



# Network Virtualization Using Cisco ASR 901 Series Aggregation Services Router as a Satellite

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This document describes Network Virtualization (nV), which uses the Cisco ASR 901 Series Aggregation Services Router as a satellite to the Cisco ASR 9000 Series Aggregation Services Router.

In this document, the focus is only on the nV (satellite) mode of the Cisco ASR 901 router. The nV mode of operation is separate from the standard mode of operation of the Cisco ASR 901 router. The features available in the standalone mode are not supported on the nV mode and the features available on the nV mode are not supported on the standalone mode.

In the nV mode, the Cisco ASR 901 router runs the control plane and features of the host (Cisco ASR 9000 router) and is managed through the IOS XR CLI. In the standalone mode, the Cisco ASR 901 router runs the standard Cisco IOS image. For details on the Cisco IOS image and features supported in the standard mode, see the release notes of the Cisco ASR 901 router at the following location:

[http://www.cisco.com/en/US/products/ps12077/prod\\_release\\_notes\\_list.html](http://www.cisco.com/en/US/products/ps12077/prod_release_notes_list.html)



## Note

Detailed conceptual and configuration information about the nV feature is documented in the Cisco IOS software documentation. We recommend that you read this document in conjunction with the *Configuring the Satellite Network Virtualization (nV) System on the Cisco ASR 9000 Series Router* guide. For information about the location of this and other related documentation, see the “[Related Documentation](#)” section on page 12.

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## Introduction

The Cisco ASR 901 Series Aggregation Services Router is a cell-site access platform specifically designed to aggregate and transport mixed-generation radio access network (RAN) traffic. The router is used at the cell site edge as a part of a 2G, 3G, or 4G RAN.

The nV feature is supported on the following models of the Cisco ASR 901 router:

- A901-12C-F-D
- A901-12C-FT-D



### Note

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The TDM ports are disabled on the FT version of the Cisco ASR 901 router.

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The nV feature is not supported on the following models of the Cisco ASR 901 router now. However, they will be supported in future releases:

- A901-4C-F-D
- A901-4C-FT-D
- A901-6CZ-F-D
- A901-6CZ-F-A
- A901-6CZ-FT-A
- A901-6CZ-FT-D

The Cisco ASR 9000 Series Router Satellite Network Virtualization service enables you to configure a topology in which one or more Cisco ASR 901 router satellites complement one or more Cisco ASR 9000 Series routers, to collectively realize a single virtual switching system. In this system, the satellites act under the management control of the Cisco ASR 9000 router. The complete configuration and management of the satellite chassis and features is performed by the Cisco ASR 9000 router.

The nV system works in the port extender satellite model, where a satellite is attached to its host through physical ethernet ports. The interconnection between the satellite and the host is through standard ethernet interfaces (1 Gigabit Ethernet on the current chassis of the Cisco ASR 901 router. 10 Gigabit Ethernet will be supported later on the 10G versions of the Cisco ASR 901 router). The physical access ports of the satellite is equivalent to physical ethernet ports on the host from a management or provisioning point of view.

For more information on port extender satellite model, see Overview of Port Extender Model section on the [Configuring the Satellite Network Virtualization \(nV\) System on the Cisco ASR 9000 Series Router](#).

Additional points to consider in port extender satellite model:

- The inter-connection between satellite and host is always through a direct physical ethernet link.
- The physical inter connect (IC) links may be transported over an optical transport network (such as Ethernet over a SONET or Synchronous Digital Hierarchy [SDH] or coarse wavelength-division multiplexing [CWDM] or dense wavelength-division multiplexing [DWDM] network).
- The IC links may be *protected* or *unprotected*.

- The satellite can be geographically at a separate location from the host. There is no explicit limitation on the geographic distance between a satellite and the host.

**Note**

When using a satellite over a significant geographical distance (greater than 100 miles) the speed-of-light propagation delay between the satellite and its host comes into play. For example, it can cause an offset in the expected value of frame latency when using features such as Y.1731 to measure end-to-end frame switching delay.

## Benefits

- Provides single point of management for multiple devices, including chassis management and port management for the Cisco ASR 9000 router and the Cisco ASR 901 router.
- Extended port scalability and density.
- Reduced cost - All the edge-routing capabilities and application features of the Cisco IOS XR software are available on the satellites.
- 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.
- Enhanced feature consistency - All the features on the regular Gigabit Ethernet ports of Cisco ASR 9000 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.
- Improved feature velocity - With the satellite solution, every feature that is implemented on the Cisco ASR 9000 router becomes instantly available at the same time in the access switch, resulting in an ideal feature velocity for the edge switch.
- Better resiliency - The nV satellite solution enables better multi-chassis resiliency, as well as better end-to-end QoS.
- Supports client-host protocol that is resilient to satellite-trunk failures as long as the communication path exists between the client and host.
- Provides a dedicated queue for the client-host control protocol traffic on its ports.
- Represents the host with basic capability information. The satellite configuration is done by the host.
- The latency of the features or mechanical and environmental events on the satellite ports is not more than a second, when compared to the same feature or event on the Cisco ASR 9000 router.
- Supports the same set of Small Form-Factor Pluggables (SFPs) used in the host.
- Retrieves or accepts a new image (including ROMMON image) through the client-host control channel.
- Supports a cross-connect forwarding model, whereby all traffic of a satellite port is relayed to a pre-configured and deterministic satellite-trunk.

- Supports a total of 12 ports, where 2 ports (g0/10 and g0/11) are used as satellite ports (ICLs). The other 10 access ports are mapped to the 2 ICL ports.

**Note**

Effective with Cisco IOS release 15.4(3)S, any 2 ports of the 12 available ports of the Cisco ASR 901 1G Series Routers can be configured as ICLs. When the router comes up, all ports are potential ICLs. After a port is marked as ICL, other ports still remain as potential ICL to configure one more ICL port. When two ports are marked as ICLs, the ICL attribute is removed from the remaining ports. While the ICL ports are being discovered, if any port is mapped as an access port, then its state (UP or Down) is as per the setting made for that port on the host. This access port is no longer a potential ICL.

- Support bundles (link aggregation group [LAG] and Equal-Cost Multipath [ECMP]) across arbitrary satellite ports.
- Responds to all port-down events with a delay of no more than 100ms, which includes detection time, and response at Layer 2 and Layer 3 control protocols.
- Provides ingress class of service (CoS) and control-protocol classification on its ports.
- Provides egress class-based queueing on the ports.
- Schedules traffic from the trunk-port queues with contemporary scheduling techniques such as modified deficit round robin (MDRR).
- Provides minimum bandwidth on its trunk ports for control-protocol traffic (Link Aggregation Control Protocol [LACP] and Multiple Spanning Tree Protocol [MSTP]) and client-host control-protocol traffic.
- Provides a default quality of service (QoS) configuration for the access and ICL ports.
- Provides ingress and egress traffic statistics and alarms for each of the ports.
- Provides the option to be managed by Cisco Prime with feature parity to line card only system.

## Supported Features

The following features that are supported on the host are also supported on the Cisco ASR 901 router. These features are configured and managed through the IOS XR configuration commands on the host.

**Note**

For a full list of features supported on the nV system, see the [Configuring the Satellite Network Virtualization \(nV\) System on the Cisco ASR 9000 Series Router](#) guide. The Cisco ASR 901 router will continue to inherit the features of Cisco ASR 9000 router due to the satellite mode.

- Ethernet:
  - Ethernet link level maximum transmission unit (MTU)
  - Link Aggregation Control Protocol (LACP)
  - Ethernet OAM (802.3ah)
  - Link level support for bidirectional forwarding detection (BFD)
  - Connectivity Fault Management (CFM).
- Layer 2 and L2VPN:

- Ethernet virtual circuit (EVC) features. Also, includes Ethernet Flow Point (EFP) classification types, VLAN rewrite, and egress filtering.
- Point-to-point local connect
- X-connect
- Ethernet over MPLS (EoMPLS) pseudowire
- Multi-point bridging and Virtual Private LAN Services (VPLS). Also, includes variations of bridging such as 802.1ad or 802.1ah, as well as all sub-features such as MAC limits, MAC security, Dynamic Address Resolution Protocol (ARP) Inspection, and IP Source Guard.
- VPLS signaling and control plane. Also, includes Label Distribution Protocol (LDP) and Border Gateway Protocol (BGP) autodiscovery and signaling, preferred path, MAC withdrawal, Pseudowire stitching, and Flow Aware Transport (FAT) pseudowire.
- Layer 2 control protocols. Also, includes CFM, Y.1731, Multiservice Transport Platform (MSTP), MST Access Gateway (MSTAG), REP Access Gateway (REPAG), and Per VLAN Spanning Tree Plus Access Gateway (PVST+AG).
- Switched Port Analyzer (SPAN)
- Integrated routing and bridging (IRB)
- Broadcast Storm Control
- IP interworking
- Layer 2 QoS
- Layer 2 ACLs
- g.8032
- Link Bundles:
  - Link bundle features (static ether-channel and LACP) are supported in non-redundant IC links mode.
  - Link bundles support with satellite in redundant IC links mode
  - Multi-chassis LAG (MC-LAG)
  - Multi-Gigabit Service Control Platform (MGSCP)
- Layer 3 and L3VPN:
  - IPv4 and IPv6. Also, includes Address Resolution Protocol (ARP), Internet Control Message Protocol (ICMP), Neighbor Discovery (ND).
  - MPLS (including LDP and BGP signaling options).
  - MPLS L3VPN
  - Generic Routing Encapsulation (GRE)
  - NetFlow.
  - Routing protocols like Open Shortest Path First(OSPF), Routing Information Protocol (RIP), Intermediate System to-Intermediate System (IS-IS), and Border Gateway Protocol (BGP).
- Layer 2 and Layer 3 Multicast:
  - Internet Group Management Protocol (IGMP)
  - IGMP snooping
  - Protocol Independent Multicast (PIM)

- Multicast Label Distribution Protocol (MLDP)
- Multicast Virtual Private Network (MVPN)
- Point-to-Multipoint Traffic Engineering (P2MP TE)
- Multicast-only FRR (MoFRR)
- Video monitoring (VidMon)
- QoS and ACL: Layer 2 and Layer 3 QoS and ACL features (The user-configured Modular QoS CLI [MQC] policies are applied only on the host. Similarly, the QoS policies are independent of any default port level QoS used for IC link congestion and oversubscription. Some QoS policies are also applied on the host for satellite traffic).
- Timing and Synchronous Ethernet

## Features Supported on ICL ports

The following set of features are supported on ICL ports.



### Note

In satellite mode, there may be differences in performance and scale to some extent for some of the features. See the [“Restrictions” section on page 6](#) for the restrictions applicable to these features.

- Basic Ethernet interface level configuration (shut/unshut and SFP control)
- Basic IPv4 support (IPv4 unicast, ARP support, and IP unnumbered)
- QoS configuration (MQC based policies) – MQC policies on IC links are used to provide additional QoS controls for satellite management traffic.



### Note

Layer 2 and Layer 3 features of the Cisco ASR 9000 router are not supported on the IC links used for satellite hosting.

## Restrictions

The following restrictions apply to the Cisco ASR 901 router:



### Note

The following restrictions are applicable only for the Cisco IOS Release 15.3(1)S and they may change in future releases. We recommend you to check the release notes of your particular release to see the exact restrictions applicable for the release.

- Local switching on the satellite is not supported. The packets are always sent to the host for layer 2 and layer 3 switching.
- The IC link redundancy is supported only through static EtherChannel. It is not supported through the LACP based link bundles.
- In redundant IC links mode, you cannot configure link bundles of any form (with or without LACP) on the access ports of the same satellite.
- In redundant IC links mode, Ethernet link level features are not supported on the access ports of that satellite. These include LACP, Ethernet OAM (802.3ah).

- In IC link bundle, LACP dependent features such as 1:1 hot standby or min-max links are not supported.
- In-Service Software Upgrade (ISSU) or Minimal Disruptive Restart (MDR) is not supported.
- Only qualified pluggables and SFPs are supported.
- Retrieving inventory or environmental state from a satellite may take a second longer than done locally on the host.
- You cannot have a link bundle in which some bundle members are satellite Ethernet access ports and other members are local Ethernet ports on the same Cisco ASR 9000 router line card that aggregates the satellite Ethernet bundle members.
- Half-duplex is not supported. You have to configure the speed manually.
- If the ring topology contains satellites, ensure that there is no redundant ICL link between satellites.

## Hardware Support

The Cisco ASR 901 router is a single RU system and supports Gigabit Ethernet interfaces. It supports the same set of SFPs and pluggable optics as that of the standalone Cisco ASR 901 router.

For hardware information about Cisco ASR 901 routers, see the following link:

[http://www.cisco.com/en/US/products/ps12077/tsd\\_products\\_support\\_install\\_and\\_upgrade.html](http://www.cisco.com/en/US/products/ps12077/tsd_products_support_install_and_upgrade.html)

See the *Release Notes for Cisco ASR 901 Series Aggregation Services Router* for a list of supported SFPs and pluggable optics.

## Satellite Chassis Management

The host performs the chassis management, inventory monitoring and reporting, and environmental parameter monitoring for the satellite.

The satellite chassis management ensures that carriers can manage a single logical device from all aspects, including service level and box level management.

The inventory monitoring and reporting functionality includes the ports, SFPs and other hardware and software components of the satellite.

The environmental variables such as temperature, voltage and fan speed are monitored and reported for each satellite through the normal environment reporting mechanisms of the host.

Though the management functions of the satellites are done by the host, you can manage a satellite without using the host in situations like troubleshooting or for installing a software. We recommend you to perform in-band telnet from the host to access the Cisco ASR 901 router for monitoring and limited debugging.



### Note

You cannot use the IOS configuration commands in the Cisco ASR 901 router, as these commands not blocked. However, you can use **show** commands for monitoring and limited debugging.

### Satellite Chassis Management Interfaces

The naming convention used for satellite access interfaces is Satellite-Ethernet SatId/sSlot/sSubslot/sPort.

- **SatId:** Satellite identifier (a global chassis identifier for the satellite and globally unique for the satellite-host combination)
- **sSlot:** Slot number on the satellite chassis
- **sSubslot:** Subslot number on the satellite chassis
- **sPort:** Port number on the satellite chassis



#### Note

The Cisco ASR 901 router supports satellite interfaces from SatId/0/0/0 to SatId/0/0/9.

## Satellite Configuration

You can configure the Cisco ASR 901 router as satellite of a Cisco ASR 9000 router using the following options:

- A Cisco ASR 901 router with a factory-installed satellite software can be directly connected to a host for use as a satellite.
- A Cisco ASR 901 router running the satellite software can be connected to a host and upgraded in-band from the host to an appropriate version of the satellite image version (See [“Upgrading the Satellite \(nV\) Version” section on page 9](#)).
- A Cisco ASR 901 router running a non-satellite software can be upgraded in the field to run as a satellite (See [“Converting a Standard Cisco ASR 901 Router to Satellite” section on page 9](#)).



#### Note

For a complete set of information on configuring and upgrading the satellite, see the [Configuring the Satellite Network Virtualization \(nV\) System on the Cisco ASR 9000 Series Router](#) guide.

## Upgrading the Satellite Image

You can upgrade an Cisco ASR 901 router to the correct version of satellite software, either through the local management console on the Cisco ASR 901 router or through in-band telnet to the host. After you connect the satellite to the host, the host verifies the satellite software version and if there is a mismatch, a syslog fault notification is raised alerting the user of the need to upgrade the satellite software. This is done to avoid simultaneous reload of multiple satellites, when the host upgrades or downgrades.

The satellite software is not upgraded automatically whenever the host software is updated. In such situations, a software mismatch notification is displayed and the user needs to manually update the satellite software from the host through the IC links.

You can also perform the upgrade or downgrade of the satellite through the user configuration from the host. The host sends an install message to the satellite with the image name. The satellite gets the image and copies it to the flash, and triggers the reload of the satellite with the new image. After the reboot, the satellite goes through the normal discovery phase and performs the image compatibility check.

**Note**

The image downloaded to the satellite from the host is stored persistently on non-volatile storage of the satellite. Subsequent reboots of the satellite do not affect the downloaded image.

## Upgrading the Satellite (nV) Version

You can upgrade a Cisco ASR 901 router running the satellite software to the latest version through in-band telnet to the host (Cisco ASR 9000 router).

For information on upgrading the satellite, see [Upgrading and Managing Satellite nV Software](#) section of the *Configuring the Satellite Network Virtualization (nV) System on the Cisco ASR 9000 Series Router* guide.

## Converting a Standard Cisco ASR 901 Router to Satellite

You can convert a Cisco ASR 901 router running a normal Cisco IOS software to run the satellite software. For that, you should download an image directly from Cisco.com and manually upgrade the Cisco ASR 901 router in the field through the faceplate management interface and then connect to the host. You can access the Cisco ASR 901 router using console or management port. The image is downloaded using the management port.

To configure the Cisco ASR 901 router (without the factory-installed satellite software) to a satellite, perform the steps given below.

- 
- Step 1** Copy nV compatible binary image to flash.
- ```
Router# copy tftp://<ip-address>/tftpboot/asr901_sat-advipservicesk9-mz:
```
- Step 2** Set the config register to 0x2042.
- ```
Router(config)# config-register 0x2042
```
- Step 3** Erase the existing configuration.
- ```
Router# write erase
```
- Step 4** Set the boot up option.
- ```
Router(config)# boot system flash:asr901_sat-advipservicesk9-mz
```
- Step 5** Save the configuration.
- ```
Router# write memory
```
- Step 6** Reload the router.
- ```
Router(config)# reload
```
-

**Note**

After you select the confirm option from reload, the system will reload in nV mode. When the ASR 901 router reloads in nV mode, you should delete the factory-installed software (asr901-universalk9-mz) from the flash by using the following commands: **delete flash:<>** and **squeeze flash:**. This ensures that the router has only one image (satellite software) in the flash.

After reloading the router, it should be detected as a satellite by the host. You can use the **show nv satellite status** command to check if the satellite image needs to be upgraded. If upgrade is required, see “[Upgrading the Satellite \(nV\) Version](#)” section on page 9.

**Note**

You cannot convert a Cisco ASR 901 router running satellite software to a standalone Cisco ASR 901 router with normal Cisco IOS software. Contact your technical support team at Cisco for additional assistance.

## IC Link Configuration Modes

The IC links support non-redundant IC links mode and redundant IC links mode. In non-redundant IC links mode, there is no link level redundancy between IC links of a satellite. In redundant IC links mode, the link level redundancy is provided using a single link aggregation (LAG) bundle.

The LAG bundle is implemented using the static EtherChannel. Due to this, LACP dependent features such as 1:1 hot standby or min-max links are not supported on the IC link bundle.

The Cisco ASR 901 router supports G0/10 and G0/11 as IC link ports. In case of bundled links, both G0/10 and G0/11 are members of a single bundled link.

For more conceptual and configuration information on IC links, see the [Configuring the Satellite Network Virtualization \(nV\) System on the Cisco ASR 9000 Series Router](#) guide.

## Mapping of Satellite Ports and IC Links

The satellite access ports are mapped to IC links using a single 802.1q VLAN multiplexing tag added by the satellite to every packet going towards the host.

### Non-redundant IC links

The IC links operate as independent links and each satellite access port is mapped (cross connected) to one of the IC links. You can configure any arbitrary mapping of one or more access ports to any of the IC links.

### Redundant IC links

Two IC links form a single logical IC port and there is no explicit configuration between satellite access ports and the IC links. The load balancing of traffic between members of the IC bundle is done by using a simple hashing function based on the satellite access port ID. This ensures that all packets for a given satellite access port use only one IC link when switched between the satellite and the host.

This makes it easier to manage QoS and bandwidth, or SLA for satellite traffic since any policer applied on a satellite access port can be applied to the hardware knowing that all of the traffic uses exactly one IC link at any given time.

For more conceptual and configuration information on IC links, see the [Configuring the Satellite Network Virtualization \(nV\) System on the Cisco ASR 9000 Series Router](#) guide.

## Layer 2 Protocol Transparency on IC Links

Layer 2 protocol transparency is supported on the Cisco ASR 901 router. The IC links are fully transparent to all Ethernet layer 2 control protocol packets received on satellite access ports and switched onto the IC links. These include LACP packets, 802.3ah link OAM packets, Cisco Discovery Protocol, Link Layer Discovery Protocol (LLDP), and multiple spanning-tree protocol (MSTP) bridge protocol data units (BPDUs). The protocol packets are then processed on the host. However, the Ethernet link level PAUSE frames received from the customer edge (CE) devices, attached to the satellite access ports, are not sent to the host.

## Troubleshooting Tips

This section explains the troubleshooting scenarios.

### Loss of an IC Link in Non-Redundant Mode

If an IC link goes *down*, the satellite automatically brings down all access ports mapped to this IC link. This ensures fast layer 2 and 3 network level re-convergence for layer 2 and 3 routing, and resiliency features configured on these ports. In addition to these, the line protocol state of the satellite access interface is also shown as *down* on the host. When the IC link comes up, the satellite automatically brings up the corresponding access ports.

### Loss of all IC Links in Redundant Mode

If all the IC links go *down*, the satellite automatically brings down all access ports mapped to these IC links. When the connectivity is re-established to the host, all the ports are automatically brought up. If one of the member link goes down, then load sharing stops and the active member link carries all the traffic.

## LED Behavior

Table 1 lists the system LED behavior of the Cisco ASR 901 router satellite.

**Table 1** Cisco ASR 901 Router System LED Behavior

System LED	Color/State	Location	Description
System	Blinking Green	Faceplate	Initial state (when the box is booting up and the control channel is down)
	Blinking Green		Control channel is down
	Steady Green		Control channel is up

## Debug Satellite Features

Use the commands available from the host (Cisco ASR 9000 Router) to check the interface status and counters of the satellite interfaces. To see the list of debug commands available from the host, refer the [Configuring the Satellite Network Virtualization \(nV\) System on the Cisco ASR 9000 Series Router](#) guide.

If additional debug is required, set up a Telnet session from the host to the satellite, and access the native console of the satellite switch and look at debug or trace messages logged on the satellite switch. No separate physical network path is required to access the Telnet console of the satellite.

You can use the following **show** commands to debug:

- **show interface** and **show controllers** commands on satellite-ethernet interfaces and sub-interfaces to examine link state and packet or byte statistics.
- **show satellite protocol discovery** and **show satellite protocol control** commands to examine the status of a satellite switch from the host; specifically the status of the machines for the discovery and control protocols.

**Note**

The debug or trace or syslog messages of a satellite are kept in the satellite itself and they are not sent to the host.

## Related Documentation

Documents related to the Cisco ASR 901 Series Aggregation Services Router include the following:

- [Configuring the Satellite Network Virtualization \(nV\) System on the Cisco ASR 9000 Series Router](#)
- [Cisco ASR 901 Series Aggregation Services Router Hardware Installation Guide](#)
- [Cisco ASR 901 Series Aggregation Services Router Software Configuration Guide](#)

To access the related documentation on Cisco.com, go to:

[http://www.cisco.com/en/US/partner/products/ps12077/tsd\\_products\\_support\\_series\\_home.html](http://www.cisco.com/en/US/partner/products/ps12077/tsd_products_support_series_home.html)

## Services and Support

For information on obtaining documentation, obtaining support, providing documentation feedback, security guidelines, and also recommended aliases and general Cisco documents, see the monthly *What's New* in Cisco Product Documentation, which also lists all new and revised Cisco technical documentation, at:

<http://www.cisco.com/en/US/docs/general/whatsnew/whatsnew.html>

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