COMP312-09A Communications and Systems Software

Intro to Juniper Routers

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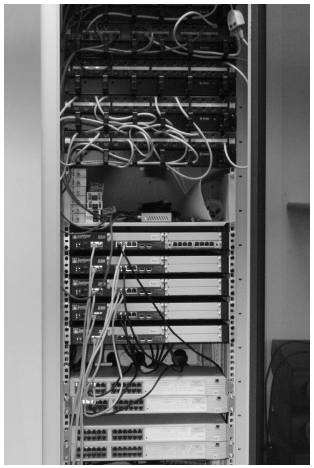
Juniper Routers

- The Router Lab
- Logging In
- Modes
- Interfaces
- Protocols
  - RIP
  - OSPF
  - BGP

The Routing Lab

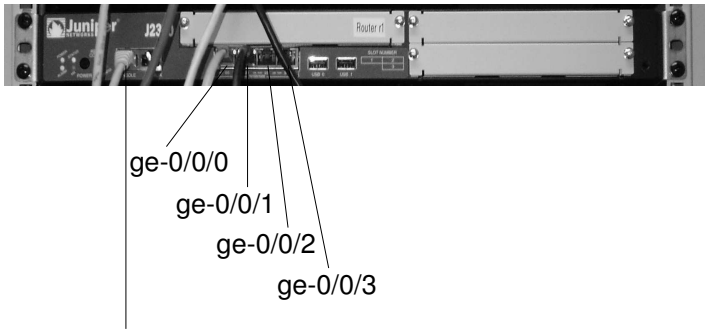
(Distributed Systems Lab, G1.04)

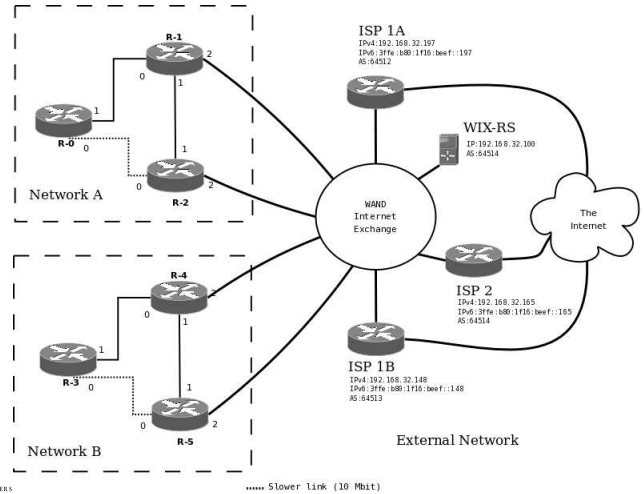


- Juniper J series routers are aimed at the “Enterprise” market
- Minus the built-in redundancy (power supplies, processors, switch fabrics ...) you'll find in a high-end router.
- But runs JUNOS - the same operating system, same configuration

Why The Lab is Like This

Base-configuration J2320





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Portal

- The server “portal” is connected to all routers' serial console ports.
- Log onto portal using your usual UNIX username and password as at 27 March 2008.
- `restore_conf.py` <number> - Installs basic “rescue” configuration on numbered router
- `restore_conf.py` <number> <filename> - Copies configuration from your file onto numbered router
- `backup_conf.py` <number> <filename> - Copies configuration from numbered router to your file
- `minicom router-`<number> - Open console session on router


```
$ ssh portal.cs.waikato.ac.nz
dmneal@portal.cs.waikato.ac.nz's password:
Linux portal 2.4.31 #1 Thu Aug 11 12:11:20 NZST 2005 i686 GNU/Linux


The programs included with the Debian GNU/Linux system are free software;
the exact distribution terms for each program are described in the
individual files in /usr/share/doc/*/copyright.


Debian GNU/Linux comes with ABSOLUTELY NO WARRANTY, to the extent
permitted by applicable law.


Last login: Wed Mar 26 13:22:58 2008
dmneal@portal:~$ restore_conf.py 3
Successfully loaded the rescue configuration.
Successfully committed the configuration.
dmneal@portal:~$ restore_conf.py 4 dmneal_rip4
Successfully loaded the rescue configuration.
.....................................................
Successfully merged your config file.
Successfully committed the configuration.
dmneal@portal:~$ backup_conf.py 3 router3conf.start
Successfully saved configuration as router3conf.start
dmneal@portal:~$ minicom router-3
```



```
Welcome to minicom 2.1
```

```
dmneal@portal:~$ minicom router-3


Welcome to minicom 2.1

OPTIONS: History Buffer, F-key Macros, Search History Buffer, I18n
Compiled on Mar 29 2005, 09:39:09.

Press CTRL-A Z for help on special keys
```

- **CTRL-A SHIFT-Z for a menu of minicom commands**
- **CTRL-A X to exit a minicom session**

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Modes

- Operational Mode
  - Execute commands

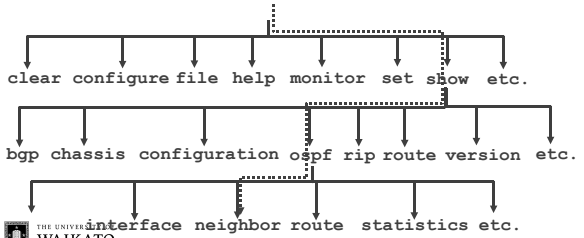
```
student@juniper-3> show interfaces
```

- Configuration Mode
  - Edit configuration

```
[edit]
student@juniper-3# commit
```


Operational Mode

- Commands to show status or run tests etc.
- e.g **`show ospf neighbor`**



Ping

```
student@juniper-2> ping 192.168.1.31
PING 192.168.1.31 (192.168.1.31): 56 data bytes
64 bytes from 192.168.1.31: icmp_seq=0 ttl=64 time=8.383 ms
64 bytes from 192.168.1.31: icmp_seq=1 ttl=64 time=4.607 ms
64 bytes from 192.168.1.31: icmp_seq=2 ttl=64 time=10.424 ms
64 bytes from 192.168.1.31: icmp_seq=3 ttl=64 time=10.457 ms
64 bytes from 192.168.1.31: icmp_seq=4 ttl=64 time=10.432 ms
64 bytes from 192.168.1.31: icmp_seq=5 ttl=64 time=10.422 ms
^C
--- 192.168.1.31 ping statistics ---
6 packets transmitted, 6 packets received, 0% packet loss
round-trip min/avg/max/stddev = 4.607/9.121/10.457/2.153 ms
```

Also, traceroute

Configuration mode

- Enter with `configure`, or `edit`
- Exit with `quit`
- Juniper configuration is in a hierarchical structure

```
dmneal@portal:~$ minicom router-3


Welcome to minicom 2.1

OPTIONS: History Buffer, F-key Macros, Search History Buffer, I18n
Compiled on Mar 29 2005, 09:39:09.

Press CTRL-A Z for help on special keys

student@juniper-3>[edit]
student@juniper-3# show
version 8.4R1.13;
system {
  host-name juniper-3;
  domain-name g104.rack;
  authentication-order password;
  root-authentication { /* ACCESS-DENIED */ };
  login { /* ACCESS-DENIED */ };
  syslog {
    user * {
      any emergency;
    }
    file messages {
      any any;
      authorization info;
    }
    file interactive-commands {
      interactive-commands any;
    }
}
```


Navigating Hierarchy

- Use `edit ....` to go down hierarchy
- Use `set …` to change configuration
- Use `up` to go up one level of the hierarchy
- Use `top` to go to the top level of hierarchy
- Help can be obtained with `?` for completions, or
  - `help topic` (for concepts)
  - `help reference` (for syntax)

Changing the configuration

- Juniper configuration is applied in batch mode
  - All edits are applied at once
- Use `commit` to apply outstanding configuration changes
- Can use `compare | show` to check what changes are from running config

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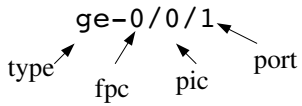
Interfaces

- e.g. `ge-0/0/1`



- Gigabit Ethernet ports are type `ge`, serial are `se`.
  - Juniper supports lots more, but we don't own any
- Routers you will be configuring have only one fpc and pic
  - Numbering starts at 0


```
student@juniper-3> configure private
warning: uncommitted changes will be discarded on exit
Entering configuration mode

[edit]
student@juniper-3# edit interfaces ge-0/0/0

[edit interfaces ge-0/0/0]
student@juniper-3# ...r-3 ge-0/0/0 - juniper-0 ge-0/0/2"
```

(set description 'juniper-3 ge-0/0/0 – juniper-0 ge-0/0/2")

```
[edit interfaces ge-0/0/0]
student@juniper-3# set unit 0 family inet address 192.168.1.41/30

[edit interfaces ge-0/0/0]
student@juniper-3# show
description "juniper-3 ge-0/0/0 - juniper-0 ge-0/0/2";
unit 0 {
  family inet {
    address 192.168.1.41/30;
  }
}
```

- Tree structure
- interfaces
  - ge-0/0/0
    - unit 0
      - family inet


```
[edit interfaces ge-0/0/0]
student@juniper-3# show
description "juniper-3 ge-0/0/0 - juniper-0 ge-0/0/2";
unit 0 {
  family inet {
    address 192.168.1.41/30;
  }
}
[edit interfaces ge-0/0/0]
student@juniper-3# set unit 0 family inet address 192.168.1.38/30

[edit interfaces ge-0/0/0]
student@juniper-3# show
description "juniper-3 ge-0/0/0 - juniper-0 ge-0/0/2";
unit 0 {
  family inet {
    address 192.168.1.41/30;
    address 192.168.1.38/30;
  }
}
```

- Tree structure
- interfaces
  - ge-0/0/0
    - unit 0
      - family inet


```
 tudent@juniper-3# show
description "juniper-3 ge-0/0/0 - juniper-0 ge-0/0/2";
unit 0 {
  family inet {
    address 192.168.1.41/30;
    address 192.168.1.38/30;
  }
}
[edit interfaces ge-0/0/0]
student@juniper-3# del unit 0 family inet address 192.168.1.41/30

[edit interfaces ge-0/0/0]
student@juniper-3# show
description "juniper-3 ge-0/0/0 - juniper-0 ge-0/0/2";
unit 0 {
  family inet {
    address 192.168.1.38/30;
  }
}
```

- Tree structure
- interfaces
  - ge-0/0/0
    - unit 0
      - family inet

```
[edit interfaces ge-0/0/0]
student@juniper-3# up

[edit interfaces]
student@juniper-3# edit ge-0/0/1

[edit interfaces ge-0/0/1]
student@juniper-3# ...r-3 ge-0/0/1 - juniper-4 ge-0/0/1"

[edit interfaces ge-0/0/1]
student@juniper-3# set unit 0 family inet address 192.168.1.41/30

[edit interfaces ge-0/0/1]
student@juniper-3# show
description "juniper-3 ge-0/0/1 - juniper-4 ge-0/0/1";
unit 0 {
  family inet {
    address 192.168.1.41/30;
  }
}

[edit interfaces ge-0/0/1]
student@juniper-3# up
```

- interfaces
  - ge-0/0/0
    - unit 0
      - family inet
  - ge-0/0/1
    - unit 0
      - family inet


```
[edit interfaces]
student@juniper-3# show
ge-0/0/0 {
  description "juniper-3 ge-0/0/0 - juniper-0 ge-0/0/2";
  unit 0 {
    family inet {
      address 192.168.1.38/30;
    }
  }
}
ge-0/0/1 {
  description "juniper-3 ge-0/0/1 - juniper-4 ge-0/0/1";
  unit 0 {
    family inet {
      address 192.168.1.41/30;
    }
  }
}
```



```
[edit interfaces]
student@juniper-3# top
```

- From here, "show" will show full configuration.

```
[edit]
student@juniper-3# show | compare
[edit]
+  interfaces {
+      ge-0/0/0 {
+          description "juniper-3 ge-0/0/0 - juniper-0 ge-0/0/2";
+          unit 0 {
+              family inet {
+                  address 192.168.1.38/30;
+              }
+          }
+      }
+      ge-0/0/1 {
+          description "juniper-3 ge-0/0/1 - juniper-4 ge-0/0/1";
+          unit 0 {
+              family inet {
+                  address 192.168.1.41/30;
+              }
+          }
+      }
+  }

[edit]
student@juniper-3# commit and-quit
commit complete
```



```
[edit]
student@juniper-3# commit and-quit
commit complete
Exiting configuration mode
```

Prompt change

```
student@juniper-3> show interfaces
Physical interface: ge-0/0/0, Enabled, Physical link is Up
  Interface index: 137, SNMP ifIndex: 34
    Description: juniper-3 ge-0/0/0 - juniper-0 ge-0/0/2
          Link-level type: Ethernet, MTU: 1514, Speed: 1000mbps, Loopback:
   Disabled,
           Source filtering: Disabled, Flow control: Enabled, Auto-
   negotiation: Enabled,
             Remote fault: Online
               Device flags   : Present Running
  Interface flags: SNMP-Traps Internal: 0x4000
Link flags     : None
  CoS queues     : 8 supported, 8 maximum usable queues
    Current address: 00:1d:b5:0f:6e:00, Hardware address: 00:1d:b5:0f:6e:00
          Last flapped   : 2008-03-26 04:32:10 UTC (05:08:23 ago)
            Input rate     : 0 bps (0 pps)
              Output rate    : 0 bps (0 pps)
                Active alarms  : None
  Active defects : None

Logical interface ge-0/0/0.0 (Index 66) (SNMP ifIndex 32)
    Flags: SNMP-Traps Encapsulation: ENET2
           Input packets : 0
             Output packets: 1
```

```
student@juniper-3> show interfaces ?
Possible completions:
  <[Enter]>            Execute this command
  <interface-name>     Name of physical or logical interface
  ge-0/0/0             juniper-3 ge-0/0/0 - juniper-0 ge-0/0/2
  ge-0/0/0.0
  gr-0/0/0
…
  ge-0/0/1             juniper-3 ge-0/0/1 - juniper-4 ge-0/0/1
  ge-0/0/1.0
  ge-0/0/2
  ge-0/0/3
  dsc
  gre
  ipip
  lo0
  lo0.16385
  lsi
  mtun
  pimd
  pime
  pp0
  tap
  brief                Display brief output
  controller           Show controller information
  descriptions         Display interface description strings
  detail               Display detailed output
  diagnostics          Show interface diagnostics information
  extensive            Display extensive output
  filters              Show interface filters information
  interval             Show interval statistics
  mac-database         Show media access control database information
  media                Display media information
  policers             Show interface policers information
  queue                Show queue statistics for this interface
  redundancy           Show redundancy status
  routing              Show routing status
  snmp-index           SNMP index of interface
  statistics           Display statistics and detailed output
  switch-port          Front end port number (0..15)
  terse                Display terse output
```



```
student@juniper-3> show r?
Possible completions:
  rip                  Show Routing Information Protocol information
  ripng                Show Routing Information Protocol for IPv6 information
  route                Show routing table information
  rsvp                 Show Resource Reservation Protocol information
```



```
student@juniper-3> show route

  inet.0: 4 destinations, 4 routes (4 active, 0 holddown, 0 hidden)
  + = Active Route, - = Last Active, * = Both

  192.168.1.36/30    *[Direct/0] 00:00:49
                     > via ge-0/0/0.0
  192.168.1.38/32    *[Local/0] 00:00:49
                     Local via ge-0/0/0.0
  192.168.1.40/30    *[Direct/0] 00:00:49
                     > via ge-0/0/1.0
  192.168.1.41/32    *[Local/0] 00:00:49
                     Local via ge-0/0/1.0

  __juniper_private1__.inet.0: 2 destinations, 2 routes (2 active, 0
   holddown, 0 )+ = Active Route, - = Last Active, * = Both

  10.0.0.1/32        *[Direct/0] 5w2d 00:27:49
                     > via lo0.16385
  10.0.0.16/32       *[Direct/0] 5w2d 00:27:49
                     > via lo0.16385
```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RIP Configuration Included For Interest Only

```
student@juniper-3> configure private
warning: uncommitted changes will be discarded on exit
Entering configuration mode

[edit]
student@juniper-3# edit policy-options policy-statement accept-connected

[edit policy-options policy-statement accept-connected]
student@juniper-3# set from protocol direct

[edit policy-options policy-statement accept-connected]
student@juniper-3# set then accept

[edit policy-options policy-statement accept-connected]
student@juniper-3# up

[edit policy-options]
student@juniper-3# set policy-statement accept-rip from protocol rip

[edit policy-options]
student@juniper-3# set policy-statement accept-rip then accept

[edit policy-options]
student@juniper-3# show
```


RIP Configuration Included For Interest Only

```
[edit policy-options]
student@juniper-3# show
policy-statement accept-connected {
  from protocol direct;
  then accept;
}
policy-statement accept-rip {
  from protocol rip;
  then accept;
}
student@juniper-3# top

[edit]
student@juniper-3# edit protocols rip group rip-neighbors

[edit protocols rip group rip-neighbors]
student@juniper-3# set export [ accept-connected accept-rip ]

[edit protocols rip group rip-neighbors]
student@juniper-3# set neighbor ge-0/0/0.0

[edit protocols rip group rip-neighbors]
student@juniper-3# set neighbor ge-0/0/1.0

[edit protocols rip group rip-neighbors]
student@juniper-3# show
export [ accept-connected accept-rip ];
neighbor ge-0/0/0.0;
neighbor ge-0/0/1.0;
```


RIP Configuration Included For Interest Only

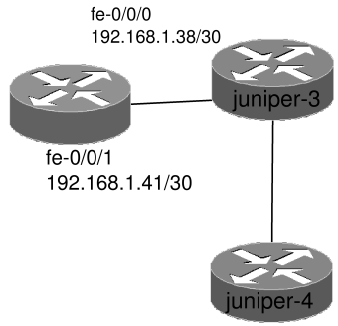
```
[edit protocols rip group rip-neighbors]
   student@juniper-3# top

   [edit]
   student@juniper-3# show | compare
   [edit]
   +  protocols {
   +      rip {
   +          group rip-neighbors {
   +              export [ accept-connected accept-rip ];
   +              neighbor ge-0/0/0.0;
   +              neighbor ge-0/0/1.0;
   +          }
   +      }
   +  }
   +  policy-options {
   +      policy-statement accept-connected {
   +          from protocol direct;
   +          then accept;
   +      }
   +      policy-statement accept-rip {
   +          from protocol rip;
   +          then accept;
   +      }
   +  }

   [edit]
   student@juniper-3# commit and-quit
   commit complete
   Exiting configuration mode
```


RIP In Use

```
student@juniper-3> show rip neighbor
                          Source           Destination      Send   Receive  In
Neighbor          State   Address          Address          Mode   Mode     Met
--------          -----   -------          -----------      ----   -------  ---
ge-0/0/0.0           Up 192.168.1.38    224.0.0.9        mcast  both      1
ge-0/0/1.0           Up 192.168.1.41    224.0.0.9        mcast  both      1
```



RIP In Use

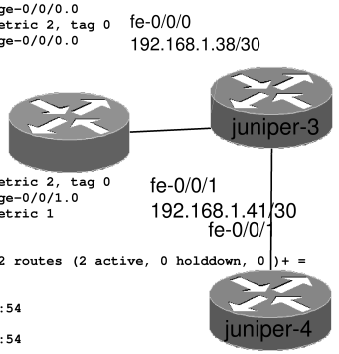
```
student@juniper-3> show route

inet.0: 8 destinations, 8 routes (8 active, 0 holddown, 0 hidden)
+ = Active Route, - = Last Active, * = Both

     0.0.0.0/0          *[RIP/100] 00:00:44, metric 2, tag 0
                        > to 192.168.1.37 via ge-0/0/0.0
     172.16.2.0/30      *[RIP/100] 00:00:44, metric 2, tag 0
                        > to 192.168.1.37 via ge-0/0/0.0
     192.168.1.36/30    *[Direct/0] 00:06:54
                        > via ge-0/0/0.0
     192.168.1.38/32    *[Local/0] 00:06:54
                         Local via ge-0/0/0.0
     192.168.1.40/30    *[Direct/0] 00:06:54
                        > via ge-0/0/1.0
     192.168.1.41/32    *[Local/0] 00:06:54
                         Local via ge-0/0/1.0
     192.168.1.44/30    *[RIP/100] 00:00:34, metric 2, tag 0
                        > to 192.168.1.42 via ge-0/0/1.0
     224.0.0.9/32       *[RIP/100] 00:00:44, metric 1
                        MultiRecv

__juniper_private1__.inet.0: 2 destinations, 2 routes (2 active, 0 holddown, 0 )+ =
    Active Route, - = Last Active, * = Both

     10.0.0.1/32        *[Direct/0] 5w2d 00:33:54
                        > via lo0.16385
     10.0.0.16/32       *[Direct/0] 5w2d 00:33:54
                        > via lo0.16385
```



RIP In Use

```
student@juniper-3> show route protocol rip detail

inet.0: 8 destinations, 8 routes (8 active, 0 holddown, 0 hidden)
  0.0.0.0/0 (1 entry, 1 announced)
             *RIP    Preference: 100
             Next hop type: Router, Next hop index: 395
             Next-hop reference count: 4
             Next hop: 192.168.1.37 via ge-0/0/0.0, selected
             State: <Active Int>
             Age: 1:14       Metric: 2       Tag: 0
             Task: RIPv2
             Announcement bits (2): 0-KRT 1-RIPv2
             AS path: I
             Route learned from 192.168.1.37 expires in 178 seconds

  172.16.2.0/30 (1 entry, 1 announced)
             *RIP    Preference: 100
             Next hop type: Router, Next hop index: 395
             Next-hop reference count: 4
             Next hop: 192.168.1.37 via ge-0/0/0.0, selected
             State: <Active Int>
             Age: 1:14       Metric: 2       Tag: 0
             Task: RIPv2
             Announcement bits (2): 0-KRT 1-RIPv2
             AS path: I
             Route learned from 192.168.1.37 expires in 178 seconds

192.168.1.44/30 (1 entry, 1 announced)
             *RIP    Preference: 100
```


RIP In Use

```
student@juniper-3> monitor traffic interface ge-0/0/0.0 no-resolve extensive
Address resolution is OFF.
Listening on ge-0/0/0.0, capture size 1514 bytes

09:51:20.908342 Out
  Juniper PCAP Flags [Ext], PCAP Extension(s) total length 16
  Device Media Type Extension TLV #3, length 1, value: Ethernet (1)
  Logical Interface Encapsulation Extension TLV #6, length 1, value: Et)
  Device Interface Index Extension TLV #1, length 2, value: 137
  Logical Interface Index Extension TLV #4, length 4, value: 66
        -----original packet-----
  0:1d:b5:f:6e:0 > 1:0:5e:0:0:9, ethertype IPv4 (0x0800), length 86: (tos RIPv2, Response, length:
    44, routes: 2
    AFI: IPv4:    192.168.1.40/30, tag 0x0000, metric: 1, next-hop: self
    AFI: IPv4:    192.168.1.44/30, tag 0x0000, metric: 2, next-hop: self
    0x0000: 0202 0000 0002 0000 c0a8 0128 ffff fffc
    0x000f: 0000 0000 0000 0001 0002 0000 c0a8 012c
    0x001f: ffff fffc 0000 0000 0000 0002
09:51:36.808710  In
  Juniper PCAP Flags [Ext, no-L2, In], PCAP Extension(s) total length 16
  Device Media Type Extension TLV #3, length 1, value: Ethernet (1)
  Logical Interface Encapsulation Extension TLV #6, length 1, value: Et)
  Device Interface Index Extension TLV #1, length 2, value: 137
  Logical Interface Index Extension TLV #4, length 4, value: 66
        -----original packet-----
  PFE proto 2 (ipv4): (tos 0xc0, ttl   1, id 45955, offset 0, flags [none RIPv2, Response, length:
    44, routes: 2
   AFI: IPv4:      172.16.2.0/30, tag 0x0000, metric: 1, next-hop: self
   AFI: IPv4:        0.0.0.0/0 , tag 0x0000, metric: 1, next-hop: self
   0x0000: 0202 0000 0002 0000 ac10 0200 ffff fffc
   0x000f: 0000 0000 0000 0001 0002 0000 0000 0000
   0x001f: 0000 0000 0000 0000 0000 0001
09:51:48.028605 Out
  Juniper PCAP Flags [Ext], PCAP Extension(s) total length 16 …
```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- Interfaces
- Protocols
  - RIP
  - OSPF
  - BGP

OSPF Configuration

```
student@juniper-1> show configuration
version 8.4R1.13;
system {
  host-name juniper-1;
…
}
interfaces {
  ge-0/0/0 {
    description "r1 ge-0/0/0 - r0 ge-0/0/0";
    unit 0 {
      family inet {
        address 192.168.1.26/30;
      }
    }
  }
  ge-0/0/1 {
    description "r1 ge-0/0/0 - r2 ge-0/0/1";
    unit 0 {
      family inet {
        address 192.168.1.29/30;
      }
    }
  }
}
protocols {
  ospf {
    area 0.0.0.0 {
      interface all;
    }
  }
}
```

Area 0

OSPF Adjacencies

```
student@juniper-1> show ospf neighbor detail
Address          Interface              State     ID               Pri  Dead
192.168.1.25     ge-0/0/0.0             Full      172.16.1.1       128    33
  Area 0.0.0.0, opt 0x42, DR 192.168.1.25, BDR 192.168.1.26
  Up 00:06:30, adjacent 00:06:30
192.168.1.30     ge-0/0/1.0             Full      192.168.1.30     128    35
  Area 0.0.0.0, opt 0x42, DR 192.168.1.30, BDR 192.168.1.29
  Up 00:05:58, adjacent 00:05:27
```

ge-0/0/0.0
192.168.1.26/30

ge-0/0/1.0
192.168.1.29/30

- Each LSA contains a router ID
- If a Juniper does not have an ID set, it will use its lowest IP address
- This may not match the neighbour address.

The Routing Table

```
student@juniper-1> show route

inet.0: 7 destinations, 7 routes (7 active, 0 holddown, 0 hidden)
+ = Active Route, - = Last Active, * = Both

172.16.1.0/30      *[OSPF/10] 00:07:17, metric 2
                   > to 192.168.1.25 via ge-0/0/0.0
192.168.1.24/30    *[Direct/0] 00:07:26
                   > via ge-0/0/0.0
192.168.1.26/32    *[Local/0] 00:07:26
                   Local via ge-0/0/0.0
192.168.1.28/30    *[Direct/0] 00:07:26
                   > via ge-0/0/1.0
192.168.1.29/32    *[Local/0] 00:07:26
                   Local via ge-0/0/1.0
192.168.1.32/30    *[OSPF/10] 00:06:13, metric 2
                   > to 192.168.1.30 via ge-0/0/1.0
224.0.0.5/32       *[OSPF/10] 00:07:27, metric 1
                     MultiRecv

__juniper_private1__.inet.0: 2 destinations, 2 routes (2 active, 0 holddown, 0 )+ =
    Active Route, - = Last Active, * = Both

10.0.0.1/32        *[Direct/0] 5w2d 00:56:37
                   > via lo0.16385
10.0.0.16/32       *[Direct/0] 5w2d 00:56:37
                   > via lo0.16385
```


OSPF Routes

```
student@juniper-1> show route protocol ospf

inet.0: 7 destinations, 7 routes (7 active, 0 holddown, 0 hidden)
+ = Active Route, - = Last Active, * = Both

172.16.1.0/30      *[OSPF/10] 00:09:18, metric 2
                   > to 192.168.1.25 via ge-0/0/0.0
192.168.1.32/30    *[OSPF/10] 00:08:14, metric 2
                   > to 192.168.1.30 via ge-0/0/1.0
224.0.0.5/32       *[OSPF/10] 00:09:28, metric 1
                     MultiRecv

__juniper_private1__.inet.0: 2 destinations, 2 routes (2 active,
   0 holddown, 0 )+ = Active Route, - = Last Active, * = Both
```

OSPF Topology – LSA's

```
student@juniper-1> show ospf database

    OSPF link state database, Area 0.0.0.0
     Type       ID               Adv Rtr           Seq      Age  Opt  Cksum  Len
     Router   172.16.1.1       172.16.1.1       0x80000007   581  0x22 0xd3d3  36
     Router  *192.168.1.26     192.168.1.26     0x80000005   512  0x22 0x7489  48
     Router   192.168.1.30     192.168.1.30     0x80000004   509  0x22 0xdd8   48
     Router   192.168.1.34     192.168.1.34     0x80000006   510  0x22 0xf308  36
     Network  192.168.1.25     172.16.1.1       0x80000001   581  0x22 0x2d8a  32
     Network  192.168.1.30     192.168.1.30     0x80000002   513  0x22 0x45d8  32
     Network  192.168.1.34     192.168.1.34     0x80000001   510  0x22 0x67a7  32
     Summary  172.16.1.0       172.16.1.1       0x80000005   567  0x22 0x4975  28
```


OSPF Topology – LSA's Again

```
student@juniper-1> show ospf database detail

    OSPF link state database, Area 0.0.0.0
      Type       ID               Adv Rtr           Seq      Age  Opt  Cksum  Len
      Router   172.16.1.1       172.16.1.1       0x80000007   596  0x22 0xd3d3  36
        bits 0x1, link count 1
        id 192.168.1.25, data 192.168.1.25, Type Transit (2)
        TOS count 0, TOS 0 metric 1
      Router  *192.168.1.26     192.168.1.26     0x80000005   527  0x22 0x7489  48
        bits 0x0, link count 2
        id 192.168.1.25, data 192.168.1.26, Type Transit (2)
        TOS count 0, TOS 0 metric 1
        id 192.168.1.30, data 192.168.1.29, Type Transit (2)
        TOS count 0, TOS 0 metric 1
      Router   192.168.1.30     192.168.1.30     0x80000004   524  0x22 0xdd8   48
        bits 0x0, link count 2
        id 192.168.1.34, data 192.168.1.33, Type Transit (2)
        TOS count 0, TOS 0 metric 1
        id 192.168.1.30, data 192.168.1.30, Type Transit (2)
        TOS count 0, TOS 0 metric 1
```

Bits: 2 External
1 ABR
(so 3 both)

Link (not route) metric

OSPF Routes

- **SPF Calculation Result**

```
student@juniper-1> show ospf route
    Prefix             Path   Route       NH   Metric  NextHop       Nexthop
                       Type   Type        Type         Interface     addr/label
    172.16.1.1         Intra  Area BR     IP        1  ge-0/0/0.0    192.168.1.25
    192.168.1.30       Intra  Router      IP        1  ge-0/0/1.0    192.168.1.30
    192.168.1.34       Intra  Router      IP        2  ge-0/0/1.0    192.168.1.30
    172.16.1.0/30      Inter  Network     IP        2  ge-0/0/0.0    192.168.1.25
    192.168.1.24/30    Intra  Network     IP        1  ge-0/0/0.0
    192.168.1.28/30    Intra  Network     IP        1  ge-0/0/1.0
    192.168.1.32/30    Intra  Network     IP        2  ge-0/0/1.0    192.168.1.30
```

- **Routes in the routing table from OSPF**

```
student@juniper-1> show route protocol ospf

inet.0: 7 destinations, 7 routes (7 active, 0 holddown, 0 hidden)
+ = Active Route, - = Last Active, * = Both

172.16.1.0/30      *[OSPF/10] 00:09:18, metric 2
                   > to 192.168.1.25 via ge-0/0/0.0
192.168.1.32/30    *[OSPF/10] 00:08:14, metric 2
                   > to 192.168.1.30 via ge-0/0/1.0
224.0.0.5/32       *[OSPF/10] 00:09:28, metric 1
                     MultiRecv
```


What are these Packets?

```
student@juniper-1> monitor traffic interface ge-0/0/0.0 no-resolve extensive
Address resolution is OFF.
Listening on ge-0/0/0.0, capture size 1514 bytes

10:12:09.073289  In
    Juniper PCAP Flags [Ext, no-L2, In], PCAP Extension(s) total length 16
        Device Media Type Extension TLV #3, length 1, value: Ethernet (1)
        Logical Interface Encapsulation Extension TLV #6, length 1, value: Et)
        Device Interface Index Extension TLV #1, length 2, value: 137
        Logical Interface Index Extension TLV #4, length 4, value: 66
          -----original packet-----
        PFE proto 2 (ipv4): (tos 0xc0, ttl   1, id 46558, offset 0, flags [none8
        Router-ID 172.16.1.1, Backbone Area, Authentication Type: none (0)
             Options [External]
             Hello Timer 10s, Dead Timer 40s, Mask 255.255.255.252, Priority 128
             Designated Router 192.168.1.25, Backup Designated Router 192.168.1.26
             Neighbor List:
                192.168.1.26

10:12:13.003000 Out
    Juniper PCAP Flags [Ext], PCAP Extension(s) total length 16
        Device Media Type Extension TLV #3, length 1, value: Ethernet (1)
        Logical Interface Encapsulation Extension TLV #6, length 1, value: Et)
        Device Interface Index Extension TLV #1, length 2, value: 137
        Logical Interface Index Extension TLV #4, length 4, value: 66
          -----original packet-----
        0:1d:b5:f:72:0 > 1:0:5e:0:0:5, ethertype IPv4 (0x0800), length 82: (tos8
        Router-ID 192.168.1.26, Backbone Area, Authentication Type: none (0)
             Options [External]
             Hello Timer 10s, Dead Timer 40s, Mask 255.255.255.252, Priority 128
             Designated Router 192.168.1.25, Backup Designated Router 192.168.1.26
             Neighbor List:
                172.16.1.1

10:12:17.253381  In
        Juniper PCAP Flags [Ext, no-L2, In], PCAP Extension(s) total length 16
        Device Media Type Extension TLV #3, length 1, value: Ethernet (1) …
```

Oops

```
student@juniper-1>show ospf neighbor
Address          Interface              State     ID              Pri  Dead
192.168.1.25     ge-0/0/0.0             Full      172.16.1.1      128    31
192.168.1.30     ge-0/0/1.0             Full      192.168.1.30    128     6

student@juniper-1> show ospf neighbor
Address          Interface              State     ID              Pri  Dead
192.168.1.25     ge-0/0/0.0             Full      172.16.1.1      128    37
192.168.1.30     ge-0/0/1.0             Full      192.168.1.30    128     3

student@juniper-1> show ospf neighbor
Address          Interface              State     ID              Pri  Dead
192.168.1.25     ge-0/0/0.0             Full      172.16.1.1      128    35
192.168.1.30     ge-0/0/1.0             Full      192.168.1.30    128     1

student@juniper-1> show ospf neighbor
Address          Interface              State     ID              Pri  Dead
192.168.1.25     ge-0/0/0.0             Full      172.16.1.1      128    34

student@juniper-1> show ospf neighbor
Address          Interface              State     ID              Pri  Dead
192.168.1.25     ge-0/0/0.0             Full      172.16.1.1      128    31
192.168.1.30     ge-0/0/1.0             Full      192.168.1.30    128    34
```


Database Descriptor

On loss of contact with a neighbour, Hello packets continue to be sent. Once an adjacency has been re-established ...

```
10:25:07.511610 Out
   Juniper PCAP Flags [Ext], PCAP Extension(s) total length 16
        Device Media Type Extension TLV #3, length 1, value: Ethernet (1)
        Logical Interface Encapsulation Extension TLV #6, length 1, value: Et)
        Device Interface Index Extension TLV #1, length 2, value: 138
        Logical Interface Index Extension TLV #4, length 4, value: 67
          -----original packet-----
        0:1d:b5:f:72:1 > 0:1d:b5:f:72:81, ethertype IPv4 (0x0800), length 226: 2
        Router-ID 192.168.1.26, Backbone Area, Authentication Type: none (0)
             Options [External, Opaque], DD Flags [none]
             Advertising Router 172.16.1.1, seq 0x80000008, age 891s, length 16
                 Router LSA (1), LSA-ID: 172.16.1.1
                 Options: [External, Demand Circuit]
             Advertising Router 192.168.1.26, seq 0x8000000c, age 4s, length 28
                 Router LSA (1), LSA-ID: 192.168.1.26
                 Options: [External, Demand Circuit]
             Advertising Router 192.168.1.30, seq 0x80000004, age 1433s, length 28
                 Router LSA (1), LSA-ID: 192.168.1.30
                 Options: [External, Demand Circuit]
             Advertising Router 192.168.1.34, seq 0x80000006, age 1434s, length 16
                 Router LSA (1), LSA-ID: 192.168.1.34
                 Options: [External, Demand Circuit]
             Advertising Router 172.16.1.1, seq 0x80000002, age 591s, length 12
                 Network LSA (2), LSA-ID: 192.168.1.25
                 Options: [External, Demand Circuit]
             Advertising Router 192.168.1.30, seq 0x80000002, age 1437s, length 12
                 Network LSA (2), LSA-ID: 192.168.1.30
                 Options: [External, Demand Circuit]
             Advertising Router 192.168.1.34, seq 0x80000001, age 1434s, length 12
                 Network LSA (2), LSA-ID: 192.168.1.34
                 Options: [External, Demand Circuit]
             Advertising Router 172.16.1.1, seq 0x80000005, age 1491s, length 8
                 Summary LSA (3), LSA-ID: 172.16.1.0
                 Options: [External, Demand Circuit]
```


Link-State Update

Back comes a Link State Request packet which contains much the same LSA headers . So out go Link-State Update packets containing full LSA's ...

```
10:25:12.531104 Out
    Juniper PCAP Flags [Ext], PCAP Extension(s) total length 16
        Device Media Type Extension TLV #3, length 1, value: Ethernet (1)
        Logical Interface Encapsulation Extension TLV #6, length 1, value: Et)
        Device Interface Index Extension TLV #1, length 2, value: 138
        Logical Interface Index Extension TLV #4, length 4, value: 67
          -----original packet-----
        0:1d:b5:f:72:1 > 0:1d:b5:f:72:81, ethertype IPv4 (0x0800), length 322: 8
        Router-ID 192.168.1.26, Backbone Area, Authentication Type: none (0), 7s
        LSA #1
          Advertising Router 172.16.1.1, seq 0x80000008, age 897s, length 16

             Router LSA (1), LSA-ID: 172.16.1.1

             Options: [External, Demand Circuit]
             Router LSA Options: [ABR]
             Neighbor Network-ID: 192.168.1.25, Interface Address: 192.168.1.21
             0x0000: 0100 0001 c0a8 0119 c0a8 0119 0200 0001
        LSA #2
          Advertising Router 192.168.1.26, seq 0x8000000c, age 10s, length 28
             Router LSA (1), LSA-ID: 192.168.1.26
             Options: [External, Demand Circuit]
             Router LSA Options: [none]
             Neighbor Network-ID: 192.168.1.25, Interface Address: 192.168.1.21
             Stub Network: 192.168.1.28, Mask: 255.255.255.252, tos 0, metric:1
             0x0000: 0000 0002 c0a8 0119 c0a8 011a 0200 0001 …
```


Juniper Routers

- The Router Lab
- Logging In
- Modes
- Interfaces
- Protocols
  - RIP
  - OSPF
  - BGP

BGP

- Read Soricelli, JNCIA Study Guide. Chapter 8
  - Available on Moodle
- For advanced config read JNCIS Study Guide, Chapters 4 and 5.