Getting Started with Monitoring and Alerting in a Cisco SAN Fabric

Using MDS 9000 Switches and Data Center Network Manager

Contents

Note: The documentation set for this product strives to use bias-free language. For the purposes of this documentation set, bias-free is defined as language that does not imply discrimination based on age, disability, gender, racial identity, ethnic identity, sexual orientation, socioeconomic status, and intersectionality. Exceptions may be present in the documentation due to language that is hardcoded in the user interfaces of the product software, language used based on RFP documentation, or language that is used by a referenced third-party product.

This document provides a step-by-step guidance to setup automated monitoring and alerting in a Cisco SAN fabric. The primary audience is first-time users of Cisco MDS 9000 switches, NX-OS, and Data Center Network Manager (DCNM) but experienced users can also benefit from it.

Scope

The command outputs, screenshots, and capabilities that are described in this document are based on Cisco NX-OS 8.4(2) for MDS 9000 switches and DCNM 11.4(1). Although the procedures and recommendations that are outlined in this document apply to most NX-OS releases for MDS 9000 switches and DCNM, we recommend referring to the release notes and the configuration guides for the up-to-date information. Also, it is an overview document, primarily aimed at the new users. For details on specific topics, please refer to the White Papers and Configuration Guides listed in the references section.

Overview of Monitoring and Alerting in a Cisco SAN fabric

Cisco MDS 9000 switches have hardware and software sensors to collect metrics and logs in real time. The hardware sensors are integrated within all the components. For example:

1. Sensors on port-ASICs collect metrics from wire-data for congestion monitoring, utilization, link-integrity, and so on.
2. Sensors on port-modules, supervisor modules and fabric modules monitor general health, temperature, hardware failures, and so on.
3. Sensors on power supplies, fan trays, and other hardware components monitor environmental conditions.

It is not an exhaustive list and is provided here for a reference only. Cisco NX-OS collects the sensor data and listens for any events that are generated by the hardware sensors. Based on the severity, the events are categorized under various levels, for example, Emergency, Critical, Informational, and so on. Finally, the events can be sent to remote monitoring systems via notification mechanisms, for example, SNMP, Syslog, and Call Home.

While Cisco NX-OS manages, monitors, and generates alerts from a single switch, Cisco DCNM can do the same for multiple switches and fabrics. It offers an intuitive web-UI to monitor the underlying SAN fabric. DCNM receives the hardware and software sensor data that is collected by Cisco NX-OS and MDS 9000 switches and it maintains long-term trends and seasonality. Also, DCNM receives event notifications that are generated by the switches and can forward them to a compatible third-party application.

In addition to monitoring the health of a SAN fabric, it is possible to monitor the storage performance using Cisco SAN Analytics. The MDS 9000 switches inspect the end-to-end SCSI and NVMe transactions to collect performance metrics in real time. Finally, the metrics are exported via streaming telemetry to SAN Insights, which is an analytics engine within DCNM.

Access mechanisms in a Cisco SAN fabric

The access mechanisms in a Cisco SAN fabric that are built using MDS 9000 switches can be used for the following functions.

- Configuration
- Monitoring
- Event notifications

The following subsections provide an overview of these functions.

Configuration

Configuring an MDS 9000 switch requires read-write access to it. This section provides an overview of the commonly used mechanisms to make configuration changes on the MDS 9000 switches. Detailed configuration options are outside the scope of this document.

For more details, please refer to the references section to access the Cisco MDS 9000 Configuration guides.

Command Line Interface (CLI)

CLI access is achieved over an SSH session to make configuration changes using the Cisco NX-OS commands. For example, the following snippet displays the steps to enable a Fibre Channel interface on MDS 9000 switches.

```
[user@~]%ssh -l admin <management_ip_address_of_the_switch>
User Access Verification
Password:
<snip>
MDS9000# configure
Enter configuration commands, one per line.  End with CNTL/Z.
MDS9000(config)# interface fc1/1
MDS9000(config-if)# no shutdown
MDS9000(config-if)# end
MDS9000#
```

The preceding snippet shows accessing the NX-OS CLI from a Linux host using SSH. The same can be achieved from other types of hosts (for example, Windows) and SSH clients (for example PuTTY).

SNMP

It is possible to make configuration changes to MDS 9000 switches using SNMP MIBs with read-write access. For example, SNMP object zoneDefaultZoneBehaviour (OID: 1.3.6.1.4.1.9.9.294.1.1.1.1.1) can change the behavior of the default zone in a VSAN.

For more details, please refer to the references section to access the Cisco MDS 9000 Series MIB Quick Reference Guide.

NX-API

NX-API provides programmable access to the MDS 9000 switches over HTTP or HTTPS. NX-API can be used to make configuration changes on the switches to achieve automation and programmability.

For more details, please refer to the references section to access the Cisco MDS 9000 Series Programmability Guide.

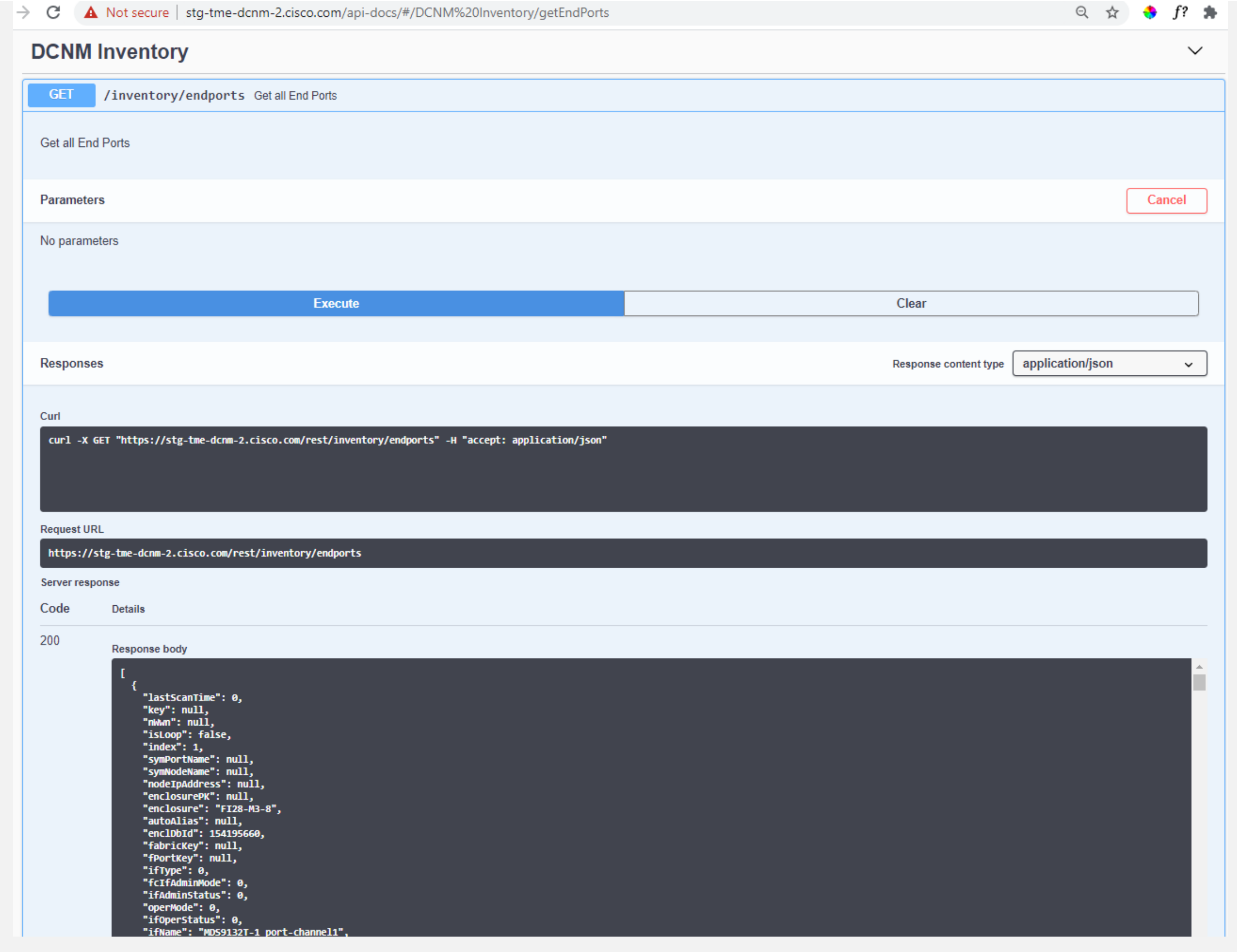
MDS 9000 Software Development Kit (SDK)

The SDK provides programmable access to the MDS 9000 switches. It leverages NX-API and CLI to communicate with the switches while abstracting the lower-level details from an end user. This SDK simplifies the rapid development of automation and programmable infrastructure to configure the SAN fabrics that are built using MDS 9000 switches.

For more details, please refer to the references section to access the MDS SDK repository on GitHub and its documentation.

DCNM REST APIs

Cisco DCNM REST APIs enable programmable access to the managed SAN fabric. DCNM REST APIs are self-documented and can be accessed by clicking on the username on the top-right corner of the screen. Click REST API Tool and then, click API-docs. It is also possible to try and execute the APIs using this tool.



```
curl -X GET "https://stg-tme-dcnm-2.cisco.com/rest/inventory/endports" -H "accept: application/json"
```

```
https://stg-tme-dcnm-2.cisco.com/rest/inventory/endports
```

```
[
  {
    "lastScanTime": 0,
    "key": null,
    "nWwn": null,
    "isLoop": false,
    "index": 1,
    "symPortName": null,
    "symNodeName": null,
    "nodeIpAddress": null,
    "enclosurePK": null,
    "enclosure": "FI28-M3-8",
    "autoAlias": null,
    "enclDbId": 154195660,
    "fabricKey": null,
    "fPortKey": null,
    "ifType": 0,
    "fcIfAdminMode": 0,
    "ifAdminStatus": 0,
    "operMode": 0,
    "ifOperStatus": 0,
    "ifName": "MDS9132T-1 port-channel1",
```

Figure 1.
DCNM REST API tool

For more details, please refer to the references section to access the Cisco DCNM REST API Reference Guide.

Monitoring

Monitoring an MDS 9000 switch requires read-only access to it. This section provides an overview of the commonly used mechanisms to monitor the MDS 9000 switches.

Command Line Interface (CLI)

CLI access is achieved over an SSH session to monitor the hardware and the software components on MDS 9000 switches using the NX-OS *show* commands. For example, the following snippet displays the steps to monitor the input and the output traffic rate on a Fibre Channel interface.

```
[user@~]%ssh -l admin <management_ip_address_of_the_switch>
User Access Verification
Password:
<snip>
MDS9000# show interface fc1/1 counters brief

-------------------------------------------------------------------------------
Interface          Input (rate is 5 min avg)      Output (rate is 5 min avg)
                   -----------------------------  -----------------------------
                   Rate     Total                 Rate     Total
                   MB/s     Frames                MB/s     Frames
-------------------------------------------------------------------------------
fc1/1              178      1205015867909         241      1724344685965
MDS9000#
```

The preceding snippet shows accessing the NX-OS CLI from a Linux host using SSH. The same can be achieved from other types of hosts (for example, Windows) and SSH clients (for example PuTTY).

SNMP

SNMP provides an extensive set of MIBs to monitor hardware and software components on MDS 9000 switches. For example, SNMP object zoneNumber (OID: 1.3.6.1.4.1.9.9.294.1.1.6) can display the number of entries present in the zone table. Using SNMP, a remote monitoring agent can poll the switches (commonly known as SNMP polling) to monitor the switches. The frequency of polling the MDS 9000 switches depends upon the type of the metric. For example, congestion (slow-drain) metrics can be polled every few seconds while memory utilization of a switch can be polled every few minutes.

For more details, please refer to the references section to access the Cisco MDS 9000 Series MIB Quick Reference.

NX-API

NX-API provides programmable access to the MDS 9000 switches over HTTP or HTTPS. NX-API can be used to request the output of *show* commands in the JSON or XML format. The recommended frequency of the request depends upon the type of the metric. For example, congestion (slow-drain) metrics can be requested every few seconds while memory utilization of a switch can be requested every few minutes.

For more details, please refer to the references section to access the Cisco MDS 9000 Series Programmability Guide.

MDS Software Development Kit (SDK)

The SDK provides programmable access to the MDS 9000 switches. It leverages NX-API and CLI to communicate with the switches while abstracting the lower-level details from an end user. This SDK simplifies the rapid development of automation and programmable infrastructure to monitor MDS 9000 fabrics.

For more details, please refer to the references section to access the MDS SDK project on GitHub and its documentation.

Streaming Telemetry

Streaming Telemetry is a push mechanism for high-fidelity metric export from the MDS 9000 switches. The primary use-case is to export IO flow metrics collected by Cisco SAN Analytics. For example, MDS 9700 directors running NX-OS 8.4(2) collects up to 70 metrics for 40,000 flows. This results in an export of 2.8 million metrics at every export interval of 30 seconds.

As of NX-OS 8.4(2), MDS 9000 switches support streaming telemetry using gRPC transport with (compact) GPB encoding. In addition to the IO flow metrics collected by SAN Analytics, interface metrics can also be exported using streaming telemetry.

For more details, please refer to the references section to access the Cisco MDS 9000 Series SAN Analytics and SAN Telemetry Streaming Configuration Guide.

DCNM APIs

It is possible to monitor various components of the managed SAN fabric using the DCNM REST APIs, for example, inventory, performance data, topology and so on. DCNM REST APIs are self-documented and can be accessed by clicking on the username on the top-right corner of the screen. Click the REST API Tool and then, click API-docs. It is possible to try and execute the APIs using this tool.

For more details, please refer to the references section to access the Cisco DCNM REST API Reference Guide.

Event notification

MDS 9000 switches can automatically send event notifications to a remote receiver in response to a local event.

It is possible to open a CLI session to MDS 9000 switches to display the events, as they are generated in the real time. These events are called system messages. A limited number of system messages can be stored on the switch for a historic view. Although this approach is commonly used for active troubleshooting in real time, it is not strictly an unsolicited event notification mechanism to a remote agent.

For example, please refer to the following snippet showing a system message when the operational state of an interface goes down.

```
2020 Jun 22 14:31:24 MDS9710-A %PORT-5-IF_DOWN_NONE: %$VSAN 1%$ Interface fc3/46 is down
(None)
```

The printing of system messages on the console or terminal is disabled by default. To enable this functionality, please use `#terminal monitor` command.

A limited number of system messages are stored on the switch and can be displayed using # `show logging [logfile | nvram]` command, as show in the following snippet.

```
MDS9710-A# show logging nvram
2020 Mar  4 09:53:30 MDS9710-A %PLATFORM-2-PS_OK: Power supply 5 ok(Serial number
DTM16510042)
2020 Mar  4 09:53:30 MDS9710-A %PLATFORM-2-PS_FANOK: Fan in Power supply 5 ok
2020 Mar  4 09:53:30 MDS9710-A %PLATFORM-2-PS_OK: Power supply 6 ok(Serial number
DTM172403YW)
2020 Mar  4 09:53:30 MDS9710-A %PLATFORM-2-PS_FANOK: Fan in Power supply 6 ok
<snip>
```

For more details, please refer to the references section to access the Cisco MDS 9000 Series System Management Configuration Guide.

SNMP Traps and Informs

SNMP provides an extensive set of MIBs to notify a remote agent via traps and informs. These notifications are generated in response to a locally generated event. For example, SNMP object linkDown (OID: 1.3.6.1.2.1.11.0.2) is a trap to notify that the operational state of a switch port has gone down.

For more details, please refer to the references section to access the Cisco MDS 9000 Series MIB Quick Reference.

Syslog

Events on MDS 9000 switch are logged as system messages carrying timestamp, device id, facility name, severity, and a text description of the event. These systems messages can be sent to remote Syslog servers.

The MDS 9000 switches support 8 levels of message severity, from level-0 (Emergency) to level-7 (Debug). By default, system message with level-5 severity (Notifications) and lower are enabled. It is possible to customize the severity of the messages that are generated by a facility and, also control what is sent to a remote Syslog server. For more details, please refer to the references section to access the Cisco MDS 9000 Series System Management Configuration Guide.

Email

Critical events can be notified via emails, directly by the MDS 9000 switches using Call Home or by DCNM using event forwarding.

Call Home

MDS 9000 switches can send event notifications via email using the Call Home functionality.

For more details, please refer to the references section to access the Cisco MDS 9000 Series System Management Configuration Guide.

DCNM Event Forwarding

DCNM acts as a centralized repository of all the events and can be the single source to generate emails to multiple destinations. The switches in the managed SAN fabric can send events to a DCNM server via any of the above-mentioned mechanisms, for example, SNMP and Syslog. Based on the configured rule and filtering, DCNM can forward the events via email for urgent attention of the owners or for automated ticketing systems.

Best practice

Use DCNM Event Forwarding to generate email notifications

Comparison and Usage recommendations

Choosing the correct mechanism for monitoring and event notification depends on the use-cases and the capability of the monitoring application. This section provides high-level guidelines about various available options.

Cisco SAN Fabric managed with DCNM

Cisco SAN fabric managed and monitored by DCNM is an end-to-end validated solution. The best monitored and notification mechanisms are used by default. For example, as of DCNM 11.4(1) and NX-OS 8.4(2):

1. Interface utilization is monitored using SNMP polling.
2. IO flow metrics that are collected by SAN Analytics are received by streaming telemetry.
3. Events are received by SNMP traps or informs and Syslog.

The preceding is not an exhaustive list and provided here for a reference only.

Using your own or third-party application

It is best to refer to the recommendations of the third-party vendor to choose the best metric export or notification mechanism. If you are building your app or customizing an existing app (for example, an open-source monitoring application), please consider the following recommendations.

Feature coverage

SNMP provides maximum coverage for monitoring and is widely supported by Cisco and third-party products. NX-API support was added on MDS 9000 switches in 2016. Commonly used features are available via NX-API at the time of writing this document, but the feature coverage is not as extensive as SNMP. Streaming telemetry supports the monitoring of IO flow metrics and interface metrics only as of NX-OS 8.4(2) for MDS 9000 switches.

Performance

SNMP is known to be a resource-intensive protocol. The MDS 9000 switches have powerful CPUs. But high-frequency monitoring is best achieved by a newer and optimized mechanism like NX-API and streaming telemetry. It is fine to continue using SNMP with legacy applications because rewriting the complete application may not be worth the effort. However, for any newer implementations, we recommend using NX-API for high-frequency monitoring of the MDS 9000 switches.

Streaming telemetry is the best option to export millions of metrics with minimal load on the switch. But it requires a gRPC receiver which may not be worth the effort just for exporting interface metrics.

Industry-wide support

SNMP is widely supported across industry. Newer monitoring applications support SNMP but also allow building custom receivers using the monitored agent APIs. NX-API can be used in such cases. Streaming telemetry is also a valid option, but it requires a dedicated gRPC receiver.

MDS 9000 switches, UCS Manager, and DCNM – Initial Setup

The initial setup of monitoring and alerting in a Cisco SAN fabric requires the following steps:

1. Setup MDS 9000 switches to be discovered by DCNM.
2. Setup UCS Manager to be discovered by DCNM. It is an optional step and is required only if you wish to monitor Cisco UCS Fabric Interconnect and servers using DCNM.
3. Setup DCNM.

The following subsections provide step-by-step details.

Initial setup of MDS 9000 switches and NX-OS before DCNM Discovery

As a first step, configure the network services like NTP, DNS, and so on. on the MDS 9000 switches. This step is important to keep correct timestamps in the outgoing event notifications, traffic utilization graphs on DCNM, streaming telemetry (if configured), and so on.

For more details on configuring the network services, please refer to the references section to access the Cisco MDS 9000 Series Fundamentals Configuration Guide.

Best practice

Use NTP to synchronize the clocks between the monitored SAN switches and the monitoring agent (DCNM)

Next, create an snmp-user on MDS 9000 switches. DCNM requires the IP address of just a single switch (known as a seed switch) to discover the entire fabric but the user and the password must be the same on all the switches.

The process of using a third-party monitoring application is similar. Please refer to the documentation of the third-party vendor for more details.

Cisco DCNM can monitor UCS Fabric Interconnects and the associated blade and rackservers when connected to a managed Cisco SAN fabric. This functionality requires the same snmp-user and password combination on the Cisco UCS Manager and SHA-AES authentication and privacy mode. Due to this reason, we recommend using the same auth-privacy mode on the MDS switches also. Even if the SAN fabric may not have UCS servers connected today, it still is best practice to avoid any changes in the future.

Best practice

Use SHA-AES as authentication and privacy mode to discover SAN fabric via DCNM

Creating a user on MDS switches for DCNM discovery

Use `#snmp-server user` command to create a local user with SHA-AES authentication and privacy mode. This user must have a `network-admin` role.

```
MDS9000#configure

MDS9000(config)#snmp-server user dcnmuser network-admin auth sha <> priv aes-128 <>

MDS9000(config)#

MDS9000(config)#end

MDS9000# show running-config | inc dcnmuser

username dcnmuser password 5 $5$5Cht7P1y$ZaR6bDvAo5dSt7KUjr4H7qoaOQ/7cyUq98Av5k3jDF3  role
network-operator

username dcnmuser passphrase lifetime 269063912 warntime 279936932

snmp-server user dcnmuser network-admin auth sha 0x9eba83d512cd70bd34165e7f45af2962211c7be1
priv aes-128 0x9eba83d512cd70bd34165e7f45af2962211c7be1 localizedkey
```

```
MDS9000#
```

Initial setup of Cisco UCS Manager before DCNM discovery

DCNM can discover and monitor Cisco UCS Fabric Interconnects when connected to a managed Cisco SAN fabric. The discovery and monitoring are achieved via SNMP that is the same mechanism used to monitor the MDS 9000 switches. Starting DCNM 11.x, it is possible to monitor components beyond the Fabric Interconnects, for example, blade servers, vHBA, and vNICs. This enhanced monitoring is performed using UCS APIs and requires a read-only user in Cisco UCS Manager. Overall, an SNMP user is required for the discovery and monitoring of the UCS Fabric Interconnects while a separate read-only user is required for monitoring vHBA and vNIC traffic.

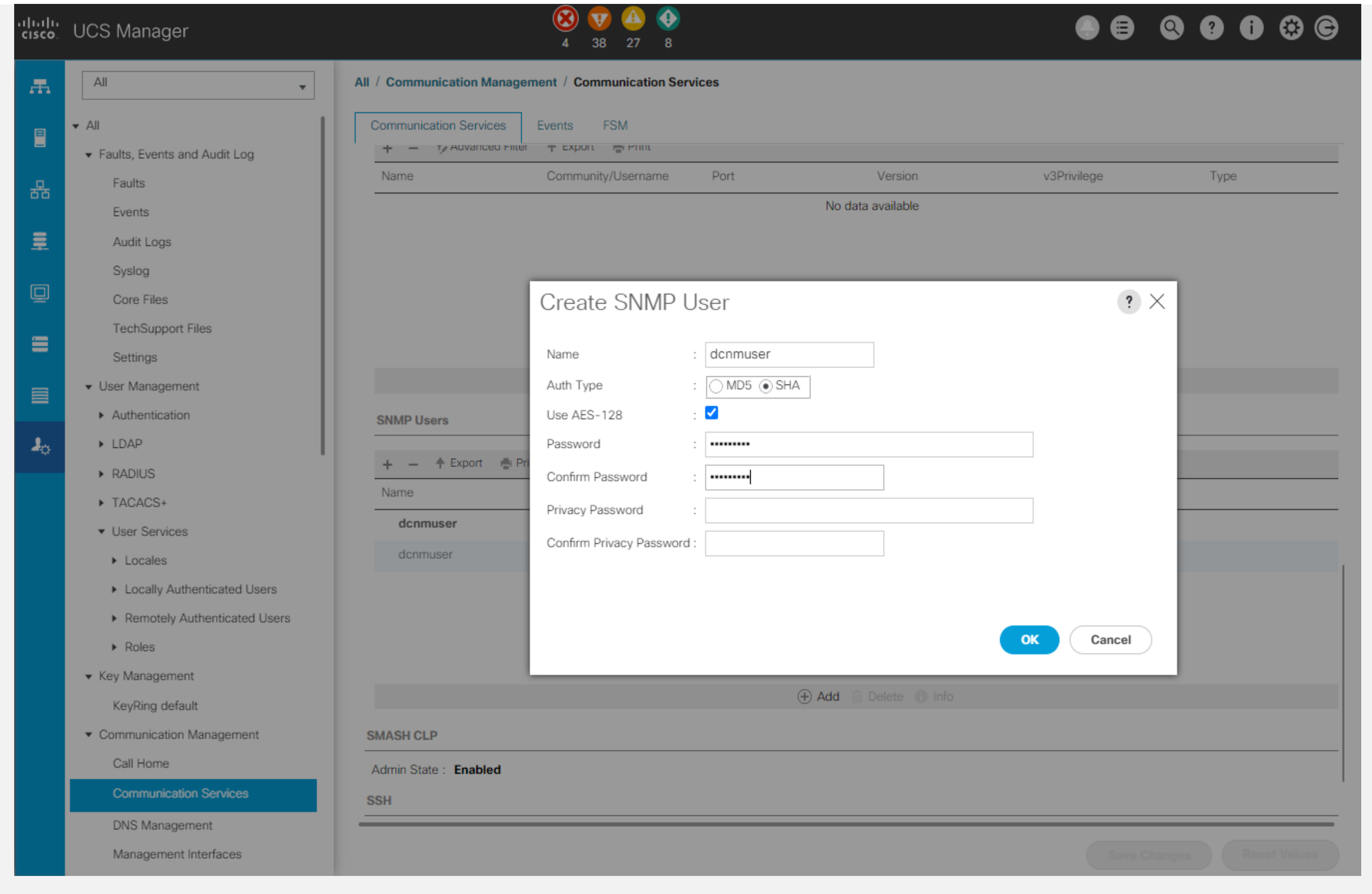
It is an optional step. Full functionality is available in DCNM if both the users are created and added correctly. If none of the users are created, DCNM can still discover the connected UCS Fabric Interconnects but is unable to show any more information on them. It is fine to reuse existing snmp-user and read-only user accounts if they already exist on UCS Manager.

It is important to setup basic network services like NTP, DNS, and so on. before enabling the monitoring and alerting of a Cisco UCS domain.

For more details, please refer to the references section to access the Cisco UCS Manager configuration guide.

Adding a SNMP user in Cisco UCS Manager

Navigate to Admin tab > Communication Management > Communication Services. Scroll down to the SNMP section and add a new SNMP user. For successful discovery by DCNM, it is mandatory to choose Auth Type as SHA and select the check box for AES-128. In some versions of UCS Manager, AES-128 is enabled by default. In such cases, no additional action is required by a user to select the privacy mode.



Admin State : Enabled

Create SNMP User

Name : dcnmuser

Auth Type : ○ MD5 ● SHA

Use AES-128 : ☑

Password : •••••••••

Confirm Password : •••••••••

Privacy Password :

Confirm Privacy Password :

OK Cancel

Figure 2.
Adding an SNMP user in Cisco UCS Manager

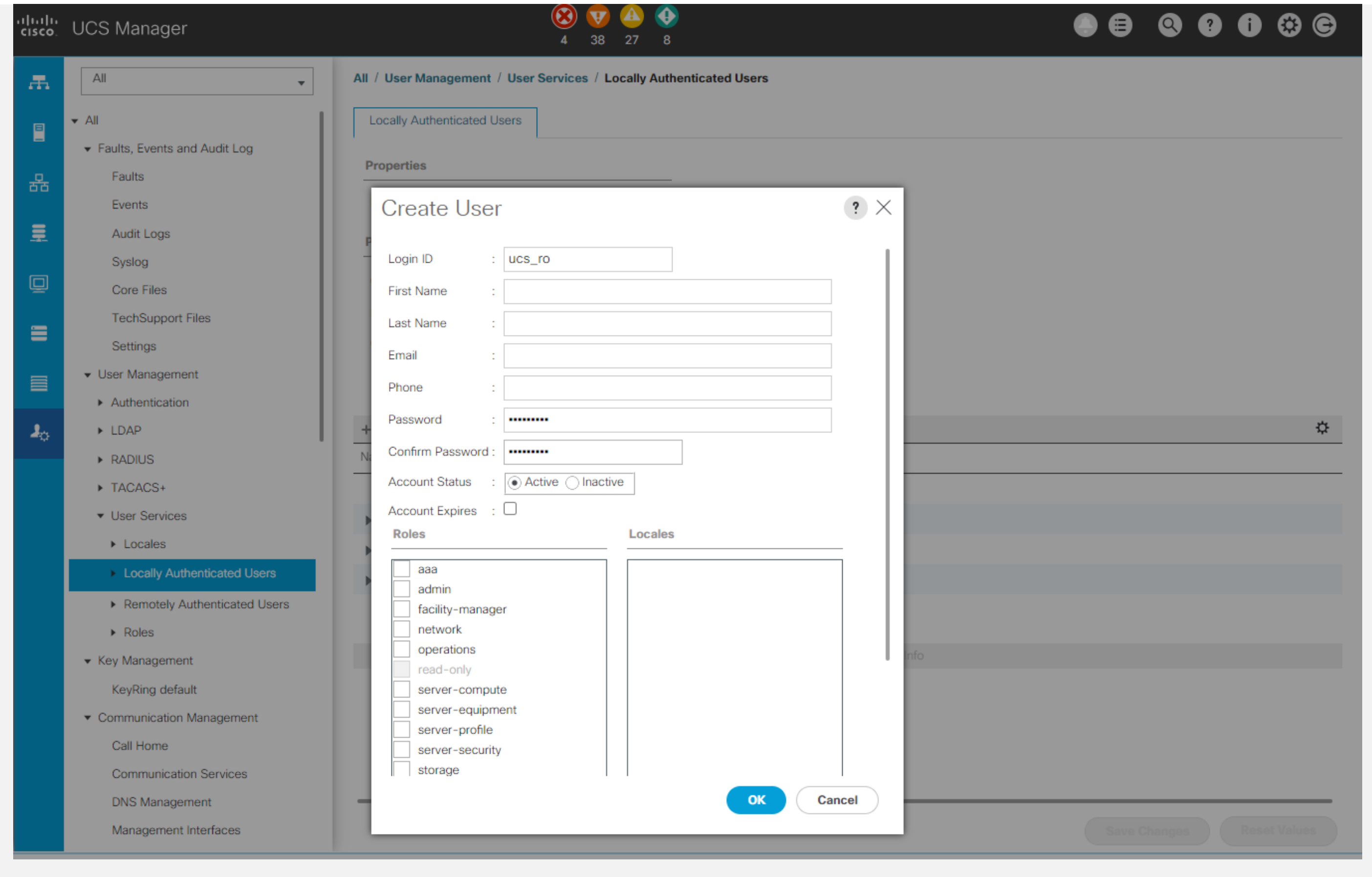
We recommended using different names for snmp-user and read-only user (for example, dcnmuser for SNMP access and ucs_ro for API access). This scheme helps in cleaner implementation and better troubleshooting if discovery does not work correctly in the future.

Best practice

For DCNM discovery and monitoring of UCS, use different name strings for snmp-user and read-only user

Adding a read-only user in Cisco UCS Manager

Navigate to Admin tab > User Management > User Services. Go to locally authenticated users and add a new user. In Cisco UCS Manager, a user with no special roles is a read-only user.



Create User

Login ID :	ucs_ro
First Name :	
Last Name :	
Email :	
Phone :	
Password :	*********
Confirm Password :	*********
Account Status :	● Active ○ Inactive
Account Expires :	□

Roles

- □ aaa
- □ admin
- □ facility-manager
- □ network
- □ operations
- □ read-only
- □ server-compute
- □ server-equipment
- □ server-profile
- □ server-security
- □ storage

Locales

OK Cancel

Figure 3.
Adding a read-only user in Cisco UCS Manager

Initial setup of DCNM

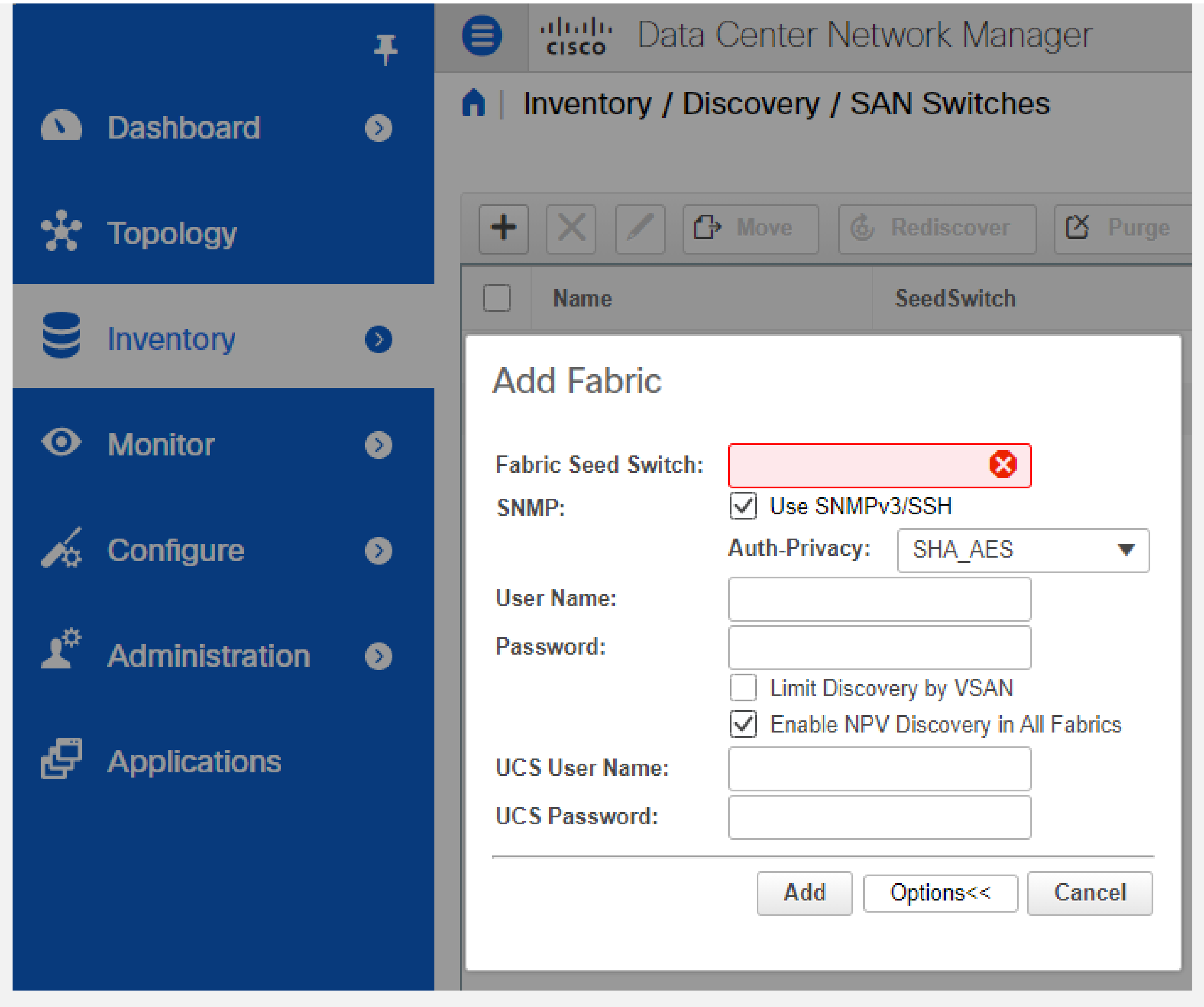
Before discovering a SAN fabric, DCNM must be correctly installed and setup for network services like DNS, NTP, and so on. For more details on DCNM installation, please refer to the references section to access the Cisco DCNM Installation and Upgrade Guide for SAN Deployment.

Discovering a SAN fabric

Log in to DCNM. Navigate to Inventory > Discovery > SAN Switches. Click + (Add) button. In the Fabric Seed switch text box, enter the IP address of any switch in the fabric. Select SHA_AES from the Auth-Privacy drop-down list as per the above-mentioned best practice. This step assumes that the User Name and the Password on the MDS 9000 switches have been created using the same auth and privacy mode. In the same pop-up window, click the Options button to display text boxes for UCS User Name and UCS Password. Under the UCS User Name, enter the read-only user (not the snmp-user) created in UCS Manager. The snmp-user in Cisco UCS Manager must be the same user as created on the MDS 9000 switches and already entered in the User Name text box.

Click Add. It takes a few minutes to completely discover the fabric. Repeat the preceding steps for adding multiple fabrics.

Discovering a SAN fabric is a mandatory step for DCNM to manage that fabric. Adding UCS is optional (but highly recommended) and is required only if you wish to monitor the Fabric Interconnects, Servers, vHBA, and vNIC using DCNM.



Add Fabric

Fabric Seed Switch:

SNMP: ☑ Use SNMPv3/SSH

Auth-Privacy: SHA_AES

User Name:

Password:

☐ Limit Discovery by VSAN

☑ Enable NPV Discovery in All Fabrics

UCS User Name:

UCS Password:

Figure 4.
Discovering a SAN fabric and the connected UCS domains in DCNM

Adding VMware vCenter

DCNM can detect the connected hypervisors (ESXi) and the hosted VMs. Navigate to Inventory > Discovery > Virtual Machine Manager and click + (Add) button to add VMware vCenter Server. To view the connected hosts, navigate to Dashboard > Hosts. Select a hypervisor host to display the hosted VMs.

It is an optional step but highly recommended.

Adding Storage arrays

DCNM can detect and display information from storage arrays using SMI-S. Navigate to Inventory > Discovery > Storage Devices and click + (Add) button. Select the storage array vendor from the drop-down list. The SMI-S server capability must be configured before adding the storage array in DCNM.

it is an optional step.

Setting login image and message of the day (MOTD)

Navigate to Administration > DCNM Server > Customization to add a custom image and message of the day (MOTD).

It is an optional step.

Setting custom Fabric names

Navigate to Inventory > Discovery > SAN Switches. Select a discovered fabric and click the edit button. Rename the fabric to make it more relevant. For example, a fabric with the autodiscovered name of Fabric_MDS9718-A can be changed to Fabric_A.

It is an optional step but highly recommended.

Creating custom Switch groups

Navigate to Administration > DCNM Server > Switch Groups. Click the Add button to create custom switch groups. Drag and drop the discovered fabrics under the switch group to create a hierarchy for global locations, data centers, floors, halls, fabrics, and so on. DCNM follows this hierarchy across all the screens to help in focusing on the relevant entities faster.

It is an optional step but highly recommended.

Best practice

Create friendly names for switch-groups. Create a hierarchy and place the discovered fabrics under them

Following is an example of switch groups and the discovered fabrics under them.

```
US
 NY
  DC-1
   Fabric-A
   Fabric-B
  DC-2
   Fabric-A
   Fabric-B
 LA
  DC-1
   Fabric-A
   Fabric-B
  DC-2
   Fabric-A
   Fabric-B
Europe
 London
  DC-1
   Fabric-A
   Fabric-B
  DC-2
```

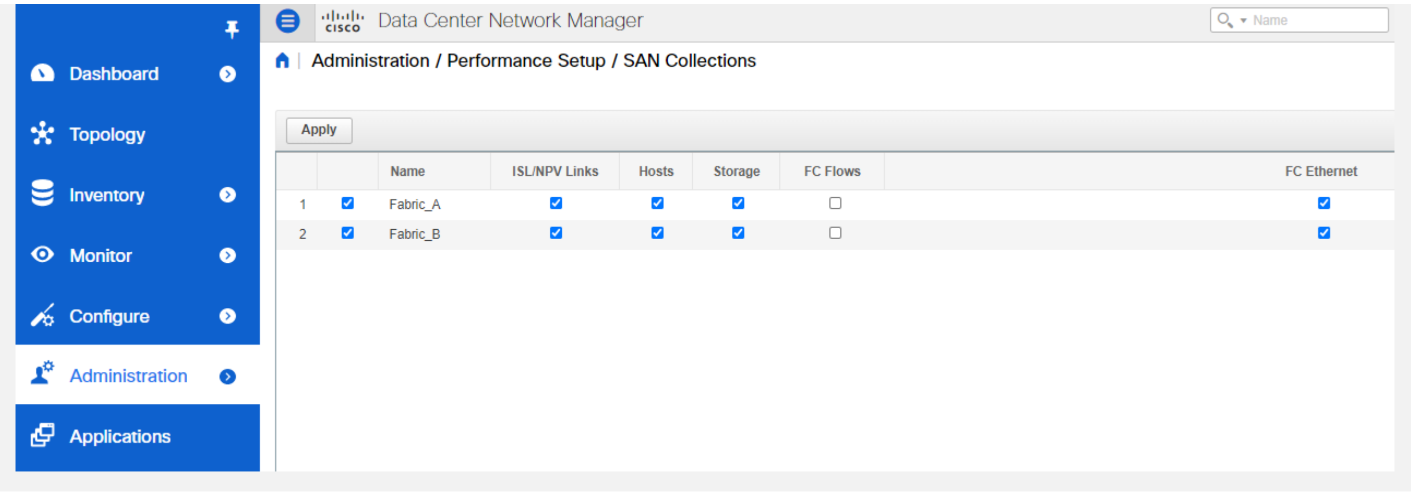
```
   Fabric-A
   Fabric-B
 Frankfurt
  DC-1
   Fabric-A
   Fabric-B
  DC-2
   Fabric-A
   Fabric-B
Asia
 Singapore
  DC-1
   Fabric-A
   Fabric-B
  DC-2
   Fabric-A
   Fabric-B
```

License enablement

Navigate to Administration > Manage Licensing > DCNM to install the appropriate licenses.

Enabling Performance Management

Monitoring the performance of the switch ports (for example, traffic utilization) is disabled by default. Enable this functionality by navigating to Administration > Performance Setup > SAN Collections. Select a fabric to enable SAN collections for ISL/NPV Links, Hosts, and Storage. Repeat this step for all the fabrics.

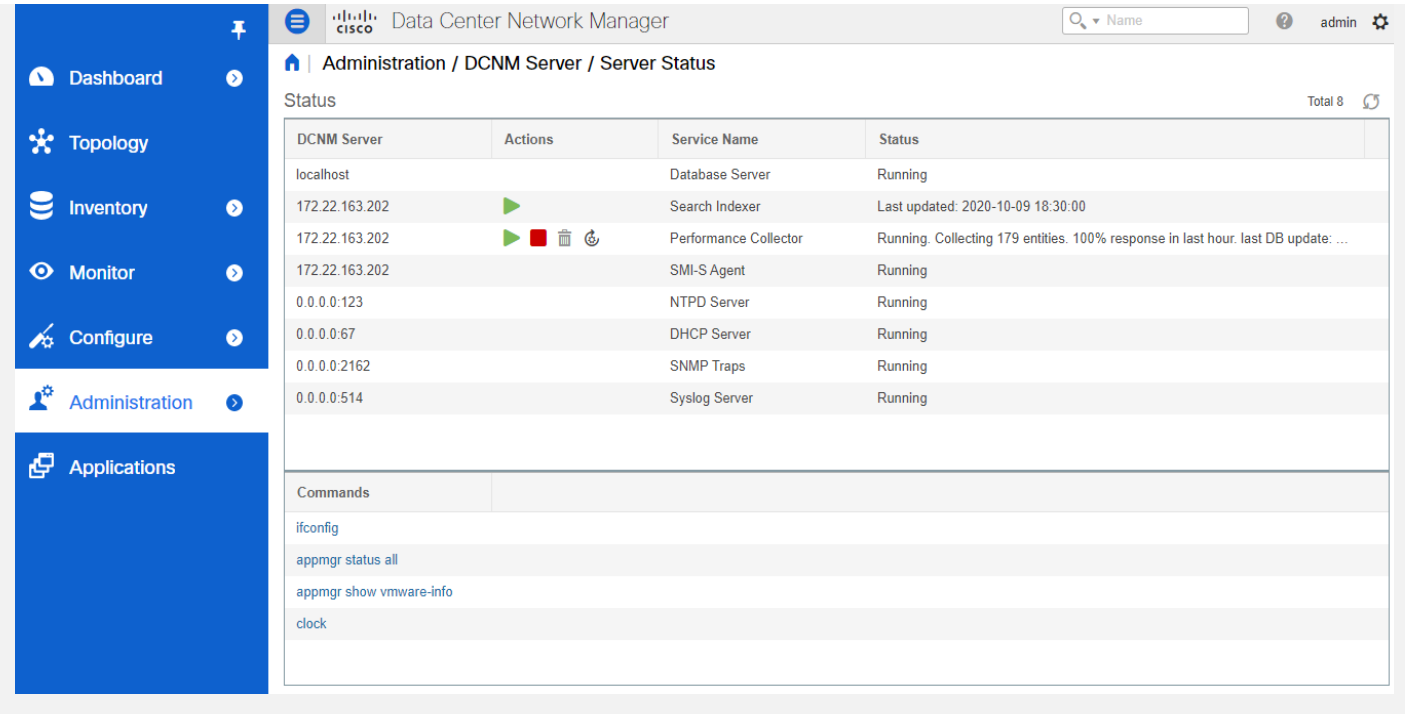


Dashboard
Topology
Inventory
Monitor
Configure
Administration
Applications
Data Center Network Manager
Name
Administration / Performance Setup / SAN Collections
Apply

		Name	ISL/NPV Links	Hosts	Storage	FC Flows	FC Ethernet
1	☑	Fabric_A	☑	☑	☑	☐	☑
2	☑	Fabric_B	☑	☑	☑	☐	☑

Figure 5.
Enabling the collection of performance data in DCNM

This step requires restarting the Performance Collector service in DCNM. The status of various services and associated actions is available under Administration > DCNM Server > Server Status.



Administration / DCNM Server / Server Status

Status

Total 8

DCNM Server	Actions	Service Name	Status
localhost		Database Server	Running
172.22.163.202	▶	Search Indexer	Last updated: 2020-10-09 18:30:00
172.22.163.202	▶ ■	Performance Collector	Running. Collecting 179 entities. 100% response in last hour. last DB update: ...
172.22.163.202		SMI-S Agent	Running
0.0.0.0:123		NTPD Server	Running
0.0.0.0:67		DHCP Server	Running
0.0.0.0:2162		SNMP Traps	Running
0.0.0.0:514		Syslog Server	Running

Commands
ifconfig
appmgr status all
appmgr show vmware-info
clock

Figure 6.
State of the DCNM server and services

It takes a few minutes for the performance graphs to display the data in DCNM. Navigating to Monitor > SAN > FC Ports and select the Performance tab to view the charts.

It is a mandatory step to display switch port utilization graphs in DCNM.

Setting up event notifications on MDS 9000 switches

DCNM uses SNMP to discover and monitor the MDS 9000 switches using the configured snmp-user. Discovering a SAN fabric by DCNM also sets itself as a receiver of the SNMP trap notifications but the Syslog notifications are not automatically enabled.

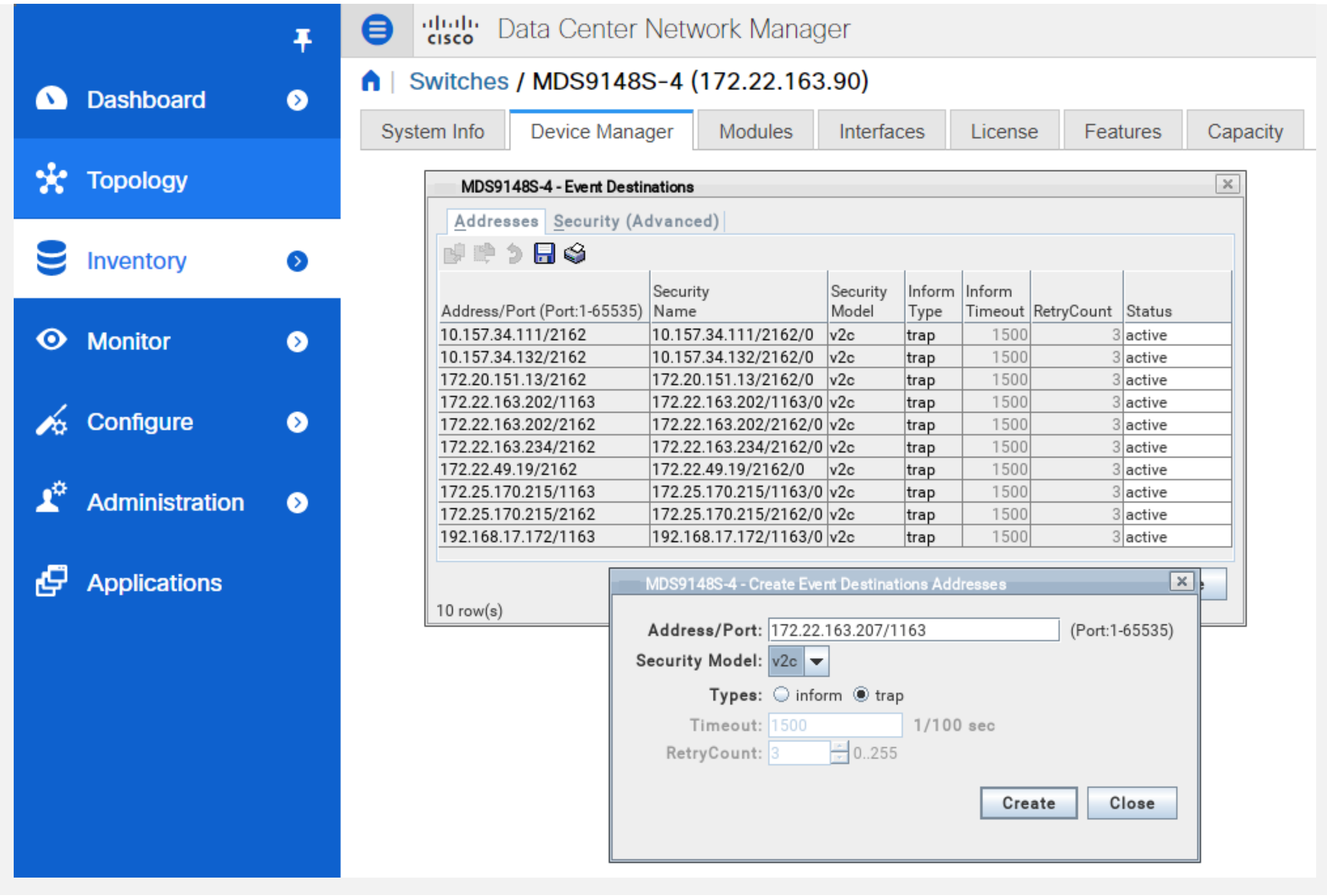
Best practice

Enable sending Syslog to DCNM for all the managed switches

Setting up SNMP traps and informs destination

SNMP trap and inform destinations can be configured by NX-OS CLI or using DCNM.

To configure via DCNM, navigate to Inventory > View > Switches. Click a switch name under the Device Name column and select the Device Manager tab. In the Device Manager, select the Admin tab > Events > Destinations. Configure the IP address of the remote SNMP trap or inform destination. It can be the IP address of the DCNM server or any other compatible third-party application. DCNM configures itself as a receiver of SNMP trap when it discovers an MDS 9000 switch and starts managing it. No additional action is needed from a user.



Address/Port (Port:1-65535)	Security Name	Security Model	Inform Type	Inform Timeout	RetryCount	Status
10.157.34.111/2162	10.157.34.111/2162/0	v2c	trap	1500	3	active
10.157.34.132/2162	10.157.34.132/2162/0	v2c	trap	1500	3	active
172.20.151.13/2162	172.20.151.13/2162/0	v2c	trap	1500	3	active
172.22.163.202/1163	172.22.163.202/1163/0	v2c	trap	1500	3	active
172.22.163.202/2162	172.22.163.202/2162/0	v2c	trap	1500	3	active
172.22.163.234/2162	172.22.163.234/2162/0	v2c	trap	1500	3	active
172.22.49.19/2162	172.22.49.19/2162/0	v2c	trap	1500	3	active
172.25.170.215/1163	172.25.170.215/1163/0	v2c	trap	1500	3	active
172.25.170.215/2162	172.25.170.215/2162/0	v2c	trap	1500	3	active
192.168.17.172/1163	192.168.17.172/1163/0	v2c	trap	1500	3	active

10 row(s)

Address/Port: 172.22.163.207/1163 (Port:1-65535)

Security Model: v2c

Types: ○ inform ● trap

Timeout: 1500 1/100 sec

RetryCount: 3 0..255

Figure 7.
Setting up SNMP trap or inform destinations in DCNM

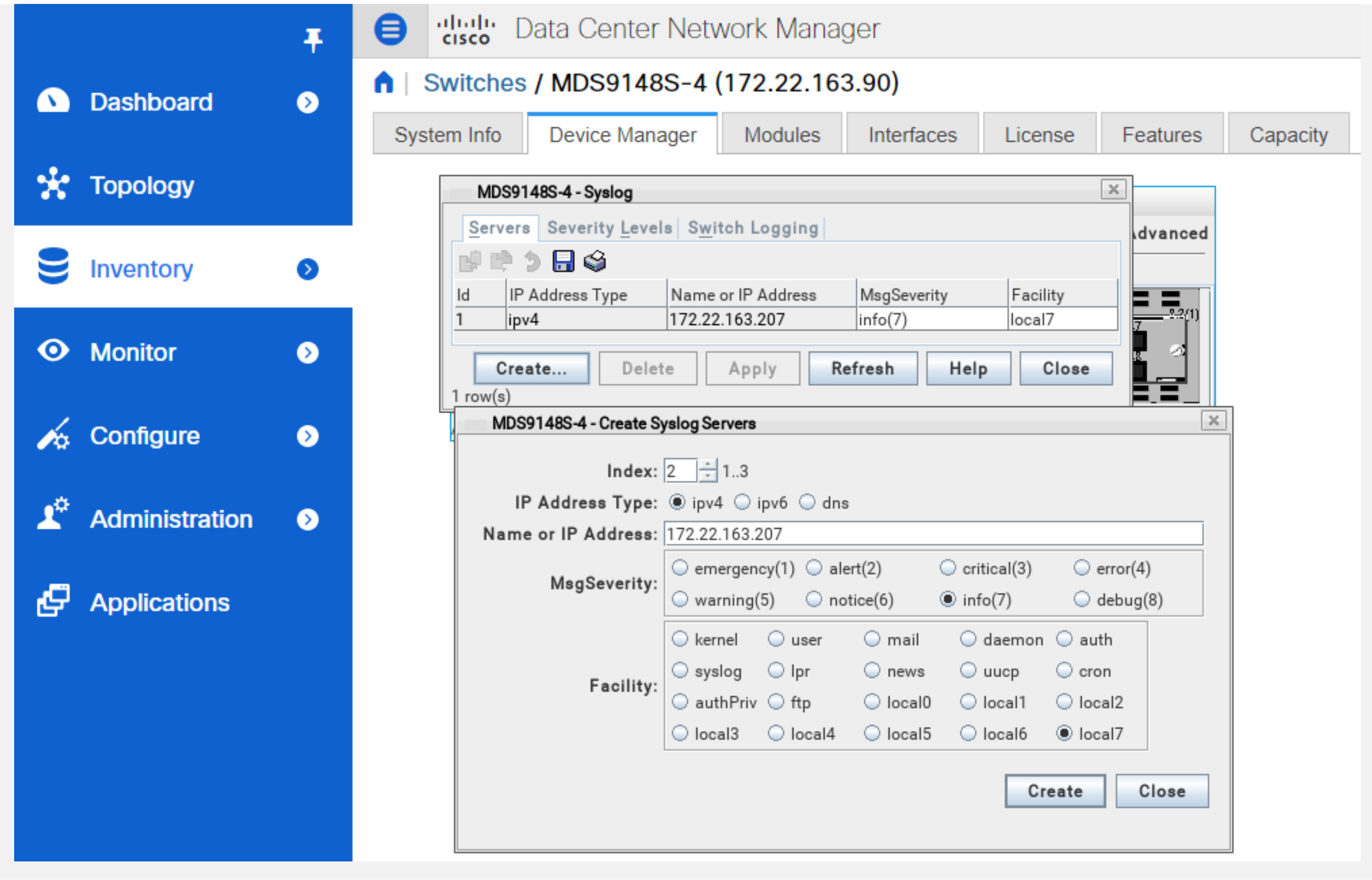
SNMP trap or inform destination can also be configured directly on the MDS 9000 switches using the `# snmp-server host` command.

```
MDS9710-A#configure
MDS9710-A(config)# snmp-server host <destination> traps version 2c <community_string>
MDS9710-A(config)# end
MDS9710-A#
```

Setting up Syslog destination

Syslog destinations can be configured by NX-OS CLI or using DCNM.

To configure via DCNM, navigate to Inventory > View > Switches. Click a switch name under the Device Name column and select the Device Manager tab. In the Device Manager, select the Logs tab > Syslog > Setup. Configure the IP address of the remote Syslog destination. It can be the IP address of the DCNM server or any other compatible third-party application.



Id	IP Address Type	Name or IP Address	MsgSeverity	Facility
1	ipv4	172.22.163.207	info(7)	local7

Index: 2 1..3

IP Address Type: ● ipv4 ○ ipv6 ○ dns

Name or IP Address: 172.22.163.207

MsgSeverity: ○ emergency(1) ○ alert(2) ○ critical(3) ○ error(4) ○ warning(5) ○ notice(6) ● info(7) ○ debug(8)

Facility: ○ kernel ○ user ○ mail ○ daemon ○ auth ○ syslog ○ lpr ○ news ○ uucp ○ cron ○ authPriv ○ ftp ○ local0 ○ local1 ○ local2 ○ local3 ○ local4 ○ local5 ○ local6 ● local7

Figure 8.
Setting up Syslog destinations in DCNM

Syslog destination can also be configured directly on the MDS 9000 switches using the `# logging server` NX-OS command.

```
MDS9710-A#configure
MDS9710-A(config)# logging server <destination>
MDS9710-A(config)# end
MDS9710-A#
```

It is possible to configure a syslog server on a single switch and distribute the same configuration to all the switches in the fabric using Cisco Fabric Services (CFS). It is the preferred approach in larger environment. Please refer to the preceding snippet.

```
switch# configure
switch(config)# switch(config)# logging distribute (to all fabric switches via CFS)
switch(config)# logging commit
```

For more information on `logging distribute` command, please refer to the references section to access the Cisco MDS 9000 Series System Management Configuration Guide.

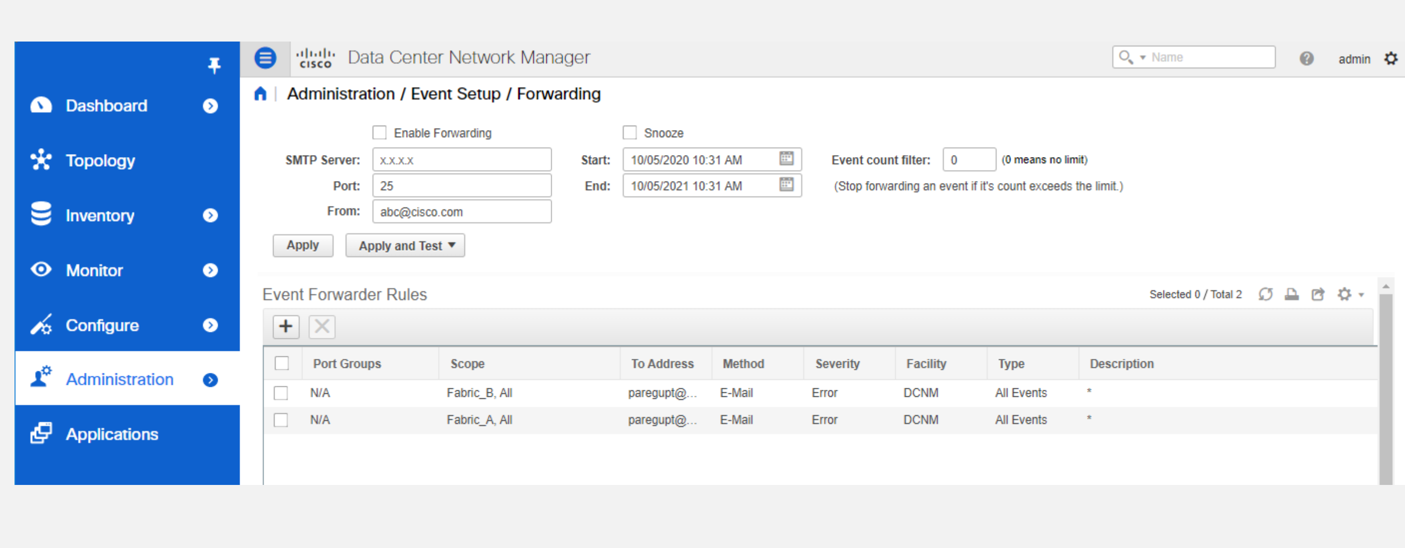
Setting up Call Home

MDS 9000 switches can send event notifications via email using the Call Home functionality.

For details configuring Call Home, please refer to the references section to access the Cisco MDS 9000 Series System Management Configuration Guide.

Setting up event notifications in DCNM

DCNM provides event forwarding using SNMP traps or informs and emails. A valid SMTP server is required for email forwarding. To configure event forwarding in DNCM, navigate to Administration > Event Setup > Forwarding. After filling up general information (for example, SMTP Server), Click the Add (+) button under Event Forwarder Rules to configure specific rules.



Administration / Event Setup / Forwarding

☐ Enable Forwarding
☐ Snooze

SMTP Server: x.x.x.x
Port: 25
From: abc@cisco.com

Start: 10/05/2020 10:31 AM
End: 10/05/2021 10:31 AM

Event count filter: 0 (0 means no limit)
(Stop forwarding an event if it's count exceeds the limit.)

Event Forwarder Rules

Selected 0 / Total 2

☐	Port Groups	Scope	To Address	Method	Severity	Facility	Type	Description
☐	N/A	Fabric_B, All	paregupt@...	E-Mail	Error	DCNM	All Events	*
☐	N/A	Fabric_A, All	paregupt@...	E-Mail	Error	DCNM	All Events	*

Figure 9.
Setting up Event Forwarding in DCNM

A note on the number of monitoring agents, traps or informs, and Syslog destinations

Multiple monitoring agents can simultaneously monitor the same MDS 9000 switches. Similarly, push notifications via SNMP traps and informs, Syslog, and Call Home can be sent to multiple destinations. Although NX-OS allows configuring many destinations, we recommend limiting to 2 or 3 in order to prevent extra load on the monitored switch.

Best practice

Limit the number of monitoring agents, SNMP trap or inform and Syslog destinations to less than 3

If more destinations are required, we recommend using the event forwarding feature of DCNM. Similar capability to relay the events is commonly available in other third-party applications also.

The destination of push notifications via SNMP or Syslog is explicitly configured on MDS 9000 switches. Hence, the number of destinations is known and can be limited by changing the configuration. On the contrary, the number of monitoring agents is not explicitly limited by an MDS 9000 switch. Many agents can simultaneously perform SNMP polling or send HTTP(s) requests causing extra load on the switch. There is little reason for more than 3 agents to simultaneously monitor the same switch. Any such access should be limited by user credentials and other security mechanisms such as Access Control Lists (ACLs) or network firewalls.

Monitoring and Alerting of specific components

The following subsections provide details on monitoring and alerting of specific hardware and software components on MDS 9000 switches and NX-OS. Details are provided for using DCNM and a compatible third-party application.

SNMP MIBs

Correct interpretation of SNMP polling or to receive trap and inform notifications require the MIB file to be present on the monitoring agent. Cisco DCNM already carries all the MIB files and no additional action is required from a user. Using a third-party monitoring agent requires loading more MIB files into it. The required MIB files can be downloaded from the Cisco SNMP Object Navigator.

SNMP support is widely available across other Cisco and industry products. While using a generic SNMP MIB, please be cautious before overwriting any existing MIB files. The generic services are common and do not require an MDS 9000 specific MIB. For example, cseSysCPUUtilization is a generic SNMP object to monitor the CPU utilization for many Cisco products. MDS 9000 switches are purposefully built for Fibre Channel and hence, carry specific MIBs for Fibre Channel services. Such MIB must be loaded in the monitoring agent in addition to the existing MIB files.

For more details, please refer to the references section to access the Cisco MDS 9000 Family MIB Quick Reference. SNMP MIBs for specific components are provided in the following subsections.

For more details to translate OIDs into object names, their descriptions, browse OID trees, and to download the MIB files, please refer to the references section to access the Cisco SNMP Object Navigator.

General switch health

General switch health can be monitored using the following NX-OS commands:

Table 1. NX-OS commands to check the overall switch health

NX-OS command	Description
show processes cpu < detailed | history | module | sort>	Check the control-plane CPU utilization of the switch
show processes memory < physical | shared | sort>	Check the memory utilization of the switch
show version	Check the NX-OS version, uptime, switch model, and so on.
show < environment | hardware >	Check the status of the hardware components of the switch

The output of the preceding commands is also available via NX-API when requested by a remote agent over HTTP or HTTPS.

SNMP MIBs can be used to poll the general health of the switch, especially the CPU, and the memory utilization.

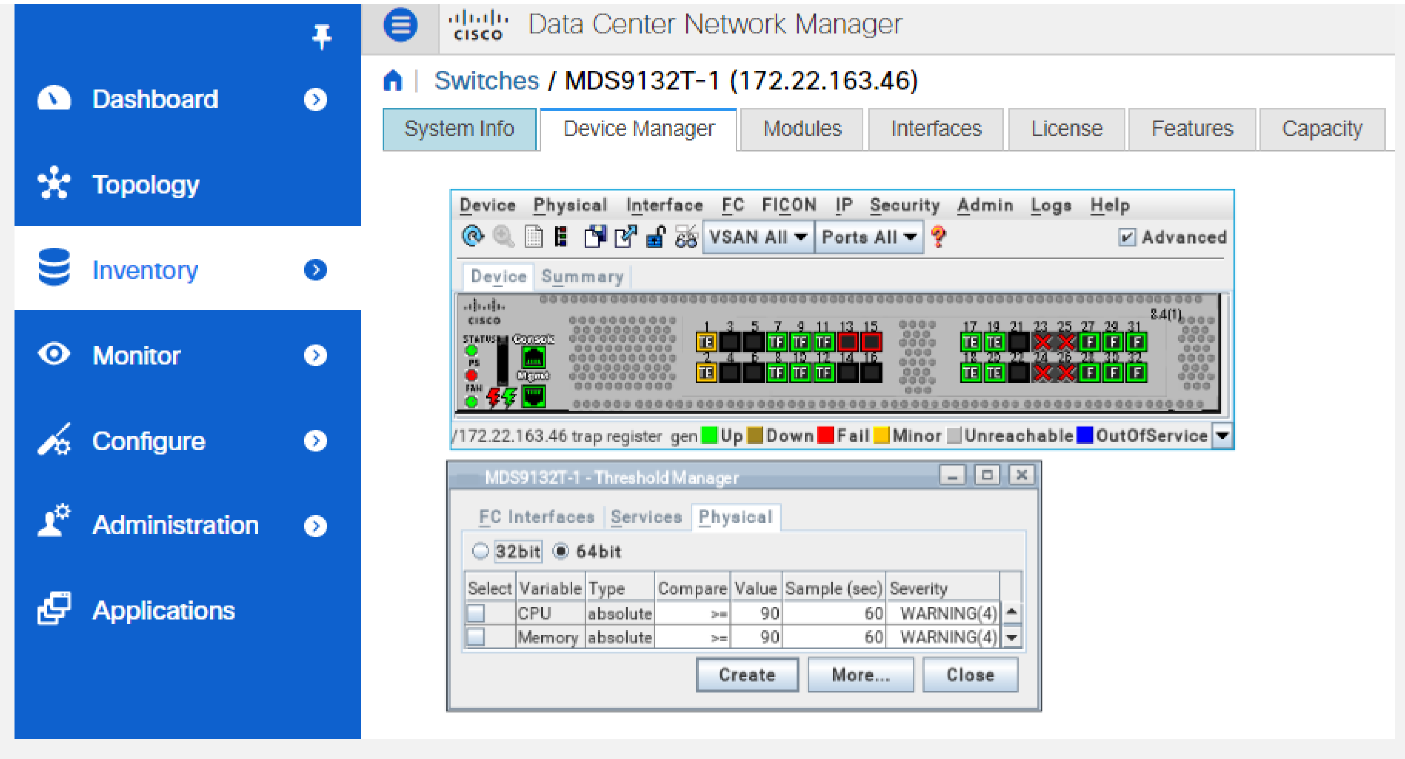
Table 2. General switch health SNMP Objects

SNMP Objects	OID	Description
cseSysMemoryUtilization	1.3.6.1.4.1.9.9.305.1.1.2	Percent utilization of memory
cseSysCPUUtilization	1.3.6.1.4.1.9.9.305.1.1.1	Percent utilization of CPU

Threshold-based alerting from common switch components

Use RMON to configure high-CPU, high-memory, and other similar alerts on MDS 9000 switch. RMON notifications are sent via SNMP trap or inform.

To configure RMON alerts from DCNM, navigate to Inventory > View > Switches. Select the switch from the Device Name column. Open Device Manager. Navigate to Admin tab > Events > Threshold Manager. Go to the Physical tab to set RMON alerts for high-CPU and high-Memory conditions.



○ 32bit ● 64bit

Select	Variable	Type	Compare	Value	Sample (sec)	Severity
□	CPU	absolute	>=	90	60	WARNING(4)
□	Memory	absolute	>=	90	60	WARNING(4)

Figure 10.
Configuring RMON events in DCNM

Best practice

Prefer DCNM over NX-OS CLI to configure threshold-based alerting using RMON

It is possible to set RMON alerts via NX-OS CLI but DCNM is recommended because it automatically translates SNMP OID to a user-friendly string. Please refer to the following snippet to configure the high-CPU and high-Memory RMON alerts using NX-OS.

```
MDS#configure
MDS(config)# rmon hcalarm 1 1.3.6.1.4.1.9.9.305.1.1.1.0 60 absolute startupalarm 1 rising-threshold 90 4 falling-threshold 89 4 owner user_1_cseSysCPUUtilization
MDS(config)# rmon hcalarm 2 1.3.6.1.4.1.9.9.305.1.1.2.0 60 absolute startupalarm 1 rising-threshold 90 4 falling-threshold 89 4 owner user_1_cseSysMemoryUtilization
MDS#
```

The RMON events are sent to the configured SNMP trap or inform destination, which can be DCNM or a compatible third-party application.

Monitoring of switch hardware components

The monitoring of switch hardware components is enabled by default. The notifications can be sent using Syslog and SNMP trap or inform. Email notifications can also be generated by MDS 9000 switches using Call Home or by DCNM event forwarding functionality.

The default enabled SNMP traps can be verified using `#show snmp trap` command. Please refer to the following snippet.

```
MDS9718-A# show snmp trap
--------------------------------------------------------------------------------
Trap type                       Description                   Enabled
--------------------------------------------------------------------------------
entity               : entity_mib_change               Yes
entity               : entity_module_status_change     Yes
entity               : entity_power_status_change      Yes
entity               : entity_module_inserted          Yes
entity               : entity_module_removed           Yes
entity               : entity_unrecognised_module      Yes
entity               : entity_fan_status_change        Yes
entity               : entity_power_out_change         Yes
link                 : linkDown                        Yes
link                 : linkUp                          Yes
link                 : extended-linkDown               Yes
link                 : extended-linkUp                 Yes
link                 : cieLinkDown                     Yes
link                 : cieLinkUp                       Yes
link                 : connUnitPortStatusChange        Yes
link                 : delayed-link-state-change       Yes
callhome             : event-notify                    No
callhome             : smtp-send-fail                  No
cfs                  : state-change-notif              No
cfs                  : merge-failure                   No
fcdomain             : dmNewPrincipalSwitchNotify      No
fcdomain             : dmDomainIdNotAssignedNotify     No
fcdomain             : dmFabricChangeNotify            No
fcsp                 : fcsp                            No
rf                   : redundancy_framework            Yes
aaa                  : server-state-change             No
license              : notify-license-expiry           Yes
license              : notify-no-license-for-feature   Yes
license              : notify-licensefile-missing      Yes
license              : notify-license-expiry-warning   Yes
scsi                 : scsi-lunDiscovery-complete      No
fcns                 : reject-reg-req                  No
fcns                 : local-entry-change              No
fcns                 : db-full                         No
fcns                 : remote-entry-change             No
rscn                 : rscnElsRejectReqNotify          No
rscn                 : rscnIlsRejectReqNotify          No
rscn                 : rscnElsRxRejectReqNotify        No
rscn                 : rscnIlsRxRejectReqNotify        No
fcs                  : request-reject                  No
fcs                  : discovery-complete              No
fctrace              : route-test-complete             No
zone                 : request-reject1                 No
zone                 : merge-success                   No
zone                 : merge-failure                   No
zone                 : default-zone-behavior-change    No
zone                 : unsupp-mem                      No
ipsec                : CryptoMap-Added                 No
ipsec                : CryptoMap-Deleted               No
ipsec                : CryptoMap-Attached              No
ipsec                : CryptoMap-Detached              No
vni                  : virtual-interface-created       No
vni                  : virtual-interface-removed       No
vsan                 : vsanStatusChange                No
vsan                 : vsanPortMembershipChange        No
fspf                 : fspfNbrStateChangeNotify        No
upgrade              : UpgradeOpNotifyOnCompletion     Yes
upgrade              : UpgradeJobStatusNotify          Yes
feature-control      : FeatureOpStatusChange           No
vrrp                 : cVrrpNotificationNewMaster      No
fdmi                 : cfdmiRejectRegNotify            No
sysmgr               : cseFailSwCoreNotifyExtended     No
rmon                 : risingAlarm                     Yes
rmon                 : fallingAlarm                    Yes
rmon                 : hcRisingAlarm                   Yes
rmon                 : hcFallingAlarm                  Yes
config               : ccmCLIRunningConfigChanged      No
snmp                 : authentication                  No
link                 : cisco-xcvr-mon-status-chg       No
vtp                  : notifs                          No
vtp                  : vlancreate                      No
vtp                  : vlandelete                      No
zone                 : enhanced-zone-db-change         No
entity               : entity_sensor                   Yes
entity               : cefcMIBEnableStatusNotification Yes
system               : Clock-change-notification       No
generic              : coldStart                       Yes
generic              : warmStart                       Yes
feature-control      : ciscoFeatOpStatusChange         No
syslog               : message-generated               No
entity               : cefcEnablePSOutputChangeNotif   Yes
vtp                  : notifs                          No
lldp                 : lldpRemTablesChange             No
switchfabric         : fabric-crc                      No
```

Traps and informs for more components can be enabled by `# snmp-server enable traps` command. Please refer to the following snippet.

```
MDS9718-A# configure
Enter configuration commands, one per line.  End with CNTL/Z.
MDS9718-A(config)# snmp-server enable traps ?
  <CR>
  aaa              Enable aaa traps
  callhome         Enable callhome traps
  cfs              Enable cfs traps
  config           Enable config traps
  entity           Enable entity traps
  fcdomain         Enable fcdomain traps
  fcns             Enable fcns traps
  fcs              Enable fcs traps
  fcsp             Enable fcsp traps
  fctrace          Enable fctrace traps
  fdmi             Enable fdmi traps
  feature-control  Enable feature-control traps
  fspf             Enable fspf traps
  generic          Enable generic traps
  ipsec            Enable ipsec traps
  license          Enable license traps
  link             Enable link traps
  lldp             Enable lldp traps
  rf               Enable rf traps
  rmon             Enable rmon traps
  rscn             Enable rscn traps
  scsi             Enable scsi traps
  snmp             Enable snmp traps
  storm-control    Enable storm-control traps
  switchfabric     Enable switchfabric traps
  syslog           Enable syslog traps
  sysmgr           Enable sysmgr traps
  system           Enable system traps
  upgrade          Enable upgrade traps
  vni              Enable vni traps
  vrrp             Enable vrrp traps
  vsan             Enable vsan traps
  vtp              Enable vtp traps
  zone             Enable zone traps
```

Hardware misconfigurations

Hardware misconfigurations are automatically detected, and alerting is enabled by default. The notifications are sent using Syslog and SNMP traps or informs. For example, switches with the support of bidirectional airflow, a misconfiguration in the airflow direction is autodetected and a system message is generated, as shown below.

```
2018 Apr 11 18:22:39 MDS9000 Apr 11 18:22:39 %KERN-0-SYSTEM_MSG: [496944.553395] Airflow
conflict is detected. Incompatible PSU/ Fan found. Switch will be shutdown if compatible
PSU/ Fan is not installed. - kernel
```

Similar alerts are generated from other hardware components when a failure or misconfiguration is detected. No actions are required from a user.

High-availability (HA) monitoring

The HA state of MDS 9000 switches can be monitored via command `# show system redundancy ha status`. Please refer to the following snippet.

```
MDS9706-C# show system redundancy ha status
This supervisor                        Other supervisor
---------------                        ----------------


Active with HA standby                 HA standby
MDS9706-C# show system redundancy status
Redundancy mode
---------------
      administrative:   HA
         operational:   HA


This supervisor (sup-3)
-----------------------
    Redundancy state:   Active
    Supervisor state:   Active
      Internal state:   Active with HA standby


Other supervisor (sup-4)
------------------------
    Redundancy state:   Standby
    Supervisor state:   HA standby
```

```
      Internal state:   HA standby
MDS9706-C#
```

The high-availability state of the MDS 9000 switches can also be monitored via CISCO-RF-MIB. For example, ciscoRFIssuStateNotif is generated to indicate a new state of the system. These state changes also generate system messages which can be sent to a remote agent via Syslog.

Email notifications can also be generated by MDS 9000 switches using Call Home or by DCNM event forwarding functionality.

SFP Monitoring and Alerting

Monitoring and alerting of SFPs on MDS 9000 switches are enabled by default. No action is required from a user. The alerting thresholds are pre-defined by the manufacturer based on the type of the SFP.

CLI

Use the `# show interface transceiver details` command to monitor the SFP.

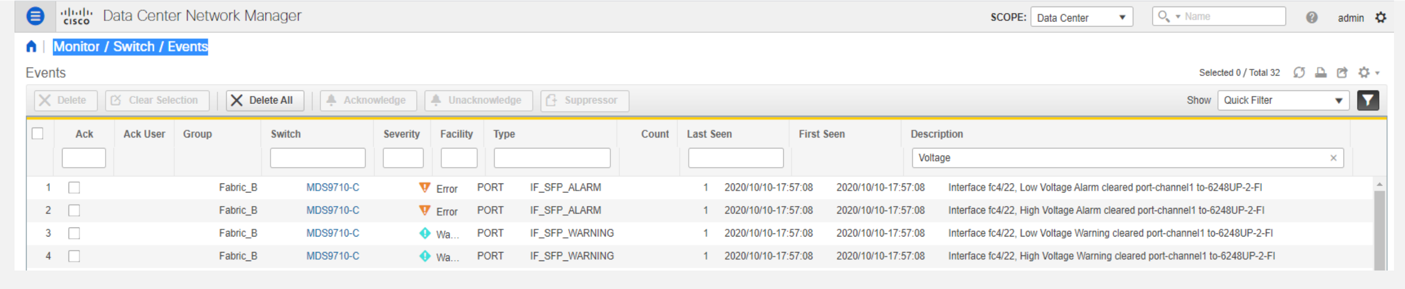
```
MDS9718-A# show interface fc1/1 transceiver details
fc1/1 sfp is present
    Name is CISCO-AVAGO
    Manufacturer's part number is AFBR-57F5PZ-CS1
    Revision is B2
    Serial number is AVJ1827JW6U
    Nominal bit rate is 14000 Mb/s
    Link length supported for 50/125um OM2 fiber is 35 m
    Link length supported for 62.5/125um fiber is 15 m
    Link length supported for 50/125um OM3 fiber is 100 m
    FC Transmitter type is short wave laser w/o OFC (SN)
    FC Transmitter supports short distance link length
    Transmission medium is multimode laser with 62.5 um aperture (M6)
    Supported speeds are - Min speed: 4000 Mb/s, Max speed: 16000 Mb/s
    Cisco extended id is unknown (0x0)
    Cisco part number is 10-2666-01
    Cisco pid is DS-SFP-FC16G-SW

    No tx fault, no rx loss, in sync state, diagnostic monitoring type is 0x68
    SFP Diagnostics Information:
----------------------------------------------------------------------------
                                     Alarms                  Warnings
                                High        Low         High          Low
----------------------------------------------------------------------------
  Temperature   29.45 C          75.00 C     -5.00 C     70.00 C        0.00 C
  Voltage        3.33 V           3.63 V      2.97 V      3.46 V        3.13 V
  Current        7.01 mA         10.50 mA     2.50 mA    10.50 mA       2.50 mA
  Tx Power      -2.16 dBm         1.70 dBm  -13.00 dBm   -1.30 dBm     -9.00 dBm
  Rx Power      -3.49 dBm         3.00 dBm  -15.90 dBm    0.00 dBm    -11.90 dBm
  Transmit Fault Count = 0
-----------------------------------------------------------------------------
  Note: ++  high-alarm; +  high-warning; --  low-alarm; -  low-warning


MDS9718-A#
```

SFPs are monitored for:

- Temperature (Celsius)
- Voltage (Volts)
- Current ((milli)Ampere)
- Tx Power (dBm)
- Rx Power (dBm)
- Transmit Fault (count)

The preceding command output also displays the alarm and warning ranges. The monitoring of the SFPs is enabled by default and alerts are generated when thresholds are exceeded. This event results in system messages (which can be sent to a remote agent via Syslog) and SNMP traps and informs.

This alert is also sent to DCNM and is accessible by navigating to Monitor > Switch > Events.



☐	Ack	Ack User	Group	Switch	Severity	Facility	Type	Count	Last Seen	First Seen	Description
											Voltage
1	☐		Fabric_B	MDS9710-C	Error	PORT	IF_SFP_ALARM	1	2020/10/10-17:57:08	2020/10/10-17:57:08	Interface fc4/22, Low Voltage Alarm cleared port-channel1 to-6248UP-2-FI
2	☐		Fabric_B	MDS9710-C	Error	PORT	IF_SFP_ALARM	1	2020/10/10-17:57:08	2020/10/10-17:57:08	Interface fc4/22, High Voltage Alarm cleared port-channel1 to-6248UP-2-FI
3	☐		Fabric_B	MDS9710-C	Wa...	PORT	IF_SFP_WARNING	1	2020/10/10-17:57:08	2020/10/10-17:57:08	Interface fc4/22, Low Voltage Warning cleared port-channel1 to-6248UP-2-FI
4	☐		Fabric_B	MDS9710-C	Wa...	PORT	IF_SFP_WARNING	1	2020/10/10-17:57:08	2020/10/10-17:57:08	Interface fc4/22, High Voltage Warning cleared port-channel1 to-6248UP-2-FI

Figure 11.
Viewing events in DCNM

SNMP polling

The SFP parameters can be polled from the switches using SNMP (CISCO-ENTITY-SENSOR-MIB). Use this option to continuously monitor the SFP parameters for a long-term trending and seasonality.

SNMP notifications

The SNMP traps and informs for SFP alarm and warning notifications are sent via CISCO-INTERFACE-XCVR-MONITOR-MIB. The object is cIfXcvrMonStatusChangeNotif with following components:

- ifName
- cIfXcvrMonDigitalDiagTempAlarm
- cIfXcvrMonDigitalDiagTempWarning
- cIfXcvrMonDigitalDiagVoltAlarm
- cIfXcvrMonDigitalDiagVoltWarning

- cIfXcvrMonDigitalDiagCurrAlarm
- cIfXcvrMonDigitalDiagCurrWarning
- cIfXcvrMonDigitalDiagRxPwrAlarm
- cIfXcvrMonDigitalDiagRxPwrWarning
- cIfXcvrMonDigitalDiagTxPwrAlarm
- cIfXcvrMonDigitalDiagTxPwrWarning
- cIfXcvrMonDigitalDiagTxFaultAlarm

For more details to translate OIDs into object names, their descriptions, browse OID trees, and to download the MIB files, please refer to the references section to access the Cisco SNMP Object Navigator.

Syslog notification

following is a sample message when a low voltage warning is generated from SFP in port fc1/1.

```
%PORT-4-IF_SFP_WARNING: Interface fc1/1, Low Voltage Warning
```

Interface State and Performance monitoring and Alerting

Hardware sensors on the port-ASICs on the Cisco MDS 9000 switches continuously collect the metrics at low granularity in real time. This section provides details to display the metrics using the NX-OS CLI or export them to a remote agent or generate automated alerting.

The monitoring of interfaces on MDS 9000 switches is enabled by default. Alerting of only major events is enabled by default, for example, link-up and link-down events. More alerts must be explicitly enabled, for example, high link utilization and B2B credit unavailability.

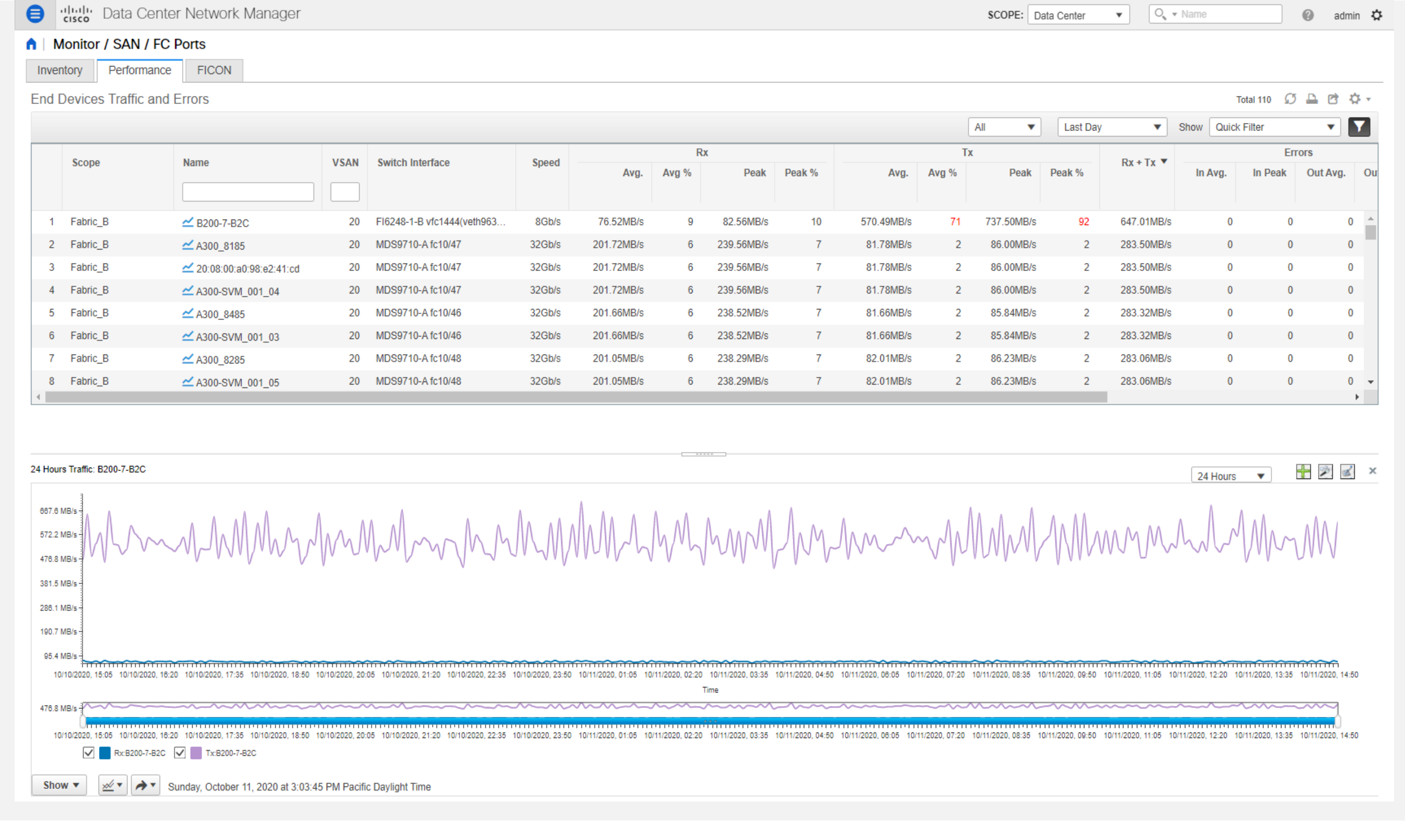
CLI

The interface counters are available under `# show interface <> counters`, `# show interface <> counters brief` and `# show interface <> counters detailed` commands, as shown below.

```
MDS9718-A# show interface fc1/15
fc1/15 is trunking
    Port description is to_MDS9706-C
    Hardware is Fibre Channel, SFP is short wave laser w/o OFC (SN)
    Port WWN is 20:0f:8c:60:4f:9e:2b:00
    Peer port WWN is 20:0f:8c:60:4f:54:51:00
    Admin port mode is auto, trunk mode is on
    snmp link state traps are enabled
    Port mode is TE
    Port vsan is 1
    Admin Speed is auto
    Operating Speed is 32 Gbps
    Rate mode is dedicated
    Port flow-control is ER_RDY

    Transmit B2B Credit for VL 0-3: 15, 15, 40, 430
    Receive B2B Credit for VL 0-3: 15, 15, 40, 430
    B2B State Change: Admin(on), Oper(up), Negotiated Value(14)
    Receive data field Size is 2112
    Beacon is turned off
    fec is enabled by default
    Logical type is core
    Belongs to port-channel2
    Trunk vsans (admin allowed and active) (1,20)
    Trunk vsans (up)                       (1,20)
    Trunk vsans (isolated)                 ()
    Trunk vsans (initializing)             ()
    5 minutes input rate 1446253536 bits/sec,180781692 bytes/sec, 135982 frames/sec
    5 minutes output rate 2023045760 bits/sec,252880720 bytes/sec, 194685 frames/sec
      1207557063868 frames input,1613205257783384 bytes
        0 discards,0 errors
        0 invalid CRC/FCS,0 unknown class
        0 too long,0 too short
      1727972173378 frames output,2257782335763584 bytes
        0 discards,0 errors
      7 input OLS,5  LRR,4 NOS,0 loop inits
      6 output OLS,10 LRR, 3 NOS, 0 loop inits
    Transmit B2B credit remaining for VL 0-3: 15, 15, 40, 429
    Receive B2B credit remaining for VL 0-3: 15, 15, 40, 430
    Last clearing of "show interface" counters: never

MDS9718-A#
MDS9718-A# show interface fc1/15 counters brief

-------------------------------------------------------------------------------
Interface          Input (rate is 5 min avg)      Output (rate is 5 min avg)
                   -----------------------------  -----------------------------
                   Rate     Total                 Rate     Total
                   MB/s     Frames                MB/s     Frames
-------------------------------------------------------------------------------
fc1/15             181      1207557888405         258      1727973322943
MDS9718-A#
MDS9718-A# show interface fc1/15 counters detailed
fc1/15
  Rx 5 min rate bit/sec:                                            1455865440
  Tx 5 min rate bit/sec:                                            2036661120
  Rx 5 min rate bytes/sec:                                           181983180
  Tx 5 min rate bytes/sec:                                           254582640
  Rx 5 min rate frames/sec:                                             136454
  Tx 5 min rate frames/sec:                                             195363

 Total Stats:
  Rx total frames:                                               1207559175743
  Tx total frames:                                               1727975142493
  Rx total bytes:                                             1613208106752576
  Tx total bytes:                                             2257786210241096
  Rx total multicast:                                                        0
  Tx total multicast:                                                        0
  Rx total broadcast:                                                        0
  Tx total broadcast:                                                        0
  Rx total unicast:                                              1207559175627
  Tx total unicast:                                              1727975142384
  Rx total discards:                                                         0
  Tx total discards:                                                         0
  Rx total errors:                                                           0
  Tx total errors:                                                           0
  Rx class-2 frames:                                                         0
  Tx class-2 frames:                                                         0
  Rx class-2 bytes:                                                          0
  Tx class-2 bytes:                                                          0
  Rx class-2 frames discards:                                                0
  Rx class-2 port reject frames:                                             0
  Rx class-3 frames:                                             1207546927035
  Tx class-3 frames:                                             1727965551223
  Rx class-3 bytes:                                           1613207164103092
  Tx class-3 bytes:                                           2257785595672952
  Rx class-3 frames discards:                                                0
  Rx class-f frames:                                                  12248475
  Tx class-f frames:                                                   9591012
  Rx class-f bytes:                                                  942649484
  Tx class-f bytes:                                                  614568144
  Rx class-f frames discards:                                                0

 Link Stats:
  Rx Link failures:                                                          3
  Rx Sync losses:                                                            0
  Rx Signal losses:                                                          0
  Rx Primitive sequence protocol errors:                                     0
  Rx Invalid transmission words:                                             0
  Rx Invalid CRCs:                                                           0
  Rx Delimiter errors:                                                       0
  Rx fragmented frames:                                                      0
  Rx frames with EOF aborts:                                                 0
  Rx unknown class frames:                                                   0
  Rx Runt frames:                                                            0
  Rx Jabber frames:                                                          0
  Rx too long:                                                               0
  Rx too short:                                                              0
  Rx FEC corrected blocks:                                                   0
  Rx FEC uncorrected blocks:                                                 0
  Rx Link Reset(LR) while link is active:                                    9
  Tx Link Reset(LR) while link is active:                                    1
  Rx Link Reset Responses(LRR):                                              5
  Tx Link Reset Responses(LRR):                                             10
  Rx Offline Sequences(OLS):                                                 7
  Tx Offline Sequences(OLS):                                                 6
  Rx Non-Operational Sequences(NOS):                                         4
  Tx Non-Operational Sequences(NOS):                                         3

 Congestion Stats:
  Tx Timeout discards:                                                       0
  Tx Credit loss:                                                            0
  BB_SCs credit resend actions:                                              0
  BB_SCr Tx credit increment actions:                                        0
  TxWait 2.5us due to lack of transmit credits for VL 0:                     0
  TxWait 2.5us due to lack of transmit credits for VL 1:                     0
  TxWait 2.5us due to lack of transmit credits for VL 2:                     0
  TxWait 2.5us due to lack of transmit credits for VL 3:                     0
  Percentage TxWait not available for last 1s/1m/1h/72h:           0%/0%/0%/0%
  Rx B2B credit remaining for VL 0:                                         15
  Rx B2B credit remaining for VL 1:                                         15
  Rx B2B credit remaining for VL 2:                                         40
  Rx B2B credit remaining for VL 3:                                        430
  Tx B2B credit remaining for VL 0:                                         15
  Tx B2B credit remaining for VL 1:                                         15
  Tx B2B credit remaining for VL 2:                                         40
  Tx B2B credit remaining for VL 3:                                        430
  Rx B2B credit transitions to zero for VL 0:                               10
  Rx B2B credit transitions to zero for VL 1:                                4
  Rx B2B credit transitions to zero for VL 2:                                4
  Rx B2B credit transitions to zero for VL 3:                           210513
  Tx B2B credit transitions to zero for VL 0:                               11
```

```
  Tx B2B credit transitions to zero for VL 1:                     5
  Tx B2B credit transitions to zero for VL 2:                     5
  Tx B2B credit transitions to zero for VL 3:                     5

 Other Stats:
  Zone drops:                                                     0
  FIB drops for ports  1-16:                                     20
  XBAR errors for ports  1-16:                                    0
  Other drop count:                                               0

 Last clearing of "show interface" counters :                 never

MDS9718-A#
```

DCNM starts monitoring interface utilization after enabling SAN Collections under the Performance setup. Switch port utilization graphs are accessible by navigating to Monitor > SAN > FC Ports > Performance tab.



End Devices Traffic and Errors

	Scope	Name	VSAN	Switch Interface	Speed	Rx				Tx				Rx + Tx ▼	Errors			
						Avg.	Avg %	Peak	Peak %	Avg.	Avg %	Peak	Peak %		In Avg.	In Peak	Out Avg.	Ou
1	Fabric_B	B200-7-B2C	20	FI6248-1-B vfc1444(veth963...	8Gb/s	76.52MB/s	9	82.56MB/s	10	570.49MB/s	71	737.50MB/s	92	647.01MB/s	0	0	0	
2	Fabric_B	A300_8185	20	MDS9710-A fc10/47	32Gb/s	201.72MB/s	6	239.56MB/s	7	81.78MB/s	2	86.00MB/s	2	283.50MB/s	0	0	0	
3	Fabric_B	20:08:00:a0:98:e2:41:cd	20	MDS9710-A fc10/47	32Gb/s	201.72MB/s	6	239.56MB/s	7	81.78MB/s	2	86.00MB/s	2	283.50MB/s	0	0	0	
4	Fabric_B	A300-SVM_001_04	20	MDS9710-A fc10/47	32Gb/s	201.72MB/s	6	239.56MB/s	7	81.78MB/s	2	86.00MB/s	2	283.50MB/s	0	0	0	
5	Fabric_B	A300_8485	20	MDS9710-A fc10/46	32Gb/s	201.66MB/s	6	238.52MB/s	7	81.66MB/s	2	85.84MB/s	2	283.32MB/s	0	0	0	
6	Fabric_B	A300-SVM_001_03	20	MDS9710-A fc10/46	32Gb/s	201.66MB/s	6	238.52MB/s	7	81.66MB/s	2	85.84MB/s	2	283.32MB/s	0	0	0	
7	Fabric_B	A300_8285	20	MDS9710-A fc10/48	32Gb/s	201.05MB/s	6	238.29MB/s	7	82.01MB/s	2	86.23MB/s	2	283.06MB/s	0	0	0	
8	Fabric_B	A300-SVM_001_05	20	MDS9710-A fc10/48	32Gb/s	201.05MB/s	6	238.29MB/s	7	82.01MB/s	2	86.23MB/s	2	283.06MB/s	0	0	0	

24 Hours Traffic: B200-7-B2C

Sunday, October 11, 2020 at 3:03:45 PM Pacific Daylight Time

Figure 12.
Monitoring performance of switch interfaces in DCNM

The interface metrics can be exported to a third-party application using SNMP, NX-API, or streaming telemetry.

For more details on NX-API, please refer to the references section to access the Cisco MDS 9000 Series Programmability Guide.

For more details on streaming telemetry, please refer to the references section to access the Cisco MDS 9000 Series SAN Analytics and SAN Telemetry Streaming Configuration Guide.

SNMP polling

IF-MIB is a commonly used MIB to monitor interface metrics. Also, table 3 provides a list of commonly used SNMB MIB objects for monitoring the interfaces on MDS 9000 switches.

Table 3. Product feature sets

S.No	MIB name	OID	Description
1	**ifHCInOctets**	1.3.6.1.2.1.31.1.1.1.6	Number of bytes received by the interface
2	**ifHCOutOctets**	1.3.6.1.2.1.31.1.1.1.10	Number of bytes transmitted by the interface
3	**fcIfTxWaitCount**	1.3.6.1.4.1.9.9.289.1.2.1.1.15	TxWait, the number of 2.5µs when a switch port could not transmit due to 0 Tx B2B credits
4	**fcHCIfBBCreditTransistionFromZero**	1.3.6.1.4.1.9.9.289.1.2.1.1.40	Tx B2B credit transition to zero
5	**fcIfBBCreditTransistionToZero**	1.3.6.1.4.1.9.9.289.1.2.1.1.40	Rx B2B credit transition to zero
6	**fcIfTxWtAvgBBCreditTransitionToZero**	1.3.6.1.4.1.9.9.289.1.2.1.1.38	Number of 100ms when a switchport could not transmit due to 0 Tx B2B credits
7	**fcIfCreditLoss**	1.3.6.1.4.1.9.9.289.1.2.1.1.37	Credit Loss (recovery) - Represents extended period (1 or 1.5 seconds) of 0 Tx B2B credits
8	**fcIfTimeOutDiscards**	1.3.6.1.4.1.9.9.289.1.2.1.1.35	Timeout discards
9	**fcIfOutDiscard**	1.3.6.1.4.1.9.9.289.1.2.1.1.36	Total number of frames discarded in egress direction, which includes timeout discards
10	**fcIfLinkResetIns**	1.3.6.1.4.1.9.9.289.1.2.1.1.9	Number of link reset protocol errors that are received by an FC port from the attached FC port
11	**fcIfLinkResetOuts**	1.3.6.1.4.1.9.9.289.1.2.1.1.10	Number of link reset protocol errors issued by the FC port to the attached FC port.
12	**fcIfSlowportCount**	1.3.6.1.4.1.9.9.289.1.2.1.1.44	Duration for which Tx B2B credits were unavailable on a port
13	**fcIfSlowportOperDelay**	1.3.6.1.4.1.9.9.289.1.2.1.1.45	Number of times for which Tx B2B credits were unavailable on a port for a duration longer than the configured admin-delay value in slowport-monitor
14	**fcIfInvalidCrcs**	1.3.6.1.4.1.9.9.289.1.2.1.1.6	Number of invalid CRC packets detected by an FC port

For more details, please refer to the references section to access the Cisco MDS 9000 Family MIB Quick Reference and Monitoring and Alerting in Cisco MDS Fabric white paper.

Alerting on interface metrics using port-monitor (PMON)

The port-monitor (PMON) feature on MDS 9000 switches proactively monitors the ports on an MDS 9000 switch and automatically generates alerts when the metrics exceed the configured thresholds. The port metrics are monitored in real time at a low granularity (as low as 2.5 microseconds). When PMON generates an event, the notification is sent using Syslog and SNMP traps or informs.

Best practice

Configure PMON for proactive and automatic notifications to monitor the health of the switch ports

Please refer to the references section to access the Sample MDS Port-Monitor Policies. A sample port-monitor policy for core and edge ports is shown below.

```
!
port-monitor name CorePorts
 logical-type core
 counter link-loss poll-interval 60 delta rising-threshold 5 event 4 falling-threshold 0 event 4
 counter sync-loss poll-interval 60 delta rising-threshold 5 event 4 falling-threshold 0 event 4
 counter signal-loss poll-interval 60 delta rising-threshold 5 event 4 falling-threshold 0 event 4
 counter invalid-words poll-interval 60 delta rising-threshold 1 event 4 falling-threshold 0 event 4
 counter invalid-crc poll-interval 60 delta rising-threshold 5 event 4 falling-threshold 0 event 4
 counter tx-discards poll-interval 60 delta rising-threshold 100 event 3 falling-threshold 10 event 3
 counter lr-rx poll-interval 60 delta rising-threshold 5 event 2 falling-threshold 1 event 2
 counter lr-tx poll-interval 60 delta rising-threshold 5 event 2 falling-threshold 1 event 2
 counter timeout-discards poll-interval 60 delta rising-threshold 100 event 3 falling-threshold 10 event 3
 counter credit-loss-reco poll-interval 60 delta rising-threshold 1 event 2 falling-threshold 0 event 2
 counter tx-credit-not-available poll-interval 1 delta rising-threshold 10 event 4 falling-threshold 0 event 4
 counter tx-datarate poll-interval 10 delta rising-threshold 80 event 4 falling-threshold 79 event 4
 counter err-pkt-from-port poll-interval 60 delta rising-threshold 50 event 3 falling-threshold 0 event 3
 counter err-pkt-to-xbar poll-interval 60 delta rising-threshold 50 event 3 falling-threshold 0 event 3
 counter err-pkt-from-xbar poll-interval 60 delta rising-threshold 50 event 3 falling-threshold 0 event 3
 counter tx-slowport-oper-delay poll-interval 1 absolute rising-threshold 80 event 4 falling-threshold 0 event 4
 counter txwait poll-interval 1 delta rising-threshold 20 event 4 falling-threshold 0 event 4
 monitor counter err-pkt-from-port
 monitor counter err-pkt-to-xbar
 monitor counter err-pkt-from-xbar
 no monitor counter state-change
 no monitor counter rx-datarate
!
port-monitor activate CorePorts
!
port-monitor name EdgePorts
 logical-type edge
 counter link-loss poll-interval 60 delta rising-threshold 5 event 4 falling-threshold 0 event 4
 counter sync-loss poll-interval 60 delta rising-threshold 5 event 4 falling-threshold 0 event 4
 counter signal-loss poll-interval 60 delta rising-threshold 5 event 4 falling-threshold 0 event 4
 counter invalid-words poll-interval 60 delta rising-threshold 1 event 4 falling-threshold 0 event 4
 counter invalid-crc poll-interval 60 delta rising-threshold 5 event 4 falling-threshold 0 event 4
 counter tx-discards poll-interval 60 delta rising-threshold 50 event 3 falling-threshold 10 event 3
 counter lr-rx poll-interval 60 delta rising-threshold 5 event 2 falling-threshold 1 event 2
 counter lr-tx poll-interval 60 delta rising-threshold 5 event 2 falling-threshold 1 event 2
 counter timeout-discards poll-interval 60 delta rising-threshold 50 event 3 falling-threshold 10 event 3
 counter credit-loss-reco poll-interval 60 delta rising-threshold 4 event 2 falling-threshold 0 event 2
 counter tx-credit-not-available poll-interval 1 delta rising-threshold 10 event 4 falling-threshold 0 event 4
 counter tx-datarate poll-interval 10 delta rising-threshold 80 event 4 falling-threshold 79 event 4
 counter tx-slowport-oper-delay poll-interval 1 absolute rising-threshold 50 event 4 falling-threshold 0 event 4
 counter txwait poll-interval 1 delta rising-threshold 20 event 4 falling-threshold 0 event 4
 no monitor counter err-pkt-from-port
 no monitor counter err-pkt-to-xbar
 no monitor counter err-pkt-from-xbar
 no monitor counter state-change
 no monitor counter rx-datarate
!
port-monitor activate EdgePorts
```

```
!
```

The preceding policy only triggers notifications. No port-guard actions are taken which can be configured for:

- Port flap
- Errodisable port (shutdown)
- Cong-isolated (Congestion Isolation)

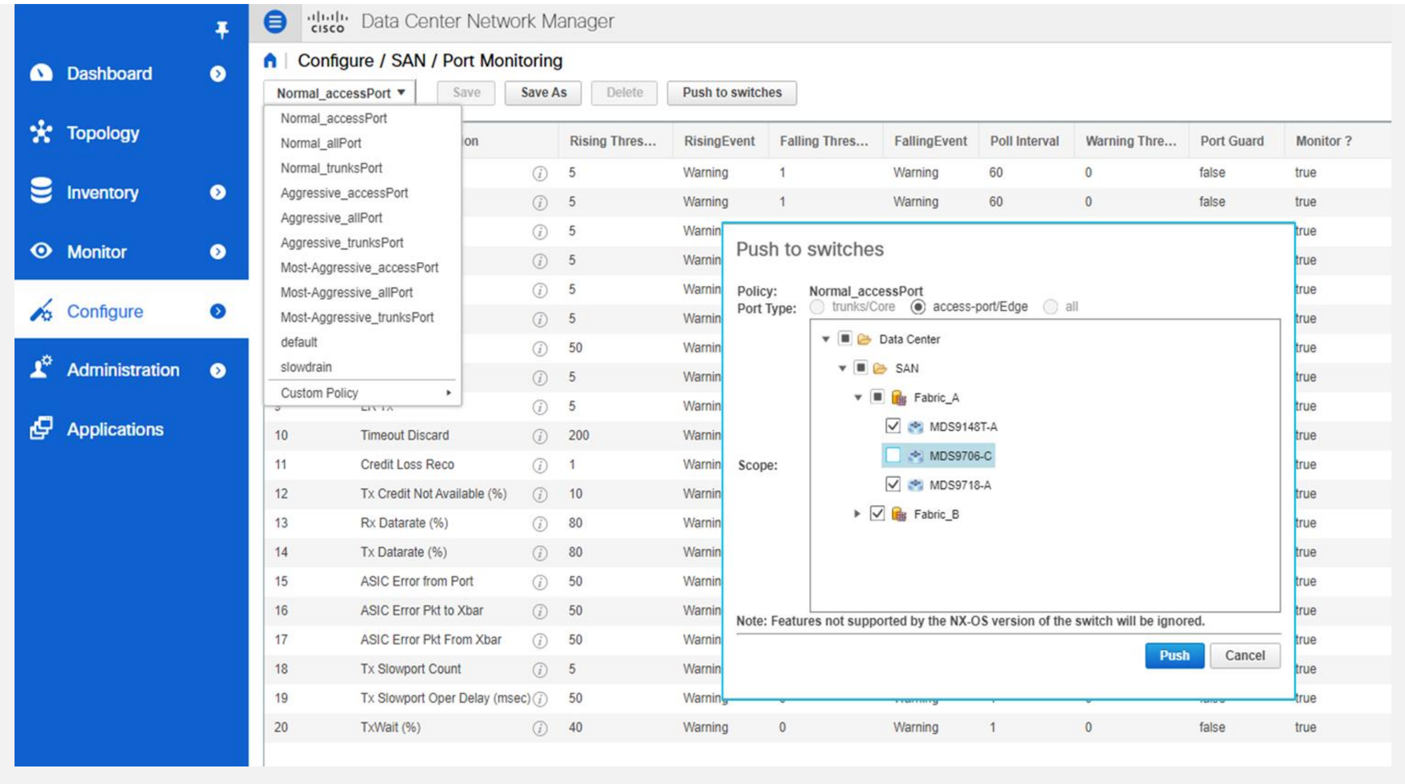
Enabling a port-guard action can be configured after a few initial weeks of soaking the thresholds values. Also, there is no single set of thresholds that fit all scenarios. The preceding policy is a good start. The aim should be to make the thresholds more aggressive if notifications are not received. When notifications are received, the root cause of the problem should be found and fixed before making the thresholds more aggressive.

Best practice

Customize the severity of the PMON events for a higher level of attention at important events

We recommend to configure higher severity for important counters. For example, the impact due to a Link Reset (lr-rx and lr-tx) event is more than a condition when a port does not have enough transmit B2B credits (txwait). Hence, the preceding sample policy configures lr-tx and lr-rx at severity level 2 and txwait to severity level 4.

Port-monitor can also be configured by DCNM for a consistent policy across multiple switches and fabrics. Navigate to Configure > SAN > Port Monitoring. Select one of the existing policy templates or create your own. The threshold values can be modified by clicking on the counter row. Finally, click the Push to switches button to configure the policy on one or multiple switches.



Configure / SAN / Port Monitoring

	on	Rising Thres...	RisingEvent	Falling Thres...	FallingEvent	Poll Interval	Warning Thre...	Port Guard	Monitor ?
		5	Warning	1	Warning	60	0	false	true
		5	Warning	1	Warning	60	0	false	true
		5	Warnin						true
		5	Warnin						true
		5	Warnin						true
		5	Warnin						true
		50	Warnin						true
		5	Warnin						true
		5	Warnin						true
10	Timeout Discard	200	Warnin						true
11	Credit Loss Reco	1	Warnin						true
12	Tx Credit Not Available (%)	10	Warnin						true
13	Rx Datarate (%)	80	Warnin						true
14	Tx Datarate (%)	80	Warnin						true
15	ASIC Error from Port	50	Warnin						true
16	ASIC Error Pkt to Xbar	50	Warnin						true
17	ASIC Error Pkt From Xbar	50	Warnin						true
18	Tx Slowport Count	5	Warnin						true
19	Tx Slowport Oper Delay (msec)	50	Warning						true
20	TxWait (%)	40	Warning	0	Warning	1	0	false	true

Policy: Normal_accessPort

Port Type: ○ trunks/Core ● access-port/Edge ○ all

Scope:

- ■ Data Center
  - ■ SAN
    - ■ Fabric_A
      - ☑ MDS9148T-A
      - □ MDS9706-C
      - ☑ MDS9718-A
    - ☑ Fabric_B

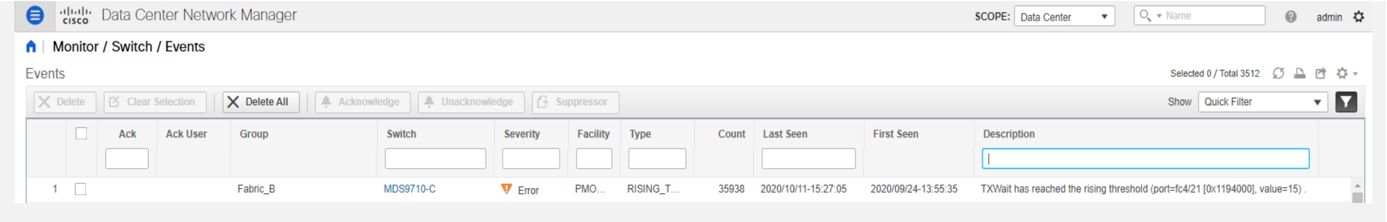
Note: Features not supported by the NX-OS version of the switch will be ignored.

Figure 13.
Configuring port-monitor from DCNM

following is a sample message generated by the port-monitor feature.

```
2020 Oct 11 11:25:55 MDS9710-C %PMON-SLOT4-3-RISING_THRESHOLD_REACHED: TXWait has
reached the rising threshold (port=fc4/26 [0x1199000], value=22) .
```

This alert is also sent to DCNM and is accessible by navigating to Monitor > Switch > Events.



	☐	Ack	Ack User	Group	Switch	Severity	Facility	Type	Count	Last Seen	First Seen	Description
1	☐			Fabric_B	MDS9710-C	Error	PMO...	RISING_T...	35938	2020/10/11-15:27:05	2020/09/24-13:55:35	TXWait has reached the rising threshold (port=fc4/21 [0x1194000], value=15) .

Figure 14.
Viewing port-monitor events in DCNM

Monitoring and Alerting of congestion and B2B credits

Cisco MDS 9000 switches and DCNM offer a strong feature-set to detect, troubleshoot, and automatically recover from SAN Congestion. An in-depth explanation of all the features is outside of the scope of this document. This section aims to help new users to quickly get started with monitoring and automated alerting for congestion in a SAN fabric built using MDS 9000 switches. For more details, please refer to the references section to access the Slow-Drain Device Detection, Troubleshooting, and Automatic Recovery white paper and Cisco MDS 9000 Series Interfaces Configuration Guide.

CLI

Monitoring of B2B credits and congestion is enabled by default on MDS 9000 switches. The metrics can be displayed by using `#show interface <> counters detailed` command, as shown in the following snippet.

```
MDS9718-A# show interface fc1/15 counters detailed

fc1/15

<snip>

 Congestion Stats:

  Tx Timeout discards:                                             0

  Tx Credit loss:                                                  0

  BB_SCs credit resend actions:                                    0

  BB_SCr Tx credit increment actions:                              0

  TxWait 2.5us due to lack of transmit credits for VL 0:           0

  TxWait 2.5us due to lack of transmit credits for VL 1:           0

  TxWait 2.5us due to lack of transmit credits for VL 2:           0

  TxWait 2.5us due to lack of transmit credits for VL 3:           0

  Percentage TxWait not available for last 1s/1m/1h/72h:     0%/0%/0%/0%

  Rx B2B credit remaining for VL 0:                               15

  Rx B2B credit remaining for VL 1:                               15

  Rx B2B credit remaining for VL 2:                               40
  Rx B2B credit remaining for VL 3:                                        430
  Tx B2B credit remaining for VL 0:                                         15
  Tx B2B credit remaining for VL 1:                                         15
  Tx B2B credit remaining for VL 2:                                         40
  Tx B2B credit remaining for VL 3:                                        430
  Rx B2B credit transitions to zero for VL 0:                               10
  Rx B2B credit transitions to zero for VL 1:                                4
  Rx B2B credit transitions to zero for VL 2:                                4
  Rx B2B credit transitions to zero for VL 3:                           210513
  Tx B2B credit transitions to zero for VL 0:                               11
  Tx B2B credit transitions to zero for VL 1:                                5
  Tx B2B credit transitions to zero for VL 2:                                5
  Tx B2B credit transitions to zero for VL 3:                                5

<snip>
 Last clearing of "show interface" counters :                            never

MDS9718-A#
```

The preceding command shows metrics in real time. A limited number of historic metrics and logs are stored in the persistent storage on the switch. This is called onboard failure logging (OBFL) and is accessible using `#show logging onboard` command. For example, please refer to the following snippet. The time at the execution of this command was 2020-10-14 11:22:52. The output displays that on Sat Apr 13 01:44:24 2019, interface fc1/3 was congested for 5% of the 20-seconds sampling period.

```
MDS9710-C# sh logging onboard txwait

---------------------------------
 Module: 1 txwait count
---------------------------------

----------------------------
Module: 1 show clock
----------------------------
2020-10-14 11:22:52

---------------------------------
Module: 1 txwait
---------------------------------
Notes:
     - Sampling period is 20 seconds
     - Only txwait delta >= 100 ms are logged

---------------------------------------------------------------------------------
```

```
| Interface | Virtual Link | Delta TxWait Time         | Congestion | Timestamp                |
|           |              | 2.5us ticks | seconds |            |                          |
--------------------------------------------------------------------------------------------
|   fc1/3   |    441949    |     1       |       5%    | Sat Apr 13 01:44:24 2019 |
```

The OBFL on MDS 9000 switches store extensive information.

For more details, please refer to the references section to access the Cisco MDS 9000 Series System Management Configuration Guide.

In addition to the congestion monitoring features enabled by default (for example, TxWait), Slowport monitor is an important feature to detect Tx B2B credit unavailability duration on the ports of MDS 9000 switches.

Best practice

Enable slowport-monitor for core and edge ports with 1 millisecond admin delay

Slowport-monitor is not enabled by default. Enable it using # `system timeout slowport-monitor` command.

```
MDS9718-A# conf t
MDS9718-A(config)# system timeout slowport-monitor 1 logical-type core
MDS9718-A(config)# system timeout slowport-monitor 1 logical-type edge
MDS9718-A(config)# end
MDS9718-A#
```

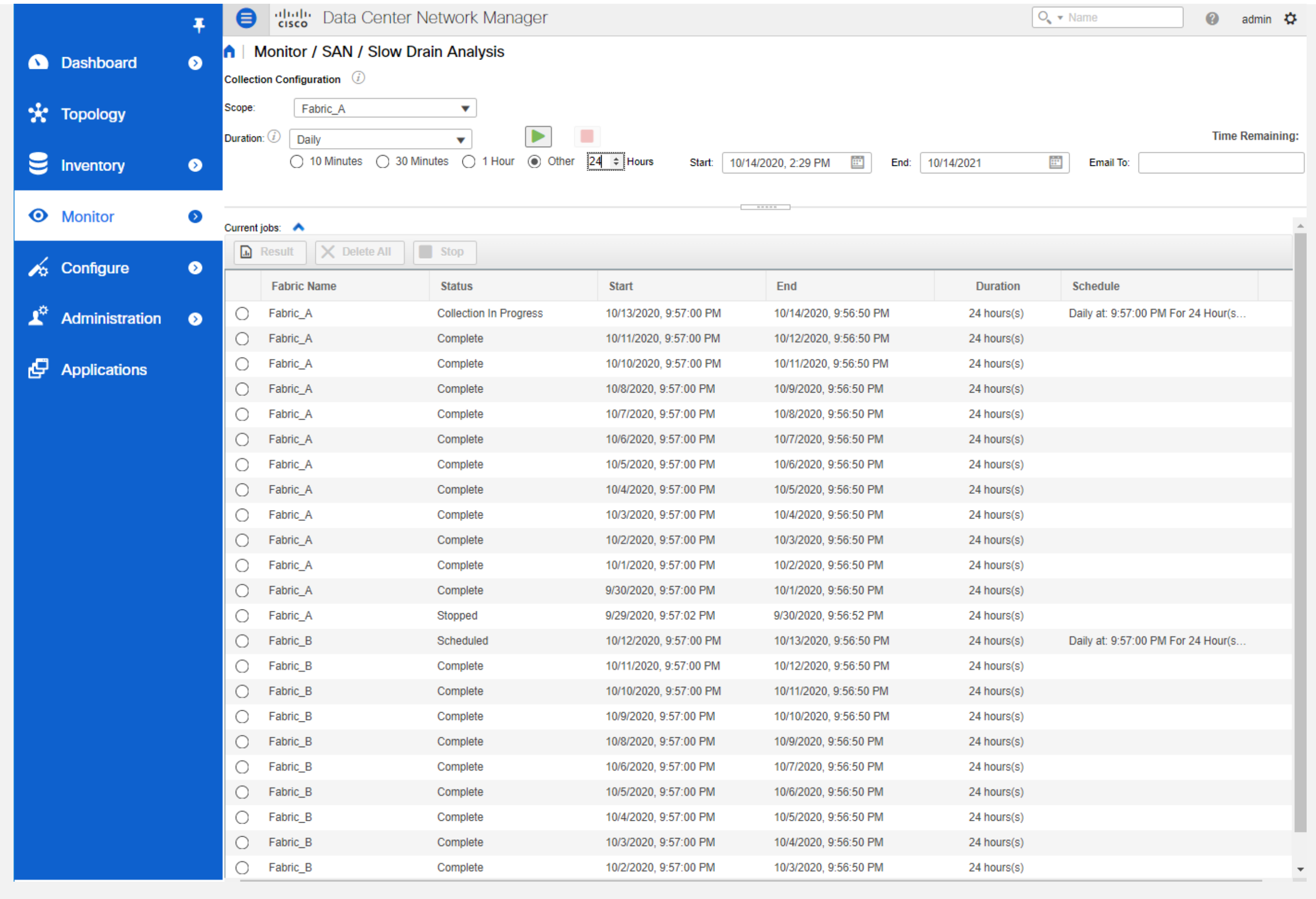
DCNM Slow drain Analysis

DCNM Slow Drain Analytics provides a single-pane-of-glass visibility across the entire fabric. This feature is not enabled by default. Start the Slow Drain analysis in DCNM by navigating to Monitor > SAN > Slow Drain Analysis. Select a Fabric from the Scope drop-down. Select Daily from the Duration drop-down. Select the Other radio-button and increase the number of hours to 24. Click the green Start Collection button to start the Slow Drain Analysis.

Best practice

Schedule slow drain analysis on all the switches daily for 24 hours for always-on monitoring

Repeat the same process for all the monitored fabrics. It is possible to visualize the results while the collection is under progress by selecting the Fabric under Current Jobs and clicking on the Results button.



Monitor / SAN / Slow Drain Analysis

Collection Configuration

Scope: Fabric_A

Duration: Daily

○ 10 Minutes ○ 30 Minutes ○ 1 Hour ● Other 24 Hours

Start: 10/14/2020, 2:29 PM End: 10/14/2021 Email To:

Time Remaining:

Current jobs:

	Fabric Name	Status	Start	End	Duration	Schedule
○	Fabric_A	Collection In Progress	10/13/2020, 9:57:00 PM	10/14/2020, 9:56:50 PM	24 hours(s)	Daily at: 9:57:00 PM For 24 Hour(s...
○	Fabric_A	Complete	10/11/2020, 9:57:00 PM	10/12/2020, 9:56:50 PM	24 hours(s)	
○	Fabric_A	Complete	10/10/2020, 9:57:00 PM	10/11/2020, 9:56:50 PM	24 hours(s)	
○	Fabric_A	Complete	10/8/2020, 9:57:00 PM	10/9/2020, 9:56:50 PM	24 hours(s)	
○	Fabric_A	Complete	10/7/2020, 9:57:00 PM	10/8/2020, 9:56:50 PM	24 hours(s)	
○	Fabric_A	Complete	10/6/2020, 9:57:00 PM	10/7/2020, 9:56:50 PM	24 hours(s)	
○	Fabric_A	Complete	10/5/2020, 9:57:00 PM	10/6/2020, 9:56:50 PM	24 hours(s)	
○	Fabric_A	Complete	10/4/2020, 9:57:00 PM	10/5/2020, 9:56:50 PM	24 hours(s)	
○	Fabric_A	Complete	10/3/2020, 9:57:00 PM	10/4/2020, 9:56:50 PM	24 hours(s)	
○	Fabric_A	Complete	10/2/2020, 9:57:00 PM	10/3/2020, 9:56:50 PM	24 hours(s)	
○	Fabric_A	Complete	10/1/2020, 9:57:00 PM	10/2/2020, 9:56:50 PM	24 hours(s)	
○	Fabric_A	Complete	9/30/2020, 9:57:00 PM	10/1/2020, 9:56:50 PM	24 hours(s)	
○	Fabric_A	Stopped	9/29/2020, 9:57:02 PM	9/30/2020, 9:56:52 PM	24 hours(s)	
○	Fabric_B	Scheduled	10/12/2020, 9:57:00 PM	10/13/2020, 9:56:50 PM	24 hours(s)	Daily at: 9:57:00 PM For 24 Hour(s...
○	Fabric_B	Complete	10/11/2020, 9:57:00 PM	10/12/2020, 9:56:50 PM	24 hours(s)	
○	Fabric_B	Complete	10/10/2020, 9:57:00 PM	10/11/2020, 9:56:50 PM	24 hours(s)	
○	Fabric_B	Complete	10/9/2020, 9:57:00 PM	10/10/2020, 9:56:50 PM	24 hours(s)	
○	Fabric_B	Complete	10/8/2020, 9:57:00 PM	10/9/2020, 9:56:50 PM	24 hours(s)	
○	Fabric_B	Complete	10/6/2020, 9:57:00 PM	10/7/2020, 9:56:50 PM	24 hours(s)	
○	Fabric_B	Complete	10/5/2020, 9:57:00 PM	10/6/2020, 9:56:50 PM	24 hours(s)	
○	Fabric_B	Complete	10/4/2020, 9:57:00 PM	10/5/2020, 9:56:50 PM	24 hours(s)	
○	Fabric_B	Complete	10/3/2020, 9:57:00 PM	10/4/2020, 9:56:50 PM	24 hours(s)	
○	Fabric_B	Complete	10/2/2020, 9:57:00 PM	10/3/2020, 9:56:50 PM	24 hours(s)	

Figure 15.
Slow Drain Analysis in DCNM

Metric export using SNMP, NX-API, or Streaming Telemetry

The Congestion metrics that are collected by MDS 9000 switches can be exported to remote agents using SNMP, NX-API, or streaming Telemetry.

Please refer to Table 3 for a list of import SNMP MIB objects for Congestion monitoring.

NX-API monitoring can be used to request the output of `#show interface counter detail` command which contains most of the congestion metrics.

Streaming telemetry can be used to export the interface counters which contain congestion metrics also.

Congestion Alerting

Automatic alerting on SAN Congestion should be enabled using port-monitor. For more details and sample configuration, please refer to the section on Interface State and Performance monitoring and Alerting.

Best practice

Use Slow Drain Analysis on DCNM and port-monitor on MDS 9000 switches together

We recommend to use DCNM Drain Analysis for fabric-wide monitoring. Proactive and automated alerting should be enabled using the port-monitor feature on the MDS 9000 switches. Both the features serve different purpose and complement each other. When proactive notifications are received from PMON, historic trends and seasonality can be inspected using the DCNM slow drain analysis.

Fabric services monitoring and alerting

Cisco MDS 9000 switches have more inbuilt monitoring for FC/FCoE services like FCNS database, zoning, VSAN, and so on. The notifications can be sent using Syslog and SNMP traps or informs. Email notifications can also be generated by MDS 9000 switches using Call Home or by DCNM using the event forwarding.

Fibre Channel Name Server (FCNS)

FCNS service can be monitored using CISCO-NS-MIB. The two important components of this MIB are

- **fcNameServerEntryAdd**: Name Server sends this notification whenever a new entry is added to the Name Server database.
- **fcNameServerEntryDelete**: Name Server sends this notification whenever an existing entry is deleted from the Name Server database.

Not all the SNMP traps are enabled by default. If necessary, more traps can be enabled by using `# snmp-server enable traps` command.

Also, RMON based alerting can be enabled on the switches using the Threshold Manager in Device Manager. For more details and example, please refer to the section on Threshold-based alerting from common switch components.

VSAN

VSAN service can be monitored using CISCO-VSAN-MIB, CISCO-VSAN-CAPABILITY, and CISCO-VLAN-MEMBERSHIP-MIB.

Like the FCNS traps, not all the SNMP traps are enabled by default. If necessary, more traps can be enabled by using `#snmp-server enable traps` command.

Also, RMON based alerting can be enabled on the switches using the Threshold Manager in Device Manager. For more details and example, please refer to the section on Threshold-based alerting from common switch components.

Zoning

Zoning service can be monitored using CISCO-ZS-MIB and CISCO-ZS-EXT-MIB. Alerts are also generated using EEM. For example, `__zone_members_max_per_sw` system policy generates a system message which can be sent via Syslog when the number of zones exceeds the maximum limit per switch.

Like the FCNS traps, not all the SNMP traps are enabled by default. If necessary, more traps can be enabled by using `#snmp-server enable traps` command.

Also, RMON based alerting can be enabled on the switches using the Threshold Manager in Device Manager. For more details and example, please refer to the section on Threshold-based alerting from common switch components.

Summary of best practices

Following is a summary of the best practices discussed in this document:

1. We recommend using NTP to synchronize the clocks between the monitored SAN switches and the monitoring agent (DCNM) before setting up alerting and event notifications. It helps in having consistent timestamps on the events generated by the managed switches and as displayed by the monitored agent (DCNM).
2. We recommend using SHA-AES as authentication and privacy mode for DCNM to discover MDS 9000 SAN fabric and the connected UCS Fabric Interconnects.
3. For DCNM to discover and monitor UCS Fabric Interconnects, servers, and traffic, we recommend using different name strings for snmp-user and read-only user in UCS Manager. This approach helps in better troubleshooting if any issues are found later in the discovery process.
4. We recommend enabling sending of Syslog to DCNM. This functionality is not enabled by default and must be configured explicitly.
5. We recommended using DCNM Event Forwarding to generate email notifications from a managed Cisco SAN Fabr . DCNM event Forwarding acts as a single-source to send email-notifications using a rule-based filtering on a central repository of the logs and events.
6. In DCNM, we recommend modifying the default names of the fabrics to use custom and friendly names to better describe the fabrics.
7. In DCNM, we recommend creating custom and friendly names for switch-groups, hierarchy, and grouping the discovered fabrics accordingly. DCNM follows this hierarchy throughput the other screen. A Custom hierarchy helps in effective monitoring and faster troubleshooting.
8. We recommend limiting the number of agents monitoring the same MDS 9000 switches to less than 3. The monitoring agents can be Cisco DCNM or other third-party applications.
9. We recommend limiting the number of event notification destinations (SNMP trap or inform, Syslog, and so on.) from an MDS 9000 switch to less than 3. The destinations of the events can be Cisco DCNM or other third-party applications.
10. RMON threshold-based alerting is recommended to be configured using DCNM. Although the configuration is possible using NX-OS CLI, configuration from DCNM is easier and does not require knowing the exact SNMP OID.
11. We recommend configuring the port-monitor (PMON) feature on MDS 9000 switches to generate proactive and automatic event notifications based on the health of the switch ports, for example, high utilization, CRC, congestion, and so on.
12. In the port-monitor (PMON) policies, we recommend customizing the severity of events (using event-id) as per the severity of the monitored metric.
13. We recommended configuring the slowport-monitor feature for core and edge ports with admin delay of 1 millisecond. Enabling slowport-monitor can help to identify fabric level congestion. This functionality is not enabled by default and must be configured explicitly.
14. We recommend running DCNM Slow Drain Analysis for always-on monitoring to help identify where slow drain symptoms are occurring within the fabric. To achieve this, schedule DCNM Slow drain analysis to run daily for 24 hours. This functionality is not enabled by default and must be configured explicitly on DCNM.

15. We recommend using the Slow Drain Analysis on DCNM and port-monitor (PMON) on MDS 9000 switches. These features complement each other to help automatically identify fabric level congestion symptoms.

Conclusion

This document provides step-by-step guidance and best-practices to configure automated monitoring and alerting in a Cisco SAN fabric. The hardware and the software components on the MDS 9000 switches collect the metrics and the logs in real time. In addition to the health of a SAN fabric, Cisco SAN Analytics provides at-the-scale visibility into the end-to-end IO flows. The collected metrics and logs can be exported via SNMP, NX-API, Syslog, or streaming telemetry in an open format to a compatible third-party app or Cisco Data Center Network Manager (DCNM). The automated monitoring and alerting features available on MDS 9000 switches and DCNM help in achieving proactive operations, reduced downtimes, and improved SLAs.

References

More for information, please refer to

- Cisco DCNM Installation and Upgrade Guide for SAN Deployment
- Cisco SNMP Object Navigator
- Cisco MDS 9000 Series Programmability Guide
- Cisco MDS 9000 Series SAN Analytics and SAN Telemetry Streaming Configuration Guide
- Slow-Drain Device Detection, Troubleshooting, and Automatic Recovery white paper
- Cisco MDS 9000 Family MIB Quick Reference
- Monitoring and Alerting in Cisco MDS Fabric white paper
- Sample MDS Port-Monitor Policies
- Cisco DCNM REST API Reference Guide
- MDS SDK Project on GitHub
- MDS SDK documentation
- Cisco UCS Manager configuration guide

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