Practical work #4: Network topology and routing

In this assignment, you will be using a network emulator called GNS3 to create a network topology. You will test different routing schemes with virtual Cisco routers.

Network topology

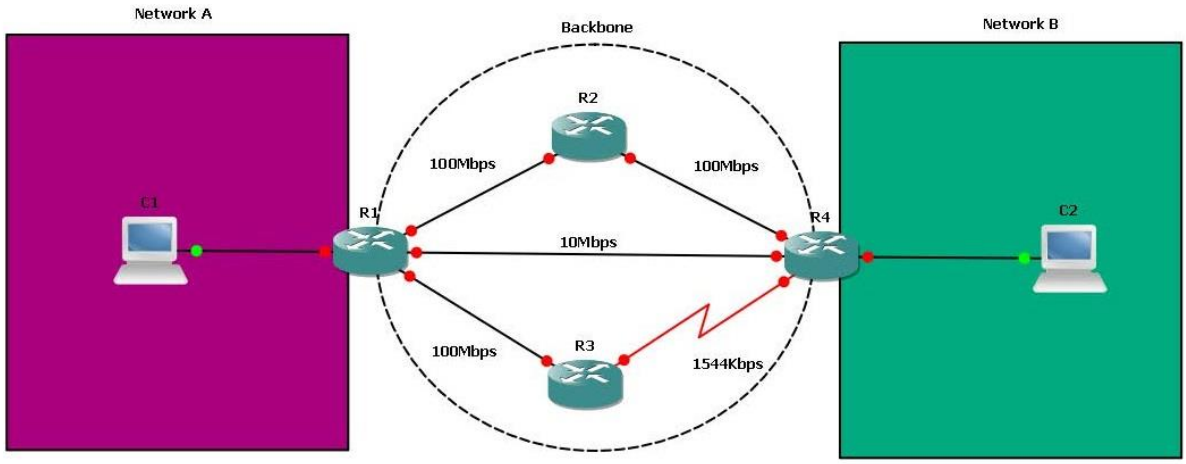

Figure 1 Physical network view

You are expected to build a topology displayed on the figure above. As you can observe, there exists three paths from PC-1 to PC-2. These are R1−> R2 −> R4, R1−> R4 and R1−> R3 −> R4.

By default, each router has only two interfaces available for connections. To add more interfaces: right click a router, then *Configure*, select the router node, go to *Slots* and add a *NM-1FE-TX* module. For connection between R3 and R4 select *WIC-1T* in the *wic 0* slot. Finally, Select *View->Show/Hide interface labels* to display the names of the router interfaces.

After creating all routes according to the figure, you can start the system (green triangle in the top menu). It is time to configure the network nodes.

Network configuration

This is the logical network view of the configuration in figure 1.

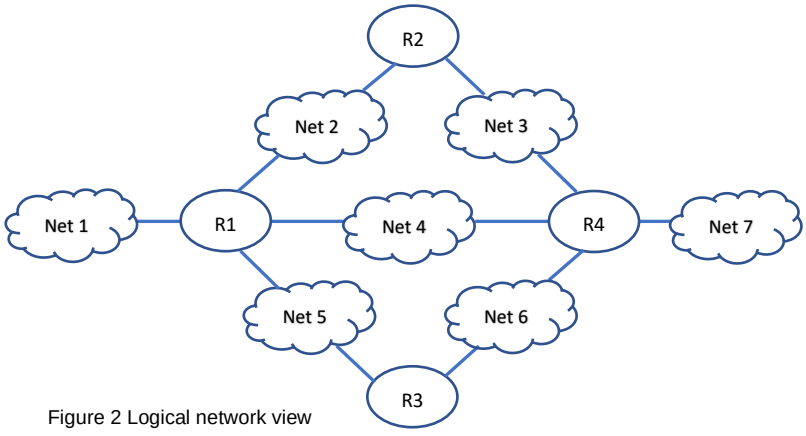

Figure 2 Logical network view

Each router interface (red dot in the topology) and VPCS node (green dots) need to have its own IP address. Your task is to create a correct IP addressing scheme with only one requirement: you must have /30 subnets in the backbone (between routers) and /24 subnets in networks A and B. Also do not waste with IP addresses! This means you must use adjacent address ranges in all the backbone networks, e.g., only use network addresses 10.0.0.x/30 for these networks.

Hint: use the subnet mask cheat sheet. *Hint #2*: Create this scheme first. A spread sheet is a good tool for it.

When the IP scheme is ready, configure the routers using the following console commands:

```
conf t
int [router_interface] //For example, f0/0
ip address [your_ip] [your_mask]
bandwidth [your_bandwidth] //Find out what metric is used for bandwidth
no shutdown
end
```

After that you should configure the VPCS nodes:

```
ip address [mask] [gateway]
```

If you face an error message about duplex mismatch, you may enter the following in the router config:

```
conf t
no cdp log mismatch duplex
end
```

After configuration is done, try to ping the next hop from each of the network nodes (only the next hop, not from R2 to R3 or PC-1 to R3). Once the pings are successful, your network topology is ready for the assignment.

Now add labels in your topology with the IP address for each interface.

Saving/Loading a configuration

At the beginning of each problem of this assignment, you will need to return to the basic state of configuration on each router you just have completed (not required for computers PC-1 and PC-2). Therefore, you need to first save the configuration of each router by issuing the *wr mem* console command. Then, in GNS3 click *File->Import/Export* and export all configurations to a folder at your computer. When you need to return to the basic configuration, stop all of your router instances, click *File->Import/Export* and import a previously saved configuration to the routers.

Hint: all router configurations can be saved in a .txt document and simply copied in the router console with shift+insert.

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Problem 1

Configure a network virtual environment and create a required topology according to the guidelines. Make sure to save the router configurations as well as the GNS3 topology at this stage as a starting point for each of the coming assignments.

Your report should include:

a) A resulting screenshot from GNS3 with a completed topology that contains all IP addresses (can be added with *Notes* tool) for both networks and for each interface. Make sure the figure is easy to read in the report.

b) Screenshots of pings from **R1 to PC-1**, **R1 to R4** and **PC-1 to PC-2**.

c) An explanation of NM-1FE-TX and WIC-1T abbreviations and why these modules are chosen among the available alternatives. Make sure to describe the properties of each type of interface.

d) Answer to the following question: what is the practical difference between a /24 and a /30 subnet?

Problem 2

In this problem you will work with static routing. Choose one of the three available routing paths between PC-1 and PC-2 that is more efficient in your opinion.
Then implement static routing using this path. To add one route to a router, use the following commands:

```
enable
conf t
ip route [ip] [mask] [router_interface] [metric]
end
```

a) Explain each of the parameters of the *ip route* command.

b) When a complete route between VPCS nodes is ready, send ping commands from PC-1 to PC-2 to test the connection. Also use traceroute to show what path is actually used. Include resulting **screenshots** and explain the choice of routing path in your report.

c) Start a continuous ping from PC-1 to PC-2. Then shut down **BOTH active** router interfaces on both sides of one of the networks along the path connecting PC-1 and PC-2:

```
conf t
int [router_interface]
shut
```

Observe that pings are failing. Include a screenshot in the report.

d) Your task now is to configure the remaining two possible routing paths between PC-1 and PC-2. Once finished, start a continuous ping from PC-1 to PC-2 again and shut down the path that is used (again make sure to close the interfaces on both

sides of a network). Observe how many packets are lost before a new routing pass starts working and include a **screenshot** in your report showing how many lost ping packets there are. Make sure it shows all lost packets as well as the situation before and after the new path is in use. Also show with traceroute what the new path is and explain why this is the new chosen path.

Problem 3

Return to the basic router configuration. Now configure a dynamic routing protocol RIPv2 in all routers using the following commands:

```
enable
conf t
router rip
version 2
no auto-summary
network [ip]
network [ip2]
network ...
end
```

a) Read about configuring RIPv2 routers to specify the correct number of networks with appropriate IP addresses for each router. Use a *traceroute* command from PC-1 to PC-2 to see which routing path has been picked by RIPv2 as the most efficient. Explain this choice in your report.

b) Similar to Problem 2, start a continuous ping between PC-1 and PC-2 and shut down one of the active router interfaces. Observe how many packets are lost before a new routing pass starts working and include a screenshot in your report.
Use *Traceroute* before and after the change an include this in the report. Observe which path is chosen by RIPv2 in case of failure and explain it in your report why it chose this one.

Problem 4

Return to the basic router configuration. Now configure the dynamic routing protocol OSPF in all routers using the following commands:

```
enable
conf t
router ospf 1
network [ip] [wildcard_mask] area [area_num]
network [ip2] [wildcard_mask2] area [area_num]
network ...
end
```

a) Read about configuring OSPF routers to specify the correct number of networks with appropriate IP addresses, masks and areas for each router. Especially think about how to use areas and explain your choice. Also describe how OSPF uses metrics to select the best path and what metric different links in your network have.

b) Repeat all testing scenarios from Problem 3 and include explanations/screenshots in your report.

Problem 5

Write a concluding section in your report, where you explain the key differences between the three routing methods (static/RIPv2/OSPF) and give a few scenarios where each of these methods would be the most efficient to use. *Hint*: consider the configuration complexity, configuration time, efficiency and number of packets lost in case of failure.

Submission

In this assignment you **only submit a report**. For other information read the general submission instructions.