7450 Ethernet Service Switch
7750 Service Router
7950 Extensible Routing System
Virtualized Service Router

Release 26.3.R1

Peering Quick Reference Guide

3HE 22318 AAAA 01
Edition: 01
March 2026

Nokia is committed to diversity and inclusion. We are continuously reviewing our customer documentation and consulting with standards bodies to ensure that terminology is inclusive and aligned with the industry. Our future customer documentation will be updated accordingly.

Table of contents

1 Getting started

1.1 About this guide

This guide provides the basic configuration required to set up a Nokia router as a peering router. The examples in this guide cover all features required for the peering function.

Note: This guide does not provide detailed information about peering features. Users are expected to have a basic understanding about these features. For detailed information, see the SR OS customer documentation WebHelp or the Nokia Doc Center.

This guide is organized into functional chapters and provides concepts and descriptions of the implementation flow, as well as Command Line Interface (CLI) syntax and command usage.

The topics and commands described in this guide apply to the:

- 7450 ESS
- 7750 SR
- 7950 XRS
- Virtualized Service Router (VSR)

Command outputs shown in this guide are examples only; actual displays may differ depending on supported functionality and user configuration.

Note: Unless otherwise indicated, this guide uses MD-CLI command syntax and configuration examples.

The SR OS CLI trees and command descriptions can be found in the following guides:

- *7450 ESS, 7750 SR, 7950 XRS, and VSR Classic CLI Command Reference Guide*
- *7450 ESS, 7750 SR, 7950 XRS, and VSR Clear, Monitor, Show, and Tools CLI Command Reference Guide* (for both the MD-CLI and the classic CLI)
- *7450 ESS, 7750 SR, 7950 XRS, and VSR MD-CLI Command Reference Guide*

Note: This guide generically covers Release 26.*x*.R*x* content and may contain some content that will be released in later maintenance loads. For information about features supported in each load of the Release 26.*x*.R*x* software or for a list of unsupported features by platform and chassis, see the *SR OS R26.x.Rx Software Release Notes*, part number 3HE 29176 000*x* TQZZA.

1.2 Conventions

This section describes the general conventions used in this guide.

1.2.1 Precautionary and information messages

The following information symbols are used in the documentation.

DANGER: Danger warns that the described activity or situation may result in serious personal injury or death. An electric shock hazard could exist. Before you begin work on this equipment, be aware of hazards involving electrical circuitry, be familiar with networking environments, and implement accident prevention procedures.

WARNING: Warning indicates that the described activity or situation may, or will, cause equipment damage, serious performance problems, or loss of data.

Caution: Caution indicates that the described activity or situation may reduce your component or system performance.

Note: Note provides additional operational information.

Tip: Tip provides suggestions for use or best practices.

1.2.2 Options or substeps in procedures and sequential workflows

Options in a procedure or a sequential workflow are indicated by a bulleted list. In the following example, at step 1, the user must perform the described action. At step 2, the user must perform one of the listed options to complete the step.

Example: Options in a procedure

1. User must perform this step.
2. This step offers three options. User must perform one option to complete this step.
   - This is one option.
   - This is another option.
   - This is yet another option.

Substeps in a procedure or a sequential workflow are indicated by letters. In the following example, at step 1, the user must perform the described action. At step 2, the user must perform two substeps (a. and b.) to complete the step.

Example: Substeps in a procedure

1. User must perform this step.
2. User must perform all substeps to complete this action.
   a. This is one substep.
   b. This is another substep.

Nested substeps within a procedure or a sequential workflow are indicated by roman numerals. In the following example, at step 1, the user must perform the described action. At step 2, the user must perform two substeps (a. and b.) to complete the step. At substep b, the user must perform two additional substeps (i. and ii.) to complete the step.

Example: Nested substeps in a procedure

1. User must perform this step.
2. User must perform all substeps to complete this action.
   a. This is one substep.
   b. User must perform all nested substeps to complete this action.
      i. This is a nested substep.
      ii. This is another nested substep.

2 Peering configuration process

The following table lists the SR OS peering configuration tasks. Information in this guide is presented in an overall logical configuration flow. Each section describes a software area and provides the MD-CLI command usage to configure commands for the functional area.

Table 1: Configuration process

Area	Task	Section
Peering configuration introduction	Introduction to peering	Introduction to peering
	Peering topology	Peering configuration topology
Hardware configuration	Management IP	Management IP
	Configure line cards	Configuring line cards
	Configure ports and interfaces	Configuring ports and interfaces
Routing protocols configuration	Configure an IGP	IGP – OSPF IGP – IS-IS
	Configure BGP	BGP
Peering configuration	Configure route policies	Route policies
	Configure cflowd	Cflowd
	Configure RPKI for prefix origin validation	RPKI for prefix origin validation
	Configure FlowSpec	BGP FlowSpec
	Configure uRPF	uRPF
System and routing security configuration	Configure CPM filters	CPM filters
	Configure management access filter	Management Access Filter
	Configure ACLs	ACLs
	Configure rate limiting for DDoS traffic	Rate limiting DDoS traffic
	Configure redirecting suspicious traffic	Redirecting suspicious traffic
	Run ACL show commands	ACL show commands
QoS configuration	Configure classification	Classification
	Configure queuing	Queuing

Area	Task	Section
	Configure scheduling	Scheduling
	Configure re-marking	Re-marking
Additional system configuration (optional)	Switching from the classic to the MD-CLI	Switching from the classic CLI to the MD-CLI
	User and profile management	User and profile management
	Configure NTP	NTP
	Configure system alarms and logging	System alarms and logging
Appendix A	Configure custom CLI commands (pySROS)	Appendix A: Custom CLI commands (pySROS)
Appendix B	Configure configuration groups	Appendix B: Configuration groups

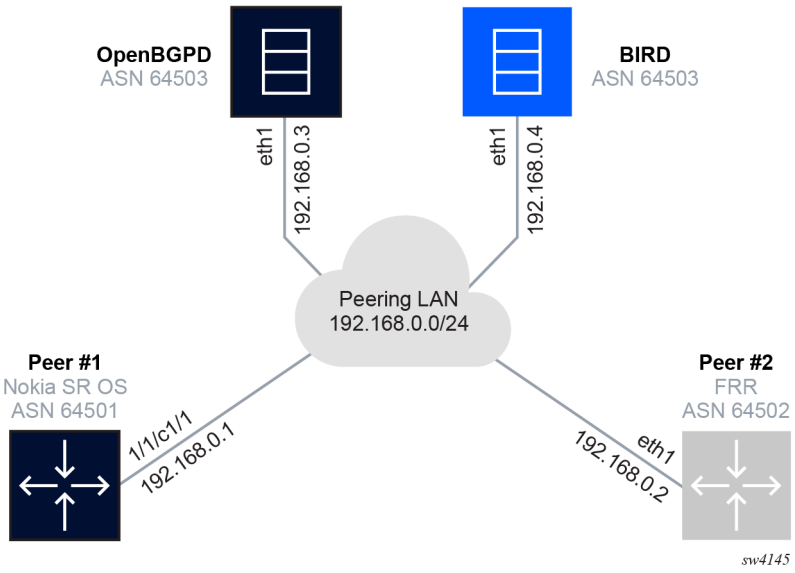
2.1 Introduction

Peering is an agreement established between two networks or two Autonomous Systems (ASs) to exchange routing information using the BGP protocol as described in this guide.

2.2 Topology

The configuration examples in this guide display the connection of the Peer #1 Nokia SR OS ASN 64501 router (shown in the following figure) as a peering router to the rest of the network.

Figure 1: Peering topology



3 Hardware configuration

The following sections describe the hardware configurations.

3.1 Management IP

About this task

To configure a management IP on the out-of-band management port of the device, perform the following steps. See Configuring ports and interfaces for more information about using in-band management and configuring an IP address for an in-band port.

Procedure

Step 1. Enter the BOF configuration context.

```
bof private
```

Step 2. Configure the management IP, as shown in the following example.

Example

```
bof router "management" interface "management" cpm active ipv4 ip-address 172.20.20.2
bof router "management" interface "management" cpm active ipv4 prefix-length 24
bof router "management" interface "management" cpm active ipv6 ipv6-address
 3fff:172:20:20::2
bof router "management" interface "management" cpm active ipv6 prefix-length 64
```

Step 3. Configure static routes for management access, if required, as shown in the following example.

Example

```
bof router "management" static-routes route 0.0.0.0/0 next-hop 172.20.20.1
```

Step 4. Commit the changes and exit from the BOF configuration mode.

Step 5. To view the BOF configuration, run the following command.

```
admin show configuration bof
```

3.2 Configuring power shelf and power modules

For systems with modular power shelves and power modules, define the power shelf and module type used in the system.

Example: Configuring power shelf and power module type for 7750 SR-2se with one shelf and four modules

```
configure chassis router chassis-number 1 power-shelf 1 power-shelf-type ps-a4-shelf-dc
configure chassis router chassis-number 1 power-shelf 1 power-module 1 power-module-type
 ps-a-dc-6000
configure chassis router chassis-number 1 power-shelf 1 power-module 2 power-module-type
 ps-a-dc-6000
configure chassis router chassis-number 1 power-shelf 1 power-module 3 power-module-type
 ps-a-dc-6000
configure chassis router chassis-number 1 power-shelf 1 power-module 4 power-module-type
 ps-a-dc-6000
```

Use the following command to display the operational status of the power shelf and modules.

```
show chassis power-shelf 1 power-module
```

Example: Power shelf and module operational status output

```
===============================================================================
Power Shelf Summary
===============================================================================
Slot       Provisioned Type             Admin Operational   Zone   Input Output
               Equipped Type (if diff)  State State               Mode
-------------------------------------------------------------------------------
1          ps-a4-shelf-dc               up    up            1      60A   on
===============================================================================

===============================================================================
Power Module Summary
===============================================================================
Slot       Provisioned Type             Admin Operational   Input  Zone
               Equipped Type (if diff)  State State         A B
-------------------------------------------------------------------------------
1          ps-a-dc-6000                 up    up            Y Y    1
2          ps-a-dc-6000                 up    up            Y Y    1
3          ps-a-dc-6000                 up    up            Y Y    1
4          ps-a-dc-6000                 up    up            Y Y    1
===============================================================================
```

3.3 Configuring line cards

Define line card types explicitly based on the system type.

Example: Configuring line card type for the 7750 SR-1 with one pluggable MDA card

```
configure card 1 card-type iom-1
configure card 1 level he
configure card 1 mda 1 mda-type me6-100gb-qsfp28
```

Use the following command to show the operational status of the card.

```
show card state
```

Example: Card state output

```
===============================================================================
Card State
===============================================================================
Slot/  Provisioned Type                  Admin Operational   Num   Num Comments
Id         Equipped Type (if different)  State State         Ports MDA
-------------------------------------------------------------------------------
1      iom-1:he                          up    up                  2
1/1    me6-100gb-qsfp28                  up    up            6
A      cpm-1                             up    up                        Active
===============================================================================
```

3.4 Configuring ports and interfaces

Configure the physical port first, followed by an interface with an IPv4 or IPv6 address.

Each port is considered a connector that supports breakout. Configure the connector with the breakout type so that the appropriate ports are created and can be configured.

Example: Configuring the connector breakout type

The following example displays the configuration of a connector breakout. The default port MTU value is 9212.

```
configure port 1/1/c1 admin-state enable
configure port 1/1/c1 connector breakout c1-100g
configure port 1/1/c1/1 admin-state enable
configure port 1/1/c1/1 description “To Peering LAN"
```

Example: Configuring the router interface

The interface is provided a name, an IP address, and is associated with a physical port as shown in the following example.

```
configure router "Base" interface "To-Peering-LAN" port 1/1/c1/1
configure router "Base" interface "To-Peering-LAN" ipv4 primary address 192.168.0.1
 prefix-length 24
configure router "Base" interface "To-Peering-LAN" ipv6 address 2001:a8::4 prefix-length
 124
```

Example: Configuring the system interface

The system interface is the router's loopback interface (like lo0 or loopback0) and is configured as shown in the following example.

```
configure router "Base" interface "system" ipv4 primary address 10.0.0.1 prefix-length 32
configure router "Base" interface "system" ipv6 address 2001:1::101 prefix-length 128
```

Use the following command to display the port information.

```
show port
```

Example: Port status output

```
===============================================================================
Ports on Slot 1
===============================================================================
Port          Admin Link Port    Cfg  Oper LAG/ Port Port Port   C/QS/S/XFP/
Id            State      State   MTU  MTU  Bndl Mode Encp Type   MDIMDX
-------------------------------------------------------------------------------
1/1/c1        Up         Link Up                          conn   100GBASE-LR4*
1/1/c1/1      Up    Yes  Up      9212 9212    - netw null cgige
```

Use the following command to display the router IP interface information.

```
show router interface
```

Example: Router interface status output

```
===============================================================================
Interface Table (Router: Base)
===============================================================================
Interface-Name                   Adm       Opr(v4/v6)  Mode    Port/SapId
   IP-Address                                                   PfxState
-------------------------------------------------------------------------------
To-Peering-LAN                   Up        Up/Up       Network 1/1/c1/1
   192.168.0.1/24                                               n/a
   2001:a8::4/124                                               PREFERRED
   fe80::1668:ffff:fe00:0/64                                    PREFERRED
system                           Up        Up/Up       Network system
   10.0.0.1/32                                                  n/a
   2001:1::101/128                                              PREFERRED
-------------------------------------------------------------------------------
Interfaces : 2
===============================================================================
```

SR OS allows the user to enable a single instance of BFD in the **interface** context, in addition to timers, for both IPv4 and IPv6. The interface BFD state can be shared by specific protocols by enabling the **bfd-liveness** command under protocol-specific CLI context.

Example: Enabling BFD for IPv4 and IPv6

```
configure router "Base" interface "Interface-to-R1" ipv4 bfd admin-state enable
```

```
configure router "Base" interface "Interface-to-R1" ipv6 bfd admin-state enable
```

Use the following command to display the protocol-specific BFD session on the router.

```
show router bfd session
```

Example: BFD session information output

The following example shows BFD sessions when **bfd-liveness** is enabled for the OSPF interface.

```
===============================================================================
Legend:
  Session Id = Interface Name | LSP Name | Prefix | RSVP Sess Name | Service Id
  wp = Working path   pp = Protecting path
===============================================================================
BFD Session
```

```
===============================================================================
Session Id                                        State      Tx Pkts    Rx Pkts
  Rem Addr/Info/SdpId:VcId                      Multipl     Tx Intvl   Rx Intvl
  Protocols                                        Type     LAG Port     LAG ID
  Loc Addr                                                             LAG name
-------------------------------------------------------------------------------
to-R2                                                Up           85         84
  192.168.0.1                                         3          100        100
  ospf2                                             iom          N/A        N/A
  192.168.0.2
-------------------------------------------------------------------------------
No. of BFD sessions: 1
===============================================================================
```

4 Configuring routing protocols

Configure an IGP protocol (OSPF or IS-IS) to connect the router to other network elements within the same AS. BGP is used to establish the peering session with the external router.

4.1 IGP – OSPF

The following example displays the OSPF configuration to connect with a router R1 within the same AS. The port and interface configuration for this connection can be configured as described in Configuring ports and interfaces.

For more information about OSPF configuration, see the *7450 ESS, 7750 SR, 7950 XRS, and VSR Unicast Routing Protocols Guide*.

Example: Configuring OSPF

```
configure router "Base" ospf 0 admin-state enable
configure router "Base" ospf 0 area 0.0.0.0 interface "Interface-to-R1" interface-type
 point-to-point
```

Use the following command to display OSPF neighbor information.

```
show router ospf neighbor
```

Example: OSPF neighbor information output

```
===============================================================================
Rtr Base OSPFv2 Instance 0 Neighbors
===============================================================================
Interface-Name                   Rtr Id          State      Pri  RetxQ   TTL
   Area-Id
-------------------------------------------------------------------------------
Interface-to-R1                  10.10.20.103    Full       1    0       35
   0.0.0.0
-------------------------------------------------------------------------------
No. of Neighbors: 1
===============================================================================
```

4.2 IGP – IS-IS

The following example displays the configuration to establish IS-IS adjacency with a router R1 within the same AS. The router is set to IS-IS Level 2 and native IPv6 routing is enabled. The port and interface configuration for this connection can be configured as described in Configuring ports and interfaces.

For more information about IS-IS configuration, see the *7450 ESS, 7750 SR, 7950 XRS, and VSR Unicast Routing Protocols Guide*.

Example: Configuring IS-IS

```
configure router "Base" isis 0 admin-state enable
configure router "Base" isis 0 ipv6-routing native
configure router "Base" isis 0 level-capability 2
configure router "Base" isis 0 system-id 0100.0000.0001
configure router "Base" isis 0 area-address [49.0000]
configure router "Base" isis 0 interface "Interface-to-R1" interface-type point-to-point
```

Use the following command to display IS-IS neighbor information.

```
show router isis adjacency
```

Example: IS-IS adjacency status output

```
===============================================================================
Rtr Base ISIS Instance 0 Adjacency
===============================================================================
System ID               Usage State Hold Interface                    MT-ID
-------------------------------------------------------------------------------
sr103                   L2    Up    25   Interface-to-R1              0
-------------------------------------------------------------------------------
Adjacencies : 1
===============================================================================
```

4.3 BGP

In the following example, the External Border Gateway Protocol (EBGP) session is configured using the interface IP as the neighbor IP. The local AS is configured as 64501 and remote AS is 64503.

For more information about BGP configuration, see the *7450 ESS, 7750 SR, 7950 XRS, and VSR Unicast Routing Protocols Guide*.

Example: Configuring an EBGP session

```
configure router "Base" autonomous-system 64501
configure router "Base" bgp router-id 10.0.0.1
configure router "Base" bgp group "eBGP-Peering" type external
configure router "Base" bgp group "eBGP-Peering" peer-as 64503
configure router "Base" bgp group "eBGP-Peering" family ipv4 true
configure router "Base" bgp group "eBGP-Peering" family ipv6 true
configure router "Base" bgp neighbor "192.168.0.3" group "eBGP-Peering"
configure router "Base" bgp neighbor "192.168.0.4" group "eBGP-Peering"
```

Use the following command to display BGP neighbor status.

```
show router bgp summary
```

Example: BGP neighbor status summary output

```
===============================================================================
 BGP Router ID:10.0.0.1         AS:64501       Local AS:64501
===============================================================================
BGP Admin State         : Up          BGP Oper State              : Up
Total Peer Groups       : 1           Total Peers                 : 2
```

```
Total VPN Peer Groups   : 0           Total VPN Peers             : 0
Current Internal Groups : 1           Max Internal Groups         : 1
Total BGP Paths         : 21          Total Path Memory           : 7416

...

===============================================================================
BGP Summary
===============================================================================
Legend : D - Dynamic Neighbor
===============================================================================
Neighbor
Description
                   AS PktRcvd InQ  Up/Down   State|Rcv/Act/Sent (Addr Family)
                      PktSent OutQ
-------------------------------------------------------------------------------
192.168.0.3
                64503      20    0 00h07m26s 3/0/0 (IPv4)
                           19    0           0/0/0 (IPv6)
192.168.0.4
                64503      27    0 00h10m05s 2/0/0 (IPv4)
                           41    0           1/0/0 (IPv6)
-------------------------------------------------------------------------------
```

Use the following command to display routes received from a neighbor.

```
show router bgp neighbor 2001:a8::5 received-routes
```

Example: Routes received from a neighbor output

```
===============================================================================
 BGP Router ID:10.0.0.1         AS:64501       Local AS:64501
===============================================================================
 Legend -
 Status codes  : u - used, s - suppressed, h - history, d - decayed, * - valid
                 l - leaked, x - stale, > - best, b - backup, p - purge
 Origin codes  : i - IGP, e - EGP, ? - incomplete

===============================================================================
BGP IPv4 Routes
===============================================================================
Flag  Network                                          LocalPref   MED
      Nexthop (Router)                                 Path-Id     IGP Cost
      As-Path                                                      Label
-------------------------------------------------------------------------------
i     10.10.1.24/29                                    n/a         None
      192.168.0.3                                      None        0
      64503                                                        -
i     10.10.20.103/32                                  n/a         None
      192.168.0.3                                      None        0
      64503                                                        -
i     192.168.0.0/24                                   n/a         None
      192.168.0.3                                      None        0
      64503                                                        -
-------------------------------------------------------------------------------
Routes : 3
===============================================================================
```

Use the following command to display the number of routes installed per line card summary output.

```
show router fib 1 summary ipv4
```

Example: Number of routes installed per line card summary output

```
===============================================================================
FIB Summary
===============================================================================
                             Active
-------------------------------------------------------------------------------
Static                       0
Direct                       3
Host                         0
BGP                          0
BGP VPN                      0
--snip---
VPN Leak                     0
-------------------------------------------------------------------------------
Total Installed              4
-------------------------------------------------------------------------------
Current Occupancy            1%
Overflow Count               0
Suppressed by Selective FIB  0
Occupancy Threshold Alerts
    Alert Raised 0 Times;
===============================================================================
```

4.3.1 BGP dynamic peering with unnumbered interfaces

SR OS supports unnumbered interfaces and dynamic peers for both IPv4 and IPv6. Dynamic sessions are identified using one of the following methods:

1. the source IP address of an incoming BGP TCP connection matches an IP prefix associated with dynamic BGP sessions
2. an ICMPv6 router advertisement message is received from a potential BGP router on an interface listed as a dynamic neighbor interface. This allows a dynamic peer to be set up over an unnumbered interface using only the IPv6 Link Local Address (LLA) as shown in the following configuration

Example: Configuring BGP dynamic peering with unnumbered interface

```
configure router "Base" interface "to-R2" admin-state enable
configure router "Base" interface "to-R2" port 1/1/c3/1
configure router "Base" interface "to-R2" ipv4 unnumbered system
configure router "Base" interface "to-R2" ipv6

configure router "Base" bgp group "BGP_Unnumbered" type external
configure router "Base" bgp group "BGP_Unnumbered" family ipv4 true
configure router "Base" bgp group "BGP_Unnumbered" family ipv6 true
configure router "Base" bgp group "BGP_Unnumbered" dynamic-neighbor interface "to-R2"
 allowed-peer-as ["64500..65500"]

configure router "Base" ipv6 router-advertisement interface "to-R2" admin-state enable
configure router "Base" ipv6 router-advertisement interface "to-R2" min-advertisement-
interval 10
```

Use the following command to display BGP neighbor status.

```
show router bgp summary
```

Example: BGP neighbor status summary output

```
===============================================================================
 BGP Router ID:10.0.0.1         AS:64501       Local AS:64501
===============================================================================
BGP Admin State         : Up          BGP Oper State              : Up
Total Peer Groups       : 1           Total Peers                 : 2
Total VPN Peer Groups   : 0           Total VPN Peers             : 0
Current Internal Groups : 1           Max Internal Groups         : 1
Total BGP Paths         : 21          Total Path Memory           : 7416
```

```
===============================================================================
BGP Summary
===============================================================================
Legend : D - Dynamic Neighbor
===============================================================================
Neighbor
Description
                   AS PktRcvd InQ  Up/Down   State|Rcv/Act/Sent (Addr Family)
                      PktSent OutQ
-------------------------------------------------------------------------------
fe80::e00:5ff:fe86:500-"to-R2"(D)
                65100     105    0 00h50m25s 0/0/0 (IPv4)
                          106    0           0/0/0 (IPv6)
-------------------------------------------------------------------------------
```

5 Configuring peering

This section provides configuration examples for peering features. Not all features are required to set up a basic peering connection.

5.1 Route policies

Routing policies control the size and content of the routing tables, the routes that are advertised, and the best route to take to reach a destination.

The following examples configure AS path and community lists that can be referenced by multiple policies.

Regular expression strings can be used to specify match criteria for the AS path and communities. For more information about using regular expressions, see the *7450 ESS, 7750 SR, 7950 XRS, and VSR Unicast Routing Protocols Guide*.

Example: Configuring AS path and community lists

Regular expression strings are used to specify match criteria for the AS path and communities in the following example.

```
configure policy-options as-path "PEERING" expression "64503"
configure policy-options as-path-group "BOGON" entry 10 expression ".* 0 .*"
configure policy-options as-path-group "BOGON" entry 20 expression ".* [64496-64511] .*"
configure policy-options as-path-group "BOGON" entry 30 expression ".* 65535 .*"

configure policy-options community "LARGE-PEER" { member "65100:100" }
configure policy-options community "SMALL-PEERS" { member "65200:200" }
configure policy-options community "SMALL-PEERS" { member "65400:.*$" }
configure policy-options community "SMALL-PEERS" { member "65500:.*" }
```

Example: Configuring prefix lists

```
configure policy-options prefix-list "AS65xx-prefixes" { prefix 10.100.100.0/24 type
 longer }
configure policy-options prefix-list "AS65xx-prefixes" prefix 10.200.0.0/16 type through
 through-length 24
configure policy-options prefix-list "AS65xx-prefixes" prefix 192.168.10.0/24 type through
 through-length 24
configure policy-options prefix-list "AS65xx-prefixes" { prefix 10.10.1.1/32 type exact }
configure policy-options prefix-list "AS65xx-prefixes" prefix 172.16.0.0/16 type range
 start-length 16
configure policy-options prefix-list "AS65xx-prefixes" prefix 172.16.0.0/16 type range
 end-length 19
configure policy-options prefix-list "IPv6-list" { prefix 2001:fd00:84::/46 type longer }
configure policy-options prefix-list "SMALLER_THAN_/48" prefix ::/0 type range start-
length 49
configure policy-options prefix-list "SMALLER_THAN_/48" prefix ::/0 type range end-length
 128
```

Example: Configuring policy statements

The following example displays a policy statement configuration. Entries can be either numbered or named.

```
configure policy-options policy-statement "EXT-AS-IMPORT" entry-type named
configure policy-options policy-statement "EXT-AS-IMPORT" named-entry "Routes-AS64503"
 from as-path name "PEERING"
configure policy-options policy-statement "EXT-AS-IMPORT" named-entry "Routes-AS64503"
 action action-type accept
```

The policy can be applied as import or export under the BGP router, group, or neighbor context.

Example: Importing policy under BGP root

```
configure router "Base" bgp group "eBGP-Peering" import policy ["EXT-AS-IMPORT"]
```

Test and evaluate route policies

Route policies can be tested and evaluated before they are applied to BGP as shown in the following example.

For more information about Route Policy Testing commands, see the *7450 ESS, 7750 SR, 7950 XRS, and VSR Clear, Monitor, Show, and Tools CLI Command Reference Guide*.

Use the following command to test and evaluate route policies.

```
show router bgp policy-test plcy-or-long-expr "EXT-AS-IMPORT" family ipv4 prefix 0.0.0.0/0
 longer neighbor 192.168.0.3
```

Example: Testing and evaluating route policies output

```
===============================================================================
 BGP Router ID:10.0.0.1         AS:64501       Local AS:64501
===============================================================================
 Legend -
 Status codes  : u - used, s - suppressed, h - history, d - decayed, * - valid
                 l - leaked, x - stale, > - best, b - backup, p - purge
 Origin codes  : i - IGP, e - EGP, ? - incomplete

===============================================================================
BGP IPv4 Routes
===============================================================================
      Network                                           LocalPref   MED
      Nexthop                                           Path-Id     Label
      As-Path
-------------------------------------------------------------------------------
Accepted by Policy EXT-AS-IMPORT Entry Routes-AS64503
      10.10.1.24/29                                     None        None
      192.168.0.3                                       None        n/a
      64503                                                         -
Accepted by Policy EXT-AS-IMPORT Entry Routes-AS64503
      10.10.20.103/32                                   None        None
      192.168.0.3                                       None        n/a
      64503                                                         -
Accepted by Policy EXT-AS-IMPORT Entry Routes-AS64503
      192.168.0.0/24                                    None        None
      192.168.0.3                                       None        n/a
      64503                                                         -
-------------------------------------------------------------------------------
```

```
Routes : 3
===============================================================================
```

5.2 Cflowd

Cflowd is a tool used to obtain samples of IPv4, IPv6, MPLS, and Ethernet traffic data flows through a router. For more information about cflowd, see the *7450 ESS, 7750 SR, 7950 XRS, and VSR Router Configuration Guide*.

Example: Configuring cflowd

```
configure cflowd overflow 10
configure cflowd active-flow-timeout 30
configure cflowd inactive-flow-timeout 10
configure cflowd sample-profile 1 sample-rate 100

configure cflowd collector 10.10.10.2 port 5000 description "Neighbor collector"
configure cflowd collector 10.10.10.2 port 5000 autonomous-system-type peer
configure cflowd collector 10.10.10.2 port 5000 version 8
configure cflowd collector 10.10.10.2 port 5000 aggregation protocol-port true
configure cflowd collector 10.10.10.2 port 5000 aggregation source-destination-prefix true

configure cflowd collector 10.10.10.9 port 2000 description "v9collector"
configure cflowd collector 10.10.10.9 port 2000 template-set mpls-ip
configure cflowd collector 10.10.10.9 port 2000 version 9
configure router "Base" interface "To-Peering-LAN" cflowd-parameters sampling unicast type
 interface
```

Use the following command to display the basic information about the administrative and operational status of cflowd.

```
show cflowd status
```

Example: Cflowd status output

```
===============================================================================
Cflowd Status
===============================================================================
Cflowd Admin Status  : Enabled
Cflowd Oper Status   : Enabled
Cflowd Export Mode   : Automatic
Active Flow Timeout  : 30 seconds
---snip---

Active Flows         : 0
Dropped Flows        : 0
Total Pkts Rcvd      : 0
Total Pkts Dropped   : 0
Overflow Events      : 0
                                        Raw Flow Counts  Aggregate Flow Counts
Flows Created                                         0                      0
Flows Matched                                         0                      0
Flows Flushed                                         0                      0

===============================================================================
Sample Profile Info
===============================================================================
```

```
Profile Id     Sample Rate
-------------------------------------------------------------------------------
    1                 100

===============================================================================
Version Info
===============================================================================
Version Status                   Sent                 Open               Errors
-------------------------------------------------------------------------------
    5   Disabled                    0                    0                    0
    8   Enabled                     0                    0                    0
    9   Enabled                     0                    0                    0
   10   Disabled                    0                    0                    0
===============================================================================
```

5.3 RPKI for prefix origin validation

7750 SR supports Resource Public Key Infrastructure (RPKI) for BGP prefix origin validation.

For more information about BGP prefix origin validation, see the *7450 ESS, 7750 SR, 7950 XRS, and VSR Unicast Routing Protocols Guide*.

Example: BGP prefix origin validation in a RPKI session

```
configure router "Base" origin-validation rpki-session 172.31.1.2 admin-state enable
configure router "Base" origin-validation rpki-session 172.31.1.2 local-address 10.10.1.4
configure router "Base" origin-validation rpki-session 172.31.1.2 port 8282

configure router "Base" bgp group "eBGP-Peering" origin-validation ipv4 true
configure router "Base" bgp group "eBGP-Peering" origin-validation ipv6 true

configure router "Base" bgp best-path-selection origin-invalid-unusable true
```

Use the following command to display RPKI session information.

```
show router origin-validation rpki-session detail
```

Example: RPKI session status detail output

```
===============================================================================
RPKI Session Information
===============================================================================
IP Address         : 172.31.1.2
Description        : (Not Specified)
-------------------------------------------------------------------------------
Port               : 8282              Oper State         : connect
Uptime             : 0d 00:00:00       Flaps              : 0
Active IPv4 Records: 0                 Active IPv6 Records: 0
Admin State        : Up                Local Address      : 10.10.1.4
Hold Time          : 600               Refresh Time       : 300
Stale Route Time   : 3600              Connect Retry      : 120
Serial ID          : 0                 Session ID         : 0
===============================================================================
No. of Sessions    : 1
===============================================================================
```

5.4 BGP FlowSpec

FlowSpec is a standardized method for using BGP to distribute traffic flow specifications (flow routes) throughout a network. FlowSpec is supported for both IPv4 and IPv6.

For more information about FlowSpec, see the *7450 ESS, 7750 SR, 7950 XRS, and VSR Unicast Routing Protocols Guide*.

Example: FlowSpec configuration

```
configure router "Base" bgp neighbor "192.168.0.3" family ipv4 ipv6 flow-ipv4 flow-ipv6
 true

configure filter ip-filter "FSPEC-filter" default-action accept
configure filter ip-filter "FSPEC-filter" filter-id 99
configure filter ip-filter "FSPEC-filter" embed flowspec offset 1000 router-instance
 "Base"

configure router "Base" interface "To-Peering-LAN" ingress filter ip "FSPEC-filter"
```

Use the following command to display BGP flow IPv4 routes.

```
show router bgp routes flow-ipv4
```

Use the following command to display IPv4 filter information.

```
show filter ip "FSPEC-filter”
```

Example: IP FPSEC filter output

```
===============================================================================
IP Filter
===============================================================================
Filter Id           : 99                            Applied        : Yes
Scope               : Template                      Def. Action    : Forward
Type                : Normal
Shared Policer      : Off
System filter       : Unchained
Radius Ins Pt       : n/a
CrCtl. Ins Pt       : n/a
RadSh. Ins Pt       : n/a
PccRl. Ins Pt       : n/a
Entries             : 0
Description         : (Not Specified)
Filter Name         : FSPEC-filter
-------------------------------------------------------------------------------
Filter Match Criteria : IP
-------------------------------------------------------------------------------
No Match Criteria Found
===============================================================================
```

5.5 uRPF

Unicast reverse path forwarding check (uRPF) helps to mitigate problems caused by the introduction of malformed or forged (spoofed) IP source addresses into a network by discarding IP packets that lack a verifiable IP source address. The uRPF feature is supported for both IPv4 and IPv6 on network and access.

For more information about uRPF, see the 7450 ESS, 7750 SR, 7950 XRS, and VSR Router Configuration Guide.

Example: uRPF configuration

```
configure router "Base" interface "To-Peering-LAN" ipv4 urpf-check mode loose
configure router "Base" interface "To-Peering-LAN" ipv6 urpf-check mode loose
```

6 Configuring system and routing security

To configure the system and routing security for peering, users can configure CPM filters, Management Access Filters (MAF), Access Control List filters (ACL), and Policy-based Routing (PBR).

6.1 CPM filters

CPM filters are hardware-based filters used to restrict traffic directed from the line cards to the CPM, such as control and management packets. A separate configuration is required for IPv4 and IPv6 packet matching conditions. Use prefix lists for groups of IP addresses. SR OS supports the use of the **apply-path** command to autogenerate the IPv4 and IPv6 prefix list entries for BGP peers.

For more information about CPM filters, see the *7450 ESS, 7750 SR, 7950 XRS, and VSR System Management Guide*.

Note: hen committing changes:

- Ensure all IP addresses communicating with the router are included in the prefix list. The other option is to change the "entry 1000" action to "accept" for testing purposes.
- Use the **commit confirmed** command to prevent getting locked out of the router

, make sure all IP addresses communicating with the router are included in the prefix list. The other option is to change the "entry 1000" action to "accept" for testing purposes.

Note: Use the **commit confirmed** command to avoid getting locked out of the router.

Example: Configuring IPv4 and IPv6 prefix list using apply-path

```
configure filter match-list ip-prefix-list "bgp-neighbors" apply-path bgp-peers 1 group
 "^eBGP-.*"
configure filter match-list ip-prefix-list "bgp-neighbors" apply-path bgp-peers 1 neighbor
 "^192.*"
configure filter match-list ip-prefix-list "bgp-neighbors" apply-path bgp-peers 1 router-
instance "Base"
configure filter match-list ipv6-prefix-list "eBGP-v6-Peers" apply-path bgp-peers 1 group
 "^eBGP-.*"
configure filter match-list ipv6-prefix-list "eBGP-v6-Peers" apply-path bgp-peers 1
 neighbor ".*"
configure filter match-list ipv6-prefix-list "eBGP-v6-Peers" apply-path bgp-peers 1
 router-instance "Base"
```

Example: Configuring IPv4 CPM filters

The following example contains three entries. The third entry logs and drops all unmatched packets not explicitly treated by the first two entries.

```
configure filter match-list { ip-prefix-list "SNMP-Source" prefix 192.168.10.30/32 }
configure filter match-list { ip-prefix-list "SSH-Sources" prefix 10.10.100.10/32 }
configure filter match-list { ip-prefix-list "SSH-Sources" prefix 172.16.20.0/24 }
```

```
configure system security cpm-filter ip-filter admin-state enable
configure system security cpm-filter ip-filter entry 100 description "SSH Access"
configure system security cpm-filter ip-filter entry 100 match protocol tcp
configure system security cpm-filter ip-filter entry 100 match src-ip ip-prefix-list "SSH-
Sources"
configure system security cpm-filter ip-filter entry 100 match dst-port eq 22
configure system security cpm-filter ip-filter entry 100 action accept
configure system security cpm-filter ip-filter entry 200 description "SNMP Access"
configure system security cpm-filter ip-filter entry 200 match protocol udp
configure system security cpm-filter ip-filter entry 200 match src-ip ip-prefix-list
 "SNMP-Source"
configure system security cpm-filter ip-filter entry 200 match dst-port eq 161
configure system security cpm-filter ip-filter entry 200 action accept
configure system security cpm-filter ip-filter entry 1000 log 101
configure system security cpm-filter ip-filter entry 1000 action drop
```

Example: Configuring IPv6 CPM filters

```
configure filter match-list { ipv6-prefix-list "EBGP-v6-PEERS" prefix 2001:a8::4/127 }
configure filter match-list { ipv6-prefix-list "EBGP-v6-PEERS" prefix 2013:ab33:1::54/
127 }

configure system security cpm-filter ipv6-filter admin-state enable
configure system security cpm-filter ipv6-filter entry 700 description "Inbound eBGP IPv6
 peers"
configure system security cpm-filter ipv6-filter entry 700 match next-header tcp
configure system security cpm-filter ipv6-filter entry 700 match src-ip ipv6-prefix-list
 "EBGP-v6-PEERS"
configure system security cpm-filter ipv6-filter entry 700 match dst-port eq 179
configure system security cpm-filter ipv6-filter entry 700 action accept

configure system security cpm-filter ipv6-filter entry 750 description "Outbound eBGP IPv6
 peers"
configure system security cpm-filter ipv6-filter entry 750 match next-header tcp
configure system security cpm-filter ipv6-filter entry 750 match src-ip ipv6-prefix-list
 "EBGP-v6-PEERS"
configure system security cpm-filter ipv6-filter entry 750 match src-port eq 179
configure system security cpm-filter ipv6-filter entry 750 action accept
```

Use the following command to display CPM IPv6 filter information,

```
show system security cpm-filter ip-filter entry 1000
```

Output example: CPM filter entry output

```
===============================================================================
CPM IP Filter Entry
===============================================================================
Entry Id           : 1000
Description        : (Not Specified)
-------------------------------------------------------------------------------
Filter Entry Match Criteria :
-------------------------------------------------------------------------------
Log Id             : 101
Src. IP            : n/a
Src. Port          : n/a
Dst. IP            : n/a
Dest. Port         : n/a
Protocol           : none              Dscp               : Undefined
ICMP Type          : Undefined         ICMP Code          : Undefined
Fragment           : Off               Option-present     : Off
IP-Option          : n/a               Multiple Option    : Off
```

```
TCP-syn            : Off                TCP-ack            : Off
Action             : Forward
Match Router ID    : n/a
Dropped pkts       : 0                  Forwarded pkts     : 0
===============================================================================
```

6.2 Management Access Filter

The CPM uses Management Access Filters (MAFs) to perform filtering that applies to both traffic from the line cards directed to the CPM's CPU, as well as traffic from the management Ethernet port. Separate configuration is required for IPv4 and IPv6 packet matching conditions.

Prefix lists can be used for groups of IP addresses.

For more information about MAFs, see the *7450 ESS, 7750 SR, 7950 XRS, and VSR System Management Guide*.

The following example shows three entries. The third entry logs and drops all unmatched packets not explicitly treated by the first two entries.

Note: Before committing the changes, make sure all IP addresses communicating with the router are included in the prefix list. The other option is to change the "entry 1000" action to "accept" for testing purposes.

Note: Use the **commit confirm** command to avoid being locked out of the router.

Example: Configuring IPv4 MAFs

```
configure system security management-access-filter ip-filter default-action drop
configure system security management-access-filter ip-filter entry 100 description "Permit
 SSH Prefix"
configure system security management-access-filter ip-filter entry 100 action accept
configure system security management-access-filter ip-filter entry 100 match router-
instance "management"
configure system security management-access-filter ip-filter entry 100 match protocol tcp
configure system security management-access-filter ip-filter entry 100 match src-ip ip-
prefix-list "SSH-Sources"
configure system security management-access-filter ip-filter entry 100 match mgmt-port cpm
configure system security management-access-filter ip-filter entry 100 match dst-port port
 22
configure system security management-access-filter ip-filter entry 200 description "Permit
 SNMP Prefix"
configure system security management-access-filter ip-filter entry 200 action accept
configure system security management-access-filter ip-filter entry 200 match router-
instance "management"
configure system security management-access-filter ip-filter entry 200 match protocol udp
configure system security management-access-filter ip-filter entry 200 match src-ip ip-
prefix-list "SNMP-Source"
configure system security management-access-filter ip-filter entry 200 match mgmt-port cpm
configure system security management-access-filter ip-filter entry 200 match dst-port port
 161
configure system security management-access-filter ip-filter entry 2000 description
 "Management Plane Default"
configure system security management-access-filter ip-filter entry 2000 action drop
configure system security management-access-filter ip-filter entry 2000 log-events true
configure system security management-access-filter ip-filter entry 2000 match router-
instance "management"
```

```
configure system security management-access-filter ip-filter entry 2000 match mgmt-port
 cpm
```

Example: Configuring IPv6 MAFs

The following example displays the configuration of MAF IPv6 filters.

```
configure filter match-list { ipv6-prefix-list "EBGP-v6-PEERS" prefix 2001:a8::4/127 }
configure filter match-list { ipv6-prefix-list "EBGP-v6-PEERS" prefix 2013:ab33:1::54/
127 }

configure system security management-access-filter ipv6-filter default-action drop
configure system security management-access-filter ipv6-filter entry 10 match router-
instance "management"
configure system security management-access-filter ipv6-filter entry 10 action accept
configure system security management-access-filter ipv6-filter entry 10 match mgmt-port
 cpm
configure system security management-access-filter ipv6-filter entry 10 match next-header
 tcp-udp
configure system security management-access-filter ipv6-filter entry 10 match src-ip ipv6-
prefix-list "EBGP-v6-PEERS"

configure system security management-access-filter ipv6-filter entry 1000 action accept
configure system security management-access-filter ipv6-filter entry 1000 match router-
instance "management"
configure system security management-access-filter ipv6-filter entry 1000 match mgmt-port
 cpm
```

Use the following command to display management-access IP filters.

```
show system security management-access-filter ip-filter entry 2000
```

Example: IPv4 MAF output

```
===============================================================================
IPv4 Management Access Filter
===============================================================================
filter type    : ip
Def. Action    : deny
Admin Status   : enabled (no shutdown)
-------------------------------------------------------------------------------
Entry          : 2000
Description    : Management Plane Default
Src-ip         : undefined
Mgmt-port      : cpm
Protocol       : undefined
Dst-port       : undefined
Src-port       : undefined
Router-instance: management
Action         : permit
Log            : enabled
Matches        : 1424
===============================================================================
```

6.3 ACLs

ACL filter policies, also referred to as Access Control Lists (ACLs) or just "filters", are sets of ordered rule entries specifying packet match criteria and actions performed on a packet after a match. Filter policies are created with a unique filter ID and filter name. After the filter policy is created, the policy must be associated with interfaces or services.

For more information about ACL configuration, see the *7450 ESS, 7750 SR, 7950 XRS, and VSR Router Configuration Guide*.

Example: Configuring and applying ACL filter policies

```
configure filter match-list port-list "AS7xx-Ports" { port 179 }
configure filter match-list port-list "AS7xx-Ports" range start 30000 end 64000
configure filter ip-filter "AS700-ALLOW" filter-id 700
configure filter ip-filter "AS700-ALLOW" entry 10 match protocol tcp
configure filter ip-filter "AS700-ALLOW" entry 10 match src-ip ip-prefix-list "SSH-
Sources"
configure filter ip-filter "AS700-ALLOW" entry 10 match dst-ip ip-prefix-list "SNMP-
Source"
configure filter ip-filter "AS700-ALLOW" entry 10 action accept

configure filter ipv6-filter "AS-IPv6-ALLOW" filter-id 800
configure filter ipv6-filter "AS-IPv6-ALLOW" entry 10 match next-header tcp
configure filter ipv6-filter "AS-IPv6-ALLOW" entry 10 match src-ip ipv6-prefix-list "EBGP-
v6-PEERS"
configure filter ipv6-filter "AS-IPv6-ALLOW" entry 10 match src-port port-list "AS7xx-
Ports"
configure filter ipv6-filter "AS-IPv6-ALLOW" entry 10 action accept
configure filter ipv6-filter "AS-IPv6-ALLOW" entry 20 match next-header tcp
configure filter ipv6-filter "AS-IPv6-ALLOW" entry 20 match dst-ip ipv6-prefix-list "EBGP-
v6-PEERS"
configure filter ipv6-filter "AS-IPv6-ALLOW" entry 20 match dst-port port-list "AS7xx-
Ports"
configure filter ipv6-filter "AS-IPv6-ALLOW" entry 20 action accept

configure router "Base" interface "To-Peering-LAN" ingress filter ip "AS700-ALLOW"
configure router "Base" interface "To-Peering-LAN" ingress filter ipv6 "AS-IPv6-ALLOW"
```

6.3.1 Rate limiting DDoS traffic

Use ACL policies to rate limit NTP, DNS, or other types of common DDoS packet types.

For more information about ACL configuration, see the *7450 ESS, 7750 SR, 7950 XRS, and VSR Router Configuration Guide*.

Example: Rate limiting NTP and DNS packets

In the following example, rate limits are configured for NTP and DNS packets based on UDP, packet length, ports and destination IP.

```
configure filter match-list ip-prefix-list "Core-IP" { prefix 172.16.20.0/24 }
configure filter ip-filter "AS700-ALLOW" type packet-length
configure filter ip-filter "AS700-ALLOW" entry 20 match protocol udp
configure filter ip-filter "AS700-ALLOW" entry 20 match dst-ip ip-prefix-list "Core-IP"
configure filter ip-filter "AS700-ALLOW" entry 20 match port eq 123
```

```
configure filter ip-filter "AS700-ALLOW" entry 20 match packet-length gt 600
configure filter ip-filter "AS700-ALLOW" entry 20 action accept
configure filter ip-filter "AS700-ALLOW" entry 20 action rate-limit pir 1000
configure filter ip-filter "AS700-ALLOW" entry 30 match protocol udp
configure filter ip-filter "AS700-ALLOW" entry 30 match dst-ip ip-prefix-list "Core-IP"
configure filter ip-filter "AS700-ALLOW" entry 30 match port eq 53
configure filter ip-filter "AS700-ALLOW" entry 30 match packet-length gt 600
configure filter ip-filter "AS700-ALLOW" entry 30 action accept
configure filter ip-filter "AS700-ALLOW" entry 30 action rate-limit pir 1000
```

6.3.2 Redirecting suspicious traffic

Use ACL policies to redirect suspicious DDoS packets to a scrubbing device. This is achieved using Policy-Based Routing (PBR) and Policy-Based Forwarding (PBF) actions under the ACL context.

For more information about ACL configuration, see the *7450 ESS, 7750 SR, 7950 XRS, and VSR Router Configuration Guide*.

Example: Redirecting packets to a different next hop based on source or destination IP match

```
configure filter match-list ip-prefix-list "Core-IP" { prefix 172.16.20.0/24 }
configure filter ip-filter "pbr-nh-1" filter-id 788
configure filter ip-filter "pbr-nh-1" entry 10 match src-ip ip-prefix-list "Core-IP”
configure filter ip-filter "pbr-nh-1" entry 10 action forward next-hop nh-ip address
 172.19.20.3
configure filter ip-filter "pbr-nh-1" entry 20 match dst-ip ip-prefix-list “Core-IP"
configure filter ip-filter "pbr-nh-1" entry 20 action forward next-hop nh-ip indirect true
configure filter ip-filter "pbr-nh-1" entry 20 action forward next-hop nh-ip address
 192.168.40.3
configure router "Base" interface "Interface-to-AS65501" ingress filter ip "pbr-nh-1"
```

6.3.3 ACL show commands

For more information about ACL configuration, see the *7450 ESS, 7750 SR, 7950 XRS, and VSR Router Configuration Guide*.

Use the following show commands to display IPv4 filter information.

```
show filter ip 10 associations
show filter ip 10 counters
show filter ip 10 detail
```

Use the following command to display all system resource usage information.

```
tools dump resource-usage system all | match ‘ACL|Total’
```

6.4 PBR

SR OS-based routers support configuring of IPv4 and IPv6 redirect policies. Redirect policies allow a user to specify multiple redirect target destinations and define status check test methods to validate the ability

for a destination to receive redirected traffic. For more information about Policy-Based Routing (PBR) configuration, see the *7450 ESS, 7750 SR, 7950 XRS, and VSR Router Configuration Guide*.

The following example displays a ping test used to verify the destination. If the destination is not reachable, traffic is not redirected to that destination, and regular route forwarding takes place.

Example: Configuring policy-based routing

```
configure filter redirect-policy "FIREWALL-V4" admin-state enable
configure filter redirect-policy "FIREWALL-V4" destination 10.200.200.0 ping-test interval
 5
configure filter redirect-policy "FIREWALL-V4" destination 10.200.200.0 ping-test drop-
count 1

configure filter ip-filter "ACL_PBR_V4" filter-id 155
configure filter ip-filter "ACL_PBR_V4" entry 1000 match protocol ip
configure filter ip-filter "ACL_PBR_V4" entry 1000 action forward redirect-policy
 "FIREWALL-V4"
```

7 Configuring QoS

SR OS implements Quality of Service (QoS) with a four-step process:

1. Classification
2. Queuing
3. Scheduling
4. Re-marking

For more information about QoS configuration, see the *7450 ESS, 7750 SR, 7950 XRS, and VSR Quality of Service Guide*.

7.1 Classification

This following example displays packet classification using DSCP, EXP, protocol and destination IP address. The classification policy is then applied to the interface. For QoS on VPRN interfaces, similar configurations can be applied on the **sap-ingress** and **sap-egress** contexts within **configure qos**.

Example: Configuring QoS classification

```
configure qos match-list ip-prefix-list “Peering-Core” prefix 10.10.10.0/24
configure qos network "Peering-Ingress-QoS" policy-id 10
configure qos network "Peering-Ingress-QoS" ingress dscp be fc be
configure qos network "Peering-Ingress-QoS" ingress dscp be profile out
configure qos network "Peering-Ingress-QoS" ingress lsp-exp 6 fc h1
configure qos network "Peering-Ingress-QoS" ingress lsp-exp 6 profile in
configure qos network "Peering-Ingress-QoS" ingress ip-criteria entry 10 match protocol
 tcp
configure qos network "Peering-Ingress-QoS" ingress ip-criteria entry 10 match dst-ip ip-
prefix-list "Peering-Core"
configure qos network "Peering-Ingress-QoS" ingress ip-criteria entry 10 action fc ef

configure router "Base" interface "To-Peering-LAN" qos network-policy "Peering-Ingress-
QoS"
```

7.2 Queuing

The following example displays a sample configuration for the queuing step in the QoS packet flow. The queuing policy is applied to the FP context of the card.

Example: Configuring QoS queuing

```
configure qos network-queue "Peering-Queue" fc be queue 1
configure qos network-queue "Peering-Queue" fc ef queue 6
configure qos network-queue "Peering-Queue" fc h1 queue 7
configure qos network-queue "Peering-Queue" fc nc queue 8
configure qos network-queue "Peering-Queue" queue 1 mbs 50.0
```

```
configure qos network-queue "Peering-Queue" queue 1 rate pir 90
configure qos network-queue "Peering-Queue" queue 1 rate cir 10
configure qos network-queue "Peering-Queue" queue 6 cbs 70.0
configure qos network-queue "Peering-Queue" queue 6 mbs 100.0
configure qos network-queue "Peering-Queue" queue 6 rate pir 100
configure qos network-queue "Peering-Queue" queue 6 rate cir 100
configure qos network-queue "Peering-Queue" queue 7 rate pir 100
configure qos network-queue "Peering-Queue" queue 7 rate cir 100
configure qos network-queue "Peering-Queue" queue 8 rate pir 10
configure qos network-queue "Peering-Queue" queue 8 rate cir 10

configure card 1 fp 1 ingress network queue-policy "Peering-Queue"
```

7.3 Scheduling

The following example displays a simple port-based scheduler that typically meets the requirements for a peering network. SR OS also supports hierarchical schedulers and slope policies.

After the scheduler policy is defined, it is applied to the physical port context.

Example: Configuring QoS scheduling

```
configure qos port-scheduler-policy "Peer-Scheduler" max-rate 100000000
configure qos port-scheduler-policy "Peer-Scheduler" level 1 rate pir 90
configure qos port-scheduler-policy "Peer-Scheduler" level 1 rate cir 10
configure qos port-scheduler-policy "Peer-Scheduler" level 6 rate pir max
configure qos port-scheduler-policy "Peer-Scheduler" level 6 rate cir max
configure qos port-scheduler-policy "Peer-Scheduler" level 7 rate pir max
configure qos port-scheduler-policy "Peer-Scheduler" level 7 rate cir max
configure qos port-scheduler-policy "Peer-Scheduler" level 8 rate pir max
configure qos port-scheduler-policy "Peer-Scheduler" level 8 rate cir max

configure port 1/1/c1/1 ethernet egress port-scheduler-policy policy-name "Peer-Scheduler"
```

7.4 Re-marking

Re-marking configuration is done inside the same policy as the classification and is applied under the interface level as shown in the following example.

Example: Configuring QoS re-marking

```
configure qos network "Peering-Ingress-QoS" egress fc be lsp-exp-in-profile 0
configure qos network "Peering-Ingress-QoS" egress fc be lsp-exp-out-profile 0
configure qos network "Peering-Ingress-QoS" egress fc ef dscp-in-profile af41
configure qos network "Peering-Ingress-QoS" egress fc h1 lsp-exp-in-profile 6

configure router "Base" interface "To-Peering-LAN" qos network-policy "Peering-Ingress-
QoS"
```

8 Configuring management

SR OS supports the following management interfaces:

- SNMP
- NETCONF
- gRPC (gNMI and gNOI)

NETCONF and gRPC interfaces are based on a common infrastructure that uses YANG models as the core definition for configuration, state, and operational actions. All model-driven interfaces, including MD-CLI, take the same common underlying YANG modules and render them for the specific management interface.

See the *7450 ESS, 7750 SR, 7950 XRS, and VSR System Management Guide* for more information about management interfaces.

8.1 SNMP

The SNMP agent in SR OS supports SNMP versions 1, 2, and 3 of the SNMP protocol.

Use the following command to enable SNMPv2 in SR OS.

```
configure system management-interface snmp admin-state enable
```

Example: Configuring SNMP v2

In the following example, an SNMP community named "private" is used.

```
configure system security snmp community "private" access-permissions rwa
configure system security snmp community "private" version v2c
```

Example: Configuring views

In the following example, a view is created that allows all SNMP OIDs except the management OID (1.3.6.1.2).

```
configure system security snmp view "testview" subtree "1" mask "ff"
configure system security snmp view "testview" subtree "1.3.6.1.2" mask "ff"
configure system security snmp view "testview" subtree "1.3.6.1.2" type excluded
```

Example: Configuring access groups

In the following example, the view is attached to an access group.

```
configure system security snmp access "testgroup" context "" security-model usm security-
level privacy read "testview"
configure system security snmp access "testgroup" context "" security-model usm security-
level privacy write "testview"
configure system security snmp access "testgroup" context "" security-model usm security-
level privacy notify "testview"
```

Example: Configuring SNMPv3 access and user authentication

In the following example, a user is created with SNMPv3-level security and assigned the access group created in the preceding example. When trying to access the system over SNMPv3 using this user, all OIDs are accessible, except the management OID blocked by the access group.

```
/configure system security user-params local-user user "testuser" password "password123"
/configure system security user-params local-user user "testuser" access snmp true
/configure system security user-params local-user user "testuser" snmp group "testgroup"
/configure system security user-params local-user user "testuser" snmp authentication
 authentication-protocol hmac-md5-96
/configure system security user-params local-user user "testuser" snmp authentication
 authentication-key "ScP+TqePGLFQCji9jsyYADLcm/U21na77A8sCzhnIeQ= hash2"
/configure system security user-params local-user user "testuser" snmp authentication
 privacy privacy-protocol cfb128-aes-128
/configure system security user-params local-user user "testuser" snmp authentication
 privacy privacy-key "ScP+TqePGLFQCji9jsyYADKYDOznv3WpBtOO9DGQJaM= hash2"
```

Use the following command to generate authentication and privacy keys.

```
tools perform system management-interface snmp generate-key
```

Example: Configuring SNMP trap destination

```
configure log snmp-trap-group "my-snmp-trap-dest1" trap-target "Trap-server1" address
 192.168.99.10
configure log snmp-trap-group "my-snmp-trap-dest1" trap-target "Trap-server1" version
 snmpv2c
configure log snmp-trap-group "my-snmp-trap-dest1" trap-target "Trap-server1" notify-
community "private"
configure log snmp-trap-group "my-snmp-trap-dest1" trap-target "Trap-server1" security-
level no-auth-no-privacy
```

Example: Configuring log events to be sent as SNMP traps

```
configure log log-id "my-snmp-trap-dest1" source main true
configure log log-id "my-snmp-trap-dest1" source security true
configure log log-id "my-snmp-trap-dest1" source change true
configure log log-id "my-snmp-trap-dest1" destination { snmp }
```

8.2 NETCONF

NETCONF is a standardized IETF configuration management protocol specified in RFC 6241, *Network Configuration Protocol (NETCONF)*. It is secure, connection-oriented, and runs on top of the SSHv2 transport protocol, as specified in RFC 6242 *Using the NETCONF Configuration Protocol over Secure Shell (SSH)*. NETCONF is an XML-based protocol that can be used as an alternative to CLI or SNMP for managing an SR OS router.

The SR OS NETCONF server supports both the base:1.1 and the base:1.0 capabilities.

SR OS NETCONF supports both a CLI content layer and an XML-based content layer.

Use the following command to enable the NETCONF server in SR OS.

```
configure system management-interface netconf listen admin-state enable
```

The default listening port is 830.

Example: Configuring NETCONF user profile

A user profile can be created for NETCONF users with authorization for each operation.

```
configure system security aaa local-profiles profile "netconf-profile" netconf base-o
p-ahorization action true
configure system security aaa local-profiles profile "netconf-profile" netconf base-op-
authorization cancel-commit true
configure system security aaa local-profiles profile "netconf-profile" netconf base-op-
authorization close-session true
configure system security aaa local-profiles profile "netconf-profile" netconf base-op-
authorization commit true
configure system security aaa local-profiles profile "netconf-profile" netconf base-op-
authorization copy-config true
configure system security aaa local-profiles profile "netconf-profile" netconf base-op-
authorization create-subscription true
configure system security aaa local-profiles profile "netconf-profile" netconf base-op-
authorization delete-config true
configure system security aaa local-profiles profile "netconf-profile" netconf base-op-
authorization discard-changes true
configure system security aaa local-profiles profile "netconf-profile" netconf base-op-
authorization edit-config true
configure system security aaa local-profiles profile "netconf-profile" netconf base-op-
authorization get true
configure system security aaa local-profiles profile "netconf-profile" netconf base-op-
authorization get-config true
configure system security aaa local-profiles profile "netconf-profile" netconf base-op-
authorization get-data true
configure system security aaa local-profiles profile "netconf-profile" netconf base-op-
authorization get-schema true
configure system security aaa local-profiles profile "netconf-profile" netconf base-op-
authorization kill-session true
configure system security aaa local-profiles profile "netconf-profile" netconf base-op-
authorization lock true
configure system security aaa local-profiles profile "netconf-profile" netconf base-op-
authorization validate true
```

Example: Configuring NETCONF user

The profile created in the preceding example can be assigned to a user for NETCONF access.

```
configure system security user-params local-user user "netconf-user" password
 "password123"
configure system security user-params local-user user "netconf-user" access netconf true
configure system security user-params local-user user "netconf-user" console member
 ["netconf-profile"]
```

Use the following command to verify connected NETCONF sessions.

```
show system netconf connection
```

Example: Displaying list of connected NETCONF sessions

```
===============================================================================
NETCONF Server connections
===============================================================================
Connection       Username       Session Status        Session Running Candidate
                                Id                    Type    Locked? Locked?
 Session Init
```

```
 Type
-------------------------------------------------------------------------------
172.20.20.1      netconf-user   12      connected     global  no      no
  Client-Initiated
-------------------------------------------------------------------------------
Number of NETCONF sessions: 1
===============================================================================
```

Use the following command to view NETCONF operation counters.

```
show system netconf counters
```

Example: Displaying NETCONF counter values

```
===============================================================================
NETCONF counters
===============================================================================
    Rx Messages
-------------------------------------------------------------------------------
      in gets            : 0
      in get-configs     : 1
      in edit-configs    : 0
      in copy-configs    : 1
      in delete-configs  : 0
      in validates       : 0
      in close-sessions  : 0
      in kill-sessions   : 0
      in locks           : 0
      in unlocks         : 0
      in commits         : 0
      in discards        : 0
      in create-subscrip*: 0
      in get-schemas     : 0
      in get-datas       : 0
      in actions         : 0

-------------------------------------------------------------------------------
      Rx Total           : 2
===============================================================================
```

8.3 gRPC gNMI

The gRPC mechanism is a modern, open-source, high-performance RPC framework that can run in any environment. In SR OS, this framework is used to implement the gRPC server, which can then be used for configuration management or telemetry.

The gRPC service runs on port 57400 by default in SR OS.

The gRPC gNMI is a gRPC-based protocol for network management functions, such as changing the configuration of network elements and retrieving state information. Additionally, gNMI provides functionality necessary for supporting telemetry. The gNMI service is specified in the OpenConfig forum.

8.3.1 Enabling gRPC gNMI

Use the following commands to enable gRPC in non-secure (non-TLS) mode.

```
configure system grpc admin-state enable
configure system grpc allow-unsecure-connection
```

Example: Configuring gRPC user profile

```
configure system security aaa local-profiles profile "grpc-profile" grpc rpc-authorization
 gnmi-capabilities permit
configure system security aaa local-profiles profile "grpc-profile" grpc rpc-authorization
 gnmi-get permit
configure system security aaa local-profiles profile "grpc-profile" grpc rpc-authorization
 gnmi-set permit
configure system security aaa local-profiles profile "grpc-profile" grpc rpc-authorization
 gnmi-subscribe permit
```

Example: Configuring gRPC user

```
configure system security user-params local-user user "grpc-user" password "password123"
configure system security user-params local-user user "grpc-user" access grpc true
configure system security user-params local-user user "grpc-user" console member ["grpc-
profile"]
```

Use the following command to verify connected gRPC sessions.

```
show system grpc connection
```

Example: Displaying list of connected gRPC sessions

```
===============================================================================
gRPC Server connections
===============================================================================
Address                   : 172.20.20.1
Port                      : 47512
Router Instance           : management
Establishment Time        : 2025/08/09 14:11:26
Active RPC Count          : 1
Total RPC Count           : 1
Rx Bytes                  : 335
Tx Bytes                  : 441
-------------------------------------------------------------------------------
No. of connections        : 1
===============================================================================
```

9 Additional system configuration

The following sections describe optional system configurations.

9.1 Switching from the classic CLI to the MD-CLI

Before SR OS Release 23.3.R1, the default management configuration mode was classic CLI. The following configuration enables model-driven configuration mode, the MD-CLI, NETCONF and gRPC on the router.

Run the following command in the classic CLI, then log out and log in to enable the MD-CLI.

```
configure system management-interface configuration-mode model-driven
logout
```

Use the following commands to enable NETCONF and gRPC.

```
configure private
configure system management-interface netconf listen admin-state enable
configure system security user-params local-user user “user1" access netconf true
configure system grpc admin-state enable
configure system grpc allow-unsecure-connection
configure system security user-params local-user user “user1" access grpc true
commit
```

For more information about the MD-CLI, see the *7450 ESS, 7750 SR, 7950 XRS, and VSR MD-CLI User Guide* and the *7450 ESS, 7750 SR, 7950 XRS, and VSR MD-CLI Command Reference Guide*.

9.2 User and profile management

SR OS supports local, TACACS+, RADIUS, or LDAP for authentication, authorization, and accounting (AAA).

Example: Configuring local management

```
configure system security aaa local-profiles profile "NOC-User" default-action deny-all
configure system security aaa local-profiles profile "NOC-User" entry 10 match "configure
 system security"
configure system security aaa local-profiles profile "NOC-User" entry 10 action deny
configure system security aaa local-profiles profile "NOC-User" entry 20 match "show"
configure system security aaa local-profiles profile "NOC-User" entry 20 action permit

configure system security user-params local-user user "markp" password “changeme"
configure system security user-params local-user user "markp" access console true
configure system security user-params local-user user "markp" console member ["NOC-User"]
```

For more information about AAA, see the *7450 ESS, 7750 SR, 7950 XRS, and VSR System Management Guide*.

9.3 NTP

The following example shows a Network Time Protocol (NTP) configuration.

Example: Configuring NTP

```
configure system time ntp admin-state enable
configure system time ntp server 172.16.1.10 router-instance "Base" key-id 5
configure system time ntp server 172.16.1.10 router-instance "Base" prefer true
configure system time ntp server 172.18.2.20 router-instance "Base" key-id 5
configure system time ntp authentication-key 5 key "keyvalue"
configure system time ntp authentication-key 5 type message-digest
```

Execute the **show system ntp all** command to display the status of NTP.

9.4 System alarms and logging

SR OS has a default **log-id 99** for all events and **log-id 100** for events with severity major and higher.

User-defined logs can be created as shown in the following example. Log destination options are **file**, **memory**, **console**, **snmp**, **netconf**, or **syslog**.

For more information about logging, see the *7450 ESS, 7750 SR, 7950 XRS, and VSR System Management Guide*.

Example: Configuring user defined logs

```
show log log-id
show log log-id 99

show log log-id 100

configure log log-id "33" admin-state enable
configure log log-id "33" source main true
configure log log-id "33" source security true
configure log log-id "33" source change true
configure log log-id "33" destination memory max-entries 500

configure log syslog "Syslog-server-1" address 192.168.15.190
configure log syslog "Syslog-server-1" port 514

configure log log-id "To-syslog" admin-state enable
configure log log-id "To-syslog" source main true
configure log log-id "To-syslog" source security true
configure log log-id "To-syslog" source change true
configure log log-id "To-syslog" destination syslog "Syslog-server-1"
```

10 Appendix A: Custom CLI commands (pySROS)

Custom Python applications can be written to run on SR OS. One example of an application is a custom CLI command. The following sample configuration shows how to configure a Python script `get_all_interfaces.py` to display all VPRN interfaces and the in/out packets in one output. For sample Python scripts, visit the Nokia pySROS GitHub repository.

For more information about pySROS, see the *7450 ESS, 7750 SR, 7950 XRS, and VSR System Management Guide* and the *pySROS API documentation*.

Example: Configuring a python script

```
configure python python-script "get_all_interfaces" admin-state enable
configure python python-script "get_all_interfaces" urls ["cf3:\get_all_interfaces.py"]
configure python python-script "get_all_interfaces" version python3
configure system management-interface cli md-cli environment command-alias alias "all-
interfaces" admin-state enable
configure system management-interface cli md-cli environment command-alias alias "all-
interfaces" description "show all VPRN interfaces"
configure system management-interface cli md-cli environment command-alias alias "all-
interfaces" python-script "get_all_interfaces"
configure system management-interface cli md-cli environment command-alias alias "all-
interfaces" mount-point "/show"

# show all-interfaces
===============================================================================================
==========
All Interfaces on all VPRNs
===============================================================================================
==========
VPRN            Interface Name  IPv4 Address    Oper Status     Port:VLAN       In-Pkts
 Out-Pkts
-----------------------------------------------------------------------------------------------
----------
100             VPRN100         99.99.99.75     up              loopback        0
 0
150             To_Ixia         150.150.150.6   up              1/1/30:150      0
 0
150             VPRN150         150.150.150.75  up              loopback        0
 0
===============================================================================================
==========
```

11 Appendix B: Configuration groups

SR OS supports the creation of configuration templates called configuration groups, which can be applied at different branches in the configuration using the **apply-groups** command as shown in the following example. To view the expanded configuration, use the **info inheritance** command under the branch context.

For more information about configuration groups, see the *7450 ESS, 7750 SR, 7950 XRS, and VSR MD-CLI User Guide*.

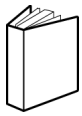
Example: Creating a configuration group

```
configure groups group "Peer-isis" router "Base" isis 0 interface "<Interface-to-AS.*>"
configure groups group "Peer-isis" router "Base" isis 0 interface "<Interface-to-AS.*>"
 hello-authentication-key "mykey"
configure groups group "Peer-isis" router "Base" isis 0 interface "<Interface-to-AS.*>"
 hello-authentication-type message-digest
configure groups group "Peer-isis" router "Base" isis 0 interface "<Interface-to-AS.*>"
 interface-type point-to-point
configure groups group "Peer-isis" router "Base" isis 0 interface "<Interface-to-AS.*>"
 level 2 metric 10

configure router "Base" interface "Interface-to-AS65501"
configure router "Base" isis 0 interface "Interface-to-AS65501" apply-groups ["Peer-isis"]

(pr)[/configure router "Base" isis 0 interface "Interface-to-AS65501"]
A:admin@sr101# info inheritance
    apply-groups ["Peer-isis"]
    ## inherited: from group "Peer-isis"
    hello-authentication-key "7NcYcNGWMxapfjrDQIyYNe1ZQ7HXjfY=" hash2
    ## inherited: from group "Peer-isis"
    hello-authentication-type message-digest
    ## inherited: from group "Peer-isis"
    interface-type point-to-point
    level 2 {
        ## inherited: from group "Peer-isis"
        metric 10
    }
```

Customer document and product support



Customer documentation

Customer documentation welcome page

Technical support

Product support portal

Documentation feedback

Customer documentation feedback