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Routerlab SoSe 2018
Worksheet 7: Intra-Domain Routing (RIP)

The purpose of this worksheet is to introduce Intra-Domain Routing. In particular the Routing Information Protocol (RIP) is used as an example. The goal is to understand the difference of distance vector routing protocols vs. link-state routing protocols and their respective advantages and disadvantages.

Configurations must be grouped per-question and provided in your response.
The basic network topology for this worksheet is the same you developed in the previous worksheets in terms of VLANs. These form the basic connectivity between network elements and should be replicated as seen in the diagram:

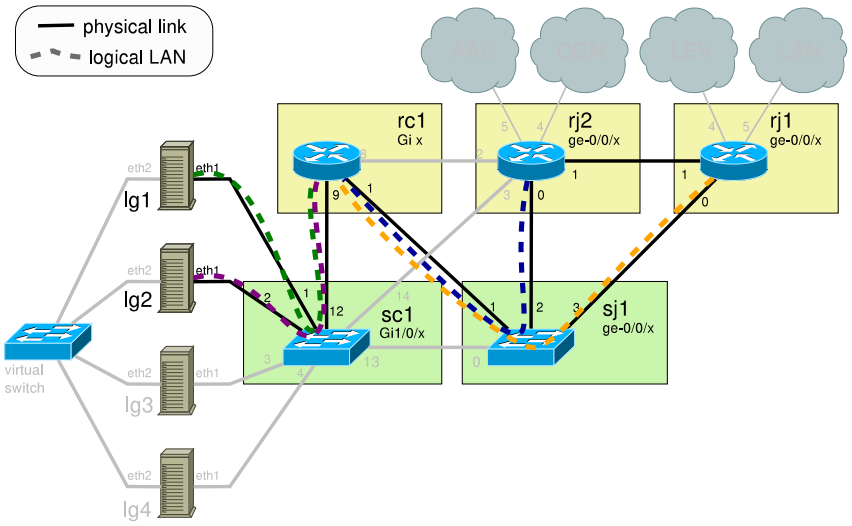

Figure 1: Topology: Mapping of VLANs to physical links.

Table 1: Device and Address Overview

Cloud	Aachen	Köln	Leverkusen
Router	aac-rc1, aac-rj1, aac-rj2	cgn-rc1, cgn-rj1, cgn-rj2	lev-rc1, lev-rj1, lev-rj2
Switches	aac-sc1, aac-sj1	cgn-sc1, cgn-sj1	lev-sc1, lev-sj1
IPv4 range		10.Z.0.0/16	
Loadgens		groupX-lg1,2	

Note: Replace X with the number of your group with leading zero, e.g. $X = 03$ for group 3. Replace Y with the number of your group without leading zero and use hex encoding, eg $Y = 3$ for group 3 and $Y = a$ for group 10. Finally replace Z with the decimal group number without leading zero, e.g. $Z = 3$ for group 3.

Question 1: (10 (2+2+3+3) Points) *Dynamic Routing*

In some previous worksheets, we configured static routes. RIP, as discussed in this worksheet, is a dynamic routing protocol.

a) Describe briefly (2 - 3 sentences) the difference between static routing and dynamic routing.

b) Dynamic routing introduces several advantages compared to static routing. Describe briefly (2 - 3 sentences) at least two of them.

c) When a dynamic routing protocol is started, how does the first routing message get forwarded through the network if no routes already exist anywhere in the network?

d) For your favourite routing protocol, give two examples of dynamic routing protocol exchanges and describe the network event that triggers each. For example: BGP route withdrawal due to link failure.

Question 2: (30 (2+2+2+2+2+2+2+2+4+4+2+2+2+2) Points) *Routing Information Protocol (RIP)*

RIP belongs to the class of distance-vector routing protocols. For more information on RIP, please have a look at RFC 2453.

a) Which entities exchange routing information (updates)?

b) How far (in terms of IP hops) does a RIP update message travel?

c) What routing information does each entity generally keep in its routing database?

d) Does a RIP routing update contain all routes or only a partial set of routes?

e) When are update messages sent?

f) How do routing entities detect that a neighbour is not reachable any more?

g) What 2 reasons are there for removing a route learned via RIP from the routing table?

h) Briefly describe what the "Count-to-Infinity" problem of distance-vector protocols is. (4 - 6 sentences)

i) Briefly describe at least two mechanisms that RIP uses to solve the "Count-to-Infinity" issue. (4 - 6 sentences)

j) "Triggered Updates" are a further enhancement to RIP. Discuss in 1 - 2 sentences the advantages that triggered updates offer.

k) Do triggered updates solve the count to infinity problem? If yes describe how this mechanism works, if no, explain what situation might happen to still cause 'count to infinity'.

l) "Count-to-Infinity" is one disadvantage of distance vector protocols. Can you think of another one? (1 - 2 sentences)

m) What is a possible advantage of distance vector protocols? (1 - 2 sentences)

Question 3: (20 (5+10+5) Points) *RIP: Calculating the Routing Table*

RIP uses the information in the updates to calculate the routing table using the Bellman-Ford algorithm. If you are not familiar with this algorithm: there is plenty of information on the web (even with cool animations).

Figure 2 shows a simple topology where each router is identified by one IP address (for simplicity we don't consider interfaces) and the cost of each link is written in the middle of the arc connecting the routers. Compute the routing table for `10.1.1.1` using Bellman-Ford.

a) For this purpose, show just the final routing table state with the same notation used in the tutorial (text format).

b) Assuming that the link between the router `10.1.1.2` and `10.1.1.4` breaks (infinity = 16), show what is the evolution of the entry concerning router `10.1.1.6` for both routing tables of `10.1.1.1` and `10.1.1.2`. Use the same notation as in the tutorial (text format).

c) In the final state of the previous point is `10.1.1.6` reachable from `10.1.1.1`?

- If yes, through which path?
- If not, can you explain why?

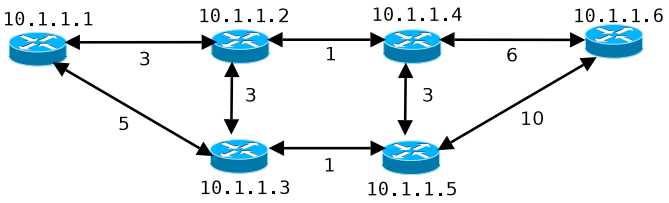

Figure 2: Simple network example.

Question 4: (40 (3+3+4+5+5+10+10) Points) *(RIP) Configuration*

In this question, you will use RIP to distribute IPv4 Routes across the topology in Figure 1.

- First, you will need to assign ip addresses and configure appropriate *VLANs* so that each host or router can ping its neighbour within its own IP subnet. **Note:** there is also a link between aac-rj1 (cgn-rj1 / lev-rj1) and aac-rj2 (cgn-rj2 / lev-rj2) - configure it without using VLANs. **Remark:** If for whatever reason aac-rc1 (cgn-rc1 / lev-rc1) does not show vlans, make sure to change the vtp to transparent: `vtp mode transparent`.
- You will then use the RIP protocol to distribute routes so that hosts and routers can communicate across subnets. For this purpose, RIP needs to be enabled on all interfaces of the routers of the configured subnets. The manuals explain how to configure RIP for Cisco and Juniper. **Note:** you need to add static routes on groupX-lg1 (into the other networks) like you did in the previous worksheets.
- You will configure groupX-lg2 to run its own RIP routing daemon, to advertise the IP prefix `10.Z.99.0/24`. In order to have groupX-lg2 to advertise this prefix, you need install and configure the Quagga routing daemon on the loadgen. You will also need to configure a dummy interface on groupX-lg2.

Quagga is a software implementation of popular (and unpopular) routing protocols which runs on ordinary commodity servers. The following shell commands should be adapted for your chosen addresses and then run on groupX-lg2.

```
ip addr add 10.Z.X.X/24 dev eth1
ip link set up dev eth1
ip link add name dummy0 type dummy
ip addr add 10.Z.99.99/24 dev dummy0
ip link set dev dummy0 up

apt-get install quagga-core
apt-get install quagga-ripd

cat >/etc/quagga/zebra.conf << EOF
!
! Zebra configuration file
!
hostname $(hostname)
password zebra
enable password zebra
!
EOF

cat >/etc/quagga/ripd.conf <<EOF
!
hostname $(hostname)
password rip
enable password rip
!
router rip
network 10.Z.X.0/24
network 10.Z.99.0/24
!
EOF

systemctl start zebra
systemctl start ripd
```

Also, you may need to log on to your groupX-lg1 and use the following command to ensure that no firewall entries are currently configured on it:

```
iptables -F
```

Note that in addition to configuring `eth1`, this is the only configuration command you need to use for this question on groupX-lg1.

After correctly setting up RIP, aac-rc1 (cgn-rc1 / lev-rc1), aac-rj1 (cgn-rj1 / lev-rj1), and aac-rj2 (cgn-rj2 / lev-rj2) in the network of Figure 1 should have a route towards each sub-network you configured. Also, after convergence the prefix `10.Z.99.0/24` should be reachable from all routers.

After you have configured RIP on all the necessary devices, test reachability by pinging the address `10.Z.99.99` from each router.

a) Which route is selected by aac-rc1 (cgn-rc1 / lev-rc1) to reach 10.Z.99.0/24? (use the command: `show ip route`). Provide traceroute output.

b) Which route is selected by aac-rj2 (cgn-rj2 / lev-rj2) to reach 10.Z.99.0/24? (use the command: `show route`). Provide traceroute output.

c) What is the metric associated with the selected route? What does the metric mean here?

d) For both loadgens in your network, traceroute every other configured interface of the routers and the other loadgen to verify that they are all reachable, and to see which path the packets are taking. Provide the traceroute output.

e) Is it possible that the "Count-to-Infinity" problem occurs somewhere in the network for the prefix `10.Z.99.0/24` if the link from aac-sc1 (cgn-sc1 / lev-sc1) to aac-rc1 (cgn-rc1 / lev-rc1) fails?

- If no, explain why.
- If yes, give an example of where it can happen.

Now we will check what happens if the link from aac-rc1 (cgn-rc1 / lev-rc1) to the groupX-lg2 is experiencing problems.

To monitor what happens, create a trace file on on aac-rj1 (cgn-rj1 / lev-rj1):

```
set protocols rip traceoptions file <somefilename>

set protocols rip traceoptions flag route
```

You can follow along the growing log file with:

```
monitor start <somefilename>
```

At a later point you can scroll through the whole log with:

```
show log <somefilename>
```

You can also filter for only the latest messages

```
show log <somefile> | last <numberoflines>
```

Now simulate packet loss between aac-rc1 (cgn-rc1 / lev-rc1) and groupX-lg2. For this purpose just make the groupX-lg2 drop all packets outgoing from interface *eth1* like you have learned during the firewall worksheet.

f) How much time elapses approximately until aac-rj1 (cgn-rj1 / lev-rj1) deletes the route to prefix `10.Z.99.0/24` from its routing table? Provide the *relevant parts* of the trace of the rip debug session in your response.

g) Explain what you see in the debug output (4-6 sentences). Can you see the effect of any of the RIP mechanisms that are supposed to prevent instabilities?

Don't forget to undo the iptable command:

```
iptables -F
```

and to stop the monitoring on aac-rj1 (cgn-rj1 / lev-rj1):

```
monitor stop <somefilename>
```

Submission details (more in ISIS):
Please submit an archive (.tar.gz or .zip) containing a *directory*, which contains all files you want to submit. Please have *your group number* in the file name and the directory name.
A report (one single PDF file, named *worksheet(num)-group(num).pdf*) containing the following elements is mandatory:

- Your group number on the first page
- Topology map with relevant routers, switches, *loadgens*, and interfaces, IPs and subnet masks (CIDR).
- For each question, the written answers with the **relevant** portions of output from all commands such as ping, tcpdump, etc in a text format. **No** screenshots of terminal windows are accepted. For ping 3-4 lines of ping requests are usually sufficient.
- For each question all commands needed to configure the *loadgens*.
- For each question all **changed parts** in the configuration of routers and switches (differences to the default config).
- **Never** include the full verbatim switch or router configuration in the pdf report.
- For all questions, state your assumptions, say what you did, describe what you observed, explain your conclusions.

Additionally, please include your config files in the archive.
For each question, please provide the full switch and router configuration in a separate text file named after the device and question, e.g.: *q01-config-sc1.txt*. This makes it easier for us to reproduce your configuration and understand what you did.
We can only grade what we find in your submission and what we understand. Please state your assumptions and observations as clearly as possible.
Due Date: Thursday, June 21st 2018, 23:55h