MPLS exploration lab

Advanced Networking 2018

Lab #4: MPLS intro

Assignment

Total points: 12 pts (Task 1: 2 points; Task 2: 7 points; Task 3: 3 points)

Lab date: March 9, 2018

Submission Date: 23:59PM Monday March 12, 2018 CET

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Introduction

The goal of this assignment is to let you familiarize with the basics of MPLS configuration on a Juniper router and get an idea of how to build and operate an MPLS network.

Work in a group of **2** people, you can choose your mate. All groups work at the same time. The set-up of the lab will stay in place till Friday night 22:00PM. Make sure you have collected all the information from the routers you need to finish your report before that time.

A network was built for you with different MPLS technologies and protocols to explore and answer questions on specific details of the configurations, the status of processes and/or protocols, etc.. You do not have to configure anything on the routers, you can use show commands to gather information or perform pings, traceroutes etc. to check things.

The lab is set up on Juniper router Chico in the SNE LAB. An environment is built consisting of a number of logical routers that are interconnected in a certain topology (see page 4). Suppose this is an MPLS backbone, with customers networks connected to it (which are not actually connected). A certain set-up is chosen and it is up to you to figure out how it was done.

Everyone can log in to ***all*** the routers and use e.g. show commands to figure out what the situation is in the network. **Do not try to change** any passwords or parts of the configuration on the routers, this will only make answering the questions in task 2 impossible for you and for your fellow students.

Use the management network as in Lab#3 (build a net).
You will be logging in using ssh to 10.0.1.22 (Chico).
The username is: `student`
The password is: `mpls18`

Task 1 - Discover the Topology

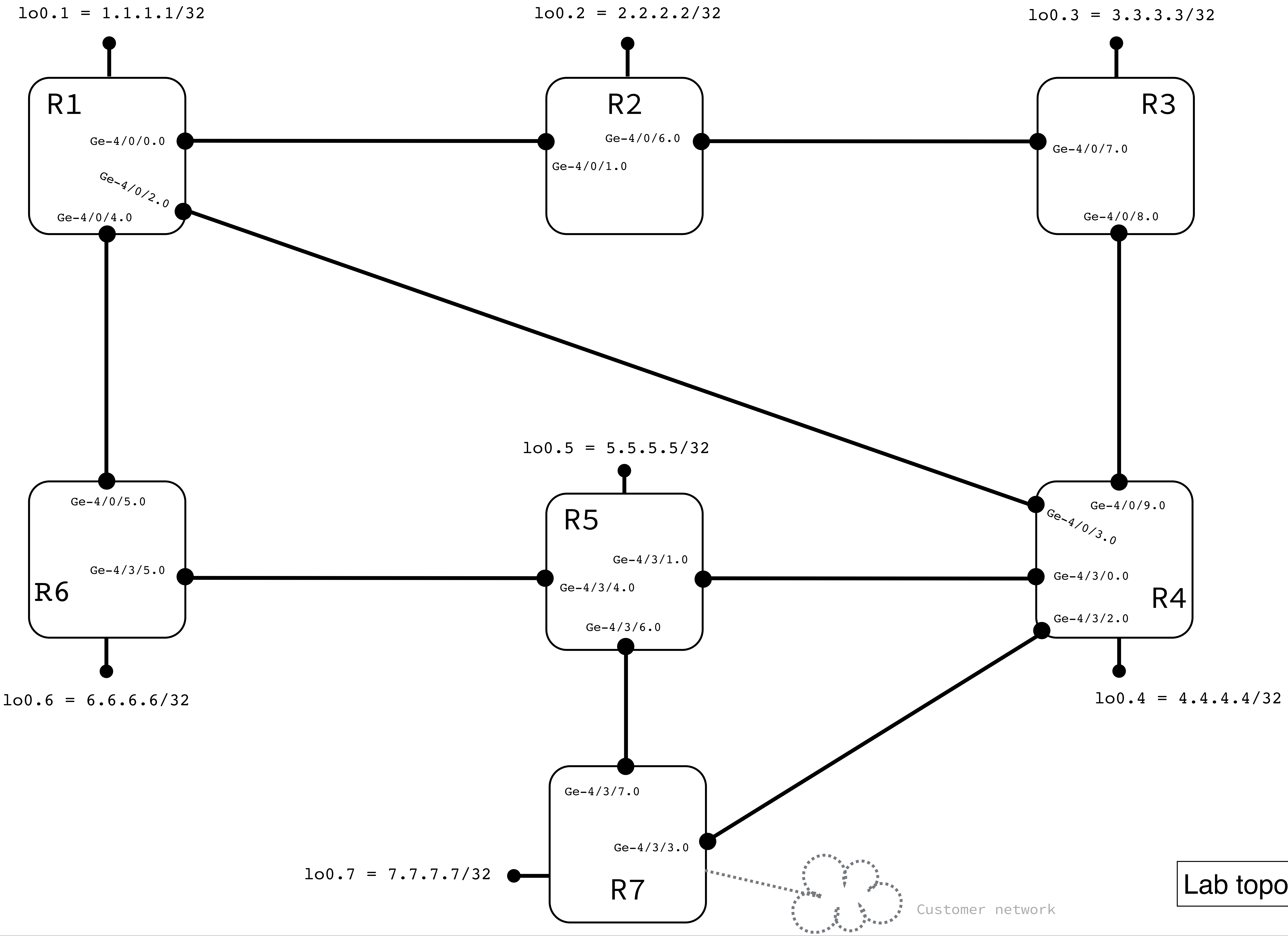
Your first task is to fill in the details in the network drawing (see next page). Gather as much information as possible to get a clear picture of the set-up of the network, e.g. addresses, prefixes, interface details, routing protocol, etc.. Doing this carefully will also help you in answering the questions in task 2 and 3. You have to add your network drawing to the report. You might want to add more details after you've answered questions 1 to 4 to the drawing. The drawing is available as a separate pdf on blackboard also.

The following information might be useful:

The routers in the lab topology are all logical routers on one physical system.
The GE interfaces are connected with physical fibers to form the given topology (see drawing).
Together they form a small MPLS backbone.

Each logical router also has its own loopback interface. The host router has loopback interface lo0.0, the logical systems have loopbacks lo0.X where X is the number given to each router.

Task 1:
Hand in the topology with the details filled in. It should be possible to rebuild the network from scratch using your diagram (while already knowing how to configure a juniper router of course).



Lab topology March 9th 2018

Task 2 - Explore the network

Your next task is to figure out how MPLS and all other needed protocols are configured and which LSPs (Label Switched Paths) are set up on the lab topology.

For MPLS to run on the routers one has to configure MPLS and enable an MPLS instance on the router. One of more label signalling protocols needs to be running. You also need a routing protocol (IGP) to exchange prefix reachability information between routers.

Check the routers, the configs, the interfaces, the protocols running and answer the following questions. You can use output from the routers (show commands etc.) in your answers for the questions, but clearly explain what it is showing and what it means.

Question 1:

How is MPLS configured on the routers? Which commands were used to set it up?

Question 2:

Which routing protocol is configured? List the relevant details from the configuration for that protocol and explain what they mean.

Task 2 - Explore the network continued

Both LDP and RSVP are used as signalling protocols for the MPLS LSPs in this lab set-up. With LDP established, the routers will automatically build (multipoint-to-point) LSPs to each other. RSVP is used to signal specific LSPs through the network.

Question 3:

Between which routers are LDP sessions established? How is this configured?
Which LSPs have been set up with LDP? List the relevant details of these LSPs to explain how you discovered this.
(Pick one of the LSPs to explain all details about it.)
Look at the label database and the FECs and check the routing table(s).

Question 4:

Which LSPs are configured with RSVP? How are they configured? Determine as many details about the LSPs as you are able to find.

Task 2:
Hand in the answers to questions 1 to 4.
Use the (relevant parts of) output of show commands in answering the questions and explain clearly what it shows.

Task 3 - Prepare the config to add a new router

In this task you have to prepare the configuration for a new router “R8" that needs to be added to the network. You must give the Junos commands to configure this router and explain why you used these commands

You do **not** have to actually connect R8, only prepare the configuration. But try to make sure you have all the details correct, so the config would load and commit properly once the device would be connected. The router should become part of the lab topology and all protocols should work with the existing routers, links should be up, routing should work, etc. You may assume it will not be another logical router but a physical one.

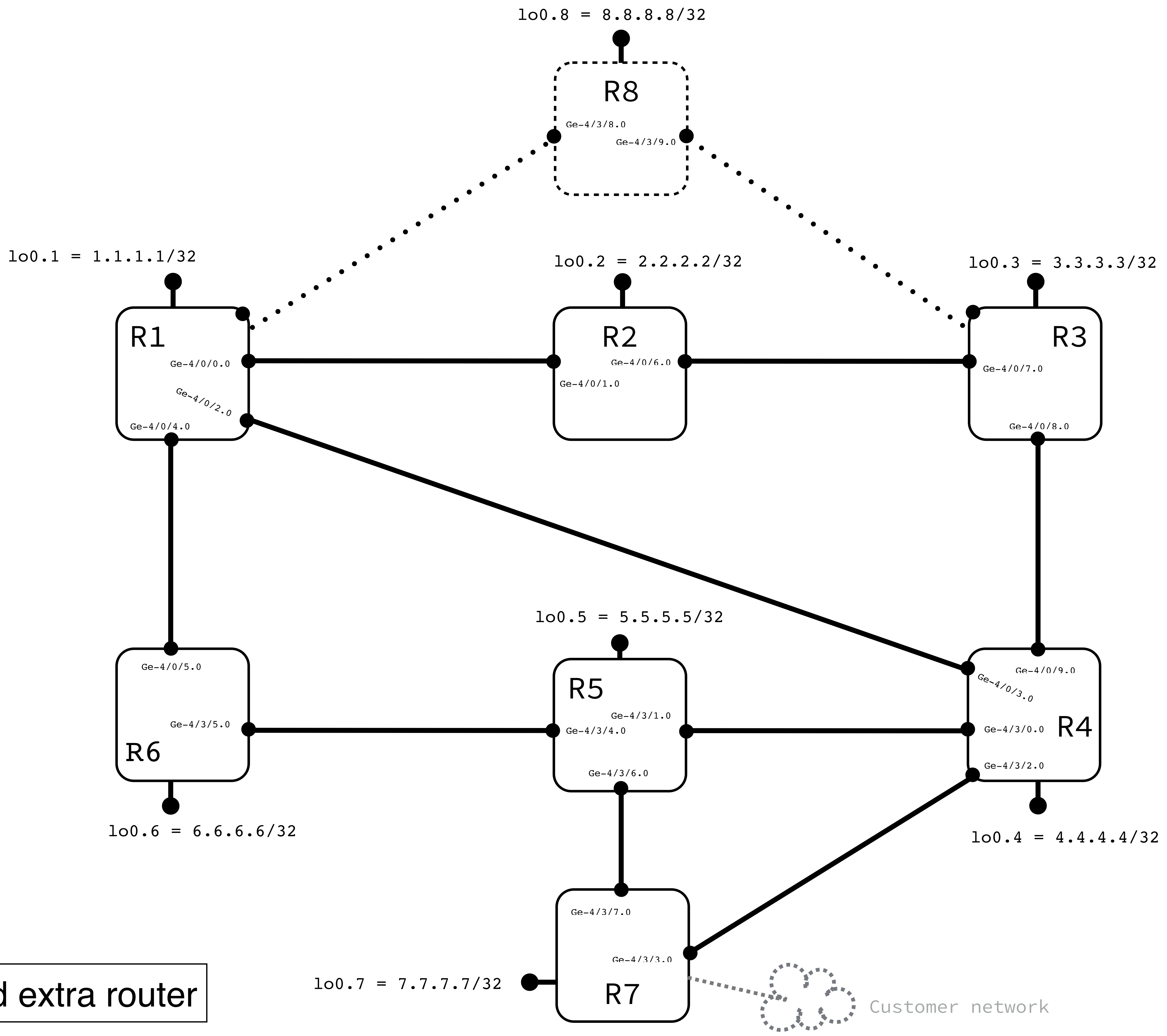
Note: you can leave out details about users’ login and authentication, logging and SNMP etc., as those would be part of the default config template for this network.

To prepare the config you need at least the following information:

- name of the router: R8
- R8 needs to be connected to R1 and R3 (see drawing next page)
- GE interfaces to be used on R8: Ge-4/3/8 and Ge-4/3/9
- Loopback address: 8.8.8.8
- Assign prefixes to the links (pick appropriately sized subnets)
- R8 should become part of the MPLS core
- R8 must run LDP
- An RSVP signalled LSP to R6 with reserved bandwidth of 200M should be built
- Another RSVP LSP to R4 with reserved bandwidth of 300M should be built

Task 3 - Prepare the config to add a new router - continued

<u>Task 3:</u>
Give your prepared configuration for router R8.
Including explanations for each command you use.



Lab topology - with added extra router

Submission report

The submission must contain the following:

A PDF document containing the finished topology drawing (may be a separate document) and the answers to the questions in task 2 and the prepared configuration in task 3.

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Useful juniper commands

- `show configuration ( | display set )`

- `set cli logical-system <name>`
- `clear cli logical-system (<name>)`

- `show interfaces (terse)`

- `show route (extensive)`
- `show route protocol <protocol>`
- `show route table inet.3`
- `show route table mpls.0`

- `show isis brief | detail | extensive`
- `show isis interface`
- `show isis neighbors`
- `show isis database`

- `show mpls lsp (detail | extensive)`
- `show mpls lsp ingress | egress |transit`
- `show mpls interface (detail)`

- `show ldp interface (detail)`
- `show ldp neighbor (extensive)`
- `show ldp session (detail)`
- `show ldp database (detail)`

- `show ldp route (extensive)`
- `show ldp path (extensive)`

- `show rsvp interface (detail)`
- `show rsvp neighbor (detail)`
- `show rsvp session (detail)`

Additional info - Routing table

The Junos OS maintains two databases for routing information:

- Routing table — Contains all the routing information learned by all routing protocols. (Some vendors refer to this kind of table as a routing information base [RIB].)
- Forwarding table — Contains the routes actually used to forward packets. (Some vendors refer to this kind of table as a forwarding information base [FIB].)

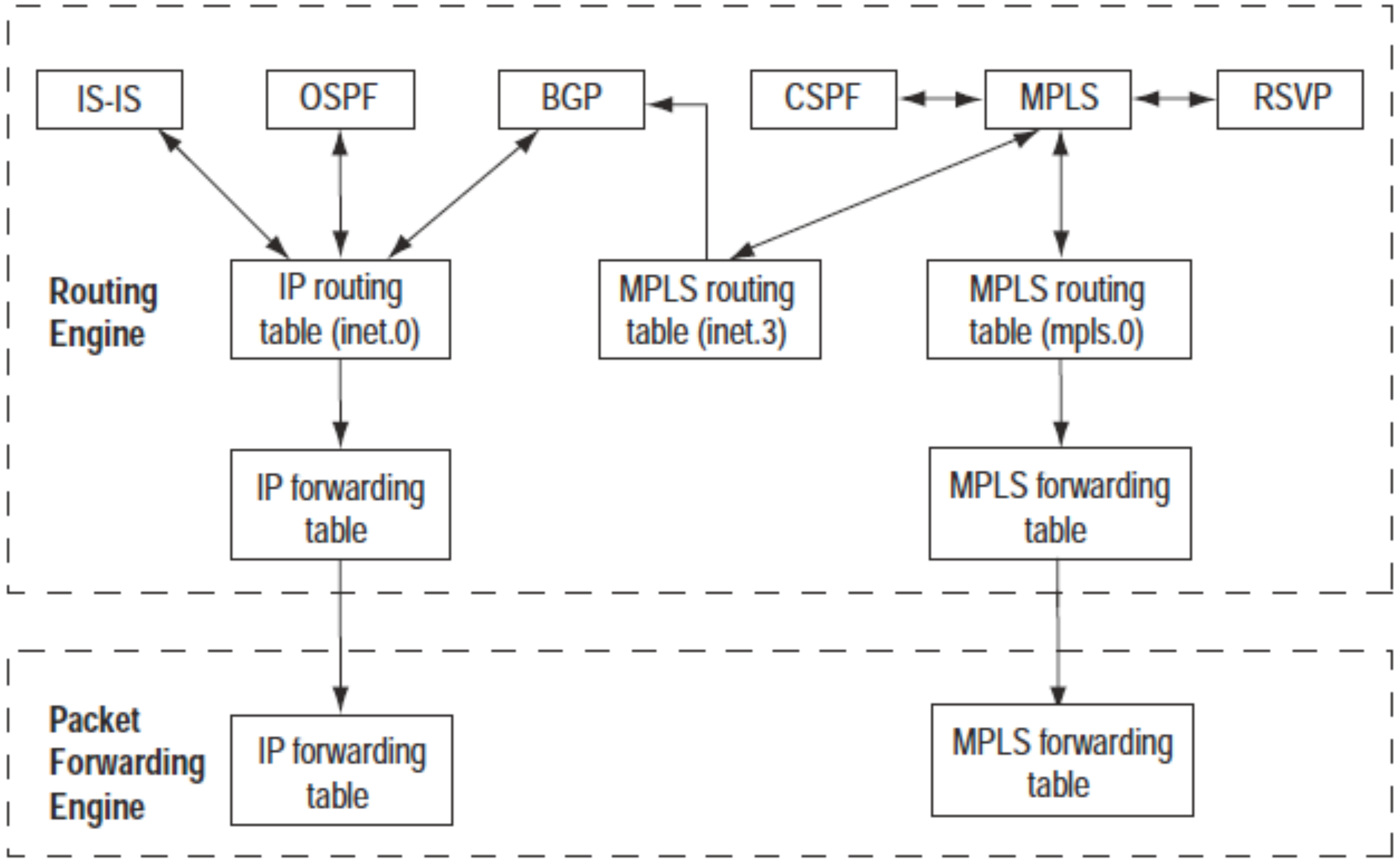
In fact there is more than 1 routing table on a Junos device. And a routing table is NOT the same as a forwarding table.

Understanding Junos OS Routing Tables

Junos OS automatically creates and maintains several routing tables. Each routing table is used for a specific purpose. In addition to these automatically created routing tables, you can create your own routing tables.

Each routing table populates a portion of the forwarding table. Thus, the forwarding table is partitioned based on routing tables. This allows for specific forwarding behaviour for each routing table. For example, for VPNs, each VPN-based routing table has its own VPN-specific partition in the forwarding table.

It is common for the routing software to maintain unicast routes and multicast routes in different routing tables. You also might have policy considerations that would lead you to create separate routing tables to manage the propagation of routing information.



Additional info - Routing table

Creating routing tables is optional. If you do not create any, Junos OS uses its default routing tables, which are as follows:

- inet.0—For IP version 4 (IPv4) unicast routes. This table stores interface local and direct routes, static routes, and dynamically learned routes.
- inet.1—For the IPv4 multicast forwarding cache. This table stores the IPv4 (S,G) group entries that are dynamically created as a result of join state information.
- inet.2—For subsequent address family indicator (SAFI) 2 routes, when multiprotocol BGP (MBGP) is enabled. This table stores unicast routes that are used for multicast reverse-path-forwarding (RPF) lookup. The routes in this table can be used by the Distance Vector Multicast Routing Protocol (DVMRP), which requires a specific RPF table. In contrast, Protocol Independent Multicast (PIM) does not need this table because it can perform RPF checks against the inet.0 table. You can import routes from inet.0 into inet.2 using routing information base (RIB) groups, or install routes directly into inet.2 from a multicast routing protocol.
- inet.3—For IPv4 MPLS. This table stores the egress address of an MPLS label-swiched path (LSP), the LSP name, and the outgoing interface name. This routing table is used only when the local device is the ingress node to an LSP.
- inet6.0—For IP version 6 (IPv6) unicast routes. This table stores interface local and direct routes, static routes, and dynamically learned routes.

MPLS and Routing Tables

The IGPs and BGP store their routing information in the inet.0 routing table, the main IP routing table. If traffic-engineering bgp is configured, thereby allowing only BGP to use MPLS paths for forwarding traffic, MPLS path information is stored in a separate routing table, inet.3. Only BGP accesses the inet.3 routing table. BGP uses both inet.0 and inet.3 to resolve next-hop addresses. If traffic-engineering bgp-igp is configured, thereby allowing the IGPs to use MPLS paths for forwarding traffic, MPLS path information is stored in the inet.0 routing table.

More info on Routing Information Bases (RIB): https://www.juniper.net/documentation/en_US/release-independent/solutions/information-products/pathway-pages/rg-understanding-tn.pdf

Additional info - Route Preference Values (Administrative Distance)

The Junos OS routing protocol process assigns a default preference value (also known as an *administrative distance*) to each route that the routing table receives. The default value depends on the source of the route. The preference value is a value from 0 through 4,294,967,295 ($2^{32} – 1$), with a lower value indicating a more preferred route.inet.0—For IP version 4 (IPv4) unicast routes. This table stores interface local and direct routes, static routes, and dynamically learned routes.

How Route Is Learned	Default Preference	Statement to Modify Default Preference
Directly connected network	0	–
System routes	4	–
Static and Static LSPs	5	static
Static LSPs	6	–
RSVP-signaled LSPs	7	RSVP preference as described in the MPLS Applications Feature Guide
LDP-signaled LSPs	9	LDP preference, as described in the MPLS Applications Feature Guide
OSPF internal route	10	OSPF preference
IS-IS Level 1 internal route	15	IS-IS preference
IS-IS Level 2 internal route	18	IS-IS preference
RIP	100	RIP preference
RIPng	100	RIPng preference
Aggregate	130	aggregate
OSPF AS external routes	150	OSPF external-preference
IS-IS Level 1 external route	160	IS-IS external-preference
IS-IS Level 2 external route	165	IS-IS external-preference
BGP	170	BGP preference, export, import