IPv4 Routing Configuration Guide, Cisco IOS XE 16 (Cisco NCS 520 Series)

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CHAPTER 1

IPv4 Routing

The IPv4 routing is supported only on BDI interfaces. The device supports Layer 3 functionality, where packets are routed across various bridge domain interfaces.

- Limitations for IPv4 Routing, on page 1
- Configuring IP Address on BDI Interface, on page 2
- Verifying IPv4 Routing, on page 2

Limitations for IPv4 Routing

- The IPv4 routing is supported only on BDI interfaces, and not supported on physical interfaces (1G, 10G) and port channel interfaces.
- IP addresses cannot be configured on the physical and the port channel interface.
- The maximum number of IPv4 routes that can be learnt is 12,000.
- BDI level IP ACLs are not supported.
- VRRP and HSRP protocols are not supported.

> **Note** Effective Cisco IOS XE Gibraltar 16.12.1 and later, VRRP and HSRP protocols are supported on the Cisco NCS 520 router.

- The maximum number of VRF lite sessions supported are 128.
- BDI statistics is supported only for CPU bounded traffic, for data traffic going over BDI interface will be shown on respective underlying EFP statistics.
- For adding static ARP, it is mandatory that you specify the static MAC address. For example, to configure static ARP, specify the following commands:
  - **arp*<ip-add>* *<mac-add>* arpa** under the **config** mode.

    mac static address ***<mac>*** under the **config-if-srv** mode.
- The router sends Gratuitous ARP only whenb the BDI interface is brought up, and processes the Gratuitous ARP if it is of the request type.

- IPv6 is not supported.
- IPv4 multicast is not supported.
- IPv4 MIBs are not supported.
- IP-FRR, LFA, segment routing, and policy-based routing are not supported.
- BFD is not supported.
- IP unnumbered is not supported.
- MPLS is not supported.

Configuring IP Address on BDI Interface

To configure IP address on BDI interface, enter the following commands:

```
interface BDI10
ip address 10.10.10.10 255.255.255.0
end
```

Verifying IPv4 Routing

Use the **show ip route** and **show ip route summary** commands to verify IP address on BDI interface:

```
router#show ip route
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2, m - OMP
       n - NAT, Ni - NAT inside, No - NAT outside, Nd - NAT DIA
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static route
       H - NHRP, G - NHRP registered, g - NHRP registration summary
       o - ODR, P - periodic downloaded static route, l - LISP
       a - application route
       + - replicated route, % - next hop override, p - overrides from PfR

Gateway of last resort is not set

      1.0.0.0/32 is subnetted, 1 subnets
O        1.1.1.1 [110/2] via 192.168.13.4, 1d01h, BDI210
                 [110/2] via 192.168.12.4, 1d01h, BDI111
      6.0.0.0/32 is subnetted, 1 subnets
C        6.6.6.6 is directly connected, Loopback0
      8.0.0.0/32 is subnetted, 1 subnets
O        8.8.8.8 [110/2] via 192.168.13.1, 1d01h, BDI210
                 [110/2] via 192.168.12.1, 1d00h, BDI111
      10.0.0.0/32 is subnetted, 1 subnets
O        10.10.10.10 [110/2] via 192.168.13.2, 03:20:31, BDI210
                     [110/2] via 192.168.12.2, 03:20:29, BDI111
      192.168.12.0/24 is variably subnetted, 2 subnets, 2 masks
C        192.168.12.0/24 is directly connected, BDI111
L        192.168.12.3/32 is directly connected, BDI111
      192.168.13.0/24 is variably subnetted, 2 subnets, 2 masks
```

```
C        192.168.13.0/24 is directly connected, BDI210
L        192.168.13.3/32 is directly connected, BDI210


router#show ip route summary
IP routing table name is default (0x0)
IP routing table maximum-paths is 32
Route Source    Networks    Subnets     Replicates  Overhead    Memory (bytes)
application     0           0           0           0           0
connected       0           5           0           560         1560
static          0           0           0           0           0
ospf 30         0           3           0           576         948
  Intra-area: 3 Inter-area: 0 External-1: 0 External-2: 0
  NSSA External-1: 0 NSSA External-2: 0
isis 1          0           0           0           0           0
  Level 1: 0 Level 2: 0 Inter-area: 0
bgp 1           0           0           0           0           0
  External: 0 Internal: 0 Local: 0
internal        6                                               2792
Total           6           8           0           1136        5300
```

CHAPTER 2

Configuring OSPF

- Cisco OSPF Implementation, on page 5
- Route Distribution for OSPF, on page 5
- Router Coordination for OSPF, on page 6
- Limitation for OSPF, on page 6
- How to Configure OSPF, on page 6

Cisco OSPF Implementation

The Cisco implementation conforms to the OSPF Version 2 specifications detailed in the Internet RFC 2328. The following list outlines key features supported in the Cisco OSPF implementation:

- Stub areas
- Route redistribution
- Authentication
- Routing interface parameters
- Virtual links
- Not-so-stubby area (NSSA
- OSPF over demand circuit

For more information on each key OSPF features, see https://www.cisco.com/c/en/us/td/docs/ios-xml/ios/iproute_ospf/configuration/xe-3s/iro-xe-3s-book/iro-cfg.html#GUID-A999A739-6B1D-4E5E-9396-F7531469D805.

Route Distribution for OSPF

You can specify route redistribution. For more information on how to configure route redistribution, see https://www.cisco.com/c/en/us/td/docs/ios-xml/ios/iproute_ospf/configuration/xe-3s/iro-xe-3s-book/iro-cfg.html#GUID-369415D9-E481-41AE-9387-ECEDFE461361.

Router Coordination for OSPF

OSPF typically requires coordination among many internal routers: Area Border Routers (ABRs), which are routers connected to multiple areas, and Autonomous System Boundary Routers (ASBRs). For more information, see https://www.cisco.com/c/en/us/td/docs/ios-xml/ios/iproute_ospf/configuration/xe-3s/iro-xe-3s-book/iro-cfg.html#GUID-CFFB7E62-5D56-4036-8DF7-F5BFC75ADF53.

Limitation for OSPF

- OSPFv3 is not supported.

How to Configure OSPF

Enabling OSPF

Before configuring, you need to enable OSPF.

To enable OSPF at the global configuration mode, enter the following commands:

```
enable
configure terminal
router ospf process-id
router-id <loopback ip-address>
network ip-address wildcard-mask area area-id
end
```

Configuring OSPF on BDI

Before configuring, you need to enable OSPF.

To enable OSPF on the BDI interface, enter the following commands:

```
enable
configure terminal
interface BDI <bdi-no>
ip address <ip-address > <subnet-mask>
ip ospf <process-id> area <area-id>
end
```

For more information, see How to Configure OSPF.

Configuring Loopback on OSPF Interface

To configure loopback on OSPF interface, enter the following commands:

```
interface loopback<loopback-no>
ip address <ip-address > <subnet-mask>
```

```
ip ospf <process-id> area <area-id>
```

Configuration Examples for OSPF

Refer the following examples on various configurations for OSPF.

CHAPTER 3

Configuring IS-IS

- IS-IS Overview, on page 9
- How to Configure IS-IS, on page 9

IS-IS Overview

Intermediate System-to-Intermediate System (IS-IS) routing protocol is a link-state Interior Gateway Protocol (IGP). Link-state protocols are characterized by the propagation of the information required to build a complete network connectivity map on each participating device. That map is then used to calculate the shortest path to destinations.

The IS-IS protocol was developed in the late 1980s by Digital Equipment Corporation (DEC) and was standardized by the International Standards Organization (ISO) in ISO/IEC 10589. The current version of this standard is ISO/IEC 10589:2002.

For more information, refer Information About IS-IS.

How to Configure IS-IS

Enabling IS-IS

To configure IS-IS, you need to enable IS-IS on the device and interface.

To enable IS-IS as an IP routing protocol on the device at the global configuration mode, enter the following commands:

```
enable
configure terminal
router isis [area-tag]
net network-entity-title
end
```

Configuring IS-IS on BDI Interface

To enable IS-IS as an IP routing protocol on the BDI interface, enter the following commands:

```
enable
```

```
configure terminal
interface BDI<bdi-no>
ip address ip-address mask
ip router isis [area-tag]
end
```

For more information, see Configuring IS-IS.

Configuring Loopback on IS-IS Interface

To configure loopback on IS-IS interface, enter the following commands:

```
interface loopback<loopback-no>
ip address <ip-address > <subnet-mask>
ip router isis  area <area-tag>
end
```

Configuration Examples for IS-IS

Refer the examples described in the Configuration Examples for IS-IS.

CHAPTER 4

Configuring BGP

- BGP Overview, on page 11
- Limitations for BGP, on page 11
- How to Configure BGP, on page 11

BGP Overview

Border Gateway Protocol (BGP) is an interdomain routing protocol designed to provide loop-free routing between separate routing domains that contain independent routing policies (autonomous systems). The Cisco software implementation of BGP version 4 includes support for 4-byte autonomous system numbers and multiprotocol extensions to allow BGP to carry routing information for IP multicast routes and multiple Layer 3 protocol address families including IP Version 4 (IPv4), IP Version 6 (IPv6), Virtual Private Networks Version 4 (VPNv4), Connectionless Network Services (CLNS), and Layer 2 VPN (L2VPN). This module contains conceptual material to help you understand how BGP is implemented in Cisco software.

For more information, see Information About Cisco BGP.

Limitations for BGP

- BGP-PIC is not supported.

  But by default, BGP-PIC is enabled on all the Cisco IOS XE platforms, hence the BGP-PIC must be disabled using the **cef table output-chain build favor memory-utilization** command under configuration mode. If the BGP-PIC is not disabled, then the route update failure might occur.

How to Configure BGP

Configuring BGP on BDI

Configuring a basic BGP network consists of a few required tasks and many optional tasks. A BGP routing process must be configured and BGP peers must be configured, preferably using the address family configuration model. If the BGP peers are part of a VPN network, the BGP peers must be configured using the IPv4 VRF address family task.

For more information, see Configuring BGP.

Verifying BGP Configuration

Use the following **show** command to verify the BGP configuration:

```
router#show run int lo0
Building configuration...

Current configuration : 86 bytes
!
interface Loopback0
ip address 10.10.10.10 255.255.255.255
ip ospf 30 area 0
end

RTR10-Dom3(config)#do sh run | sec router bgp
router bgp 1
bgp router-id 10.10.10.10
bgp log-neighbor-changes
redistribute connected
neighbor 1.1.1.1 remote-as 1
neighbor 1.1.1.1 update-source Loopback0
neighbor 6.6.6.6 remote-as 1
neighbor 6.6.6.6 update-source Loopback0
neighbor 8.8.8.8 remote-as 1
neighbor 8.8.8.8 update-source Loopback0
```

Configuration Examples for BGP

Refer the examples described in the Configuration Examples for a Basic BGP Network.

CHAPTER 5

Configuring EIGRP

Perform this task to enable EIGRP and create an EIGRP routing process. EIGRP sends updates to interfaces in specified networks. If you do not specify the network of an interface, the interface will not be advertised in any EIGRP update.

Configuring the router eigrp autonomous-system-number command creates an EIGRP autonomous system configuration that creates an EIGRP routing instance, which can be used for tagging routing information.

```
enable
configure terminal
router eigrp <autonomous-system-number>
network <network-number>
end
```

For more information on configuring EIGRP, refer How to Configure EIGRP.

- EIGRP Features, on page 13
- How to Configure EIGRP, on page 14

EIGRP Features

- Increased network width—With IP Routing Information Protocol (RIP), the largest possible width of your network is 15 hops. When EIGRP is enabled, the largest possible width is increased to 100 hops, and the EIGRP metric is large enough to support thousands of hops.
- Fast convergence—The DUAL algorithm allows routing information to converge as quickly as any currently available routing protocol.
- Partial updates—EIGRP sends incremental updates when the state of a destination changes, instead of sending the entire contents of the routing table. This feature minimizes the bandwidth required for EIGRP packets.
- Neighbor discovery mechanism—This simple protocol-independent hello mechanism is used to learn about neighboring devices.
- Scaling—EIGRP scales to large networks.

For more information, refer Information About Configuring EIGRP.

How to Configure EIGRP

Configuring EIGRP

Perform this task to enable EIGRP and create an EIGRP routing process. EIGRP sends updates to interfaces in specified networks. If you do not specify the network of an interface, the interface will not be advertised in any EIGRP update.

Configuring the router eigrp autonomous-system-number command creates an EIGRP autonomous system configuration that creates an EIGRP routing instance, which can be used for tagging routing information.

```
enable
configure terminal
router eigrp <autonomous-system-number>
network <network-number>
end
```

For more information on configuring EIGRP, refer How to Configure EIGRP.

Configuration Examples for EIGRP

Refer the examples described in the Configuration Examples for EIGRP.

CHAPTER 6

Configuring Static Route

- Static Route Overview, on page 15
- How to Configure Static Route, on page 15

Static Route Overview

Static routes are entirely user configurable and can point to a next-hop interface, next-hop IP address, or both. In Cisco IOS XR software, if an interface was specified, then the static route is installed in the Routing Information Base (RIB) if the interface is reachable. If an interface was not specified, the route is installed if the next-hop address is reachable. The only exception to this configuration is when a static route is configured with the permanent attribute, in which case it is installed in RIB regardless of reachability.

How to Configure Static Route

Configuring Static Route on BDI Interface

You can configure static route to point to an IP address on a network. The static route enables traffic going to the network through the specified forwarding IP address.

the router to send all the traffic going out of the router which sends

To configure static route on the BDI interface, enter the following commands:

```
router(config)#ip route <Destination prefix> <Destination prefix mask> <Forwarding router's
 address>
```

The following example shows how to configure static route on the BDI interface:

```
router(config)#ip route 10.10.23.0 255.255.255.0 10.10.11.2
```

Verifying Static Route Configuration

You can verify the static route configured on the BDI interface using the **show ip route** command.

CHAPTER 7

Configuring IPv4 Unicast Routing ECMP

By default ECMP is enabled on the host if protocols such as OSPF or IS-IS are configured on the BDI interface. There is no specific CLI to configure ECMP. ECMP based on Source IP (SIP), Destination IP (DIP), Source Port (SP), and Destination port (DP).

- IPv4 Unicast Routing ECMP, on page 17
- Limitation for IPv4 Unicast Routing ECMP, on page 17
- How to Configure IPv4 Unicast Routing ECMP, on page 17

IPv4 Unicast Routing ECMP

IPv4 unicast routing equal-cost multi-path (ECMP) feature enables to forward traffic to destination over multiple best paths.

If there are more than one next hop is available to reach the same next network or host, then an ECMP group is created associating all the available next hop options. When an route entry is added for the ECMP destination, the ECMP interface is associated with the route entry. This ensures that all the packets destined to this particular host is load balanced to all the available next hop options.

Limitation for IPv4 Unicast Routing ECMP

ECMP supports a maximum of four paths.

How to Configure IPv4 Unicast Routing ECMP

Configuring IPv4 Unicast Routing ECMP

By default ECMP is enabled on the host if protocols such as OSPF or IS-IS are configured on the BDI interface. There is no specific CLI to configure ECMP. ECMP based on Source IP (SIP), Destination IP (DIP), Source Port (SP), and Destination port (DP).

Verifying IPv4 Unicast Routing ECMP Configuration

Use the following show commands to verify the IPv4 unicast routing ECMP configuration:

- **show ip route**
- **Show ip cef**

```
router#show ip route
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2, m - OMP
       n - NAT, Ni - NAT inside, No - NAT outside, Nd - NAT DIA
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static route
       H - NHRP, G - NHRP registered, g - NHRP registration summary
       o - ODR, P - periodic downloaded static route, l - LISP
       a - application route
       + - replicated route, % - next hop override, p - overrides from PfR

Gateway of last resort is not set

      1.0.0.0/32 is subnetted, 1 subnets
O        1.1.1.1 [110/2] via 192.168.13.4, 1d01h, BDI210
                 [110/2] via 192.168.12.4, 1d01h, BDI111
      6.0.0.0/32 is subnetted, 1 subnets
C        6.6.6.6 is directly connected, Loopback0
      8.0.0.0/32 is subnetted, 1 subnets
O        8.8.8.8 [110/2] via 192.168.13.1, 1d01h, BDI210
                 [110/2] via 192.168.12.1, 1d00h, BDI111
      10.0.0.0/32 is subnetted, 1 subnets
O        10.10.10.10 [110/2] via 192.168.13.2, 03:20:31, BDI210
                     [110/2] via 192.168.12.2, 03:20:29, BDI111
      192.168.12.0/24 is variably subnetted, 2 subnets, 2 masks
C        192.168.12.0/24 is directly connected, BDI111
L        192.168.12.3/32 is directly connected, BDI111
      192.168.13.0/24 is variably subnetted, 2 subnets, 2 masks
C        192.168.13.0/24 is directly connected, BDI210
L        192.168.13.3/32 is directly connected, BDI210
```