HELSINKI UNIVERSITY OF TECHNOLOGY
Networking laboratory
S-38.2132/S-38.3133 Networking technology, laboratory course A/B

Fall 2006 - Spring 2007
Work number 27: IPv4 Routing
Instructions, preliminary exercises, questions for final report

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1 Preliminary Report

*Answer the following questions shortly but **clearly**. You can answer in Finnish or in English. Native Finnish speakers should answer in Finnish. You should also examine the laboratory assignment beforehand. There is only 5 hours work time on your lab turn*

There are only two preliminary exercises to be returned in this work. Return your answers to the Labwork Reservation System at least three days before your lab time. In question 2 return your allocation in a table format. Take a copy of your preliminary report and take it with you to the lab.

1. Consider a network presented in the figure 1. OSPF version 2 is used. There is a little trick that has to be done to get the full connectivity into the network, when the areas are defined as presented. Find out, what is the trick that has to be done, so that the networks connected to the rightmost router can be reached from the leftmost router. Hint: See RFC 2178.

10.38.161.2/30 Area 0   10.38.161.6/30 Area 1   10.38.161.10/30 Area 2

10.38.161.1/30 Area 0   10.38.161.5/30 Area 1   10.38.161.9/30 Area 2
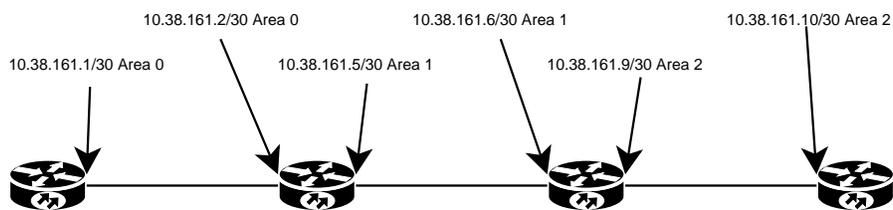
Figure 1: OSPF network.

2. Make IP address allocation for network used in this laboratory work. The test network topology is located at appendix A. In the topology chart S stands for Serial and F for Fast Ethernet. In the appendix B there is screenshot from IP address checking system.

2 Laboratory Assignment

2.1 Work Description

This work relates to IP routing. You will get familiar with IP addressing and configuring IP routers. Both RIP and OSPF protocols are used. In addition Wireshark is used to capture and make packet analysis. However, this work is a very basic lesson about how to configure IP networks. All routers in the network are made by Cisco. Three of the routers have both Fast Ethernet interfaces and Serial V.35 interfaces and others have only two Fast Ethernet interfaces.

- You just have to allocate IP addresses and configure the network as follows:

    1. The entire network uses RIP
    2. The entire network uses OSPF
    3. RIP is used at the other side of the network and OSPF at another

2.2 Environment

The work environment consists of six Cisco routers and two client PCs, which are used to test the network. In addition there is a gateway, which is pre-configured. Routers are named according to Finnish cities: Helsinki, Lahti, Oulu, Tampere, Turku and Vaasa. Domain name for this labwork is ipv4.lab. Two LAN's are connected to routers, one in Helsinki and other in Oulu. Topology can be seen in the appendix A. Default gateway is connected to Turku's Fast Ethernet 0/0 interface and its address is set to 10.38.161.1/30. All interfaces of routers apart from serial interfaces and PCs are connected to a managed switch. Topology is configured using Virtual LANs. Your assistant configures the topology for you. So, you don't need to worry about it!

The routers' console ports are connected to a terminal server. Terminal server forwards the SSH connection to certain IP address to a router's console port. In the beginning you are not able to connect routers except through terminal server.

You need to configure IP addresses for every interface in every router. You must also assign a loopback address for every router. The address space is only 10.38.161.0-10.38.161.65. In Helsinki there are 13 computers connected to the LAN and in Oulu 4 computers. So, you really have to think carefully how to set the IP addresses for interfaces. Client PCs use dhcp for obtaining their IP addresses so you have to configure Helsinki and Oulu routers act as dhcp servers.

Configure routers by taking an SSH connection through terminal server. Every router's console port has a domain name. Names are listed in Table 1.

2.2.1 IP Addresses

IP addresses must be bound to interfaces. Depending on router, you have to configure 3-5 interfaces. The interfaces are named FastEthernet0/0, FastEthernet0/1,

router	DNS name
helsinki	helsinki.ts.lab
turku	turku.ts.lab
lahti	lahti.ts.lab
tampere	tampere.ts.lab
vaasa	vaasa.ts.lab
oulu	oulu.ts.lab

Table 1: DNS names

Serial0/0, Serial0/1 and Loopback 0. In Turku and Oulu one interface is connected to two VLANs. Subinterfaces are named FastEthernet0/0.1 and 0/0.2. Some of the routers don't use all available interfaces. For serial interfaces you should set the clockrate and encapsulation method and also an ip address. In this work we use ppp as the encapsulation method and a link speed of 2Mbit/s. These parameters can be set by assigning commands clockrate 2000000 and encapsulation ppp. The clockrate command is only given to one interface per link because we don't get sync pulses from a telephone network as in normal situation. Serial cables are connected so that the clockrate command has to be given for both serial interfaces in Tampere and for S0/1 in Lahti. It is recommended that you save the running configuration when you have configured router by giving the copy running-config startup-config command in privileged EXEC mode (Prompt: Router#). You don't have to reboot routers, IP addresses are in use immediately. If you have to reboot router, startup-config will be used. Use reload command if you need to reboot the router.

To modify RIP or OSPF routing, give the next command in global configuration mode (Prompt: Router(config)#):

```
router rip
router ospf <id-number>
```

where id-number is a process ID number. The number is between 1 and 65535. When you have left the router configuration mode (Prompt: Router(config-router)#), routing process will start automatically. You can check routing tables in privileged EXEC mode by giving the command

```
show ip route
```

Configurations are immediately in use when you are back in privileged EXEC mode (Prompt: Router#). There is no tutorial about routing protocols RIP and OSPF included in this document. Almost any book concerning basic IP routing is enough to cope with this exercise. RFC 2178 presents OSPF version 2 in detail and RFC 2453 is about RIP version 2. As mentioned, the purpose of this work is not to teach the protocol details. You must still have the basic knowledge of these

protocols. For example S-38.2121 Routing in Communications Networks (or S-38.122 Telecommunications Switching Technology 2 earlier) gives the theory for this work.

The commands in Cisco IOS are divided into two main categories. Firstly, there are router commands and secondly, there are interface commands. To configure RIP, it is not necessary to use interface commands at all. But in the case of OSPF you have to set link costs for some interfaces.

```
router rip
    version 2
    network
    redistribution rules
    default-information originate

router ospf <id>
    network
    redistribution rules
```

In Cisco's OSPF the command structure is the same as shown above. Look at the Cisco manual on how to use different OSPF commands. In that case, there might be several network commands, because each subnet running OSPF must be defined separately. OSPF area is also defined in the network command. In this case, there are three different areas: 0 (backbone), 1 and 2. When you are configuring the network, remember the first preliminary exercise! In Cisco default route should be set with ip route command.

When some data is wanted to be captured from some link with the Wireshark, go to http://switchcontrol.noc.lab/port_mirroring.php. There you can choose from different source ports which are mirrored to the capturing device. Take a SSH connection with X forwarding to the capturing device by assigning the command 'ssh -X capture@capture.noc.lab' and call the assistant to show you how to use the Wireshark.

You are not allowed to do any changes to topology by changing, removing, connecting cables or doing any similar. If this happens, your IPv4 labwork is failed this time.

It is also very recommended, that you go through RIP and OSPF and get familiar with the Cisco manual in advance. Otherwise this laboratory exercise is impossible to do in five hours. First in the lab you have to validate your IP addresses with IPv4 Checker, which creates dns zone ipv4.lab and reverse zone for 10.38.161.0/24.

2.3 Exercises in laboratory

2.3.1 IPv4 Checker

Go to http://admin.noc.lab/ipv4checker/. Fill in the www form shown in Appendix B. This validates your IP addresses. If they are right, dns zones are created. Why do we need nameserver in this labwork? For example traceroute makes reverse DNS queries for all IP addresses in route. So it's remarkable easier to check where route goes when you see name of interface instead of IP addresses.

2.3.2 Setting the IP Addresses and DHCP servers

Set the IP addresses according to your plan for each interface. Test them by pinging. You also have to configure a DHCP server to Helsinki and Oulu.

2.3.3 RIP is used in the network

Configure the whole network according to the instructions of Cisco manual. When routing works, test the network by pinging from LAN1 to LAN2. The running-config from Turku and Lahti have to be included in your final report. You can use for example webmail or floppy disk to transfer these files. An easy way to transport data from the routers is to take a HTTP connection to the router's loopback interface. There you can give normal CLI commands for example: show running-config.

Now, call the assistant to show you how to use the Wireshark. Start message capturing according to the assistant's instructions. Capture data from Oulu's F0/1 and Tampere F0/1. Start pinging from LAN1 to LAN2. Remember add -t switch to ping command. Disable Lahti F0/0 Interface from http://switchcontrol.noc.lab/port_control.php. How long does it take until the packets go via Vaasa? Next enable the disabled link again. How much time did it take when the route went back to the previous route? Captured data can be also used to get time between the route changes or you can use traditional clock method.

2.3.4 OSPF is used in the network

Configure the whole network according to the instructions of Cisco manual. After you have configured OSPF to every router, test that you are able to ping from LAN1 to LAN2. OSPF enables metric manipulation much easier than RIP. Configure the network in a such way as Appendix A shows. The small numbers besides the links are their costs. Default cost for FastEthernet links are 1 so you only have to change costs for Serial links. Remember that virtual-link carries traffic over transit area. Ask assistant if you don't know where to place the virtual-links.

The areas listed below:

- Area 0:

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- Turku-Helsinki
- Turku-Tampere
- Helsinki-Tampere

- Area 1:

  - Helsinki-Lahti
  - Lahti-Tampere
  - Tampere-Vaasa

- Area 2:

  - Vaasa-Oulu
  - Lahti-Oulu

Check by "traceroute" that the shortest path from LAN1 to LAN2 is Helsinki-Turku-Tampere-Vaasa-Oulu. The running-config from Turku and Lahti have to be included in your final report. Now, capture traffic again from Oulu F0/1 and Tampere F0/1 interfaces. Ping from LAN1 to LAN2. At first, disable interface Vaasa F0/1 (now the traffic should go through Helsinki-Lahti-Oulu). How long does it take until packets go through again? Enable Vaasa F0/1 interface and wait until the packets go via Vaasa again. How much time did it take when the route went back to the previous route? Now disable both Vaasa's interfaces. How long does it now take that traffic goes via Helsinki-Lahti-Oulu? Again captured data can be used to get time between the route changes or you can use traditional clock method.

2.3.5 Both RIP and OSPF are used in the network

This exercise should be quite easy, if you have coped with last two exercises. Configure the network in such way, that routers Turku and Helsinki only use OSPF and routers Vaasa and Oulu only use RIP. And Lahti and Tampere use both RIP and OSPF. The running-config from Lahti has to be included in your final report. In OSPF areas can be either 0 or 1. You don't need to change them from the last section. When you redistribute routing information from OSPF to RIP, put 1 to the default-metric value. Don't change link costs of OSPF compared to the section 2.3.4. Ping again from LAN1 to LAN2 and make the capturing again from Oulu F0/1 and Tampere F0/1 interfaces. Disable interface F0/1 from Lahti. How long did it take that the traffic went via Vaasa? Enable interface again. How much time did it take when the route went back to the previous route?

2.3.6 Restoring the initial setting

Copy clean.conf from flash to startup-config and reboot router. This can be done with following commands:

```
copy flash:ipv4.conf startup-config
reload
```

3 Final Report

1. Present your final version of IP address allocation. Explain how you ended up with it.

2. Explain the main differences between RIP and OSPF.

3. In what kind of situations routing loops are possible when RIP is used. Are there any situations in which OSPF can create routing loops?

4. Study the messages you captured in the lab and present an analysis about them. Don't put whole captures to the report but explain what kind of messages RIP and OSPF sends. Also explain how routing protocols behaved when link got broken.

5. Remember to add your running-config from the three different scenarios.

A   Appendix
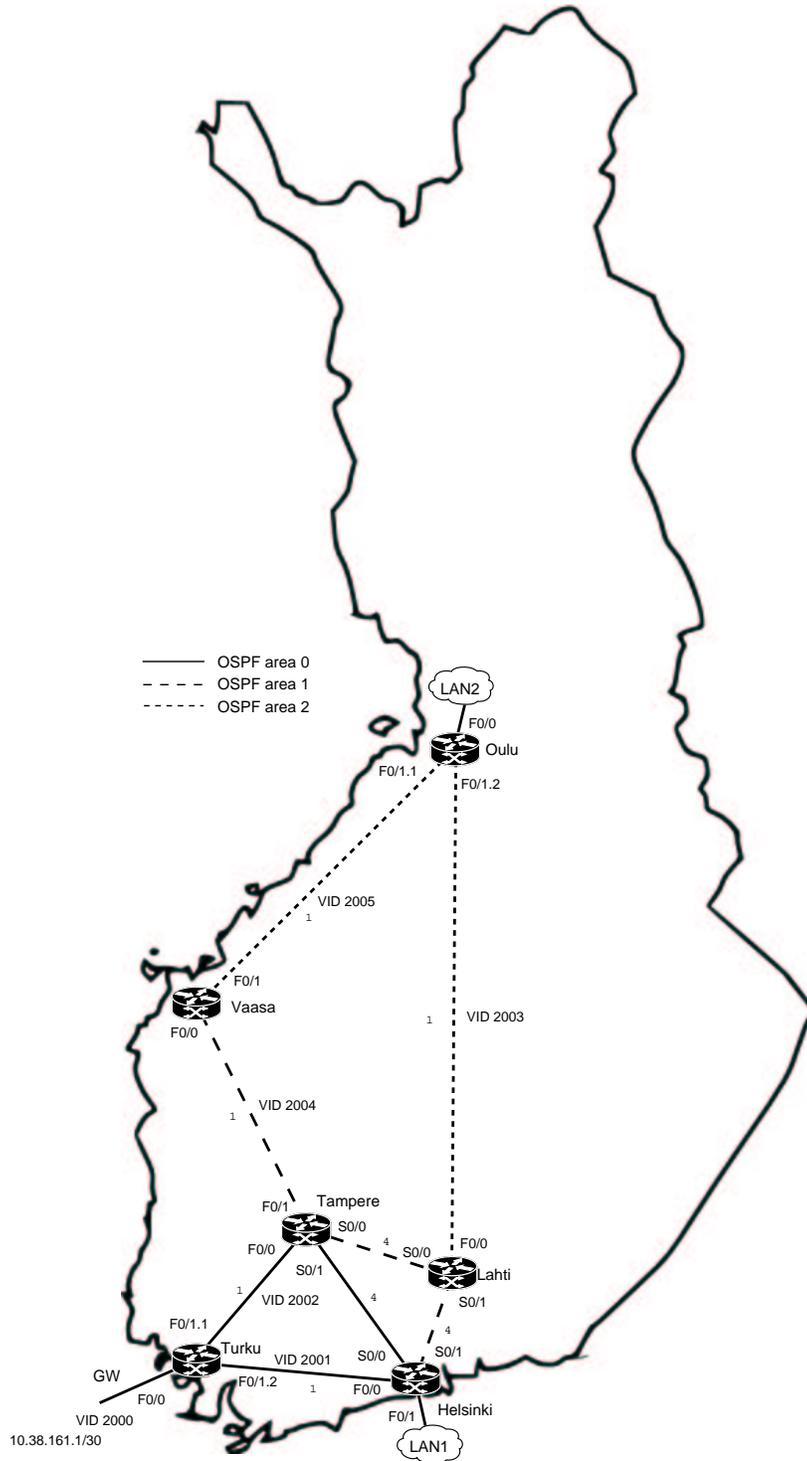
B   Appendix

IPv4 Checker v2.0

Helsinki

F0/0:	Address: 10.38.____	Netmask: 255.255.____
F0/1:	Address: 10.38.____	Netmask: 255.255.____
S0/0:	Address: 10.38.____	Netmask: 255.255.____
S0/1:	Address: 10.38.____	Netmask: 255.255.____
Loopback:	Address: 10.38.____	Netmask: 255.255.____

Turku

F0/0:	Address: 10.38.____	Netmask: 255.255.____
F0/1.1:	Address: 10.38.____	Netmask: 255.255.____
F0/1.2:	Address: 10.38.____	Netmask: 255.255.____
Loopback:	Address: 10.38.____	Netmask: 255.255.____

Tampere

F0/0:	Address: 10.38.____	Netmask: 255.255.____
F0/1:	Address: 10.38.____	Netmask: 255.255.____
S0/0:	Address: 10.38.____	Netmask: 255.255.____
S0/1:	Address: 10.38.____	Netmask: 255.255.____
Loopback:	Address: 10.38.____	Netmask: 255.255.____

Lahti

F0/0:	Address: 10.38.____	Netmask: 255.255.____
S0/0:	Address: 10.38.____	Netmask: 255.255.____
S0/1:	Address: 10.38.____	Netmask: 255.255.____
Loopback:	Address: 10.38.____	Netmask: 255.255.____

Vaasa

F0/0:	Address: 10.38.____	Netmask: 255.255.____
F0/1:	Address: 10.38.____	Netmask: 255.255.____
Loopback:	Address: 10.38.____	Netmask: 255.255.____