Aalto University
School of Science
and Technology

S-38.2131/3133 Networking Technology, laboratory course A/B

31 – Multicast Routing

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Contents

Note:
This laboratory work includes 17 questions. The total number of points is 80.
Answer the following questions shortly but **clearly**. You **must** answer in English. Too long answers will decrease your points. It is also a good idea to examine the laboratory assignment beforehand. There is only **3 hours** work time on your lab turn.

1 Preliminary

It is a good idea to examine the laboratory assignment and the Juniper HowTo beforehand. It is also important to examine the Juniper Logical Systems Feature Guide. Please do these preliminary exercises carefully and return them on time.

1.1 Multicast Theory

P1 (5 points)
In a multicast network, destinations (clients) do not often communicate directly with the source (server). Routing devices between the source and destination must be able to determine the topology of the network from the unicast or multicast perspective. Give at least three functions of multicast routing devices. Also name at least three network applications that can function with unicast but are better suited for multicast.

P2 (3 points)
Write a short note (maximum of 3 lines) about the following.
(a) Anycast Rendezvous Point (RP) in multicast
(b) Multicast Source Discovery Protocol (MSDP)

P3 (3 points)
What is the meaning of TTL field in IP header in multicast routing? Why is TTL more important in multicast routing than in normal unicast routing?

P4 (4 points)
What is Protocol Independent Multicast-Sparse Mode (PIM-SM)? What is the difference between Any Source Multicast (ASM) and Source Specific Multicast (SSM) service models?

P5 (6 points)
Explain the following terms:
(a) PIM-DM
(b) Static RP in PIM-SM
(c) Multicast Reverse Path Forwarding (RPF)

P6 (5 points)
What are multicast routing protocols? Name three of these protocols. What is the use of Anycast RP within a domain?

P7 (3 points)
In IPv4 there is special multicast address space. Actually these are not just traditional addresses, but they are multicast group identifiers. What addresses have been reserved for multicast routing? Explain also the address format of IPv6 multicast.

P8 (6 points)
Draw and explain how PIM-DM forms multicast routes in the network shown in figure 1. The members of the group are marked with G, the sender/Source with S.

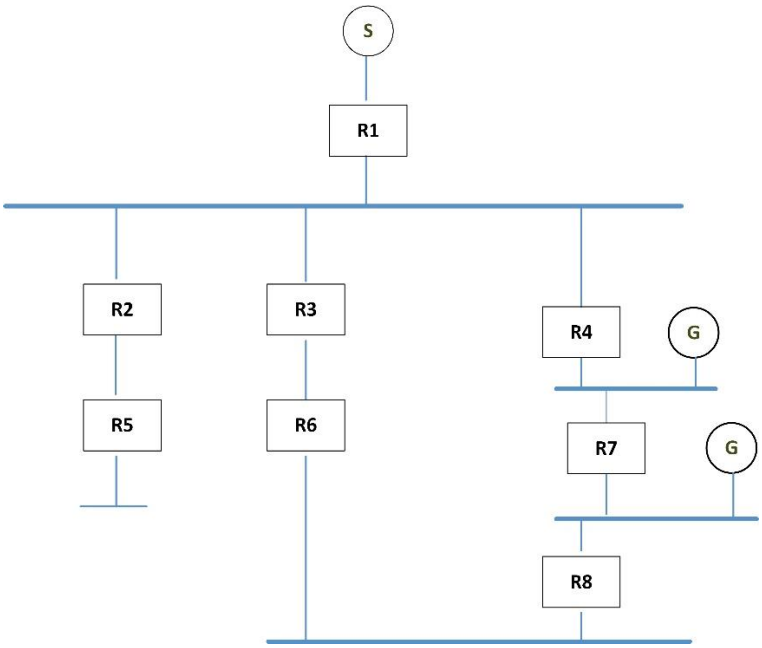

Figure 1: Network topology for question 8.

2 Laboratory exercises

2.1 Introduction

This laboratory exercise involves ten Juniper logical systems (logical routers) of which some of them are preconfigured. The ten logical routers are named after some main cities in Finland.

In this laboratory work, you will learn how to configure Multicast routing in a network with Protocol Independent Multicast (PIM). You are required to configure the interfaces of only **three** of these routers (**Vaasa, Turku** and **Helsink**i) according to Appendix A. In the end you will configure Anycast RP with Multicast Source Discovery Protocol (MSDP) in the network. Other routers in the network have been preconfigured for this laboratory exercise.

In the network, the multicast source (MCAST_SENDER) is connected to router **Helsinki** while the receiver (MCAST_RECEIVER) connected to **Vaasa**. You will use Sparse Mode properties of PIM where you will first configure static RP and then later configure Anycast RP with MSDP multicast feature between RP1 and RP2. After the configurations, you will test the multicast properties between the source and receiver machines.

In your report you have to answer questions, which are located in the different sections of this documents labeled as "Q" and "F". Some of these questions can be answered later after the exercise. Please follow the lab instructions to make sure you are configuring the right device. Please familiarize yourself with Juniper logical systems configuration before the laboratory section. There many information about Juniper logical systems configuration in the “Juniper Logical Systems Feature Guide”. Also you can find more information about Anycast RP with MSDP configuration on the internet.

The final report plays a big part in grading, so please put effort into the report. Please mention also all **references** used in the report.

2.2 Work Environment

On a Juniper router (Mx80), you can build logical systems (routers) on physical router and connect them using logical tunnel (lt) interfaces or by physical connections. The configuration commands for configuring any feature or protocols are the same as if you configure it on a physical router. You can familiarize yourself with the syntax of the configuration commands in the Juniper Logical Systems Feature Guide.

As stated earlier, the test network consists of ten Juniper logical routers and two virtual client machines (Windows XP). You are required to configure only the interfaces of only **three** routers located in **Vaasa, Turku** and **Helsinki**. Please configure only the interfaces given according to Appendix B and do not **delete** or **disable** any interface on any other logical routers.

Please note that in some cases you have to configure both Ethernet gigabit and logical interfaces on the same router.

In order to become more familiar with logical systems, all routers are configured such that they cannot be accessed through **ssh** like in the previous lab. Only the master router has been preconfigured for management. You can **ssh** to the management interface using the IP address **10.255.4.195** and "**root**" as the username. Ask lab assistant for password. After that you can access the three logical routers and other logical router if required.

In order to test multicast delivery, we have Multicast Tester tool and Video LAN (VLC) player in both machines. VLC player is widely used for multicast related video transmission.

2.3 Capturing packets

When you want to capture packets with Wireshark (interface: eth1), go to http://switchcontrol.noc.lab/port_mirroring.php. There you can choose the source ports to be mirrored to the capturing device. Establish an SSH connection with X11 forwarding to the capturing device using the command ssh -X capture@capture.noc.lab and call the assistant to show you how to use Wireshark. The password is **capture**.

2.4 Exercises in the laboratory

Questions marked with letter F should be answered in the final report. You also need to take some notes during the lab work.

2.4.1 Lab equipment information

Before configuring the routers, assistant will give a short introduction about the lab work and also will show you the locations of the routers and client machines.

2.4.2 Configure the IP addresses

Q1 (2 point)

Connect to the routers and set IP addresses according to Appendix B for each interface. Also add description to the interfaces. Test that every link works before you continue. It is really important that the basic things are working before starting to configure routing.

2.4.3 Configure OSPF

Q2 (2 points)

Configure OSPF on the three routers such that **only** the interfaces configured participates in OSPF. Also ensure that their loopback interfaces do not run OSPF but advertise it. Use your IPv4 lab work experience. You need to do only the basic OSPF configuration. Check if there is connectivity between client machines. Do not worry about metric manipulation.

F1: Explain your OSPF configuration. Please add all configuration lines in your final report.

2.4.4 Configure IGMP

Q3 (1 points)

Configure IGMP to the required routers interfaces according to the Juniper router configuration manual.

F2: Explain your IGMP configuration. Please add all configuration lines in your final report.

2.4.5 Configure PIM-SM

Q4 (5 points)

Configure PIM-SM to the required interfaces of the three routers according to the Juniper router configuration manual and the logical systems feature guide. Also set interfaces to use version 2 of PIM. First, you need to configure all the **ten** routers as they all use router Turku as static RP (RP_1). Start packet capturing on interface **ge-1/1/7** of router **Vaasa** according to the assistant's instructions. Now test that multicast is working by executing from chapter 2.4.7 to chapter 2.4.9. If VLC streaming works, keep streaming and disable the interface **ge-1/2/10** and **lt-1/1/10.60** on router **Turku** and wait for some time to determine if streaming stop. Stop VLC and restart VLC streaming on both machines again.

F3: Explain your PIM-SM configuration with Static RP Mechanism. After disabling the interfaces, are you able to continue streaming? Give reason. With the interfaces disabled and restarting VLC, are you able to start streaming? Give reason. What is the role of RP_1 in this case? Please add all configuration lines in your final report.

2.4.6 Configure Anycast RP with MSDP

Q5 (8 points)

Now we have to make some changes to our configuration in order to configure router **Turku** (RP1) and **Ivalo** (RP2) as Anycast RPs. First delete all static RP configuration done in section 2.4.5 from all routers in the network. Please ask supervisor for more information.

Start packet capture on router **Ivalo** interface **ge-1/3/7** and choose any IP address (example 10.1.1.2) as shared address. Configure Anycast RP with MSDP between the two routers.

Now test that multicast is working by executing from chapter 2.4.7 to chapter 2.4.9. Disable both interfaces (ge-1/2/10 and lt-1/1/10.60) on router Turku again while streaming with VLC. Verify by executing chapter 2.4.9 on routers Turku and Ivalo. Restart VLC once again on both machines to check if it possible to stream without RP_1.

F4: Explain your MSDP configuration. Which RP was first active? During VLC streaming, was there a brake after disabling the interfaces on router Turku? Are you able to stream after VLC restart? On which interfaces are multicast packets being received on router Vaasa. Please add all configuration lines in your final report.

2.4.7 Multicast Tester tool

Q6 (2 point)

First we will use the Multicast Tester tool to test our network. Start “MCastTest” tool on both machines and test multicast traffic between them.

F5: Write the configuration of MCastTest. Print screen on both machines is enough.

2.4.8 Video streaming with VLC player

Q7 (5 points)

We shall use VLC player for this purpose. Start streaming on the source machine and check from receiver machine.

F6: Write the configuration of VLC player.

2.4.9 Monitoring Multicast Routing State Information

Q8 (10 points)

Run the following commands in routers **Vaasa**, **Turku**, **Helsinki, Ivalo** and **Tampere** and check the results.

(a) show pim join
(b) show pim neighbors
(c) show pim rps
(d) show multicast route extensive
(e) mtrace “source address” (run this from router Vaasa only)
(f) show msdp detail (run on MSDP peers after section 2.4.6)

F7: Attach results in your final report. Also explain the result.

2.4.10 Analyzing Anycast RP with MSDP

Q9 (10 points)

From your results in section 2.4.6, describe with figure the step by step situation between routers **Helsinki**, **Turku**, **Vaasa, Tampere** and **Ivalo** how multicast route had formed after Anycast RP with MSDP configuration. For example which RP was first active after the configuration and at which stages and what kind of messages were sent between the routers. Also what message was sent between the MSDP peers before final multicast route was created between the MCAST_SENDER and MCAST_RECEIVER? You can use the simple topology in Appendix C for the description if needed. Ask instructor for more information.

2.4.11 Restoring the initial settings

Remember to take all the files required for the final report with you. After this you should delete all the files you have made in the client machines. Assistant will reset the **routers**.

Points and Grade

The grade should be given according to the next table:

Preliminary report: 5+3+3+4+6+5+3+6 = 35 pts.
Laboratory work performance: 20 pts.
Final report: 1+2+2+5+8+2+5+10+10 = 45 pts.
Total: 100 pts.

Grades

Points	Grade
0…45	0
46…55	1
56…65	2
66…75	3
76…85	4
86…100	5

However, the grade must be zero (0) if any of the following conditions is true:

- Less than 50% of preliminary exercises are right.
- The student has failed to pass tasks in the laboratory.

Appendix A – The Network Topology

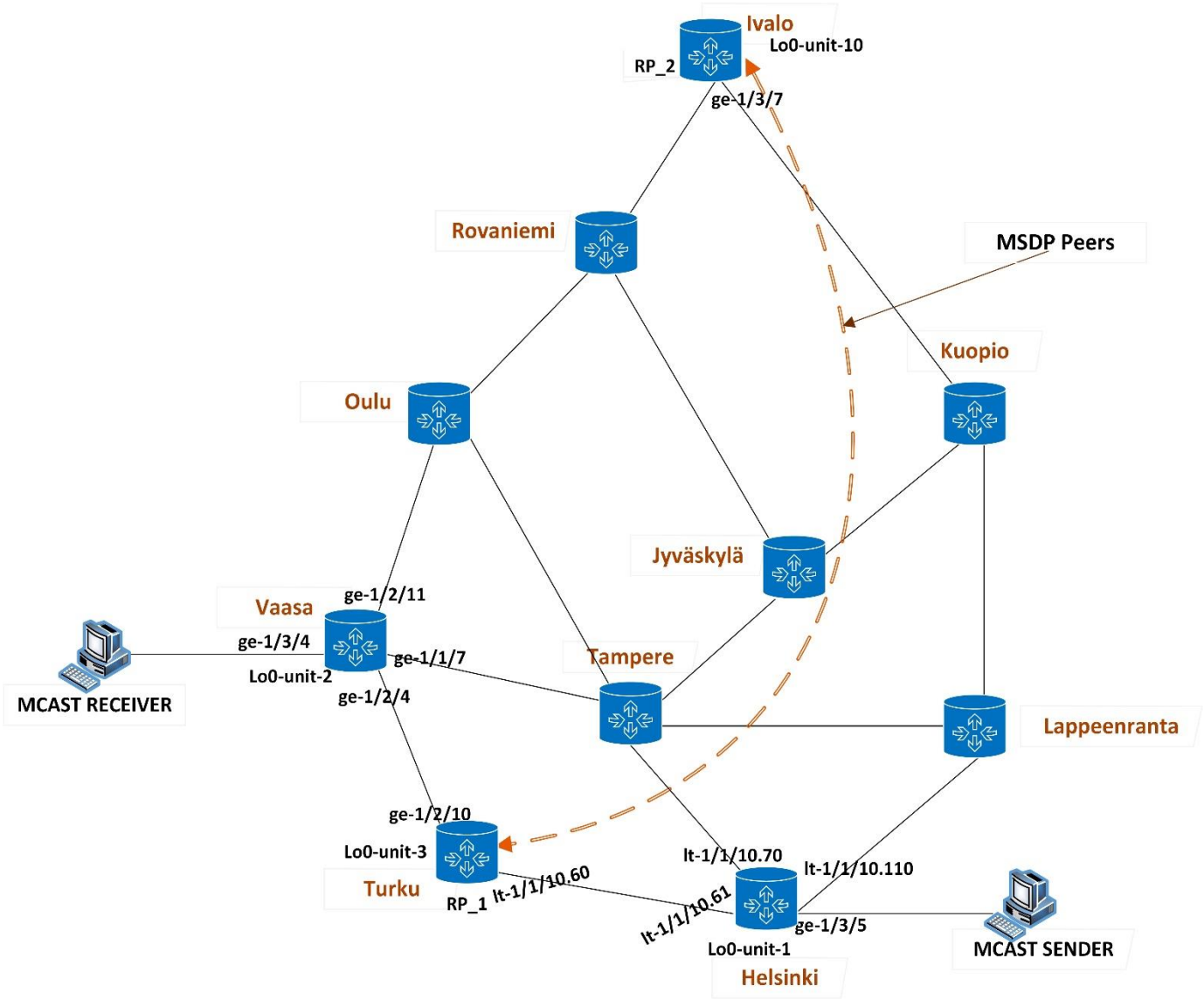

Figure 2: Network topology

Appendix B – The IP Address Table

Logical Routers	Interfaces	IP addresses	Peer Unite
Helsinki	lt-1/1/10.70	10.38.171.46/30	71
	lt-1/1/10.61	10.38.171.42/30	60
	lt-1/1/10.110	10.38.171.53/30	111
	ge-1/3/5	10.38.171.69/30	
	lo0.1	10.38.171.89/32	
Turku	ge-1/2/10.0	10.38.171.14/30	
	lt-1/1/10.60	10.38.171.41/30	61
	lo0.3	10.38.171.85/32	
Vaasa	ge-1/2/4.0	10.38.171.13/30	
	ge-1/2/11.0	10.38.171.10/30	
	ge-1/1/7.0	10.38.171.77/30	
	ge-1/3/4.0	10.38.171.65/30	
	lo0.2	10.38.171.81/32	
MCAST SENDER		10.38.171.70/30	
MCAST RECEIVER		10.38.171.66/30	

Appendix C – Simple Anycast RP with MSDP Topology

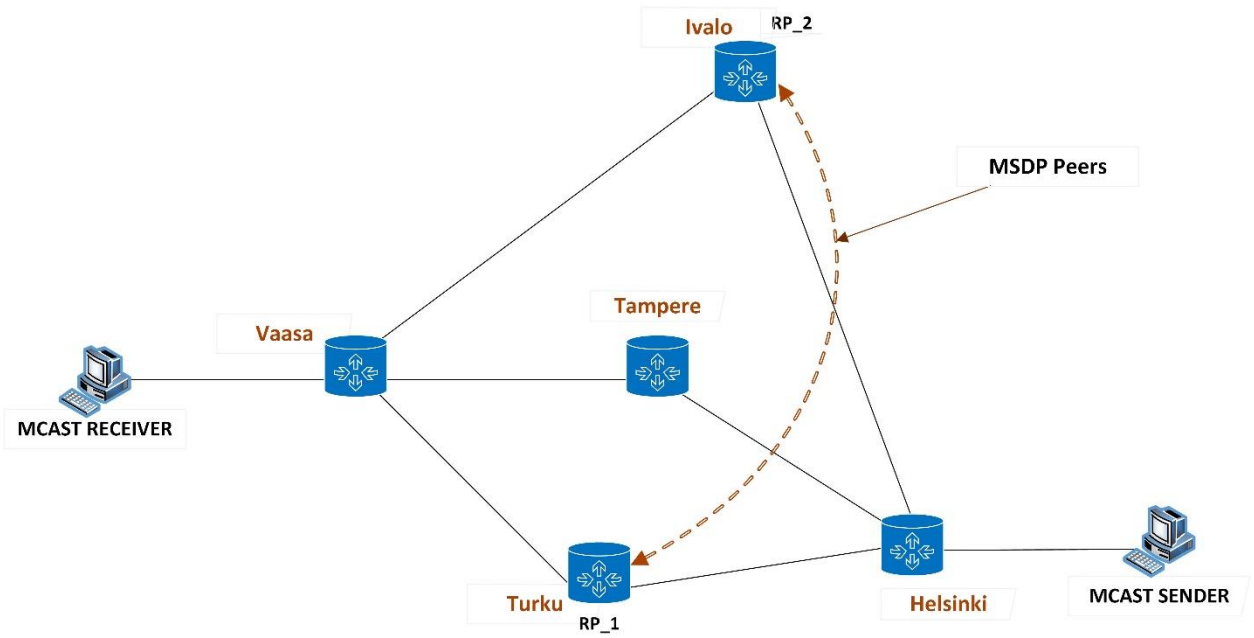

Figure 3: Anycast RP with MSDP.