Network Technology and Programming Lab

Assignment 4: OSPF routing, VLANs

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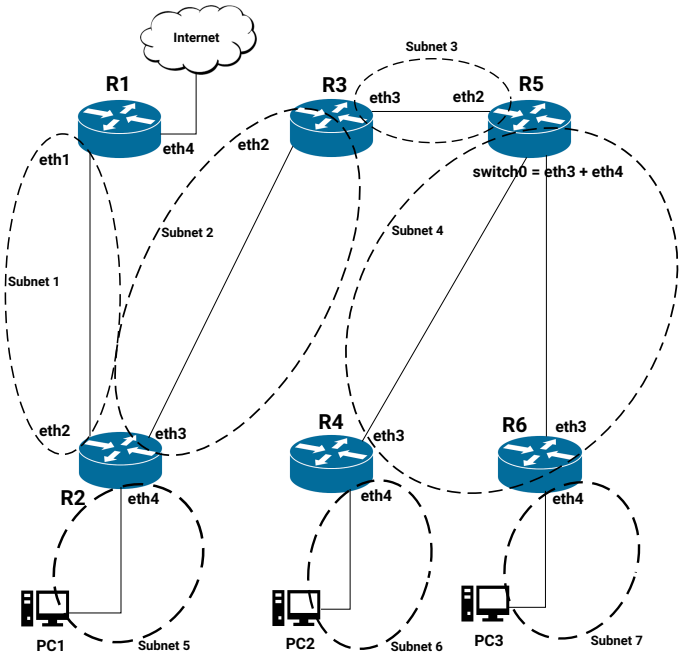

Figure 1: OSPF Subnet Topology

1. OSPF routing

Intro

The goal of this part of the assignment is to familiarize you with the OSPF routing protocol. The network topology should be able to automatically configure the routing tables and provide backup connectivity with minimum effort.

1.1 Before you start

Before you start take a good look at the slides about OSPF that have been presented during the lab session. Read carefully the OSPF manual of the Vyatta OS and make sure that you fully understand all the OSPF parameters available from the Web UI of the EdgeRouter.

In addition, have in mind that the EdgerouterX routers have a special configuration that two or more interfaces, can be switched together to form up a single interface with multiple ports. This may be useful in situations where two gateways are on the same subnet and no additional network equipment (e.g switch) is available.

1.2 Set up the network

This part of the assignment uses a topology similar to the topology used in assignment 2.

Figure 1 depicts the topology that you will setup in this assignment. Take a good look at it, and comprehend it. You will now build it step-by-step.

Configure **Subnet 1** by setting the interfaces of R1 and R2 accordingly. Do not add any additional routing table entry yet. The details of **Subnet 1** are the following:

Subnet 1: 10.0.0.0/24
R1:eth1 = 10.0.0.1
R2:eth2 = 10.0.0.2

Configure the rest of the subnets in a similar manner:

Subnet 2: 192.168.21.0/24
R3:eth2 = 192.168.21.1
R2:eth3 = 192.168.21.2

Subnet 3: 192.168.20.0/24
R3:eth3 = 192.168.20.1
R5:eth2 = 192.168.20.2

Subnet 4: 192.168.0.0/24
R5:switch0 = 192.168.0.3
R4:eth3 = 192.168.0.1
R6:eth3 = 192.168.0.2

Subnet 5: 147.52.20.148/28
R2:eth4 = 147.52.20.149
PC1 = 147.52.20.150

Subnet 6: 192.168.8.0/24
R4:eth4 = 192.168.8.1
PC2 = 192.168.8.2

Subnet 7: 192.168.9.0/24
R6:eth4 = 192.168.9.1
PC3 = 192.168.9.2

1.3 OSPF configuration

The network should be divided into 3 different OSPF areas, as Figure 2 depicts. In the backbone area belong the R2-R3-R4 routes, whereas in area 1.1.1.1 R1-R2 and in area 2.2.2.2 R4-R5-R6 respectively.

The default route announcement is enabled in R1. Use this option with caution in the rest of the routers.

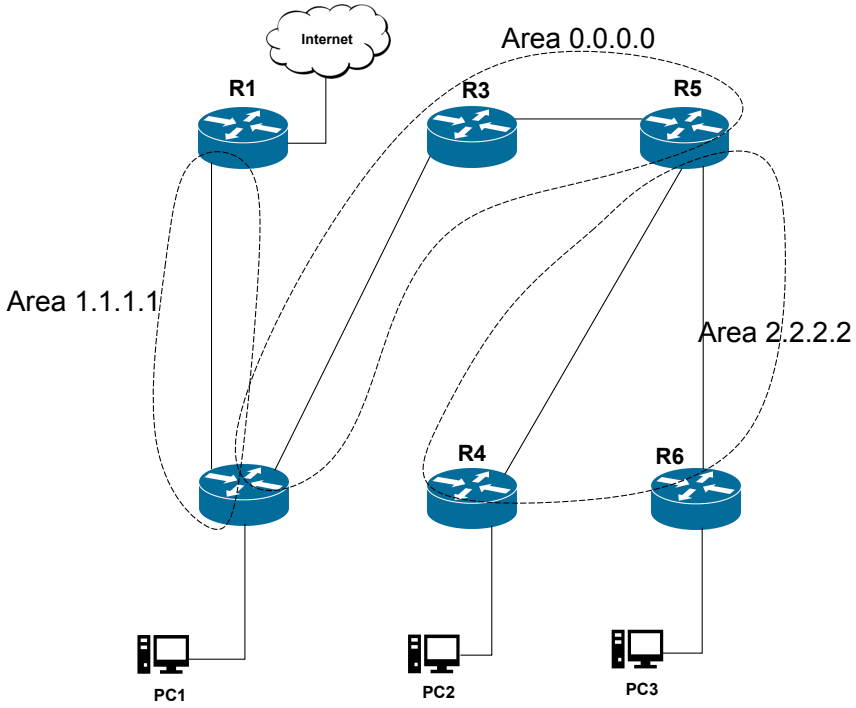

Figure 2: OSPF Topology

1.4 Configure the Routing Tables

Now that your network is in place, you will need to configure the routing tables of routers R2 to R6 so that connectivity between all 3 hosts (PC1, PC2, PC3) is accomplished. In addition, PC1 should be able to reach a host on the Internet, whereas PC2 and PC3 should be able to ping **eth4** of R1.

Note that in the R1 you have read-only access, but the routing tables are already configured. If you need additional routing tables on the R1, contact the TAs.

1.4.1 Roadmap

It is a good practice in an OSPF enabled topology to start from the routers of the backbone area. After establishing communication within the backbone area, move to the rest of the OSPF areas. Leave last any static routing configuration on R2, R4, R6 and the PCs. It is essential to establish communication between the routers first and then move to the PCs. Do not use the Web UI console. Connect through SSH to the corresponding router and get a proper terminal.

Do not forget to backup your configuration and restore the default (found at CSD Gitlab) prior to leaving the lab.

1.5 Backup Connectivity

Make all the necessary changes on the backbone, so the network can operate normally even if R3 router goes off. This requires a backup link from R2 to R5. However, as you may (or should) know, OSPF uses the shortest path to forward the packets towards the desired destination. The result will be the packets to be forwarded through this backup link (R2-R5) and not the primary one (R2-R3-R5). Use any necessary means, so the primary link remains the (R2-R3-R5).

Report and submission

- Report in text form all the routing tables of the hosts and the R2-R6
- Report the traceroutes for the following cases:
  - PC2 →PC3
  - PC3 →PC2
  - PC2 →PC1
  - PC3 →PC1
  - PC1 →147.52.17.85
  - PC2 →R1:eth4
  - PC3 →R1:eth4
- Break the primary path for R2-R3-R5. Report again the traceroutes of the affected links using the backup link that you configured.
- Submit the configurations of the routers together with the report.

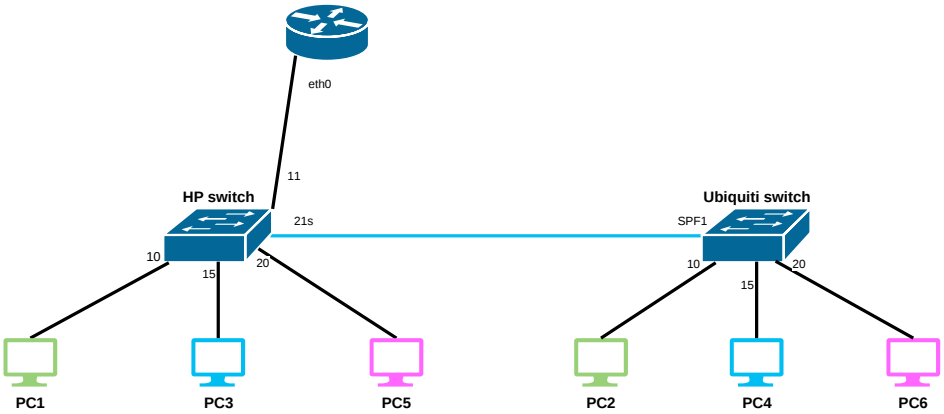

Figure 3: VLAN Topology

2. VLAN configuration

Intro

This part of the assignment will attempt to give you experience with VLANs and the protocols that run them.

This exercise will use the usual 24-port switch as well as the 24-port HP switch. You can find the HP switch in address 192.168.4.10 and you can connect to it using the usual passwords.

2.1 Before you start

First of all, reset the routers, switches and PCs to the default configuration. Also, disconnect all the devices you will not use from the switch and connect the two switches using the cyan fiber optic cable.

Figure 3 depicts the topology that you will setup in this assignment. Note that PCs with the same color belong to the same VLAN. Take a good look at it, and comprehend it. You will now build it step-by-step.

VLAN 10 will be the management VLAN. This way you can use a computer on the lab network to control the switches and router. At the same time, it simulates what you might do on a production network to prevent users from accessing the management interfaces of the network devices. The details of the VLANs are the following:

- **VLAN 10:** 192.168.4.0/24
  - PC1 = 192.168.4.171
  - PC2 = 192.168.4.172
  - HP Switch = 192.168.4.10
  - Ubiquiti Switch = 192.168.4.8
  - R2:eth0 = 192.168.4.2

- **VLAN 20:** 192.168.21.0/24

  - PC3 = 192.168.21.1
  - PC4 = 192.168.21.2
  - R2:eth0 = 192.168.21.3

- **VLAN 30:** 192.168.20.0/24
  - PC5 = 192.168.20.1
  - PC6 = 192.168.20.2
  - R2:eth0 = 192.168.20.3

Your job is to configure the switches and router so that only some communications are possible. To do that, you will configure the ports on the switches to belong to specific VLANs, or set them as trunk links.

At the end, only hosts on VLAN 10 should be able to access the management interfaces of the network devices. Also, hosts on VLAN 20 should be able to communicate with hosts on VLAN 30 and vice versa. Let's go:

1. Choose 6 PCs and statically assign them IP addresses in their respective subnet, according to the list above. Report the IP addresses you chose. Connect these devices on the switches but do **not** connect the router yet. Don't forget to setup routes between the VLAN subnets on every host.

2. Using PC1 or PC2 connect to each switch to create the 3 VLANs described. Configure ports 10, 15, 20 to belong to their respective VLAN.

3. Configure ports 21s (on the HP switch) and SFP 1 (on the Ubiquiti switch) as trunk ports. This will make the fiber optic cable a trunk link.

Now, you should be able to ping devices in the same VLAN, but not across them. Try it!

Let's now enable communication between VLAN 20 and VLAN 30. We are going to use a technique called router-on-a-stick.

1. Connect the router to port 11 of the HP switch.

2. Configure the router so that eth0 belongs to VLANs 10, 20, 30. This should make the router produce 802.1Q-tagged packets on this port.

3. Configure the router so that there are static routes for each VLAN subnet. Do you really need to do that (report)? If your answer is no, remove the static routes.

4. Configure port 11 (on the HP switch) as trunk port. This will make the link to the router a trunk link.

At this point you should be able to ping all devices from all devices. However, we need to make sure that VLAN 10 is not accessible from any other VLAN:

1. Add firewall rules on R2 that prevent access to VLAN 10 hosts from other VLANs while allowing communication between VLAN 20 and 30.

2. Verify that this works as expected by trying the following pings (some of them should not work):

   - PC1 →PC2
   - PC1 →R2:eth0
   - PC1 →HP switch
   - PC1 →Ubiquiti switch
   - PC3 →PC2
   - PC3 →R2:eth0
   - PC3 →PC4
   - PC3 →PC5
   - PC5 →PC6
   - PC5 →PC4
   - PC5 →R2:eth0

2.2 BONUS (10%)

Router-on-a-stick has various drawbacks. Research and write a short report on some of them. Try performing iperf measurements between PC3 and PC5. What do you notice? Please explain.

Report and submission

- Report screenshots of the above pings, or explanations on why they don't work.
- Submit the configurations of the routers and switches, and your report.

The submission deadline is 01/06/2026 23:59 via the course's elearn page
Have fun!

Oral Examination

All the students who have submitted their exercises are requested to attend the oral exam session, in order to present their solutions. A short quiz will also take place during that time. You will need to choose a timeslot for the oral exam using Rallly. More details will be sent to you via email.

Attention

- Each team will only be examined during the timeslot chosen.

- During this session both the Assignments 3, 4 will be examined.
- Both the timely submission and the oral exam session will contribute to the grading of the assignments.