Turbo Router

6WIND Border Router Deployment Guide

Release 2.2

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Contents

1. Overview

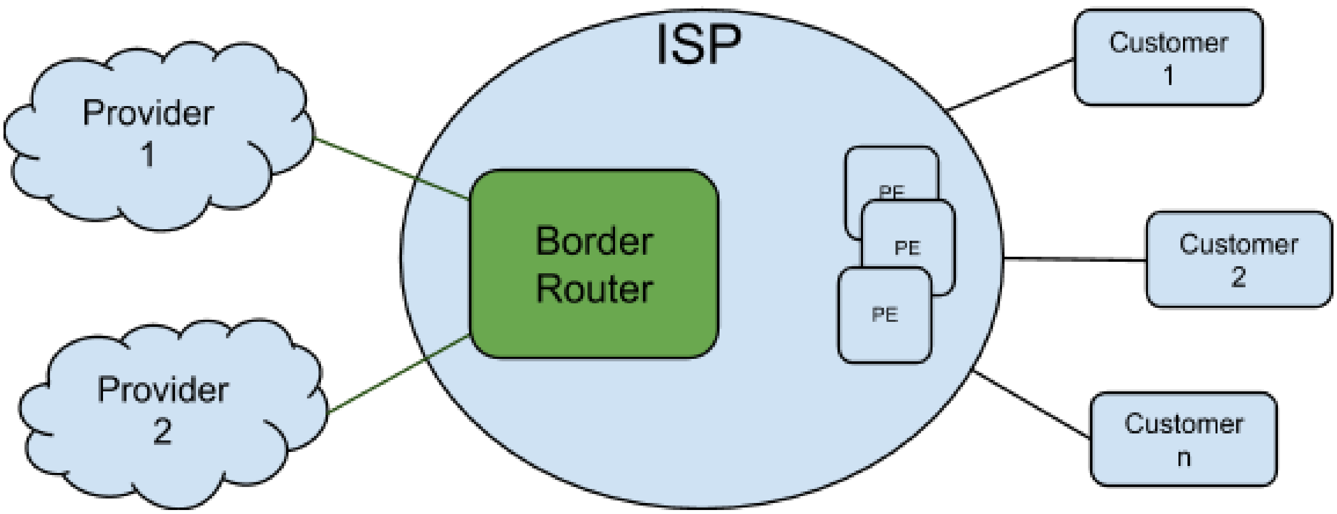
The purpose of this document is to guide the user in deploying the vRouter for a Border Router use case. It focuses on the concepts that are relevant to this specific use case, in order to provide a practical example. Exhaustive documentation of the vRouter features that are not covered in the use case can be found in the standard vRouter documentation (https://doc.6wind.com/turbo-router-2.x/).

Follow the Getting Started guide (https://doc.6wind.com/turbo-router-2.x/getting-started/index.html) to install the software in your environment and get a remote console with SSH.

2. Use case: dual multi-homed BGP peering

2.1 Overview

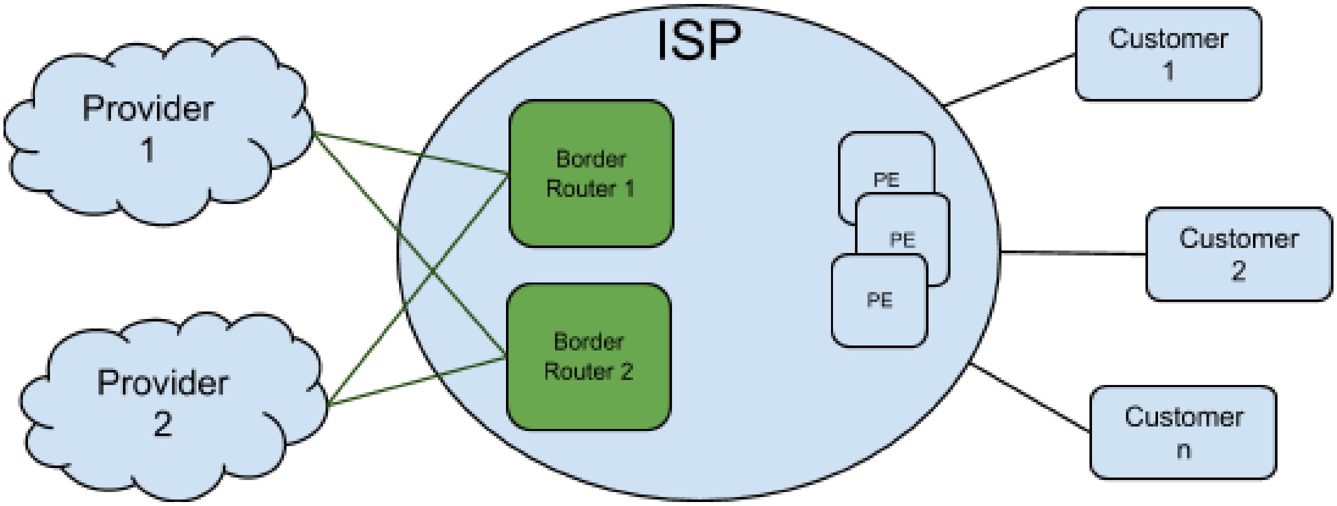
The following diagram depicts a fairly common use case where a border router provides connectivity to the Internet via several Peering and Transit Service Providers.



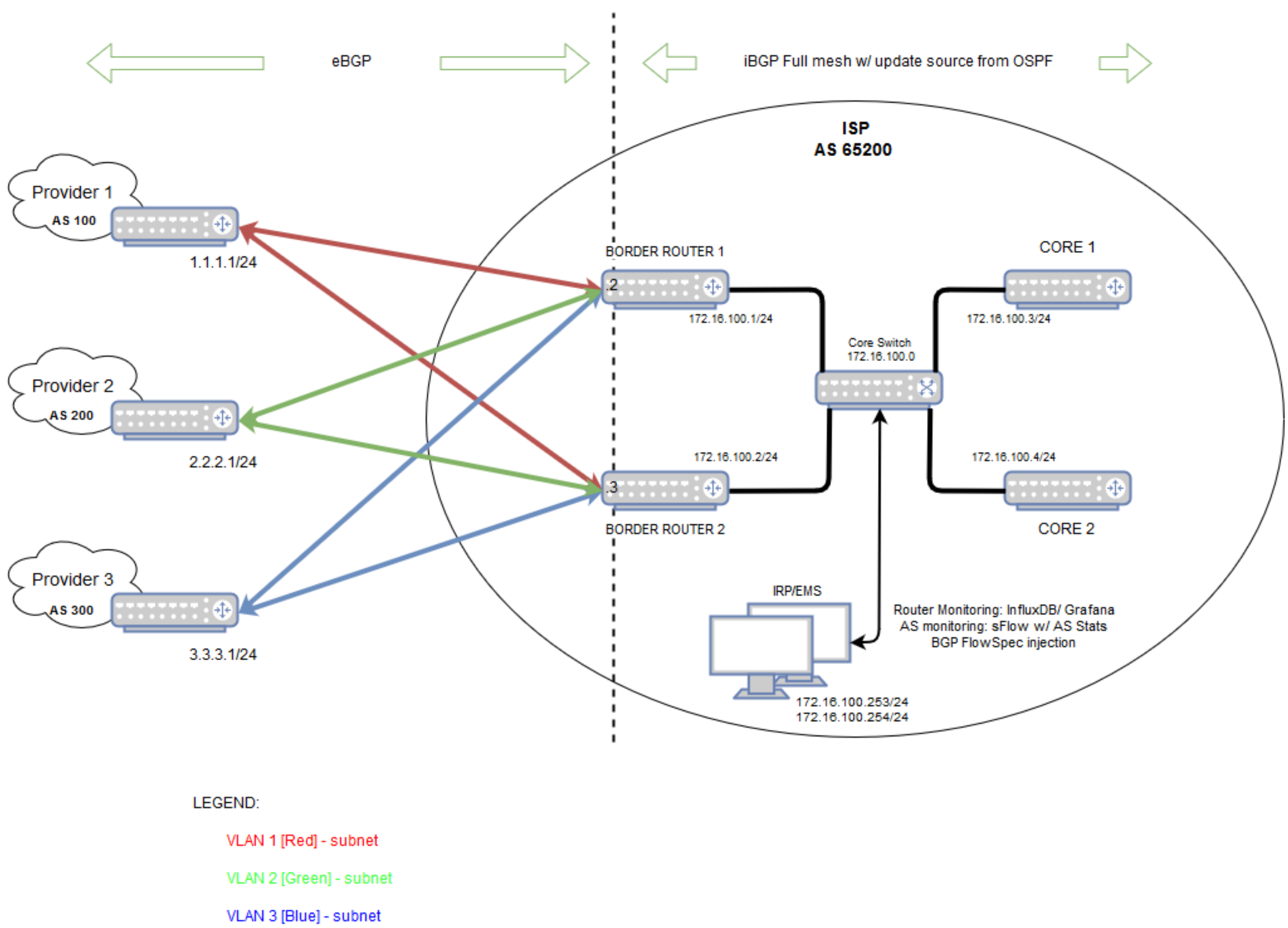
The outside network connectivity via EBGP (External BGP) provides service availability using different ASes. The inside network connectivity is established using an IGP (Internal Gateway Protocol) that usually relies on OSPF (Open Shortest Path First) or IBGP (Internal BGP) or a combination of both. In the described case and for illustration purposes, we will be using IBGP and OSPFv2.

To avoid the border router being a single point of failure, we will describe how an ISP can provide a multi-homed BGP (Border Gateway Protocol) peering with several peering and transit providers.

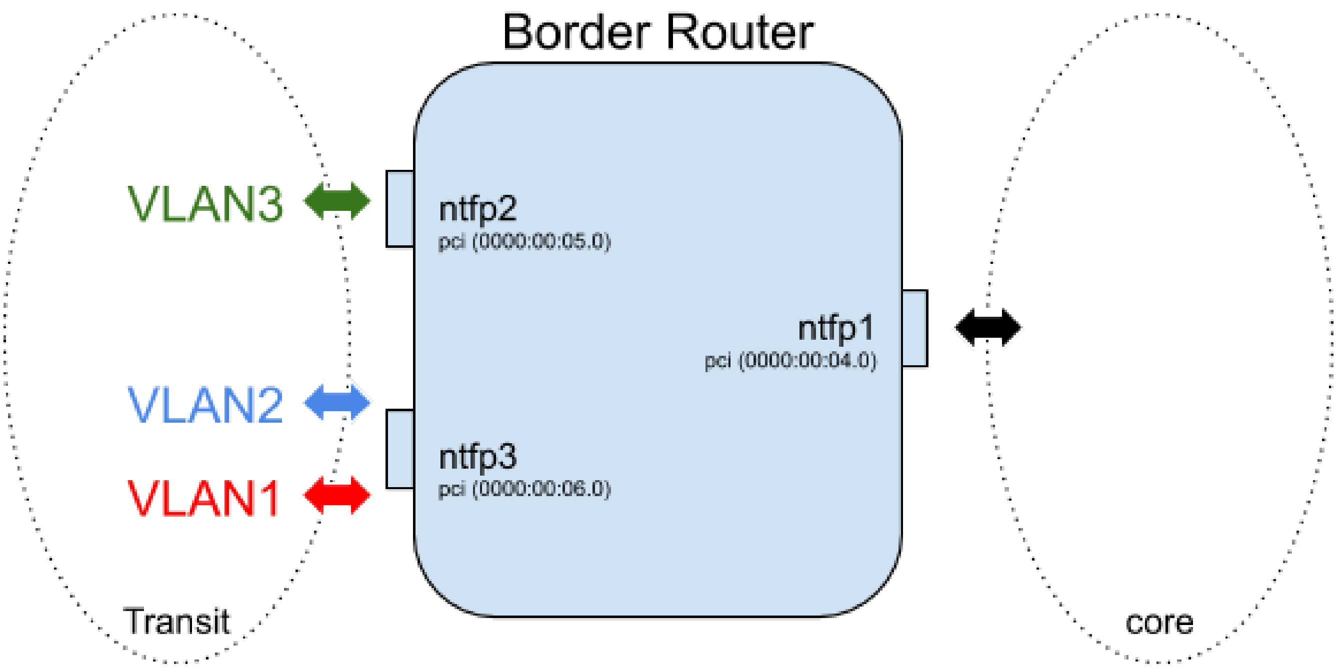
The setup we will be implementing in the following guide will be structured as follows:



2.2 Platform description



A number of VLANs are configured for ISP traffic separation in this dual-homed scenario.



In summary, the following router configuration items are covered using the vRouter CLI (Command Line Interface):

- Interface configuration for physical, loopback & VLAN interfaces
- OSPF
- BGP, prefix-list, route-map & Flowspec
- SNMP (Simple Network Management Protocol)
- KPI (Key Performance Indicator)
- sFlow

See *Appendix: complete configuration* for the complete configuration of these items.

2.3 Network configuration

2.3.1 Hostname

Using the vRouter CLI, let us start with setting the hostname and then getting the interfaces configured.

To set the vRouter hostname, proceed as follows:

```
vrouter> edit running
vrouter running config# system hostname border1
vrouter running config# commit
border1 running config#
```

2.3.2 Interfaces

Allocate the ports that will be involved in data plane processing into the fast path:

```
border1> edit running
border1 running config# / system fast-path
border1 running fast-path#! port pci-b0s4
border1 running fast-path# port pci-b0s5
border1 running fast-path# port pci-b0s6
```

All physical and logical interfaces are configured under the 'main' VRF (Virtual Routing and Forwarding) in this example.

```
border1 running fast-path# / vrf main
```

Create Ethernet interfaces and attach them to a port of a NIC (Network Interface Card):

```
border1 running vrf main# interface physical ntfp1
border1 running physical ntfp1#! port pci-b0s4
border1 running physical ntfp1# description "Border1_internal"
border1 running physical ntfp1# ipv4 address 172.16.100.1/24
border1 running physical ntfp1# ..

border1 running interface# physical ntfp2
border1 running physical ntfp2#! port pci-b0s5
border1 running physical ntfp2# ..

border1 running interface# physical ntfp3
border1 running physical ntfp3#! port pci-b0s6
border1 running physical ntfp3# ..
```

Add VLANs towards the ISP networks:

```
border1 running interface# vlan vlan1
border1 running vlan vlan1# description "Transit_1"
border1 running vlan vlan1# ipv4 address 1.1.1.2/24
border1 running vlan vlan1# vlan-id 1
border1 running vlan vlan1# link-interface ntfp3
border1 running vlan vlan1# ..

border1 running interface# vlan vlan2
border1 running vlan vlan2# description "Transit_2"
border1 running vlan vlan2# ipv4 address 2.2.2.2/24
```

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```
border1 running vlan vlan2# vlan-id 2
border1 running vlan vlan2# link-interface ntfp3
border1 running vlan vlan2# ..

border1 running interface# vlan vlan3
border1 running vlan vlan3# description "Transit_3"
border1 running vlan vlan3# ipv4 address 3.3.3.2/24
border1 running vlan vlan3# vlan-id 3
border1 running vlan vlan3# link-interface ntfp2
border1 running vlan vlan3# ..
```

Add a loopback interface for OSPF to use as a BGP update-source:

```
border1 running interface# loopback loopback0
border1 running loopback loopback0# ipv4 address 172.16.200.1/32
border1 running loopback loopback0# ..
```

Add VRRP (Virtual Router Redundancy Protocol) interfaces on top of each VLAN towards the ISP networks and on top of the internal network interface, and enable the VRRP service:

```
border1 running interface# vrrp vrrp1
border1 running vrrp vrrp1#! vrid 1
border1 running vrrp vrrp1#! link-interface vlan1
border1 running vrrp vrrp1# virtual-address 1.1.1.4/24
border1 running vrrp vrrp1# priority 150
border1 running vrrp vrrp1# track-fast-path true
border1 running vrrp vrrp1# preempt-delay 60
border1 running vrrp vrrp1# ..

border1 running interface# vrrp vrrp2
border1 running vrrp vrrp2#! vrid 2
border1 running vrrp vrrp2#! link-interface vlan2
border1 running vrrp vrrp2# virtual-address 2.2.2.4/24
border1 running vrrp vrrp2# priority 150
border1 running vrrp vrrp2# track-fast-path true
border1 running vrrp vrrp2# preempt-delay 60
border1 running vrrp vrrp2# ..

border1 running interface# vrrp vrrp3
border1 running vrrp vrrp3#! vrid 3
border1 running vrrp vrrp3#! link-interface vlan3
border1 running vrrp vrrp3# virtual-address 3.3.3.4/24
border1 running vrrp vrrp3# priority 150
border1 running vrrp vrrp3# track-fast-path true
border1 running vrrp vrrp3# preempt-delay 60
border1 running vrrp vrrp3# ..

border1 running interface# vrrp vrrp_internal
border1 running vrrp vrrp_internal#! vrid 100
```

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```
border1 running vrrp vrrp_internal#! link-interface ntfp1
border1 running vrrp vrrp_internal# virtual-address 172.16.100.5/24
border1 running vrrp vrrp_internal# priority 150
border1 running vrrp vrrp_internal# track-fast-path true
border1 running vrrp vrrp_internal# preempt-delay 60
border1 running vrrp vrrp_internal# ..

border1 running interface# ..
border1 running vrf main# vrrp router-id border1
border1 running vrf main# vrrp group vrrp_group
border1 running group vrrp_group# instance vrrp1
border1 running group vrrp_group# instance vrrp2
border1 running group vrrp_group# instance vrrp3
border1 running group vrrp_group# instance vrrp_internal
border1 running group vrrp_group# /
```

Note: In order to direct traffic across a specific border router, we increase the priority of the VRRP interface on this router while leaving the default priority on border2, so that border1 holds the virtual addresses. The preemption delay ensures that border1 will have time to learn all routes after a reboot before performing a failback.

Review the configuration and commit it:

```
border1 running config# show config nodefault
interface
    physical ntfp1
        port pci-b0s4
[...]
border1 running config# commit
Configuration committed.
```

Be sure other routers of the setup (PE1, PE2) are configured correctly, then check connectivity using the ping command. Here we will simply ping 172.16.100.4 (PE1) as an example:

```
border1 running config# cmd ping 172.16.100.4

PING 172.16.100.4 (172.16.100.4) 56(84) bytes of data:
64 bytes from 172.16.100.4: icmp_seq=1 ttl=64 time=0.396 ms
64 bytes from 172.16.100.4: icmp_seq=2 ttl=64 time=0.326 ms
64 bytes from 172.16.100.4: icmp_seq=3 ttl=64 time=0.346 ms
^C
--- 172.16.100.4 ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 3136 ms
rtt min/avg/max/mdev = 0.326/0.356/0.396/0.0.036ms
```

See also:

See the User's Guide for more information regarding:

- CLI basics (https://doc.6wind.com/turbo-router-2.x/user-guide/cli/basics/index.html)
- Fast path configuration (https://doc.6wind.com/turbo-router-2.x/user-guide/cli/system/fast-path.html)
- interfaces configuration (https://doc.6wind.com/turbo-router-2.x/user-guide/cli/network-interface/index.html)
- ping command (https://doc.6wind.com/turbo-router-2.x/user-guide/cli/troubleshooting/network/ping.html)

2.3.3 OSPF

Next, we configure an interior routing protocol. This will be a very simple OSPF configuration with only neighbors on the 172.16.100.0 private network. We redistribute the loopback address configured earlier and make it a passive OSPF interface. The router-id will simply be set to the same IPv4 loopback address for ease of reading.

```
border1 running config# / routing
border1 running routing# ipv4-prefix-list BGP-endpoints
border1 running ipv4-prefix-list BGP-endpoints# seq 1 address 172.16.200.0/24␣
↪policy permit le 32
border1 running ipv4-prefix-list BGP-endpoints# ..
border1 running routing# route-map FILTER-OSPF
border1 running route-map FIILTER-OSPF#! seq 10
border1 running seq 10#! policy permit
border1 running seq 10# match ip address prefix-list BGP-endpoints
border1 running seq 10# / vrf main routing ospf
border1 running ospf# router-id 172.16.200.1
border1 running ospf# abr-type standard
border1 running ospf# log-adjacency-changes detail
border1 running ospf# network 172.16.100.0/24 area 0
border1 running ospf# passive-interface loopback0
border1 running ospf# redistribute connected route-map FILTER-OSPF
border1 running ospf# commit
```

At this time, it would be a good idea to check the OSPF adjacencies and routes. See the *Troubleshooting* section below.

See also:

See the User's Guide for more information regarding:

- OSPF (https://doc.6wind.com/turbo-router-2.x/user-guide/cli/routing/ospf/index.html)

2.3.4 BGP

The key configuration item of this and most border routers is the exterior routing protocol BGP.

This configuration example will have IBGP/EBGP ipv4-unicast neighbors. Route-reflectors could easily have been used, but in this example we choose to create a full internal mesh using OSPF.

We will anchor the update-sources using the loopback addresses that was redistributed via OSPF in section 3.2.2.

iBGP

First we will peer with the internal network, i.e. the other border router and PEs. We start out by defining our own AS and router-id.

Configuring the local AS and router-id:

```
border1 running vrf main# routing bgp
border1 running bgp#! as 65200
border1 running bgp# router-id 172.16.200.1
border1 running bgp# address-family ipv4-unicast redistribute connected
```

Next, we configure BGP peering with the second Border Router:

```
border1 running bgp# neighbor 172.16.200.2
border1 running neighbor 172.16.200.2#! remote-as 65200
border1 running neighbor 172.16.200.2# neighbor-description border2
border1 running neighbor 172.16.200.2# update-source loopback0
border1 running neighbor 172.16.200.2# address-family ipv4-unicast soft-
↪reconfiguration-inbound true
border1 running neighbor 172.16.200.2# ..
border1 running bgp# commit
```

Then finally, as part of our iBGP configuration, we configure BGP peering with the internal routers PE1 & PE2:

```
border1 running bgp# neighbor 172.16.200.3
border1 running neighbor 172.16.200.3#! remote-as 65200
border1 running neighbor 172.16.200.3# neighbor-description PE1
border1 running neighbor 172.16.200.3# update-source loopback0
border1 running neighbor 172.16.200.3# address-family ipv4-unicast nexthop-self␣
↪force true
border1 running neighbor 172.16.200.3# address-family ipv4-unicast soft-
↪reconfiguration-inbound true
border1 running neighbor 172.16.200.3# ..
border1 running bgp# neighbor 172.16.200.4
border1 running neighbor 172.16.200.4#! remote-as 65200
border1 running neighbor 172.16.200.4# neighbor-description PE2
border1 running neighbor 172.16.200.4# update-source loopback0
border1 running neighbor 172.16.200.4# address-family ipv4-unicast nexthop-self␣
↪force true
border1 running neighbor 172.16.200.4# address-family ipv4-unicast soft-
↪reconfiguration-inbound true
border1 running neighbor 172.16.200.4# ..
```

In order to improve the global failover and failback duration, we then declare and apply a route-map to update the source address of the routes that we redistribute to PE1 and PE2 with the virtual IP address of the internal VRRP interface:

```
border1 running bgp # / routing
border1 running routing# route-map BGP-REDISTRIBUTE-INTERNAL
```

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```
border1 running route-map BGP-REDISTRIBUTE-INTERNAL#! seq 10
border1 running seq 10#! policy deny
border1 running seq 10# match ip address prefix-list BGP-endpoints
border1 running seq 10# .. seq 20
border1 running seq 20#! policy permit
border1 running seq 20# set ip next-hop 172.16.100.5
border1 running seq 20# / vrf main routing bgp
border1 running bgp # neighbor 172.16.200.3 address-family ipv4-unicast route-map␣
↪out route-map-name BGP-REDISTRIBUTE-INTERNAL
border1 running bgp # neighbor 172.16.200.4 address-family ipv4-unicast route-map␣
↪out route-map-name BGP-REDISTRIBUTE-INTERNAL
border1 running bgp # commit
```

eBGP

Configure peering with ISPs:

```
border1 running bgp# neighbor 1.1.1.1
border1 running neighbor 1.1.1.1#! remote-as 100
border1 running neighbor 1.1.1.1# neighbor-description Transit1-IPv4
border1 running neighbor 1.1.1.1# address-family ipv4-unicast soft-reconfiguration-
↪inbound true
border1 running neighbor 1.1.1.1# ..

border1 running bgp# neighbor 2.2.2.1
border1 running neighbor 2.2.2.1#! remote-as 200
border1 running neighbor 2.2.2.1# neighbor-description Transit2-IPv4
border1 running neighbor 2.2.2.1# address-family ipv4-unicast soft-reconfiguration-
↪inbound true
border1 running neighbor 2.2.2.1# ..

border1 running bgp# neighbor 3.3.3.1
border1 running neighbor 3.3.3.1#! remote-as 300
border1 running neighbor 3.3.3.1# neighbor-description Transit3-IPv4
border1 running neighbor 3.3.3.1# address-family ipv4-unicast soft-reconfiguration-
↪inbound true
border1 running neighbor 3.3.3.1# ..
```

In order to direct traffic across a specific border router, we will update the source address of the locally originated prefixes to the external VRRP interfaces by way of a route-map:

```
border1 running config# / routing
border1 running routing# ipv4-prefix-list prefix-local-origin
border1 running ipv4-prefix-list prefix-local-origin#! seq 10 address 200.200.208.
↪0/20 policy permit le 32
border1 running ipv4-prefix-list prefix-local-origin# / routing route-map TRANSIT-
↪1-OUT
border1 running route-map TRANSIT-1-OUT#! seq 1 match ip address prefix-list␣
↪prefix-local-origin
```

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```
border1 running route-map TRANSIT-1-OUT#! seq 1 policy permit
border1 running route-map TRANSIT-1-OUT# seq 1 set ip next-hop 1.1.1.4
border1 running route-map TRANSIT-1-OUT# ..
border1 running routing# route-map TRANSIT-2-OUT
border1 running route-map TRANSIT-2-OUT#! seq 1 match ip address prefix-list␣
↪prefix-local-origin
border1 running route-map TRANSIT-2-OUT#! seq 1 policy permit
border1 running route-map TRANSIT-2-OUT# seq 1 set ip next-hop 2.2.2.4
border1 running route-map TRANSIT-2-OUT# ..
border1 running routing# route-map TRANSIT-3-OUT
border1 running route-map TRANSIT-3-OUT#! seq 1 match ip address prefix-list␣
↪prefix-local-origin
border1 running route-map TRANSIT-3-OUT#! seq 1 policy permit
border1 running route-map TRANSIT-3-OUT# seq 1 set ip next-hop 3.3.3.4
border1 running route-map TRANSIT-3-OUT# ..
border1 running routing# / vrf main routing bgp
border1 running bgp# neighbor 1.1.1.1 address-family ipv4-unicast route-map out␣
↪route-map-name TRANSIT-1-OUT
border1 running bgp# neighbor 2.2.2.1 address-family ipv4-unicast route-map out␣
↪route-map-name TRANSIT-2-OUT
border1 running bgp# neighbor 3.3.3.1 address-family ipv4-unicast route-map out␣
↪route-map-name TRANSIT-3-OUT
border1 running bgp# commit
```

We can optimize the configuration further by filtering out possible bogus IP addresses we could receive:

```
border1 running config# / routing ipv4-prefix-list filter-bogons
border1 running ipv4-prefix-list filter-bogons# seq 5 address 0.0.0.0/8 policy␣
↪deny le 32
border1 running ipv4-prefix-list filter-bogons# seq 10 address 10.0.0.0/8 policy␣
↪deny le 32
border1 running ipv4-prefix-list filter-bogons# seq 15 address 127.0.0.0/8 policy␣
↪deny le 32
border1 running ipv4-prefix-list filter-bogons# seq 20 address 169.254.0.0/16␣
↪policy deny le 32
border1 running ipv4-prefix-list filter-bogons# seq 25 address 172.16.0.0/12␣
↪policy deny le 32
border1 running ipv4-prefix-list filter-bogons# seq 30 address 192.168.0.0/16␣
↪policy deny le 32
border1 running ipv4-prefix-list filter-bogons# seq 35 address 224.0.0.0/3 policy␣
↪deny le 32
border1 running ipv4-prefix-list filter-bogons# seq 40 address 0.0.0.0/0 policy␣
↪deny ge 25
border1 running ipv4-prefix-list filter-bogons# seq 45 address 0.0.0.0/0 policy␣
↪permit le 32

border1 running ipv4-prefix-list filter-bogons# / vrf main routing bgp
border1 running bgp# neighbor 1.1.1.1 address-family ipv4-unicast prefix-list in␣
↪prefix-list-name filter-bogons
```

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```
border1 running bgp# neighbor 2.2.2.1 address-family ipv4-unicast prefix-list in␣
↪prefix-list-name filter-bogons
border1 running bgp# neighbor 3.3.3.1 address-family ipv4-unicast prefix-list in␣
↪prefix-list-name filter-bogons
border1 running bgp# commit
```

See also:

See the User's Guide for more information regarding:

- BGP (https://doc.6wind.com/turbo-router-2.x/user-guide/cli/routing/bgp/index.html)

2.3.5 Route optimization through BGP FlowSpec and sFlow

The IRP monitoring station runs route optimization software that relies on sFlow for collecting traffic statistics from the border router and on BGP Flowspec to inject Policy-Based Routing rules to redirect a specific traffic through a transit router or another.

This section details the sFlow and BGP configuration on the border router for this purpose.

Configure sFlow on the loopback interface, reporting information from the VLAN interfaces connected to the transit routers:

```
border1 running config# / vrf main sflow
border1 running sflow# agent-interface loopback0
border1 running sflow# sflow-collector 172.16.100.253
border1 running sflow# sflow-collector 172.16.100.254
border1 running sflow# sflow-interface vlan1
border1 running sflow# sflow-interface vlan2
border1 running sflow# sflow-interface vlan3
border1 running sflow# sflow-sampling speed 40G
border1 running sflow# sflow-sampling speed 10G rate 10000
border1 running sflow# /
border1 running config# commit
```

Add the IRP monitoring station as a BGP Flowspec peer:

```
border1 running config# / vrf main routing bgp
border1 running bgp# neighbor 172.16.100.253
border1 running neighbor 172.16.100.253#! remote-as 65200
border1 running neighbor 172.16.100.253# neighbor-description IRP
border1 running neighbor 172.16.100.253# address-family ipv4-unicast soft-
↪reconfiguration-inbound true
border1 running neighbor 172.16.100.253# address-family ipv4-unicast route-
↪reflector-client true
border1 running neighbor 172.16.100.253# address-family ipv4-flowspec soft-
↪reconfiguration-inbound true
border1 running neighbor 172.16.100.253# address-family ipv4-flowspec route-
↪reflector-client true
```

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```
border1 running neighbor 172.16.100.253# commit
```

See also:

See the User's Guide for more information regarding:

- sFlow (https://doc.6wind.com/turbo-router-2.x/user-guide/cli/monitoring/sflow.html)
- Flowspec (https://doc.6wind.com/turbo-router-2.x/user-guide/cli/routing/bgp/flowspec/index.html)

2.4 Monitoring

For remote monitoring, the vRouter supports:

- SNMP
- Exporting KPIS (Key Performance Indicators) to a time-series database for viewing system counters (CPU usage, IP statistics and many more). These are displayable via a graphical dashboard (for instance Grafana) for a very convenient remote view of the router health & status.
- sFlow for statistical sampling on selected interfaces

2.4.1 SNMP

The following example shows a minimal SNMP setup:

```
border1> edit running
border1 running config# / vrf main snmp
border1 running snmp# static-info contact "noc@6wind.com"
border1 running snmp# static-info location "paris"
border1 running snmp# community local authorization read-only
border1 running snmp# community local source 127.0.0.1
border1 running snmp# community ems authorization read-only
border1 running snmp# community ems source 172.16.100.254
border1 running snmp# /
border1 running vrf main# commit
```

See also:

See the User's Guide for more information regarding:

- SNMP (https://doc.6wind.com/turbo-router-2.x/user-guide/cli/monitoring/snmp.html)

2.4.2 KPIS and dashboard

Here we will show how to export KPIS to a time-series database which can then be used with a graphical tool like Grafana.

```
border1> edit running
border1 running config# system kpi enabled true
border1 running config# vrf main kpi
border1 running kpi# interface ntfp1
border1 running kpi# interface ntfp2
border1 running kpi# interface ntfp3
border1 running kpi# telegraf influxdb-output url http://172.16.100.254:8086␣
↪database telegraf
border1 running kpi# /
border1 running config# commit
```

See also:

- 6WIND Grafana Setup on github (https://github.com/6WIND/supervision-grafana)

2.5 Troubleshooting

2.5.1 CLI show commands

The CLI incorporates a number of show commands of which a few are shown here.

Showing the current basic state of an interface (add a command qualifier for more detail):

```
border1> show interface name ntfp1
10: ntfp1: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc mq state UP mode␣
↪DEFAULT group default qlen 1000
 link/ether de:ed:01:29:7e:0e brd ff:ff:ff:ff:ff:ff
```

Basic interface UDP (User Datagram Protocol) traffic dump example:

```
border1> cmd show-traffic ntfp1 filter udp
tcpdump: verbose output suppressed, use -v or -vv for full protocol decode
listening on ntfp1, link-type EN10MB (Ethernet), capture size 262144 bytes
18:38:47.221472 de:ed:01:e3:55:78 > de:ed:01:07:da:e2, ethertype IPv4 (0x0800),␣
↪length 746: 172.16.100.2.45791 > 172.16.100.254.6343: sFlowv5, IPv4 agent 172.16.
↪200.2, agent-id 100000, length 704
18:38:47.221482 de:ed:01:e3:55:78 > de:ed:01:07:da:e2, ethertype IPv4 (0x0800),␣
↪length 746: 172.16.100.2.45791 > 172.16.100.254.6343: sFlowv5, IPv4 agent 172.16.
↪200.2, agent-id 100000, length 704
18:38:47.221484 de:ed:01:e3:55:78 > de:ed:01:1b:a5:56, ethertype IPv4 (0x0800),␣
↪length 746: 172.16.100.2.45791 > 172.16.100.253.6343: sFlowv5, IPv4 agent 172.16.
↪200.2, agent-id 100000, length 704
18:38:47.221485 de:ed:01:e3:55:78 > de:ed:01:1b:a5:56, ethertype IPv4 (0x0800),␣
↪length 746: 172.16.100.2.45791 > 172.16.100.253.6343: sFlowv5, IPv4 agent 172.16.
↪200.2, agent-id 100000, length 704
^C
4 packets captured
```

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```
4 packets received by filter
0 packets dropped by kernel
```

See also:

See the User's Guide for more information regarding:

- Show Traffic (https://doc.6wind.com/turbo-router-2.x/user-guide/cli/troubleshooting/network/show-traffic.html)

The first obvious choice to troubleshoot connectivity problems is to verify that all the routes are in the routing table using the following command:

```
border1> show ipv4-routes
Codes: K - kernel route, C - connected, S - static, R - RIP,
O - OSPF, I - IS-IS, B - BGP, E - EIGRP, N - NHRP,
T - Table, v - VNC, V - VNC-Direct, A - Babel, D - SHARP,
F - PBR, f - OpenFabric,
> - selected route, * - FIB route

VRF main:
K>* 0.0.0.0/0 [0/0] via 10.0.2.2, ens3, 06:22:10
C * 1.1.1.0/24 is directly connected, vrrp1, 06:21:53
C>* 1.1.1.0/24 is directly connected, vlan1, 06:21:58
C * 2.2.2.0/24 is directly connected, vrrp2, 06:21:53
C>* 2.2.2.0/24 is directly connected, vlan2, 06:21:58
C * 3.3.3.0/24 is directly connected, vrrp3, 06:21:53
C>* 3.3.3.0/24 is directly connected, vlan3, 06:21:58
C>* 10.0.2.0/24 is directly connected, ens3, 06:22:10
O   172.16.100.0/24 [110/100] is directly connected, ntfp1, 06:21:11
                              is directly connected, vrrp_internal, 06:21:11
C * 172.16.100.0/24 is directly connected, vrrp_internal, 06:21:53
C>* 172.16.100.0/24 is directly connected, ntfp1, 06:21:58
C>* 172.16.200.1/32 is directly connected, loopback0, 06:22:08
B   172.16.200.2/32 [200/0] via 172.16.200.2, 06:21:04
O>* 172.16.200.2/32 [110/20] via 172.16.100.2, ntfp1, 06:21:10
  *                          via 172.16.100.2, vrrp_internal, 06:21:10
B   172.16.200.3/32 [200/0] via 172.16.200.3, 06:21:04
O>* 172.16.200.3/32 [110/20] via 172.16.100.3, ntfp1, 06:21:05
  *                          via 172.16.100.3, vrrp_internal, 06:21:05
B   172.16.200.4/32 [200/0] via 172.16.200.4, 06:21:09
O>* 172.16.200.4/32 [110/20] via 172.16.100.4, ntfp1, 06:21:10
  *                          via 172.16.100.4, vrrp_internal, 06:21:10
B>  200.200.210.0/24 [200/0] via 172.16.200.3 (recursive), 06:21:04
  *                            via 172.16.100.3, ntfp1, 06:21:04
  *                            via 172.16.100.3, vrrp_internal, 06:21:04
B>  200.200.220.0/24 [200/0] via 172.16.200.4 (recursive), 06:21:09
  *                            via 172.16.100.4, ntfp1, 06:21:09
  *                            via 172.16.100.4, vrrp_internal, 06:21:09
B>* 217.151.210.0/24 [20/0] via 1.1.1.1, vlan1, 06:21:54
```

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```
B>* 217.151.211.0/24 [20/0] via 2.2.2.1, vlan2, 06:21:54
B>* 217.151.212.0/24 [20/0] via 3.3.3.1, vlan3, 06:21:54
```

Refining the show command, we can first look at the OSPF routes:

```
border1> show ospf route
VRF Name: default
============ OSPF network routing table ============
N    172.16.100.0/24       [100] area: 0.0.0.0
                           directly attached to ntfp1
                           directly attached to vrrp_internal

============ OSPF router routing table =============
R    172.16.200.2          [100] area: 0.0.0.0, ASBR
                           via 172.16.100.2, ntfp1
                           via 172.16.100.2, vrrp_internal
R    172.16.200.3          [100] area: 0.0.0.0, ASBR
                           via 172.16.100.3, ntfp1
                           via 172.16.100.3, vrrp_internal
R    172.16.200.4          [100] area: 0.0.0.0, ASBR
                           via 172.16.100.4, ntfp1
                           via 172.16.100.4, vrrp_internal

============ OSPF external routing table ===========
N E2 172.16.200.2/32       [100/20] tag: 0
                           via 172.16.100.2, ntfp1
                           via 172.16.100.2, vrrp_internal
N E2 172.16.200.3/32       [100/20] tag: 0
                           via 172.16.100.3, ntfp1
                           via 172.16.100.3, vrrp_internal
N E2 172.16.200.4/32       [100/20] tag: 0
                           via 172.16.100.4, ntfp1
                           via 172.16.100.4, vrrp_internal
```

If OSPF routes seem to be missing, try verifying that OSPF has formed the correct neighbor relationships:

```
border1> show ospf neighbor
VRF Name: default

Neighbor ID     Pri State           Dead Time Address         Interface           ␣
↪RXmtL RqstL DBsmL
172.16.200.2      1 2-Way/DROther     36.233s 172.16.100.2    ntfp1:172.16.100.1  ␣
↪     0     0     0
172.16.200.3      1 Full/Backup       34.142s 172.16.100.3    ntfp1:172.16.100.1  ␣
↪     0     0     0
172.16.200.4      1 Full/DR           33.873s 172.16.100.4    ntfp1:172.16.100.1  ␣
↪     0     0     0
```

And we can also verify the OSPF topology database:

```
border1> show ospf database
VRF Name: default

       OSPF Router with ID (172.16.200.1)

                Router Link States (Area 0.0.0.0)

Link ID         ADV Router      Age  Seq#       CkSum  Link count
172.16.200.1    172.16.200.1     716 0x80000011 0xba10 2
172.16.200.2    172.16.200.2     723 0x80000018 0x96e8 1
172.16.200.3    172.16.200.3     717 0x8000000f 0x4c93 1
172.16.200.4    172.16.200.4     717 0x80000011 0x4694 1

                Net Link States (Area 0.0.0.0)

Link ID         ADV Router      Age  Seq#       CkSum
172.16.100.4    172.16.200.4     717 0x8000000f 0x6c7e

                AS External Link States

Link ID         ADV Router      Age  Seq#       CkSum  Route
172.16.200.1    172.16.200.1     716 0x8000000b 0x5156 E2 172.16.200.1/32 [0x0]
172.16.200.2    172.16.200.2     977 0x80000008 0x4761 E2 172.16.200.2/32 [0x0]
172.16.200.3    172.16.200.3     717 0x8000000a 0x3371 E2 172.16.200.3/32 [0x0]
172.16.200.4    172.16.200.4     717 0x8000000b 0x2180 E2 172.16.200.4/32 [0x0]
```

If 2-way and FULL states have not been established between the OSPF neighbors, check that all OSPF interface settings are correct. All usual OSPF neighborship requirements must be fulfilled.

The next step would be to enable OSPF logging as shown under the *CLI log commands* section.

Now, let's check BGP.

Verify the BGP routes:

```
border1> show bgp ipv4
BGP table version is 13, local router ID is 172.16.200.1, vrf id 0
Status codes:  s suppressed, d damped, h history, * valid, > best, = multipath,
               i internal, r RIB-failure, S Stale, R Removed
Nexthop codes: @NNN nexthop's vrf id, < announce-nh-self
Origin codes:  i - IGP, e - EGP, ? - incomplete

   Network          Next Hop            Metric LocPrf Weight Path
* i1.1.1.0/24       172.16.100.2             0    100      0 ?
*>                  0.0.0.0                  0         32768 ?
* i2.2.2.0/24       172.16.100.2             0    100      0 ?
*>                  0.0.0.0                  0         32768 ?
* i3.3.3.0/24       172.16.100.2             0    100      0 ?
*>                  0.0.0.0                  0         32768 ?
* i10.0.2.0/24      172.16.100.2             0    100      0 ?
* i                 172.16.200.3             0    100      0 ?
```

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```
* i                  172.16.200.4              0    100      0 ?
*>                   0.0.0.0                   0         32768 ?
* i172.16.100.0/24   172.16.100.2              0    100      0 ?
* i                  172.16.200.3              0    100      0 ?
* i                  172.16.200.4              0    100      0 ?
*>                   0.0.0.0                   0         32768 ?
*> 172.16.200.1/32   0.0.0.0                   0         32768 ?
*>i172.16.200.2/32   172.16.200.2              0    100      0 ?
*>i172.16.200.3/32   172.16.200.3              0    100      0 ?
*>i172.16.200.4/32   172.16.200.4              0    100      0 ?
*>i200.200.210.0     172.16.200.3              0    100      0 ?
*>i200.200.220.0     172.16.200.4              0    100      0 ?
* i217.151.210.0     172.16.100.2              0    100      0 100 100 i
*>                   1.1.1.1                   0             0 100 100 i
* i217.151.211.0     172.16.100.2              0    100      0 200 200 200 i
*>                   2.2.2.1                   0             0 200 200 200 i
* i217.151.212.0     172.16.100.2              0    100      0 300 i
*>                   3.3.3.1                   0             0 300 i

Displayed  14 routes and 26 total paths
```

Let's check BGP neighbors; in this example just the Transit_3 neighbor for brevity:

```
border1> show bgp neighbor 3.3.3.1
 BGP neighbor is 3.3.3.1, remote AS 300, local AS 65200, external link
 Description: Transit3-IPv4
Hostname: transit3-vm
  BGP version 4, remote router ID 7.7.7.7
  BGP state = Established, up for 00:30:02
  Last read 00:00:02, Last write 00:00:02
  Hold time is 180, keepalive interval is 60 seconds
  Neighbor capabilities:
        4 Byte AS: advertised and received
        AddPath:
        IPv4 Unicast: RX advertised IPv4 Unicast and received
        Route refresh: advertised and received(old & new)
        Address Family IPv4 Unicast: advertised and received
        Address Family IPv6 Unicast: received
        Hostname Capability: advertised (name: border1,domain name: n/a) received
↪(name: transit3-vm,domain name: n/a)
        Graceful Restart Capabilty: advertised and received
        Remote Restart timer is 120 seconds
        Address families by peer:
        none
  Graceful restart informations:
        End-of-RIB send: IPv4 Unicast
        End-of-RIB received: IPv4 Unicast
  Message statistics:
        Inq depth is 0
```

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```
        Outq depth is 0
                        Sent       Rcvd
        Opens:                  1          1
        Notifications:          0          0
        Updates:                3          4
        Keepalives:            31         31
        Route Refresh:          0          0
        Capability:             0          0
        Total:                 35         36
  Minimum time between advertisement runs is 0 seconds

For address family: IPv4 Unicast
 Update group 1, subgroup 1
 Packet Queue length 0
 Inbound soft reconfiguration allowed
 Community attribute sent to this neighbor(all)
 Inbound path policy configured
 Outbound path policy configured
 Incoming update prefix filter list is *filter-bogons
 Route map for outgoing advertisements is *TRANSIT-OUT
 1 accepted prefixes

 Connections established 1; dropped 0
 Last reset never
Local host: 3.3.3.2, Local port: 40048
Foreign host: 3.3.3.1, Foreign port: 179
Nexthop: 3.3.3.2
Nexthop global: fe80::dced:1ff:fed8:6d1c
Nexthop local: fe80::dced:1ff:fed8:6d1c
BGP connection: shared network
BGP Connect Retry Timer in Seconds: 120
Read thread: on  Write thread: on
```

Verify BGP flowspec (so far in this case nothing to show):

```
border1> show bgp ipv4 flowspec
No BGP prefixes displayed, 0 exist
```

Many more show commands are available, please check in the User's Guide (https://doc.6wind.com/turbo-router-2.x/user-guide/cli/) as appropriate.

2.5.2 CLI log commands

To display the system log locally (kernel logs in this case):

```
border1> show log facility kernel
-- Logs begin at Tue 2019-07-09 14:37:46 UTC, end at Tue 2019-07-09 21:03:52 UTC. -
↪-
```

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```
Jul 09 14:40:24 border1 kernel: Silicon Labs C2 port support v. 0.51.0 - (C) 2007␣
↪Rodolfo Giometti
Jul 09 14:40:31 border1 kernel: VFIO - User Level meta-driver version: 0.3
Jul 09 14:40:32 border1 kernel: iommu: Adding device 0000:00:04.0 to group 0
Jul 09 14:40:32 border1 kernel: vfio-pci 0000:00:04.0: Adding kernel taint for␣
↪vfio-noiommu group on device
Jul 09 14:40:32 border1 kernel: iommu: Adding device 0000:00:05.0 to group 1
Jul 09 14:40:32 border1 kernel: vfio-pci 0000:00:05.0: Adding kernel taint for␣
↪vfio-noiommu group on device
Jul 09 14:40:32 border1 kernel: iommu: Adding device 0000:00:06.0 to group 2
Jul 09 14:40:32 border1 kernel: vfio-pci 0000:00:06.0: Adding kernel taint for␣
↪vfio-noiommu group on device
Jul 09 14:40:33 border1 kernel: dpvi: loading out-of-tree module taints kernel.
Jul 09 14:40:33 border1 kernel: dpvi: module verification failed: signature and/or␣
↪required key missing - tainting kernel
Jul 09 14:40:33 border1 kernel: dpvi_shmem: dpvi_shmem module initialized␣
↪00000000bfa363e7
```

To specifically look at routing system (BGP, OSPF,..) events:

```
border1> show log service routing
-- Logs begin at Fri 2019-07-26 09:16:24 UTC, end at Fri 2019-07-26 09:47:01 UTC. -
↪-
Jul 26 09:18:54 border1 systemd[1]: Started zebra.
Jul 26 09:19:13 border1 systemd[1]: Started bgpd.
Jul 26 09:19:13 border1 systemd[1]: Started ospfd.
```

Logging of BGP neighbor changes:

```
border1> edit running
border1 running config# / vrf main routing bgp
border1 running bgp# log-neighbor-changes true
```

A per VRF remote logging capability can be enabled for the system log:

```
border1> edit running
border1 running config# / vrf main logging syslog
border1 running syslog#! remote-server 172.16.100.253 protocol tcp port 514
border1 running syslog# commit
```

See also:

For more details, please refer to:

- System logging (https://doc.6wind.com/turbo-router-2.x/user-guide/cli/system/logging.html)
- Troubleshooting guide (https://doc.6wind.com/turbo-router-2.x/troubleshooting/index.html)

2.6 Optimizing performance

The default limit of 1 Million IPV4 (Internet Protocol version 4) routes may not be sufficient for a border router receiving several full BGP tables. The following example shows how to increase this to 3 Million.

```
border1> edit running
border1 running config# system fast-path limits ip4-max-route 3000000
border1 running config# commit
```

In case the router is overloaded and control packets are lost, the amount of CPU dedicated to prioritizing control plane vs. data plane traffic can be increased using the following command (default is 10%):

```
border1> edit running
border1 running config# system fast-path cp-protection budget 20
border1 running config# commit
```

See also:

For more details, see:

- Fast path limits configuration (https://doc.6wind.com/turbo-router-2.x/user-guide/cli/system/fast-path.html#fp-limits-configuration)
- Control plane protection (https://doc.6wind.com/turbo-router-2.x/user-guide/cli/system/fast-path.html#control-plane-protection)

2.7 Appendix: complete configuration

Listed here is the CLI configuration for the configuration discussed in this use case.

```
border1 running config# show config nodefault
vrf main
    routing
        bgp
            as 65200
            router-id 172.16.200.1
            address-family
                ipv4-unicast
                    redistribute connected
                    ..
                ..
            neighbor 172.16.200.3
                remote-as 65200
                neighbor-description PE1
                update-source loopback0
                address-family
                    ipv4-unicast
                        soft-reconfiguration-inbound true
```

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```
                    route-map out route-map-name BGP-REDISTRIBUTE-INTERNAL
                    ..
                ..
            ..
        neighbor 172.16.200.4
            remote-as 65200
            neighbor-description PE2
            update-source loopback0
            address-family
                ipv4-unicast
                    nexthop-self
                        force true
                        ..
                    soft-reconfiguration-inbound true
                    route-map out route-map-name BGP-REDISTRIBUTE-INTERNAL
                    ..
                ..
            ..
        neighbor 3.3.3.1
            remote-as 300
            neighbor-description Transit3-IPv4
            address-family
               ipv4-unicast
                   prefix-list in prefix-list-name filter-bogons
                   soft-reconfiguration-inbound true
                   route-map out route-map-name TRANSIT-3-OUT
                   ..
               ..
            ..
        neighbor 1.1.1.1
            remote-as 100
            neighbor-description Transit1-IPv4
            address-family
                ipv4-unicast
                    prefix-list in prefix-list-name filter-bogons
                    soft-reconfiguration-inbound true
                    route-map out route-map-name TRANSIT-1-OUT
                    ..
                ..
            ..

        neighbor 2.2.2.1
            remote-as 200
            neighbor-description Transit2-IPv4
            address-family
                ipv4-unicast
                    prefix-list in prefix-list-name filter-bogons
                    soft-reconfiguration-inbound true
                    route-map out route-map-name TRANSIT-2-OUT
```

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```
                    ..
                ..
            ..
        neighbor 172.16.200.2
            remote-as 65200
            neighbor-description border2
            update-source loopback0
            address-family
                ipv4-unicast
                    soft-reconfiguration-inbound true
                    ..
                ..
            ..
        neighbor 172.16.100.253
            remote-as 65200
            neighbor-description IRP
            address-family
                ipv4-unicast
                    soft-reconfiguration-inbound true
                    route-reflector-client true
                    ..
                ipv4-flowspec
                    soft-reconfiguration-inbound true
                    route-reflector-client true
                    ..
                ..
            ..
        ..
    ospf
        router-id 172.16.200.1
        abr-type standard
        log-adjacency-changes detail
        network 172.16.100.0/24 area 0
        passive-interface loopback0
        redistribute connected route-map FILTER-OSPF
        ..
    ..
interface
    physical ntfp1
        port pci-b0s4
        rx-cp-protection true
        tx-cp-protection true
        ipv4
            address 172.16.100.1/24
        ..
        ethernet
           auto-negotiate true
           ..
        ..
```

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```
        physical ntfp2
            port pci-b0s5
            rx-cp-protection true
            tx-cp-protection true
            ethernet
                auto-negotiate true
                ..
            ..
        physical ntfp3
            port pci-b0s6
            rx-cp-protection true
            tx-cp-protection true
            ethernet
                auto-negotiate true
                ..
            ..
        loopback loopback0
            ipv4
                address 172.16.200.1/32
                ..
            ..
        vlan vlan1
            description Transit_1
            ipv4
                address 1.1.1.2/24
                ..
            vlan-id 1
            link-interface ntfp3
            ..
        vlan vlan3
            description Transit_3
            ipv4
                address 3.3.3.2/24
                ..
            vlan-id 3
            link-interface ntfp2
            ..
        vlan vlan2
            description Transit_2
            ipv4
                address 2.2.2.2/24
                ..
            vlan-id 2
            link-interface ntfp3
            ..
        vrrp vrrp1
            link-interface vlan1
            vrid 1
            priority 150
```

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```
            preempt-delay 60
            track-fast-path true
            virtual-address 1.1.1.4/24
            ..
        vrrp vrrp2
            link-interface vlan2
            vrid 2
            priority 150
            preempt-delay 60
            track-fast-path true
            virtual-address 2.2.2.4/24
            ..
        vrrp vrrp3
            link-interface vlan3
            vrid 3
            priority 150
            preempt-delay 60
            track-fast-path true
            virtual-address 3.3.3.4/24
            ..
        vrrp vrrp_internal
            link-interface ntfp1
            vrid 200
            priority 150
            preempt-delay 60
            track-fast-path true
            virtual-address 172.16.100.5/24
            ..
        ..
    kpi
        telegraf
            influxdb-output url http://172.16.100.254:8086 database telegraf
            ..
        ..
    sflow
        agent-interface loopback0
        sflow-collector 172.16.100.253
        sflow-collector 172.16.100.254
        sflow-interface vlan1
        sflow-interface vlan3
        sflow-interface vlan2
        sflow-sampling speed 40G
        sflow-sampling speed 10G rate 10000
        ..
    snmp
        static-info
            location paris
            contact noc@6wind.com
            ..
```

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```
        community local
            authorization read-only
            source 127.0.0.1
            ..

        community ems
            authorization read-only
            source 172.16.100.254
            ..
        ..
    vrrp
        router-id border1
        group vrrp_group
            instance vrrp1
            instance vrrp2
            instance vrrp3
            instance vrrp_internal
            ..
        ..
    ..
system
    fast-path
        port pci-b0s4
        port pci-b0s5
        port pci-b0s6
        ..
    kpi
       ..
    ..
routing
    ipv4-prefix-list prefixes-local-originated
        seq 10 address 200.200.208.0/20 policy permit le 32
        ..
    ipv4-prefix-list filter-bogons
        seq 5 address 0.0.0.0/8 policy deny le 32
        seq 10 address 10.0.0.0/8 policy deny le 32
        seq 15 address 127.0.0.0/8 policy deny le 32
        seq 20 address 169.254.0.0/16 policy deny le 32
        seq 25 address 172.16.0.0/12 policy deny le 32
        seq 35 address 192.168.0.0/16 policy deny le 32
        seq 40 address 224.0.0.0/3 policy deny le 32
        seq 45 address 0.0.0.0/0 policy deny ge 25
        seq 50 address 0.0.0.0/0 policy permit le 32
        ..
    ipv4-prefix-list BGP-endpoints
        seq 1 address 172.16.200.0/24 policy permit le 32
        ..

    route-map TRANSIT-1-OUT
```

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```
        seq 1
            policy permit
            match
                ip
                    address
                        prefix-list prefixes-local-originated
                        ..
                    ..
                ..
            set
                ip
                    next-hop 1.1.1.4
                    ..
                ..
            ..
        ..
    route-map TRANSIT-2-OUT
        seq 1
            policy permit
            match
                ip
                    address
                        prefix-list prefixes-local-originated
                        ..
                    ..
                ..
            set
                ip
                    next-hop 2.2.2.4
                    ..
                ..
            ..
        ..
    route-map TRANSIT-3-OUT
        seq 1
            policy permit
            match
                ip
                    address
                        prefix-list prefixes-local-originated
                        ..
                    ..
                ..
            set
                ip
                    next-hop 3.3.3.4
                    ..
                ..
            ..
```

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```
        ..

    route-map FILTER-OSPF
        seq 10
            policy permit
            match
                ip
                    address
                        prefix-list BGP-endpoints
                        ..
                    ..
                ..
            ..
        ..
    route-map BGP-REDISTRIBUTE-INTERNAL
        seq 10
            policy deny
            match
                ip
                    address
                        prefix-list BGP-endpoints
                        ..
                    ..
                ..
            ..
        seq 20
            policy permit
            set
                ip
                    next-hop 172.16.100.5
                    ..
                ..
            ..
        ..
    bgp
        ..
    ..
```