



Layer 3 Unicast Routing on NX-OS



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In This Section

- ▶ NX-OS Layer 3 Support
- ▶ NX-OS Routing Protocols Overview
- ▶ Routing in NX-OS vs. IOS

NX-OS Layer 3 Switching Support

- ▷ NX-OS layer 3 features are hardware dependent
 - M cards and F2e/F3 cards on N7K
 - Nexus 5500 with Layer 3 Module
 - Native support in Nexus 3000, 5600, 6000, & 9000
- ▷ NX-OS layer 3 features are license dependent
 - [Licensing Cisco NX-OS Software Features](#)

NX-OS Layer 3 Interfaces

▷ Like Catalyst IOS, NX-OS supports...

- Native layer 3 routed interfaces
 - i.e. `no switchport`
- Switched Virtual Interfaces (SVIs)
 - i.e. VLAN interfaces
 - Must be enabled with `feature interface-vlan`

NX-OS Virtual Routing & Forwarding Instances (VRFs)

- ▶ Like IOS, NX-OS Virtual Routing & Forwarding Instances are used to create separate logical routing tables
 - Layer 3 interfaces in different VRFs cannot exchange traffic by default
- ▶ NX-OS VRFs behave slightly different than IOS, as...
 - All layer 3 interfaces are automatically in VRF table “default”
 - MGMT0 is automatically in vrf “management”
 - VRFs are defined as **vrf context**
 - Static routes are defined under the vrf context
 - Dynamic routing is VRF aware, but configured under the same process
 - Exec mode **routing-context vrf** can change the default VRF for verifications

NX-OS Routing Protocol Support

- ▶ NX-OS supports all dynamic routing protocols
 - RIPv2, EIGRP, OSPF, IS-IS, BGP
- ▶ NX-OS also supports static routes & Policy Based Routing (PBR)
- ▶ NX-OS protocols are...
 - IPv4 & IPv6 aware
 - VRF aware
 - NSF aware
 - Supported with BFD for fast convergence

NX-OS Dynamic Routing

- ▶ Like IOS, NX-OS has both global and interface routing configuration
 - Global routing process affects all links or the routing instance as a whole
 - E.g. EIGRP AS, OSPF SPF Timers, IS-IS Level, etc.
 - Interface commands affect routing protocol behavior of that link
 - E.g. Passive interface, EIGRP route filters, OSPF hello timers, etc.
- ▶ Unlike IOS there is no **network** command for IGP
 - Protocols are enabled directly at the link level
 - **network** command used for BGP NLRI origination

NX-OS Policy Based Routing (PBR)

▷ Like IOS, NX-OS can use PBR to...

- Classify inbound traffic by ACL, packet length, etc.
- Choose next-hop, output interface, etc. outside the normal RIB/FIB

▷ Unlike IOS, NX-OS PBR...

- Must be enabled with **feature pbr**
- Needs **route-map [name] pbr-statistics** to enable policy statistics

NX-OS Route Redistribution

- ▷ Unlike IOS, route-maps are *required* to perform redistribution on NX-OS
 - Same route-map match/set logic as IOS
- ▷ Redistribution does not include directly connected interfaces
 - Requires `redistribute direct route-map...`

Recommended Resources

▷ [Cisco Nexus 7000 NX-OS/IOS Comparison Tech Notes](#)

- [Cisco NX-OS/IOS Layer-3 Virtualization Comparison](#)
- [Cisco NX-OS/IOS EIGRP Comparison](#)
- [Cisco NX-OS/IOS OSPF Comparison](#)
- [Cisco NX-OS/IOS BGP \(Basic\) Comparison](#)
- [Cisco NX-OS/IOS BGP \(Advanced\) Comparison](#)

Q&A

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In This Section

- ▶ EIGRP Routing on NX-OS

EIGRP on NX-OS vs. IOS Caveats

▷ [Cisco NX-OS/IOS EIGRP Comparison](#)

- ▷ Feature is disabled by default
 - `feature eigrp`
- ▷ Routing process ID is a string, not an AS number
 - `autonomous-system` must be defined under process
- ▷ Protocol enabled at the interface level instead of process level
 - No `network` command like in IOS
- ▷ Loopback0 is always used as Router-ID
 - Even if there is another loopback with a higher IP address
- ▷ No support for unicast neighbors
 - No `neighbor` command under process
- ▷ No support for unequal cost load balancing
 - No `variance` command under process

Configuring EIGRP on NX-OS

- ▷ Enable global process
 - router eigrp [name]
- ▷ Define Autonomous System
 - autonomous-system [num]
- ▷ Enable EIGRP at link level
 - ip router eigrp [name]

Verifying EIGRP on NX-OS

▷ Common verifications

- show run eigrp
- show ip eigrp
- show ip eigrp interfaces brief
- show ip eigrp neighbors
- show ip eigrp topology [all-links]
- show ip eigrp topology w.x.y.z/len
- show ip route eigrp
- debug ip eigrp packet hello
- debug ip eigrp neighbor w.x.y.z

EIGRP Features – Passive Interface

- ▶ Passive interface stops the sending of EIGRP hellos
 - Result is no adjacency forms on the link
 - Does not stop link from being advertised into EIGRP topology
- ▶ Typical use case is for SVIs at L2/L3 boundary
 - Routing protocol peerings should happen North and East/West, not South
- ▶ Configured at the link level
 - `ip passive-interface eigrp [name]`

EIGRP Features – Authentication

- ▷ Authenticates EIGRP hello packets before adjacency occurs
 - Neighbors don't form unless authentication is correct
- ▷ Syntax is identical to IOS
 - Define key chain globally
 - key chain MYKEYCHAIN
 - key 1
 - key-string MYPASSWORD
 - Apply key chain at interface level
 - ip authentication mode eigrp A md5
 - ip authentication key-chain eigrp A MYKEYCHAIN

EIGRP Features – Distribute Lists

- ▷ Distribute lists are used to filter routing updates
 - Can be applied inbound and outbound at link level
 - References a prefix-list that matches prefix/len
- ▷ EIGRP has no hierarchy, unlike OSPF/IS-IS
 - Implies distribute-list filtering can be applied anywhere
- ▷ Implementing Distribute Lists
 - Define prefix-list
 - `ip prefix-list FILTER permit 10.0.0.0/24`
 - Apply at interface level
 - `ip distribute-list eigrp A prefix-list FILTER out`

EIGRP Features – Default Routing

- ▶ Default route is a fallback for all prefixes without a longer match
 - I.e. prefix doesn't match any route of /1 - /32
- ▶ Default route advertisement is configured under process level
 - default-information originate

EIGRP Features – Summarization

- ▶ Summarization used to combine prefixes into shorter match advertisement
 - E.g. two /24's combine to a single /23
- ▶ Secondary result is limiting the QUERY domain
 - Helps to improve EIGRP convergence and scaling
- ▶ EIGRP has no hierarchy, unlike OSPF/IS-IS
 - Implies summarization can be applied anywhere
- ▶ Summarization is applied at interface level
 - `ip summary-address eigrp A 10.0.0.0/23`

EIGRP Features – Stub Routing

- ▷ Like summarization, used to limit the QUERY domain
 - Don't send QUERY to neighbor with stub flag set
- ▷ Configured under the process level
 - `igmp stub [direct | summary ...]`

Configuring IPv6 EIGRP on NX-OS

- ▷ Enable IPv6 under EIGRP process
 - address-family ipv6 unicast
- ▷ Define AS number
 - autonomous-system [num]
- ▷ Enable IPv6 EIGRP at link level
 - ipv6 router eigrp A

Verifying IPv6 EIGRP on NX-OS

▷ Common verifications

- show run eigrp
- show ipv6 eigrp
- show ipv6 eigrp interfaces brief
- show ipv6 eigrp neighbors
- show ipv6 eigrp topology [all-links]
- show ipv6 eigrp topology A:B::C:D/len
- show ipv6 route eigrp
- debug ipv6 eigrp packet hello
- debug ipv6 eigrp neighbor A:B::C:D

Q&A

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In This Section

- ▶ OSPF Routing on NX-OS

OSPF on NX-OS vs. IOS Caveats

▷ [Cisco NX-OS/IOS OSPF Comparison](#)

▷ Feature is disabled by default

- feature ospf

▷ Protocol enabled at the interface level instead of process level

- No `network` command like in IOS

▷ Protocol process must be globally enabled

- Interface level command does not generate global process automatically

▷ Loopback0 is always used as Router-ID

- Even if there is another loopback with a higher IP address

▷ Reference bandwidth is 40Gbps

- Can cause suboptimal path selection when combined with older platforms

OSPF on NX-OS vs. IOS Caveats (cont.)

- ▷ Areas appear as dotted-decimal in configuration
 - Area 0 and 0.0.0.0 are the same
- ▷ Adjacency logging is not on by default
 - Needs `log-adjacency-changes` under process
- ▷ No support for distribute-lists
- ▷ Secondary addresses are advertised by default
 - Can be disabled with `ip router ospf <instance> area <#> secondaries none`
- ▷ Loopbacks are always advertised as /32
 - Can be disabled with `ip ospf advertise-subnet`

Configuring OSPF on NX-OS

- ▷ Enable global OSPF process
 - feature ospf
 - router ospf [process-id]
- ▷ Enable interface OSPF process
 - Interface level ip ospf [process-id] area [area-id]

Verifying OSPF on NX-OS

▷ Common Verificaitons

- Verify OSPF is enabled
 - `show ip ospf`
 - `show ip ospf interface [brief]`
- Verify OSPF adjacencies
 - `show ip ospf neighbor`
 - `debug ip ospf adj`
- Verify OSPF database
 - `show ip ospf database [router | network | summary | ...]`

Troubleshooting OSPF Adjacencies

▷ Where can problems arise?

- Transport problems
- Attribute negotiation problems

▷ Useful troubleshooting commands

- show ip ospf neighbor
- show ip ospf database
- debug ip ospf adj
- debug ip packet
 - *Use with caution*

OSPF Adjacency State Machine

▷ Normal OSPF Adjacency State Machine Order

- Down/Attempt
- Init
- 2-Way
 - Stop here for DROthers
- ExStart
- Exchange
- Loading
- Full

OSPF Adjacencies Attributes

- ▷ Unique OSPF Adjacency Attributes
 - Router-ID
 - Interface IP Address
- ▷ Common OSPF Adjacency Attributes
 - Interface Area-ID
 - Hello interval & dead interval
 - Interface network address
 - Interface MTU
 - Network Type
 - Authentication
 - Stub Flags
 - Other optional capabilities

Q&A

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In This Section

- ▶ IS-IS Routing on NX-OS

IS-IS Overview

▷ Intermediate System to Intermediate System

- “Router to Router” communication
- Link-State IGP similar to OSPF

▷ Typically used in core of SP networks

- Simple flat network design
- Highly scalable
- Supports both IPv4 and IPv6 routing

▷ Not an IP protocol - Part of the CLNS stack

- Integrated IS-IS: IP extensions to IS-IS

IS-IS NET Addressing

▷ Network Entity Title

- Essentially CLNS Router-ID

▷ Uses ISO NSAP Addressing Format

- Maximum 20 bytes
- Minimum 8 bytes

▷ NET format

- AA.AAAA.AAAA.AAAA.AAAA.AAAA.AAAA.SSSS.SSSS.SSSS.NN
- Area – not link-state area like OSPF
- System-ID - Router-ID inside the area
- N-Selector - always zero

IS-IS Adjacency Levels

- ▶ IS-IS uses two “levels” of adjacency
 - Level 2 (L2)
 - Level 1 (L1)
- ▶ IS-IS Level 2
 - Inter or intra area adjacency
 - Like area 0 in OSPF
 - Must be contiguous
 - Cisco IOS/XE/XR/NX-OS does not support IS-IS virtual links
- ▶ IS-IS Level 1
 - Intra area adjacency only
 - Like a not so totally stubby area in OSPF
 - Intra area routes
 - Default route out
 - Redistribution allowed

Level 1 / Level 2 Routing

▷ Level 1 / Level 2 (L1/L2) Router

- Like ABR in OSPF
- Used as exit point from L1 to L2

▷ Injects default route into level-1

- Sets the “attached” bit

IS-IS Level Manipulation

▷ Process & interfaces default to Level-1-2

- Forms both L1 and L2
- Separate LSP databases
- Double the overhead

▷ Level can be defined...

- Global under the process
 - Affects all interfaces
- Under the interface
 - Affects only that interface

IS-IS Network Type

- ▷ Only two network types
- ▷ Broadcast
 - Default on multipoint interfaces
 - Uses DIS instead of DR / BDR
- ▷ Point-to-point
 - Default on point-to-point interfaces

DIS Election

- ▷ Designated Intermediate System
- ▷ Like OSPF DR / BDR
 - No backup DIS
- ▷ Election is dynamic, preemption can occur
 - Separate election for L1 and L2
 - Occurs by
 - Highest priority
 - Highest SNPA (MAC) address

Forming IS-IS Adjacency

- ▷ Level of adjacency must match
 - Area must match if L1 adjacency
- ▷ MTU must match
 - IS-IS pads hellos to interface MTU
 - Different behavior than OSPF but same result
- ▷ Network type must match
 - Broadcast
 - Point-to-Point

Configuring IS-IS on NX-OS

- ▷ Enable global IS-IS process
 - feature isis
 - router isis [process-id]
- ▷ Define Network Entity Title
 - net [nsap]
- ▷ Enable interface IS-IS process
 - Interface level ip router isis [process-id]

Verifying IS-IS on NX-OS

▷ Common Verifications

- Verify IS-IS is enabled
 - show isis
 - show isis interface [brief]
- Verify IS-IS adjacencies
 - show is-is adjacency
 - debug isis adjacency
 - debug isis iih
- Verify IS-IS
 - show isis database [detail]

IS-IS Path Selection

- ▷ Link cost depends on OS
 - E.g. IOS vs. XR vs. NX-OS
 - Can be manually modified
- ▷ Neighbors must agree on metric *style*
 - Narrow
 - Default
 - Wide
 - Needed for MPLS TE and IPv6
 - Transition
- ▷ Level 1 paths preferred over Level 2 paths
 - Like OSPF Intra-Area over Inter-Area

IS-IS Optimizations

▷ IS-IS by default runs both Level-1 and Level-2

- Redundant database information
- CLOS fabric is a flat link state flooding domain
- IS-IS should use L1 or L2, but not both
- **is-type** under global process
- **isis circuit-type** under interface

▷ Ethernet is network type Broadcast by default

- In physical P2P designs, IS-IS DIS / OSPF DR is redundant
- IS-IS should run as network-type point-to-point
- Interface level **isis network point-to-point** or medium p2p

IS-IS Optimizations (cont.)

▷ Convergence is timers based

- Hello interval and multiplier, similar logic to OSPF
- BFD should be used for faster neighbor failure detection

▷ IS-IS supports two types of authentication

- Global authentication of LSPs
- Interface authentication of Hellos

IS-IS Optimizations (cont.)

▷ IS-IS Overload Bit

- Signals other routers not to include this node as transit in the SPT
- Useful for performing a maintenance window on a spine or leaf

▷ IS-IS supports two types of authentication

- Global authentication of LSPs
- Interface authentication of Hellos

Q&A

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