Installation Requirements

This section provides general guidelines and minimum requirements for individual components installed on a single server.

This section contains the following topics:

Cisco Crosswork Optimization Engine Network Requirements

The following figures show the different topology models, and the corresponding network components and connections needed to install and use Cisco Crosswork Optimization Engine.

Figure 1: Crosswork Optimization Engine Network Components - 1 NIC Network Topology
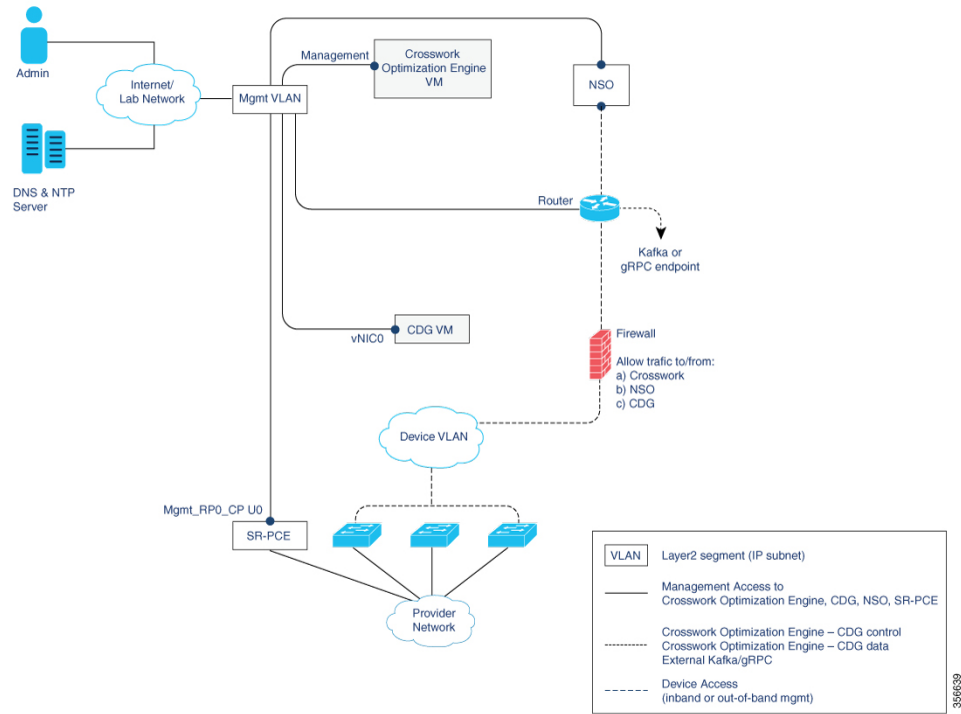

Figure 2: Crosswork Optimization Engine Network Components - 2 NIC Network Topology
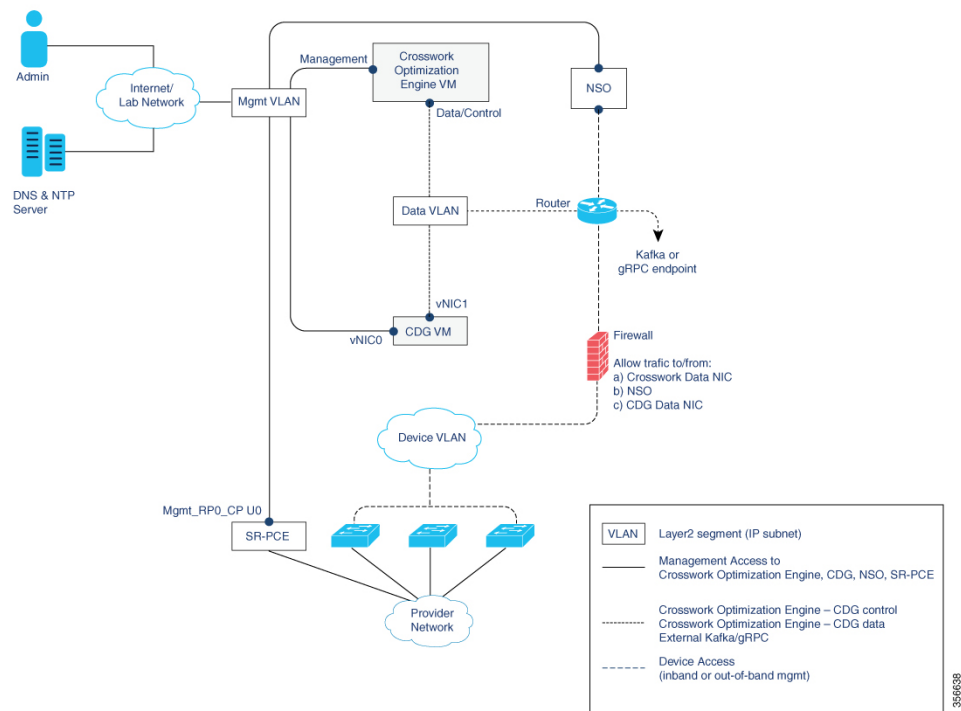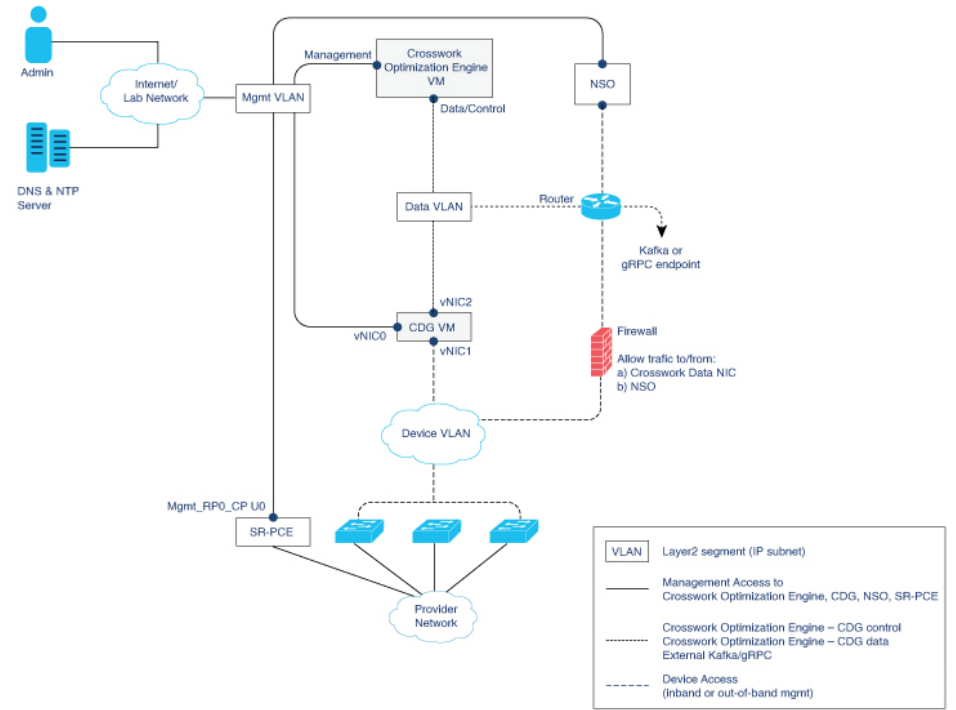
Figure 3: Crosswork Optimization Engine Network Components - 3 NIC Network Topology

There are three types of traffic flowing between the network components, as explained in the following table.

Table 1: Types of Network Traffic

Traffic	Description
Management	For accessing the UI and command line, and passing Data/Control information between servers (for example, Cisco Crosswork Optimization Engine to Crosswork Data Gateway or NSO)
Data/Control	Data and configuration transfer between CDG and Cisco Crosswork Optimization Engine, and other data destinations (external Kafka/gRPC).
Device Access	Device configuration and management and telemetry data being forwarded to the CDG.

Cisco Crosswork Optimization Engine Virtual Machine (VM)

The Cisco Crosswork Optimization Engine VM has the following vNIC deployment options:

Table 2: Cisco Crosswork Optimization Engine vNIC deployment modes

No. of vNICs	vNIC	Description
1	Management	Management, Data/Control and Device access passing through a single NIC

No. of vNICs	vNIC	Description
2	Management	Management
	Data/Control	Data/Control and Device access

Cisco Crosswork Data Gateway (CDG) VM

The Cisco Crosswork Data Gateway VM has the following vNIC deployment options:

Table 3: CDG vNIC deployment modes

No. of vNICs	vNIC	Description
1	vNIC0	Management, Data/Control and Device access passing through a single NIC
2	vNIC0	Management
	vNIC1	Data/Control and Device access
3	vNIC0	Management
	vNIC1	Device Access
	vNIC2	Data/Control

Cisco Network Services Orchestrator (NSO) VM

The NSO VM has the following vNICs:

- Management: Used for Crosswork applications to reach NSO.

- Device Access: Used for NSO to reach devices or NSO Resource Facing Services (RFS).

Note Preference for the number of vNICs can vary from one deployment to another. The number of vNICs can be dependent on the security and traffic isolation needs of the deployment. CDG and Crosswork accommodates this variability by introducing a variable number of vNICs.

Routed and Device Networks

Connectivity between the various components should be accomplished via an external routing entity. The figures show various line styles suggesting possible routing domains within the routed network.

- Solid—Management routing domain.

- Dotted—Data/Control routing domain (information transferred between Cisco Crosswork Optimization Engine and Cisco Crosswork Data Gateway, and other data destinations (external Kafka/gRPC)).

- Dashes—Device access routing domain (from Cisco Crosswork Data Gateway and NSO).

The IP/subnet addressing scheme on each of these domains depends on the type of deployment.

Routing between domains is needed for Crosswork and NSO to reach the devices. However, proper firewall rules need to be in place to allow only select sources (for example, Crosswork and NSO) to reach the devices.

On the device network, devices can be reached in-band or using out-of-band management interfaces, depending on the local security policies of each deployment.

A controller supporting Segment Routing Path Computation Element (SR-PCE) is both a device and a Software-Defined Networking (SDN) controller. Some deployments may want to treat an SR-PCE instance as a device, in which case they would need access via the device network. Some deployments may want to treat an SR-PCE instance as an SDN controller and access it on the Management routing domain. Crosswork supports both models. By default, Crosswork will use `eth0` (Management) to access SR-PCE as an SDN controller on the Management domain (shown in the figures). To enable Crosswork access to an SR-PCE instance as a device on the device network (not shown in the figures): When adding an SR-PCE as a provider, add the Property Key and Property Value as `outgoing-interface` and `eth1` (Data/Control) respectively.

Cisco Crosswork Optimization Engine Installation Requirements

Cisco Crosswork Optimization Engine deployment requirements vary, depending on which of the platform's components are installed together and the number of devices being managed. This section provides general guidelines and minimum requirements for installing Cisco Crosswork Optimization Engine on a single host, unless otherwise specified.

Virtual Machine Requirements

You can deploy Cisco Crosswork Optimization Engine as a VM on a host that meets the minimum requirements specified in Table 4: Cisco Crosswork Optimization Engine VM Requirements.

Table 4: Cisco Crosswork Optimization Engine VM Requirements

Requirement	Description
Hypervisor and vCenter **Note** Installation should be done only from vCenter. Installation is not supported on ESXi directly.	• VMware vCenter Server 6.7 Update 3g or later (ESXi 6.7 Update 1 installed on hosts). • VMware vCenter Server 6.5 Update 2d or later (ESXi 6.5 Update 2 installed on hosts)
Memory	96 GB

Requirement	Description
Storage	Storage requirements vary based on factors such as the number of devices being supported and the type of deployment selected.
	Due to their performance, solid state drives (SSD) are preferred over traditional hard disk drives (HDD). If you are using HDD, the minimum speed should be 10,000 RPM.
	For demonstration and lab environments, we recommend the thin provision format because it requires the least amount of storage on the host machine. This deployment configuration uses roughly 23 GB of storage. For live systems, we recommend the Thick provision eager zeroed format that allocates 1 TB of storage by default. This should be sufficient for most customer use cases.
	For more information, see the volume requirements displayed in the VMware GUI when configuring disk space, as shown in Install Cisco Crosswork Optimization Engine.
vCPU/CPU Planning (avoid overcommittment)	16 vCPUs
	CPU and memory overcommitment can occur when the number of vCPUs running on a host is greater than the total number of the host's physical processor cores. VMware vCenter/ESXi permits this in order to allow flexibility in deploying and running the VMs on physical hosts. It is natural to assume that vCenter users will try to maximize usage of physical resources by deploying and running a reasonably high amount of VMs on a specific ESXi host. However, this can lead to a problem manifested in a "soft lockup" situation, where a VM will not be able to get a vCPU allocated in a reasonable amount of time.
Network Connections	For live deployments, we recommend that you use dual interfaces, one for the Management network and one for the Data network, between Cisco Crosswork Optimization Engine and Cisco Crosswork Data Gateway.

Requirement	Description
IP Addresses	• You have a public IP address (IPv4 or IPv6) to assign to the Cisco Crosswork Optimization Engine VM's Management network. The default gateway must be reachable using this IP address. **Note** It is preferred that the DNS and NTP servers are reachable using the Management network. However, it is not mandatory. The only requirement is that these servers are reachable on one of the networks connected to the server. • You have a public or private IP address (IPv4 or IPv6) to assign to the Cisco Crosswork Optimization Engine VM's Data network. This IP address must be able to reach the gateway address for the network where Cisco Crosswork Data Gateway will be installed.
NTP Servers	The IPv4 or IPv6 addresses or host names of the NTP servers you plan to use. If you want to enter multiple NTP servers, separate them with spaces. These should be the same NTP servers you use to synchronize the Cisco Crosswork Optimization Engine VM clock, devices, clients, and servers across your network. Confirm that the NTP servers are reachable on the network before attempting installation. The installation will fail if the servers cannot be reached.
DNS Servers	The IPv4 or IPv6 addresses of the DNS servers you plan to use. These should be the same DNS servers you use to resolve host names across your network. Confirm that the DNS servers are reachable on the network before attempting installation. The installation will fail if the servers cannot be reached.
DNS Search Domain	The search domain you want to use with the DNS servers, for example, cisco.com. You can have only one search domain.
Disclaimer	The text of the legal disclaimer displayed to clients accessing the VM using the CLI. Consult your organization's IT or legal department for this content.

Important Notes

• The VM runs Ubuntu Server 18.04.1 (ubuntu-18.04.1-server).

- Kubernetes runs within the Cisco Crosswork Optimization Engine VM and uses Docker for containerization. The number of containers varies as applications are added or deleted.

✎

Note   Dual stack configuration is not supported in Cisco Crosswork Optimization Engine. Therefore, all addresses for the environment must be either IPv4 or IPv6. Do not attempt to configure both in a single interface.

Cisco IOS XR Software Version Support

Cisco Crosswork Optimization Engine supports the following Cisco IOS XR software versions.

Table 5: Cisco IOS XR Software Versions

SR-PCE Software Version	PCC Software Version (Headend Routers)				
	Cisco ASR 9000	**Cisco NCS 5500 series**	**Cisco NCS 540 series**	**Cisco NCS 560 series**	**Cisco XRv 9000**
6.6.3 + SMU	6.6.3 + SMU	6.6.3 + SMU [1]	6.6.3 + SMU [2]	6.6.3 + SMU	6.6.3 + SMU
7.1.2	7.1.2	7.1.2	7.1.2	7.1.2	7.1.2

[1]   This SMU is available via the Cisco NCS 5508 Software Download Center.
[2]   This SMU is available via the Cisco NCS 540-ACC-SYS Router or Cisco NCS 540x-ACC-SYS Router Software Download Center.

✎

Note
- Segment Routing Traffic Matrix (SRTM) is only available in Cisco ASR 9000 devices.

- Software Maintenance Updates (SMUs) are required for both PCC/Headend and SR-PCE versions indicated in the table. To download the Cisco IOS XR versions and updates, see the IOS XR Software Maintenance Updates (SMUs) document. The correct SMUs to download will have "Optima" or the bug ID appended to the filename. For example: `asr9k-x64-6.6.3.Optima.tar`

Cisco Network Services Orchestrator and Network Element Driver Requirements

The requirements in Table 3 are applicable only if you plan to use Cisco Network Services Orchestrator.

Table 6: Cisco NSO and NED requirements

Software/Driver	Version/Notes
Cisco Network Services Orchestrator (Cisco NSO)	• NSO 5.2.0.3 (NSO Telemetry - Traffic Collector Function Pack 1.0.0) **Note** See the Telemetry - Traffic Collector Function Pack Installation Guide 1.0 (PDF) for information on how to install the function pack.
Cisco IOS XR Network Element Driver (NED)	7.18.3, 7.21
Cisco IOS Network Element Driver	6.36

Device and TE Tunnel Scale Support

The following number of devices and TE tunnels (SR policies and RSVP-TE tunnels) are supported.

Table 7: Device and TE Tunnel (SR Policies and RSVP-TE Tunnels) Scale Support

Feature	Devices	TE Tunnels
SR Policy Visualization and Provisioning	• 5,000 nodes • 50,000 interfaces	2,000 SR Policies
RSVP-TE Tunnel (PCE initiated) Visualization and Provisioning	• 5,000 nodes • 50,000 interfaces	2,000 RSVP-TE Tunnels
RSVP-TE Tunnel (PCC initiated) Visualization only	• 5,000 nodes • 50,000 interfaces	2,000 RSVP-TE Tunnels
Bandwidth Optimization Function Pack	• 2,000 nodes • 20,000 interfaces	—
Bandwidth On Demand Function Pack (with Priority Mode)	• 5,000 nodes • 50,000 interfaces	—
Bandwidth On Demand Function Pack (without Priority Mode)	• 2,000 nodes • 20,000 interfaces	—
Demand Deduction Function Pack	500 nodes	—

IGP and Inter-AS

The following table captures the IGP and inter-AS features that Cisco Crosswork Optimization Engine supports.

Table 8: IGP and Inter-AS Support

Feature	OSPF	IS-IS	Inter-AS
Topology Visualization (including SR Policies)	Supported	Supported	Egress Peer Engineering (EPE) is limited to EPE adjacency segment IDs (SIDs)
SR Policy Creation, Modification, and Deletion	Supported	Supported	EPE is limited to EPE adjacency SIDs
Bandwidth on Demand Function Pack	Supported	Supported	Not Supported
Bandwidth Optimization Function Pack	Only single area is supported	Only single level is supported	Not Supported
RSVP TE	Supported	Supported	Supported with IGP between ASes but not EPE.

Table 9: RSVP-TE Tunnel Traffic Steering Configuration

Feature	Intra Area/Level	Inter Area/Level, Multiple IGP, Inter-AS

PCC Initiatied	Requires Autoroute Announce configuration in individual tunnel interface:
	
	`int tunnel-te <id>`
	`autoroute-announce`
	`exclude-traffic`
	`segment-routing`
		Requires Static Route configuration pointing to the tunnel interface:
		
		`router static`
		`address-family ipv4 unicast`
		`<destination-ip>`
		`<tunnel-interface>`

PCE Initiatied	Requires Autoroute Announce configuration under MPLS TE:
	
	`mpls traffic-eng`
	`pcc`
	`stateful-client`
	`autoroute-announce`	

Supported Web Browsers

This version of Cisco Crosswork Optimization Engine supports the web browsers shown in Table 4.

The recommended display resolution: 1600 x 900 pixels or higher (minimum: 1366 x 768).

Table 10: Supported Web Browsers

Browser	Version
Google Chrome (recommended)	75 or later
Mozilla Firefox	70 or later

In addition to using a supported browser, all client desktops accessing geographical map information in the Cisco Crosswork Optimization Engine topology maps must be able to reach the mapbox.com map data URL directly, using the standard HTTPS port 443. Similar guidance may apply if you choose a different map data provider, as explained in "Configure Geographical Map Settings" in the Cisco Crosswork Optimization Engine User Guide .

Cisco Crosswork Optimization Engine Ports

The following ports are needed by Cisco Crosswork Optimization Engine to operate correctly.

Table 11: Eth0 - Management NIC

Port	Protocol	Used for...	Direction
22	TCP	SSH access to Crosswork	Inbound
30603	TCP	Web UI access to Crosswork	Inbound
30607	TCP	Crosswork Controller	Outbound
53	TCP/UDP	DNS	Outbound
123	UDP	NTP	Outbound
8080	TCP	REST API to SR-PCE	Outbound
30607	TCP	CDG vitals collection	Outbound

Table 12: Eth1 - Data NIC

Port	Protocol	Used for...	Direction
30993	TCP	CDG sending collected data (Kafka)	Both
30649	TCP	CDG Monitoring	Outbound

Collection Considerations

MDT Collection

When Cisco NSO is used in conjunction with Cisco Crosswork Optimization Engine, the telemetry configurations are pushed to the devices by Cisco NSO. To use Cisco NSO, it is important during installation

to check the "Is NSO used as the provider for device management?" checkbox under Crosswork Collection Configuration (see Install Cisco Crosswork Optimization Engine).

If you do not plan to use to use Cisco NSO, you must apply the telemetry configuration on your devices. See the "Prerequisites for Device Telemetry" topic in the Cisco Crosswork Optimization Engine User Guide.

Note The default MDT collector port is 9010.

Device Limits

Cisco Data Gateway collection supports 1000 devices. If your network requires collection of more than 1000 devices, multiple Cisco Data Gateways must be deployed.

Cisco Crosswork Data Gateway Installation Requirements

This section provides information about the general guidelines and minimum requirements for installing Cisco Crosswork Data Gateway.

This section contains the following topics:

Virtual Machine (VM) Requirements

You can deploy Cisco Crosswork Data Gateway as a VM on a host that meets the following minimum requirements:

Note
- Although Cisco Crosswork Data Gateway supports both IPv6 and IPv4, it is required to use IPv4 as Cisco Crosswork Optimization Engine supports only IPv4.
- IPv4 on a single interface (demo mode) is not supported.

Table 13: Cisco Crosswork Data Gateway VM requirements

Requirement	Description
Hypervisor	• VMware vCenter Server 6.7 Update 3g or later (ESXi 6.7 Update 1 installed on hosts) • VMware vCenter Server 6.5 Update 2d or later (ESXi 6.5 Update 2 installed on hosts)
Memory	32 GB

Requirement	Description
Disk space	50 GB
vCPU	8 vCPUs
Interfaces	Minimum: 1 Maximum: 3 Cisco Crosswork Data Gateway 1.1.3 can be deployed with either 1, 2, or 3 interfaces as per the combinations below:
IP Addresses	1, 2, or 3 IPv4 addresses based on the number of interfaces you choose to use. **Note** Crosswork does not support dual stack configurations. Therefore, ALL addresses for the environment must be either IPv4 or IPv6.

Combination #	vNIC0	vNIC1	vNIC2
1	• Management Traffic • Device Access Traffic • Control/Data Traffic	—	—
2	• Management Traffic	• Device Access Traffic • Control/Data Traffic	—
3	• Management Traffic	• Device Access Traffic	• Control/Data Traffic

- Management traffic: for accessing the UIs and command line and passing Control/Data information between servers (for example, Cisco Crosswork Change Automation and Health Insights to Cisco Crosswork Data Gateway or NSO).

- Device access traffic: for device configuration and management (NSO or to the devices as a result of KPI configuration or playbook execution) and telemetry data being forwarded to the Cisco Crosswork Data Gateway.

- Control/Data traffic: for data and configuration transfer between Cisco Crosswork Data Gateway and Cisco Crosswork Optimization Engine and other data destinations.

Requirement	Description
NTP Servers	The IPv4 addresses or host names of the NTP servers you plan to use. If you want to enter multiple NTP servers, separate them with spaces. These should be the same NTP servers you use to synchronize devices, clients, and servers across your network. Confirm that the NTP IP address or host name is reachable on the network or installation will fail. Also, the ESXi hosts that will run the Cisco Crosswork Optimization Engine and Cisco Crosswork Data Gateway VM must have NTP configured, or the initial handshake may fail with "certificate not valid" errors.
DNS Servers	The IPv4 addresses of the DNS servers you plan to use. These should be the same DNS servers you use to resolve host names across your network.
DNS Search Domain	The search domain you want to use with the DNS servers (for example, cisco.com). You can only have one search domain.
Destination Networks	For live deployments, we recommend one virtual switch for the Data Network (connection between the Cisco Crosswork Optimization Engine VM and the Cisco Crosswork Data Gateway VM) and second virtual switch for all the management traffic (vms to dns, ntp and the network you will use to access and manage the applications).

Note The VM runs Ubuntu Server 18.04.3 (ubuntu-18.04.3-server).

Tested Cisco Operating Systems

Table 7 lists the software versions on which Cisco Crosswork Data Gateway 1.1.3 was tested. For OS software versions that only Cisco Crosswork Optimization Engine supports, please refer to Cisco IOS XR Software Version Support, on page 8. Cisco Crosswork Data Gateway allows you to expand device coverage by means of custom packages.

Table 14: Tested IOS and NX-OS Versions

OS	Software Version	Collection Protocols	MDT Encoding
Cisco IOS-XR*	6.4.1, 6.4.2, 6.5.1, 6.5.2, 6.5.3, 6.6.2, 6.6.3, 7.0.1	MDT[3] CLI SNMP	KVGPB, TCP
Cisco IOS-XE	16.9.2, 16.10, 17.1.1	SNMP	—
Cisco NX-OS	7.0(3).7(2), 8.4(0).SK(1)	CLI	—

[3] For MDT configuration via NSO on IOS-XR, use NSO XR NED 7.18.3 or 7.21.

Installation Requirements

Ports Used ■

Note All collection types support IPv4. For IPv4, day-zero configurations, and limitations for different device platforms, contact your network administrator and refer to the corresponding platform configuration guide.

Ports Used

As a general policy, ports that are not needed should be disabled.

Tables 8, 9 and 10 show the minimum set of ports needed for Cisco Crosswork Data Gateway to operate correctly.

Note SCP port can be tuned.

Table 15: Ports to be Opened for Management Traffic

Port	Protocol	Used for...	Direction
22	TCP	SSH server	Inbound
22	TCP	SCP client	Outbound
123	UDP	NTP Client	Outbound
53	UDP	DNS Client	Outbound
30607	TCP	Crosswork Controller	Outbound

Table 16: Ports to be Opened for Control/Data Traffic

Port	Protocol	Used for...	Direction
161	UDP	SNMP Collector	Inbound
1062	UDP	SNMP Trap Collector	Inbound
9010	TCP	MDT Collector	Inbound
22	TCP	CLI Collector	Outbound

Table 17: Ports to be Opened for Device Access Traffic

Port	Protocol	Used for...	Direction
30649	TCP	Crosswork Controller	Outbound
30993	TCP	Crosswork Kafka	Outbound
Site Specific	Site Specific	Kafka and gRPC Destination	Outbound