Cisco SD-AVC User Guide, Release 2.2.1

First Published: 2019-01-30

Last Modified: 2019-04-20

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PART I

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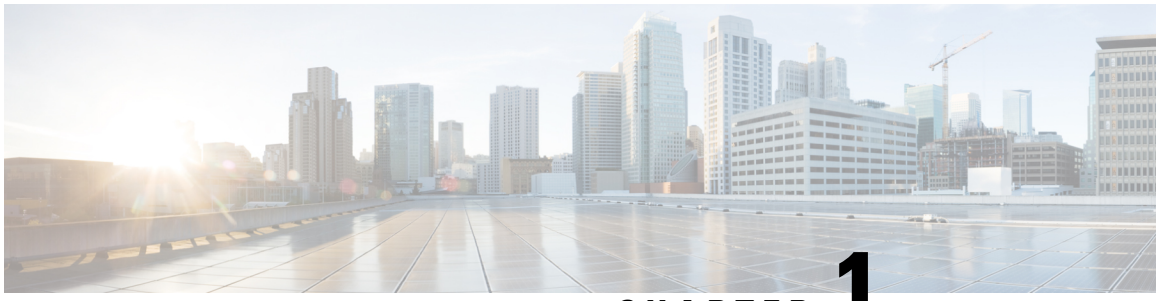

CHAPTER 1

SD-AVC Overview

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- Using SD-AVC in an Asymmetric Routing Scenario, on page 5

SD-AVC Overview

Cisco Software-Defined AVC (SD-AVC) is a component of Cisco Application Visibility and Control (AVC). It functions as a centralized network service, operating with specific participating devices in a network.

As an SDN solution operating network-wide, Cisco SD-AVC complements solutions such as:

- Cisco Intelligent WAN (IWAN)
- Cisco EasyQoS
- Application Assurance

Features and Benefits

Feature/Benefit	Description
Network-level application recognition consistent across the network	The SD-AVC network service aggregates application data from multiple devices and sources, and provides that composite application information in return. Because SD-AVC operates at the network level, any application rule created by SD-AVC based on aggregated application data is shared and applied consistently across all participating network devices.

Feature/Benefit	Description
Improved application recognition in symmetric and asymmetric routing environments	Cisco SD-AVC further refines application recognition accuracy by helping numerous devices in a network SD-AVC aggregates application data shared by participating devices in the network, and analyzes the shared application data. It then provides this composite application information (in the form of an application rules pack) to the participating routers, improving application recognition. Because SD-AVC shares application rules across numerous network devices, devices that see only one direction of a flow can benefit from the information collected on the other direction of the same flow. See SD-AVC and Application Recognition, on page 10.
Improved first packet recognition	SD-AVC application rules are based on flow tuple (address and port) information. After a learning phase and sharing tuples among participating devices, the devices are able to identify new flows on the first packet, based on the tuple information
Protocol Pack update at the network level	SD-AVC can assist in deploying Protocol Packs to numerous routers in the network. Download the Protocol Packs to deploy, store them on the centralized SD-AVC network service, then use the SD-AVC Dashboard to select which devices in the network will receive the Protocol Packs. See Protocol Packs Page, on page 46.
SD-AVC Dashboard	Secure browser-based SD-AVC Dashboard over HTTPS for monitoring SD-AVC functionality and statistics, and for configuring Protocol Pack updates network-wide. See Using SD-AVC, on page 39.
Improved Microsoft Office 365 traffic classification	The MS-Office365 Connector component improves classification for Microsoft Office 365 traffic. The SD-AVC Dashboard displays the status of the component. See MS-Office365 Connector, on page 44.
REST API	REST API for user-defined applications. See SD-AVC REST API, on page 77.
Analysis of unclassified traffic	To improve traffic visibility, SD-AVC analyzes unclassified/unidentified traffic and provides server or socket information about unclassified traffic flows that use significant bandwidth. See Unclassified Traffic Analysis and Discovery, on page 42.

No Change to Topology

Deploying SD-AVC within an existing network does not require any changes to the network topology.

New Features and Changes, by Release

Table 1: New and Changed Features, SD-AVC Release 2.2.1

Feature	Description
REST API improvements	Several improvements to the SD-AVC REST API.
Optimization of device update time	SD-AVC optimizes the time interval for updating devices in the network, according to the number of devices in the network. For networks containing a relatively small number of devices, updates can occur up to 10 times faster. Updates include the latest aggregated application data, custom applications, and Protocol Pack updates.
Changed TCP port range	SD-AVC uses TCP ports for communication between the central SD-AVC network service and the devices in the network running the SD-AVC agent. The range was simplified from 21 and 59900-60000, to 21 and 59990-600000.
Improved handling of proxy servers	When a network includes a proxy server, SD-AVC recognizes the proxy server IP and synchronizes the IP as a proxy, thereby preventing the SD-AVC agent from caching the IP. This prevents errors in flow classification.

Table 2: New and Changed Features, SD-AVC Release 2.2.0

Feature	Description
Improved scale	SD-AVC supports 1 segment with 6000 devices, or up to 12 segments with 1000 devices in each.
MS-Office365 Connector updates	The MS-Office 365 Connector (external source for SD-AVC) has been updated to incorporate the new Microsoft Office 365 web API. Recent changes that Microsoft has made to the Microsoft Office 365 web API have blocked the SD-AVC Microsoft Office 365 Connector, breaking its functionality in previous releases of SD-AVC.

Table 3: New and Changed Features, SD-AVC Release 2.1.1

Feature	Description
Memory and CPU allocation	Smart allocation of memory and CPU resources used for tracking sockets and L3 incoming entries.
Application rules pack distribution by network segment	For improved control, you can assign application rules pack distribution by network segment.
User-defined applications by network segment	For improved control, user-defined applications can be defined by network segment.

Feature	Description
Debugging by device or network segment	SD-AVC **Dashboard** > **Serviceability** page > **Vertical Debug**: Can track traffic for a specific device or network segment.
Unclassified Traffic Visibility	Ability to enable or disable the Unclassified Traffic Visibility feature. See Serviceability Page, on page 47.
User Interface improvements	Numerous improvements to usability.

Table 4: New and Changed Features, SD-AVC Release 2.1.0

Feature	Description
REST API	The REST API enables configuring user-defined applications, providing classification of applications not covered by the standard Protocol Pack. See SD-AVC REST API, on page 77.
Unclassified traffic discovery	To improve traffic visibility, SD-AVC analyzes unclassified/unidentified traffic and provides server or socket information about unclassified traffic flows that use significant bandwidth. See Unclassified Traffic Analysis and Discovery, on page 42.
Source interface configuration	On network devices operating with SD-AVC, you can specify the interface that will appear as the source address for all SD-AVC traffic between the network device and the SD-AVC network service. See Source Interface Configuration Overview, on page 95.
Ability to configure proxy DNS servers for the MS-Office365 Connector	By default, SD-AVC has two Cisco OpenDNS DNS servers configured. Improved ability to add additional DNS servers. See MS-Office365 Connector, on page 44.

Table 5: New and Changed Features, SD-AVC Release 2.0.1

Feature	Description
SD-AVC system time and displayed times	Improved display of times in the SD-AVC Dashboard. Internally, the SD-AVC network service uses standard UTC. The Dashboard displays times according to the internal SD-AVC system time, adjusted by the local time zone offset of the PC that is accessing the Dashboard. See SD-AVC System Time and Displayed Times, on page 45.
Improved ability to configure and view DNS servers for the MS-Office365 Connector	By default, SD-AVC has two Cisco OpenDNS DNS servers configured. Improved ability to add additional DNS servers. See MS-Office365 Connector, on page 44.

Table 6: New and Changed Features, SD-AVC Release 2.0.0

Feature	Description
Updated user interface	• Improved interactive display of traffic data • Improved presentation of warnings and errors affecting devices
Improved control of Protocol Pack deployment	• Can update Protocol Packs for individual devices, for segments, or for all devices in the network • Ability to revert to the Protocol Pack built into the Cisco IOS release See: Protocol Packs Page, on page 46
Improved Microsoft Office 365 traffic classification	MS-Office365 Connector is a component introduced in this release that improves classification for Microsoft Office 365 traffic. The SD-AVC Dashboard displays the status of the component. This feature requires connectivity to a DNS server. By default, SD-AVC uses Cisco OpenDNS servers: 208.67.222.222 and 208.67.220.220 See: MS-Office365 Connector, on page 44
Support for more devices	Support for 4000 network devices operating with SD-AVC

Using SD-AVC in an Asymmetric Routing Scenario

The Challenge of Asymmetric Routing

One of the challenges that SD-AVC addresses well is application recognition in asymmetric routing scenarios. While it is not the only situation in which SD-AVC offers improved results, asymmetric routing demonstrates one of the advantages of aggregating application data from many sources.

Certain network configurations may produce "asymmetric routing" as an unintended effect. In asymmetric routing, the packets of a single two-way connection travel by different paths between network nodes. For example the downstream traffic from a server to a client might be routed through one path, while the upstream traffic from the client to the server might be through a different path. When this occurs, AVC operating on a hub router may see only a single direction of the traffic for that connection, posing a challenge to application recognition.

Deep Packet Inspection and Asymmetry

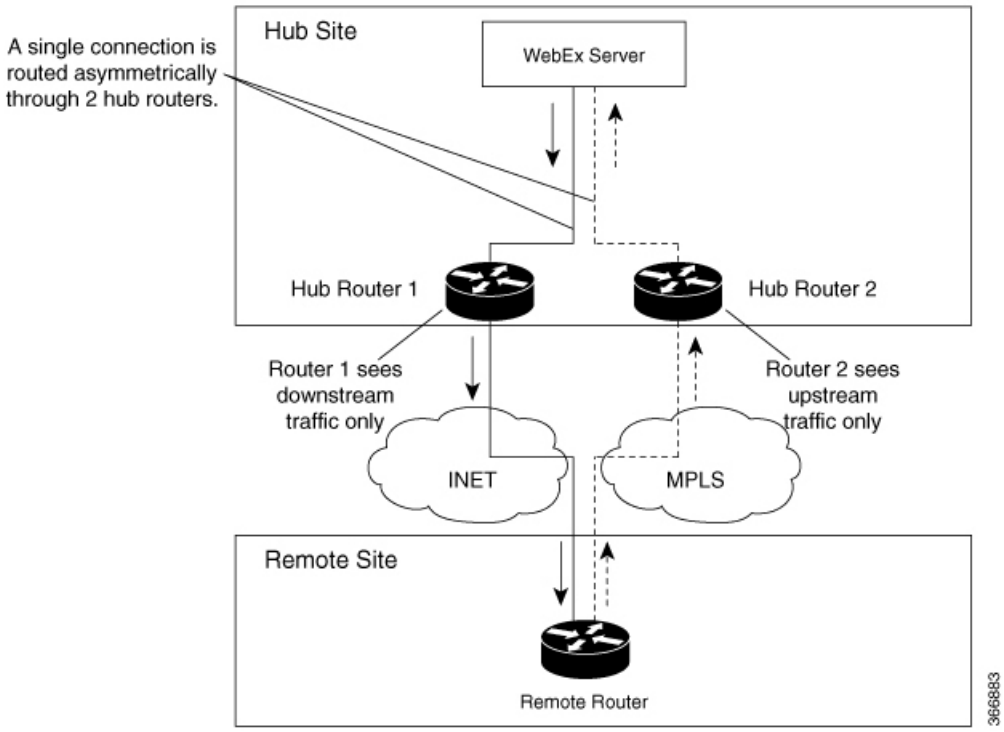
AVC deep packet inspection (DPI) operates best when it sees both directions of traffic. In symmetric routing, AVC operating on a single device that handles both directions of a flow can fully analyze metadata and other traffic attributes to help identify the application creating the flow. By contrast, an asymmetric scenario can limit the ability to recognize some types of traffic. This is especially true when AVC sees only to the downstream traffic for a particular flow.

Asymmetric routing may occur for various reasons, including from intelligent path selection by Cisco IWAN. The issue particularly affects hub routers within an enterprise network with a hub/branch topology.

Effects of Limited Application Recognition

Limiting AVC application recognition can affect classification of traffic for QoS policy, visibility, and other functionality. Consequently, a solution that overcomes the limitations caused by asymmetric routing is especially helpful for maximum network efficiency.

Figure 1: Asymmetric Routing Example

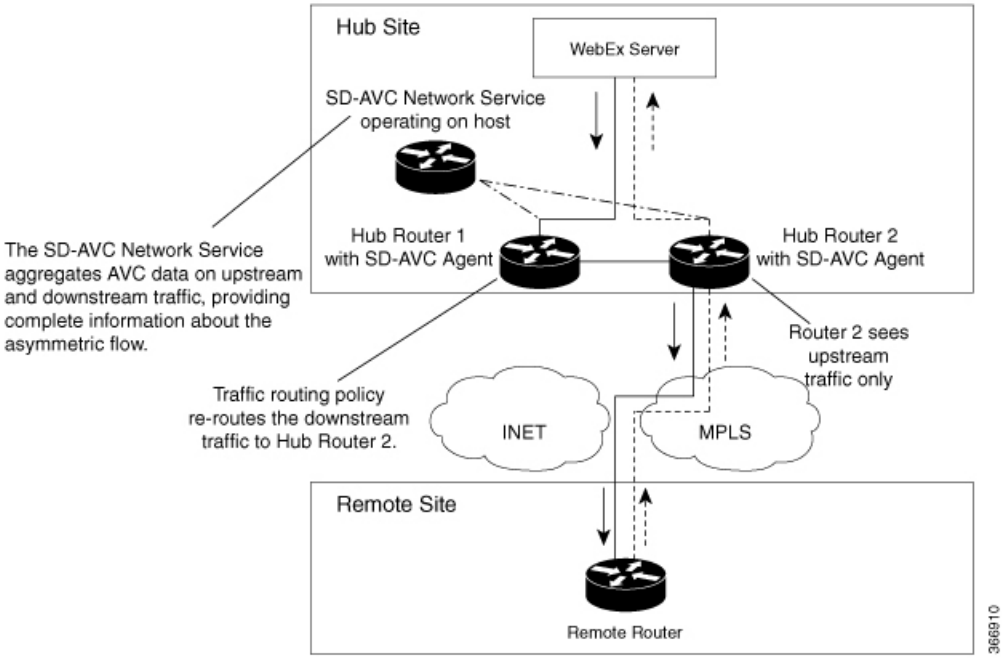


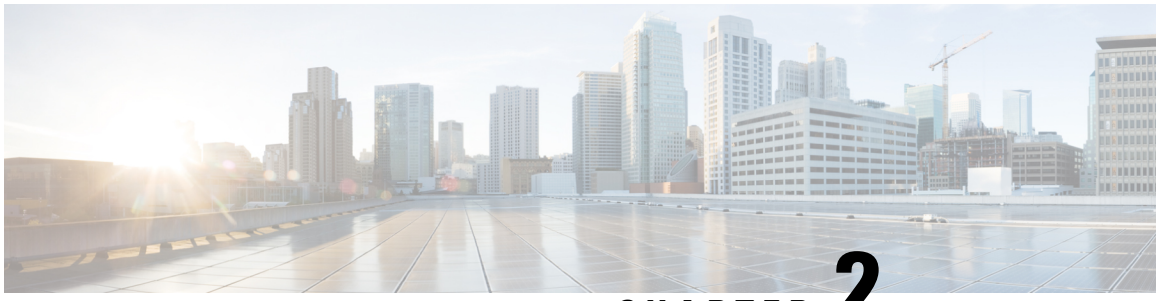
Centralized Server Aggregating Application Data

SD-AVC compiles and analyzes application data from multiple devices within the network, including devices that separately handle the downstream and upstream traffic for a single flow. Using data from multiple sources, SD-AVC synchronizes application information network-wide, overcoming the challenges of asymmetric routing. This strategy provides a major improvement to application recognition within networks, improving the effectiveness of application-based solutions.

With the improved application recognition, AVC can apply application-based policies, such as QoS, path selection, and visibility more accurately. For example, with complete information about both streams of a flow, a path selection policy can direct the downstream path through the same route as the upstream.

Figure 2: Asymmetric Routing and SD-AVC





CHAPTER 2

Operation

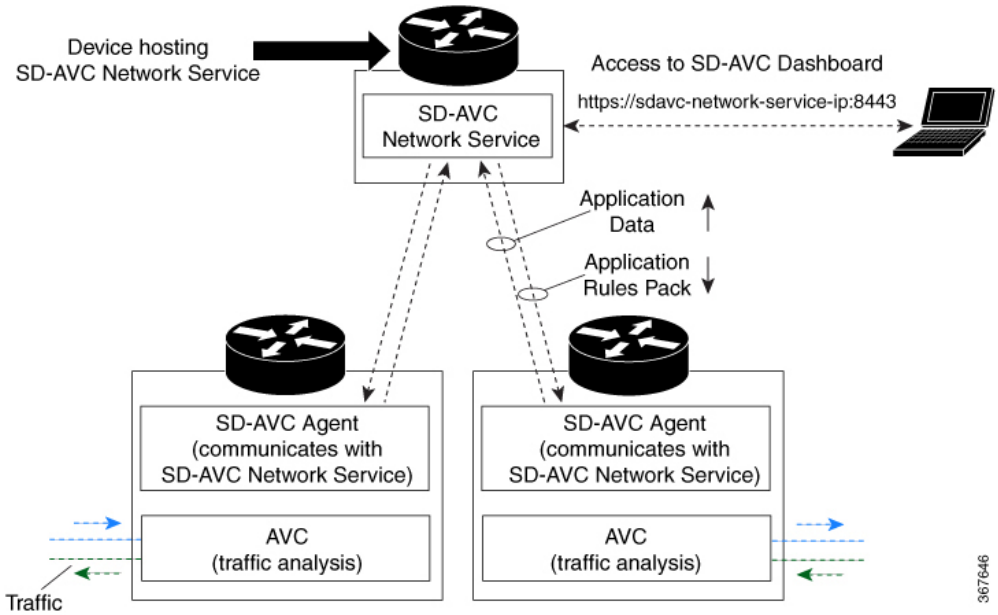
- SD-AVC Architecture, on page 9
- SD-AVC and Application Recognition, on page 10

SD-AVC Architecture

SD-AVC architecture consists of two basic components:

- Centralized SD-AVC network service component operating on a host device
- SD-AVC Agent component running on each SD-AVC-enabled device in the network

Figure 3: SD-AVC Network Service and Agents



SD-AVC and Application Recognition

Cisco AVC can recognize 1400+ network applications, providing recognition of most enterprise network traffic. SD-AVC offers a network-wide approach, aggregating application information collected across the network, and centralized deployment of Protocol Pack updates.

To improve recognition of uncommon or in-house network applications, as well as for other uses, SD-AVC enables creating user-defined applications, expanding on the range of applications included in the Cisco-provided Protocol Packs. The user-defined applications are distributed to all participating devices in the network.

SD-AVC improves application recognition, and offers a solution to challenges posed by complex networks that use a variety of routing devices and routing methods. Such challenges include asymmetric routing, first packet classification, encryption, and so on.

Collecting Application Data

Devices in the network running AVC analyze traffic and generate application data. If a device is connected to SD-AVC, the SD-AVC agent operating on the device receives this application data, and processes and caches the data. Periodically, the SD-AVC agent sends the latest application data to the centralized SD-AVC network service.

As new servers are detected or as server addresses change, the agent continually discovers and validates these servers and updates the SD-AVC network service with the new information. The process of discovery and validation can take several minutes.

Server addresses usually remain constant over time, but when they do change, the SD-AVC agent detects the changes and updates the network service.

Aggregating Application Data

The SD-AVC network service aggregates application data from multiple sources, producing an application rules pack from the composite data. This is made available to network devices using SD-AVC.

Periodically, the network devices using SD-AVC request the application rules pack. Relying on devices to pull (request) the application rules pack on their own schedule improves efficiency and simplifies administration.

The application rules pack contains the following type of information: ID, IP address, port, network protocol, VRF name, application name, and so on.

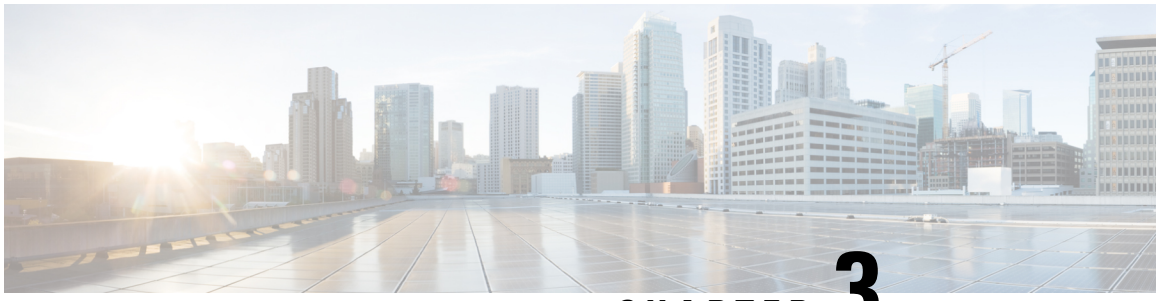
Example:

```
ID   | IP Address | Port | Protocol | VRF-name | App-Name
=================================================================
0    | 192.0.2.1  | 5901 | TCP      | Mgt      | VNC
```

PART II

Part: Deployment

- Installation Overview, on page 13
- Unconfiguring or Uninstalling the SD-AVC Network Service, on page 25
- Configuring Network Devices, on page 27
- SD-AVC High Availability, on page 33



CHAPTER 3

Installation Overview

SD-AVC operates in a service/agent configuration. For details, see SD-AVC Architecture, on page 9.

- **Network Service**: The SD-AVC network service is installed as a virtualized component on a Cisco device service container, and operates on the device as a service. See: System Requirements: SD-AVC Network Service Host, on page 14
- **Agent**: Other devices in the network are enabled as agents, and communicate with the SD-AVC network service. See: Configuring Network Devices to Use SD-AVC, on page 27
- **High Availability**: SD-AVC supports a high availability (HA) configuration, using more than one SD-AVC network service. See: SD-AVC High Availability, on page 33
- **Connectivity**: Operating SD-AVC requires connectivity between the SD-AVC network service and the SD-AVC agents that operate on devices in the network. See: Configuring Connectivity, on page 15

Summary of Setup

The following table briefly describes the steps to set up SD-AVC:

Table 7: Setup

	Setup Task	Section
1	Download the open virtual appliance (OVA) file for the SD-AVC network service and install it on a host device accessible by other devices in the network.	See: Installing the SD-AVC Network Service, on page 16
2	Enable the SD-AVC agent on Cisco devices in the network, pointing them to the SD-AVC network service set up in the previous step. (In a high availability setup, include more than one SD-AVC network service instance.)	See: Configuring Network Devices, on page 27
3	Configure connectivity, or optionally, secure connectivity.	See: Configuring Connectivity, on page 15, Configuring Secure Connectivity, on page 71

- System Requirements: SD-AVC Network Service Host, on page 14
- Configuring Connectivity, on page 15

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• Installing the SD-AVC Network Service, on page 16
• Upgrading the SD-AVC Network Service, on page 21

System Requirements: SD-AVC Network Service Host

The following table describes platform requirements for hosting the SD-AVC network service.

Table 8: SD-AVC Network Service Host Requirements

Host	Memory	Storage	Recommended OS (extended maintenance release trains only)	CPU
Cisco ASR1001-X Aggregation Services Routers	M-ASR1001X-16GB	NIM-SSD and SSD-SATA-400G	Cisco IOS XE Everest 16.6.1 or later	—
Cisco ASR1002-X Aggregation Services Router	M-ASR1002X-16GB	MASR1002X-HD-320G	Cisco IOS XE Everest 16.6.1 or later	—
Cisco ASR1002-HX Aggregation Services Router	M-ASR1002HX-16GB	NIM-SSD and SSD-SATA-400G	Cisco IOS XE Fuji 16.7.1 or later	—
Cisco ISR4431 Integrated Services Router	RAM: MEM-4400-4GU16G Flash: MEM-FLASH-16G	NIM-SSD and SSD-MSATA-400G	Cisco IOS XE Everest 16.6.1 or later	—
Cisco ISR4451 Integrated Services Router	RAM: MEM-4400-4GU16G Flash: MEM-FLASH-16G	NIM-SSD and SSD-MSATA-400G	Cisco IOS XE Everest 16.6.1 or later	—

Host	Memory	Storage	Recommended OS (extended maintenance release trains only)	CPU
Cisco CSR1000V Cloud Services Router	Minimum: 8 GB Recommended: 8 GB	20 GB	Cisco IOS XE Everest 16.6.1 or later	Large-scale scenario (100 or more devices): 4 cores Small-scale scenario (<100 devices): 1 core See: Allocating VM CPUs for Cisco CSR1000V, on page 75

Configuring Connectivity

Operating SD-AVC requires connectivity between various components.

- SD-AVC network service and host
- SD-AVC network service and agents
- Connectivity to the SD-AVC Dashboard

This section describes the connectivity requirements. If secure connectivity is required, see: Configuring Secure Connectivity, on page 71

Connectivity between SD-AVC Network Service and Host

Connectivity is required between the SD-AVC network service, which operates as a virtualized service, and the device hosting it. The host platform requires connectivity with the service through a virtual interface called VirtualPortGroup. The virtual service communicates with the host over this virtual interface, using SSH on TCP port 22.

Connectivity between SD-AVC Network Service and Agents

Network devices operating with SD-AVC use an SD-AVC agent, which operates in the background on the device, to communicate with the central SD-AVC network service. Connectivity is required between each of these network devices and the SD-AVC network service (more than one network service in SD-AVC high availability configurations).

- **Ports**

  Communication between agent and service uses the following protocols and ports:

  - **UDP**: Port 50000
  - **TCP**: Ports 21, 59990-60000

- **Firewalls and Access Lists**

  Ensure that communication is possible from the SD-AVC agent to the SD-AVC network service on these ports for the relevant traffic. For example:

  - Firewall policy must enable communication from the SD-AVC agent to the SD-AVC network service.
  - If a network device has an access control list (ACL) configured, the ACL must permit communication from the SD-AVC agent to the SD-AVC network service.

Connectivity to the SD-AVC Dashboard

Connecting to the SD-AVC Dashboard (see Using SD-AVC, on page 39) requires access to the device hosting the SD-AVC network service, and involves TCP traffic through port 8443. Ensure that network policy (firewall, ACL, and so on) permits this connectivity for devices requiring access to the SD-AVC Dashboard.

Using SD-AVC with Cisco IWAN

When operating SD-AVC in a Cisco IWAN environment, the SD-AVC network service may be hosted on the hub master controller (MC) or on a router dedicated for the purpose of hosting the service.

In either case, verify that the host device meets the system requirements for hosting the SD-AVC network service.

See: System Requirements: SD-AVC Network Service Host, on page 14, Installing the SD-AVC Network Service, on page 16

Installing the SD-AVC Network Service

The SD-AVC network service operates as a virtualized service on a Cisco router. It is installed as an open virtual appliance (OVA) virtual machine container, and requires a few steps of configuration on the host router. After configuration is complete, you can check service status using the browser-based SD-AVC Dashboard.

Table 9: Overview of Installation Steps

Task	Steps
System requirements	Step 1
Installation	Steps 2 to 7
Configuration, Activation	Step 8 to 12
Verification	Steps 13 to 14
Connecting to SD-AVC Dashboard	Step 15

Examples follow the steps below.

Installation Procedure

The following procedure installs the SD-AVC network service as a virtualized service on a Cisco router.

1. Verify that the intended host device meets the system requirements. See: System Requirements: SD-AVC Network Service Host, on page 14
2. Download the OVA container for the SD-AVC network service from Cisco.com, using the Download Software tool. Specify a platform that supports hosting the SD-AVC virtual service, then navigate to software downloads for the platform. Select the "SD AVC Router Virtual Service" option to display available OVA files for SD-AVC.

   Example filename: **`iosxe-sd-avc.2.1.0.ova`**
3. Copy the downloaded OVA file onto the device that will host the SD-AVC network service. Copy to one of the following locations, depending on the platform type:
   - For the CSR1000V router, use: **`bootflash`**
   - For ASR1000 Series or ISR4000 Series devices, use: **`harddisk`**

     `harddisk` refers to the SSD or HD specified in the system requirements for the platform (System Requirements: SD-AVC Network Service Host, on page 14).
4. On the device, verify that the MD5 checksum of the downloaded package matches the checksum value provided.

Note The correct MD5 checksum value apears on the Download Software page when downloading the package.

verify /md5 bootflash:*ova-filename.ova*

Example:

```
Device#verify /md5 bootflash:iosxe-sd-avc.2.1.0.ova
.....................................................................................Done!
verify /md5 (bootflash:iosxe-sd-avc.2.1.0.ova) = d8b7af1b163ccc5ad28582a3fd86c44e
```

5. Ensure that the system time is set correctly on the host device.
   - (If using an NTP server) Verify that the platform is connected to the NTP server and that the system time is correct.
   - (If setting time manually) Set the system time correctly.

Important If you change the system time after the SD-AVC service is already running, uninstall and re-install the SD-AVC service to ensure correct synchronization.

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Installation Overview, on page 13

6. If specific DNS servers are required, configure the server(s) on the host device.

Important Adding DNS servers after SD-AVC is active restarts the SD-AVC network service. During restart, the following are interrupted:

- Protocol Pack deployment to network devices
- Vertical debug

7. On the host device, execute the following command to extract the OVA package and install the SD-AVC network service. By default, it is installed on the same storage device where the OVA package was saved.

   service sd-avc install package *disk-with-OVA*:*OVA-filename* **media** *location-for-OVA-expansion*

   Table 10: Command Details

CLI keyword/argument	Description
disk-with-OVA	Specify one of the following, according to the platform type. The location refers to where the OVA was saved in a previous step. • CSR: **bootflash** • ASR1000 Series or ISR4000 Series: **harddisk**
OVA-filename	Downloaded OVA file.
location-for-OVA-expansion	Specify one of the following, according to the platform type: • For CSR1000V routers, use: **bootflash** • For ASR1000 Series or ISR4000 Series devices, use only: **harddisk** **Important** On ASR1000 and ISR4000 platforms, do not use **bootflash**. The CLI may allow you incorrectly to choose **bootflash**, but but this causes the step to fail. On these platforms, specify **only harddisk**.

   Examples:

   - For CSR1000V router:

     ```
     service sd-avc install package bootflash:iosxe-sd-avc.2.1.0.ova media bootflash
     ```

   - For ASR1000 Series or ISR4000 Series routers:

     ```
     service sd-avc install package harddisk:iosxe-sd-avc.2.1.0.ova media harddisk
     ```

8. Configure the SD-AVC network service.
   - Specify the router gateway interface that the virtualized service uses for external access.
   - Specify a user-selected external-facing service IP address for the SD-AVC network service. This address must be within the same subnet as the gateway interface address.

This step accomplishes the following:

- Enables routers in the network to communicate with the SD-AVC network service.
- Enables access to the browser-based SD-AVC Dashboard.

Note Use this command only in scenarios in which the gateway interface is not attached to a VRF. If the gateway interface is attached to a VRF, use the steps described in Operating the SD-AVC Network Service with Host Interface Attached to a VRF, on page 69.

service sd-avc configure gateway interface *interface* **service-ip** *service-ip-address* [**activate** | **preview**]

Table 11: Command Details

CLI keyword/argument	Description
activate	Activates the service immediately. It is not typically recommended to use this option during this configuration step. Execute the `activate` option in a separate step, as shown below.

preview	Preview the configuration without configuring or activating the service. When using this option, the configuration is not sent to the device.
	Note: If the gateway interface is attached to a VRF, see Operating the SD-AVC Network Service with Host Interface Attached to a VRF, on page 69.
	Example output:
	`! Virtual port configuration`
	`interface VirtualPortGroup31`
	`  description automatically created for sd-avc service by`
	`'service sd-avc configure' exec command`
	`  ip unnumbered gigabitEthernet1`
	`end`
	
	`! Virtual service configuration`
	`virtual-service SDAVC`
	`  description automatically created for sd-avc service by`
	`'service sd-avc configure' exec command`
	`  vnic gateway VirtualPortGroup31`
	`    guest ip address 10.56.196.101`
	`  exit`
	`end`
	
	`! Static route configuration`
	`ip route  10.56.196.101 255.255.255.255 VirtualPortGroup31`

interface	Gateway interface: The device interface that the virtualized service uses for external access. **Note**: If the interface is attached to a VRF, see Operating the SD-AVC Network Service with Host Interface Attached to a VRF, on page 69 for instructions for configuring the gateway.

CLI keyword/argument	Description
service-ip-address	External-facing IP address, must be in the same subnet as the IP of the gateway interface. **Example**: Gateway interface: 10.56.196.100 service-ip-address: 10.56.196.101

Example:

```
service sd-avc configure gateway interface gigabitEthernet1 service-ip 10.56.196.146
```

9. Activate the service.

   service sd-avc activate

   Example:

   ```
   service sd-avc activate
   ```

10. Verify that the status of the SD-AVC network service is activated.

    service sd-avc status

    If installation and activation were successful, the displayed status is:

    ```
    SDAVC service is installed, configured and activated
    ```

11. (ASR1000 Series or ISR4000 Series routers only, not CSR1000 Series) Execute the following:

    ```
    (config)#platform punt-policer service-engine 100000 100000
    ```

12. Save the new configuration.

    copy running-config startup-config

13. Ping the service IP configured in a previous step to verify that it is reachable.

14. Verify that SSH is enabled on the host device. Details vary according to different scenarios, but the following is a helpful reference:
    https://www.cisco.com/c/en/us/support/docs/security-vpn/secure-shell-ssh/4145-ssh.html

    Example (uses SSH local authentication):

    ```
    aaa new-model
    !
    aaa authentication login default local
    username cisco privilege 15 password cisco
    ip domain name cisco.com
    crypto key generate rsa
    ```

15. Wait several minutes for the service to become fully active, then use a Chrome browser to access the browser-based SD-AVC Dashboard, at the following URL, which uses the service-ip configured in an earlier step and port 8443. The SD-AVC Dashboard uses the same authentication as the platform hosting the SD-AVC network service.

    https://<service-ip>:8443

Note Accessing the SD-AVC Dashboard requires connectivity from the PC you are using to access the SD-AVC interface.

Installation Example for CSR1000V Router

The following is an example of the CLI steps used to install the SD-AVC Network Service on a Cisco CSR1000V Cloud Services Router. For this router, the first step includes “bootflash” as the location for extracting the OVA.

```
service sd-avc install package harddisk:iosxe-sd-avc.2.1.0.ova media bootflash
service sd-avc configure gateway interface gigabitEthernet1 service-ip 10.56.196.146
service sd-avc activate
service sd-avc status
copy running-config startup-config
```

Installation Example for ASR1000 Series or ISR4000 Series Routers

The following is an example of the CLI steps used to install the SD-AVC network service on a Cisco ASR1000 Series or ISR4000 Series Router. For these routers, the first step includes “harddisk” as the location for extracting the OVA.

```
service sd-avc install package harddisk:iosxe-sd-avc.2.1.0.ova media harddisk
service sd-avc configure gateway interface gigabitEthernet1 service-ip 10.56.196.146
service sd-avc activate
service sd-avc status
platform punt-policer service-engine 100000 100000
copy running-config startup-config
```

Upgrading the SD-AVC Network Service

Use the following procedure to upgrade the SD-AVC network service on the router hosting the service.

Note Upgrading clears the traffic data stored by the SD-AVC network service.

Table 12: Overview of Upgrade Steps

Task	Steps
Installation	Steps 1 to 7
Activation	Step 8
Verification	Step 9

1. Download the OVA container for the SD-AVC network service from Cisco.com, using the Software Download tool. Specify a platform that supports hosting the SD-AVC virtual service, then navigate to software downloads for the platform. Select the "SD AVC Router Virtual Service" option to display available OVA files for SD-AVC.

Example filename: **iosxe-sd-avc.2.1.0.ova**

2. Copy the downloaded OVA file onto the device hosting the SD-AVC network service to be upgraded. Copy to one of the following locations, depending on the platform type:
   - CSR1000V: **bootflash**
   - ASR1000 Series or ISR4000 Series: **harddisk**

     harddisk refers to the SSD or HD specified in the system requirements for the platform (System Requirements: SD-AVC Network Service Host, on page 14).

3. On the device, verify the MD5 checksum of the downloaded package. The correct MD5 checksum value apears on the Download Software page when downloading the package.

   verify /md5 bootflash:*ova-filename.ova*

   Example:

   ```
   Device#verify /md5 bootflash:iosxe-sd-avc.2.1.0.ova
   ....................................................................................Done!
   verify /md5 (bootflash:iosxe-sd-avc.2.1.0.ova) = d8b7af1b163ccc5ad28582a3fd86c44e
   ```

4. Deactivate the service. This step stops the service but does not erase the database of compiled application data.

   service sd-avc deactivate

5. Verify that the service has been deactivated.

   service sd-avc status

   The following output confirms that the service has been deactivated:

   ```
   Service SDAVC is installed, configured and deactivated
   ```

6. On the host router, execute the following command to extract and install the OVA package. By default, it is installed on the same storage device where the OVA package is stored.

   service sd-avc upgrade package *disk-with-OVA*:*OVA-filename*

   Table 13: Command Details

CLI keyword/argument	Description
disk-with-OVA	Specify one of the following, according to the platform type. The location refers to where the OVA was stored in a previous step. • CSR: **bootflash** • ASR1000 Series or ISR4000 Series: **harddisk**
OVA-filename	Downloaded OVA file.

   Examples:

   - For Cisco CSR1000V router:

     ```
     service sd-avc upgrade package bootflash:iosxe-sd-avc.2.1.0.ova
     ```

- For Cisco ASR1000 Series or ISR4000 Series routers:

```
service sd-avc upgrade package harddisk:iosxe-sd-avc.2.1.0.ova
```

7. (Optional) During the upgrade process, view the service status.

   service sd-avc status

   During the upgrade, the following output indicates that the service is being installed:

   ```
   Service SDAVC is installing..., configured and deactivated
   ```

   The following output indicates that the upgrade is complete:

   ```
   Service SDAVC is installed, configured and deactivated
   ```

8. Activate the service.

   service sd-avc activate

   Example:

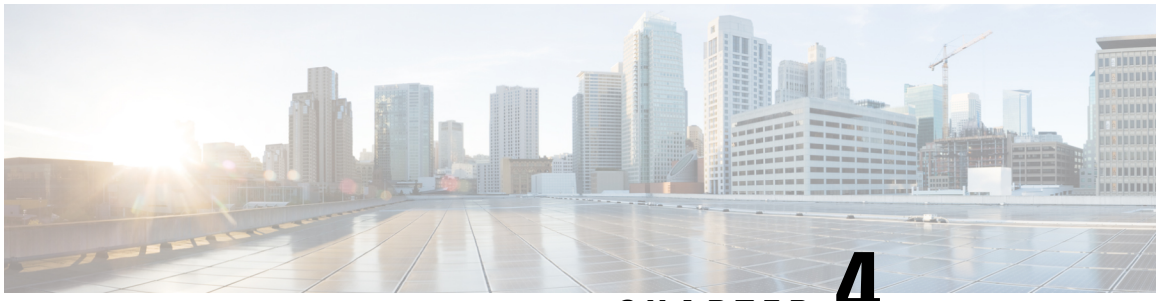
   ```
   service sd-avc activate
   ```

9. Verify that the status of the SD-AVC network service is activated.

   service sd-avc status

   If upgrade and activation were successful, the displayed status is:

   ```
   SDAVC service is installed, configured and activated
   ```



CHAPTER 4

Unconfiguring or Uninstalling the SD-AVC Network Service

- Unconfiguring the SD-AVC Network Service, on page 25
- Uninstalling the SD-AVC Network Service, on page 25

Unconfiguring the SD-AVC Network Service

Use the following procedure to unconfigure the SD-AVC Network Service on the router hosting the service. Unconfiguring the service is necessary before changing the SD-AVC Network Service configuration.

1. Deactivate the service. This step stops the service but does not erase the database of compiled application data.

   service sd-avc deactivate
2. Verify that the service has been deactivated.

   service sd-avc status

   The following output confirms that the service has been deactivated:

   ```
   Service SDAVC is installed, configured and deactivated
   ```
3. Unconfigure the service.

   service sd-avc unconfigure
4. Verify that the service has been unconfigured.

   service sd-avc status

   The following output confirms that the service has been unconfigured:

   ```
   Service SDAVC is installed, not configured and deactivated
   ```

Uninstalling the SD-AVC Network Service

Use the following procedure to uninstall the SD-AVC Network Service on the router hosting the service.

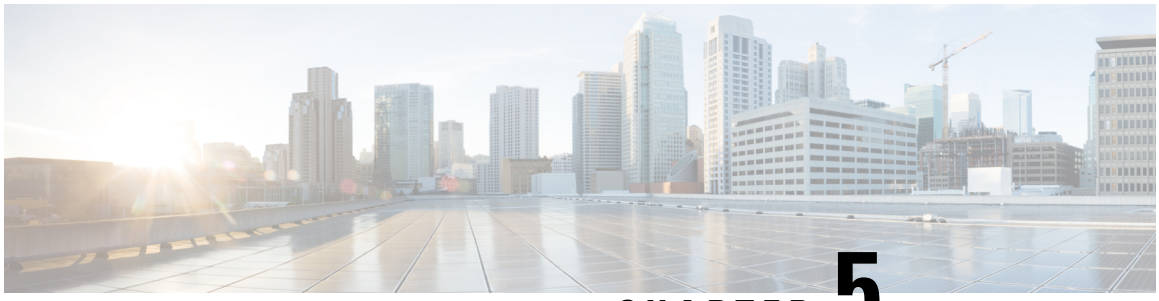
1. Deactivate and unconfigure the SD-AVC Network Service. Follow the full procedure in: Unconfiguring the SD-AVC Network Service, on page 25
2. Uninstall the service. This step deletes all information from the SD-AVC database for this SD-AVC Network Service.

   service sd-avc uninstall
3. Verify that the service has been uninstalled.

   service sd-avc status

   The following output confirms that the service has been uninstalled:

   ```
   Service SDAVC is uninstalled, not configured and deactivated
   ```



CHAPTER 5

Configuring Network Devices

- Configuring Network Devices to Use SD-AVC, on page 27
- System Requirements: Network Devices Using SD-AVC, on page 27
- Configuration Prerequisites: Network Devices Using SD-AVC, on page 29
- Activating the SD-AVC Agent, on page 29
- Deactivating the SD-AVC Agent, on page 30

Configuring Network Devices to Use SD-AVC

After the SD-AVC Network Service has been set up, use the information in this section to check the prerequisites for Cisco devices in the network to operate with the SD-AVC Network Service. Then activate and configure SD-AVC on the devices. This activates an SD-AVC agent that operates on the devices to communicate with the SD-AVC Network Service.

After configuration is complete, verify the status of each device using the SD-AVC Dashboard:

Dashboard > **Application Visibility** page > **SD-AVC Monitoring**

For High Availability SD-AVC, which employs more than one SD-AVC Network Service, see SD-AVC High Availability, on page 33.

System Requirements: Network Devices Using SD-AVC

The following table describes the supported platforms and requirements for network devices to operate with SD-AVC. When operating with SD-AVC, network devices run the SD-AVC agent, which manages communication between the devices and the SD-AVC Network Service.

Table 14: Network Device Requirements

Platform	Recommended OS (extended maintenance release trains only)
Cisco ASR1001-X Aggregation Services Router	Cisco IOS XE Fuji 16.9.1 or later Cisco IOS XE Everest 16.6.4 or later (See note 1.)

Platform	Recommended OS (extended maintenance release trains only)
Cisco ASR1002-X Aggregation Services Router	Cisco IOS XE Fuji 16.9.1 or later Cisco IOS XE Everest 16.6.4 or later (See note 1.)
Cisco ASR1001-HX Aggregation Services Router	Cisco IOS XE Fuji 16.9.1 or later Cisco IOS XE Everest 16.6.4 or later (See note 1.)
Cisco ASR1002-HX Aggregation Services Router	Cisco IOS XE Fuji 16.9.1 or later Cisco IOS XE Everest 16.6.4 or later (See note 1.)
Cisco 1100 Series Integrated Services Routers	Cisco IOS XE Fuji 16.9.1 or later
Cisco ISR4000 Series Integrated Services Routers: 4221, 4321, 4331, 4431, 4451	Cisco IOS XE Fuji 16.9.1 or later Cisco IOS XE Everest 16.6.4 or later (See note 1.)
Cisco Integrated Services Virtual Router	Cisco IOS XE Fuji 16.9.1 or later
Cisco CSR1000V Cloud Services Router	Cisco IOS XE Fuji 16.9.1 or later Cisco IOS XE Everest 16.6.4 or later (See note 1.)
Cisco Route Processor RP2, operating on Cisco ASR1004, ASR1006, or ASR1013	Cisco IOS XE Fuji 16.9.1 or later Cisco IOS XE Everest 16.6.4 or later (See note 1.)
Cisco Route Processor RP3, operating on Cisco ASR1004, ASR1006, or ASR1013	Cisco IOS XE Fuji 16.9.1 or later Cisco IOS XE Everest 16.6.4 or later (See note 1.)

Note

1. Cisco IOS XE 16.6.3 is supported, but with limited SD-AVC functionality. IOS XE 16.6.4 adds support for: Unclassified Traffic Discovery, source interface configuration, and improved scale. For questions about support for specific OS releases, please contact the SD-AVC team at:

   cs-nbar@cisco.com

Connectivity

For connectivity requirements and procedures, see Configuring Connectivity, on page 15.

Configuration Prerequisites: Network Devices Using SD-AVC

Network devices participating with SD-AVC run an SD-AVC agent (see SD-AVC Architecture, on page 9).

SD-AVC functionality depends on receiving application statistics from each participating network device. Application statistics are collected on each interface (on participating devices) on which one of the following is enabled: Cisco Performance Monitor, Easy Performance Monitor (ezPM), PfR policy, or Protocol Discovery. Each of these activates NBAR2 on the interface.

Depending on the Cisco solution in place, application statistics must be collected as follows:

- **IWAN solution**: (No additional user configuration required) Collection of application statistics is enabled by the use of Easy Performance Monitor (ezPM) and PfR policy.
- **Application Assurance solution**: (No additional user configuration required) Collection of application statistics is enabled by the use of Performance Monitor or Easy Performance Monitor (ezPM), and PfR policy.
- **EasyQoS**: (Requires user configuration) Configure Protocol Discovery on WAN-side interfaces.

Activating the SD-AVC Agent

Use the following procedure on a device in the network to activate the SD-AVC agent, enabling the device to communicate with the SD-AVC Network Service.

Note See system requirements for network devices operating with SD-AVC .

Note The term, SD-AVC Network Service, refers to the virtual service that operates on a host device and performs SD-AVC functions, such as aggregating application data. The **avc sd-service** command used in this procedure does not refer to the SD-AVC Network Service.

1. Activate SD-AVC.

   avc sd-service

   Example:

   ```
   (config)#avc sd-service
   ```

2. Configure the segment (group of devices that share the same purpose, such as routers within the same hub).

   segment cisco

   Example:

   ```
   (config-sd-service)#segment cisco
   ```

3. Enter controller mode to configure the agent to use the SD-AVC Network Service (not related to the **avc sd-service** command used in an earlier step).

   controller

   Example:

   ```
   (config-sd-service)#controller
   ```

4. Enter the service-IP used when the SD-AVC Network Service (running on a host device) was set up.

   address *service-ip*

Note For a high availability (HA) configuration, more than one SD-AVC Network Service is specified in this step. See: SD-AVC High Availability, on page 33

   Example:

   ```
   (config-sd-service-controller)#address 10.56.196.146
   ```

5. Configure VRF.

   vrf vrf_mgmt

   Example:

   ```
   (config-sd-service-controller)#vrf vrf_mgmt
   ```

   The device is now configured to operate with SD-AVC, and begins:

   - Sending collected application data to the SD-AVC Network Service
   - Receiving application rules packs periodically from the SD-AVC Network Service

6. See Scenarios that Benefit from Source Interface Configuration, on page 96 to determine whether to specify a source interface for SD-AVC traffic.
7. Using the SD-AVC Dashboard confirm that the router appears as a device in the network.

Configuration Example

The following is an example of the CLI steps used to configure the SD-AVC agent on a device.

```
(config)#avc sd-service
(config-sd-service)#segment cisco
(config-sd-service)#controller
(config-sd-service-controller)#address 10.56.196.146
(config-sd-service-controller)#vrf vrf_mgmt
```

Deactivating the SD-AVC Agent

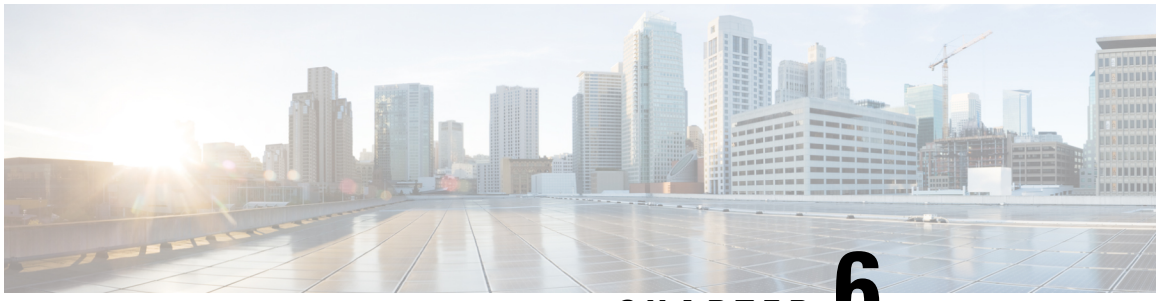
Use the following procedure on a device in the network to deactivate the SD-AVC agent and clear any SD-AVC agent configuration details that have been entered. This stops SD-AVC functionality on the device, and the device stops communicating with the SD-AVC network service.

1. Deactivate SD-AVC and remove SD-AVC agent configuration.

no avc sd-service

Example:

```
(config)#no avc sd-service
```



CHAPTER 6

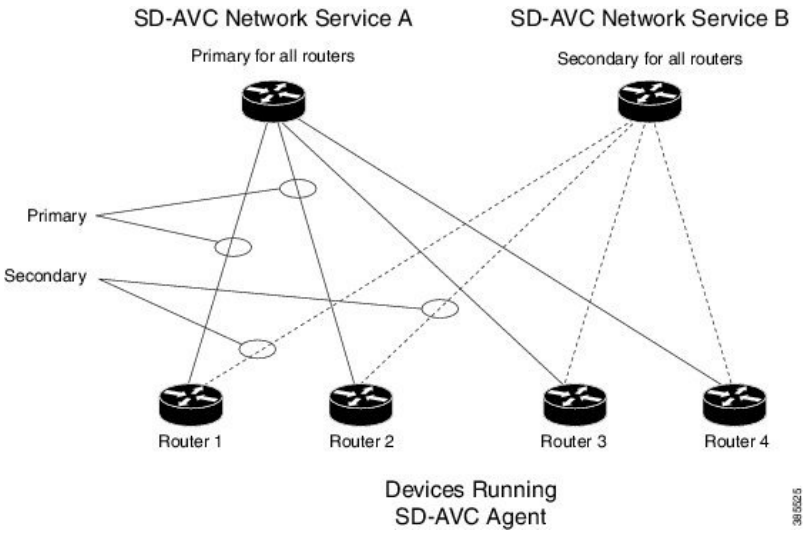
SD-AVC High Availability

SD-AVC supports a high availability (HA) configuration, using more than one SD-AVC network service. Each network device operating with SD-AVC, and consequently running the SD-AVC agent, designates a primary and secondary SD-AVC network service. If the primary SD-AVC network service becomes unavailable, the device fails over to the secondary service.

In the event of failover, the secondary SD-AVC network service receives the application data (state) maintained by the SD-AVC agents on participating network devices. This provides SD-AVC a degree of resilience, enabling the secondary network service to receive previously aggregated data and resume operation where the primary network service left off. In addition, because each SD-AVC agent maintains its state locally, classification of traffic on each device continues seamlessly during the failover from primary to secondary network service.

For all devices in the network that are operating with SD-AVC, it is recommended to use the same primary SD-AVC network service.

Figure 4: Primary and Secondary SD-AVC Network Services in High Availability Configuration



SD-AVC Network Services Collect Application Data Separately

Each SD-AVC network service collects application data from the devices that are using it as their active service. Multiple SD-AVC network services do not share application data with each other directly. So if the

primary service becomes unavailable, the agents that were using it fail over to the secondary service, and that service begins collecting application data from the agents.

- Configuring High Availability SD-AVC, on page 34
- Switchover Between Primary and Secondary SD-AVC Network Services, on page 34

Configuring High Availability SD-AVC

Setting up SD-AVC in a high availability configuration requires two steps that differ from a non-HA configuration.

1. Set up more than one SD-AVC Network Service. For information about setting up an SD-AVC Network Service, see Installation Overview, on page 13.
2. When configuring a device to use SD-AVC, specify primary and secondary SD-AVC Network Services with the **address** command. In other respects, configuring the device is identical to a non-HA configuration. For information about setting up a device, see Configuring Network Devices to Use SD-AVC, on page 27. The configuration commands are shown below.

```
avc sd-service
segment cisco
controller
address primary-network-service-ip secondary-network-service-ip
vrf vrf_mgmt
```

Example:

```
(config)#avc sd-service
(config-sd-service)#segment cisco
(config-sd-service)#controller
(config-sd-service-controller)#address 10.56.196.146 10.56.196.150
(config-sd-service-controller)#vrf vrf_mgmt
```

Switchover Between Primary and Secondary SD-AVC Network Services

If the primary SD-AVC network service for a device becomes unavailable, the device switches over to its secondary network service.

Note The primary SD-AVC network service may become unavailable either by unexpected failure, or for a planned outage, such as for an upgrade.

Appearance in Dashboard

After the switchover, the SD-AVC Dashboard for the secondary network service displays the device. To indicate that the device is in a switchover state, the **Application Visibility** page > **SD-AVC Monitoring** pane shows a yellow warning indicator. Clicking the warning indicator shows device warnings.

Functionality

After switchover, the secondary SD-AVC network service handles all operations for the device, including:

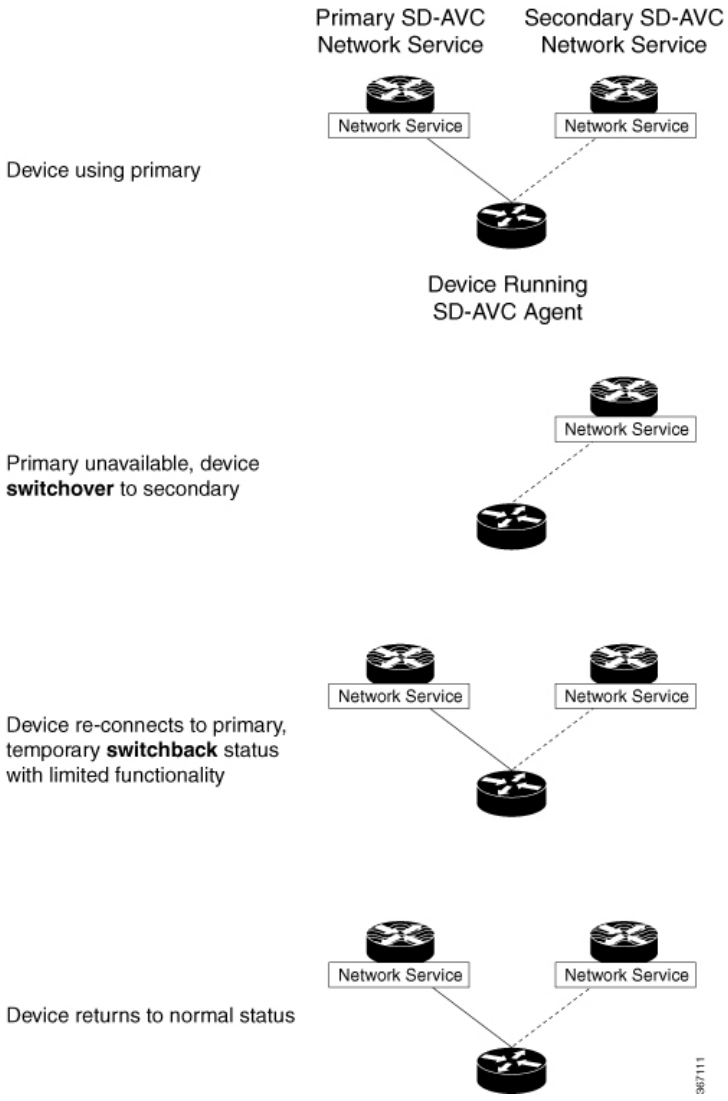
- Collecting traffic data from the device
- Displaying the traffic data
- Deploying Protocol Packs to the device if necessary

Returning to the Primary

When the primary SD-AVC network service becomes available again, the device returns to the primary network service.

For a temporary period after re-connecting, the device status is **switchback**.

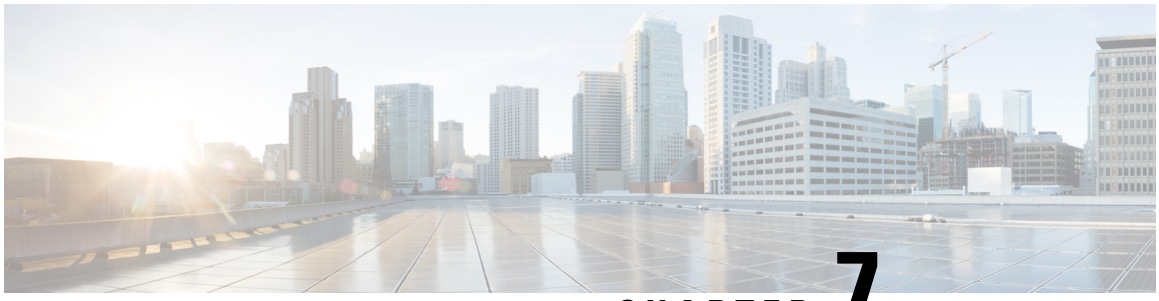
During the temporary **switchback** period, no Protocol Packs can be deployed to the device.



PART III

Part: Use

- Using SD-AVC, on page 39
- SD-AVC Notes and Limitations, on page 51



CHAPTER 7

Using SD-AVC

- Using SD-AVC, on page 39
- Connecting to the Dashboard, on page 39
- Application Visibility Page, on page 40
- Protocol Packs Page, on page 46
- External Sources Page, on page 47
- Serviceability Page, on page 47

Using SD-AVC

Functionality	See...
Connect to the SD-AVC Dashboard	Connecting to the Dashboard, on page 39
View traffic analytics interactively, monitor devices operating with SD-AVC	Application Visibility Page, on page 40
Upload and deploy Protocol Packs	Protocol Packs Page, on page 46
View details of external sources of application classification	External Sources Page, on page 47
View system information, application rules, and debugging tools	Serviceability Page, on page 47 Application Rules Page, on page 48

Connecting to the Dashboard

Using a browser (Chrome recommended) with access to the device hosting the SD-AVC Network Service, open the SD-AVC Dashboard. The Dashboard is accessible using the service IP configured when setting up the SD-AVC Network Service, and port 8443, in the format:

https://<service-ip>:8443

Example:

```
https://10.56.196.153:8443
```

Note The SD-AVC Dashboard uses the same authentication as the platform hosting the SD-AVC Network Service. The host platform may use locally configured usernames and passwords, or it may use other methods, such as an Authentication, Authorization, and Accounting (AAA) server.

If prompted, enter the username and password used on the host platform.

Application Visibility Page

The **Application Visibility** page shows network activity handled by the devices in the network operating with SD-AVC, as well as displaying any warnings or errors for each device.

Table 15: Top of Window

Information/Control	Description
All Devices	Indicates that the application data displayed in this window includes traffic handled by all devices in the network that are operating with SD-AVC.
Filter	Filters the displayed application data to include only a single segment or a single device. (A network segment is a group of devices that share the same purpose, such as routers within the same hub.)
Time Range	Time range for application data displayed on this page.

Table 16: Summary Pane

Information/Control	Description
Classification Score	Last measured classification quality score for the device. This indicates the degree of classification quality (specificity), calculated according to traffic volume. Higher score indicates better quality.
Unclassified Traffic Discovery button ()	Displays details of unclassified traffic. See Viewing Unclassified Traffic Details, on page 43. To return, use the menu in the **Timeline** pane.
First Packet Classification	Ratio of flows classified on the first packet, to total TCP/UDP flows.
Total Usage	Total traffic volume handled in the selected time range.
SD-AVC Coverage Ratio	Ratio of flows covered by the SD-AVC application rules pack, to the total number of TCP/UDP flows.
Asymmetric Index	Last measured degree of asymmetry seen by device. This is the ratio of asymmetric flows to total flows for TCP and DNS traffic. 0 is least asymmetry, and 10 is highest asymmetry.

Information/Control	Description
Timeline	Graph of one of the following (select in dropdown menu): • Bandwidth • Classification score • First packet classification score • SD-AVC coverage ratio • Unclassified Traffic

Table 17: Applications by Usage Pane

Information/Control	Description
Table of applications	Usage and business relevance for each network application. Select one or more applications to display data for the applications in the **Timeline** pane. Use the Search field to filter the display of traffic.

Table 18: SD-AVC Monitoring Pane

Information/Control	Description
Note: When filtering to display data for a single segment or device, this pane displays information for that segment or device.	
Segment	Network segments. Click to filter display by a network segment.
Devices	Number of devices in the network. Click the magnifying glass to list devices, and for filtering options. Device warnings and alerts. Click the warning/alert for details
External Sources	Status of external sources, such as MS-Office365. Click MS-Office365 to display its configured DNS servers. See MS-Office365 Connector, on page 44.
Installed Protocol Packs	Protocol Packs installed on devices in the network.

Table 19: Business Relevance Pane

Information/Control	Description
Business Relevance Graph	Indicates portions of traffic classified as: • Business-relevant • Business-irrelevant • Default

Unclassified Traffic Analysis and Discovery

Background

The **SD-AVC Dashboard** > **Application Visibility** page shows a summary of network traffic, including a table of network applications, organized by network usage.

Traffic that has been identified and classified as belonging to a specific network application appears in the table by name.

Traffic that is not classified by Protocol Pack or external sources (example: MS-Office365) is called unclassified traffic. Unclassified traffic reduces the traffic classification score. Unclassified traffic appears as:

Label	Description
HTTP	Generic host, HTTP traffic
SSL	Generic host, SSL/HTTPS traffic
Unknown	Unknown socket

In the following example, WebEx Meeting traffic has been identified. Unclassified traffic is listed as **HTTP** and **Unknown**.

Application	Usage	Business Relevance
HTTP	0.00% (3.96 MB)	default
WebEx Meeting	6.84% (91.58 GB)	relevant
Unknown	6.35% (84.98 GB)	default

Partial Classification of Traffic

To improve traffic visibility and the classification score, SD-AVC analyzes top hosts and sockets that appear in unclassified traffic. For those using significant bandwidth, it provides a best-effort partial classification of the otherwise unclassified traffic. The process is dynamic, adapting to the network traffic of a given period.

Unclassified traffic that impacts the classification score by 1% or more meets the threshold for partial classification.

On the **SD-AVC Dashboard** > **Application Visibility** page, the partial classification appears as host or socket information in the traffic table.

Example:

- Unclassified HTTP traffic from the **am.cisco.com** domain
- Traffic on an unknown socket, with **source 128.107.107.107**, **port 50000**, using the **UDP** transport protocol

Application	Usage	Business Relevance
HTTP > am.cisco.com	7.44% (99.60 GB)	default
WebEx Meeting	6.84% (91.58 GB)	relevant
Unknown	6.35% (84.98 GB)	default
Unknown > 128.107.107.107:50000_UDP	1.94% (25.97 GB)	default

In the table, **HTTP**, **SSL**, or **Unknown** can refer to a single unclassified flow or an aggregate of numerous unclassified flows. In the example, numerous unclassified flows are represented by a single line: **Unknown**. The unclassified flows included in that line are each below the threshold for automatic partial classification, but together they total 6.35% of bandwidth.

Viewing Unclassified Traffic Details

On the **SD-AVC Dashboard** > **Application Visibility** page, in the **Summary** pane, click the **Unclassified traffic discovery** button () to display detailed information for unclassified and partially classified traffic.

- The timeline changes mode to show unclassified traffic.
- The traffic table shows all unclassified and partially classified traffic.

As with the default view, you can select items in the traffic table to display their contribution to total traffic bandwidth in the timeline.

To return to the default view, select **Bandwidth** from the dropdown menu in the **Timeline** pane.

Improves Visibility, Does Not Affect Policy

Partial classification of traffic, as described here, improves application visibility, and improves the overall classification score.

Partial classification is dynamic, adapting to current traffic, so it not applied to security (firewall) or QoS policies.

Features affected by partial classification:

- Application visibility (FNF, performance-monitor, ezPM, MACE, ...)

Features not affected by partial classification:

- MQC/QoS
- WAAS
- Performance Routing (PfR)
- NAT

Enabling and Disabling

To enable or disable the feature, use the control in:

SD-AVC Dashboard > **Serviceability** > **System**

See Serviceability Page, on page 47.

Notes and Limitations

See SD-AVC Notes and Limitations, on page 51.

MS-Office365 Connector

MS-Office365 Connector improves classification of Microsoft Office 365 traffic. It requires connectivity between the device hosting the SD-AVC network service, and one or more DNS servers. By default, SD-AVC has two Cisco OpenDNS DNS servers configured (208.67.222.222 and 208.67.220.220).

Optionally, you can add addition DNS servers or proxy DNS servers, as described below.

Adding DNS Servers

If you need to add additional DNS servers, configure them on the platform hosting the SD-AVC network service, using the **ip name-server** command, before installing the network service.

Example (adds two DNS servers):

```
(config)#ip name-server 198.51.100.1 198.51.100.2
```

Adding a Proxy DNS Server

If you need to configure a proxy DNS server, configure it on the platform hosting the SD-AVC network service before installing the network service, as follows:

1. Before configuring a proxy DNS server, remove any standard name servers.

   no ip name-server

2. Configure the host to act as a DNS server.

   ip dns server

3. Configure the external DNS server address.

   ip dns spoofing *address*

In the following example, 198.51.100.3 is the external DNS server.

```
(config)#no ip name-server
(config)#ip dns server
(config)#ip dns spoofing 198.51.100.3
```

Viewing DNS or Proxy Servers

To view the configured DNS or proxy servers:

In the **SD-AVC Dashboard** > **Application Visibility** page > **SD-AVC Monitoring** pane, click **MS-Office365 Connector**.

A window opens, displaying a list of the default DNS servers, and any manually configured DNS and proxy servers.

Manually configured DNS servers have higher priority than the default servers. The priority of manually configured DNS servers is the order in which they were added—the first server added has the highest priority. If the highest-priority DNS server on the list is not available, SD-AVC uses the next in the list.

SD-AVC System Time and Displayed Times

SD-AVC receives the UTC time from the host platform. UTC times appear in activity logs.

The SD-AVC Dashboard displays times according to the local time zone of the PC that is accessing the Dashboard. Times appear at the bottom left of the Dashboard, in timelines of network activity, and so on.

Note If the host platform clock is set incorrectly, the times shown in logs and in the Dashboard will be incorrect.

Setting the System Time on the Host Platform

To set the system time, use:

clock set *hh*:*mm*:*ss day month year*

Example:

```
#clock set 12:13:00 27 Mar 2018
```

Setting the Time Zone on the Host Platform

Note SD-AVC receives the time from the host platform as UTC.

To set the time zone (hour offset from UTC), use the following in config mode. The timezone-name is arbitrary.

clock timezone *timezone-name offset-from-UTC*

Example:

```
(config)#clock timezone NYC -5
```

Showing the time includes the configured offset (-5 hours for New York (NYC) in the example).

Example:

```
#show clock
15:47:59.481 NYC Thu Mar 22 2018
```

To remove the time zone setting and use UTC time:

```
(config)#no clock timezone
```

Protocol Packs Page

The **SD-AVC Dashboard** > **Protocol Pack Update** page lists devices in the network, with Protocol Pack information for each.

Click **Manage & Deploy** to:

- Upload Protocol Pack files to the repository (for deploying to devices).
- Deploy Protocol Packs to devices in the network.

Understanding Protocol Pack Files

Cisco releases Protocol Packs on an ongoing basis. Each Protocol Pack release provides updates that expand and improve AVC application recognition. Typically, it is recommended to use the latest Protocol Pack compatible with the OS running on a device. The Protocol Library page indicates the latest Protocol Pack and provides compatibility information.

Protocol Packs are available using the Cisco Software Download tool. When using the tool, specify a platform and then navigate to software downloads for the platform.

Protocol Pack filename format:

pp-adv-<platform-type>-<OS>-<engine-id>-<protocol-pack-version>.pack

Platform type may be, for example, asr1k, csr1000v, or isr4000. However, a Protocol Pack may be installed on any compatible device, even if that device is not indicated by the filename.

Uploading Protocol Packs to the SD-AVC Repository

Use the SD-AVC network service to deploy Protocol Packs to participating devices in the network.

Step 1 Select a Protocol Pack to deploy (typically the latest Protocol Pack compatible with the OS running on a device). See the Protocol Library page for compatibility information.

Step 2 Download the Protocol Pack using the Cisco Software Download tool. In the filename of the downloaded Protocol Pack, note the engine ID.

Step 3 In the SD-AVC Dashboard, upload the Protocol Pack file into the Protocol Pack repository. The repository is stored on the device hosting the SD-AVC network service.

Protocol Packs page > **Manage & Deploy** button > **Protocol Pack Repository** > **Upload**

Deploying Protocol Packs to Devices

Note In SD-AVC high availability configurations, if a device switches over to its secondary SD-AVC network service, then switches back to its primary, the device has a temporary "switchback" status. During this brief period, you cannot deploy Protocol Packs to the device. See SD-AVC High Availability, on page 33.

Step 1 Open the SD-AVC Dashboard Protocol Packs page.

Protocol Packs page > **Manage & Deploy** button > **Deploy to...**

Step 2 In the **Protocol Pack Repository** pane, select a Protocol Pack or the **Builtin** option.

The **Builtin** option re-installs the original built-in Protocol Pack that was included with the OS (for example, Protocol Pack 33.0.0 for Cisco IOS-XE Fuji 16.7.1).

Step 3 In the **Deploy to...** pane, select a segment and one or more devices, then click **Continue**.

Note After selecting a Protocol Pack, only devices running an IOS version compatible with the Protocol Pack can be selected.

Step 4 Select the time to deploy the Protocol Pack(s), then click **Continue**.

Step 5 Review the deployment plan and click the **Deploy** button.

Note To return to an earlier step, click the step number.

External Sources Page

The External Sources page displays additional sources of application information used for classifying network traffic.

Source	Description
MS Office 365 Cloud	Provides domain names used by Microsoft Office 365. Click the **View Details** button for details about each domain. See MS-Office365 Connector, on page 44. **Note** Must be enabled to view details.

Serviceability Page

The Serviceability page provides system information, debugging tools, and detailed information about the application rules used to classify network traffic.

Tool	Description
System	System information, such as disk, memory, and CPU status, and system logs.
	An **Unclassified Traffic Visibility** control enables/disables the feature (see Unclassified Traffic Analysis and Discovery, on page 42). When enabled, top hosts and sockets will be identified on the Application Visibility page, in the table and in the graph of traffic bandwidth. By default, the feature is enabled. After enabling Unclassified Traffic Visibility, the effect is not immediate. SD-AVC gathers information about top hosts and sockets in network traffic (communicated from network devices to the SD-AVC network service by Netflow) and identifies them gradually. Similarly, after disabling the feature, the top hosts and sockets that have been identified may remain in the table and graph for a period of time (dependent on the time range displayed) while SD-AVC continues to analyze traffic and update the Application Visibility page.
Vertical Debug	Create rules to track specific traffic criteria, for debugging.
SD-AVC Message Capture	Collect and download SD-AVC messages (between the SD-AVC network service and one or more agents).
Application Rules	Detailed information about the application rules used to classify network traffic. Application Rules Page, on page 48

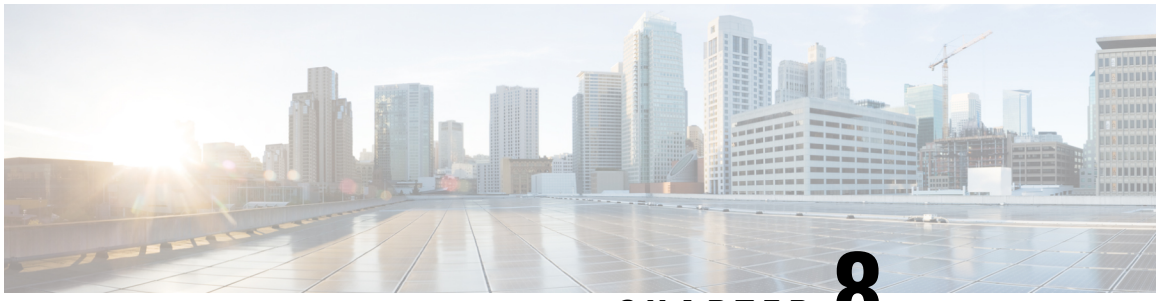
Application Rules Page

The SD-AVC network service collects traffic classification data from network devices. The network service merges the data and sends it to devices as an application rules pack (see Operation, on page 9). This page shows the merged application rules data.

Segment: Select the network segment using the dropdown menu at the top right.

Field	Description
IP	Server IP
Port	Port
VRF	VRF name, if applicable
Application Name	Application name, defined by: • Protocol Pack protocol • User-defined protocols

Field	Description
Entry Type	Network cache type: • **L3** • **socket-cache**
Source	Protocol/application: • **network**: Identification of flow by Protocol Pack • **dynamic**: Identification of flow by user-defined application • **ac_hosts** or **ac_sockets**: Tracking of flow by Unclassified Traffic Discovery feature
Rating	Number of significant flow (session) hits in the network layer
Transport	Transport protocol
TTL	Time to Live: Timespan (in cycles) for tracking the socket • If there is active traffic for the socket, the TTL remains at maximum value of 384. • If there is no active traffic for the socket, the TTL value is decremented over time.



CHAPTER 8

SD-AVC Notes and Limitations

- General, on page 51
- Setup, on page 51
- Classification, on page 52
- High Availability, on page 53
- Protocol Pack, on page 53
- REST API, on page 53

General

Note/Limitation	Description
Maximum number of participating network devices	Maximum number of network devices participating with SD-AVC (running the SD-AVC agent): 6000

Setup

Note/Limitation	Description
MD5 checksum of OVA download	When installing or upgrading the SD-AVC network service, download the OVA package, copy it to the device that will host the network service, then verify the MD5 checksum of the package before installing. The correct MD5 checksum value apears on the Download Software page when downloading the package.
Network Service gateway interface attached to VRF	For the SD-AVC Network Service, running on a host device, if the host interface that is used as a gateway interface is attached to a VRF, see Operating the SD-AVC Network Service with Host Interface Attached to a VRF, on page 69 for configuration details.

Note/Limitation	Description
Running and startup configurations of participating devices	SD-AVC adds two lines to the running and startup configurations of participating devices: • To enable the MS-Office365 Connector feature, which improves classification of Microsoft Office traffic: **`ip nbar protocol-pack bootflash:sdavc/sdavc_ppdk.pack force`** • When SD-AVC deploys Protocol Packs to a device: **`ip nbar protocol-pack harddisk:sdavc/`***`protocol-pack-name`***`.pack`**

Classification

Note/Limitation	Description
Interval before sending application data	SD-AVC requires a few minutes to learn from the network traffic before the application data is sent to the SD-AVC Network Service and compiled at the network level. See SD-AVC and Application Recognition, on page 10.
SD-AVC application rules pack less relevant for client-to-client traffic	SD-AVC provides application classification for server-based applications. The SD-AVC application rules pack is less relevant for client-to-client traffic, which is more granular and dynamic. Client-to-client traffic is classified by NBAR2 running on each network element.
Proxy or CDN	In the case of a proxy or content delivery network (CDN), multiple applications may use the same IP/port combination. The network devices themselves classify such traffic fully. However, for these applications, the SD-AVC agent operating on a device may report application data to the SD-AVC network service with a lesser degree of detail: they may be reported with less detailed classification granularity or not at all.
Reported bandwidth of Unclassified Traffic Discovery	For traffic that appears in the Unclassified Traffic view, the reported bandwidth is based on samples and may not be accurate in some cases. See Unclassified Traffic Analysis and Discovery, on page 42.
High-stress flows may not be discovered by the Unclassified Traffic Discovery feature	High-stress flows that require a large amount of system resources may be excluded from the traffic reported in the **Unclassified Traffic** view. For example, the Timeline may show a high-bandwidth of unknown/generic traffic that is not reported in the table. This is done to minimize the utilization of resources in case of high stress flows and skip the discovery mechanism. See Unclassified Traffic Analysis and Discovery, on page 42.

High Availability

Note/Limitation	Description
Error status and Protocol Pack deployment during high availability switchover and switchback	In SD-AVC high availability configurations, if the primary SD-AVC network service becomes unavailable, network devices switch to the secondary SD-AVC network service. When the primary SD-AVC network service becomes available again, the devices switch back to primary. The **switchover** and **switchback** processes require approximately 30 minutes. During this time: • Service in the network continues normally without interruption. • The **SD-AVC Dashboard** > **Application Visibility** page shows an error status for the devices. • The **SD-AVC Dashboard** > **Protocol Packs** page shows that the devices are not active. During this brief period, SD-AVC does not deploy Protocol Packs to the devices. See SD-AVC High Availability, on page 33.

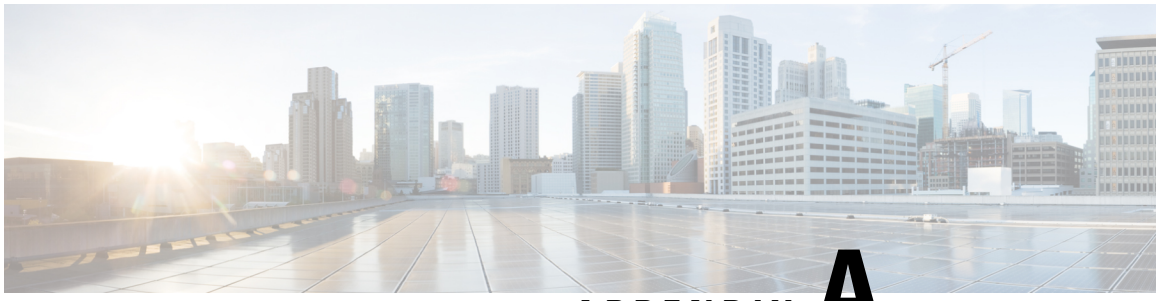
Protocol Pack

Note/Limitation	Description
Cisco ISR4000 Series: hard disk limitation	Protocol Pack files must be loaded on the boot flash. For ISR4000 routers operating with SD-AVC, it is not recommended to install a hard disk. Doing so will cause Protocol Pack deployment by SD-AVC to fail.
Protocol Pack deployment during high availability switchover and switchback	See High Availability, on page 53.

REST API

Note/Limitation	Description
User-defined application source	In the initial release of the REST API, only one source is supported.

Note/Limitation	Description
Total number of user-defined applications available	For each network segment: • Maximum user-defined applications: 1100 • Maximum L3L4 rules: 20000 • Maximum serverNames: 50000
High-availability SD-AVC configurations	High-availability SD-AVC configurations are supported. On the primary and secondary SD-AVC network services, configure the same REST API-based user-defined application configuration.



APPENDIX A

Troubleshooting SD-AVC

This section provides several SD-AVC troubleshooting scenarios. If this information does not provide a solution, contact Cisco TAC for assistance.

- Troubleshooting Overview, on page 55
- Troubleshooting SD-AVC Network Service Issues, on page 58
- Troubleshooting SD-AVC Agent Issues, on page 64
- Troubleshooting SD-AVC Connectivity Issues, on page 65
- Troubleshooting Protocol Pack Issues, on page 68

Troubleshooting Overview

The following tables describe troubleshooting for issues with:

- SD-AVC network service

  (operates on a dedicated host)

- SD-AVC agent

  (operates on each participating device in the network)

- Connectivity

  (between network service and one or more devices in the network)

Table 20: Troubleshooting: SD-AVC Network Service

Problem	How it appears	Troubleshooting
SD-AVC network service: installation failure	SD-AVC not active, **sd-avc status** shows installation failure.	**Summary** Diagnose with **sd-avc status** and then **service sd-avc trace**. Possible issues: • Not enough memory: see system requirements • Not enough disk space: see system requirements **Troubleshooting Details** Troubleshooting Commands for Network Service Issues, on page 58 System Requirements: SD-AVC Network Service Host, on page 14
SD-AVC network service: activation failure	SD-AVC not active, **sd-avc status** shows activation failure.	**Summary** Diagnose with **sd-avc status** and then **service sd-avc trace**. Possible issue: Something may be using CPU resources. Ensure that nothing is using CPU resources. **Troubleshooting Details** Troubleshooting Commands for Network Service Issues, on page 58 Activation Failure Caused by Shared CPU Resources, on page 61
SD-AVC network service: configuration failure	SD-AVC not active, **sd-avc status** shows configuration failure.	**Summary** A VRF is attached to the interface used as the management interface on the device hosting the SD-AVC network service. Remove the VRF assignment from the management interface using: **interface** *interface* **no ip vrf forwarding** **Troubleshooting Details** Configuration Failure Caused by VRF, on page 63

Table 21: Troubleshooting: SD-AVC Agent Operating on Devices in the Network

Problem	How it appears	Troubleshooting
NBAR2 is not activated on the device	On the **Dashboard** > **Application Visibility** page, the **Timeline** graph of bandwidth shows no activity.	**Summary** NBAR2 is not active: Activate NBAR2 on the device. **Troubleshooting Details** NBAR2 Not Activated on Interfaces, on page 64

Error: More than one active session	When attempting to enable the agent, an error message indicates that there is an active session already.
	Example:
	`Device(config-sd-service)# controller`
	`%% NBAR Error: There is an active session already`
	`in sd-service-controller submode`
		Summary
		Close any interfering sessions.
		Troubleshooting Details
		Active Sessions Preventing Agent Configuration, on page 64

Table 22: Troubleshooting: Connectivity between SD-AVC Network Service and Devices in the Network

Problem	How it appears	Troubleshooting
UDP	Warning in: **Dashboard** > **Application Visibility** page > **SD-AVC Monitoring** pane	**Summary** Check UDP connectivity. **Troubleshooting Details** Problem with UDP Communication with Devices, on page 65
TCP	Warning in: **Dashboard** > **Application Visibility** page > **SD-AVC Monitoring** pane	**Summary** Check TCP connectivity. **Troubleshooting Details** Problem with TCP Communication with Devices , on page 66

Problem	How it appears	Troubleshooting
FTP	Warning in: **Dashboard** > **Application Visibility** page > **SD-AVC Monitoring** pane	**Summary** 1. Check FTP connectivity: **show avc sd-service info summary** 2. Verify FTP connectivity between the SD-AVC network service and the network device. This includes checking ACL, firewalls, and so on. 3. On the device, ensure that FTP connectivity is possible from the routable interface to the SD-AVC network service. To enable FTP connections from a specific interface, use: **ip ftp source-interface** *interface-name* **Troubleshooting Details** Problem with FTP Communication with Devices, on page 66

Table 23: Troubleshooting: Protocol Packs

Problem	How it appears	Troubleshooting
Failure to load Protocol Pack on a device	When deploying Protocol Packs to one or more devices, results page shows error, such as "out of sync."	**Summary** Load the Protocol Pack manually on the device to determine whether the Protocol Pack is valid. **Troubleshooting Details** Failure to Deploy Protocol Pack to Device, on page 68

Troubleshooting SD-AVC Network Service Issues

Troubleshooting Commands for Network Service Issues

The following commands are helpful for troubleshooting SD-AVC network service issues. Execute the commands on the network service host device. The output may indicate any installation or configuration problems.

Table 24: Summary

Command	Description
service sd-avc status	Status of SD-AVC network service installation, configuration, and activation
service sd-avc trace	Memory or disk problems
show virtual-service list	Activation errors
show virtual-service global	CPU and memory usage

Command Details: service sd-avc status

Execute the command on the network service host device.

Output indicates status of SD-AVC installation, configuration, and activation.

- Installation error:

```
Service SDAVC is uninstalled, not configured and deactivated
```

- Activation error:

```
Service SDAVC is installed, configured and Activate Failed
```

Command Details: service sd-avc trace

Execute the command on the network service host device.

Output indicates memory or disk problems.

- **Memory** problem (shown in bold below):

```
service sd-avc trace
2017/11/27 02:06:42.384 [errmsg] [3071]: UUID: 0, ra: 0, TID: 0 (noise):(2):
%VMAN-2-MACH_PARSE_FAILURE: Virtual Service[SDAVC]::Parsing::XML parsing failure::Unable
 to parse VM machin
e definition::Requests 3072 MB of memory which exceeds the maximum of
1024
2017/11/27 02:06:42.383 [errmsg] [3071]: UUID: 0, ra: 0, TID: 0 (noise):(2):
%VMAN-2-MEMORY_LIMIT_WARN: Virtual service (SDAVC) defines 3072 MB of Memory
 exceeding the maximum 1024 MB.
...
```

- **Disk** problem (shown in bold below):

```
2017/11/27 03:36:52.500 [vman] [3222]: UUID: 0, ra: 0, TID: 0 (ERR): Failed to get
per-VM mac address binding from FDB
2017/11/27 03:36:52.500 [vman] [3222]: UUID: 0, ra: 0, TID: 0 (ERR): Failed to get mac
 binding from persistent DB file
2017/11/27 03:36:52.500 [vman] [3222]: UUID: 0, ra: 0, TID: 0 (ERR): Could not retrieve
 HA disk info for VM 'SDAVC'
2017/11/27 03:36:52.500 [vman] [3222]: UUID: 0, ra: 0, TID: 0 (ERR): Unable to locate
fdb attributes for vm(SDAVC)
2017/11/27 03:36:52.500 [vman] [3222]: UUID: 0, ra: 0, TID: 0 (ERR): Failed to get
per-VM storage info list from FDB
2017/11/27 03:36:52.500 [vman] [3222]: UUID: 0, ra: 0, TID: 0 (ERR): Failed to get
```

```
storage pool from persistent DB file
2017/11/27 03:36:52.499 [vman] [3222]: UUID: 0, ra: 0, TID: 0 (ERR): Virtual Service
failure log[SDAVC]::Install::The installation of the virtual service failed
```

Command Details: show virtual-service list

Execute the command on the network service host device.

Output indicates activation status (**failed** in this example):

```
Virtual Service List:
Name                   Status             Package Name
------------------------------------------------------------------------------
SDAVC                  Activate Failed    avc_iosxe_221533.ova
```

Command Details: show virtual-service global

Execute the command on the network service host device.

Output indicates virtual service CPU and memory usage:

Example showing a service using 5% of CPU:

```
show virtual-service global
Maximum VCPUs per virtual service : 1
Resource virtualization limits:
Name                              Quota     Committed     Available
------------------------------------------------------------------------
system CPU (%)                      75            5            70
memory (MB)                       3072          800          2272
bootflash (MB)                   20000         6764         10672
```

Installation Failure Caused by Memory or Disk

Component(s)

Device hosting the SD-AVC network service

Background

Memory or disk allocation issues can prevent successful installation of the SD-AVC network service.

Troubleshooting

1. Use **service sd-avc status** on the network service host device to check status of installation. If installation is unsuccessful, the output shows "Service SDAVC is uninstalled."

   ```
   service sd-avc status
   Service SDAVC is uninstalled, not configured and deactivated
   ```

2. Use **service sd-avc trace** on the network service host device to indicate whether the installation problem is due to **memory** or **disk**.

   - **Memory** problem:

```
service sd-avc trace
2017/11/27 02:06:42.384 [errmsg] [3071]: UUID: 0, ra: 0, TID: 0 (noise):(2):
%VMAN-2-MACH_PARSE_FAILURE: Virtual Service[SDAVC]::Parsing::XML parsing
failure::Unable to parse VM machin
e definition::Requests 3072 MB of memory which exceeds the maximum of
 1024
2017/11/27 02:06:42.383 [errmsg] [3071]: UUID: 0, ra: 0, TID: 0 (noise):(2):
%VMAN-2-MEMORY_LIMIT_WARN: Virtual service (SDAVC) defines 3072 MB of
Memory exceeding the maximum 1024 MB.
...
```

- **Disk** problem:

```
2017/11/27 03:36:52.500 [vman] [3222]: UUID: 0, ra: 0, TID: 0 (ERR): Failed to get
per-VM mac address binding from FDB
2017/11/27 03:36:52.500 [vman] [3222]: UUID: 0, ra: 0, TID: 0 (ERR): Failed to get
mac binding from persistent DB file
2017/11/27 03:36:52.500 [vman] [3222]: UUID: 0, ra: 0, TID: 0 (ERR): Could not
retrieve HA disk info for VM 'SDAVC'
2017/11/27 03:36:52.500 [vman] [3222]: UUID: 0, ra: 0, TID: 0 (ERR): Unable to locate
 fdb attributes for vm(SDAVC)
2017/11/27 03:36:52.500 [vman] [3222]: UUID: 0, ra: 0, TID: 0 (ERR): Failed to get
per-VM storage info list from FDB
2017/11/27 03:36:52.500 [vman] [3222]: UUID: 0, ra: 0, TID: 0 (ERR): Failed to get
storage pool from persistent DB file
2017/11/27 03:36:52.499 [vman] [3222]: UUID: 0, ra: 0, TID: 0 (ERR): Virtual Service
 failure log[SDAVC]::Install::The installation of the virtual service
failed
```

Solutions

Table 25: Resolving Memory or Disk Errors

Problem	Solution
Memory error	Increase the device memory to the amount specified in System Requirements: SD-AVC Network Service Host, on page 14.
Disk error	Increase the size of the harddisk or bootflash (for CSR) device according to the requirements specified in System Requirements: SD-AVC Network Service Host, on page 14.

Activation Failure Caused by Shared CPU Resources

Component(s)

Device hosting the SD-AVC network service

Background

The platform hosting the SD-AVC network service should not have other virtual services operating. Sharing CPU resources with other virtual services can prevent successful activation.

Use **service sd-avc status** on the network service host device to check status of installation. If installation has succeeded, but activation is unsuccessful, the output shows "Activate Failed."

```
service sd-avc status
Service SDAVC is installed, configured and Activate Failed
```

Troubleshooting

Use **service sd-avc trace** on the network service host device to troubleshoot. The following output shows a problem (shown in bold) with activation, due to shared CPU.

```
service sd-avc trace
2017/11/26 15:46:49.133 [vman] [2224]: UUID: 0, ra: 0, TID: 0 (ERR): Failed to find domain
 SDAVC - state query
2017/11/26 15:46:49.133 [vman] [2224]: UUID: 0, ra: 0, TID: 0 (ERR): Domain not found: No
domain with matching name 'SDAVC'
2017/11/26 15:46:49.133 [vman] [2224]: UUID: 0, ra: 0, TID: 0 (ERR): Error from libvirt:
code=42
2017/11/26 15:46:48.131 [vman] [2224]: UUID: 0, ra: 0, TID: 0 (note): VM (SDAVC) State
Transition: next_state: LIFECYCLE_ACTIVATE_FAILED
2017/11/26 15:46:48.131 [vman] [2224]: UUID: 0, ra: 0, TID: 0 (ERR): Virtual Service failure
 log[SDAVC]::Activate::Internal error::Machine definition customization failed
2017/11/26 15:46:48.131 [vman] [2224]: UUID: 0, ra: 0, TID: 0 (ERR): Machine definition
customization failed
2017/11/26 15:46:48.131 [vman] [2224]: UUID: 0, ra: 0, TID: 0 (ERR): Customization of common
 XML parameters failed
2017/11/26 15:46:48.131 [vman] [2224]: UUID: 0, ra: 0, TID: 0 (ERR): Customize CPU tunes:
Cannot commit CPU tunes
2017/11/26 15:46:48.131 [errmsg] [2224]: UUID: 0, ra: 0, TID: 0 (noise):(2):
%VMAN-2-CPUSHARES_LIMIT: Virtual Service[SDAVC]::CPU shares limit::The virtual
 service definition exceeds the maximum number of CPU shares::Defined:
75, available: 70
```

Use **show virtual-service global** to provide details. In this example, another process is using 5% of the CPU resources (shown in bold).

```
show virtual-service global
Maximum VCPUs per virtual service : 1
Resource virtualization limits:
Name                                 Quota     Committed     Available
-----------------------------------------------------------------
system CPU (%)                          75             5            70
memory (MB)                           3072           800          2272
bootflash (MB)                       20000          6764         10672
```

Solutions

Deactivate Interface Using CPU Resources

1. Check the running configuration using **show run** on the network service host device. If an active interface is using CPU resources, deactivate the interface.

   Example

   GigabitEthernet1 is using CPU resources.

   ```
   show run | section csr_mgmt
   virtual-service csr_mgmt
   ip shared host-interface GigabitEthernet1
   ```

```
activate
```

2. Deactivate the interface.

   Example

```
conf t
virtual-service csr_mgmt
no activate
no ip shared host-interface GigabitEthernet1
```

3. Repeat the installation of the SD-AVC network service.

Configuration Failure Caused by VRF

Component(s)

Device hosting the SD-AVC network service

Background

If the host interface that is used as a gateway interface for the SD-AVC network service is attached to a VRF, the SD-AVC network service installation may be successful, but a configuration step may fail.

Troubleshooting

1. Check VRF status of the SD-AVC network service gateway interface.

   Example showing a VRF configured on the gateway interface GigabitEthernet1:

```
interface GigabitEthernet1
ip vrf forwarding Mgt
ip address 10.56.196.177 255.255.252.0

service sd-avc configure gateway interface gigabitEthernet 1 service-ip 10.56.196.180
% Error: VRF 'Mgt' is configured on gateway. This type of configuration is not
 supported.
```

Solutions

Remove the VRF assignment from the management interface. Example:

```
interface GigabitEthernet1
no ip vrf forwarding
```

Troubleshooting SD-AVC Agent Issues

NBAR2 Not Activated on Interfaces

Component(s)

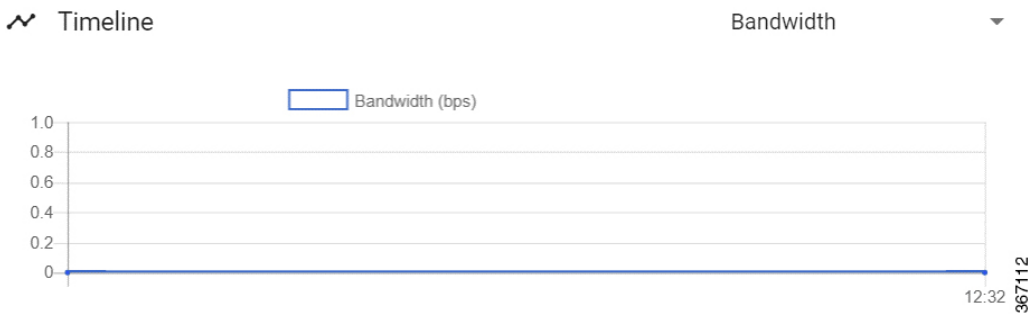
Devices in the network that are using SD-AVC

Background

The NBAR2 component must be active on any interface that processes network traffic, in order to report on traffic handled by the interface. For details, see Configuration Prerequisites: Network Devices Using SD-AVC, on page 29.

If NBAR2 is not active on an interface processing network traffic:

- The device will not report on any traffic on that interface.
- On the **Dashboard** > **Application Visibility** page, the **Timeline** graph of bandwidth will show no activity.



- The device will not receive application rules packs from the SD-AVC network service.

Troubleshooting

Verify that NBAR2 is active on interfaces that process network traffic.

Solutions

If necessary, activate NBAR2 on the interface(s).

Active Sessions Preventing Agent Configuration

Component(s)

Devices in the network that are using SD-AVC

Background

The SD-AVC agent must be enabled on any device participating with SD-AVC. This requires entering sd-service-controller submode on the device.

It is possible to connect to the device through multiple sessions. An error may occur in the following conditions, with an error message indicating the problem:

- One active session is in sd-service-controller submode.
- You attempt to open sd-service-controller submode in a new session.

Example:

```
Device(config)#avc sd-service
Device(config-sd-service)# segment sdavc
Device(config-sd-service)# controller
%% NBAR Error: There is an active session already in sd-service-controller submode
```

Solutions

Close any interfering active sessions.

1. On the device, use **show users** to display active sessions.
2. In the command output, note the line number of a session to close. Use **clear line** *line-number* to close a session.

Example:

```
Device#show users
  Line     User    Host(s)   Idle    Location
*  1       vty 0   prod      idle    00:00:00
                                     dhcp-10-11-12-13-14-15.cisco.com
   3       vty 2   prod      idle    1d04h 198.51.100.10

Device#clear line 3
[confirm]
[OK]

Device#show users
    Line   User    Host(s)   Idle    Location
*  1       vty 0   prod      idle    00:00:00
                                     dhcp-10-11-12-13-14-15.cisco.com
```

Troubleshooting SD-AVC Connectivity Issues

Problem with UDP Communication with Devices

Component(s)

SD-AVC network service

Devices in the network that use SD-AVC

Background

The SD-AVC Network Service uses UDP over port 50000 to communicate with the devices that it manages.

Troubleshooting

1. If a **Connection** warning appears in the SD-AVC Dashboard, for a specific device in the network, check connectivity on UDP port 50000. Warnings appear here:

   SD-AVC Dashboard > **Application Visibility** page > **SD-AVC Monitoring** pane

2. If no problem is found, contact Cisco TAC.

Solutions

Ensure that UDP connectivity is possible on port 50000 between the affected device and the SD-AVC network service.

Problem with TCP Communication with Devices

Component(s)

SD-AVC network service

Devices in the network that use SD-AVC

Background

The SD-AVC network service uses TCP over port 21 (FTP) to communicate with the devices that it manages.

Troubleshooting

1. If an FTP warning appears in the SD-AVC Dashboard, for a specific device in the network, check connectivity on TCP port 21. Warnings appear here:

   SD-AVC Dashboard > **Application Visibility** page > **SD-AVC Monitoring** pane

2. If no problem is found, contact Cisco TAC.

Solutions

Ensure that TCP communication is possible over port 21 (FTP) between the affected device and the SD-AVC network service.

Problem with FTP Communication with Devices

Component(s)

SD-AVC network service

Devices in the network that use SD-AVC

Background

The SD-AVC network service uses FTP to communicate with the devices that it manages.

A device with partial connectivity, but problems specific to FTP may show a warning in the SD-AVC Dashboard.

For FTP issues caused by connecting a device to an internal FTP server for non-SD-AVC FTP traffic, see Scenario: Internal FTP Server, on page 98.

Troubleshooting

1. If an FTP warning appears in the SD-AVC Dashboard while the **Connection** status is green, for a specific device in the network, check the FTP connection status. Warnings appear here:

   SD-AVC Dashboard > **Application Visibility** page > **SD-AVC Monitoring** pane

2. On the device with the connectivity issue, use **show avc sd-service info summary** to check the FTP connection status. "Status: DISCONNECTED" in the output below shows an FTP connectivity problem.

```
show avc sd-service info summary

Status: DISCONNECTED

Device ID: csi-mcp-asr1k-4ru-32
Device segment name: cisco
Device address: 10.56.192.31

Active controller:
   Type  : Primary
   IP    : 64.103.125.30
   Status: Disconnected
   Last connection: Never
```

Solutions

Ensure that FTP communication is possible between the affected device and the SD-AVC network service.

1. Verify that nothing is preventing FTP network connectivity between the SD-AVC network service and the network device. This includes checking ACL, firewalls, and so on.

2. On the device with the FTP warning, ensure that FTP connectivity is possible from the routable interface to the SD-AVC network service. To enable FTP connections from a specific interface, use:

   ip ftp source-interface *interface-name*

   Example:

```
ip ftp source-interface GigabitEthernet1
```

Troubleshooting Protocol Pack Issues

Failure to Deploy Protocol Pack to Device

Component(s)

SD-AVC network service

Cisco NBAR2 Protocol Packs

Background

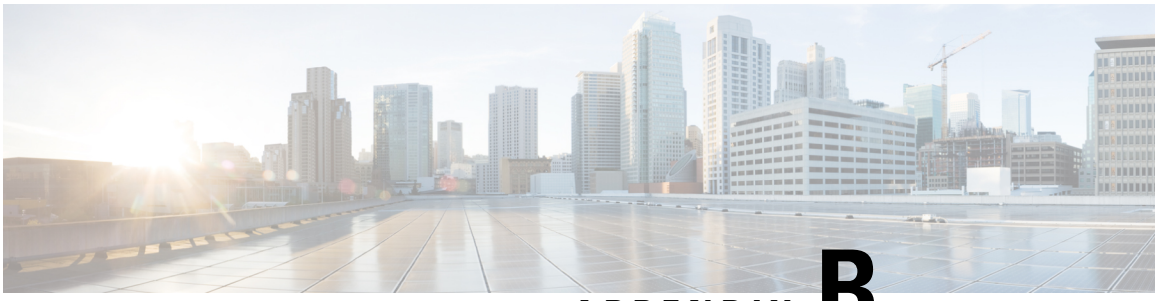
Use the SD-AVC network service to deploy Protocol Packs to one or more devices. See Deploying Protocol Packs to Devices, on page 47. When deploying Protocol Packs to one or more devices, if the deployment fails, the results page may show an error.

Troubleshooting

1. Load the Protocol Pack manually on the device indicated by the error to verfiy that the Protocol Pack is valid and can be loaded onto the device. This rules out any problems with the Protocol Pack file.

   ```
   (config)#ip nbar protocol-pack bootflash:pack_file_name.pack
   ```

2. If no problem is found, contact Cisco TAC.



APPENDIX B

Operating the SD-AVC Network Service with Host Interface Attached to a VRF

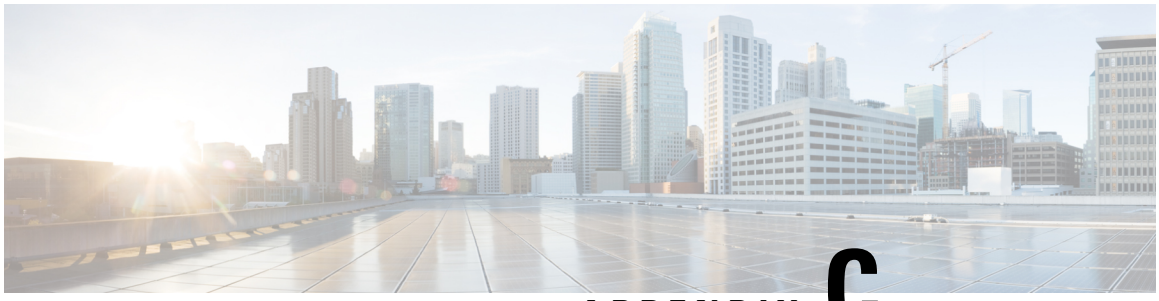
In specific use cases, it may be necessary to operate the SD-AVC Network Service on a host device on which the host interface that is used by SD-AVC as its gateway interface may be attached to a VRF. In this case, the typical installation command described in Installing the SD-AVC Network Service, on page 16 cannot be used, and manual configuration is required, using the following guidelines:

- Ensure that the virtual port group and gateway interface(s) are not on the same subnet.
- Assign the virtual port group and gateway interface(s) to a VRF.
- Ensure that the IP address of the SD-AVC network service (**guest IP** in the configuration steps below) is on the virtual port group subnet.

Example:

```
ip vrf Mgt
!
interface VirtualPortGroup31
ip vrf forwarding Mgt
ip address 10.56.197.221 255.255.255.0
!
interface GigabitEthernet1
ip vrf forwarding Mgt
ip address 10.56.196.169 255.255.255.0
!
virtual-service SDAVC
vnic gateway VirtualPortGroup31
  guest ip address 10.56.197.222
activate
!
```

Operating the SD-AVC Network Service with Host Interface Attached to a VRF



APPENDIX C

Configuring Secure Connectivity

- Securing Connections to the SD-AVC Network Service, on page 71
- Configuring ACL Access, on page 73

Securing Connections to the SD-AVC Network Service

The SD-AVC Network Service, operating on a host device, communicates with:

One or more PC-type devices running the SD-AVC Dashboard
Network devices running the SD-AVC Agent

Enable Connectivity

To enable connectivity, ensure that ports, firewall policy, and so on, are configured to enable communication between the SD-AVC Network Service and the other relevant devices. See Configuring Connectivity, on page 15.

Secure Connectivity

You can optionally use the mechanisms described below to secure the connections between the SD-AVC Network Service and other devices.

Method	Information
Access control list (ACL)	Configure an ACL on the device hosting the SD-AVC Network Service to define a white list of devices authorized to communicate with the SD-AVC Network Service. The ACL may be applied on a physical interface of the host device, or on the virtual interface between the host device and the SD-AVC Network Service. **Note** When using ACLs, only configured addresses will have access to the device hosting the SD-AVC Network Service.

Method	Information
IPsec tunnels	For network scenarios that require a secure connection between the SD-AVC Network Service and network devices running the SD-AVC agent, you can use IPsec tunnels to encrypt the SD-AVC communication. For information about configuring Cisco IOS IPsec VPN connections, see Cisco IOS IPsec.

Figure 5: Apply ACL to Physical Interface or Virtual Interface

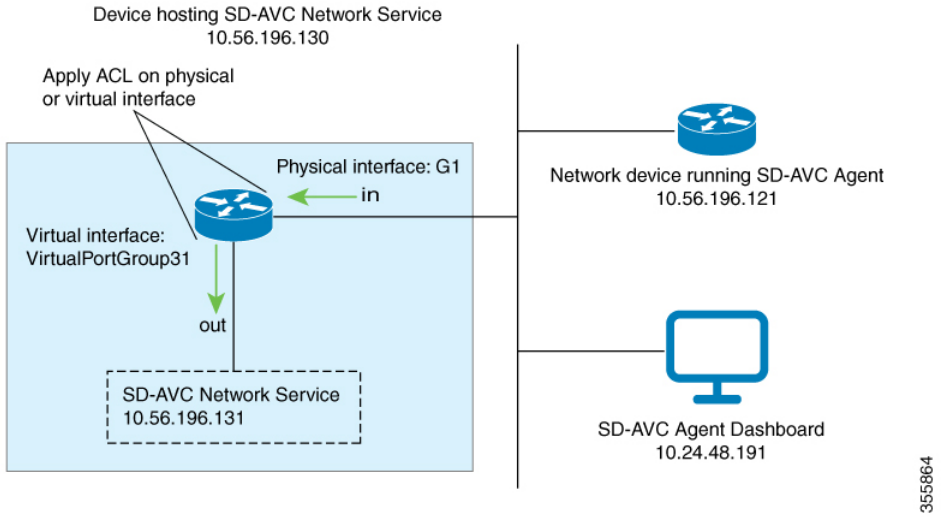
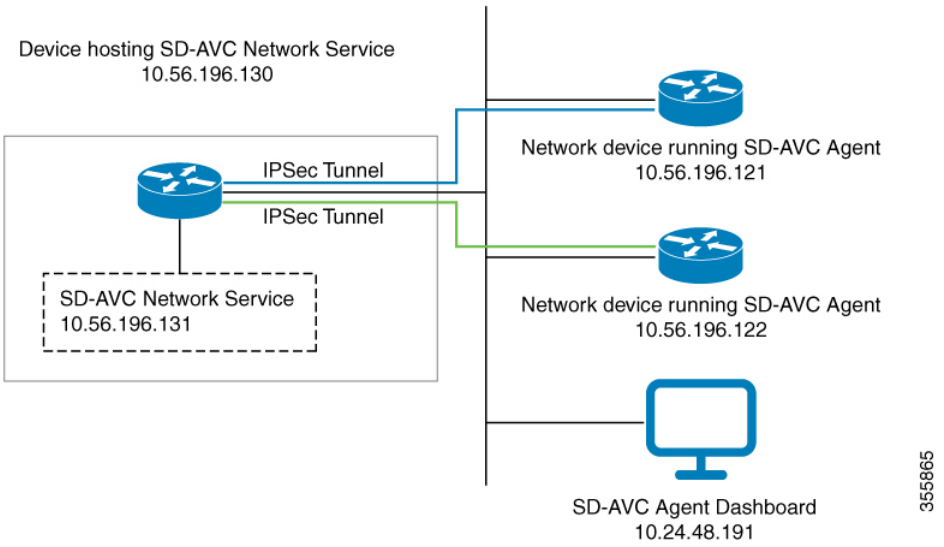


Figure 6: IPsec Tunnels between SD-AVC Network Service and Network Devices



Configuring ACL Access

Prerequisites

Ports, firewall policy, and so on, have been configured to enable communication between the SD-AVC Network Service and:

- Network devices running the SD-AVC Agent
- PC-type devices that connect to the SD-AVC Network Service to display the SD-AVC Dashboard

Configuring ACL

1. Create the ACL.

   ip access-list extended sdavc-acl

2. Configure access for a PC-type device that will connect to run the SD-AVC Dashboard.

   permit tcp host *dashboard-access-device-address* **host** *sdavc-network-service-address* **eq 8443**

   Example:

   ```
   permit tcp host 10.24.48.191 host 10.56.196.131 eq 8443
   ```

3. Configure access for one or more network devices running the SD-AVC Agent. For each network device, permit these ports:

   UDP: 50000
   TCP: 21, 59990-60000

   The complete syntax options for ACL configuration, such as address wildcards, are beyond the scope of this document. For complete information about configuring ACL, see the documentation for your platform.

   permit udp host *sdavc-agent-address* **host** *sdavc-network-service-address* **eq 50000**

   permit tcp host *sdavc-agent-address* **host** *sdavc-network-service-address* **eq 21**

   permit tcp host *sdavc-agent-address* **host** *sdavc-network-service-address* **range 59990 60000**

   Example:

   ```
   permit udp host 10.56.196.121 host 10.56.196.131 eq 50000
   permit tcp  host 10.56.196.121 host 10.56.196.131 eq 21
   permit tcp  host 10.56.196.121 host 10.56.196.131 range 59990 60000
   ```

4. Apply the ACL to a physical interface of the host device or to the virtual interface between the host device and the SD-AVC Network Service. Use one of the following:

   - Physical interface (note the **in** keyword):

     interface *interface*

     ip access-group sdavc-acl in

     Example:

     ```
     interface GigabitEthernet1
       ip access-group sdavc-acl in
     ```

- Virtual interface (note the **out** keyword):

  interface *virtual-interface*

  ip access-group sdavc-acl out

  Example:

```
interface VirtualPortGroup31
   ip access-group sdavc-acl out
```

Examples

Complete example, configuring a single device for Dashboard access and a single network device. This example uses the virtual interface option:

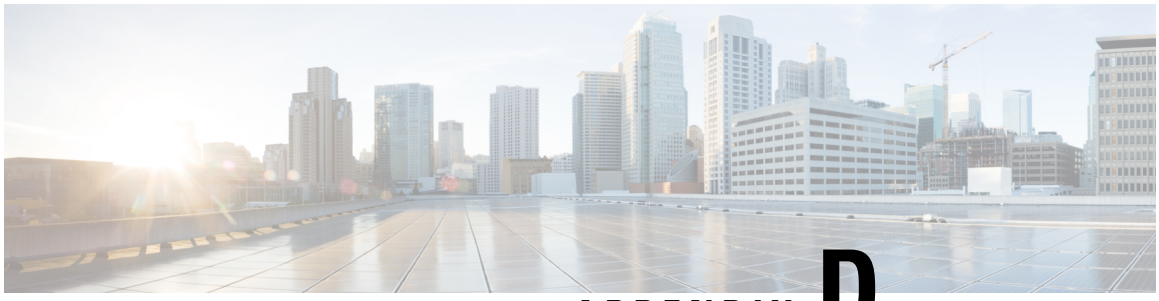
```
ip access-list extended sdavc-acl
     permit tcp host 10.24.48.191 host 10.56.196.131 eq 8443
     permit udp host 10.56.196.121 host 10.56.196.131 eq 50000
     permit tcp  host 10.56.196.121 host 10.56.196.131 eq 21
     permit tcp  host 10.56.196.121 host 10.56.196.131 range 59990 60000

interface VirtualPortGroup31
   ip access-group sdavc-acl out
```

Complete example, configuring a single device for Dashboard access, and a range of devices (10.56.0.0 to 255). This example uses the physical interface option.

```
ip access-list extended sdavc-acl
     permit tcp host 10.24.48.191 host 10.56.196.131 eq 8443
     permit udp 10.56.0.0 0.0.255.255 host 10.56.196.131 eq 50000
     permit tcp 10.56.0.0 0.0.255.255 host 10.56.196.131 eq 21
     permit tcp 10.56.0.0 0.0.255.255 host 10.56.196.131 range 59990 60000

interface GigabitEthernet1
  ip access-group sdavc-acl in
```



APPENDIX D

Configuring CSR1000V for SD-AVC

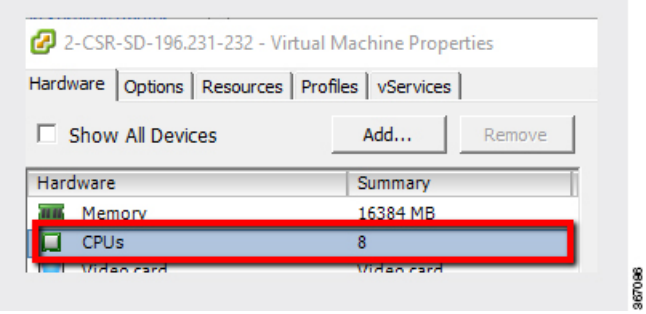
- Allocating VM CPUs for Cisco CSR1000V, on page 75

Allocating VM CPUs for Cisco CSR1000V

Use this task to allocate CPU resources when setting up a Cisco Cloud Services Router CSR1000V as a host for the SD-AVC network service.

Before you begin

Step 1 On the VMware ESXi hypervisor client that is hosting the Cisco CSR, edit the CSR that is hosting the SD-AVC network service. Allocate 8 CPUs to the virtual machine. (For small-scale scenarios, fewer CPUs may be necessary. See System Requirements: SD-AVC Network Service Host, on page 14.



Step 2 On the CSR device, execute the following:

```
(config)#platform resource service-plane-heavy
Please reboot to activate this template
```

Step 3 Copy the running configuration to the starting configuration.

```
copy running-config startup-config
```

Step 4 Reload the device.

```
reload
```

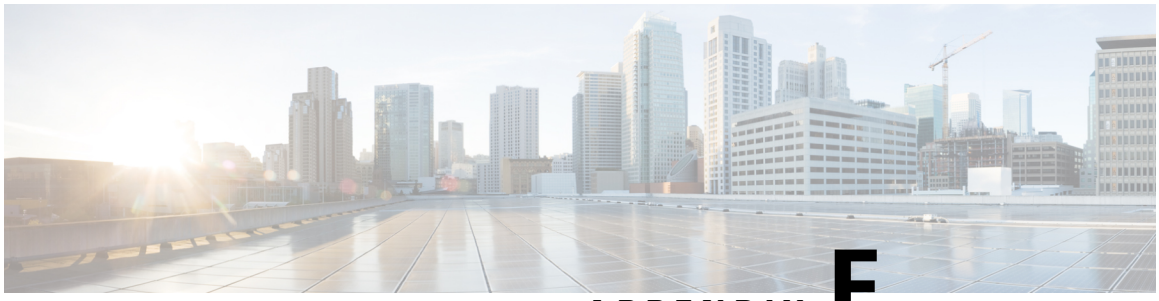
Step 5 Use **show platform software cpu alloc** to check the number of CPU cores allocated.

Check the command output for the **Control plane cpu alloc** line. The output indicates 4 CPUs (numbered 0 to 3).

```
(config)#show platform software cpu alloc
CPU alloc information:
  Control plane cpu alloc: 0-3
  Data plane cpu alloc: 4-7
  Service plane cpu alloc: 0-3
  Template used: CLI-service_plane_heavy
```

Note If the VM has only 4 cores allocated, the **Control plane cpu alloc** line in the command output shows only a single CPU (numbered 0).

```
CPU alloc information:
  Control plane cpu alloc: 0
  Data plane cpu alloc: 1-3
  Service plane cpu alloc: 0
  Template used: CLI-control_plane_heavy
```



APPENDIX E

SD-AVC REST API

- REST API Overview, on page 77
- Authentication from SD-AVC Network Service, on page 79
- System, on page 80
- External Sources, on page 83
- User-defined Applications, on page 84
- Generic Applications, on page 93
- REST API Notes and Limitations, on page 93

REST API Overview

The REST API provides numerous system functions, including:

- Displaying information about devices in the SD-AVC network
- Controlling external sources
- Displaying information about generic traffic
- Creating user-defined applications

Note Using the REST API requires authentication. See Authentication from SD-AVC Network Service, on page 79.

Table 26: Authentication

POST https://*SD-AVC-network-service-address*:8443/avc-sd-service/ external-api/login	Acquires an authentication token, enabling use of the REST API. Authentication from SD-AVC Network Service, on page 79

SD-AVC REST API

Table 27: System

GET /avc-sd-service/external-api/system-info	Displays the SD-AVC version and system times. Display System Version and System Times, on page 80
GET /avc-sd-service/external-api/devices	Displays devices in the SD-AVC network. Display Devices, on page 80
POST /avc-sd-service/external-api/remove-devices	Removes a device from the SD-AVC network. Delete Devices from SD-AVC, on page 81
GET /avc-sd-service/external-api/visibility?period=*period* - **GET** /avc-sd-service/external-api/visibility/*segmentName* ?period=*period* - **GET** /avc-sd-service/external-api/visibility/*segmentName*/ *deviceName*?period=*period*	Display traffic analytics (applications and bandwidth) for the complete SD-AVC network, a specific segement, or a specific device. Display Traffic Analytics, on page 82

Table 28: External Sources

POST /avc-sd-service/external-api/external-sources/*externalSourceName*	Enables or disables receiving data from an external source. In this release, the only external source is the MS Office 365 Connector (ms-office-365). Enable/Disable External Sources, on page 83
GET /avc-sd-service/external-api/external-sources	Displays status of external sources. Display Status of External Sources, on page 84

Table 29: User-defined Applications

POST /avc-sd-service/external-api/app-rules	Create one or more user-defined applications. Create User-defined Application Rules, on page 85
GET /avc-sd-service /external-api/app-rules - **GET** /avc-sd-service /external-api/app-rules?sourceId=*sourceId*	Displays user-defined applications defined by REST API. Display User-defined Application Rules, on page 91

GET /avc-sd-service/external-api/app-rules/status - **GET** /avc-sd-service /external-api/app-rules/status[?sourceId=*sourceId*]	Displays activation status of user-defined applications, per device. Display User-defined Application Status, on page 92
DELETE /avc-sd-service /external-api/app-rules - **DELETE /avc-sd-service /external-api/app-rules?sourceId=***sourceId*	Deletes a set of user-defined applications. Delete User-defined Applications, on page 92

Table 30: Generic Applications

GET /avc-sd-service/external-api/apps/generics	Displays the list of traffic types that contribute to "generic" traffic. Display Generic Application Traffic Types, on page 93

Authentication from SD-AVC Network Service

Using the REST API requires a token-based authentication from the SD-AVC network service. To acquire an authentication token:

1. Send the following HTTP request to the API:

   POST https://*SD-AVC-network-service-address*:8443/avc-sd-service/external-api/login

   Example:

   ```
   POST https://192.168.0.1:8443/avc-sd-service/external-api/login
   ```

   - In the request header, include the following key:

     Content-Type: application/x-www-form-urlencoded

   - In the request body, include the following keys, providing login credentials:

     username: *username*
     password: *password*

2. The API response body provides an authentication token. Use the token to authorize REST API calls to the SD-AVC network service.

Note The token expires after 12 hours.

Example:

```
{"token":"Bearer eyJhbGciOiJIUzUxMiJ9.eyJqdGkiOiJhYjZkGGUxOS0zMmU3LTRlY2ItYWQ5OC
1kYmVmZTdjZjE5YzYiLCJzdWIiOiJsYWIiLCJleHAiOjE1MzAwMqk1MzJ9.EfP3wd4fZbWrOQ6Skh-I0
bbPffF4NaruB-o_OV0EQ7fwMwfmkUUNP00R58fRGKkYWR3tQu8HjoVDp37EPtDl5Q"}
```

3. Use this token in the "Authorization" request header field of each HTTP request.

System

System Overview

The REST API can display information about the SD-AVC system, and change the configuration.

Display System Version and System Times

API

GET /avc-sd-service/external-api/system-info

Description

Displays:

- Current time: Time in UNIX format.
- System uptime: SD-AVC uptime in milliseconds.
- SD-AVC version

Example Response

```
{
"systemTime": "20190120T16:23:39+02:00",
"systemUpTimeSec": "19593132",
"version": "2.2.1"
}
```

Display Devices

API

GET /avc-sd-service/external-api/devices

Description

Displays the devices in the SD-AVC network, organized by segment, in JSON format. The response includes errors and warnings, and additional information per device.

Response

The output shows errors and warnings for:

- total network
- each segment
- each device

Example Response

The example represents a network with one segment (datacenter-01) and one device (asr-device-100) within that segment.

```
{
   "total":{
      "connection":{
         "error":[],
         "warn":[]
      },
   },
   "segments":[
      {
         "name":"datacenter-01",
         "connection":{
            "error":[],
            "warn":[]
         },
         "devices":[
            {
               "name":"asr-device-100",
               "ip":"192.168.1.0",
               "connection":{
                  "error":[],
                  "warn":[]
               }
            }
         ]
      }
   ]
}
```

Delete Devices from SD-AVC

API

POST /avc-sd-service/external-api/remove-devices

Description

Removes a device from the SD-AVC network. Specify the device and segment in the body.

Body

```
{
   "devices":[
      {
         "name":"device-name-1",
         "ip":"address-1"
      },
      {
         "name":"device-name-2",
         "ip":"address-2"
      }
   ],
   "segment":"segment-name"
}
```

Example Body

```
{
   "devices":[
      {
         "name":"dev1",
         "ip":"10.10.10.10"
```

```
      },
      {
         "name":"dev2",
         "ip":"10.10.10.11"
      }
   ],
   "segment":"dnac"
}
```

Example Response

```
{"success":true,"message":"2 devices from segment dnac were deleted successfully"}
```

Display Traffic Analytics

API

GET /avc-sd-service/external-api/visibility?period=*period*

-

GET /avc-sd-service/external-api/visibility/*segmentName*?period=*period*

-

GET /avc-sd-service/external-api/visibility/*segmentName*/*deviceName*?period=*Period*

Description

Displays traffic analytics (applications and bandwidth) for the complete SD-AVC network, a specific segment, or a specific device. Optionally, specify a period for the analytics. The response includes:

- Application name and bandwidth (bytes) used by the application
- Total bandwidth (bytes) used

Table 31: Properties

Property	Description
segmentName	(Optional) Specifies a segment. Response includes only analytics from this segment.
deviceName	(Optional) Specifies a device. Response includes only analytics from this device.
period	Use ?period=*period* to specify the period to include in the analytics. Possible values for *period*: 120, 720, 1440, 2880 minutes (These correspond to 2, 12, 24, and 48 hours.)

Example:

In this example, the period is set to 24 hours (1440 minutes).

```
GET /avc-sd-service/external-api/visibility/datacenter01/device-300?period=1440

{
"apps": [{
```

```
"name": "vmwarevsphere",
"bandwidth": 226331127989634
}, {
"name": "telepresencecontrol",
"bandwidth ": 146787859067274
}, {
"name": "unknown",
"bandwidth": 132586088501412
}],
"totalBandwidth": 505705075558320
}
```

External Sources

External Sources Overview

External sources provide additional application information that SD-AVC uses for classifying network traffic. An example is the MS-Office365 Connector (MS-Office365 Connector, on page 44).

Enable/Disable External Sources

API

POST /avc-sd-service/external-api/external-sources/*externalSourceName*

Description

Enables or disables receiving data from an external source.

Table 32: Properties

Property	Description
externalSourceName	(Mandatory) Name of the external source. **Note** In this release, the only external source that operates with SD-AVC is "ms-office-365" (MS-Office365 Connector, on page 44).
start stop	In the JSON body of the command, enables or disables the external source.

Examples

```
POST /avc-sd-service/external-api/external-sources/ms-office-365

{
   "action":"start"
}
```

```
POST /avc-sd-service/external-api/external-sources/ms-office-365

{
```

```
   "action":"stop"
}
```

Display Status of External Sources

API

GET /avc-sd-service/external-api/eternal-sources

Description

Displays external sources and their status: true = enabled, false = disabled.

Example

```
GET /avc-sd-service/external-api/external-sources
```

Example Response

In this example, the MS Office 365 Connector, an external source, is enabled.

```
{
  "sources": [{
    "ms-office-365":true
  }]
}
```

User-defined Applications

User-defined Applications Overview

Network devices operating with SD-AVC use Cisco NBAR2 and other tools to identify network traffic. The composite of information that NBAR2 uses to identify a network applications is called an "application" (or a "protocol" in the Protocol Packs released periodically by Cisco). User-defined applications may be specified on individual devices by CLI, or network-wide using SD-AVC.

Each application includes:

- **Signature**: Details that identify the network application
- **Attributes**: Assigned characteristics of the application, such as business-relevance, used for visibility and QoS policy.

Table 33: Application Types

Application Type	Description
Protocol Pack applications	Standard applications provided by Cisco in a Protocol Pack.
User-defined applications on individual devices	Defined by CLI on individual devices, sometimes called custom protocols.
Network-wide user-defined applications	Defined by SD-AVC REST API. These appear on the **SD-AVC Dashboard** > **External Sources** page.

SD-AVC User-defined Applications

SD-AVC can provision user-defined applications at the network level, available for all participating devices in the network. In effect, this is similar to adding user-defined applications manually on each device.

Create User-defined Application Rules

API

POST /avc-sd-service/external-api/app-rules

Description

Defines one or more user-defined applications.

Body

Body must include the full set of user-defined applications. Executing the API overwrites any currently defined user-defined applications for the specified source (sourceId).

```
{
    "sourceId": string,
    "rules": [{
        "allSegments": boolean,
        "segment": string,
        "rules": [{
            "appName": string,
            "serverNames": [string],
            "L3L4": [{
                "ipAddresses": [string],
                "ports": [integer(s) or range],
                "l4Protocol": string,
                "vrf": string
            }],
            "attributes": {
                "category": string,
                "sub-category": string,
                "application-group": string,
                "business-relevance": string,
                "traffic-class": string,
                "application-set": string
                }
        }]
    }]
}
```

Table 34: Top-level Properties

Property	Description
sourceId	(Mandatory) ID of the external source. **Note** In the initial release of the REST API, only one source is supported.
rules	(Mandatory) Contains complete list of the user-defined application rules. **Note** This property contains a sub-property also called rules.

Table 35: Sub-properties of rules

Property	Description
allSegments	(Must include either allSegments or segment.) Set to **true** to apply the user-defined applications to all segments, not only one segment. **Possible values**: true, false (default)
segment	(Must include either allSegments or segment.) List of user-defined application rules for a specific SD-AVC segment.
rules	(Mandatory) List of segment rules.

Table 36: Sub-properties of rules > rules

Property	Description
appName	(Mandatory) Name of user-defined application, reflecting name of the network application. **Note** Do not use a name that conflicts with an existing application, such as one defined in the Protocol Pack.
serverNames	(Must include at least one of serverNames, L3L4, and attributes.) List of all server names (FQDNs, SNIs, …) for the network application. **Note** Server names are case-sensitive.
L3L4	(Must include at least one of serverNames, L3L4, and attributes.) List of all IP-based rules. (See sub-properties below.)
attributes	(Must include at least one of serverNames, L3L4, and attributes.) Attributes to assign to the application. (See sub-properties below.)

Table 37: Sub-properties of rules > rules > L3L4

Property	Description
IpAddresses	(Mandatory) List of IPs. Can be both normal IP and subnet (using CIDR notation).

Property	Description

ports	Port(s) or port range.
	Examples:
	`"ports": [23]`
	`"ports": [23,24]`
	`"ports": [23, "25-30"]`

l4Protcol	Transport layer protocol. **Possible values**: TCP, UDP, TCP-UDP
vrf	VRF name.

Table 38: Sub-properties of rules > rules > attributes

Property	Description
application-set	(Must include at least one of serverNames, L3L4, and attributes.) Attributes to assign to the application.
application-group	(Defining a partial list of attributes is supported. If **attributes** is included, must include at least one of these properties.)
category	
sub-category	
traffic-class	
business-relevance	

Response

Response code 200 indicates success.

In case of failure, the response body provides information about the reason for failure.

Example 1: Single domain name

This example shows:

- 1 network segment: datacenter01
- 1 user-defined application: myDocs
- 1 server name
- No attributes specified

```
{
  "sourceId": "mySource",
  "rules": [{
    "segment": "datacenter01",
    "rules": [{
      "appName": "myDocs",
      "serverNames": [
        "www.myApp.com"
```

```
        ]
      }]
    }]
}
```

Example 2: Three IP addresses and ports

This example shows:

- 1 network segment: datacenter01
- 1 user-defined application: myDocs
- 3 IP addresses and 3 ports
- No attributes specified

```
{
    "sourceId": "mySource",
    "rules": [{
        "segment": "datacenter01",
        "rules": [{
            "appName": "myDocs",
            "L3L4": [{
                    "ipAddresses": ["2.2.2.2"],
                    "ports": [20],
                    "l4Protocol":"TCP"
                },
                {
                    "ipAddresses": ["3.3.3.3"],
                    "ports": [30],
                    "l4Protocol":"TCP"
                },
                {
                    "ipAddresses": ["4.4.4.4"],
                    "ports": [40],
                    "l4Protocol":"TCP"
                }
            ]
        }]
    }]
}
```

Example 3: Two user-defined applications in one network segment

This example shows:

- 1 network segment: datacenter01
- 2 user-defined applications: myDocs and myTelepresence
- No attributes specified for the myDocs user-defined application
- business-relevance attribute specified for the myTelepresence user-defined application
- IP address with subnet specified
- Individual ports and a range of ports

```
{
  "sourceId": "mySource",
  "rules": [{
    "segment": "datacenter01",
    "rules": [{
        "appName": "myDocs",
        "serverNames": [
          "www.myApp.com"
        ],
        "L3L4": [{
          "ipAddresses": ["10.1.1.0/24", "2.2.2.2"],
          "ports": [23, 34, "37-42"],
          "l4Protocol": "TCP",
          "vrf": "vrf1"
        }]
      },
      {
        "appName": "myTelepresence",
        "L3L4": [{
          "ipAddresses": ["2.2.2.2"],
          "ports": [35],
          "l4Protocol": "TCP"
        }],
        "attributes": {
          "business-relevance": "business-relevant"
        }
      }
    ]
  }]
}
```

Example 4: User-defined applications in two network segments

This example shows:

- 2 network segments: datacenter01, datacenter02
- 3 user-defined applications: myDocs, myTelepresence, myEnterpriseIM
- No attributes specified for: myDocs, myEnterpriseIM
- business-relevance attribute specified for myTelepresence
- IP address with subnet specified
- Individual ports and a range of ports

```
{
  "sourceId": "mySource",
  "rules": [{
      "segment": "datacenter01",
      "rules": [{
          "appName": "myDocs",
          "serverNames": [
            "www.myDocs.com"
          ],
          "L3L4": [{
            "ipAddresses": ["10.1.1.0/24", "2.2.2.2"],
            "ports": [23, 34, "37-42"],
            "l4Protocol": "TCP",
            "vrf": "vrf1"
          }]
```

```
        },
        {
          "appName": "myTelepresence",
          "L3L4": [{
            "ipAddresses": ["2.2.2.2"],
            "ports": [35],
            "l4Protocol": "TCP"
          }],
          "attributes": {
            "business-relevance": "business-relevant"
          }
        }
      ]
    },
    {
      "segment": "datacenter02",
      "rules": [{
        "appName": "myEnterpriseIM",
        "serverNames": [
          "www.myEnterpriseIM.com"
        ],
        "L3L4": [{
          "ipAddresses": ["2.2.2.10"],
          "ports": [23],
          "l4Protocol": "TCP"
        }]
      }]
    }
  ]
}
```

Example 5: Using allSegments and specific network segments

This example shows:

- 2 user-defined applications (myDocs, myTelepresence) for all network segments, using allSegments
- User-defined application (myEnterpriseIM) only for 1 network segment: datacenter02
- 3 user-defined applications: myDocs, myTelepresence, myEnterpriseIM
- No attributes specified for: myDocs, myEnterpriseIM
- business-relevance attribute specified for myTelepresence
- IP address with subnet specified
- Individual ports and a range of ports

```
{
  "sourceId": "mySource",
  "rules": [{
      "allSegments": true,
      "rules": [{
          "appName": "myDocs",
          "serverNames": [
            "www.myApp.com"
          ],
          "L3L4": [{
            "ipAddresses": ["10.1.1.0/24", "2.2.2.2"],
            "ports": [23, 34, "37 - 42"],
            "l4Protocol": "TCP",
```

```
            "vrf": "vrf1"
          }]
        },
        {
          "appName": "myTelepresence",
          "L3L4": [{
            "ipAddresses": ["2.2.2.2"],
            "ports": [35],
            "l4Protocol": "TCP"
          }],
          "attributes": {
            "business-relevance": "business-relevant"
          }
        }
      ]
    },
    {
      "segment": "datacenter02",
      "rules": [{
        "appName": "myEnterpriseIM",
        "serverNames": [
          "www.myEnterpriseIM.com"
        ],
        "L3L4": [{
          "ipAddresses": ["2.2.2.10"],
          "ports": [23],
          "l4Protocol": "TCP"
        }]
      }]
    }
  ]
}
```

Display User-defined Application Rules

API

GET /avc-sd-service /external-api/app-rules

GET /avc-sd-service /external-api/app-rules?sourceId=*sourceId*

Description

Displays the user-defined applications defined by REST API.

Response

The response lists the user-defined applications defined for a single source or all sources. The response body uses the same JSON structure as POST.

If no *sourceId* is specified, the response lists the user-defined applications for all sources.

If *sourceId* is specified, the response lists the user-defined applications for the specified source. The *sourceId* is user-defined by POST when defining user-defined applications.

Note In the initial release of the REST API, only one source is supported.

Display User-defined Application Status

API

GET /avc-sd-service/external-api/app-rules/status

GET /avc-sd-service /external-api/app-rules/status[?sourceId=*sourceId*]

Description

The SD-AVC network service sends the user-defined applications defined by REST API to the devices in the network. This API displays the activation status of the applications, per device.

If *sourceId* is specified, the output is limited to that source.The *sourceId* is user-defined by POST when defining user-defined applications.

Note In the initial release of the REST API, only one source is supported.

Response

The response lists each network device, arranged by segment. For each device:

- ID/version of application rules currently loaded on the device
- Status: SUCCESS, FAILED, IN-PROGRESS

Delete User-defined Applications

API

DELETE /avc-sd-service /external-api/app-rules

DELETE /avc-sd-service /external-api/app-rules?sourceId=*sourceId*

Description

Deletes a set of user-defined applications.

If no *sourceId* is specified, deletes the full set of user-defined applications.

If *sourceId* is specified, deletes the full set of user-defined applications for the specified source. The *sourceId* is user-defined by POST when defining user-defined applications.

Note In the initial release of the REST API, only one source is supported.

Response

Response code 200 indicates success.

Generic Applications

Generic Applications Overview

"Generic" network traffic is not attributed to a specific network application. This portion of network traffic reduces the classification index, which is shown in the SD-AVC Dashboard.

Display Generic Application Traffic Types

API

GET /avc-sd-service/external-api/apps/generics

Description

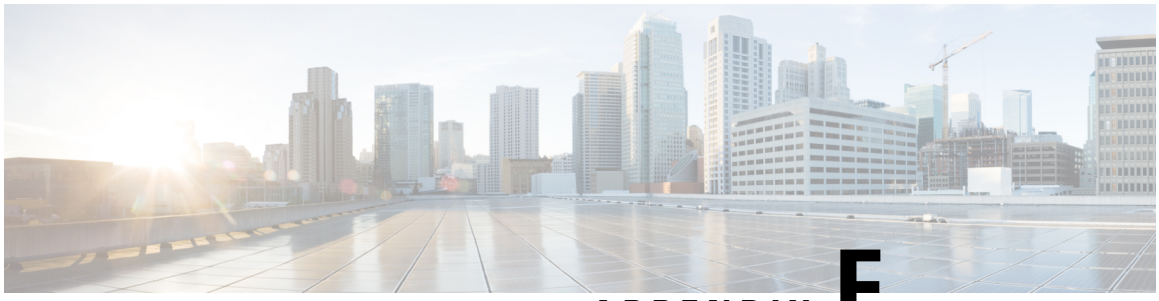
Displays the list of traffic types that contribute to generic traffic. The response is preconfigured - it does not depend on current traffic.

Response

```
["statistical-conf-audio","rtp-audio","spdy","statistical-p2p","rtp-video","http","statistical-conf-video",
"quic","statistical-download","ssl","unknown","rtp"]
```

REST API Notes and Limitations

See SD-AVC Notes and Limitations, on page 51.



APPENDIX F

Source Interface Configuration

- Source Interface Configuration Overview, on page 95
- Background, on page 95
- Scenarios that Benefit from Source Interface Configuration, on page 96

Source Interface Configuration Overview

On network devices operating with SD-AVC, you can specify the interface to be used for communication from the device to the SD-AVC network service, using the **source-interface** command. This can be any type of interface, including virtual, such as a loopback interface.

When the network device sends packets to the SD-AVC network service, the Source IP of the packets will be the IP address of the interface specified by the **source-interface** command.

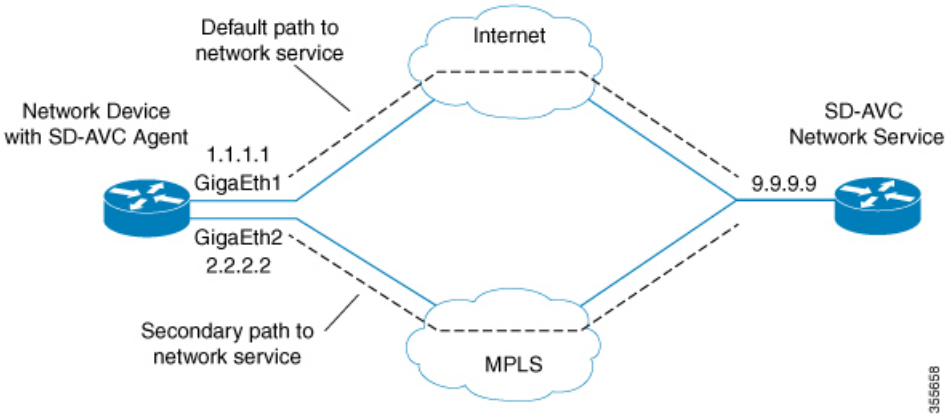
Specifying the interface for SD-AVC traffic can address several issues described in Scenarios that Benefit from Source Interface Configuration, on page 96.

Background

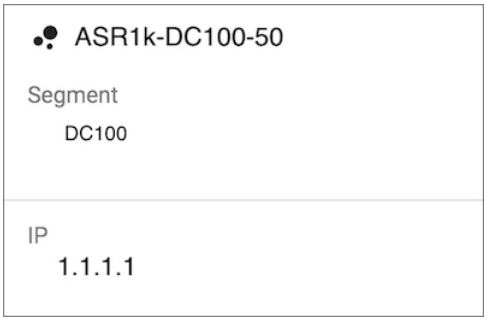
Network devices appear in the SD-AVC Dashboard, identified by an address. Typically, this is the IP of the interface on the device used for communication between the device and the SD-AVC network service. The routing table on the device determines the interface(s) used for communication with the SD-AVC network service.

In the following example, the default path for packets sent from the device to the network service will be:

Source: 1.1.1.1
Destination: 9.9.9.9



In this case, the network device appears in the SD-AVC Dashboard, identified as 1.1.1.1, as shown below.



Scenarios that Benefit from Source Interface Configuration

Specifying a source interface for SD-AVC traffic can be helpful in numerous scenarios.

- Improve visibility by providing a consistent IP address for SD-AVC traffic.
- Simplify configuring a network firewall by providing a consistent source IP address for SD-AVC traffic.
- Separate SD-AVC FTP traffic from non-SD-AVC FTP traffic.

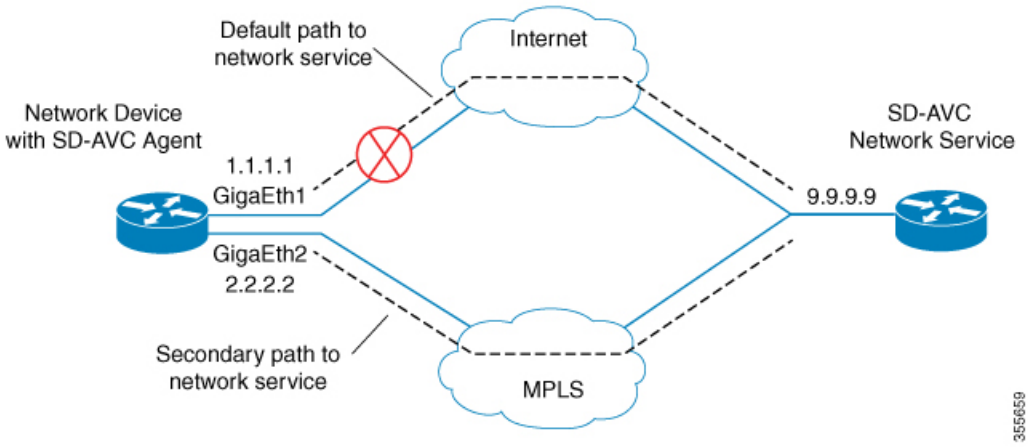
Scenario: Default Connection Down

If the default path between a network device and the SD-AVC service is not available, and traffic is routed over a different interface, the source of the packets may change. For example:

Default packet source: 1.1.1.1
Packet source when using secondary path: 2.2.2.2

In the following example, the default path is not available, and packets sent from the device to the network service will follow the secondary path (using interface 2.2.2.2) instead of the default (interface 1.1.1.1):

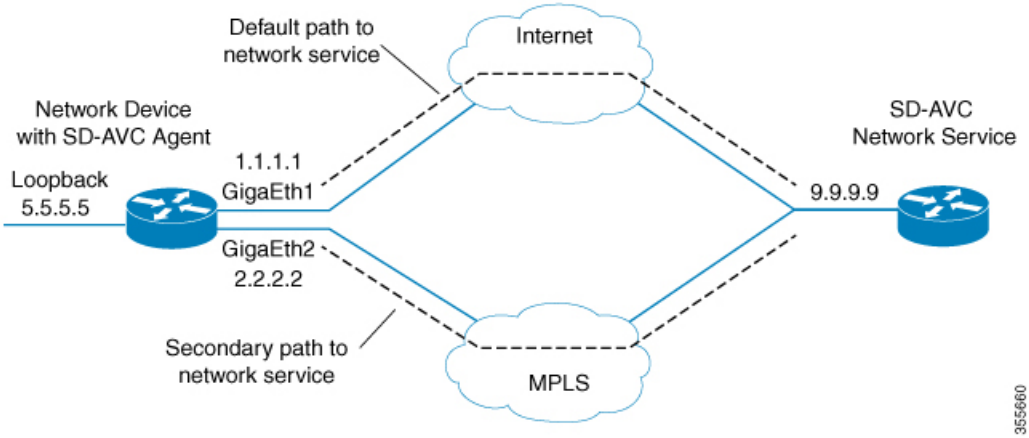
Source: 2.2.2.2
Destination: 9.9.9.9



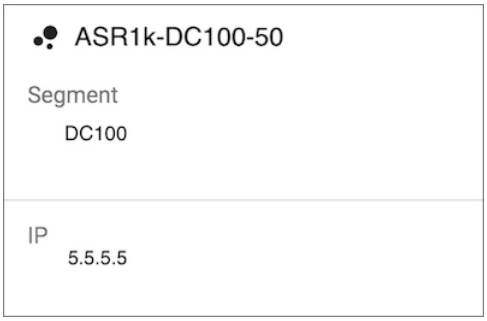
Earlier, the network device appeared in the SD-AVC Dashboard as 1.1.1.1. Now it appears as 2.2.2.2, reflecting the secondary path to the SD-AVC network service. The device hostname remains the same, but the IP has changed, as shown below. This may not be desired.

Configuring a consistent source interface ensures that the network device appears in the SD-AVC Dashboard with a consistent IP.

This can be accomplished by creating a loopback interface (5.5.5.5 in the example below) and setting it to be the source interface for all SD-AVC traffic from the device. See Specifying a Loopback as Source Interface, on page 99.



Regardless of the path used for SD-AVC traffic, the device appears consistently in the SD-AVC Dashboard as 5.5.5.5.

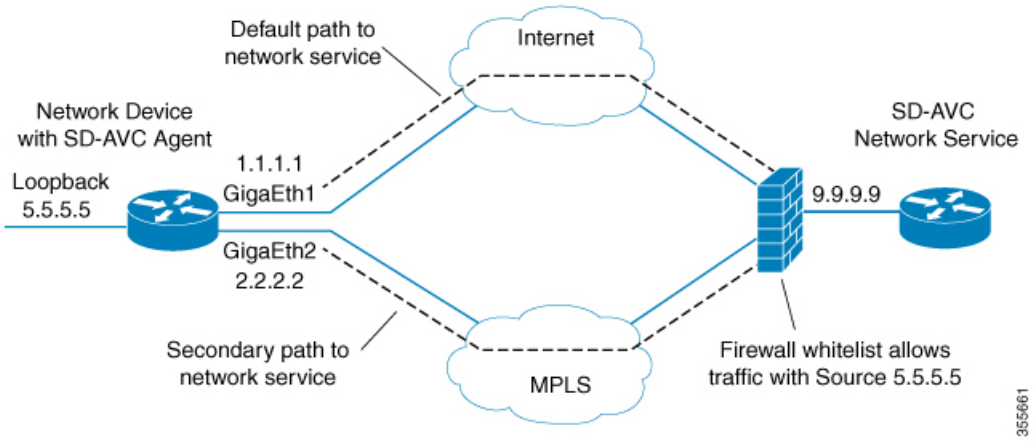


Scenario: Network Firewall Policy

In some network configurations, a firewall blocks all traffic to the SD-AVC network service, other than devices on a whitelist. This may require whitelisted devices to present themselves to the firewall with a consistent IP address. In the following illustration, traffic to the SD-AVC network service can use the 1.1.1.1 or 2.2.2.2 paths.

Configuring a consistent source interface ensures that SD-AVC traffic from the network device consistently presents itself to the firewall with the same IP. This simplifies firewall whitelist policy.

This can be accomplished by creating a loopback interface (5.5.5.5 in the example below) and setting it to be the source interface for all SD-AVC traffic from the device. See Specifying a Loopback as Source Interface, on page 99.



Scenario: Internal FTP Server

In some network configurations, a network device communicates with an FTP server through an interface that cannot reach the SD-AVC network service. This can cause conflict with the FTP communications between the SD-AVC agent on the network device and the SD-AVC network service.

To avoid conflict between different types of FTP activity, use the **source-interface** command to specify an interface that can reach the SD-AVC network service. This enables SD-AVC FTP traffic on one interface, and other FTP traffic on another interface.

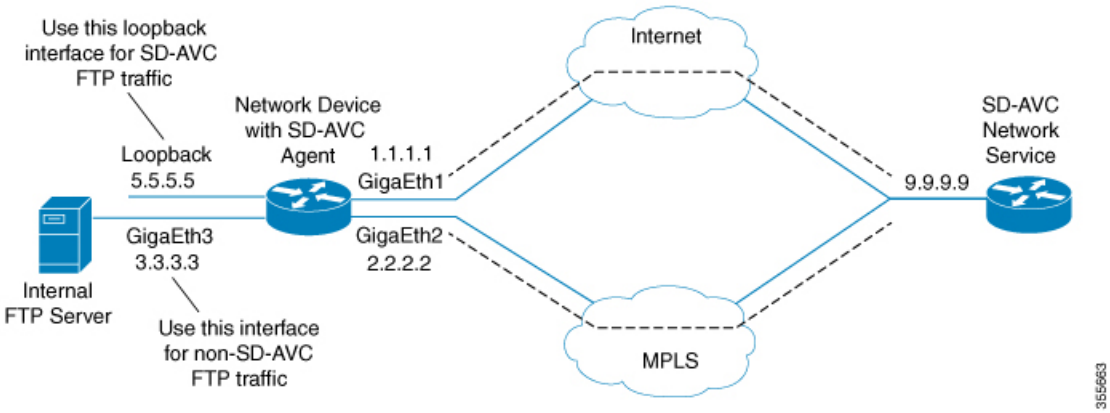
In the example below:

- Non-SD-AVC FTP traffic is on gigabitEthernet interface 3:

```
Device(config)#ip ftp source-interface gigabitEthernet 3
```

- SD-AVC FTP traffic uses the loopback interface as source (see Specifying a Loopback as Source Interface, on page 99):

```
Device(config-sd-service-controller)#source-interface loopback0
```



Configuring Source Interface for SD-AVC Communication

On network devices, use the **source-interface** command to specify the source interface, and therefore the Source IP, for SD-AVC traffic.

You can specify any physical or virtual interface on the device, but to address the scenarios described above, use a loopback interface.

Specifying a Loopback as Source Interface

To address scenarios such as those described above, create a virtual (loopback) interface and specify that SD-AVC traffic sent from the network device to the SD-AVC network service will use the virtual interface to define the Source address. The Source IP for SD-AVC packets sent from the network device will be the IP address of the specified interface.

1. On the network device, create a loopback interface (virtual), and assign it an IP address.
2. On the SD-AVC network service host, ensure access to the loopback interface on the network device.

Note This may require adding one or more routing table entries to enable access to the loopback interface. Configuring a routing table path to the loopback interface may be something like this:

ip route *device-loopback-ip* **255.255.255.255** *device-physical-interface*

Example:

```
HostDevice(config)#ip route 5.5.5.5 255.255.255.255 1.1.1.1
```

3. On the network device, use the **source-interface** command to select the loopback interface. In the example, the loopback interface is **loopback0**.

   In configuration mode:

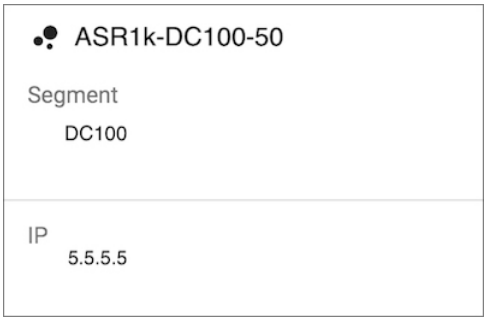
   avc sd-service
   segment *segment*
   controller
   address *sd-avc-network-service-IP*
   source-interface *source-interface*

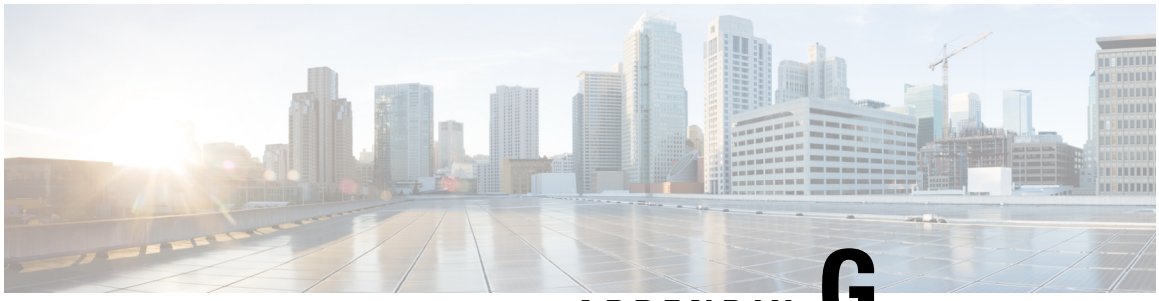
   Example:

```
Device(config)#avc sd-service
Device(config-sd-service)#segment sdavc
Device(config-sd-service)#controller
Device(config-sd-service-controller)#address 9.9.9.9
Device(config-sd-service-controller)#source-interface loopback0
```

In the **SD-AVC Dashboard**, the network device will be identified consistently by the specified source interface. In the example above, the source interface specified is **loopback0**, with IP 5.5.5.5.

Note The IP is updated in the Dashboard when the network device sends an update to the SD-AVC network service.





APPENDIX G

Additional References

Topic	Document
SD-AVC release notes	Cisco SD-AVC Release Notes, Release 2.2.1
Cisco AVC product page	Cisco Application Visibility and Control (AVC)

Additional References