University of Pisa
Department of Computer Science

MASTER'S DEGREE IN COMPUTER SCIENCE AND NETWORKING

Routing Architectures and Protocols Lab

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CONFIGURE INTERFACES FOR THE GIVEN NETWROK TOPOLOGY IMPLEMENT SINGLE AREA OSPF AND CLASS OF SERVICE

Author
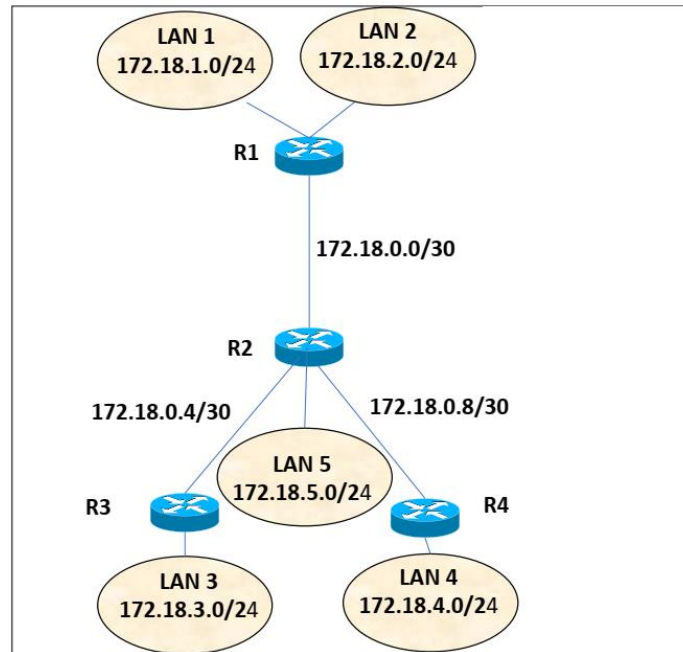*Hassan Shabir*
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Contents

Network Topology

R1 and R2 are Juniper Routers, R3 and R4 are Cisco Routers. All interfaces are Gigabit Ethernet or Fast Ethernet,
a) Configure all interfaces
b) Configure OSPF Single-Area.
c) Configure CoS on R1 and R2. Forwarding Classes configuration is reported in the following table.

Queue	Forwarding Class	Bandwidth and buffer allocation (%)	Priority
0	best-effort	75	Low
1	research	10	High
2	sales	10	Medium-Low
3	Network control	5	Medium-high

research (department) = traffic exchanged between 172.18.3.0/24 and 172.18.1.3 or 172.18.2.0/24
sales = traffic to/from 172.18.4.0/24

Network Topology Diagram Using Gn3

R1 and R2 are Juniper Routers, R3 and R4 are Cisco Routers.

OSPF AREA 0.0.0.0

Loop back	
#	**IP Address**
R1	192.168.1.1/32
R2	192.168.1.2/32
R3	192.168.1.3/32
R4	192.168.1.4/32
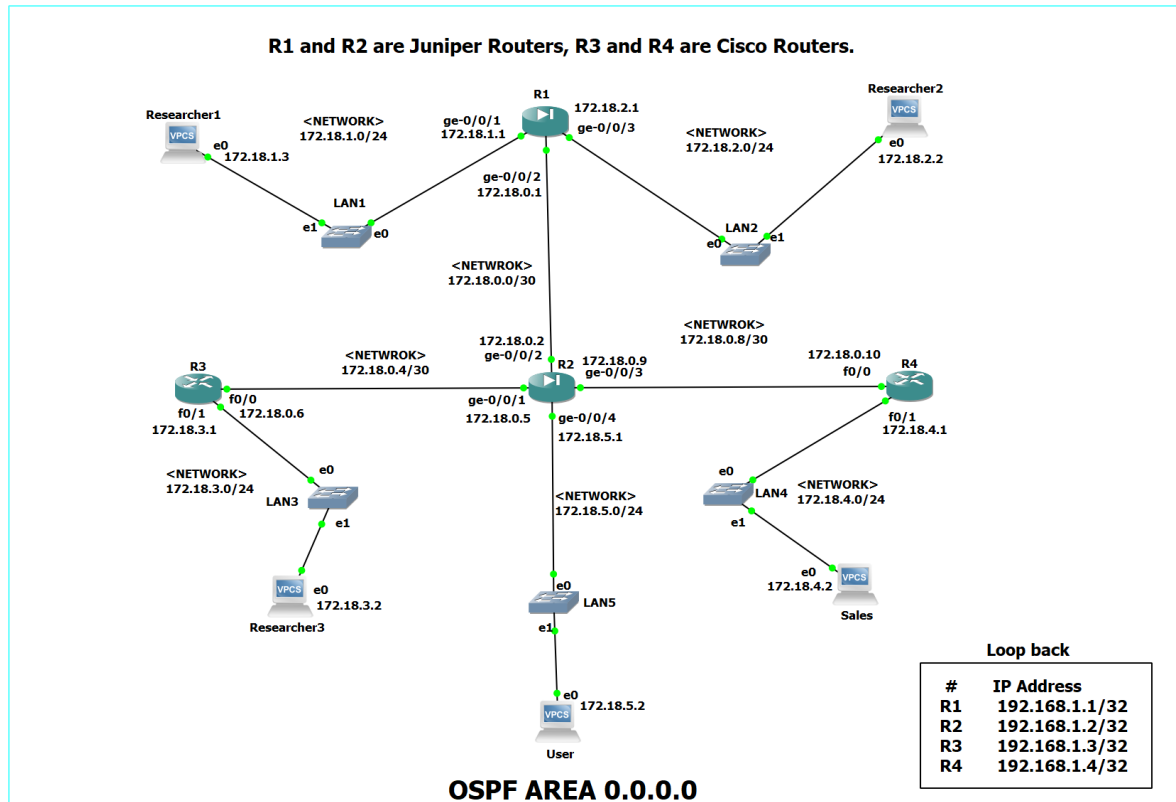
Juniper Router R1 Configuration

hassan@R1# run show configuration
Last commit: 2022-12-19 18:44:59 CET by hassan
version 12.1X47-D15.4;
system {
  host-name R1;
  time-zone Europe/Rome;
  root-authentication {
    encrypted-password "1YIOguI8t$6yw3Nxf9dPm8oVnWO1WDW."; ## SECRET-
DATA
  }
  login {
    class juniper {
      permissions [reset view view-configuration];
    }
    user guest {
      uid 2001;
      class read-only;
      authentication {
        encrypted-password "1UPaI1UTJ$agIj3WAPe4TIC6tebdMCa/"; ## SECRET-
DATA
      }
    }

```
    user hassan {
       uid 2002;
       class super-user;
       authentication {
          encrypted-password "$1$DJOPf1XS$WdrSNSXgcHisVAZwqNCZD0"; ## SECRET-
DATA
       }
    }
    user intern {
       uid 2003;
       class juniper;
       authentication {
          encrypted-password "$1$jtMfpVWI$zZW/ekLZLhxzVJR//1JGL1"; ## SECRET-
DATA
       }
    }
  }
  services {
    ssh;
    telnet;
    web-management {
       http {
          interface ge-0/0/0.0;
       }
    }
  }
  syslog {
    user * {
       any emergency;
    }
    file messages {
       any any;
       authorization info;
    }
    file interactive-commands {
       interactive-commands any;
    }
  }
  license {
    autoupdate {
       url https://ae1.juniper.net/junos/key_retrieval;
    }
  }
}
interfaces {
  ge-0/0/0 {
    unit 0;
  }
  ge-0/0/1 {
    unit 0 {
       family inet {
          filter {
             input classify-traffic;
          }
          address 172.18.1.1/24;
```

```
                }
            }
        }
        ge-0/0/2 {
            unit 0 {
                family inet {
                    address 172.18.0.1/30;
                }
            }
        }
        ge-0/0/3 {
            unit 0 {
                family inet {
                    filter {
                        input classify-traffic;
                    }
                    address 172.18.2.1/24;
                }
            }
        }
        lo0 {
            unit 0 {
                family inet {
                    address 192.168.1.1/32;
                }
            }
        }
    }
    protocols {
        ospf {
            area 0.0.0.0 {
                interface ge-0/0/1.0;
                interface ge-0/0/2.0;
                interface ge-0/0/3.0;
                interface lo0.0;
            }
        }
    }
    class-of-service {
        forwarding-classes {
            queue 1 research;
            queue 2 sales;
        }
        interfaces {
            ge-0/0/1 {
                scheduler-map my-sched-map;
            }
            ge-0/0/2 {
                scheduler-map my-sched-map;
                unit 0 {
                    rewrite-rules {
                        inet-precedence default;
                    }
                }
            }
```

```
        ge-0/0/3 {
            scheduler-map my-sched-map;
        }
    }
    scheduler-maps {
        my-sched-map {
            forwarding-class best-effort scheduler best-effort-sched;
            forwarding-class research scheduler research-sched;
            forwarding-class sales scheduler sales-sched;
            forwarding-class network-control scheduler network-control-sched;
        }
    }
    schedulers {
        best-effort-sched {
            transmit-rate percent 75;
            buffer-size percent 75;
            priority low;
        }
        research-sched {
            transmit-rate percent 10;
            buffer-size percent 10;
            priority high;
        }
        sales-sched {
            transmit-rate percent 10;
            buffer-size percent 10;
            priority medium-low;
        }
        network-control-sched {
            transmit-rate percent 5;
            buffer-size percent 5;
            priority medium-high;
        }
    }
}
security {
    forwarding-options {
        family {
            mpls {
                mode packet-based;
            }
        }
    }
}
firewall {
    family inet {
        filter classify-traffic {
            term research {
                from {
                    source-address {
                        172.18.1.3/32;
                        172.18.2.0/24;
                    }
                    destination-address {
                        172.18.3.0/24;
```

```
                }
            }
            then {
                forwarding-class research;
                accept;
            }
        }
        term sales {
            from {
                destination-address {
                    172.18.4.0/24;
                }
            }
            then {
                forwarding-class sales;
                accept;
            }
        }
        term accept-all {
            then accept;
        }
    }
  }
}
```

Juniper Router R2 Configuration

```
hassan# run show configuration
## Last commit: 2022-12-19 14:47:28 CET by hassan
version 12.1X47-D15.4;
system {
    time-zone Europe/Rome;
    root-authentication {
        encrypted-password "$1$3DhIKHSO$ow.V4jKAp5V1B7mjRdbMX1"; ## SECRET-DATA
    }
    login {
        class juniper {
            permissions [ reset view view-configuration ];
        }
        user guest {
            uid 2001;
            class read-only;
            authentication {
                encrypted-password    "$1$REzCa7YD$KO/.H3zKiV.IXleld2AY3.";    ##    SECRET-
DATA
            }
        }
        user hassan {
            uid 2002;
            class super-user;
            authentication {
                encrypted-password "$1$8ncAEk/W$6BA64Y88HxzPGUJsunQ330"; ## SECRET-
DATA
            }
        }
        user intern {
            uid 2003;
            class juniper;
        }
    }
    services {
        ssh;
        telnet;
        web-management {
            http {
                interface ge-0/0/0.0;
            }
        }
    }
    syslog {
        user * {
            any emergency;
        }
        file messages {
```

```
            any any;
            authorization info;
        }
        file interactive-commands {
            interactive-commands any;
        }
    }
    license {
        autoupdate {
        url https://ae1.juniper.net/junos/key_retrieval;
        }
    }
}
interfaces {
    ge-0/0/0 {
        unit 0;
    }
    ge-0/0/1 {
        unit 0 {
            family inet {
                filter {
                    input classify-traffic;
                }
                address 172.18.0.5/30;
            }
        }
    }
    ge-0/0/2 {
        unit 0 {
            family inet {
                address 172.18.0.2/30;
            }
        }
    }
    ge-0/0/3 {
        unit 0 {
            family inet {
                filter {
                    input classify-traffic;
                }
                address 172.18.0.9/30;
            }
        }
    }
    ge-0/0/4 {
        unit 0 {
            family inet {
                address 172.18.5.1/24;
```

```
            }
          }
        lo0 {
          unit 0 {
            family inet {
              address 192.168.1.2/32;
            }
          }
        }
      }
      protocols {
        ospf {
          area 0.0.0.0 {
            interface ge-0/0/1.0;
            interface ge-0/0/2.0;
            interface ge-0/0/3.0;
            interface ge-0/0/4.0;
            interface lo0.0;
          }
        }
      }
      class-of-service {
        forwarding-classes {
          queue 1 research;
          queue 2 sales;
        }
        interfaces {
          ge-0/0/1 {
            scheduler-map my-sched-map;
          }
          ge-0/0/2 {
            scheduler-map my-sched-map;
          }
          ge-0/0/3 {
            scheduler-map my-sched-map;
          }
          ge-0/0/4 {
            scheduler-map my-sched-map;
          }
        }
        scheduler-maps {
          my-sched-map {
            forwarding-class best-effort scheduler best-effort-sched;
            forwarding-class research scheduler research-sched;
            forwarding-class sales scheduler sales-sched;
            forwarding-class network-control scheduler network-control-sched;
          }
```

```
        }
        schedulers {
            best-effort-sched {
                transmit-rate percent 75;
                buffer-size percent 75;
                priority low;
            }
            research-sched {
                transmit-rate percent 10;
                buffer-size percent 10;
                priority high;
            }
            sales-sched {
                transmit-rate percent 10;
                buffer-size percent 10;
                priority medium-low;
            }
            network-control-sched {
                transmit-rate percent 5;
                buffer-size percent 5;
                priority medium-high;
            }
        }
    }
    security {
        forwarding-options {
            family {
                mpls {
                    mode packet-based;
                }
            }
        }
    }
    firewall {
        family inet {
            filter classify-traffic {
                term sales {
                    from {
                        source-address {
                            172.18.4.0/24;
                        }
                        destination-address {
                            172.18.4.0/24;
                        }
                        protocol icmp;
                    }
                    then {
                        forwarding-class sales;
```

```
                accept;
            }
        }
        term researcher3 {
            from {
                source-address {
                    172.18.3.0/24;
                }
                destination-address {
                    172.18.1.3/32;
                    172.18.2.0/24;
                }
                protocol icmp;
            }
            then {
                forwarding-class research;
                accept;
            }
        }
        term accept-all {
            then accept;
        }
    }
  }
}
```

Results

- Packets from User Researcher1 to Sales.

```
   High                 :                    0                   0 bps
Queue: 1, Forwarding classes: research
  Queued:
    Packets             :                   15                   0 pps
    Bytes               :                 1470                   0 bps
  Transmitted:
    Packets             :                   15                    0 pps
    Bytes               :                 1470                   0 bps
    Tail-dropped packets :                   0                   0 pps
    RED-dropped packets  :                   0                   0 pps
     Low                :                    0                   0 pps
     Medium-low         :                    0                   0 pps
     Medium-high        :                    0                   0 pps
     High               :                    0                   0 pps
    RED-dropped bytes   :                    0                   0 bps
     Low                :                    0                   0 bps
     Medium-low         :                    0                   0 bps
     Medium-high        :                    0                   0 bps
     High               :                    0                   0 bps
Queue: 2, Forwarding classes: sales
  Queued:
    Packets             :                    5                   0 pps
    Bytes               :                  490                   0 bps
  Transmitted:
    Packets             :                    5                    0 pps
    Bytes               :                  490                   0 bps
    Tail-dropped packets :                   0                   0 pps
    RED-dropped packets  :                   0                   0 pps
     Low                :                    0                   0 pps
     Medium-low         :                    0                   0 pps
     Medium-high        :                    0                   0 pps
     High               :                    0                   0 pps
    RED-dropped bytes   :                    0                   0 bps
     Low                :                    0                   0 bps
     Medium-low         :                    0                   0 bps
     Medium-high        :                    0                   0 bps
     High               :                    0                   0 bps
Queue: 3, Forwarding classes: network-control
  Queued:
    Packets             :                  771                   0 pps
    Bytes               :                72502                   0 bps
  Transmitted:
    Packets             :                  771                    0 pps
    Bytes               :                72502                   0 bps
    Tail-dropped packets :                   0                   0 pps
---(more 86%)---
```

Figure 1 Packets from User Researcher1 to Sales

- Packets from User Researcher2 to Researcher3.

```
Egress queues: 8 supported, 4 in use
Queue: 0, Forwarding classes: best-effort
  Queued:
    Packets             :                   0                   0 pps
    Bytes               :                   0                   0 bps
  Transmitted:
    Packets             :                   0                   0 pps
    Bytes               :                   0                   0 bps
    Tail-dropped packets :                  0                   0 pps
    RED-dropped packets  :                  0                   0 pps
     Low                :                   0                   0 pps
     Medium-low         :                   0                   0 pps
     Medium-high        :                   0                   0 pps
     High               :                   0                   0 pps
    RED-dropped bytes   :                   0                   0 bps
     Low                :                   0                   0 bps
     Medium-low         :                   0                   0 bps
     Medium-high        :                   0                   0 bps
     High               :                   0                   0 bps
Queue: 1, Forwarding classes: research
  Queued:
    Packets             :                  10                   0 pps
    Bytes               :                 980                   0 bps
  Transmitted:
    Packets             :                  10                   0 pps
    Bytes               :                 980                   0 bps
    Tail-dropped packets :                  0                   0 pps
    RED-dropped packets  :                  0                   0 pps
     Low                :                   0                   0 pps
     Medium-low         :                   0                   0 pps
     Medium-high        :                   0                   0 pps
     High               :                   0                   0 pps
    RED-dropped bytes   :                   0                   0 bps
     Low                :                   0                   0 bps
     Medium-low         :                   0                   0 bps
     Medium-high        :                   0                   0 bps
     High               :                   0                   0 bps
Queue: 2, Forwarding classes: sales
  Queued:
    Packets             :                   0                   0 pps
    Bytes               :                   0                   0 bps
  Transmitted:
    Packets             :                   0                   0 pps
    Bytes               :                   0                   0 bps
    Tail-dropped packets :                  0                   0 pps
    RED-dropped packets  :                  0                   0 pps
     Low                :                   0                   0 pps
     Medium-low         :                   0                   0 pps
     Medium-high        :                   0                   0 pps
     High               :                   0                   0 pps
    RED-dropped bytes   :                   0                   0 bps
     Low                :                   0                   0 bps
     Medium-low         :                   0                   0 bps
     Medium-high        :                   0                   0 bps
     High               :                   0                   0 bps
Queue: 3, Forwarding classes: network-control
  Queued:
    Packets             :                  70                   0 pps
    Bytes               :                6564                   0 bps
---(more 82%)---
```

Figure 2 User Researcher2 to Researcher3.

- Packets from Sales to Researcher 1

```
Transmitted:
   Packets              :              0               0 pps
   Bytes                :              0               0 bps
   Tail-dropped packets :              0               0 pps
   RED-dropped packets  :              0               0 pps
    Low                 :              0               0 pps
    Medium-low          :              0               0 pps
    Medium-high         :              0               0 pps
    High                :              0               0 pps
   RED-dropped bytes    :              0               0 bps
    Low                 :              0               0 bps
    Medium-low          :              0               0 bps
    Medium-high         :              0               0 bps
    High                :              0               0 bps
Queue: 1, Forwarding classes: research
  Queued:
   Packets              :              0               0 pps
   Bytes                :              0               0 bps
  Transmitted:
   Packets              :              0               0 pps
   Bytes                :              0               0 bps
   Tail-dropped packets :              0               0 pps
   RED-dropped packets  :              0               0 pps
    Low                 :              0               0 pps
    Medium-low          :              0               0 pps
    Medium-high         :              0               0 pps
    High                :              0               0 pps
   RED-dropped bytes    :              0               0 bps
    Low                 :              0               0 bps
    Medium-low          :              0               0 bps
    Medium-high         :              0               0 bps
    High                :              0               0 bps
Queue: 2, Forwarding classes: sales
  Queued:
   Packets              :              5               0 pps
   Bytes                :            490               0 bps
  Transmitted:
   Packets              :              5               0 pps
   Bytes                :            490               0 bps
   Tail-dropped packets :              0               0 pps
   RED-dropped packets  :              0               0 pps
    Low                 :              0               0 pps
    Medium-low          :              0               0 pps
    Medium-high         :              0               0 pps
    High                :              0               0 pps
   RED-dropped bytes    :              0               0 bps
    Low                 :              0               0 bps
    Medium-low          :              0               0 bps
    Medium-high         :              0               0 bps
    High                :              0               0 bps
Queue: 3, Forwarding classes: network-control
  Queued:
   Packets              :             41               0 pps
   Bytes                :           3914               0 bps
  Transmitted:
   Packets              :             41               0 pps
   Bytes                :           3914               0 bps
   Tail-dropped packets :              0               0 pps
   RED-dropped packets  :              0               0 pps
---(more 88%)---
```

Figure 3 Sales to Researcher

- Packets from User

```
Tail-dropped packets :                    0              0 pps
  RED-dropped packets  :                    0              0 pps
   Low                 :                    0              0 pps
   Medium-low          :                    0              0 pps
   Medium-high         :                    0              0 pps
   High                :                    0              0 pps
  RED-dropped bytes    :                    0              0 bps
   Low                 :                    0              0 bps
   Medium-low          :                    0              0 bps
   Medium-high         :                    0              0 bps
   High                :                    0              0 bps

hassan> show interfaces queue ge-0/0/2
Physical interface: ge-0/0/2, Enabled, Physical link is Up
  Interface index: 136, SNMP ifIndex: 519
Forwarding classes: 8 supported, 4 in use
Egress queues: 8 supported, 4 in use
Queue: 0, Forwarding classes: best-effort
  Queued:
    Packets             :                    5              0 pps
    Bytes               :                  490              0 bps
  Transmitted:
    Packets             :                    5              0 pps
    Bytes               :                  490              0 bps
    Tail-dropped packets :                   0              0 pps
    RED-dropped packets  :                   0              0 pps
     Low                :                    0              0 pps
     Medium-low         :                    0              0 pps
     Medium-high        :                    0              0 pps
     High               :                    0              0 pps
    RED-dropped bytes    :                   0              0 bps
     Low                :                    0              0 bps
     Medium-low         :                    0              0 bps
     Medium-high        :                    0              0 bps
     High               :                    0              0 bps
Queue: 1, Forwarding classes: research
  Queued:
    Packets             :                    0              0 pps
    Bytes               :                    0              0 bps
  Transmitted:
    Packets             :                    0              0 pps
    Bytes               :                    0              0 bps
    Tail-dropped packets :                   0              0 pps
    RED-dropped packets  :                   0              0 pps
     Low                :                    0              0 pps
     Medium-low         :                    0              0 pps
     Medium-high        :                    0              0 pps
     High               :                    0              0 pps
    RED-dropped bytes    :                   0              0 bps
     Low                :                    0              0 bps
     Medium-low         :                    0              0 bps
     Medium-high        :                    0              0 bps
     High               :                    0              0 bps
Queue: 2, Forwarding classes: sales
  Queued:
    Packets             :                    5              0 pps
    Bytes               :                  490              0 bps
  Transmitted:
    Packets             :                    5              0 pps
---(more 59%)---
```

Figure 4 Packets from User