12 before you setup the static routes? Why? (10 points)**
    If you get a message similar to "-sh: 7: traceroute: not found" when trying to execute traceroute, use `sudo apt-get install traceroute` to install traceroute
    Include a screenshot of the traceroute output in your write up. (10 points)

The below command will add the network aaa.bbb.ccc.0 to the routing table and use qqq.www.eee.rrr on interface "eth0" as the gateway.

`` `sudo route add -net aaa.bbb.ccc.0 netmask 255.255.255.0 gw qqq.www.eee.rrr eth0` ``

Note: qqq.www.eee.rrr must be the address that the localhost can access directly (ie it is not further routed before getting to qqq.www.eee.rrr)

To delete this entry in the table, simply replace "add" with "del":

`` `sudo route ``**del**`` -net aaa.bbb.ccc.0 netmask 255.255.255.0 gw qqq.www.eee.rrr eth0` ``

Note: Packets that are destined for hosts other than the gateway they are arriving at will not be forwarded by that gateway unless ip forwarding is turned on at that gateway. This can be done by:

`` `sudo sh -c 'echo 1 > /proc/sys/net/ipv4/ip_forward'` ``

7) Now, modify the routing tables to allow for node A to reach the IP addresses that you couldn't reach in step 6. *(More details on the route command can be found in the man page: `` `man route` ``)*
Include a screenshot of the routing table of node A. (10 points)

8) **What happens when you traceroute from A to IP address 192.168.2.12 after your setup the static routes? (10 points) In your write up include a screenshot of the traceroute output. (10 points)**

Cleanup

After you are done with your experiment, you should always release your resources so that other experimenters can use the resources. In order to cleanup your slice:

Press the **Delete** button in the bottom of the Manage Resources panel on the Slice page.

Wait a few moments for all the resources to be released and you will have an empty canvas again. Notice that your slice is still there. There is no way to delete a slice. It will be removed automatically after its expiration date, but remember that a slice is just an empty container, which doesn't take up any resources.

Tips

- If you get a "Command not found " error when executing standard commands like *ifconfig* or *traceroute*, add *sbin* to your path:

  ```
  export PATH=$PATH:/sbin
  ```

- Remember that you can use "ifconfig" to determine which Ethernet interface (e.g., eth0) is bound to what IP address at each of the nodes.
- In order to enable IP forwarding of packets on a node you have to execute the following command:

  ```
  sudo sh -c 'echo 1 > /proc/sys/net/ipv4/ip_forward'
  ```

- A new slice will always be in its initial state with NO routing set up!
- A useful tool to debug the packet flow is **tcpdump**. In order to install it run:

  ```
  sudo apt-get install tcpdump
  ```