Configuring the Satellite Network Virtualization (nV) System

This module describes Satellite Network Virtualization (Satellite nV) system configurations on Cisco CRS Router.

Table 1: Feature History for Configuring Satellite System

Release	Modification
Release 4.3.2	• Multi-chassis and back to back support on Cisco CRS-3 Router was included.

Prerequisites for Configuration

You must be in a user group associated with a task group that includes the proper task IDs. The command reference guides include the task IDs required for each command. If you suspect user group assignment is preventing you from using a command, contact your AAA administrator for assistance.

Before configuring the Satellite nV system, you must have these hardware and software installed in your chassis:

- Host — Cisco CRS-3 Modular Services Line Card with fixed PLIM (14x10GE, 20x10GE, and MSC140). The Line card that hosts the Satellite nV device can be a Cisco CRS Multi Chassis and Back to Back system.

• Satellite — Cisco ASR9000v.

• Software— Cisco IOS XR Software Release 4.3.1 or later with **hfr-asr9000v-nV-px.pie**.

Overview of Satellite nV System

The Satellite Network Virtualization (nV) service or the Satellite Switching System enables you to configure a topology in which one or many satellite switches complement one or many Cisco CRS-3 Routers, to collectively realize a single virtual switching system. In this system, the satellite switches act under the management control of the routers.

The complete configuration and management of the satellite chassis and features are performed through the control plane and management plane of the Cisco CRS-3 Router, referred to as the Host.

Interconnection between the Cisco CRS-3 Router and its satellites is through standard Ethernet interfaces or bundle ethernet interfaces coming from a single modular services line card. All bundle members must be connected to the same satellite device.

When the Satellite nV service was introduced in Cisco IOS XR Software Release 4.3.x, Cisco ASR 9000v was used as the satellite device. It had four 10 Gigabit ports that were used as Interchassis Links (ICL).

In general, the type of interface used on the host is decided on the basis of the satellite device used.

Figure 1: Satellite nV System
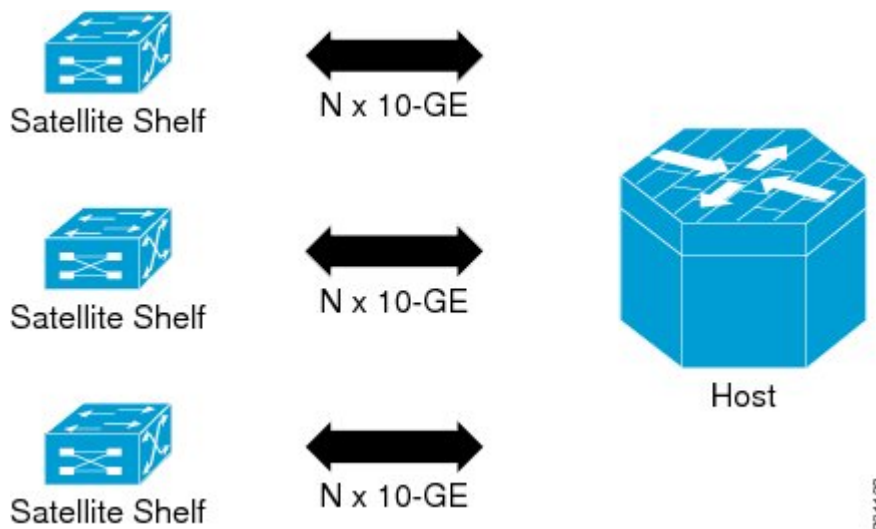
This type of architecture can be realized in a carrier Ethernet transport network, with the satellite switches used as either access switches, pre-aggregation, or aggregation switches. These switches feed into the Cisco CRS Router where more advanced Layer 2 and Layer 3 services are provisioned.

You can also utilize this model in a Fiber To The Business (FTTB) network application, where business internet and VPN services are offered on a commercial basis. Further, it can also be used in other networks, such as wireless or Radio Access Network (RAN) back-haul aggregation networks.

Benefits of Satellite nV System

The satellite nV system offers these benefits:

1. **Extended port scalability and density** - You can create a virtual line card with more than 100 physical Gigabit Ethernet ports per slot. There is a significant increase of Ethernet port density in the resulting logical Cisco CRS-3 Router. For example, a single 14-port or 20-port Ten Gigabit Ethernet line card on the Cisco CRS-3 Router could integrate multiple satellite switches with a maximum of 100 Gig Ethernet ports per line card. This is beneficial because the Cisco CRS-3 Router has a per-slot non blocking capacity of up to 400 Gbps (with appropriate RSPs) and there is no other way of physically fitting hundreds of gigabit ethernet ports/ SFPs on the face plate of a single Cisco CRS-3 line card. As a result, in order to utilize the full capacity of an Cisco CRS-3 line card, it is necessary to physically separate out the ethernet ports, while maintaining logical management control. This would appear as if all ports were physically on a single large line card of the Cisco CRS-3 Router.

2. **Reduced cost** - All the core-routing capabilities and application features of the Cisco IOS XR Software are available on low cost access switches.

3. **Reduced operating expense** - You can upgrade software images, and also manage the chassis and services from a common point. This includes a single logical router view, single point of applying CLI or XML interface for the entire system of switches, a single point of monitoring the entire system of switches and a single point of image management and software upgrades for the entire system.

4. **Enhanced feature consistency** - All the features on the regular GigE ports and 10GigE ports of Cisco CRS Router are also available on the access ports of a satellite access switch in a functionally identical and consistent manner. The typical application of a satellite system would be in the access and aggregation layers of a network. By integrating the access switches along with the aggregation or core switch, you can ensure that there are no feature gaps between the access switch and the aggregation or core switch. All features, such as carrier ethernet features, QoS and OAM, function consistently, from access to core, because of this integrated approach.

5. **Improved feature velocity** - With the satellite solution, every feature that is implemented on the Cisco CRS Router becomes instantly available at the same time in the access switch, resulting in an ideal feature velocity for the edge switch.

6. **Better resiliency** - The nV satellite solution enables better multi-chassis resiliency, as well as better end-to-end QoS. For more information on QoS capabilities, see *Cisco IOS XR Quality of Service Configuration Guide for the Cisco CRS Router*.

Overview of Port Extender Model

In the Port Extender Satellite switching system, a satellite switch is attached to its host through physical ethernet ports.

The parent router, Cisco CRS-3 Router is referred to as the host in this model. From a management or a provisioning point of view, the physical access ports of the satellite switch are equivalent to the physical ethernet ports on the Cisco CRS-3 Router. You do not need a specific console connection for managing the Satellite Switching System, except for debugging purposes. The interface and chassis level features of the satellite are visible in the control plane of Cisco IOS XR software running on the host. This allows the complete management of the satellites and the host as a single logical router.

Figure 2: Port Extender Satellite Switching System
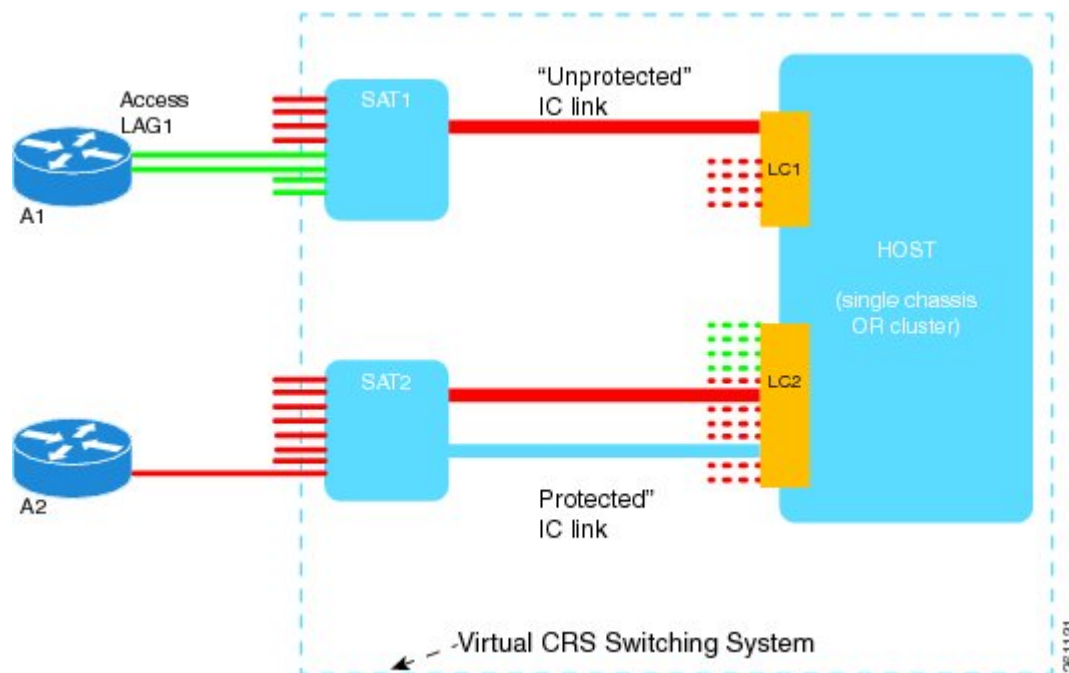
In this model, a single Cisco CRS-3 Router hosts two satellite switches, SAT1 and SAT2, to form an overall virtual switching system; represented by the dotted line surrounding the Cisco CRS-3 Router, SAT1, and SAT2 in the Figure.

This structure effectively appears as a single logical Cisco CRS-3 Router to the external network. External access switches (A1, A2) connect to this overall virtual switch by physically connecting to SAT1 and SAT2 using normal ethernet links. The links between the satellite switches and the Cisco CRS-3 Router are ethernet links referred to as the Inter-Chassis Links (ICL). The Cisco CRS-3 Router is referred to as the Host. When there is congestion on the ICLs, an inbuilt QoS protection mechanism is available for the traffic.

Note SAT1, SAT2, and the host Cisco CRS-3 Router need not be located in the same geographic location. This means that the ICLs need not be of nominal length for only intra-location or intra-building use. The ICLs may be tens, hundreds, or even thousands of miles in length, thereby creating a logical satellite switch spanning a large geography. This distance depends on the pluggables used on the CRS host and Satellite ICL port.

Satellite System Physical Topology

The Satellite nV system supports point-to-point hub and spoke physical topology for the ICLs between satellite switches and the host. This topology allows a physical Ethernet MAC layer connection from the satellite to the host. This can be realized using a direct Ethernet over Fiber or Ethernet over Optical transport (such as, Ethernet over a SONET/ SDH/ CWDM/ DWDM network).

This topology also allows a satellite switch to geographically be at a different location than the host, Cisco CRS-3 Router.

Features Supported in the Satellite nV System

This section provides details of the features of a satellite system.

Inter-Chassis Link Redundancy Modes and Load Balancing

The Satellite system supports these redundancy modes:

- **Non-redundant inter-chassis links mode** - In this mode, there is no link level redundancy between inter-chassis links of a satellite.

- **Redundant inter-chassis links mode** - In this mode, the link level redundancy between inter-chassis links are provided using a single link aggregation (LAG) bundle.

In the redundant ICL mode, the host device load-balances the host to satellite traffic between the members of the ICL bundle using a simple modulo of access port number and number of active ICL bundle member links.

The satellite devices use a similar hashing function to load-balance satellite to host traffic between the members of the ICL bundle.

Each device independently implements the hash function to pin the access ports to the ICL member links for a traffic direction. L2 or L3 header contents from the packet are not used for flow based hashing of the access-port to the ICL bundle member links. This ensures that all packets use a single ICL for a given satellite access-port per direction. Although, each device might pick a different member for egress as they independently implement the hash function. As a result, the actions applied for QoS and other per-direction features still consider all the packets as belonging to a single physical port.

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Note   Both the Access Bundles and ICL bundles can co-exist, but not concurrently.

For more details on QoS application and configuration on ICLs, see *Cisco IOS XR Modular Quality of Service Configuration Guide for the Cisco CRS Router*.

Satellite Discovery and Control Protocols

Cisco's proprietary discovery and control protocols are used between the satellite switches and the host devices, to handle discovery, provisioning, and monitoring of the satellite devices from the host Cisco CRS-3 Satellite System in-band over the ICLs. The Satellite Discovery And Control (SDAC) Protocol provides the behavioral, semantic, and syntactic definition of the relationship between a satellite device and its host.

Satellite Discovery and Control Protocol IP Connectivity

The connectivity for the SDAC protocol is provided through a normal in-band IP routed path over the ICLs using private and public IP addresses appropriate for the carrier's network.

You can configure a management IP address on the host CLI for each satellite switch and corresponding IP addresses on the ICLs. You can select addresses from the private IPv4 address space (for example, 10.0.0.0/8 or 192.1.168.0/24) in order to prevent any conflict with normal service level IPv4 addresses being used in the IPv4 FIB. You can also configure a private VRF that is used for only satellite management traffic, so that the

IP addresses assigned to the satellites can be within this private VRF. This reduces the risk of address conflict or IP address management complexity compared to other IP addresses and VRFs that are used on the router.

Note   Auto-IP is the recommended mode of configuration. For more information on Auto-IP mode, see Auto-IP, on page 9.

Quality of Service

Most Layer-2, Layer-3 QoS and ACL features are supported on Satellite Ethernet interfaces that are similar to normal physical Ethernet interfaces, with the exception of any ingress policy with a queuing action. However, for QoS, there may be some functional differences in the behavior because, in the Cisco IOS XR Software Release 4.2.x, user-configured MQC policies are applied on the Cisco CRS Router, and not on the satellite switch interfaces.

For more detailed information on QoS offload and QoS policy attributes, features, and configuration, see *Cisco IOS XR Modular Quality of Service Configuration Guide for the Cisco CRS Router*.

Note   User-configured QoS policies are independent of any default port level QoS that are applied in order to handle IC link congestion and over-subscription scenarios. In addition to the default port-level QoS applied on the satellite system ports, default QoS is also applied on the Host side, to the ingress and egress traffic from and to the Satellite Ethernet ports.

Time of Day Synchronization

The Time of Day parameter on the satellite switch is synchronized with the time of day on the host. This ensures that time stamps on debug messages and other satellite event logs are consistent with the host, and with all satellite switches across the network. This is achieved through the SDAC Discovery Protocol from the host to the satellite switch when the ICLs are discovered.

Satellite Chassis Management

The chassis level management of the satellite is done through the host because the satellite switch is a logical portion of the overall virtual switch. This ensures that service providers get to manage a single logical device with respect to all aspects including service-level, as well as box-level management. This simplifies the network operations. These operations include inventory management, environmental sensor monitoring, and fault/alarm monitoring for the satellite chassis through the corresponding CLI, SNMP, and XML interfaces of the host.

Restrictions of the Satellite nV System

Software restrictions of the Cisco CRS-3 satellite system are:

- The inter-chassis link redundancy is supported only through the static EtherChannel, and not through LACP based link bundles. Minimum and maximum link commands are not applicable when ICL is a bundle.

- Access bundles having both satellite and non-satellite interfaces is not supported.

- These features, protocols, and topologies are not supported on the nV Satellite System:

    - L2VPN

    - QinQ

    - TE tunnel over Satellite Interface

    - Pseudowire Headend

    - GRE over satellite interface

    - L2TPv3

    - Multicast over satellite interface

    - Satellite interface as core facing interface

    - 801.1ad/.1ah encapsulation

    - HSRP and VRRP

    - HW DBA based netflow

- If a satellite system is operating in redundant ICL mode, then Cisco Discovery Protocol (CDP) and Link Layer Discovery Protocol (LLDP) are not supported on the access ports of that satellite.

- You cannot connect the same satellite box to more than one Cisco CRS-3 Modular Services Line Card.

- Both the access link bundles and ICL bundles can co-exist, but not concurrently.

- BFD echo mode is not supported on Satellite Gigabit Ethernet links. BFD Asynchronous mode is supported on the Satellite Gigabit Ethernet links that are not part of a bundle. When Satellite links are part of the Access bundle, only BFD over Logical Bundles (BLB) is supported.

- The nV Satellite access port bundles do not support BFD over bundles (BoB) over physical or bundle ICLs

- Adding non-ICL links (normal TenGigE links) to ICL bundle is not supported. This configuration is not rejected, but the behavior is unpredictable.

- Only Cisco CRS-3 Modular Services Line Card with fixed PLIM (14x10GE and 20x10GE) can be used to interconnect with the Satellite boxes.

- All bundle members must be from same satellite. The maximum number of bundle members is restricted to 44.

- ISSU and MDR are not supported on the satellite.

- In the case of Cisco ASR 9000v satellites with bundle ICL, you should first shut down the ICL bundle before making any configuration changes on the ICL bundle or before changing the bundle members or the bundle member interface types

- The feature Provider Backbone Bridging Ethernet Virtual Private Network (PBB EVPN) is not supported with nV Satellite Access Interface bundles over ICL bundles.

- Mixing of interface types (1G, 10G, 100G) is not supported for bundle ICLs.

- The maximum number of satellites per system is 16.

- The range in which the satellite ID can be configured is from 100 to 230.

Implementing a Satellite nV System

The Interface Control Plane Extender (ICPE) infrastructure has a mechanism to provide the Control Plane of an interface physically located on the Satellite device in the local Cisco IOS XR software. After this infrastructure is established, the interfaces behave like other physical ethernet interfaces on the router.

The ICPE configuration covers these functional areas, which are each required to set up full connectivity with a Satellite device:

Defining the Satellite nV System

Each satellite that is to be attached to Cisco IOS XR Software must be configured on the host, and also be provided with a unique identifier. In order to provide suitable verification of configuration and functionality, the satellite type, and its capabilities must also be specified.

Further, in order to provide connectivity with the satellite, an IP address must be configured, which will be pushed down to the satellite through the Discovery protocol, and allows Control protocol connectivity.

This task explains how to define the satellite system by assigning an ID and basic identification information.

Procedure

	Command or Action	Purpose
Step 1	**configure** **Example:** `RP/0/RP0/CPU0:router# configure`	Enters global configuration mode.
Step 2	**nv** **Example:** `RP/0/RP0/CPU0:router(config)# nv`	Enters the nV configuration submode.

Step 3	**satellite** *Satellite ID*
	
	Example:
	
	`RP/0/RP0/CPU0:router(config-nV)# satellite`
	`<100-239>`
		Declares a new satellite that is to be attached to the host and enters the satellite configuration submode. .
		
		The Cisco CRS Router chassis supports 139 satellite racks. Satellite Ids ranges from 100 to 239.

Step 4	**serial-number** *string*
	
	Example:
	
	`RP/0/RP0/CPU0:router(config-satellite)#`
	`serial-number CAT1521B1BB`
		(Optional) Serial number is used for satellite authentication.

	Command or Action	Purpose
Step 5	**description** *string* **Example:** RP/0/RP0/CPU0:router(config-satellite)# description Milpitas Building12	(Optional) Specifies any description string that is associated with a satellite such as location and so on.
Step 6	**type** *type_name* **Example:** RP/0/RP0/CPU0:router(config-satellite)# satellite 200 type ? asr9000v Satellite type	Defines the expected type of the attached satellite.
Step 7	**ipv4 address** *address* **Example:** RP/0/RP0/CPU0:router(config-satellite)# ipv4 address 10.22.1.2	Specifies the IP address to assign to the satellite. ICPE sets up a connected route to the specified IP address through all configured ICLs.
Step 8	**end** or **commit** **Example:** RP/0/RP0/CPU0:router(config)# end or commit	Saves configuration changes. • When you issue the **end** command, the system prompts you to commit changes: Uncommitted changes found, commit them before exiting(yes/no/cancel)? [cancel]: - Entering **yes** saves configuration changes to the running configuration file, exits the configuration session, and returns the router to EXEC mode. - Entering **no** exits the configuration session and returns the router to EXEC mode without committing the configuration changes. - Entering **cancel** leaves the router in the current configuration session without exiting or committing the configuration changes. • Use the **commit** command to save the configuration changes to the running configuration file and remain within the configuration session.

Auto-IP

The Auto IP feature improves the plug-and-play set up of an nV satellite system. With the Auto IP feature, IP connectivity to the satellite is automatically provisioned. As a result:

- The nV Satellite Loopback interface is created on the host
- Loopback interface is given an IP address from a private satellite VRF
- Satellite fabric links are unnumbered to the loopback interface

• The IP address assigned to satellite is auto-generated from the satellite VRF

In the case of Auto IP, you do not need to provide IP address on the nv satellite global configuration and on the ICL. In the case of manual IP, you need to provide IP address on the nV satellite global configuration and on ICL.

The auto-IP feature assigns an IP address in the format 10.x.y.1 automatically, where:

• x is the top (most significant) 8 bits of the satellite ID

• y is the bottom 8 bits (the rest) of the satellite ID

Configuration Example for Auto IP

```
configure
nv satellite 150
type asr9000v

configure
interface TenGigabitEthernet 0/1/0/0
nv satellite-fabric-link satellite 150
remote-ports GigabitEthernet 0/0/0-5
```

• You do not have to assign IP for the satellite and **10.0.<satellite-id>.1** is assigned automatically.
• **nV-Loopback0** is created automatically. ****nVSatellite** VRF is created automatically, and assigned to **nV-Loopback0** . **10.0.0.1/32** is assigned to **nV-Loopback0.**

• **nV-Loopback0** is referenced by the Ten Gigabit Ethernet interface automatically when it is made as an ICL .

There is no CLI to enable Auto IP. If you do not configure manual IP, this will be invoked.

Note   You can also override the Auto IP feature by using the standard IP configuration.

Configuring the Host IP Address

This procedure gives you the steps to configure a host IP address on a loopback interface.

Procedure

	Command or Action	Purpose
Step 1	**configure** **Example:** RP/0/0RSP0/CPU0:router# configure	Enters global configuration mode.
Step 2	**interface** *loopback0* **Example:** RP/0/0RSP0/CPU0:router(config)# interface loopback0	Specifies the loopback address for the interface.

	Command or Action	Purpose

Step 3	**ipv4 address**
	
	Example:
	
	`RP/0/0RSP0/CPU0:router(config-int)# ipv4 address`
	`8.8.8.8 255.255.255.255`
		Configures the host IP address on a loopback interface.

Step 4	**end or commit**
	
	Example:
	
	`RP/0/0RSP0/CPU0:router(config)# end or`
	`RP/0/0RSP0/CPU0:router(config)# commit`
		Saves configuration changes.
		
		• When you issue the **end** command, the system prompts you to commit changes:
		
		Uncommitted changes found, commit them before exiting(yes/no/cancel)?
		
		[cancel]:
		
		- Entering **yes** saves configuration changes to the running configuration file, exits the configuration session, and returns the router to EXEC mode.
		
		- Entering **no** exits the configuration session and returns the router to EXEC mode without committing the configuration changes.
		
		- Entering **cancel** leaves the router in the current configuration session without exiting or committing the configuration changes.
		
		• Use the **commit** command to save the configuration changes to the running configuration file and remain within the configuration session.

Configuring Inter-Chassis Links and IP Connectivity

Inter-Chassis Links (ICLs) need to be explicitly configured, in order to indicate which satellite is expected to be connected. You must also specify the access port, that is down-stream 10GigE ports, which cross-link up to the Host through the configured ICL. In order to establish connectivity between the host and satellite, suitable IP addresses must be configured on both sides. The satellite IP address is forwarded through the Discovery protocol. The configuration is described in the section, Defining the Satellite nV System, on page 8.

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Note   This configuration shows the use of the global default VRF. The recommended option is to use a private VRF for nV IP addresses as shown in the Satellite Management Using Private VRF, on page 26 subsection under *Configuration Examples for Satellite nV System*.

Procedure

	Command or Action	**Purpose**
Step 1	**configure** **Example:** RP/0/RP0/CPU0:router# configure	Enters global configuration mode.
Step 2	**interface** *interface-name* **Example:** RP/0/RP0/CPU0:router(config)# interface TenGigE0/2/1/0	The supported inter-chassis link interface types are limited by the connectivity provided on the supported satellites. GigabitEthernet, TenGigE, HundredGigE and Bundle-Ether interfaces are the supported ICL types.
Step 3	**description** **Example:** RP/0/RP0/CPU0:router(config-interface)# description To Sat5 1/46	Specifies the description of the supported inter-chassis link interface type.
Step 4	**ipv4 point-to-point** **Example:** RP/0/RP0/CPU0:router(config-interface)# ipv4 point-to-point	(Optional) Configures the IPv4 point to point address.
Step 5	**ipv4 unnumbered loopback0** **Example:** RP/0/RP0/CPU0:router(config-interface)# interface unnumbered loopback0	(Optional) Configures the IPv4 loopback address on the interface.
Step 6	**nV** **Example:** RP/0/RP0/CPU0:router(config-if)# nv	Enters the Network Virtualization configuration mode.
Step 7	**satellite-fabric-link satellite** *<id>* **Example:** RP/0/0RSP0/CPU0:router(config-int-nv)# satellite-fabric-link satelite 200	Specifies that the interface is an ICPE inter-chassis link.
Step 8	**remote-ports** *interface-type* **Example:** RP/0/RP0/CPU0:router(config-int-nv)# remote-ports GigabitEthernet 0/0/0-43	Configures the remote satellite ports 0 to 43.
Step 9	**end** or **commit** **Example:** RP/0/RP0/CPU0:router(config)# end or RP/0/0RSP0/CPU0:router(config)# commit	Saves configuration changes. • When you issue the **end** command, the system prompts you to commit changes: Uncommitted changes found, commit them before exiting(yes/no/cancel)? [cancel]:

	Command or Action	Purpose
		- Entering **yes** saves configuration changes to the running configuration file, exits the configuration session, and returns the router to EXEC mode.
		- Entering **no** exits the configuration session and returns the router to EXEC mode without committing the configuration changes.
		- Entering **cancel** leaves the router in the current configuration session without exiting or committing the configuration changes.
		• Use the **commit** command to save the configuration changes to the running configuration file and remain within the configuration session.

Configuring Inter-Chassis Links and IP Connectivity in Redundant ICL mode

This procedure describes the configuration of ICL in redundant mode.

Procedure

	Command or Action	Purpose
Step 1	**configure** **Example:** RP/0/RP0/CPU0:router# configure	Enters global configuration mode.
Step 2	**interface** *bundle-ether id* **Example:** RP/0/RP0/CPU0:router(config)# interface Bundle-Ether 100	Specifies the supported inter-chassis link interface type.
Step 3	**description** **Example:** RP/0/RP0/CPU0:router(config-interface)# description To Sat5 1/46	Specifies the description of the supported inter-chassis link interface type.
Step 4	**nv** **Example:** RP/0/RP0/CPU0:router(config-if)# nv	Enters the Network Virtualization configuration mode.
Step 5	**satellite-fabric-link satellite** *<id>* **Example:** RP/0/RP0/CPU0:router(config-int-nv)# satellite-fabric-link satelite 200	Specifies that the interface is an ICPE inter-chassis link.
Step 6	**remote-ports** *interface-type* **Example:**	Configures the remote satellite ports 0 to 43.

	Command or Action	Purpose
	`RP/0/RP0/CPU0:router(config-int-nv)# remote-ports GigabitEthernet 0/0/0-43`	
Step 7	**interface** *interface_type* **Example:** `RP/0/RP0/CPU0:router(config-interface)# interface TenGigE0/0/0/6`	Configures the specified interface.

Step 8	**bundle id mode on**
	
	Example:
	
	`Example:`
	`RP/0/RP0/CPU0:router(config-interface)# bundle id 100 mode on`
		Specifies the bundle id and activates it.

Step 9	**end** or **commit**
	
	Example:
	
	`RP/0/RP0/CPU0:router(config)# end`
	`or`
	`RP/0/RP0/CPU0:router(config)# commit`
		Saves configuration changes.
		
		• When you issue the **end** command, the system prompts you to commit changes:
		
		`Uncommitted changes found, commit them before exiting(yes/no/cancel)?`
		`[cancel]:`
		
		• Entering **yes** saves configuration changes to the running configuration file, exits the configuration session, and returns the router to EXEC mode.
		
		• Entering **no** exits the configuration session and returns the router to EXEC mode without committing the configuration changes.
		
		• Entering **cancel** leaves the router in the current configuration session without exiting or committing the configuration changes.
		
		• Use the commit command to save the configuration changes to the running configuration file and remain within the configuration session.
		
		Note For information on QoS configuration on ICLs , see *Cisco IOS XR Modular Quality of Service Configuration Guide for the Cisco CRS Router*.

Configuring the Satellite nV Access Interfaces

The access 1Gigabit Ethernet/10GigE interfaces on the satellite are represented locally in Cisco IOS XR Software using interfaces named Gigabit Ethernet similar to other non-satellite 1Gigabit Ethernet/10GigE interfaces. The only difference is that the rack ID used for a satellite access 1Gigabit Ethernet/10GigE interface is the configured satellite ID for that satellite.

These interfaces support all features that are normally configurable on 1Gigabit Ethernet/10GigE interfaces (when running over a physical ICL), or Bundle-Ether interfaces (when running over a virtual ICL).

Plug and Play Satellite nV Switch Turn up: (Rack, Plug, and Go installation)

1. Unpack the satellite rack, stack, and connect to the power cord.

2. Plug in the qualified optics of correct type into any one or more of the SFP+ slots and appropriate qualified optics into SFP+ or XFP slots on the host. Connect through the SMF/MMF fiber.

   Note The nV system can use the Cisco CRS-3 Router as host. The Cisco ASR 9000v Satellite can be used as sa device.

   To configure wavelength on DWDM SFP+, use the following CLI command on satellite console:

   test dwdm wavelength set *ppmId wavelength_channel_number*

   Note ppmId = port number -1

   The following example shows how to configure wavelength channel 20 on port 45.

   ```
   Satellite#test dwdm wavelength set 44 20
   ```

   To see the configured wavelength, use the following CLI command on satellite console:

   • **show satellite dwdm-dump** *ppmId*

   • **show satellite inventory port 45**

   Note It is mandatory to configure the same wavelength on both hosts and satellite, you can follow the same above on the hosts.

3. Configure the host for nV operations as described in the sections Defining the Satellite nV System, on page 8, Configuring the Host IP Address, on page 10 and Configuring Inter-Chassis Links and IP Connectivity, on page 11. Configure the satellite nV system through CLI or XML on the host on 100GigE ports for Cisco NCS 5002 Satellite.

4. Power up the chassis of the satellite device.

   Note For power supply considerations of ASR 9000v, refer to the *Appendix C, Cisco ASR 9000 and Cisco C Satellite Systems (ASR 9000v)* of the *Cisco ASR 9000 Series Aggregation Services Router Hardware Instal Guide* online.

5. You can check the status of the satellite chassis based on these chassis error LEDs on the front face plate.

   • If the Critical Error LED turns ON, then it indicates a serious hardware failure.

   • If the Major Error LED turns ON, then it indicates that the hardware is functioning well but unable to connect to the host.

- If the Critical and Major LEDs are OFF, then the satellite device is up and running and connected to the host.

- You can do satellite ethernet port packet loopback tests through the host, if needed, to check end to end data path.

Note	When the satellite software requires an upgrade, it notifies the host. You can do an inband software upgrade from the host, if needed. Use the **show nv satellite status** on the host to check the status of the satellite.

Upgrading and Managing Satellite nV Software

Satellite software images are bundled inside a PIE and the **PIE name is dependent on the type of satellite, such as hfr-asr9000v-nV-px.pie** within the Cisco CRS-3 Router package. The Cisco IOS XR software production SMU tool can be used to generate patches for the satellite image in the field to deliver bug fixes or minor enhancements without requiring a formal software upgrade.

Prerequisites

- You must have installed the satellite installation procedure using the Plug and Play Satellite installation procedure. For more information, check the topic in this chapter.

Installing a Satellite

To download and activate the software image on the satellite, use the **install nv satellite** satellite ID / all **transfer/activate** commands. The **transfer** command downloads the image to the satellite. When the **transfer** command is followed by the **activate** command, the software is activated on the satellite.

```
RP/0/RSP0/CPU0:sat-host# install nv satellite 100 transfer

Install operation initiated successfully.
RP/0/RSP0/CPU0:sat-host#RP/0/RSP0/CPU0:May  3 20:12:46.732 : icpe_gco[1146]:
%PKT_INFRA-ICPE_GCO-6-TRANSFER_DONE : Image transfer completed on Satellite 100

RP/0/RSP0/CPU0:sat-host# install nv satellite 100 activate

Install operation initiated successfully.
LC/0/2/CPU0:May  3 20:13:50.363 : ifmgr[201]: %PKT_INFRA-LINK-3-UPDOWN : Interface
GigabitEthernet100/0/0/28, changed state to Down
RP/0/RSP0/CPU0:May  3 20:13:50.811 : invmgr[254]: %PLATFORM-INV-6-OIROUT : OIR: Node 100
removed
```

Note	If the **activate** command is run directly, then the software image is transferred to the satellite and also activated.

```
RP/0/RSP0/CPU0:sat-host# install nv satellite 101 activate

Install operation initiated successfully.

RP/0/RSP0/CPU0:sat-host#RP/0/RSP0/CPU0:May  3 20:06:33.276 : icpe_gco[1146]:
%PKT_INFRA-ICPE_GCO-6-TRANSFER_DONE : Image transfer completed on Satellite 101
RP/0/RSP0/CPU0:May  3 20:06:33.449 : icpe_gco[1146]: %PKT_INFRA-ICPE_GCO-6-INSTALL_DONE :
Image install completed on Satellite 101
RP/0/RSP0/CPU0:May  3 20:06:33.510 : invmgr[254]: %PLATFORM-INV-6-OIROUT : OIR: Node 101
removed
```

Note   For the satellite image upgrade to work, you must ensure that the management-plane CLI is not
configured on the Cisco CRS-3 Router . If it is configured, then you need to add this exception for
each of the satellite ICLs. This is not required for Auto IP configurations from Cisco IOS XR Software
Release 5.3.2.

You can include the exception using this CLI:

```
control-plane
 management-plane
  inband
    !
    !
   interface TenGigE0/0/0/5  <=== To enable TFTP on nV satellite ICL
allow TFTP
```

If you do not include this exception, then the image download and upgrade fails.

Monitoring the Satellite Software

Status Check

To perform a basic status check, use the **show nv satellite status brief** command.

```
RP/0/RSP0/CPU0:router# show nv satellite status brief

Sat-ID  Type      IP Address    MAC address      State
------  --------  -----------   -------------   --------------------------------
100     asr9000v  101.102.103.105  dc7b.9426.1594  Connected (Stable)
200     asr9000v  101.102.103.106  0000.0000.0000  Halted; Conflict: no links configured
400               194.168.9.9   0000.0000.0000  Halted; Conflict: satellite has no type
configured
```

Check if Upgrade is Required

To check if an upgrade is required on satellite, run the **show nv satellite status satellite** *satellite_id*.

```
RP/0/RSP0/CPU0:router# show nv satellite status satellite 100

Satellite 100
-------------
  State: Connected (Stable)
  Type: asr9000v
```

```
Description: sat-test
MAC address: dc7b.9427.47e4
IPv4 address: 100.1.1.1
Configured Serial Number: CAT1521B1BB
Received Serial Number: CAT1521B1BB
Remote version: Compatible (latest version)
  ROMMON: 125.0 (Latest)
  FPGA: 1.13 (Latest)
  IOS: 200.8 (Latest)
Configured satellite fabric links:
  TenGigE0/2/0/6
  --------------
    State: Satellite Ready
    Port range: GigabitEthernet0/0/0-9
  TenGigE0/2/0/13
  ---------------
    State: Satellite Ready
    Port range: GigabitEthernet0/0/30-39
  TenGigE0/2/0/9
  --------------
    State: Satellite Ready
    Port range: GigabitEthernet0/0/10-19
```

Check if Upgrade is Required

To check if an upgrade is required on satellite, run the **show nv satellite status satellite** *satellite_id*.

```
RP/0/RSP0/CPU0:router# show nv satellite status satellite 100

Satellite 100
-------------
  State: Connected (Stable)
  Type: asr9000v
  Description: sat-test
  MAC address: dc7b.9427.47e4
  IPv4 address: 100.1.1.1
  Configured Serial Number: CAT1521B1BB
  Received Serial Number: CAT1521B1BB
  Remote version: Compatible (latest version)
    ROMMON: 125.0 (Latest)
    FPGA: 1.13 (Latest)
    IOS: 200.8 (Latest)
  Configured satellite fabric links:
    TenGigE0/2/0/6
    --------------
      State: Satellite Ready
      Port range: GigabitEthernet0/0/0-9
    TenGigE0/2/0/13
    ---------------
      State: Satellite Ready
      Port range: GigabitEthernet0/0/30-39
    TenGigE0/2/0/9
    --------------
      State: Satellite Ready
      Port range: GigabitEthernet0/0/10-19
```

Note   In this example output, **Remote version**, **ROMMON**, **FPGA**, and **IOS** must show the latest version. If it does not, an upgrade is required on the satellite. The version numbers displayed are the installed version on the ASR 90000v. If a version number is displayed, instead of latest key word in the above output, that would correspond to the ASR9000v image bundles in the satellite pie.

Note   show tech from satellite devices can be pulled out remotely using **show tech-support satellite remote satellite [sat id] file disk0:/[filename]** option for offline analysis of the states on the satellite device.

Monitoring the Satellite Protocol Status

To check the status of the satellite discovery protocol, use the **show nv satellite protocol discovery** command.

```
RP/0/RSP0/CPU0:router# show nv satellite protocol discovery brief

Interface       Sat-ID  Status                         Discovered links
--------------  ------  -----------------------------  ----------------------
Te0/1/0/0       100     Satellite Ready                Te0/1/0/0
Te0/1/0/1       100     Satellite Ready                Te0/1/0/1

(Or)
RP/0/RSP0/CPU0:router# show nv satellite protocol discovery interface TenGigE 0/1/0/0

  Satellite ID: 100
  Status: Satellite Ready
  Remote ports: GigabitEthernet0/0/0-15
  Host IPv4 Address: 101.102.103.104
  Satellite IPv4 Address: 101.102.103.105
  Vendor: cisco, ASR9000v-DC-E
  Remote ID: 2
  Remote MAC address: dc7b.9426.15c2
  Chassis MAC address: dc7b.9426.1594
```

To check the status of the satellite control protocol status, use the **show nv satellite protocol control** command.

```
RP/0/RSP0/CPU0:router# show nv satellite protocol control brief

Sat-ID  IP Address     Protocol state  Channels
------  ------------   -------------   -----------------------------------
   101.102.103.105  Connected     Ctrl, If-Ext L1, If-Ext L2, X-link, Soft Reset, Inventory,
 EnvMon, Alarm


RP/0/RSP0/CPU0:shanghai# sh nv satellite protocol control
Satellite 100
-------------
  IP address: 101.102.103.105
  Status: Connected
  Channels:
    Control
```

```
-------
  Channel status: Open
  Messages sent: 24 (24 control), received: 23 (23 control).
Interface Extension Layer 1
-------------------------
  Channel status: Open
  Messages sent: 7 (3 control), received: 14 (2 control).
Interface Extension Layer 2
-------------------------
  Channel status: Open
  Messages sent: 11 (3 control), received: 10 (2 control).
Interface Extension Cross-link
------------------------------
  Channel status: Open
  Messages sent: 4 (3 control), received: 3 (2 control).
```

Monitoring the Satellite Inventory

You can use the **show inventory chassis**, **show inventory fans** commands in the admin configuration mode to monitor the status of satellite inventory.

✎

Note   Along with a physical entity for the ASR-9000v/v2 satellite, logical entities are also created for the satellite and the power module. Both these entities (physical and logical) are seen in the inventory details command output and in SNMP MIBs. The logical entities can be identified by the lack of serial number (SN) and version identifier (VID).

```
RP/0/RSP0/CPU0:router(admin)# show inventory chassis

NAME: "module 0/RSP0/CPU0", DESCR: "ASR9K Fabric, Controller, 4G memory"
PID: A9K-RSP-4G, VID: V02, SN: FOC143781GJ
...
NAME: "fantray SAT100/FT0/SP", DESCR: "ASR9000v"
PID: ASR-9000v-FTA, VID: V00 , SN: CAT1507B228

NAME: "module SAT100/0/CPU0", DESCR: "ASR-9000v GE-SFP Line Card"
PID: ASR-9000v, VID: N/A, SN: /*Logical Entity of the Satellite*/
NAME: "module mau GigabitEthernet100/0/CPU0/8", DESCR: "CISCO-AVAGO     "
PID: SFP-GE-S, VID: V01, SN: AGM1424P08N

NAME: "module mau TenGigE100/0/CPU0/3", DESCR: "CISCO-FINISAR   "
PID: SFP-10G-SR, VID: V02, SN: FNS144502Y3

NAME: "power-module SAT100/PM0/SP", DESCR: "ASR-9000v Power Module"
PID: ASR-9000v, VID: N/A, SN: /*Logical Entity of the Power Module*/
NAME: "Satellite Chassis ASR-9000v ID 100", DESCR: "ASR9000v"
PID: ASR-9000v-AC-A, VID: V00 , SN: CAT12345678/*Physical Entity of the Satellite*/


RP/0/RSP0/CPU0:router(admin)# show inventory fans

NAME: "fantray 0/FT0/SP", DESCR: "ASR-9006 Fan Tray"
PID: ASR-9006-FAN, VID: V02, SN: FOX1519XHU8

NAME: "fantray 0/FT1/SP", DESCR: "ASR-9006 Fan Tray"
PID: ASR-9006-FAN, VID: V02, SN: FOX1519XHTM
```

```
NAME: "fantray SAT100/FT0/SP", DESCR: "ASR9000v"
PID: ASR-9000v-FTA, VID: V01 , SN: CAT1531B4TC

NAME: "fantray SAT101/FT0/SP", DESCR: "ASR9000v"
PID: ASR-9000v-FTA, VID: V01 , SN: CAT1542B0LJ

NAME: "fantray SAT102/FT0/SP", DESCR: "ASR9000v"
PID: ASR-9000v-FTA, VID: V01 , SN: CAT1531B4T7


RP/0/RSP0/CPU0:sat-host(admin)# show inventory | b GigabitEthernet100/

NAME: "module mau GigabitEthernet100/0/CPU0/0", DESCR: "CISCO-FINISAR    "
PID: SFP-GE-S, VID:  , SN: FNS11350L5E

NAME: "module mau GigabitEthernet100/0/CPU0/1", DESCR: "CISCO-FINISAR    "
PID: SFP-GE-S, VID: V01, SN: FNS0934M290

NAME: "module mau GigabitEthernet100/0/CPU0/2", DESCR: "CISCO-FINISAR    "
PID: SFP-GE-S, VID:  , SN: FNS12280L59
```

Monitoring the Satellite Environment

You can use the **show environment temperatures** and **show environment fans** commands in the admin configuration mode to monitor the status of satellite environment.

```
RP/0/RSP0/CPU0:router(admin)# show environment temperatures

R/S/I   Modules Sensor              (deg C)
0/RSP0/*
        host    Inlet0              33.1
        host    Hotspot0            46.9

0/RSP1/*
        host    Inlet0              32.1
        host    Hotspot0            45.9

0/0/*
        host    Inlet0              37.3
        host    Hotspot0            52.3

0/1/*
        spa0    InletTemp           34.0
        spa0    Hotspot             34.5

        spa1    LocalTemp           38.0
        spa1    Chan1Temp           36.0
        spa1    Chan2Temp           39.0
        spa1    Chan3Temp           39.0
        spa1    Chan4Temp           48.0

        host    Inlet0              36.1
        host    Hotspot0            64.0

0/2/*
        host    Inlet0              39.2
        host    Hotspot0            54.6

0/3/*
        host    Inlet0              41.3
```

```
                host    Hotspot0                48.5

0/FT0/*
                host    Inlet0                  42.3
                host    Hotspot0                36.1

0/FT1/*
                host    Inlet0                  40.4
                host    Hotspot0                35.8

SAT100/FT0/*
                host    Hotspot0                53.0


SAT101/FT0/*
                host    Hotspot0                56.0


SAT102/FT0/*
                host    Hotspot0                53.0

RP/0/RSP0/CPU0:router(admin)# show environment fans

Wed Apr  8 17:40:00.313 UTC
  Fan speed (rpm) and run time (in hours) :
        FAN0    FAN1    FAN2    FAN3    FAN4    FAN5    FAN6    FAN7    FAN8            \
FAN9    FAN10   FAN11   FAN12   FAN13

0/FT0/* (Speed)
        7980    7830    7920    8010    7920    7920    7920    7950    7920            \
7980    7890    8010    8010    7950
0/FT0/* (Run Time)
        N/A     N/A     N/A     N/A     N/A     N/A     N/A     N/A     N/A     N/A \
    N/A     N/A     N/A     N/A
SAT100/FT0/*
        15000   14117   14117   0
```

Reloading the Satellite and Monitoring DOM Parameters

In order to reload the satellite device, use the **hw-module satellite** *satellite id/all* **reload** command.

```
RP/0/RSP0/CPU0:router# hw-module satellite 101 reload

Reload operation completed successfully.
RP/0/RSP0/CPU0:May  3 20:26:51.883 : invmgr[254]: %PLATFORM-INV-6-OIROUT : OIR: Node 101
removed
```

In order to see the DOM parameters of the SFPs and XSPs or access ports and ICL ports of the satellite, use the **show controllers gigabitEthernet interface phy** command.

For access ports

```
RP/0/RSP0/CPU0:Saturn#show controllers gigabitEthernet 100/0/0/22 phy
Wed Apr  8 17:42:32.100 UTC

        Port: 22
        Xcvr Type: SFP
        Vendor Name: CISCO-FINISAR
        CLEI Code: IPUIALJRAA
        Part Number: 10-2143-01V01
```

```
        Product Id: SFP-GE-S
       Thresholds:              Alarm High                Warning High          \
      Warning Low              Alarm Low
          Temperature:            109C                        103C             \
      -13C                     -29C
             Voltage:            3900uV                      3700uV            \
      2900uV                   2700uV
                Bias:            15mAmps                     12mAmps           \
        2mAmps                  1mAmps
        Transmit Power:  0.63100 mW (-1.99971 dBm)   0.63100 mW (-1.99971 dBm)   \
0.07900 mW (-11.02373 dBm)   0.06600 mW (-11.80456 dBm)
          Receive Power:  1.25800 mW (0.99681 dBm)   0.79400 mW (-1.00179 dBm)     \
0.01500 mW (-18.23909 dBm)   0.01000 mW (-20.00000 dBm)
        Temperature: 32 C
        Voltage: 3327 uV
        Bias: 5 mAmps
        Tx Power:  0.28100 mW (-5.51294 dBm)
        Rx Power:  0.000 mW (<-40.00 dBm)


For ICL port

RP/0/RSP0/CPU0:Saturn#show controllers nvFabric-TenGigE 100/0/0/46 phy
Wed Apr  8 17:46:57.045 UTC


        Port: 46
        Xcvr Type: SFP
        Vendor Name: CISCO-FINISAR
        CLEI Code: COUIA75CAA
        Part Number: 10-2457-02V02
        Product Id: SFP-10G-LR
       Thresholds:              Alarm High                Warning High          \
      Warning Low              Alarm Low
          Temperature:             75C                         70C             \
       0C                       -5C
             Voltage:            3630uV                      3465uV            \
      3135uV                   2970uV
                Bias:            70mAmps                     68mAmps           \
        2mAmps                  1mAmps
        Transmit Power:  2.23800 mW (3.49860 dBm)   1.12200 mW (0.49993 dBm)     \
0.15100 mW (-8.21023 dBm)   0.06000 mW (-12.21849 dBm)
          Receive Power:  2.23800 mW (3.49860 dBm)   1.12200 mW (0.49993 dBm)     \
0.03600 mW (-14.43697 dBm)   0.01400 mW (-18.53872 dBm)
        Temperature: 30 C
        Voltage: 3366 uV
        Bias: 34 mAmps
        Tx Power:  0.86300 mW (-0.63989 dBm)
        Rx Power:  1.01000 mW (0.04321 dBm)
```

Port Level Parameters Configured on a Satellite

These are the port-level parameters that can be configured on a satellite nV system:

- Admin state (shut and no shut)

- Ethernet MTU

✎

Note   For Cisco ASR 9000v access ports, the maximum MTU is 9212 for a hub and spoke topology.

- Ethernet MAC Address.

- Ethernet link auto-negotiation that includes,

    - Half and full duplex

    - Link speed

    - Flow control

- Static configuration of auto-negotiation parameters such as speed, duplex, and flow control

- Carrier-delay

> **Note** The Cisco ASR 9000v satellite does not support asymmetric carrier-delay values for access ports. If the host side configuration includes asymmetric values, the satellite applies the minimum of the two for both the up and down carrier-delay values. If any of the carrier-delay values from the host side is less than 100ms, then the satellite applies the value of 100ms, as that is the smallest supported value for carrier-delay.

- Layer-1 packet loopback which includes,

    - Line loopback

    - Internal loopback

- All satellite access port features on Cisco CRS-3 Routers .

Loopback Types on Satellite Ports

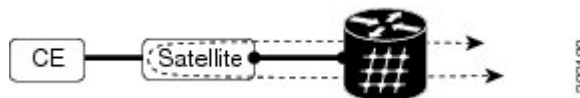There are two types of loopback interfaces that can be configured on satellite ports. They are,

- Line Loopback

- Internal Loopback

These illustrations show how the loopback interface types function on a satellite.

Figure 3: Line Loopback

Figure 4: Internal Loopback

You can specify the type of loopback to be used, as specified in this example:

```
Interface GigabitEthernet 100/0/0/0
```

```
loopback line | internal
```

Configuration Examples for Satellite nV System

This section contains configuration examples for the Satellite nV system:

Satellite System Configuration: Example

This example shows a sample configuration to configure connectivity for a Satellite System:

Satellite Global Configuration

The satellite ID, type, serial number, description, and satellite IP address are configured in the satellite global configuration sub-mode:

```
nv
 satellite 100
  type asr9000v
  serial-number CAT1521B1BB
  description milpitas bldg20
  ipv4 address 10.0.0.100
 !
!
```

ICL (satellite-fabric-link) Interface Configuration

On an interface connected to a Satellite (TenGigE or Bundle interface), the ports associated with the satellite-id must be specified. All fabric links connected to the same Satellite must use the same (Host) IPv4 address. This Host IPv4 addresses can be used for the same Host to connect to different Satellites.

Note   Before you remove or change a configuration on an ICL interface, shut down the ICL port.

```
interface Loopback1000
vrf <vrf_name>
 ipv4 address 10.0.0.1 255.0.0.0
vrf <vrf_name>
interface TenGigE0/2/1/0
 description To Sat5 1/46
 ipv4 point-to-point
 ipv4 unnumbered Loopback1000
 nv
  satellite-fabric-link satellite 200
   remote-ports GigabitEthernet 0/0/0-30
  !
 !
!
```

> ✎
>
> **Note** To manage satellite traffic, use the IP addresses from the global VRF of the router (shown in the examples). As mentioned in Satellite Discovery and Control Protocol IP Connectivity section, you can use a private VRF to prevent IP address conflict with global VRF. In such a case, the loopback interface and ICL interface (in the examples) must be assigned to the private VRF dedicated for satellite management traffic.

Satellite Interface Configuration

A Satellite interface can be used like any other regular Gigabit Ethernet interfaces:

```
interface TenGigE 200/0/0/0
l2transport
!
!

interface TenGigE 200/0/0/0
ip address 99.0.0.1 255.255.255.0
!
!

interface TenGigE 200/0/0/2
bundle id 100 mode active
!
!
```

Satellite Management Using Private VRF

You can use a special private VRF instead of the global default routing table, to configure the loopback interface and ICLs used for satellite management traffic. IP addresses in this VRF will not conflict with any other addresses used on the router.

```
router(config)# vrf NV_MGMT_VRF
router(config)# address ipv4 unicast

router(config)# interface Loopback 1000
router(config)# vrf NV_MGMT_VRF
router(config)# ipv4 address 10.0.0.1 / 24

router(config)# interface TenGige 0/1/0/3
router(config)# vrf NV_MGMT_VRF
router(config)# ipv4 point-to-point
router(config)# ipv4 unnumbered Loopback 1000
router(config)# nv
router(config-nv)# satellite-fabric-link satellite 500
router(config-nv)# remote-ports GigabitEthernet 0/0/28-39
router(config)# nv satellite 500
router(config)# ipv4 address 10.0.0.2 / 24
```

Additional References

These sections provide references to related documents.

Related Documents

Related Topic	Document Title
Satellite System software upgrade and downgrade on Cisco IOS XR Software	*Cisco IOS XR Getting Started Guide for the Cisco CRS Router*
Cisco IOS XR interface configuration commands	*Cisco IOS XR Interface and Hardware Component Command Reference*
Satellite QoS configuration information for the Cisco IOS XR software	*Cisco IOS XR Modular Quality of Service Configuration Guide*
Bidirectional Forwarding Detection features on the satellite system	*Cisco Routing Configuration Guide*
Multicast features on the satellite system	*Cisco Multicast Configuration Guide*
Broadband Network Gateway features on the satellite system	*Cisco Broadband Network Gateway Configuration Guide*
AAA related information and configuration on the satellite system	*Cisco System Security Configuration Guide*
Information about user groups and task IDs	*Configuring AAA Services on Cisco IOS XR Software module of Cisco IOS XR System Security Configuration Guide*

Standards

Standards	Title
No new or modified standards are supported by this feature, and support for existing standards has not been modified by this feature.	—

MIBs

MIBs	MIBs Link
There are no applicable MIBs for this module.	To locate and download MIBs for selected platforms using Cisco IOS XR software, use the Cisco MIB Locator found at the following URL: *http://cisco.com/public/sw-center/netmgmt/cmtk/mibs.shtml*

RFCs

RFCs	Title
None	N.A.

Technical Assistance

Description	Link
The Cisco Technical Support website contains thousands of pages of searchable technical content, including links to products, technologies, solutions, technical tips, and tools. Registered Cisco.com users can log in from this page to access even more content.	http://www.cisco.com/support