# Configuring the Satellite Network Virtualization (nV) System on the Cisco ASR 9000 Series Router

This module describes the configuration of the Satellite Network Virtualization system on the Cisco ASR 9000 Series Aggregation Services Routers.

**Feature History for Configuring Satellite System on Cisco ASR 9000 Series Router**

| Release | Modification |
|---|---|
| Release 4.2.1 | • Support for Satellite Network Virtualization (Satellite nV) Service was included on the Cisco ASR 9000 Series Router. |
| Release 4.2.3 | • Support for 36-Port 10-Gigabit Ethernet Line Card was included. |
| Release 4.3.0 | • Support for Cisco ASR 9001 and Cisco ASR 9922 Series Routers as hosts was included. |
| | • Support for Cisco ASR 901, and Cisco ASR 903 as Satellite devices was included. |
| Release 4.3.1 | • Support for Auto-IP feature was included. |
| | • Support for Link Layer Discovery Protocol(LLDP) over ICL bundle was included. |
| | • Support for Cisco CRS-3 Router with Cisco CRS-3 Modular Services Line Card as host was included. |
| | • Procedure to convert a Cisco ASR 901 or Cisco ASR 903 Router to a satellite was added. |

# Contents

# 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:

- Hardware — Cisco ASR 9000 Series Aggregation Services Routers with Cisco ASR 9000 Enhanced Ethernet line cards as the location of Inter Chassis Links and Cisco ASR9000v, Cisco ASR 901, Cisco ASR 903 routers as Satellite boxes.

- Software — Cisco IOS XR Software Release 4.2.1 or later.

For more information on other hardware requirements, see *Cisco ASR 9000 Series Aggregation Services Router Hardware Installation Guide*.

# Overview of Satellite nV Switching System

The Cisco ASR 9000 Series Router Satellite Network Virtualization (nV) service or the Satellite Switching System enables you to configure a topology in which one or more satellite switches complement one or more Cisco ASR 9000 Series 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 is performed through the control plane and management plane of the Cisco ASR 9000 Series Router, which is referred to as the host.

**Note** Cisco ASR 9001 and Cisco ASR 9922 Series Routers, and Cisco CRS-3 Router with Modular Services Line Card can also be used as hosts in the Satellite nV service.

Interconnection between the Cisco ASR 9000 Series Router and its satellites is through standard Ethernet interfaces. When the Satellite nV service was introduced in Cisco IOS XR Release 4.2.x, Cisco ASR 9000v was used as the satellite device. It had four 10 Gigabit ports that were used as Interchassis Links (ICL). On the other hand, the Cisco ASR 901 has two 1-Gigabit Ethernet ports that are used as ICL. Cisco ASR 903 can have upto two 10 Gigabit ports that can be used as ICL and the 10 Gigabit IMs must be inserted in subslots 0 and 1 only on the ASR903 chassis. The rest of the subslots can be used for 1 Gigabit SFP/Ethernet IMs for access ports. In general, the type of interface used on the host is decided on the basis of the satellite device used. See Figure 1.

**Note** Both the 1-Gigabit Ethernet or 10-Gigabit Ethernet interfaces used as ICL are supported on the Cisco ASR 9000 Enhanced Ethernet line card and not on the Cisco ASR 9000 Ethernet line card.

**Figure 1** *Cisco ASR 9000 Series Satellite nV Switching System*
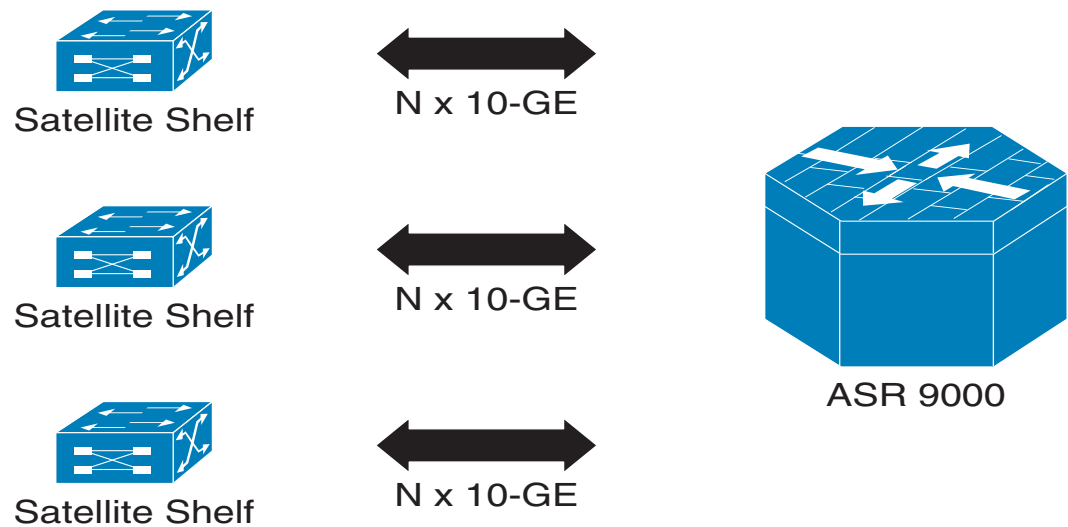


This type of architecture can be realized in a carrier Ethernet transport network, with the satellite switches used as either access switches, or pre-aggregation and aggregation switches. These switches feed into an edge router, such as the Cisco ASR 9000 Series Router or Cisco CRS-3 Router where more 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) backhaul aggregation networks.

# Benefits of Satellite nV System

The Cisco ASR 9000 Series satellite nV system offers these benefits:

1. **Extended port scalability and density -** You can create a virtual line card with more than 400 physical Gigabit Ethernet ports. There is a significant increase of Ethernet port density in the resulting logical Cisco ASR 9000 Series Router. For example, a single 24-port Ten Gigabit Ethernet line card on the Cisco ASR 9000 Series Router could integrate up to 24 satellite switches each with 44 GigE ports; this results in an effective port density of 1056 Gigabit Ethernet ports for each Cisco ASR 9000 Series Router line card slot. In other configurations, even higher port density can be achieved. This is beneficial because the Cisco ASR 9000 Series 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 ASR 9000 Series line card. As a result, in order to utilize the full capacity of an Cisco ASR 9000 Series 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 ASR 9000 Series Router.

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

3. **Reduced operating expense -** You can seamlessly 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 of Cisco ASR 9000 Series 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 ASR 9000 Series 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 ASR 9000 Series Aggregation Services Router QoS Configuration Guide*.

# Overview of Port Extender Model

In the Port Extender Satellite switching system, a satellite switch is attached to its parent Cisco ASR 9000 Series Router through physical ethernet ports.

> **Note** In releases later than Cisco IOS XR Software Release 4.2.1, attachment models beyond the port extender model are also supported.

The parent Cisco ASR 9000 Series Router is referred 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 ASR 9000 Series 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*
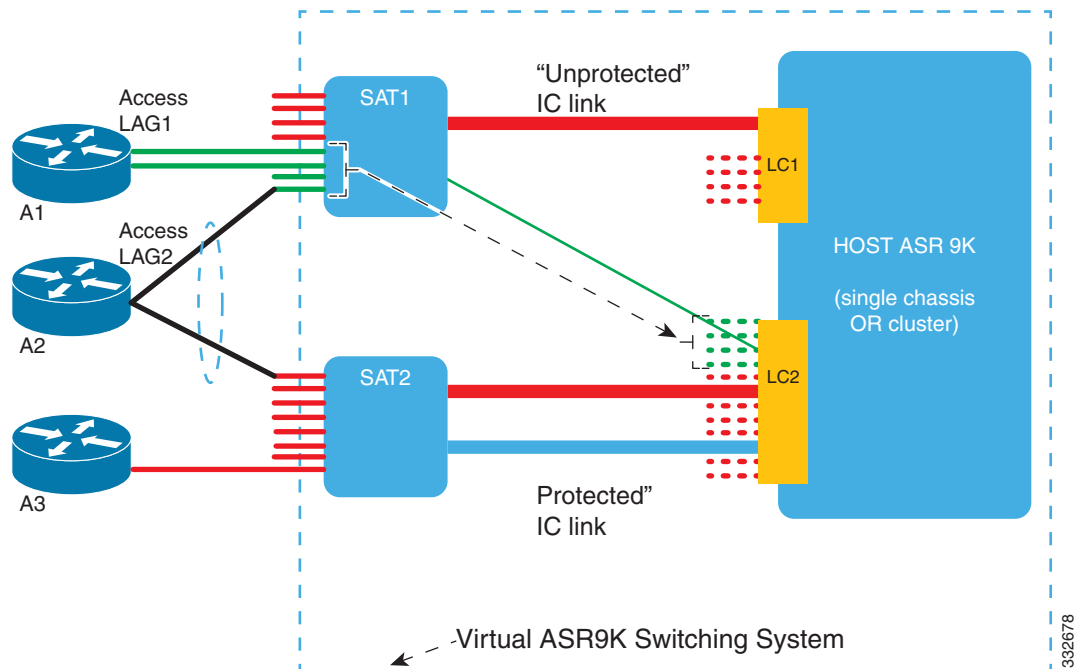


In this model, a single Cisco ASR 9000 Series Router hosts two satellite switches, SAT1 and SAT2, to form an overall virtual Cisco ASR 9000 switching system; this is shown by the dotted line surrounding the Cisco ASR 9000 Series Router, SAT1, and SAT2 in Figure 2.

This structure effectively appears as a single logical Cisco ASR 9000 Series Router to the external network. External access switches A1, A2 and A3 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 ASR 9000 Series Router are ethernet links, and are referred as ICLs (Inter-Chassis Links). The Cisco ASR 9000 Series Router is referred as the host in this system. When there is congestion on the interchassis links, an inbuilt QoS protection mechanism is available for the traffic.

> **Note** SAT1, SAT2, and the host Cisco ASR 9000 Series 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.

> **Note** In a Cisco ASR 9000 Series Router multi-chassis cluster system, there are multiple Cisco ASR 9000 Series Router systems within a single virtual switch system. Logically, however, it is still considered a single host system.

# Features Supported in the Satellite nV System

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

## Satellite System Physical Topology

The satellite system supports the point-to-point hub and spoke physical topology for the ICLs between satellite switches and the host Cisco ASR 9000 Series Router. This topology allows a physical Ethernet MAC layer connection from the satellite to the Cisco ASR 9000 Series Router. 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 be geographically at a separate location, other than that of the host Cisco ASR 9000 Series Router. There is no limit set for the distance, and the solution works even when the satellite is placed at a distance of tens, hundreds, or even thousands of miles from the host.

## Inter-Chassis Link Redundancy Modes and Load Balancing

The Cisco ASR 9000 Series 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 load balancing of traffic between members of the IC bundle is done using a simple hashing function based on the satellite access port ID, and not based on the flow based hash using L2 or L3 header contents from the packets. This ensures that a single ICL is used by all packets for a given satellite access port. As a result, the actions applied for QoS and other features consider all the packets belonging to a single satellite access port.

> **Note** Cisco IOS XR Software supports the co-existence of redundant and non-redundant ICL modes on the same nV satellite shelf (only for 9000v) from Cisco IOS XR Software Release 4.3.x onwards.

For more details on QoS application and configuration on ICLs, see *Cisco ASR 9000 Series Aggregation Services Router Modular Quality of Service Configuration Guide*.

## Satellite Discovery and Control Protocols

A Cisco proprietary discovery and control protocol is used between the satellite switches and the host Cisco ASR 9000 Series Router devices, to handle discovery, provisioning, and monitoring of the satellite devices from the host Cisco ASR 9000 Series Satellite System in-band over the ICLs. The Satellite Discovery And Control (SDAC) Protocol provides the behavioural, 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.

## Layer-2 and L2VPN Features

All L2 and L2VPN features that are supported on physical ethernet or bundle ethernet interfaces are also supported on Satellite Ethernet interfaces. The maximum number of bundles supported by Cisco ASR 9000 Series Router is increased to 510. For more details on L2VPN features supported on the Cisco ASR 9000 Series Satellite System, see *Cisco ASR 9000 Series Aggregation Services Router L2VPN and Ethernet Services Configuration Guide*.

## Layer-3 and L3VPN Features

All MPLS L3VPN features that are supported on ethernet interfaces such as GRE, netflow, and so on, are also supported on the Cisco ASR 9000 Series Satellite System. For more information on these features, see *Cisco ASR 9000 Series Aggregation Services Router MPLS Layer 3 VPN Configuration Guide* and *Cisco ASR 9000 Series Aggregation Services Router Netflow Configuration Guide*.

## Layer-2 and Layer-3 Multicast Features

All Layer-2 and Layer-3 multicast features, including IGMP, IGMP snooping, PIM, mLDP, MVPN, P2MP TE, are supported on Satellite Ethernet interfaces, as they are supported on normal Ethernet and bundle ethernet interfaces. For more information on these features supported on a satellite system, see *Cisco ASR 9000 Series Aggregation Services Routers Multicast Configuration Guide*.

## 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 queueing action. However, for QoS, there may be some functional differences in the behavior because in the Cisco IOS XR Software Release 4.2.1, user-configured MQC policies are applied on the Cisco ASR 9000 Series Router, and not on the satellite switch interfaces. For more detailed information on QoS policy attributes, features, and their configuration, see *Cisco ASR 9000 Series Aggregation Services Router Modular Quality of Service Configuration Guide.*

> **Note** User-configured QoS policies are independent of any default port level QoS that are applied in order to handle IC link congestion and oversubscription scenarios. In addition to the default port-level QoS applied on the satellite system ports, there is also some default QoS applied on the Cisco ASR 9000 Series Router side, to the ingress and egress traffic from and to the Satellite Ethernet ports.

## Cluster Support

A cluster of Cisco ASR 9000 Series Routers is supported along with the satellite mode. A single cluster system can act like one logical Cisco ASR 9000 Series Router host system for a group of satellite switches. A satellite switch can also have some ICLs connect to rack 0 and other ICLs connect to rack 1 of a cluster system. For more information, see *Configuring the nV Edge System on the Cisco ASR 9000 Series Router* chapter.

> **Note** The Satellite Ethernet interfaces cannot be used as cluster inter-rack links.

## 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 Cisco ASR 9000 Series Router.

> **Note** The satellite system hardware features, support for SFPs, and compatible topologies are described in the *Cisco ASR 9000 Series Aggregation Services Router Hardware Installation Guide*.

## Restrictions of the Satellite nV System

These are some of the software restrictions of the satellite nV system:

- 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.

- If a satellite system is operating in redundant ICL mode, then you cannot configure link bundles of any form (with or without LACP) on the access ports of that same satellite switch.

- If a satellite system is operating in redundant ICL mode, then Ethernet OAM features are not supported on the access ports of that satellite.

- Multi-chassis Link Aggregation is supported if there are two independent Cisco ASR 9000 Series Routers acting as the POA (Point of Attachment), each with its own satellite switch, and the DHD (Dual Homed Device) connecting through each of the satellite switches. However, MC-LAG is not supported with a single satellite switch that connects two separate Cisco ASR 9000 Series Routers through an ICL LAG.

- The Cisco Discovery Protocol (CDP) is not supported on a bundle Inter Chassis Link (ICL) between the Cisco ASR 9000 Series Router and satellite.

- Cisco ASR 903 Router is not supported on RSP2 Route Processor due to the image size.

**Note** Refer to the *Cisco ASR 9000 Series Aggregation Services Router Release Notes* for additional software restrictions.

# 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.

## SUMMARY STEPS

1. **configure**
2. **nv**
3. **satellite** *Satellite ID*
4. **serial-number** *string* (Optional)
5. **description** *string* (Optional)
6. **type** *type*
7. **ipv4 address** *address*
8. **secret** <password>
9. **end**
   or
   **commit**

## DETAILED STEPS

| | Command or Action | Purpose |
|---|---|---|
| **Step 1** | `configure`<br><br>**Example:**<br>`RP/0/RSP0/CPU0:router# configure` | Enters global configuration mode. |
| **Step 2** | `nv`<br><br>**Example:**<br>`RP/0/RSP0/CPU0:router(config)# nv` | Enters the nV configuration submode. |
| **Step 3** | `satellite` *Sat ID*<br><br>**Example:**<br>`RP/0/RSP0/CPU0:router(config-nV)#`<br>`satellite <100-65534>` | Declares a new satellite that is to be attached to the host and enters the satellite configuration submode. |
| **Step 4** | `serial-number` *string*<br><br>**Example:**<br>`RP/0/RSP0/CPU0:router(config-nV)#`<br>`serial-number CAT1521B1BB` | (Optional) Serial number is used for satellite authentication. |
| **Step 5** | `description` *string*<br><br>**Example:**<br>`RP/0/RSP0/CPU0:router(config-nV)#`<br>`description Milpitas Building12` | (Optional) Specifies any description string that is associated with a satellite such as location and so on. |

| | | Command or Action | Purpose |
|---|---|---|---|
| Step 6 | | **type** *type_name*<br><br>**Example:**<br>RP/0/RSP0/CPU0:router(config-nV)#<br>satellite 200 type?<br>asr9000v Satellite type | Defines the expected type of the attached satellite. The satellite types are ASR9000v, ASR901v, and ASR 903v. |
| Step 7 | | **ipv4 address** *address*<br><br>**Example:**<br>RP/0/RSP0/CPU0:router(config-nV)# ipv4<br>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 | | **secret** *password*<br><br>**Example:**<br>RP/0/RSP0/CPU0:router(config-satellite)#<br>secret <password> | Specifies the secret password to access the satellite. In order to login you must use root as the user name and password as the secret password. |
| Step 9 | | **end**<br>or<br>**commit**<br><br>**Example:**<br>RP/0/0RSP0/CPU0:router(config)# end<br>or<br>RP/0/RSP0/CPU0:router(config)# commit | Saves configuration changes.<br><br>• When you issue the **end** command, the system prompts you to commit changes:<br><br>Uncommitted changes found, commit them before exiting(yes/no/cancel)?<br>[cancel]:<br><br>– Entering **yes** saves configuration changes to the running configuration file, exits the configuration session, and returns the router to EXEC mode.<br><br>– Entering **no** exits the configuration session and returns the router to EXEC mode without committing the configuration changes.<br><br>– Entering **cancel** leaves the router in the current configuration session without exiting or committing the configuration changes.<br><br>• Use the **commit** command to save the configuration changes to the running configuration file and remain within the configuration session. |

# Configuring the Host IP Address

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

## SUMMARY STEPS

1. **configure**
2. **interface Loopback0**
3. **ipv4 address** 8.8.8.8 255.255.255.255
4. **end**
   or
   **commit**

## DETAILED STEPS

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

| | Command or Action | Purpose |
|---|---|---|
| **Step 3** | `ipv4 address`<br><br>**Example:**<br>`RP/0/RSP0/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`<br>or<br>`commit`<br><br>**Example:**<br>`RP/0/RSP0/CPU0:router(config)# end`<br>or<br>`RP/0/RSP0/CPU0:router(config)# commit` | Saves configuration changes.<br><br>• When you issue the **end** command, the system prompts you to commit changes:<br><br>`Uncommitted changes found, commit them before exiting(yes/no/cancel)?`<br>`[cancel]:`<br><br>   – Entering **yes** saves configuration changes to the running configuration file, exits the configuration session, and returns the router to EXEC mode.<br><br>   – Entering **no** exits the configuration session and returns the router to EXEC mode without committing the configuration changes.<br><br>   – Entering **cancel** leaves the router in the current configuration session without exiting or committing the configuration changes.<br><br>• Use the **commit** command to save the configuration changes to the running configuration file and remain within the configuration session. |

# Configuring the 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 GigE ports, which crosslink 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, page 9.

**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 subsection under Satellite System Configuration: Example.

**SUMMARY STEPS**

1. **configure**

2. **interface** *interface_name*

3. **description**

4. **ipv4 point-to-point** (optional)

5. **ipv4 unnumbered Loopback0** (optional)

6. **nv**

7. **satellite-fabric-link satellite** *id*

8. **remote-ports** *interface-type*

9. **end**
   or
   **commit**

## DETAILED STEPS

| | Command or Action | Purpose |
|---|---|---|
| Step 1 | **configure**<br><br>Example:<br>RP/0/RSP0/CPU0:router# configure | Enters global configuration mode. |
| Step 2 | **interface** *interface-name*<br><br>Example:<br>RP/0/RSP0/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, and Bundle-Ether interfaces are the only support ICL types. |
| Step 3 | **description**<br><br>Example:<br>RP/0/RSP0/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**<br><br>Example:<br>RP/0/RSP0/CPU0:router(config-interface)# ipv4 *point-to-point* | (Optional) Configures the IPv4 point to point address. |
| Step 5 | **ipv4 unnumbered loopback0**<br><br>Example:<br>RP/0/RSP0/CPU0:router(config-interface)# interface unnumbered loopback0 | (Optional) Configures the IPv4 loopback address on the interface. |
| Step 6 | **nv**<br><br>Example:<br>RP/0/RSP0/CPU0:router(config-if)# nv | Enters the Network Virtualization configuration mode. |

| | Command or Action | Purpose |
|---|---|---|
| **Step 7** | `satellite-fabric-link satellite <id>`<br><br>**Example:**<br>`RP/0/RSP0/CPU0:router(config-int-nv)#`<br>`satellite-fabric-link satelite 200` | Specifies that the interface is an ICPE inter-chassis link. |
| **Step 8** | `remote-ports interface-type`<br><br>**Example:**<br>`RP/0/RSP0/CPU0:router(config-int-nv)#`<br>`remote-ports GigabitEthernet 0/0/0-30` | Configures the remote satellite ports 0 to 30. |
| **Step 9** | **end**<br>or<br>**commit**<br><br>**Example:**<br>`RP/0/RSP0/CPU0:router(config)# end`<br>or<br>`RP/0/RSP0/CPU0:router(config)# commit` | Saves configuration changes.<br><br>• When you issue the **end** command, the system prompts you to commit changes:<br><br>`Uncommitted changes found, commit them before`<br>`exiting(yes/no/cancel)?`<br>`[cancel]:`<br><br>– Entering **yes** saves configuration changes to the running configuration file, exits the configuration session, and returns the router to EXEC mode.<br><br>– Entering **no** exits the configuration session and returns the router to EXEC mode without committing the configuration changes.<br><br>– Entering **cancel** leaves the router in the current configuration session without exiting or committing the configuration changes.<br><br>• 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 ASR 9000 Series Aggregation Services Router Modular Quality of Service Configuration Guide*.

## 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

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

## Configuring the Satellite nV Access Interfaces

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

These interfaces support all features that are normally configurable on GigabitEthernet 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** Connect the 10GigE fibers from the host to any of the 10G SFP+ ports on the satellite device in any order.

**Note** The Satellite nV service can use Cisco ASR 9000 Series Router or Cisco ASR 9001 and Cisco ASR 9922 Series Routers as hosts. The Cisco ASR 9000v, Cisco ASR 901, or Cisco ASR 903 Routers can be used as satellite devices.

3. Configure the satellite nV system through CLI or XML on the host 10GigE ports. Configure the host for nV operations as described in the sections Defining the Satellite nV System, Configuring the Host IP Address, and Configuring the Inter-Chassis Links and IP Connectivity.
4. Power up the chassis of the satellite device.

**Note** For power supply considerations of ASR 9000v, ASR 901, and ASR 903, refer to the *Appendix C, Cisco ASR 9000 and Cisco CRS Satellite Systems (ASR 9000v, ASR 903, ASR 901)* of the *Cisco ASR 9000 Series Aggregation Services Router Hardware Installation 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 **asr9k-9000v-nV-px.pie**, **asr9k-asr901-nV-px.pie**, **asr9k-asr903-nV-px.pie** within the Cisco ASR 9000 Series 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.

This section provides the commands to manage the satellite nV Software.

## Prerequisites

You must have installed the satellite installation procedure using the Plug and Play Satellite installation procedure. For more information, see Plug and Play Satellite nV Switch Turn up: (Rack, Plug, and Go installation).

## 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.

**Example**

```
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.

**Example**

```
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 ASR 9000 Series Router. If it is configured, then you need to add this exception for each of the 10GigE interfaces, which are the satellite ICLs.

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.

## Converting a Standard Cisco ASR 901 to Satellite

In order to convert a standard Cisco ASR 901 Router to Satellite, see *Network Virtualization Using Cisco ASR 901 Series Aggregation Services Router as a Satellite*.

## Converting a Standard Cisco ASR 903 to Satellite

In order to convert a standard Cisco ASR 903 Router to a Satellite, see *Enabling Network Virtualization Satellite Mode on the Cisco ASR 903 Router*.

In order to upgrade the Cisco ASR 903 Router to the latest Satellite nV image from Cisco ASR 9000 Series Router, carry out these steps:

✎

**Note**  These steps are applicable only in Cisco IOS XR Software Release 4.3.x. Future releases will follow the standard nV upgrade procedure.

1.  Install the 903 satellite PIE on the Cisco ASR 9000 Series Router.

2.  Install the 903 satellite SMU, if any, on the Cisco ASR 9000 Series Router.

3.  Configure a sufficiently-long session timeout value on the Cisco ASR 9000 Series Router to ensure that the session does not time out while the satellite image is copied to the satellite.

    ```
    RP/0/RSP0/CPU0:router(config)# line default
    RP/0/RSP0/CPU0:router(config-line)# session-timeout 120
    ```

4.  Log in to the satellite using the procedure described in the Defining the Satellite nV System section.

    ```
    RP/0/RSP0/CPU0:router# Telnet 66.66.66.60
    ```

    a.  If there is no secret configured on the host for satellite, you can telnet to the satellite.

    b.  If there is a secret configured on the host for satellite, you must telnet to the satellite and login using username "root" and password as configured in the Implementing a Satellite nV System section.

5.  After you log in to the satellite, download the 903 nv binary to the Cisco ASR 903 Router. Use TFTP IP address as the address of the host loopback address.

**Example**:

```
LC:Satellite# copy tftp bootflash:

Address or name of remote host []? 66.66.66.61
Source filename []? /rp_super_universalk9_npe.rudy.bin
Destination filename [rp_super_universalk9_npe.rudy.bin]?
Accessing t ftp://66.66.66.61//rp_super_universalk9_npe.rudy.bin...
Loading rp_super_universalk9_npe.rudy.bin .from 66.66.66.61 (via BDI100):
!!!!!!!!!!!!!!!!!!!!
```

**Note**    Ensure to put the "/" (slash) before image name - **/rp_super_universalk9_npe.rudy.bin**.

6. Exit from the telnet session to the satellite.

7. Reload the satellite using the command **hw-module satellite** *sat id* **reload**.

## Monitoring the Satellite Software

- 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
```

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

**Example**

```
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.

## 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, show environment temperatures** commands in the admin configuration mode to monitor the status of satellite inventory.

```
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:
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:
NAME: "Satellite Chassis ASR-9000v ID 100", DESCR: "ASR9000v"
PID: ASR-9000v-AC-A, VID: V00 , SN: CAT12345678



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


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
```

## Reloading the Satellite Device

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

### Example

```
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
```

## 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
- 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
- Layer-1 packet loopback which includes,
    - Line loopback
    - Internal loopback
- All satellite access port features on Cisco ASR 9000 Series Router.

## 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*
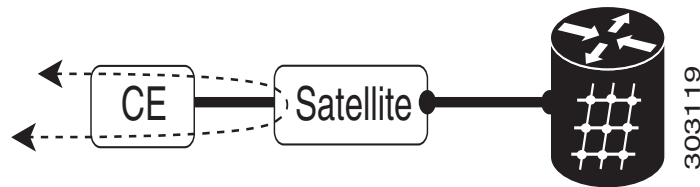


*Figure 4    Internal Loopback*
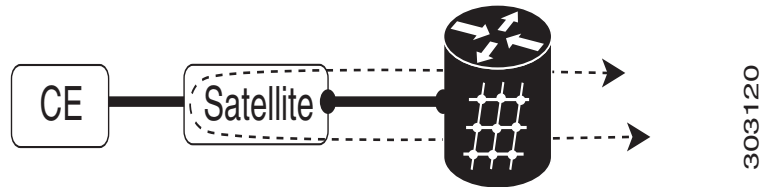


You can specify the type of loopback to be used, as specified in this example:

```
Interface GigabitEthernet 100/0/0/0
loopback line | internal
```

# Configuration Examples for Satellite nV System

This section contains these examples:

## Satellite System Configuration: Example

This example shows a sample configuration for setting up the connectivity of a Satellite System.

## Satellite Global Configuration

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

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

## ICL (satellite-fabric-link) Interface Configuration

On the interface connected to the satellite (TenGig 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. The same or different host IPv4 addresses can be used for the same host to connect to different satellites.

```
interface Loopback1000
 ipv4 address 10.0.0.1 255.0.0.0
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** These examples illustrate using IP addresses from the global VRF of the router for satellite management traffic. As discussed Satellite Discovery and Control Protocol IP Connectivity section, this can also be done using a private VRF, to prevent IP address conflict with the global VRF. In this case, the loopback interface and the ICL interfaces in the examples must be assigned to the private VRF dedicated for satellite management traffic.

## Satellite Interface Configuration

The Satellite interface can be used as any other regular GigabitEthernet interfaces:

```
interface GigabitEthernet200/0/0/0
l2transport
!
!

interface GigabitEthernet200/0/0/0
ip address 99.0.0.1 255.255.255.0
!
!

interface GigabitEthernet200/0/0/2
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 |
|---|---|
| Cisco IOS XR master command reference | *Cisco IOS XR Master Commands List* |
| Satellite System software upgrade and downgrade on Cisco IOS XR Software | *Cisco ASR 9000 Series Aggregation Services Router Getting Started Guide* |
| Cisco IOS XR interface configuration commands | *Cisco ASR 9000 Series Aggregation Services Router Interface and Hardware Component Command Reference* |
| Satellite QoS configuration information for the Cisco IOS XR software | *Cisco ASR 9000 Series Aggregation Services Router Modular Quality of Service Configuration Guide* |
| Bidirectional Forwarding Detection features on the satellite system | *Cisco ASR 9000 Series Aggregation Services Router Routing Configuration Guide* |
| Layer-2 and L2VPN features on the satellite system | *Cisco ASR 9000 Series Aggregation Services Router L2VPN and Ethernet Services Configuration Guide* |
| Layer-3 and L3VPN features on the satellite system | *Cisco ASR 9000 Series Aggregation Services Router MPLS Layer 3 VPN Configuration Guide* |
| Multicast features on the satellite system | *Cisco ASR 9000 Series Aggregation Services Router Multicast Configuration Guide* |
| Broadband Network Gateway features on the satellite system | *Cisco ASR 9000 Series Aggregation Services Router Broadband Network Gateway Configuration Guide* |
| AAA related information and configuration on the satellite system | *Cisco ASR 9000 Series Aggregation Services Router System Security Configuration Guide* |
| Cisco ASR 901 Router configuration | *Network Virtualization Using Cisco ASR 901 Series Aggregation Services Router as a Satellite* |
| Cisco ASR 903 Router configuration | *Enabling Network Virtualization Satellite Mode on the Cisco ASR 903 Router* |
| 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 |