# Cisco MDS 9000 Series SAN Analytics and SAN Telemetry Streaming Configuration Guide, Release 9.x

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# Preface

This preface describes the audience, organization of, and conventions used in the Cisco MDS 9000 Series Configuration Guides. It also provides information on how to obtain related documentation, and contains the following chapters:


- Audience, on page vii
- Document Conventions, on page vii
- Related Documentation, on page viii
- Communications, Services, and Additional Information, on page viii


## Audience

To use this installation guide, you need to be familiar with electronic circuitry and wiring practices, and preferably be an electronic or electromechanical technician.

## Document Conventions

This document uses the following conventions:

**Note** Means *reader take note*. Notes contain helpful suggestions or references to material not covered in the manual.

**Caution** Means *reader be careful*. In this situation, you might do something that could result in equipment damage or loss of data.

Warnings use the following conventions:

**Warning** This warning symbol means danger. You are in a situation that could cause bodily injury. Before you work on any equipment, be aware of the hazards involved with electrical circuitry and be familiar with standard practices for preventing accidents. Use the statement number provided at the end of each warning to locate its translation in the translated safety warnings that accompanied this device. Statement 1071.

# Related Documentation

The documentation set for the Cisco MDS 9000 Series Switches includes the following documents.

**Release Notes**

http://www.cisco.com/c/en/us/support/storage-networking/mds-9000-nx-os-san-os-software/products-release-notes-list.html

**Regulatory Compliance and Safety Information**

http://www.cisco.com/c/en/us/td/docs/switches/datacenter/mds9000/hw/regulatory/compliance/RCSI.html

**Compatibility Information**

http://www.cisco.com/c/en/us/support/storage-networking/mds-9000-nx-os-san-os-software/products-device-support-tables-list.html

**Installation and Upgrade**

http://www.cisco.com/c/en/us/support/storage-networking/mds-9000-nx-os-san-os-software/products-installation-guides-list.html

**Configuration**

http://www.cisco.com/c/en/us/support/storage-networking/mds-9000-nx-os-san-os-software/products-installation-and-configuration-guides-list.html

**CLI**

http://www.cisco.com/c/en/us/support/storage-networking/mds-9000-nx-os-san-os-software/products-command-reference-list.html

**Troubleshooting and Reference**

http://www.cisco.com/c/en/us/support/storage-networking/mds-9000-nx-os-san-os-software/tsd-products-support-troubleshoot-and-alerts.html

To find a document online, use the Cisco MDS NX-OS Documentation Locator at:

http://www.cisco.com/c/en/us/td/docs/storage/san_switches/mds9000/roadmaps/doclocater.html

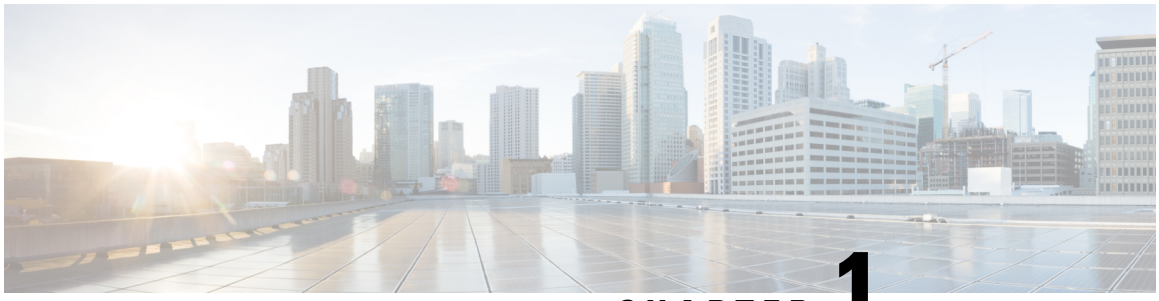
# Communications, Services, and Additional Information

- To receive timely, relevant information from Cisco, sign up at Cisco Profile Manager.
- To get the business impact you're looking for with the technologies that matter, visit Cisco Services.
- To submit a service request, visit Cisco Support.
- To discover and browse secure, validated enterprise-class apps, products, solutions and services, visit Cisco DevNet.
- To obtain general networking, training, and certification titles, visit Cisco Press.
- To find warranty information for a specific product or product family, access Cisco Warranty Finder.

### Cisco Bug Search Tool

Cisco Bug Search Tool (BST) is a web-based tool that acts as a gateway to the Cisco bug tracking system that maintains a comprehensive list of defects and vulnerabilities in Cisco products and software. BST provides you with detailed defect information about your products and software.

Preface



CHAPTER 1

# New and Changed Information


- Change Summary, on page 1


## Change Summary

The following table summarizes the new and changed information in this document, and provides information about the releases in which each feature is supported.

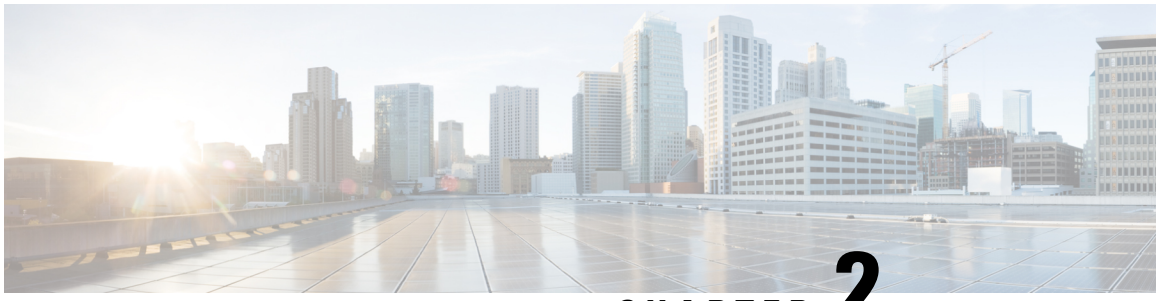
Note that your software release might not support all the features described in this document. For the latest caveats and feature information, see the Bug Search Tool at https://tools.cisco.com/bugsearch/, and the release notes document pertaining to your software release.

***Table 1: New and Changed Features***

| Feature Name | Description | Release | Where Documented |
|---|---|---|---|
| SAN Analytics | Added support for SAN Analytics and SAN Telemetry Streaming on MDS 9396V | 9.4(2) | Configuring SAN Analytics, on page 7 |
| SAN Analytics | Added support for SAN Analytics and SAN Telemetry Streaming on the following switches:<br>• MDS 9124V<br>• MDS 9148V | 9.4(1) | Configuring SAN Analytics, on page 7 |
| Reset AMC | Added support for non-disruptive recovery of analytics by resetting the AMC. | 9.3(1) | Troubleshooting SAN Analytics, on page 104 |

| Feature Name | Description | Release | Where Documented |
|---|---|---|---|
| SAN Analytics | Added the Cisco MDS 9700 48-Port 64-Gbps Fibre Channel Switching Module to the list of supported hardware.<br>Some flow metrics were added and some flow metrics were deprecated. | 9.2(2) | Appendix, on page 129 |
| Virtual Machine Identifier (VMID) Analytics | The VMID Analytics feature is introduced to monitor, analyze, identify, and troubleshoot performance issues at VM level. | 8.5(1) | Configuring SAN Analytics, on page 7 |
| SAN Analytics | Added support for Non-Volatile Memory Express (NVMe) analytics type. | 8.4(1) | Configuring SAN Analytics, on page 7 |
| SAN Telemetry Streaming | Updated the *fabric_telemetry.proto* file with NVMe flow metrics. | 8.4(1) | Configuring SAN Telemetry Streaming, on page 107 |
| SAN Analytics Support for Cisco MDS 9396T 32-Gbps 96-Port Fibre Channel Fabric Switch and Cisco MDS 9148T 32-Gbps 48-Port Fibre Channel Fabric Switch | The SAN Analytics and SAN Telemetry Streaming features are supported on the Cisco MDS 9396T 32-Gbps 96-Port Fibre Channel Fabric Switch and Cisco MDS 9148T 32-Gbps 48-Port Fibre Channel Fabric Switch. | 8.4(1) | Configuring SAN Analytics, on page 7 |
| Query Syntax | Added support for sorting metrics and metadata fields in ascending or descending order. | 8.3(2) | Configuring SAN Analytics, on page 7 |
| SAN Telemetry Streaming | Added support for compact Google Protocol Buffers (GPB-Compact) encoding. | 8.3(2) | Configuring SAN Telemetry Streaming, on page 107 |

| Feature Name | Description | Release | Where Documented |
|---|---|---|---|
| SAN Telemetry Streaming | The SAN Telemetry Streaming feature provides the capability to stream analytics and interface statistics to receivers such as Cisco Data Center Network Manager (DCNM). | 8.3(1) | Configuring SAN Telemetry Streaming, on page 107 |
| SAN Analytics Support for Cisco MDS 9132T 32 Gbps 32-Port Fibre Channel Switch | The SAN Analytics and SAN Telemetry Streaming features are supported on the Cisco MDS 9132T 32-Gbps 32-Port Fibre Channel Switch. | 8.3(1) | Configuring SAN Analytics, on page 7 |
| SAN Analytics Support for Cisco N-Port Virtualizer (Cisco NPV) Switch | The SAN Analytics and SAN Telemetry Streaming features are supported on the Cisco MDS 9132T 32-Gbps 32-Port Fibre Channel Switch operating in Cisco NPV mode. | 8.3(1) | Configuring SAN Analytics, on page 7 |
| SAN Analytics Support for Cisco MDS 9700 48-Port 32-Gbps Fibre Channel Switching Module | The SAN Analytics feature is supported on the Cisco MDS 9700 48-Port 32-Gbps Fibre Channel Switching module. | 8.2(1) | Configuring SAN Analytics, on page 7 |
| SAN Analytics | The SAN Analytics feature allows you to monitor, analyze, identify, and troubleshoot performance issues on supported Cisco MDS switches. | 8.2(1) | Configuring SAN Analytics, on page 7 |



CHAPTER 2

# SAN Analytics Solution


- Overview of the SAN Analytics Solution, on page 5


## Overview of the SAN Analytics Solution

The SAN Analytics solution provides insights into your fabric by allowing you to monitor, analyze, identify, and troubleshoot performance issues. This solution consists of the following components:

- SAN Analytics—The SAN Analytics feature collects performance and error metrics by inspecting data frames on switch ports. It also allows on-switch display of these metrics through the SAN Analytics CLI.
- SAN Telemetry Streaming—The SAN Telemetry Streaming feature is used to stream the data of interest to one or more receivers such as Cisco Data Center Network Manager (DCNM) for analysis.

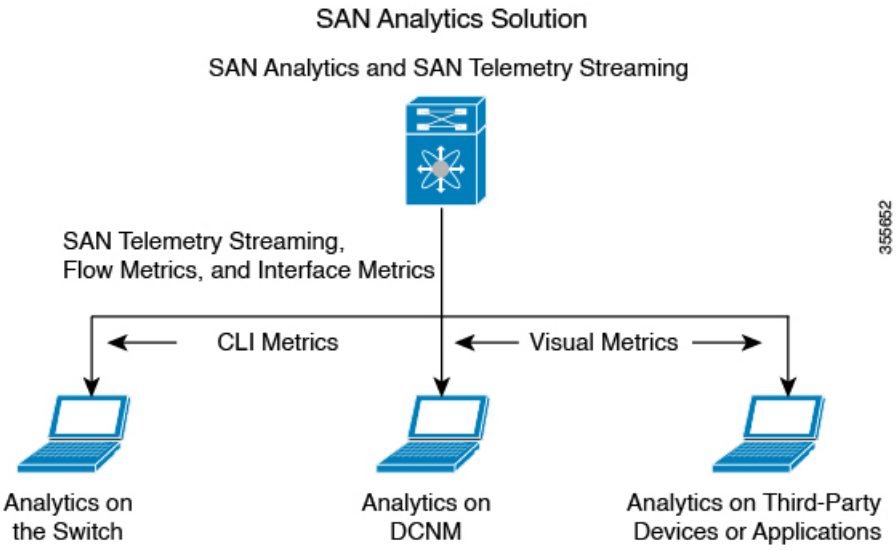
  Currently, there are two types of data that are supported for streaming:

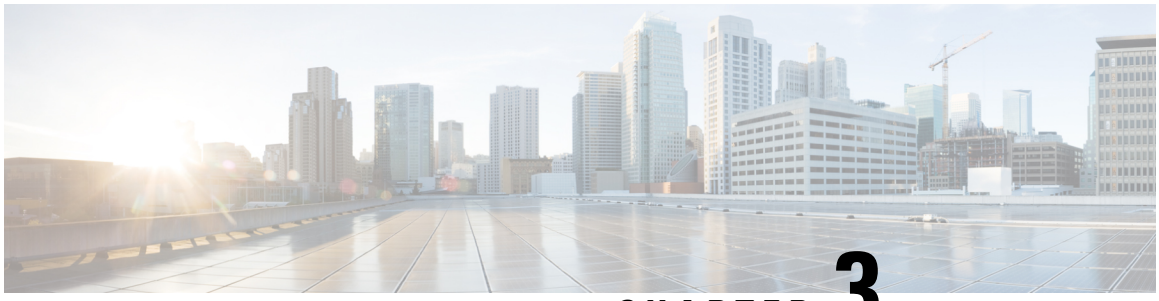
  - Flow Metrics—Small Computer System Interface (SCSI) and Non-Volatile Memory Express (NVMe) flow metrics that comprise of key components of Fibre Channel exchanges.
  - Interface Metrics—Statistical information of interfaces.

- Cisco DCNM SAN Insights—The Cisco DCNM SAN Insights feature represents the data of interest in a visual manner for analysis. For more information, see the Cisco DCNM SAN Management User Guide.
- Third-Party Devices or Applications—The data of interest can also be streamed and analyzed visually on supported third-party devices (such as VirtualWisdom from Virtual Instruments) or applications.

The following figure depicts the workflow of the SAN Analytics solution:

*Figure 1: SAN Analytics Solution*





CHAPTER 3

# Configuring SAN Analytics

This chapter provides information about the SAN Analytics feature and how to configure it:


- Feature History for Configuring SAN Analytics, on page 7
- SAN Analytics Overview, on page 10
- Hardware Requirements for SAN Analytics, on page 11
- Guidelines and Limitations for SAN Analytics, on page 12
- Command Changes, on page 15
- Information About SAN Analytics, on page 15
- Configuring SAN Analytics, on page 29
- Querying Metrics on a Switch, on page 34
- Constructing and Using Queries, on page 55
- Using the ShowAnalytics Overlay CLI, on page 73
- Displaying Congestion Drops Per Flow, on page 94
- Verifying SAN Analytics, on page 95
- Troubleshooting SAN Analytics, on page 104


# Feature History for Configuring SAN Analytics

*Table 2: Feature History for Configuring SAN Analytics*

| Feature Name | Release | Feature Information |
|---|---|---|
| Reset AMC | 9.3(1) | Added support for non-disruptive recovery of analytics by resetting the AMC. |
| SAN Analytics | 9.2(2) | Added the Cisco MDS 9700 48-Port 64-Gbps Fibre Channel Switching Module to the list of supported hardware.<br>Some flow metrics were added and some flow metrics were deprecated. For more information, see Appendix, on page 129. |
| Virtual Machine Identifier (VMID) Analytics | 8.5(1) | The VMID Analytics feature was introduced to monitor, analyze, identify, and troubleshoot performance issues at VM level.<br>The **analytics vm-tag veid** command was introduced. |

| Feature Name | Release | Feature Information |
|---|---|---|
| SAN Analytics | 8.5(1) | Analysis of NVMe traffic was changed to count only IO frames. Previously, admin frames were also included. |
| ShowAnalytics Overlay CLI | 8.5(1) | Added the **--appendfile** and **--outfile** options for the **ShowAnalytics** command.<br>The **ShowAnalytics --help** command output was modified. |
| ShowAnalytics Overlay CLI | 8.4(2) | Added the option to list the command keywords and variables for the **ShowAnalytics** command and its options.<br>Added support for the Non-Volatile Memory Express (NVMe) metrics in the **ShowAnalytics** command. |
| ShowAnalytics Overlay CLI | 8.4(1a) | Added the **--alias** argument for the **--top** option of the **ShowAnalytics** command. |
| SAN Analytics | 8.4(1) | Added support for NVMe analytics type.<br>New NVMe view instances and flow metrics were added. For more information, see Flow Metrics, on page 129.<br>The following commands were modified:<br>• Added the **fc-all** and **fc-nvme** keywords to the [**no**] **analytics type** {**fc-all** \| **fc-nvme** \| **fc-scsi**} command.<br>• Removed the **type fc-scsi** keyword from the **show analytics flow congestion-drops** [**vsan** *number*] [**module** *number* **port** *number*] command.<br>• Added the **--errorsonly**, **--evaluate-npuload**, **--minmax**, **--outstanding-io**, **--top**, **--vsan-thput**, **--alias**, **--limit**, **--key**, **--module**, **--progress**, and **--refresh** options to the **ShowAnalytics** command.<br>The **show analytics schema** {**fc-nvme** \| **fc-scsi**} {**view-instance** *instance-name* \| **views**} command was introduced to display schema for the SCSI and NVMe analytics types. |
| Query Syntax | 8.4(1) | Added support for NVMe analytics type.<br>The following query syntax supports *fc-nvme* analytics type:<br>**select all** \| *column1*[, *column2*, *column3*, …] **from** *analytics_type.view_type* [**where** *filter_list1* [**and** *filter_list2* …]] [**sort** *column* [**asc** \| **desc**]] [**limit** *number*] |
| SAN Analytics | 8.4(1) | The following command outputs were modified:<br>• **show analytics port-sampling module** *number*<br>• **show analytics system-load**<br>• **ShowAnalytics** |

| Feature Name | Release | Feature Information |
|---|---|---|
| SAN Analytics | 8.4(1) | Added the Cisco MDS 9396T 32-Gbps 96-Port Fibre Channel Fabric Switch and Cisco MDS 9148T 32-Gbps 48-Port Fibre Channel Fabric Switch to the list of supported hardware. |
| Query Syntax | 8.3(2) | Added support for sorting the metrics and metadata fields in ascending or descending order.<br>The **asc** and **desc** options were added to the query syntax:<br>**select all** \| *column1*[, *column2*, *column3*, …] **from** *analytics_type.view_type* [**where** *filter_list1* [**and** *filter_list2* …]] [**sort** *column* [**asc** \| **desc**] ] [**limit** *number*]<br>The **show analytics system-load** command was introduced. |
| SAN Analytics | 8.3(1) | The following command was introduced:<br>**no analytics name** *query_name*<br>See the Table 4: Command Changes, on page 15 for commands that have changed from Cisco MDS NX-OS Release 8.2(1) to Cisco MDS NX-OS Release 8.3(1). |
| Port Sampling | 8.3(1) | The Port Sampling feature allows you to gather data from a subset of ports in a module that is being monitored, cycle through multiple subsets of ports, and stream data from these ports at a regular port-sampling interval.<br>The following commands were introduced:<br>• **analytics port-sampling module** *number* **size** *number* **interval** *seconds*<br>• **show analytics port-sampling module** *number* |
| SAN Analytics | 8.3(1) | Some flow metrics were introduced. For more information, see Flow Metrics, on page 129. |
| SAN Analytics Support for Cisco MDS 9132T 32-Gbps 32-Port Fibre Channel Switch | 8.3(1) | Added the Cisco MDS 9132T 32-Gbps 32-Port Fibre Channel switch to the list of supported hardware. |
| SAN Analytics Support for Cisco N-Port Virtualizer (Cisco NPV) switches | 8.3(1) | Added guidelines and limitations for using the SAN Analytics feature on Cisco NPV switches. |
| SAN Analytics | 8.2(1) | Added the Cisco MDS 9700 48-Port 32-Gbps Fibre Channel Switching Module to the list of supported hardware. |

| Feature Name | Release | Feature Information |
|---|---|---|
| SAN Analytics | 8.2(1) | The SAN Analytics feature allows you to monitor, analyze, identify, and troubleshoot performance issues on Cisco MDS 9000 Series Multilayer Switches.<br>The following commands were introduced:<br>• **analytics type fc-scsi**<br>• **analytics query** *"query_string"* **type timer** *timer_val*<br>• **clear analytics** *"query_string"*<br>• **feature analytics**<br>• **purge analytics** *"query_string"*<br>• **ShowAnalytics**<br>• **show analytics** {**query** {*"query_string"* \| *id* **result**} \| **type fc-scsi flow congestion-drops** [**vsan** *number*] [**module** *number* **port** *number*]} |

# SAN Analytics Overview

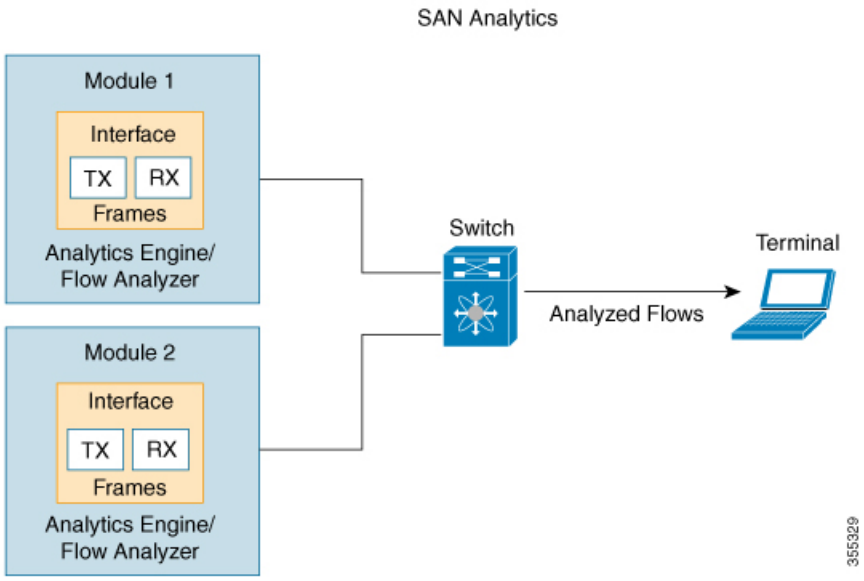
**Note** We recommended that you use the SAN Analytics feature in Cisco MDS NX-OS Release 8.3(1) or later releases.

The SAN Analytics feature allows you to monitor, analyze, identify, and troubleshoot performance issues on Cisco MDS switches. For a list of supported switches, see the Hardware Requirements for SAN Analytics, on page 11.

In a Fibre Channel SAN environment, it is important to provision and monitor the performance of all devices to be able to resolve any issues that can hinder the performance of such devices. The SAN Analytics feature monitors flows bidirectionally, correlates the flows in a network processing unit (NPU) within a module or individual switch, and provides the fully analyzed network data to the user.

The following figure shows the functionality of the SAN Analytics feature:

*Figure 2: SAN Analytics Overview*




# Hardware Requirements for SAN Analytics

The following table lists the Cisco MDS hardware that supports the SAN Analytics feature:

*Table 3: List of Supported Hardware*

| Switch | Module |
|---|---|
| Cisco MDS 9700 Series Multilayer Directors | • Cisco MDS 9700 48-Port 32-Gbps Fibre Channel Switching Module (DS-X9648-1536K9)<br>• Cisco MDS 9700 48-Port 64-Gbps Fibre Channel Switching Module (DS-X9748-3072K9) |
| Cisco MDS 9396V 64-Gbps 96-Port Fibre Channel Fabric Switch | • 96 x 64 Gbps Fixed Ports |
| Cisco MDS 9124V Fibre Channel Switch | • 24 x 64 Gbps Fixed Ports |
| Cisco MDS 9148V Fibre Channel Switch | • 48 x 64 Gbps Fixed Ports |
| Cisco MDS 9396T 32-Gbps 96-Port Fibre Channel Fabric Switch | • 96 x 32 Gbps Fixed Ports<br>• 32 Gbps Fibre Channel Expansion Module (M9XT-FC1632) |
| Cisco MDS 9148T 32-Gbps 48-Port Fibre Channel Fabric Switch | • 48 x 32-Gbps Fixed Ports |

| | |
|---|---|
| Cisco MDS 9132T 32-Gbps 32-Port Fibre Channel Fabric Switch | • 16 x 32-Gbps Fixed Ports<br>• 16 x 32-Gbps Fibre Channel Expansion Module (M9XT-FC1632) |

# Guidelines and Limitations for SAN Analytics

- This feature is not supported on VSANs where:
  - The default zone permit is configured.
  - The Inter-VSAN Routing (IVR) or Cisco MDS 9000 Input/Output Accelerator (IOA) feature is enabled.
  - Interoperability mode is enabled.
  - In-Order Delivery (IOD) is enabled.
- This feature has the following restriction about queries:
  - The maximum number of push queries is eight. For information about push queries, see Information About SAN Analytics, on page 15.
  - Does not support clearing and purging of individual metrics. For information about clearing and purging metrics, see Information About SAN Analytics, on page 15.
  - The where condition in the query syntax can accept only the equal (=) operator. For more information, see Query Syntax, on page 35.
- We recommend that you do not configure the **analytics type** command on ports that are members of port channels that are connected to Cisco Nexus switches and Cisco UCS Fabric Interconnects (SAN port channels) to avoid seeing missing and erroneous metrics.
- For a switch operating in Cisco NPV mode, when server logins move from one uplink to another, either via automatic load balancing by NX-OS or manual rebalancing by the user, the **show analytics system-load** command output may display an incorrect ITL count on that switch. This occurs if any auto load balanced devices ever need to log in again and do so via a different upstream link. If they do so, then they are assigned a new FCID. Because old analytics device FCID metrics are not automatically removed these stale entries result in additional ITL counts. You must purge the metrics first using the **purge analytics** *"query_string"* command before using the **show analytics system-load** command to get the correct data.
- The **show analytics system-load** command output displays incorrect ITL count after the VMID Analytics feature is initially enabled. To get the correct ITL count, you must first purge the metrics using the **purge analytics "select all from fc-scsi.port"** command before using the **show analytics system-load** command to get the correct data.
- If the total number of ITL records in an analytics engine port set exceeds 4000 on a Cisco MDS 48-Port 64-Gbps Fibre Channel Switching Module (DS-X9748-3072K9), incomplete analytics data may be reported. See the Analytics Engine Port Set Mapping, on page 22 section for how to reduce the number of flows in the port set and avoid this issue.

  The following syslog is displayed when this limit is exceeded:

```
%ANALYTICS_LC_MGR-SLOT1-4-ANALYTICS_LC_MGR_4K_ITL_LIMIT_HIT: Analytics data may be
incomplete on few ports :
Affected ports are fc1/5,fc1/1,fc1/7,fc1/3
```

- Analytics support on interfaces that are part of a port channel can have an impact on the overall analytics scale numbers.
- The **select all** option in the query syntax does not display VMID metrics. To view VMID metrics, you must specify one or more individual metrics in the query string and include the *vmid* key. For example, **show analytics query "select port,vsan,app_id,vmid,target_id,initiator_id,lun, active_io_read_count,active_io_write_count from fc-scsi.scsi_initiator_itl_flow"**.
- When this feature is used along with Cisco DCNM (or third-party devices or applications), the Network Time Protocol (NTP) must be synchronized. For information on NTP, see the "Configuring NTP" section in the Cisco MDS 9000 Series Fundamentals Configuration Guide.
- This feature is not supported on Switched Port Analyzer (SPAN) Destination ports, more commonly known as SD ports, and NP (N-Port) ports. If you are enabling this feature on a range of interfaces, ensure that there are no SD or NP ports in that range of interfaces. Otherwise, this feature will not get enabled on any interface.
- This feature only analyzes frames containing standards-based commands. In Cisco MDS NX-OS Releases 8.2(x) and Release 8.3(x), Fibre Channel Protocol (FCP) SCSI read and write commands are supported. From Cisco MDS NX-OS Release 8.4(1), both Fibre Channel SCSI and Fibre Channel Non-Volatile Memory Express (NVMe) read and write commands are supported. This feature does not analyze any frames containing proprietary commands; these are typically used by storage replication technologies.
- If the **feature analytics** command is enabled in Cisco MDS NX-OS Release 8.2(1) or Release 8.3(1), upgrading or downgrading between Cisco MDS NX-OS Release 8.2(1) and Release 8.3(1) is supported only after this feature is disabled using the **no feature analytics** command before upgrading or downgrading, and then re-enabling this feature using the **feature analytics** command.

  After downgrading from Cisco MDS NX-OS Release 8.3(1) or later releases to Release 8.2(1), this feature works only after you perform the workarounds mentioned in the caveat CSCvm19337.
- After upgrading, downgrading, reloading a switch, or reloading a module, all the flow metrics will be purged.
- This feature is not supported when the switch is in soft zoning mode.
- We recommend that the streaming-sample interval (**snsr-grp** *id* **sample-interval** *interval*), port-sampling interval (**analytics port-sampling module** *number* **size** *number* **interval** *seconds*), and push-query interval (**analytics query** *"query_string"* **name** *query_name* **type periodic** [**interval** *seconds*] [**clear**] [**differential**]) be configured with the same value. We also recommend that you change or configure the push-query interval first, then the port-sampling interval, and finally, the streaming-sample interval.

**Caution**

- We recommend that you set the streaming-sample interval, port-sampling interval, and push-query interval to be equal to or more than the minimum recommended value of 30 seconds. Configuring intervals below the minimum value may result in undesirable system behavior.
- See the Cisco MDS NX-OS Configuration Limits, Release 8.x document for information on the maximum number of Initiator-Target-LUNs (ITLs) supported per module.

  If the active ITL count exceeds the documented limit, a syslog message is logged. If the limit is exceeded for a significant amount of time, the stability of the switch may be impacted. Use the **show analytics system-load** command to check the ITL count and NPU load. For more information, see the Cisco MDS 9000 Family and Nexus 7000 Series NX-OS System Messages Reference Guide and the Cisco MDS NX-OS Configuration Limits, Release 8.x document.

- To avoid exceeding the network processing unit (NPU) capacity and its consequences, use the Port Sampling feature to analyze the flow metrics. For more information, see Port Sampling, on page 20.
- After you purge a view instance and its associated metrics, we recommend that you wait for few seconds before executing a pull query, because some fields in the flow metrics may contain irrelevant values until the purge operation is complete.
- NVMe analytics is compatible with the Fibre Channel Non-Volatile Memory Express - 1 (FC-NVMe-1) and FC-NVMe-2 standards.
- This feature tracks every flow metric on a per-port basis. Flow requests and responses spanning different physical ports on a switch may result in some flow metrics not being accurately computed. This condition specifically occurs when this feature is enabled on Inter-Switch Link (ISL) ports (E ports).

  The following is a lists the scenarios where a request response can be seen on different ISL ports:

  - The load-balancing scheme is changed to Source ID (SID)-Destination ID (DID) by the user using the **vsan** *ID* **loadbalancing src-dst-id** command.
  - ISLs (E ports) are configured to nontrunking mode by the user using the **switchport trunk mode off** command.
  - ISLs (E ports) that are part of a port channel, and the port-channel is not configured to the active mode using the **no channel mode active** command.
  - This feature does not work on nontrunk ISL or port channel. For this feature to work on an E port, the E port should have the trunk mode on.
  - ISLs are not bundled together to be part of a port channel; that is, ECMP ISLs and ECMP port-channels are not supported.
  - There is a port channel between the Cisco MDS 9250i Multiservice Fabric Switch or Cisco MDS 9148S 16-G Multilayer Fabric Switch and the Cisco MDS 9700 48-Port 32 Gbps Fibre Channel Switching Module (DS-X9648-1536K9).

- This feature is not supported on a FICON enabled Cisco MDS 9000 switches.

- SAN Analytics is supported on MDS 9124V and MDS 9148V from Release 9.4(1). To downgrade to an earlier release on this switch, you must disable SAN Analytics before the downgrade.
- SAN Analytics is supported on MDS 9396V from Release 9.4(2). To downgrade to an earlier release on this switch, you must disable SAN Analytics before the downgrade.

# Command Changes

Some commands have undergone changes in Cisco MDS NX-OS Release 8.3(1). This document displays commands that are introduced or changed in Cisco MDS NX-OS Release 8.3(1). See the Table 4: Command Changes, on page 15 for the commands that are equivalent to the ones used in Cisco MDS NX-OS Release 8.2(1).

We recommended that you use the SAN Analytics feature in Cisco MDS NX-OS Release 8.3(1) and later releases.

Table 4: Command Changes, on page 15 lists the changes made to the commands in Cisco MDS NX-OS Release 8.3(1):

***Table 4: Command Changes***

| Cisco MDS NX-OS Release 8.2(1) | Cisco MDS NX-OS Release 8.3(1) |
|---|---|
| **analytics query** *"query_string"* **type timer** *timer_val* | **analytics query** *"query_string"* **name** *query_name* **type periodic** [**interval** *seconds*] [**clear**] [**differential**] |
| **clear analytics** *"query_string"* | **clear analytics query** *"query_string"* |
| **purge analytics** *"query_string"* | **purge analytics query** *"query_string"* |
| **show analytics query** {*"query_string"* \| *id* **result**} | **show analytics query** {*"query_string"* [**clear**] [**differential**] \| **all** \| **name** *query_name* **result**} |

# Information About SAN Analytics

The SAN Analytics feature collects flow metrics using frames of interest, for data analysis, and includes the following components:

- Data Collection—The flow data is collected from NPU and eventually sent and stored on the supervisor of a switch. The data that is displayed is the real time view of the data and does not display historical data.
- On-board Querying—The data that is stored in a database can be extracted using a pull query, a push query, or overlay CLIs. Queries are used to extract the flow metrics of interest from the database. The frames of interest are used to monitor, analyze, and troubleshoot performance issues on a switch. For more information, see Constructing and Using Queries, on page 55.

  The following are the different ways of querying the database:

- The pull query is a one-time query that is used to extract the flow information that is stored in the database at the instant the query is executed. The output is in JSON format. Pull queries are NX-API compliant.

  The overlay CLI **ShowAnalytics** command is a python script that issues a predefined pull query that displays the flow metrics in a user-friendly tabular format. It is a CLI wrapper that is written in Python and stored in the bootflash for execution.

  From Cisco MDS NX-OS Release 8.3(1), the following options are supported in a pull query:

  - Clear—Clears all minimum, maximum, and peak flow metrics.
  - Differential—Returns the absolute value of only the ITL or ITN flow metrics that were updated between the last and the present streaming intervals. We recommend that you use the differential query to improve scale values of your switch.

- Push query—A recurring query that is installed to periodically extract the flow metrics that are stored in the database and send them to a destination. The output is in JSON format.

  From Cisco MDS NX-OS Release 8.3(1), the following options are available in a push query:

  - Clear—Clears all minimum, maximum, and peak flow metrics.
  - Differential—Returns the absolute value of only the ITL or ITN flow metrics that were updated between the last and the present streaming intervals. We recommend that you use the differential query to improve scale values of your switch.

  Push query supports the following modes for extracting flow metrics:

  - Continuous mode—Data is gathered continuously on all analytics-enabled ports.
  - Sampling mode—Data is gathered on a subset of analytics-enabled ports at a configured port-sampling interval, and then the data-gathering mechanism is cycled through the next subset of ports. For example, data is gathered on a group of 6 ports from the 24 analytics-enabled ports with a port sampling interval of 30 seconds. For more information, see Port Sampling, on page 20.

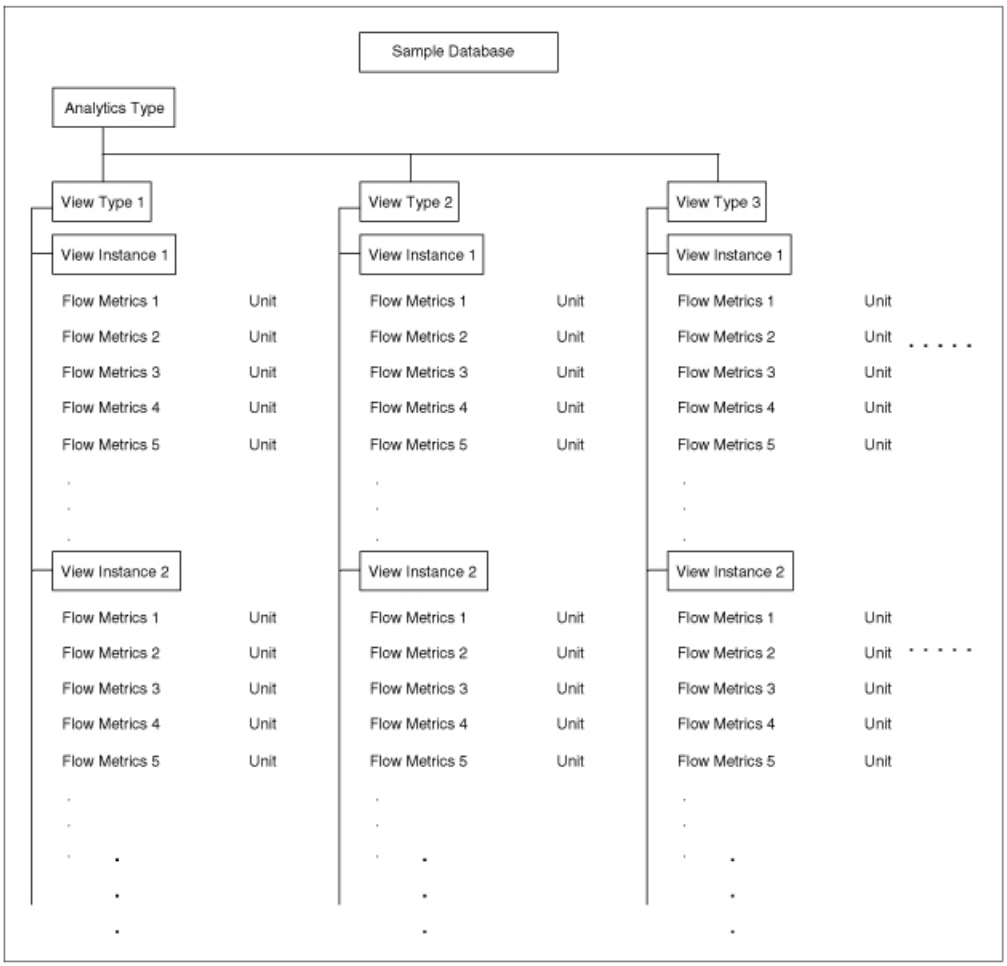
The database that is used for storing the flow metrics is organized according to the following hierarchy:

- Analytics Type—The protocol type to analyze. *fc-scsi* analytics type is supported in Cisco MDS NX-OS Release 8.2(x) and Cisco MDS NX-OS Release 8.3(x). *fc-scsi* and *fc-nvme* analytics types are supported from Cisco MDS NX-OS Release 8.4(1).
- View—A view is a selection of flow metrics in the database defined by any valid combination of port, VSAN, initiator, target, LUN, and namespace ID parameters.
- View Type—Views are defined based on components that constitute a flow, for example, port view, initiator_IT view, target_ITL view, and so on. The query syntax is used to run queries on a view type. The syntax supports only one query on a single view type. For a list of view types that are supported, see List of Supported View Types, on page 36.
- View Instance—An instance of a given view type. View instance has its own flow metrics. For example, for port view type, fc1/1 is one instance, fc1/2 is another instance, and so on.
- Flow Metrics—The flow metrics that are used for analysis. From Cisco MDS NX-OS 8.5(1) NVMe traffic metrics include only IO frames as classified by the NVMe frame's *Category* field. Prior to this

release both IO and admin frames were included. For information about the list of flow metrics that are supported, see the view profiles in the Flow Metrics, on page 129 section in Appendix.

The following image shows the various components of a sample database:

***Figure 3: Sample Database***




For sample examples on configuring a query syntax, see the Examples: Configuring Query Syntax, on page 50.

The following is the flow data collection workflow:

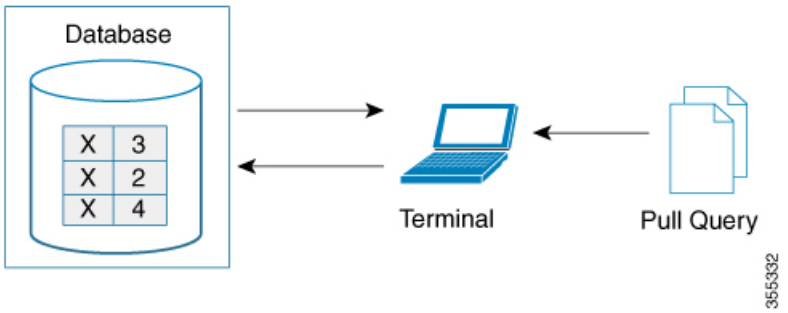
1. Feature Enablement—Enable the SAN Analytics feature on switches for which flow metrics have to be analyzed.
2. Interface Enablement—Enable collection of flow metrics on interfaces. We recommend that you enable the SAN Analytics feature on host interfaces, as seen in the images in Deployment Modes, on page 23.
3. Executing and Installing Queries—The following queries are used to retrieve flow metrics from the database:
    - Pull Query—Provides near real-time flow metrics for troubleshooting issues directly on a switch. Data from a pull query is extracted from the database at that instant and responded to the query. Pull

query can be executed using CLI or via NX-API. Cisco DCNM can use the NX-API to gather data for visualization.

Overlay CLI—A predefined pull query that displays the flow metrics in a user-friendly tabular format. It provides near real-time flow metrics for troubleshooting issues directly on a switch.

The following image shows the functionality of a pull query:

***Figure 4: Pull Query***



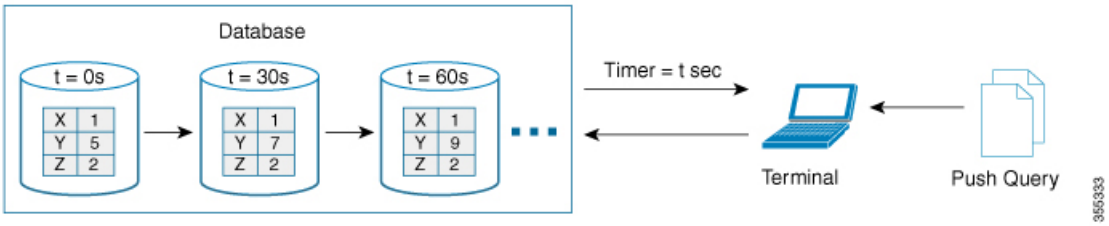

- Push Query—Provides flow metrics at regular intervals. You can specify a time interval, in seconds. After the time interval expires, the flow metrics that are of interest to the user are refreshed and pushed from the database. When multiple queries are installed, each of the push queries pushes the flow metrics independent of each other, which is the expected behavior.

**Note**

- Pull query, push query, and overlay CLI are applicable only on the interfaces on which the SAN Analytics feature is enabled.
- Push query timer fetches flow metrics from the NPU and stores them in the database on the supervisor at a specified push query interval.

The following image shows the functionality of a push query where only certain metrics are set to be updated at specific intervals:

***Figure 5: Push Query***

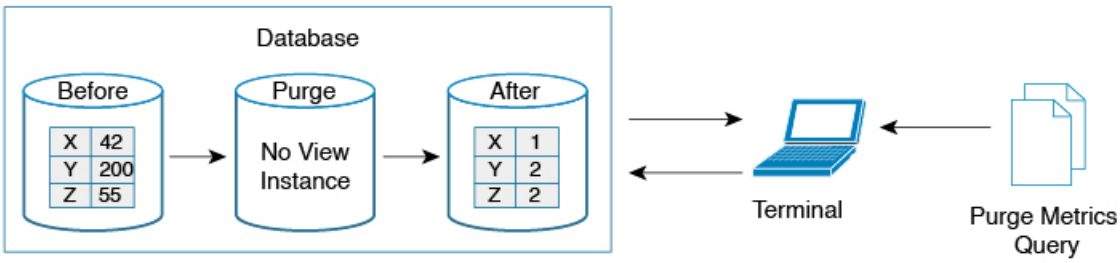



4. Clearing and Resetting Metrics—The following features allow you to clear or reset the flow metrics that are collected in a database:
   - Purge—Deletes a specified view instance and all the metrics that are associated with this view instance. The view instance is immediately rebuilt with the new IO and all view metrics start counting

from zero. Use this option to flush any stale metrics from a view, such as when an initiator or target is no longer active or present.

The following image shows the purge metrics query functionality:

***Figure 6: Purge Metrics Query***

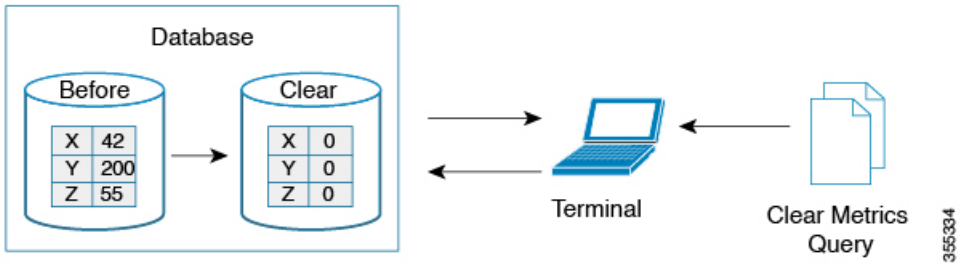



- Clear—Resets all the metrics that match the specified query string to zero except the flow metrics of the type *key*. After clearing, the database continues to collect the flow metrics for the specified query.

**Note** The **clear analytics query** command is different from the **clear** option that is used in a push query. The **clear analytics query** command resets all the metrics that meet the query syntax and the **clear** option that is used in a push query resets the minimum, maximum, and peak flow metrics.

The following image shows the clear metrics query functionality:

***Figure 7: Clear Metrics Query***




# VMID Analytics

**Note** The VMID Analytics feature is currently in beta status for use in non-production environment only. Contact your account teams or Cisco MDS marketing team to understand the use case before enabling this feature. This beta status and restriction will change to regular production status in an upcoming release.

The SAN Analytics feature provides Fibre Channel traffic information at a device (per FCID) level. However, end devices can host multiple virtual entities (virtual machines [VMs]) and each VM can cause a varying load on the Fibre Channel fabric. Therefore, it becomes crucial to monitor the Fibre Channel performance of each VM. The VMID Analytics feature can be used to monitor, analyze, identify, and troubleshoot Fibre Channel performance issues at a VM level.

Individual VMs within a given device use the same FCID for their SCSI and NVMe IO exchanges. The NX-OS Virtual Machine Identifier (VMID) server feature enables resolving traffic sources from a per-FCID device level to an individual VM level. For more information on this feature, see the "VMID" section in the "Managing FLOGI, Name Server, FDMI, and RSCN Databases" chapter of the Cisco MDS 9000 Series Fabric Configuration Guide, Release 8.x.

After the VMID server feature is enabled, the VMID Analytics feature can subsequently be enabled to resolve performance metrics for initiators. When enabled, analytics views that used to report the initiator level metrics will also report VMID level metrics. Only the view types which include the *scsi-initiator-id* or *nvme-initiator-id* key are monitored. An additional *vmid* key is supported for these view types. You must specify the *vmid* key as part of the "selected fields" list along with the initiator ID in the query syntax to collect the VMID-specific analytics. If VMID is not specified in the "selected fields" list and only the initiator ID is specified then the aggregated metrics are collected for the initiator.

Disabling the VMID Server feature cause attached devices to stop inserting VMID information into Fibre Channel frames. Also, when the VMID Analytics feature is disabled the frames are counted against the source FCID and not the VMID. However, the Analytics database continues to retain the previously collected per-VMID metrics. You must purge the metrics or perform a nondisruptive module upgrade to reset the database. If you do not purge the metrics, then the output of the pull or push query with and without using the differential option will be as follows:

- When you use the differential option in a pull or push query after the VMID Analytics feature is disabled, only the first pull or push query will contain the stale per-VMID metrics.
- When you do not use the differential option in a pull or push query after the VMID Analytics feature is disabled, every pull or push query will fetch the stale per-VMID metrics.

The VMID Analytics feature was introduced in Cisco MDS NX-OS Release 8.5(1).

# Port Sampling

The Port Sampling feature that is introduced in Cisco MDS NX-OS Release 8.3(1) allows you to gather data from a subset of ports in a module that is already being monitored, cycle through the various subsets of ports, and stream data from these ports at a regular port-sampling interval.

This feature is useful when the NPU load is high and you cannot reduce the number of ports that are being monitored on a module. In such a situation, the load on the NPU can be reduced by sampling a subset of the monitored ports at a specified port-sampling interval. Use the **show analytics system-load** command to check the NPU load.

In Cisco MDS NX-OS Release 8.3(2), system messages were introduced to alert you if the NPU load is high when the ITL count exceeds a module limit, when the ITL count exceeds the system limit, and when there is no response from NPU for analytics data. For more information, see the Cisco MDS 9000 Family and Nexus 7000 Series NX-OS System Messages Reference document.

Any I/O and errors that occur on a monitored port, when it is not being sampled, are not seen and not included in the analytics data.

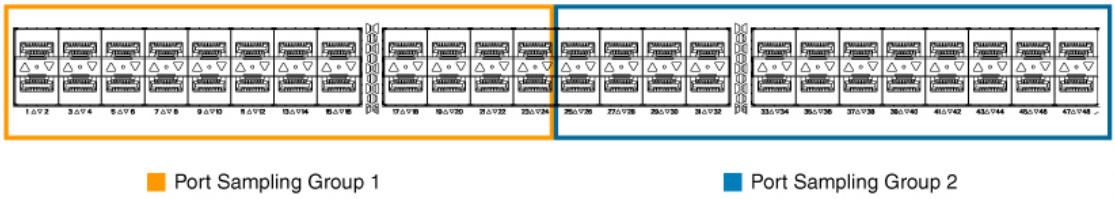
The port sampling interval that is used in this feature is independent of the streaming sample interval. We recommend that you set the streaming-sample interval, port-sampling interval, and push query interval to be equal to or more than the minimum recommended value of 30 seconds.

**Note** When this feature is enabled on a module and then the SAN Analytics feature is enabled on new ports on the module, the port-sampling data for the new ports are streamed only after the next port-sampling interval.

### Port-Sampling Scenarios

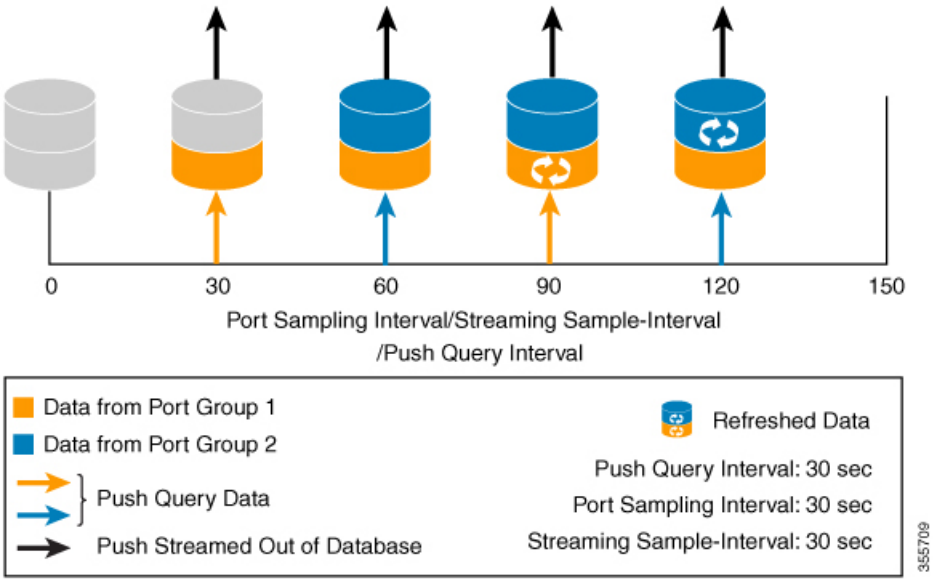
Let us consider a module consisting of 48 ports and group them into two subsets of 24 ports. Depending on the port-sampling intervals that are configured for these subsets of ports and the streaming-sample interval that is configured, flow metrics can be captured at different intervals as seen in the following examples:

***Figure 8: Port-Sampling Groups***



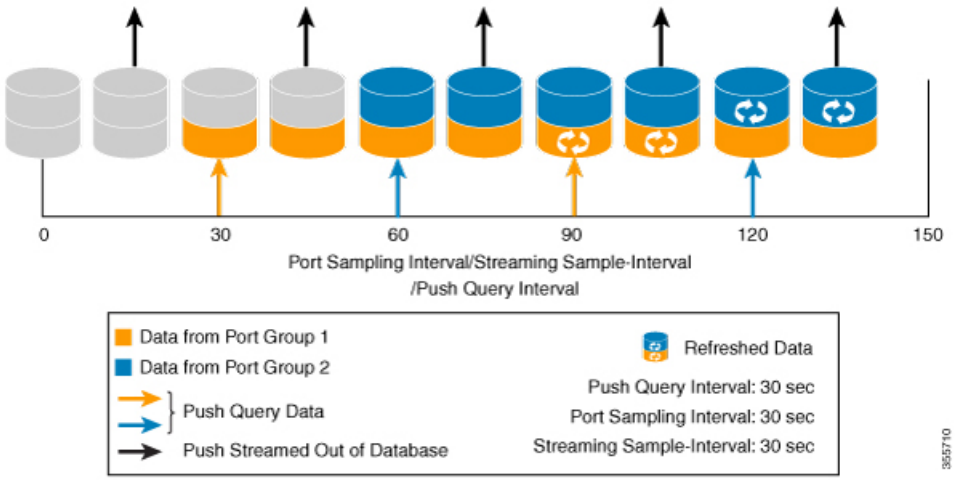

- When the port-sampling interval and the streaming-sample interval start at the same time:

***Figure 9: Port Sampling Interval and Streaming Sample Interval Starting at the Same Time***




- When the port-sampling interval and the streaming-sample interval start at a different time:

*Figure 10: Port Sampling Interval and Streaming Sample Interval Starting at a Different Time*




# Analytics Engine Port Set Mapping

Starting with 64 Gbps capable ports, analytics data on a module is managed as sets of ports by the port ASICs. The data from each port set are stored in a dedicated memory block. To avoid analytics data loss, the total number of ITL flows monitored through each port set should not exceed the capacity of the associated block.

| Device | Maximum ITL Flows per monitoring interval |
|---|---|
| DS-X9748-3072K9 | 4000 flows per port set |

If the number of ITL flows per port set exceeds the capacity of the associated block, it may be reduced by disabling analytics on one or more of the ports in a port set, or by moving the traffic to a physical port in a different port set.

Table 5: Analytics Engine Port Set Mapping, on page 23 provides the partitioning of ports to analytics engine port sets:

*Table 5: Analytics Engine Port Set Mapping*

| Device | Analytics Engine Port Set | Front Panel Port Numbers |
|---|---|---|
| DS-X9748-3072K9 | 1 | 9, 11, 13, 15 |
| | 2 | 25, 27, 29, 31 |
| | 3 | 10, 12, 14, 16 |
| | 4 | 26, 28, 30, 32 |
| | 5 | 1, 3, 5, 7 |
| | 6 | 33, 35, 37, 39 |
| | 7 | 2, 4, 6, 8 |
| | 8 | 34, 36, 38, 40 |
| | 9 | 17, 19, 21, 23 |
| | 10 | 41, 43, 45, 47 |
| | 11 | 18, 20, 22, 24 |
| | 12 | 42, 44, 46, 48 |

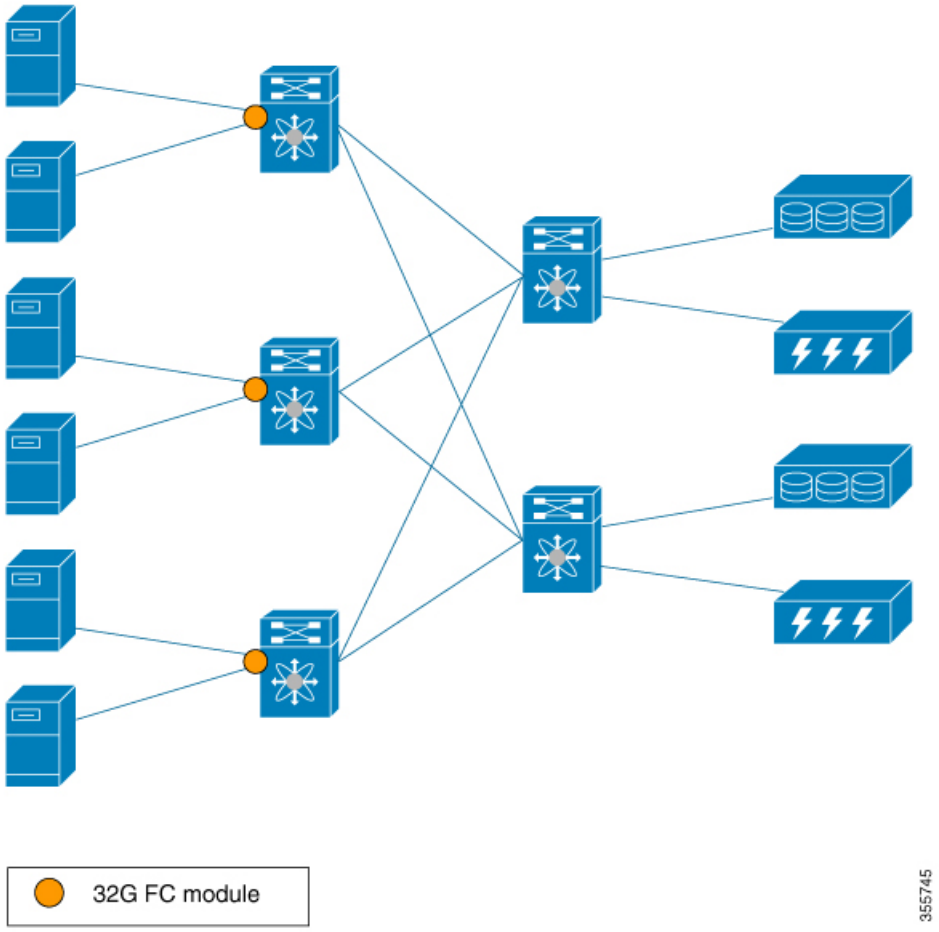
# Deployment Modes

Depending on where the switches that support the SAN Analytics feature are deployed in a SAN fabric, the following deployment modes are possible:

### Host Edge Deployment Mode

The SAN Analytics feature is enabled on all Cisco MDS core switches and on interfaces that are connected to hosts.

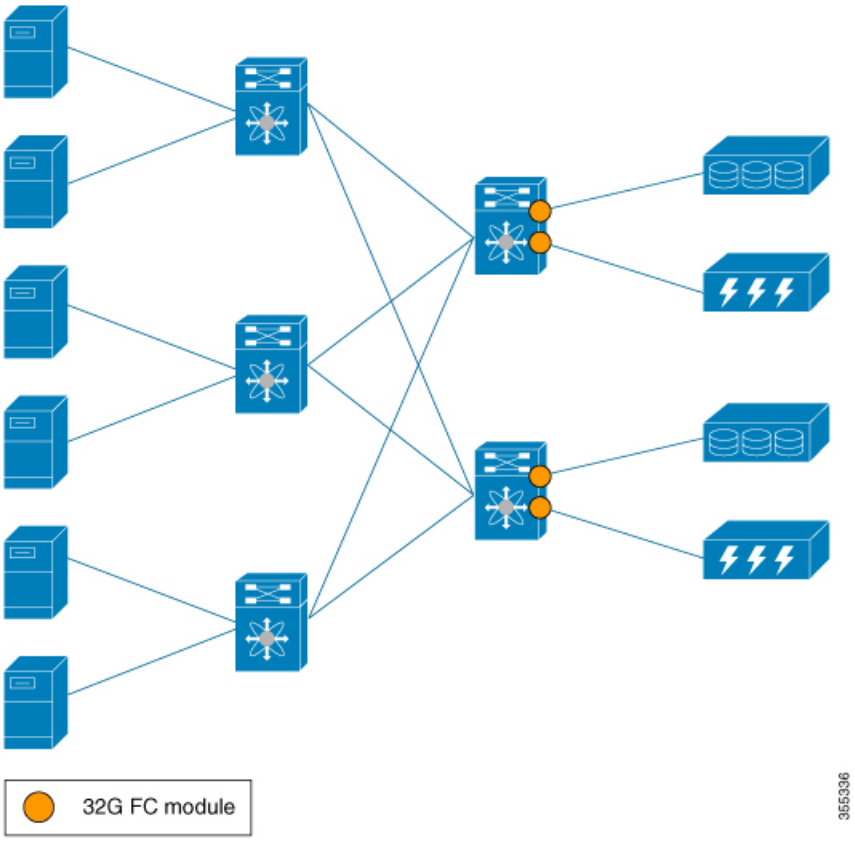
*Figure 11: Host Edge Deployment Mode*




### Storage Edge Deployment Mode

The SAN Analytics feature is enabled on all the Cisco MDS core switches and on the interfaces that are connected to storage arrays.

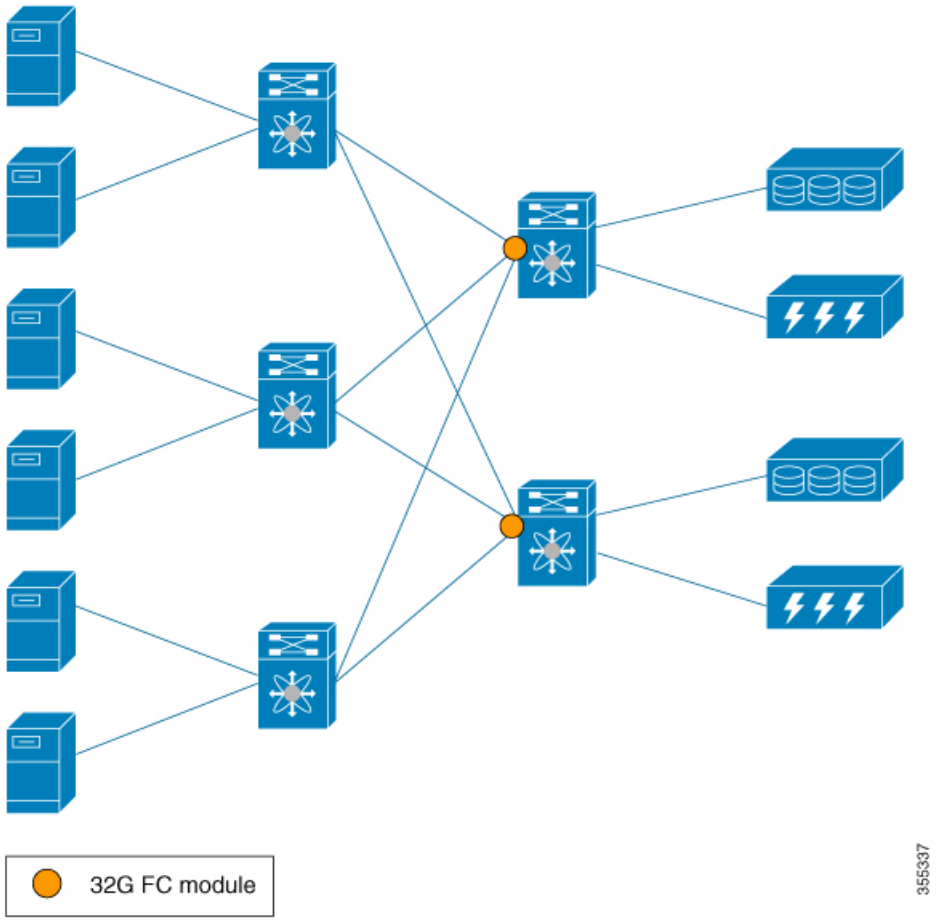
*Figure 12: Storage Edge Deployment Mode*




### ISL Deployment Mode

The SAN Analytics feature is enabled on all the Cisco MDS switches and on the interfaces that are on any one side of ISLs.

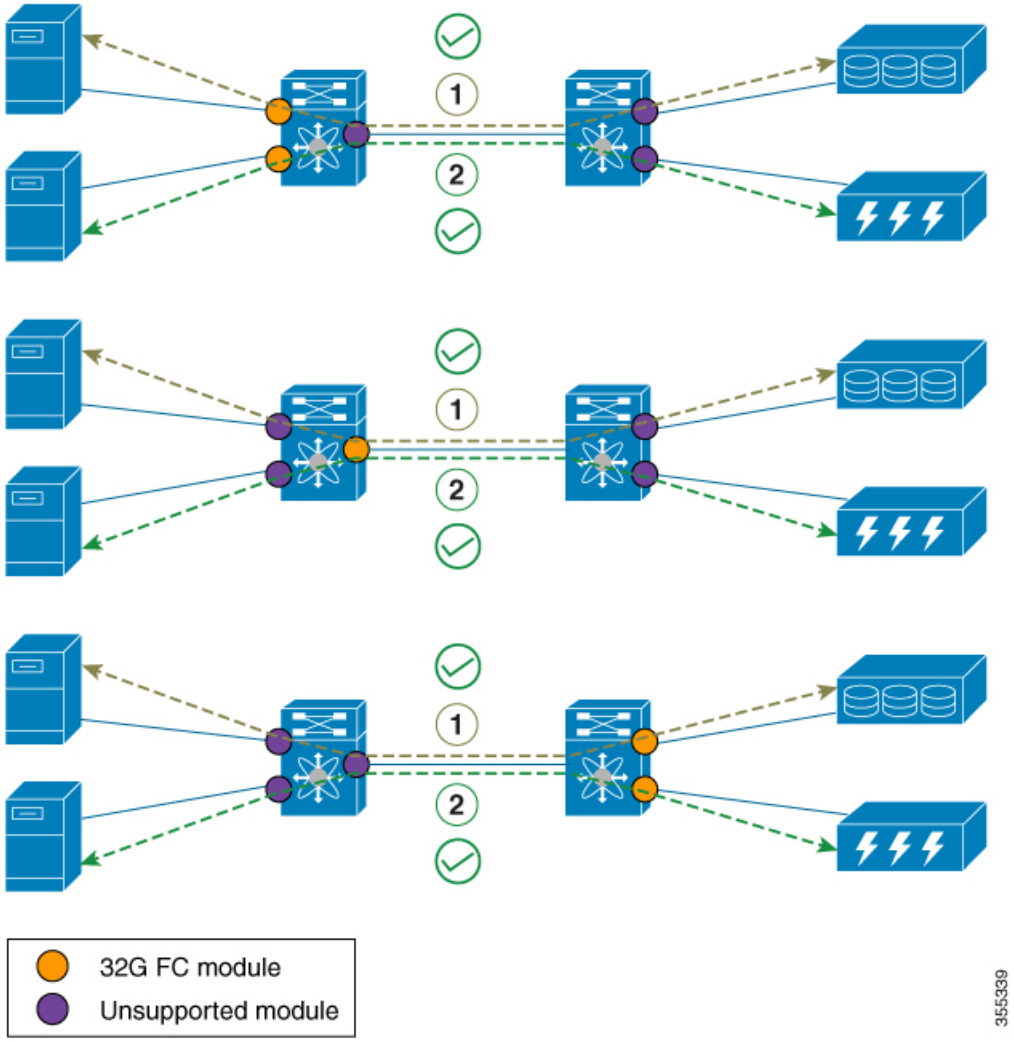
*Figure 13: ISL Deployment Mode*

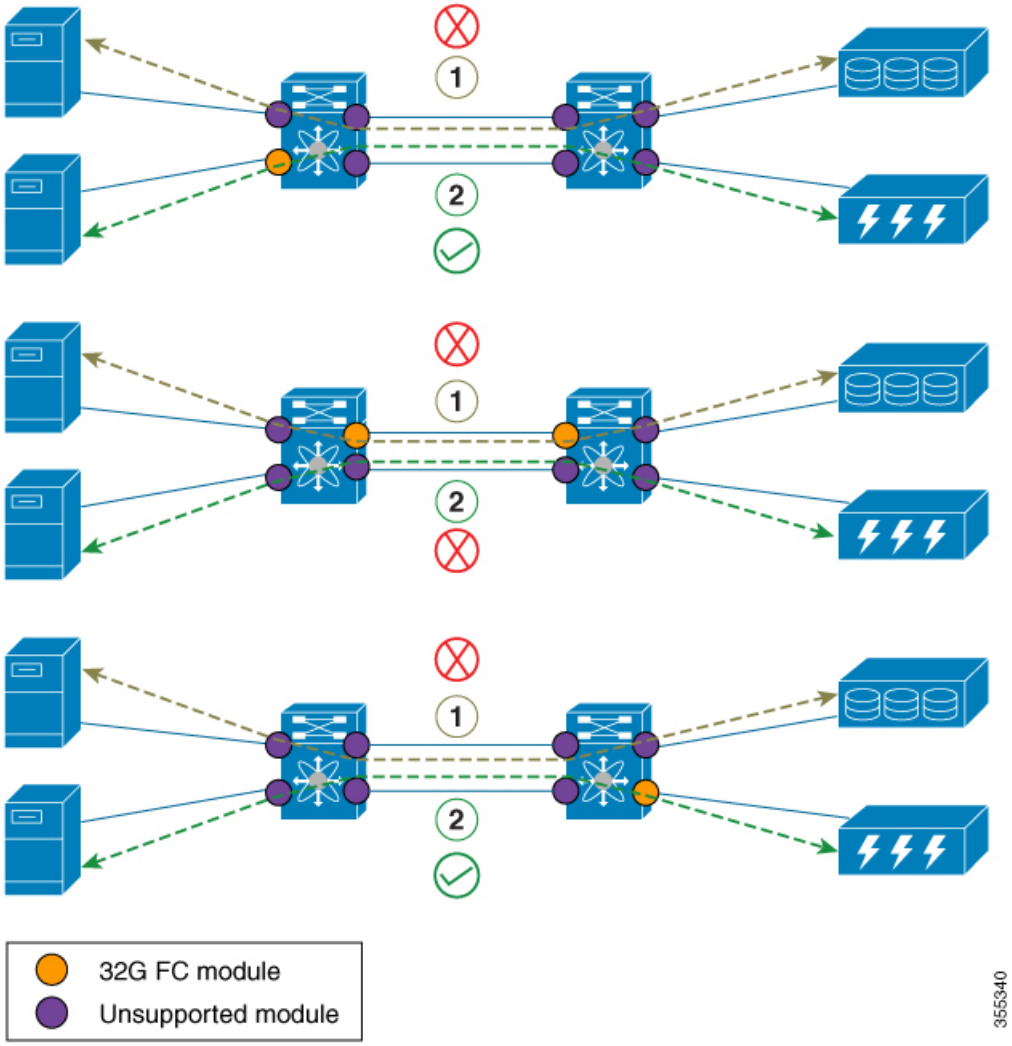



The following image shows the functionality of the SAN Analytics feature when supported and unsupported modules (16-Gbps Fibre Channel, Cisco MDS 9700 40-Gbps 24-Port FCoE Module (DS-X9824-960K9), Cisco MDS 24/10-Port SAN Extension Module (DS-X9334-K9), and so on) are used in SAN.

**Note** The numbers 1 and 2 in the Figure 14: Functionality of The SAN Analytics Feature When Supported and Unsupported Modules are Used represent two different flows from initiators to targets respectively.

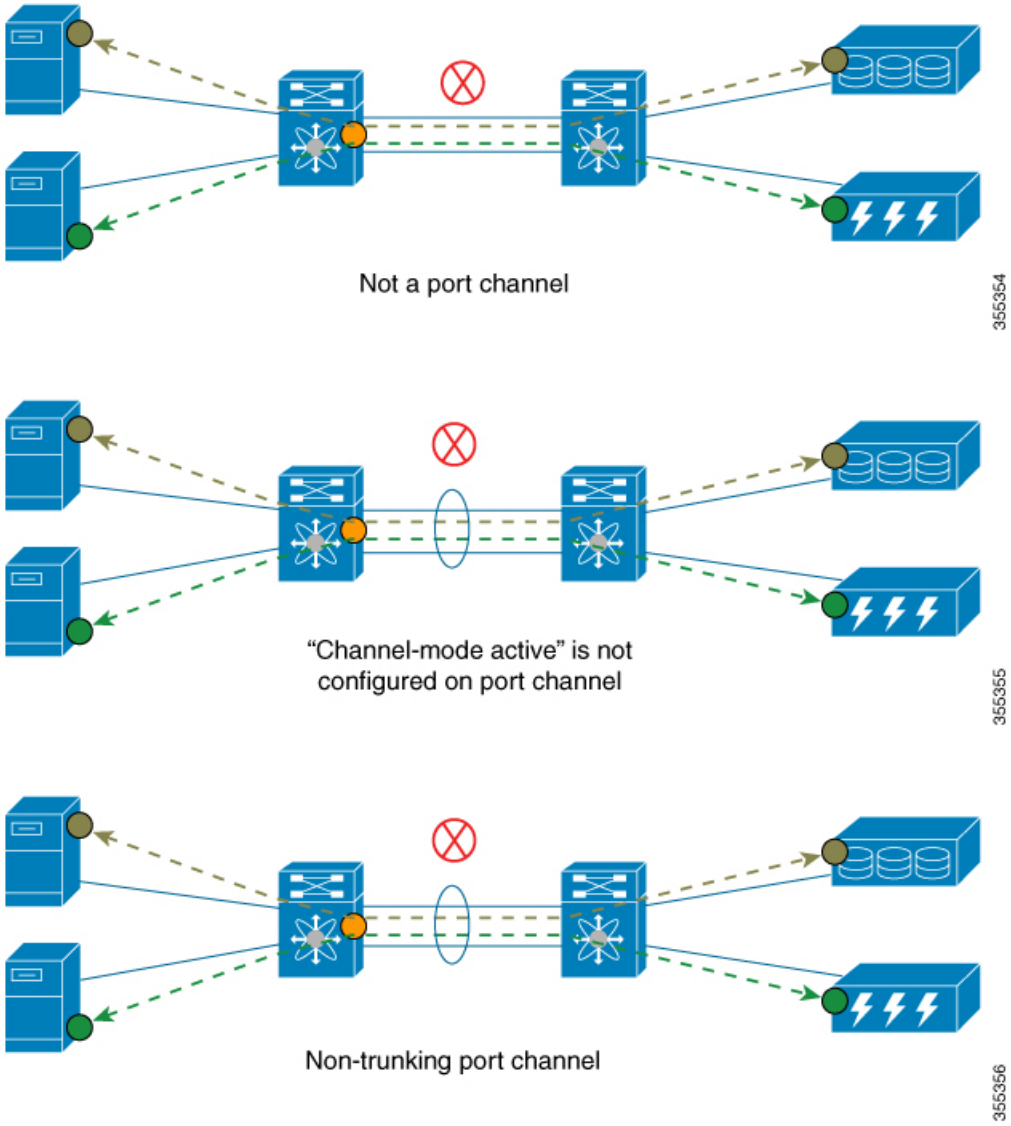
*Figure 14: Functionality of The SAN Analytics Feature When Supported and Unsupported Modules are Used*






**Note**

- In the above ISL mode scenarios, the request responses can be seen on different members of port channel.
- When supported and unsupported modules are used on ISL, the analytics data that is analyzed on the ISL may not be accurate. Hence, we recommend that you do not analyze data on ISL where supported and unsupported modules are used.




# Configuring SAN Analytics

Enable the SAN Analytics feature on both a switch and its interfaces in order to enable flow metric collection from the interfaces.

**Note**

- To use the SAN Analytics feature, you must install an appropriate license package using the **install license** command. For more information, see the Cisco MDS 9000 Series Licensing Guide.
- If you are using Cisco DCNM SAN Insights, you can configure the SAN Analytics feature in Cisco DCNM SAN Insights and there is no need to configure this feature on the switch. For more information, see the "Configuring SAN Insights" section in the Cisco DCNM SAN Management Configuration Guide.

# Enabling SAN Analytics

**Note**
- The SAN Analytics feature is disabled by default.
- When the active ITL count exceeds the documented limit, a syslog message will be logged..

To enable the SAN Analytics feature on a switch, perform these steps:

**Procedure**

**Step 1** Enter global configuration mode:
switch# **configure terminal**

**Step 2** Enable the SAN Analytics feature on the switch:
switch(config)# **feature analytics**

# Disabling SAN Analytics

To disable the SAN Analytics feature on a switch, perform these steps:

**Procedure**

**Step 1** Enter global configuration mode:
switch# **configure terminal**

**Step 2** Disable the SAN Analytics feature on the switch:
switch(config)# **no feature analytics**

# Enabling SAN Analytics on an Interface

To enable the SAN Analytics feature on an interface, perform these steps:

**Before you begin**

**Note** The SAN Analytics feature is disabled by default on all interfaces.

- Enable the SAN Analytics feature on the switch. See the Enabling SAN Analytics, on page 30 section.

- In port channels, enable the SAN Analytics feature on all the interfaces.

### Procedure

**Step 1** Enter global configuration mode:

switch# **configure terminal**

**Step 2** Select a Fibre Channel interface or a range of interfaces and enter interface configuration submode:

switch(config)# **interface fc** *slot number/port number*

**Note** You can also specify the range for interfaces using the **interface fc** *slot number/port number - port number* **,** **fc** *slot number/port number - port number* command. The spaces are required before and after the dash ( - ) and before and after the comma ( , ).

**Step 3** Enable the SAN Analytics feature on the selected interface:

switch(config-if)# **analytics type** {**fc-all** | **fc-nvme** | **fc-scsi**}

**Note** Only the **fc-scsi** analytics type was supported in Cisco MDS NX-OS Release 8.2(x) and Cisco MDS NX-OS Release 8.3(x). From Cisco MDS NX-OS Release 8.4(1), the **fc-scsi**, **fc-nvme**, and **fc-all** analytics types are supported.

# Disabling SAN Analytics on an Interface

To disable the SAN Analytics feature on an interface, perform these steps:

### Before you begin

In port channels, disable the SAN Analytics feature on all the interfaces.

### Procedure

**Step 1** Enter global configuration mode:

switch# **configure terminal**

**Step 2** Select a Fibre Channel interface or a range of interfaces and enter interface configuration submode:

switch(config)# **interface fc** *slot number/port number*

**Note** You can also specify the range for interfaces using the **interface fc** *slot number/port number - port number* **,** **fc** *slot number/port number - port number* command. The spaces are required before and after the dash ( - ) and before and after the comma ( , ).

**Step 3** Disable the SAN Analytics feature on the selected interface:

switch(config-if)# **no analytics type** {**fc-all** | **fc-nvme** | **fc-scsi**}

# Enabling VMID Analytics

To enable the VMID Analytics feature on a switch, perform these steps:

### Before you begin

1. Ensure that the attached HBAs have firmware that supports VMID capability and that the capability is enabled on the HBA.
2. Enable the SAN Analytics feature on the switch. See the Enabling SAN Analytics, on page 30 section.
3. Enable SAN Analytics on an interface. See the Enabling SAN Analytics on an Interface, on page 30 section.
4. Enable the VMID Server feature. See the "Enabling the VMID Server" section in the "Managing FLOGI, Name Server, FDMI, and RSCN Databases" chapter of the Cisco MDS 9000 Series Fabric Configuration Guide, Release 8.x.

### Procedure

**Step 1** Enter global configuration mode:

switch# **configure terminal**

**Step 2** Enable the VMID Analytics feature on the switch:

switch(config)# **analytics vm-tag veid**

# Disabling VMID Analytics

To disable the VMID Analytics feature on a switch, perform these steps:

### Procedure

**Step 1** Enter global configuration mode:

switch# **configure terminal**

**Step 2** Disable the VMID Analytics feature on the switch:

switch(config)# **no analytics vm-tag veid**

# Enabling Port Sampling

**Note**

- Port sampling is supported only in Cisco MDS NX-OS Release 8.3(1) and later releases.
- Port sampling is disabled by default, and continuous monitoring is enabled on all the analytics-enabled ports. For more information on port sampling, see Port Sampling, on page 20.

To enable port sampling on a module, perform these steps:

**Procedure**

**Step 1** Enter global configuration mode:

switch# **configure terminal**

**Step 2** Enable port sampling on a module:

switch# **analytics port-sampling module** *number* **size** *number* **interval** *seconds*

# Disabling Port Sampling

To disable port sampling on a module, perform these steps:

**Procedure**

**Step 1** Enter global configuration mode:

switch# **configure terminal**

**Step 2** Disable port sampling on a module and go back to the default mode of monitoring all analytics-enabled ports with the configured streaming-sample interval:

switch# **no analytics port-sampling module** *number*

# Example: Configuring SAN Analytics

This example shows how to enable the SAN Analytics feature on a switch:

```
switch# configure terminal
switch(config)# feature analytics
```

This example shows how to disable the SAN Analytics feature on a switch:

```
switch# configure terminal
switch(config)# no feature analytics
```

This example shows how to enable the SAN Analytics feature on an interface for the SCSI analytics type when the NVMe analytics type is already enabled:

- This example displays that the NVMe analytics type is already enabled:

```
switch# show running-config analytics

!Command: show running-config analytics
!Running configuration last done at: Wed Mar 13 09:01:56 2019
!Time: Wed Mar 13 09:02:52 2019

version 8.4(1)
feature analytics


interface fc1/1
  analytics type fc-nvme
```

- This example displays how to enable the SCSI analytics type on a single port:

```
switch# configure terminal
switch(config)# interface fc 1/1
switch(config-if)# analytics type fc-scsi
```

- This example displays that the SCSI analytics type is enabled:

```
switch# show running-config analytics

!Command: show running-config analytics
!Running configuration last done at: Wed Mar 13 09:01:56 2019
!Time: Wed Mar 13 09:02:52 2019

version 8.4(1)
feature analytics


interface fc1/1
  analytics type fc-scsi
  analytics type fc-nvme
```

# Querying Metrics on a Switch

When you run a pull query CLI, the specified metrics are collected from the NPU of a module, stored in the metric database on the supervisor, and then displayed in the user session.

# Schema for Querying Metrics

A schema is used to display the data of interest that is stored in a database to a user. Use the **show analytics schema** command for more information on schema. Metrics are maintained in a database in the form of various view instances. These view instances can be retrieved using queries. See Views, on page 36 for more information.

# Query Syntax

The following is the *query syntax* that is used in the pull query, push query, clearing metrics, and purging views:

**select all** | *column1*[, *column2*, *column3*, …] **from** *analytics_type.view_type* [**where** *filter_list1* [**and** *filter_list2* …]] [**sort** *column* [**asc** | **desc**]] [**limit** *number*]

The following are the elements of the query syntax:

- *analytics_type*—Specifies the analytics type. Only the *fc-scsi* type is supported in Cisco MDS NX-OS Release 8.2(1) and Cisco MDS NX-OS Release 8.3(1). From Cisco MDS NX-OS Release 8.4(1), *fc-nvme* analytics type is supported.
- *view_type*—Specifies the view type of a metric database. The syntax is used to run queries on it. The syntax supports only one query on a single view type. For the list of supported view types and their descriptions, see List of Supported View Types, on page 36.
- *column*—Specifies the flow metrics. A view instance contains multiple columns.
- *filter_list*—Specifies the filters to extract specific metrics of a view instance. You can use the filter conditions on a flow metric column whose type is a *key* value or on a view instance column. You can also use the AND operator for filtering. For a list of view types that are supported, see List of Supported View Types, on page 36.
- **sort**—Specifies to sort the results in a column. Sorting is performed before the limit operation is performed.
- **asc**—Sorts the results in a column in ascending order. By default, sorting is done in ascending order if no order is specified.
- **desc**—Sorts the results in a column in descending order.
- **limit**—Limits the number of metrics that are returned in a result.

For examples on configuring query syntax, see the Examples: Configuring Query Syntax, on page 50.

**Note**

- The *limit* and *where* options in the *"query_string"* can only be used on the *key* fields.
- Prior to Cisco MDS NX-OS, Release 8.3(2), the sort option in the *"query_string"* could only be used on the *key* fields and the metrics were sorted only in ascending order. From Cisco MDS NX-OS, Release 8.3(2), the *sort* option in the *"query_string"* can be used on all the *metrics* and *metadata* fields and can be sorted in ascending or descending order using the **asc** or **desc** options respectively. By default, sorting is performed in ascending order if no order is specified.

  If you have configured push queries with the **sort asc** or **sort desc** option, make sure that you remove these sort options before downgrading from Cisco MDS NX-OS, Release 8.3(2) to Cisco MDS NX-OS, Release 8.3(1) or earlier releases.

# Query Rules

The following are the rules for constructing queries:

- The **select**, **from**, **where**, **sort**, and **limit** conditions should be used in the same order as described in Query Syntax, on page 35.
- The list of columns under the **select** condition should belong to the schema that corresponds to the *view_type* under the **from** condition.
- The **where** condition is allowed only on flow metric fields whose type is a *key* value. For information about the flow metric fields whose type is a key value, see List of Supported View Types, on page 36.
- Before Cisco MDS NX-OS, Release 8.3(2), the **sort** condition must be a *metric* field and should be present among the columns that are listed under the **select** condition. From Cisco MDS NX-OS, Release 8.3(2), the **sort** condition must be a *metric* or *metadata* field and should be present among the columns that are listed under the **select** condition.

# Views

A view is a representation of the flow metrics about a port, initiator, target, LUN, or any valid combination of these. Each view type supports specific flow metrics. To optimize resource utilization, long names in the flow metrics are used for OnBoard queries and short names are used for SAN Telemetry Streaming. For more information, see Flow Metrics, on page 129.

## List of Supported View Types

The following table lists the supported view types:

***Table 6: Supported View Types***

| View Type | Description | Keys |
|---|---|---|
| port | A port's view contains metadata and IO metrics for ports on a switch. | port |
| logical_port | A logical port view contains metadata and IO metrics for VSANs configured for ports on a switch. | port and vsan |
| app | An application view contains metadata and IO metrics for the concerned applications hosted behind various ports that are performing IO operations. | port and app-id |
| scsi_target | A target view contains metadata and IO metrics for SCSI targets that are deployed behind various ports on a switch that execute IO operations. | port, vsan, and scsi-target-id |

| View Type | Description | Keys |
|---|---|---|
| nvme_target | A target view contains metadata and IO metrics for NVMe targets that are deployed behind various ports on a switch that execute IO operations. | port, vsan, and nvme-target-id |
| scsi_initiator | An initiator view contains metadata and IO metrics for initiators that are deployed behind various ports on a switch that initiate IO operations. | port, vsan, scsi-initiator-id, and vmid |
| nvme_initiator | An initiator view contains metadata and IO metrics for initiators that are deployed behind various ports on a switch that initiate IO operations. | port, vsan, nvme-initiator-id, and vmid |
| scsi_target_app | A target app view contains metadata and IO metrics for the applications whose data is hosted on various targets. | port, vsan, scsi-target-id, and app-id |
| nvme_target_app | A target app view contains metadata and IO metrics for the applications whose data is hosted on various targets. | port, vsan, nvme-target-id, and app-id |
| scsi_initiator_app | An initiator app view contains metadata and IO metrics for the applications for which initiators initiate IO operations. | port, vsan, scsi-initiator-id, app-id, and vmid |
| nvme_initiator_app | An initiator app view contains metadata and IO metrics for the applications for which initiators initiate IO operations. | port, vsan, nvme-initiator-id, app-id, and vmid |
| scsi_target_it_flow | A target initiator-target (IT) flow view contains metadata and IO metrics for IT flows associated with various targets. | port, vsan, scsi-target-id, scsi-initiator-id, and vmid |
| nvme_target_it_flow | A target initiator-target (IT) flow view contains metadata and IO metrics for IT flows associated with various targets. | port, vsan, nvme-target-id, nvme-initiator-id, and vmid |
| scsi_initiator_it_flow | An initiator IT flow view contains metadata and IO metrics for the IT flows associated with various initiators. | port, vsan, scsi-initiator-id, scsi-target-id, and vmid |

| View Type | Description | Keys |
|---|---|---|
| nvme_initiator_it_flow | An initiator IT flow view contains metadata and IO metrics for the IT flows associated with various initiators. | port, vsan, nvme-initiator-id, nvme-target-id, and vmid |
| scsi_target_tl_flow | A target target-LUN (TL) flow view contains metadata and IO metrics for the LUNs associated with various SCSI targets. | port, vsan, scsi-target-id, and lun-id |
| nvme_target_tn_flow | A target target-namespace ID (TN) flow view contains metadata and IO metrics for the namespace IDs associated with various NVMe targets. | port, vsan, nvme-target-id, and namespace-id |
| scsi_target_itl_flow | A target initiator-target-LUN (ITL) flow view contains metadata and IO metrics for the ITL flows associated with various SCSI targets. | port, vsan, scsi-target-id, scsi-initiator-id, lun-id, and vmid |
| nvme_target_itn_flow | A target initiator-target-namespace ID (ITN) flow view contains metadata and IO metrics for the ITN flows associated with various NVMe targets. | port, vsan, nvme-target-id, nvme-initiator-id, namespace-id, and vmid |
| scsi_initiator_itl_flow | An initiator ITL flow view contains metadata and IO metrics for the ITL flows associated with various SCSI initiators. | port, vsan, scsi-initiator-id, scsi-target-id, lun-id, and vmid |
| nvme_initiator_itn_flow | An initiator ITN flow view contains metadata and IO metrics for the ITN flows associated with various NVMe initiators. | port, vsan, nvme-initiator-id, nvme-target-id, namespace-id, and vmid |
| scsi_target_io | A target IO view contains IO transaction details for the active IOs that various targets execute. | port, vsan, scsi-target-id, scsi-initiator-id, ox-id, and vmid |
| nvme_target_io | A target IO view contains IO transaction details for the active IOs that various targets execute. | port, vsan, nvme-target-id, nvme-initiator-id, ox-id, and vmid |
| scsi_initiator_io | An initiator IO view records IO transaction details for the active IOs that various initiators initiate. | port, vsan, scsi-initiator-id, scsi-target-id, ox-id, and vmid |

| View Type | Description | Keys |
|---|---|---|
| nvme_initiator_io | An initiator IO view records IO transaction details for the active IOs that various initiators initiate. | port, vsan, nvme-initiator-id, nvme-target-id, ox-id, and vmid |

## View Types Representation

**Note** The examples provided in this section are for SCSI analytics type and can be extended to the NVMe analytics type as well.

We have considered a sample topology to explain the different view types. In the following image:

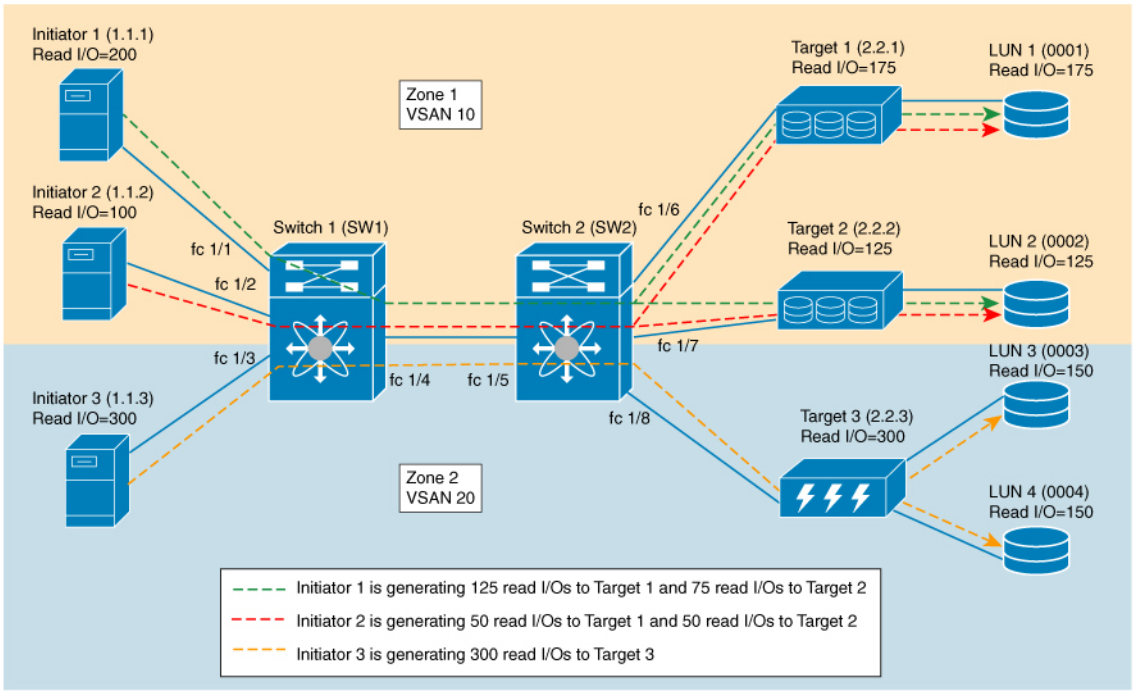
- Initiator 1 and Initiator 2 are configured in VSAN 1 and are communicating with Target 1, Target 2, LUN 1, and LUN 2 in zone 1.
  - Initiator 1 generates 125 read I/Os to Target 1 and 75 read I/Os to Target 2.
  - Initiator 2 generates 50 read I/Os to Target 1 and Target 2 respectively.
- Initiator 3 is configured in VSAN 2 and communicates with Target 3, LUN 3, and LUN 4 in zone 2.

  Initiator 3 generates 300 read I/Os to Target 3. Target 3 is generating 150 read I/Os to LUN 3 and LUN 4 respectively.

**Note** The information that is provided in brackets in the following images are the Fibre Channel IDs (FCIDs) of the devices.

For the list of supported view types and their descriptions, see List of Supported View Types, on page 36.

*Figure 15: Sample Topology for View Types Representation*




The following image shows the flow metrics as viewed from a port view type:

*Figure 16: Port View Type*

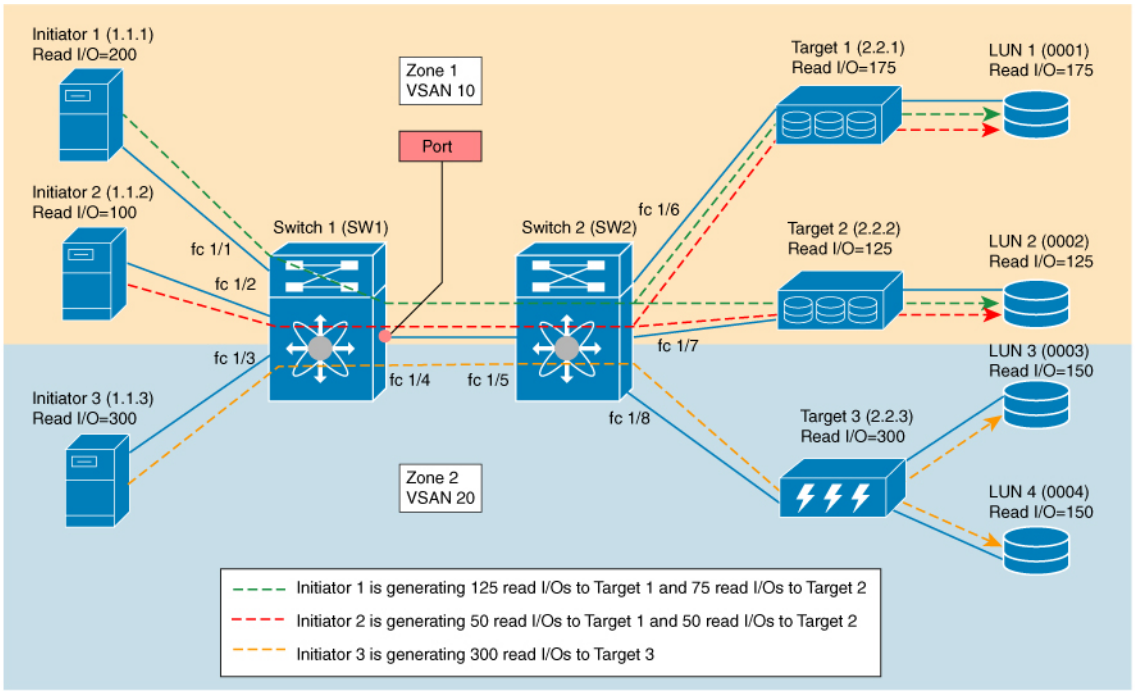


*Table 7: Port View Type*

| Port View | Flow Metrics |
|---|---|
| Port view, where port = fc 1/4 | total_read_io_count = 600 (read I/Os of all the initiators that are seen on the port) |

The following image shows the flow metrics as viewed from a logical port view type:

*Figure 17: Logical Port View Type*

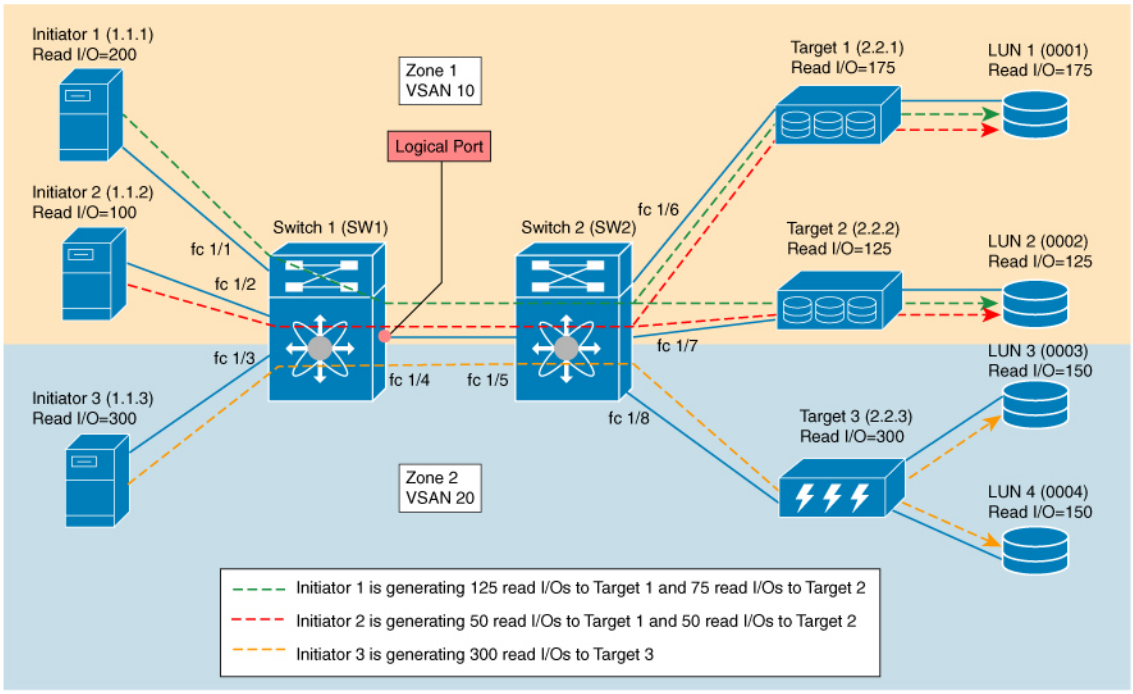



*Table 8: Logical Port View Type*

| Logical Port View | Flow Metrics |
|---|---|
| Logical port, view where port = fc 1/4 and VSAN =1 | total_read_io_count = 300 (read I/Os of all the initiators in VSAN 1) |

The following image shows the flow metrics as viewed from a scsi_initiator view type:

*Figure 18: scsi_initiator View Type*

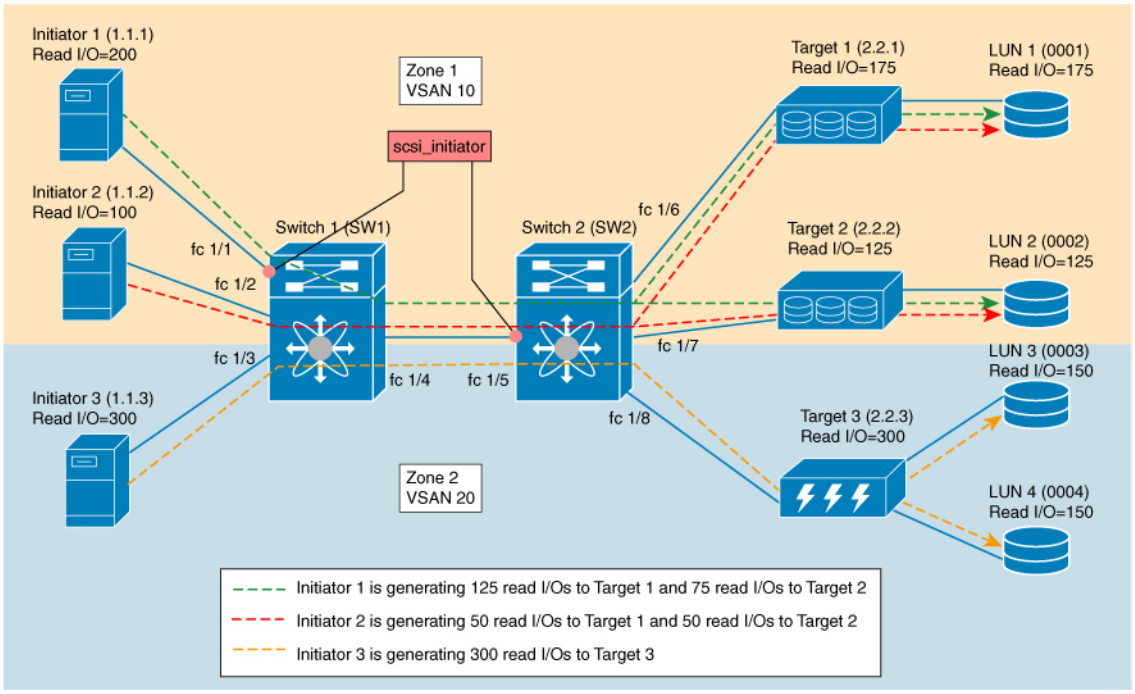



*Table 9: scsi_initiator View Type*

| scsi_initiator View | Flow Metrics |
|---|---|
| scsi_initiator view, where port = fc 1/1, VSAN = 1, and initiator ID = 1.1.1<br><br>scsi_initiator view where port = fc 1/5, VSAN = 1, and initiator ID = 1.1.1 | total_read_io_count = 200 (read I/Os of the initiator ID 1.1.1) |
| scsi_initiator view, where port = fc 1/5, VSAN = 1, and initiator ID = 1.1.2 | total_read_io_count = 100 (read I/Os of the initiator ID 1.1.2) |
| scsi_initiator view, where port = fc 1/5, VSAN = 2, and initiator ID = 1.1.3 | total_read_io_count = 300 (read I/Os of the initiator ID 1.1.3) |

The following image shows the flow metrics as viewed from a scsi_target view type:

*Figure 19: scsi_target View Type*

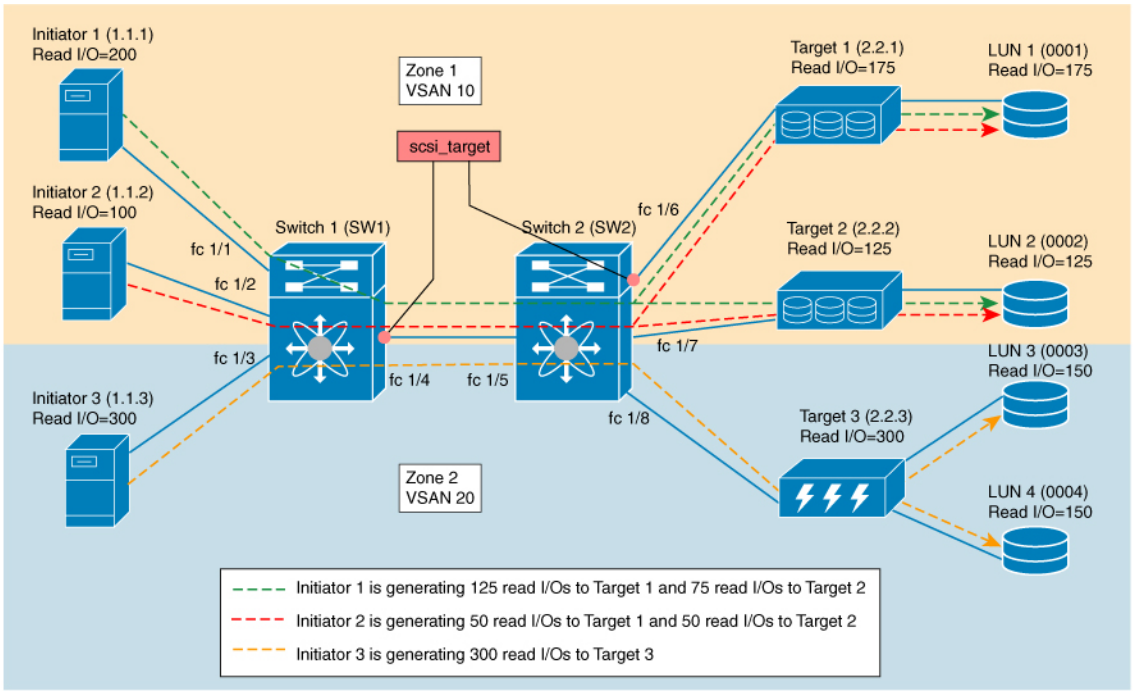



*Table 10: scsi_target View Type*

| scsi_target View | Flow Metrics |
|---|---|
| scsi_target view, where port = fc 1/6, VSAN = 1, and target ID = 2.2.1<br>scsi_target view, where port = fc 1/4, VSAN = 1, and target ID = 2.2.1 | total_read_io_count = 175 (read I/Os of the target ID 2.2.1) |
| scsi_target view, where port = fc 1/4, VSAN = 1, and target ID = 2.2.2 | total_read_io_count = 125 (read I/Os of the target ID 2.2.2) |
| scsi_target view, where port = fc 1/4, VSAN = 2, and target ID = 2.2.3 | total_read_io_count = 300 (read I/Os of the target ID 2.2.3) |

The following image shows the flow metrics as viewed from a scsi_initiator_it_flow view type:

*Figure 20: scsi_initiator_it_flow View Type*

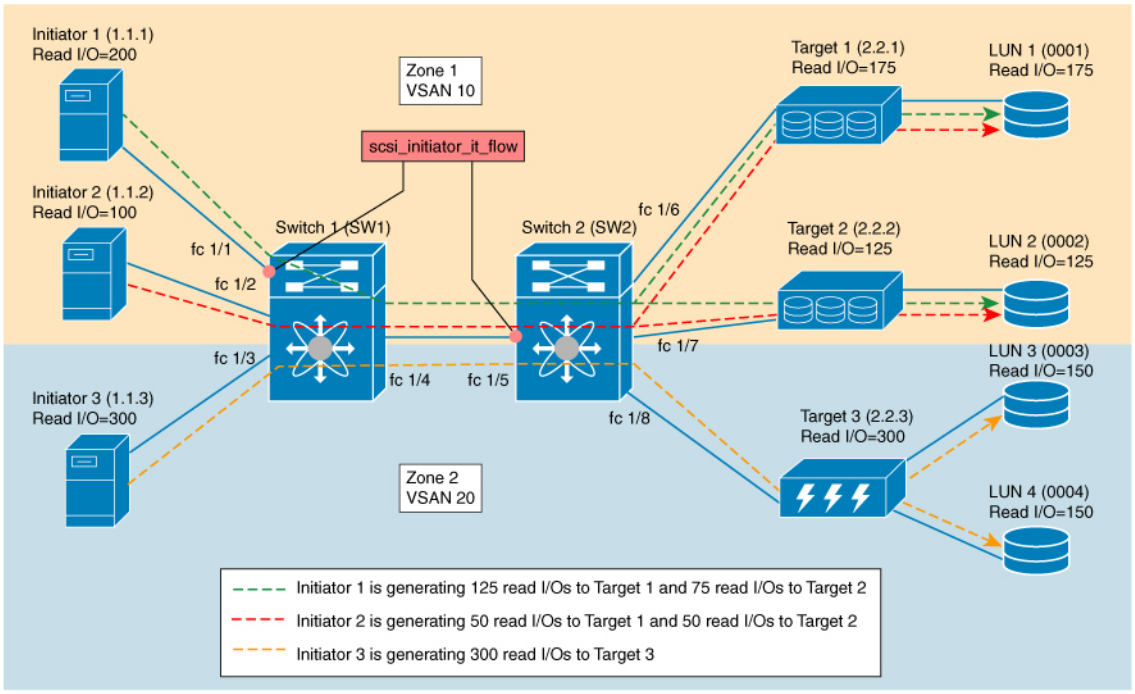



*Table 11: scsi_initiator_it_flow View Type*

| scsi_initiator_it_flow View | Flow Metrics |
|---|---|
| scsi_initiator_it_flow view, where port = fc 1/1, VSAN = 1, initiator ID = 1.1.1, and target ID = 2.2.1<br><br>scsi_initiator_it_flow view, where port = fc 1/5, VSAN = 1, initiator ID = 1.1.1, and target ID = 2.2.1 | total_read_io_count = 125 (read I/Os only between initiator ID 1.1.1 and target ID 2.2.1) |
| scsi_initiator_it_flow view, where port = fc 1/1, VSAN = 1, initiator ID = 1.1.1, and target ID = 2.2.2<br><br>scsi_initiator_it_flow view, where port = fc 1/5, VSAN = 1, initiator ID = 1.1.1, and target ID = 2.2.2 | total_read_io_count = 75 (read I/Os only between initiator ID 1.1.1 and target ID 2.2.2) |
| scsi_initiator_it_flow view, where port = fc 1/5, VSAN = 1, initiator ID = 1.1.2, and target ID = 2.2.1 | total_read_io_count = 50 (read I/Os only between initiator ID 1.1.2 and target ID 2.2.1) |
| scsi_initiator_it_flow view, where port = fc 1/5, VSAN = 1, initiator ID = 1.1.2, and target ID = 2.2.2 | total_read_io_count = 50 (read I/Os only between initiator ID 1.1.2 and target ID 2.2.2) |
| scsi_initiator_it_flow view, where port = fc 1/5, VSAN = 2, initiator ID = 1.1.3, and target ID = 2.2.3 | total_read_io_count = 300 (read I/Os only between initiator ID 1.1.3 and target ID 2.2.3) |

The following image shows the flow metrics as viewed from a scsi_target_it_flow view type:

*Figure 21: scsi_target_it_flow View Type*

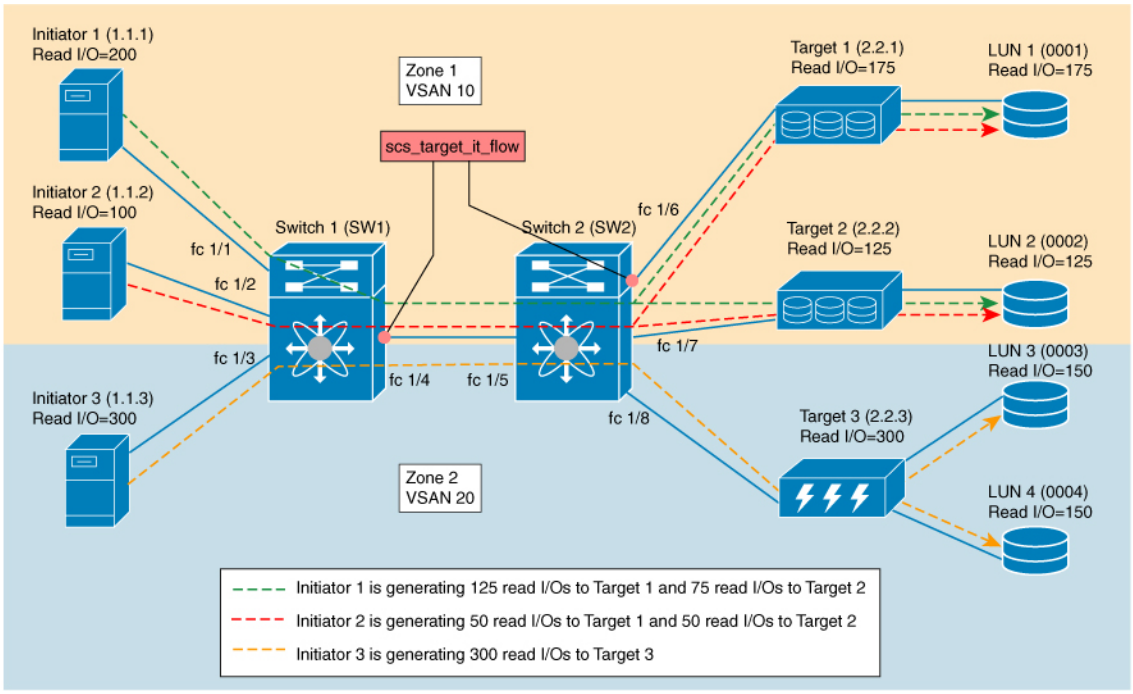



*Table 12: scsi_target_it_flow View Type*

| scsi_target_it_flow View | Flow Metrics |
|---|---|
| scsi_target_it_flow view, where port = fc 1/6, VSAN = 1, initiator ID = 1.1.1, and target ID = 2.2.1<br><br>scsi_target_it_flow view, where port = fc 1/4, VSAN = 1, initiator ID = 1.1.1, and target ID = 2.2.1 | total_read_io_count = 125 (read I/Os only between initiator ID 1.1.1 and target ID 2.2.1) |
| scsi_target_it_flow view, where port = fc 1/6, VSAN = 1, initiator ID = 1.1.2, and target ID = 2.2.1<br><br>scsi_target_it_flow view, where port = fc 1/4, VSAN = 1, initiator ID = 1.1.2, and target ID = 2.2.1 | total_read_io_count = 50 (read I/Os only between initiator ID 1.1.2 and target ID 2.2.1) |
| scsi_target_it_flow view, where port = fc 1/4, VSAN = 1, initiator ID = 1.1.1, and target ID = 2.2.2 | total_read_io_count = 75 (read I/Os only between initiator ID 1.1.1 and target ID 2.2.2) |
| scsi_target_it_flow view, where port = fc 1/4, VSAN = 1, initiator ID = 1.1.2, and target ID = 2.2.2 | total_read_io_count = 50 (read I/Os only between initiator ID 1.1.2 and target ID 2.2.2) |
| scsi_target_it_flow view, where port = fc 1/4, VSAN = 2, initiator ID = 1.1.3, and target ID = 2.2.3 | total_read_io_count = 300 (read I/Os only between initiator ID 1.1.3 and target ID 2.2.3) |

The following image shows the flow metrics as viewed from a scsi_initiator_itl_flow view type:

*Figure 22: scsi_initiator_itl_flow View Type*

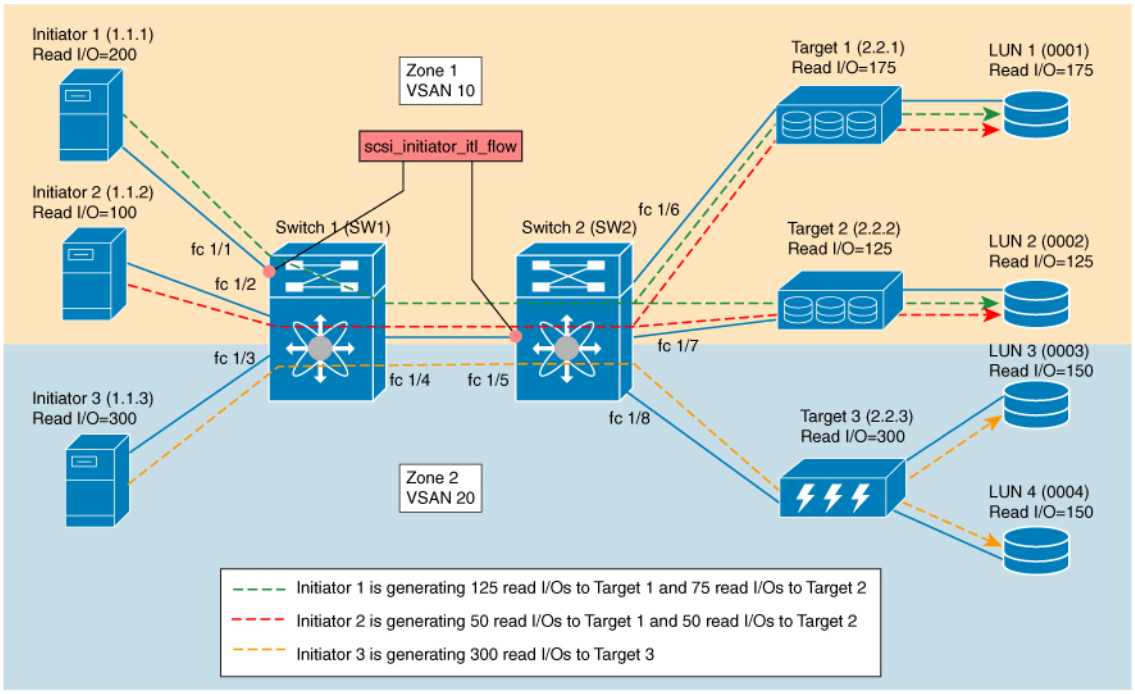



*Table 13: scsi_initiator_itl_flow View Type*

| scsi_initiator_itl_flow View | Flow Metrics |
|---|---|
| scsi_initiator_itl_flow view, where port = fc 1/1, VSAN = 1, initiator ID = 1.1.1, target ID = 2.2.1, and LUN ID = 0001<br><br>scsi_initiator_itl_flow view, where port = fc 1/5, VSAN = 1, initiator ID = 1.1.1, target ID = 2.2.1, and LUN ID = 0001 | total_read_io_count = 125 (read I/Os only between initiator ID 1.1.1, target ID 2.2.1, and LUN ID 0001) |
| scsi_initiator_itl_flow view, where port = fc 1/1, VSAN = 1, initiator ID = 1.1.1, target ID = 2.2.2, and LUN ID = 0002<br><br>scsi_initiator_itl_flow view, where port = fc 1/5, VSAN = 1, initiator ID = 1.1.1, target ID = 2.2.2, and LUN ID = 0002 | total_read_io_count = 75 (read I/Os only between initiator ID 1.1.1, target ID 2.2.2, and LUN ID 0002) |
| scsi_initiator_itl_flow view, where port = fc 1/5, VSAN = 1, initiator ID = 1.1.2, target ID = 2.2.1, and LUN ID = 0001<br><br>scsi_initiator_itl_flow view, where port = fc 1/5, VSAN = 1, initiator ID = 1.1.2, target ID = 2.2.2, and LUN ID = 0002 | total_read_io_count = 50 (read I/Os only between initiator ID 1.1.2, target ID 2.2.1, and LUN ID 0001 and initiator ID 1.1.2, target ID 2.2.2, and LUN ID 0002) |

| | |
|---|---|
| scsi_initiator_itl_flow view, where port = fc 1/5, VSAN = 2, initiator ID = 1.1.3, target ID = 2.2.3, and LUN ID = 0003<br><br>scsi_initiator_itl_flow view, where port = fc 1/5, VSAN = 2, initiator ID = 1.1.3, target ID = 2.2.3, and LUN ID = 0004 | total_read_io_count = 150 (read I/Os only between initiator ID 1.1.3, target ID 2.2.3, and LUN ID 0003, and initiator ID 1.1.3, target ID 2.2.3, and LUN ID 0004) |

The following image shows the flow metrics as viewed from a scsi_target_itl_flow view type:

***Figure 23: scsi_target_itl_flow View Type***

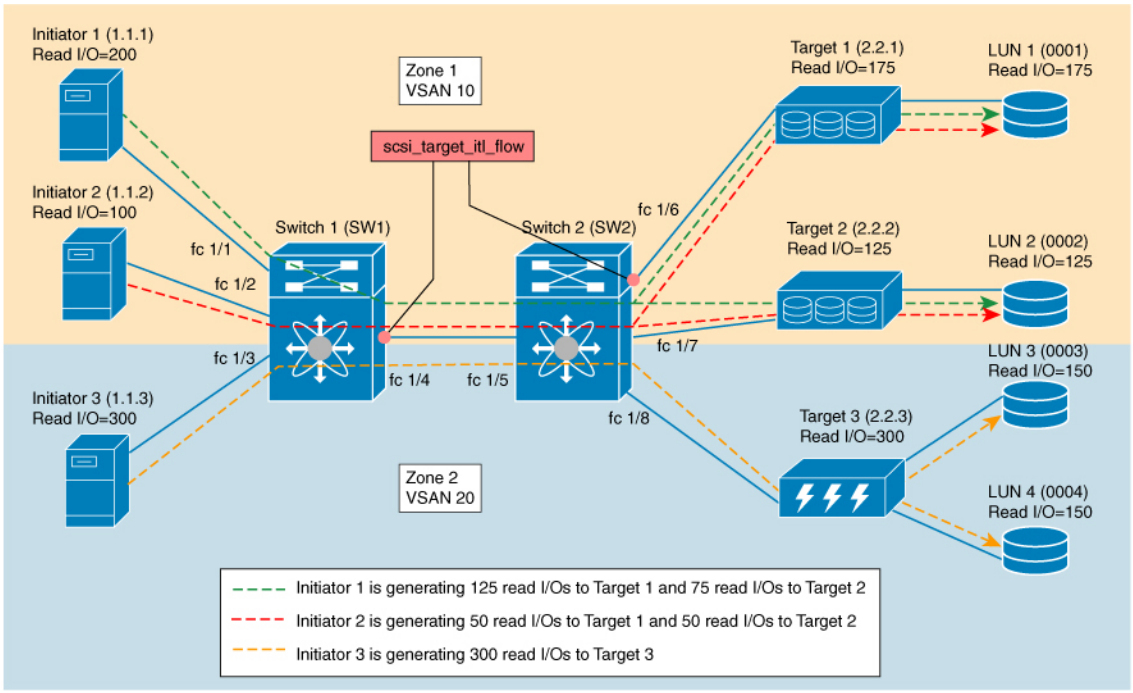



***Table 14: scsi_target_itl_flow View Type***

| scsi_target_itl_flow View | Flow Metrics |
|---|---|
| scsi_target_itl_flow view, where port = fc 1/6, VSAN = 1, initiator ID = 1.1.1, target ID = 2.2.1, and LUN ID = 0001<br><br>scsi_target_itl_flow view, where port = fc 1/4, VSAN = 1, initiator ID = 1.1.1, target ID = 2.2.1, and LUN ID = 0001 | total_read_io_count = 125 (read I/Os only between initiator ID 1.1.1, target ID 2.2.1, and LUN ID 0001) |
| scsi_target_itl_flow view, where port = fc 1/6, VSAN = 1, initiator ID = 1.1.2, target ID = 2.2.1, and LUN ID = 0001<br><br>scsi_target_itl_flow view, where port = fc 1/4, VSAN = 1, initiator ID = 1.1.2, target ID = 2.2.1, and LUN ID = 0001 | total_read_io_count = 50 (read I/Os only between initiator ID 1.1.2, target ID 2.2.1, and LUN ID 0001) |

| | |
|---|---|
| scsi_target_itl_flow view, where port = fc 1/4, VSAN = 1, initiator ID = 1.1.1, target ID = 2.2.2, and LUN ID = 0002 | total_read_io_count = 75 (read I/Os only between initiator ID 1.1.1, target ID 2.2.2, and LUN ID 0002) |
| scsi_target_itl_flow view, where port = fc 1/4, VSAN = 1, initiator ID = 1.1.2, target ID = 2.2.2, and LUN ID = 0002 | total_read_io_count = 50 (read I/Os only between initiator ID 1.1.2, target ID 2.2.2, and LUN ID 0002) |
| scsi_target_itl_flow view, where port = fc 1/4, VSAN = 2, initiator ID = 1.1.3, target ID = 2.2.3, and LUN ID = 0003<br>scsi_target_itl_flow view, where port = fc 1/4, VSAN = 2, initiator ID = 1.1.3, target ID = 2.2.3, and LUN ID = 0004 | total_read_io_count = 150 (read I/Os only between initiator ID 1.1.3, target ID 2.2.3, and LUN ID 0003, and initiator ID 1.1.3, target ID 2.2.3, and LUN ID 0004) |

The following image shows the flow metrics as viewed from a scsi_target_tl_flow view type:

***Figure 24: scsi_target_tl_flow View Type***

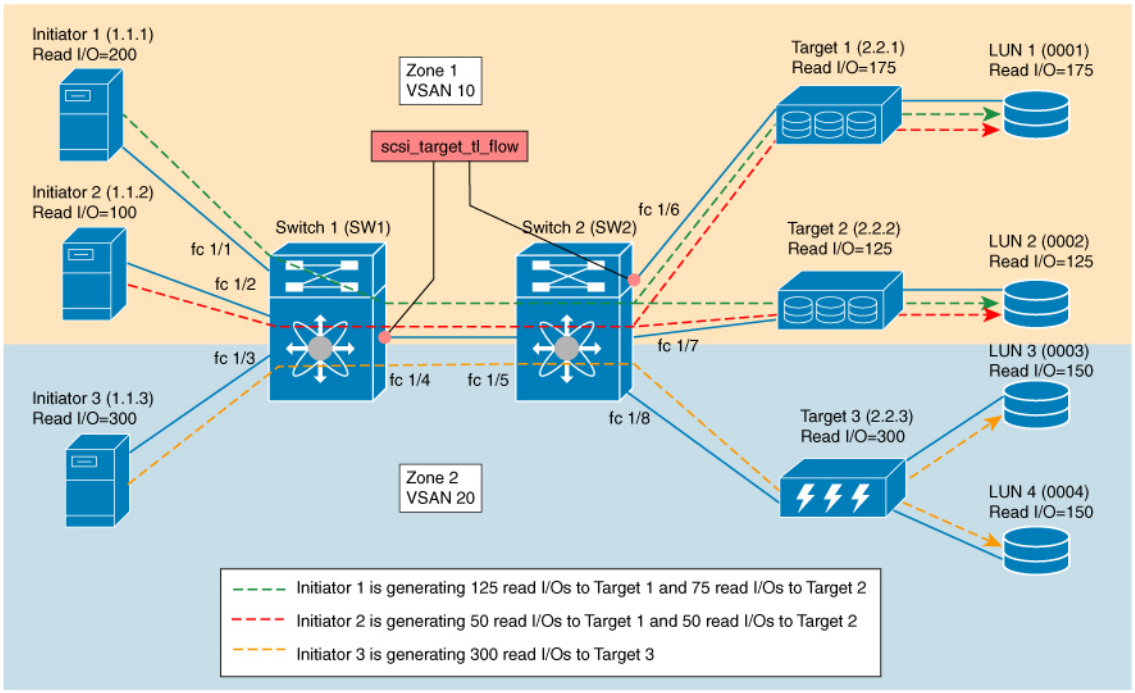


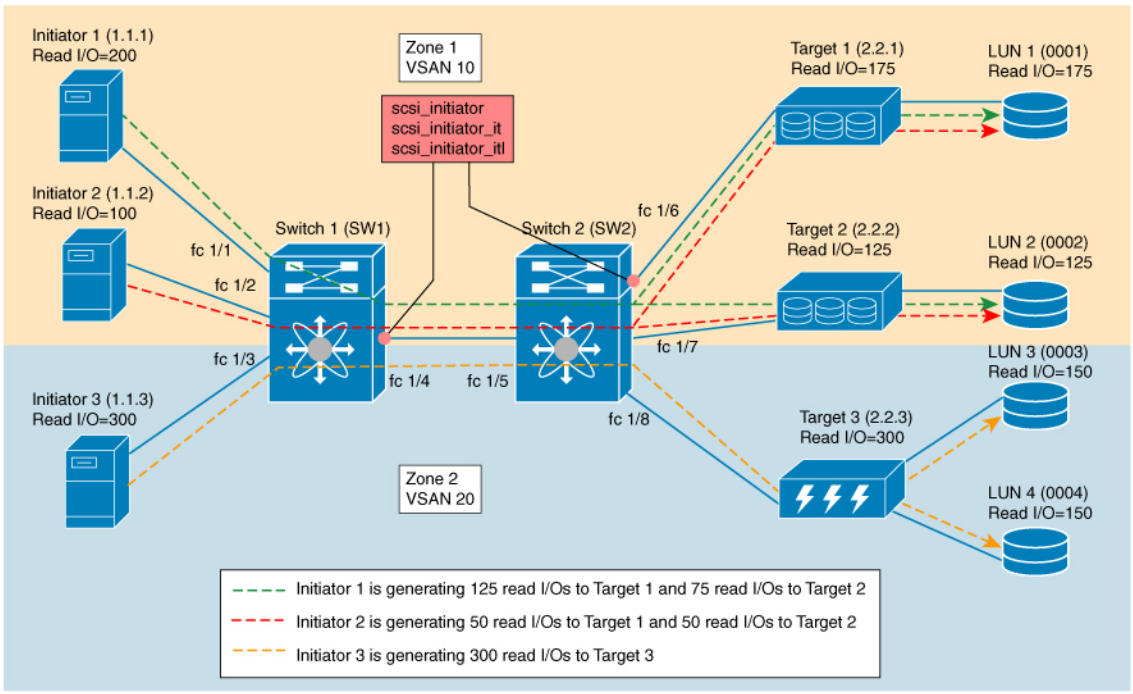

***Table 15: scsi_target_tl_flow View Type***

| scsi_target_tl_flow View | Flow Metrics |
|---|---|
| scsi_target_tl_flow view, where port = fc 1/6, VSAN = 1, target ID = 2.2.1, and LUN ID = 0001<br>scsi_target_tl_flow view, where port = fc 1/4, VSAN = 1, target ID = 2.2.1, and LUN ID = 0001 | total_read_io_count = 175 (read I/Os only between target ID 2.2.1 and LUN ID 0001) |

| | |
|---|---|
| scsi_target_tl_flow view, where port = fc 1/4, VSAN = 1, target ID = 2.2.2, and LUN ID = 0002 | total_read_io_count = 125 (read I/Os only between target ID 2.2.2 and LUN ID 0002) |
| scsi_target_tl_flow view, where port = fc 1/4, VSAN = 2, target ID = 2.2.3, and LUN ID = 0003<br>scsi_target_tl_flow view, where port = fc 1/4, VSAN = 2, target ID = 2.2.3, and LUN ID = 0004 | total_read_io_count = 150 (read I/Os only between target ID 2.2.3 and LUN ID 0003 and target ID 2.2.3 and LUN ID 0004) |

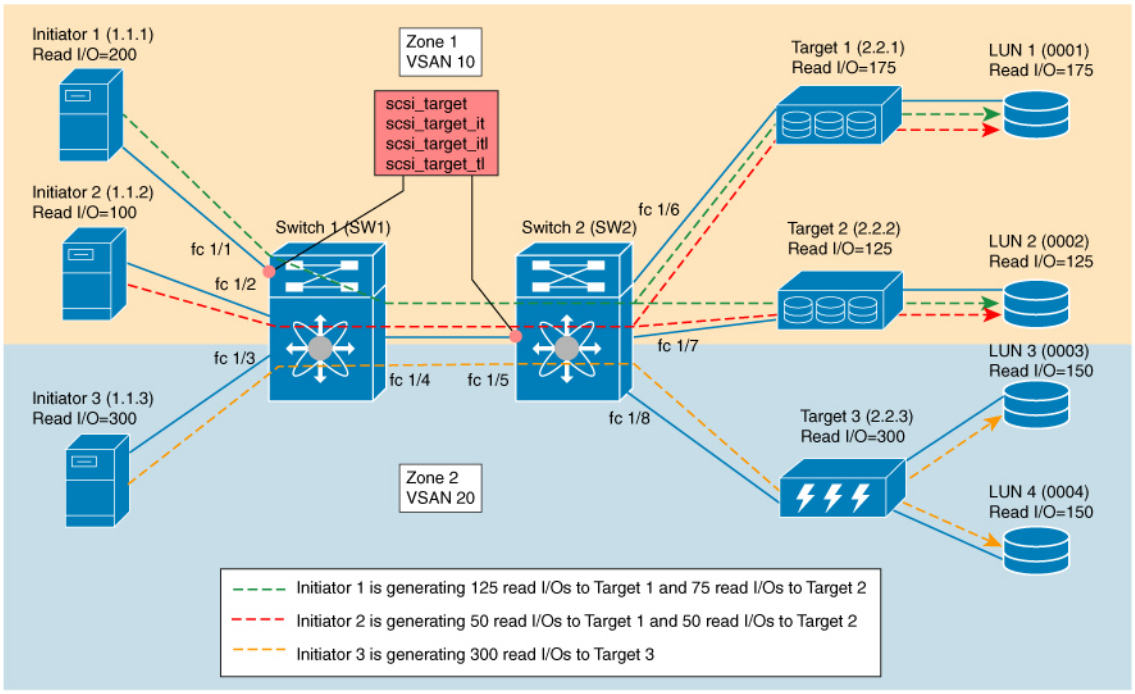
The following image shows initiator views where the total_read_io_count is 0.

***Figure 25: Initiator Views Where the total_read_io_count is Zero***




The following image shows target views where the total_read_io_count is 0.

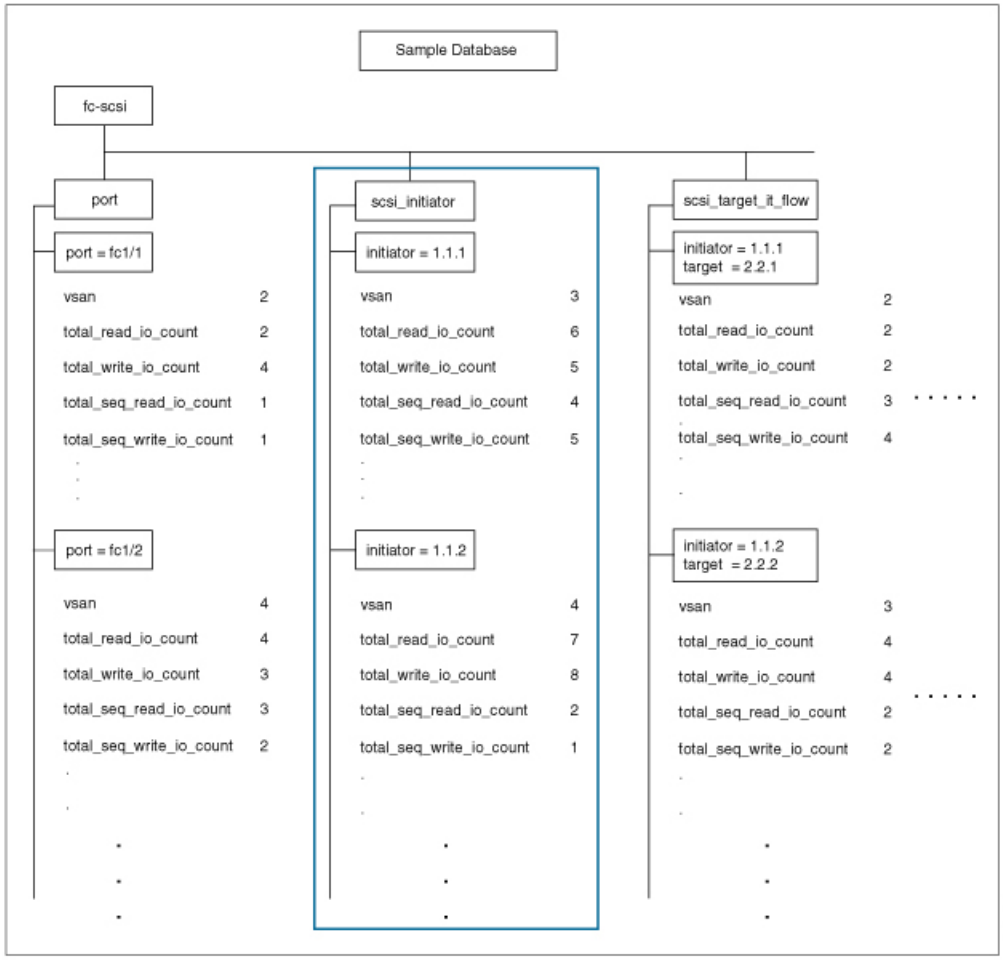
*Figure 26: Target Views Where the total_read_io_count is Zero*




# Examples: Configuring Query Syntax

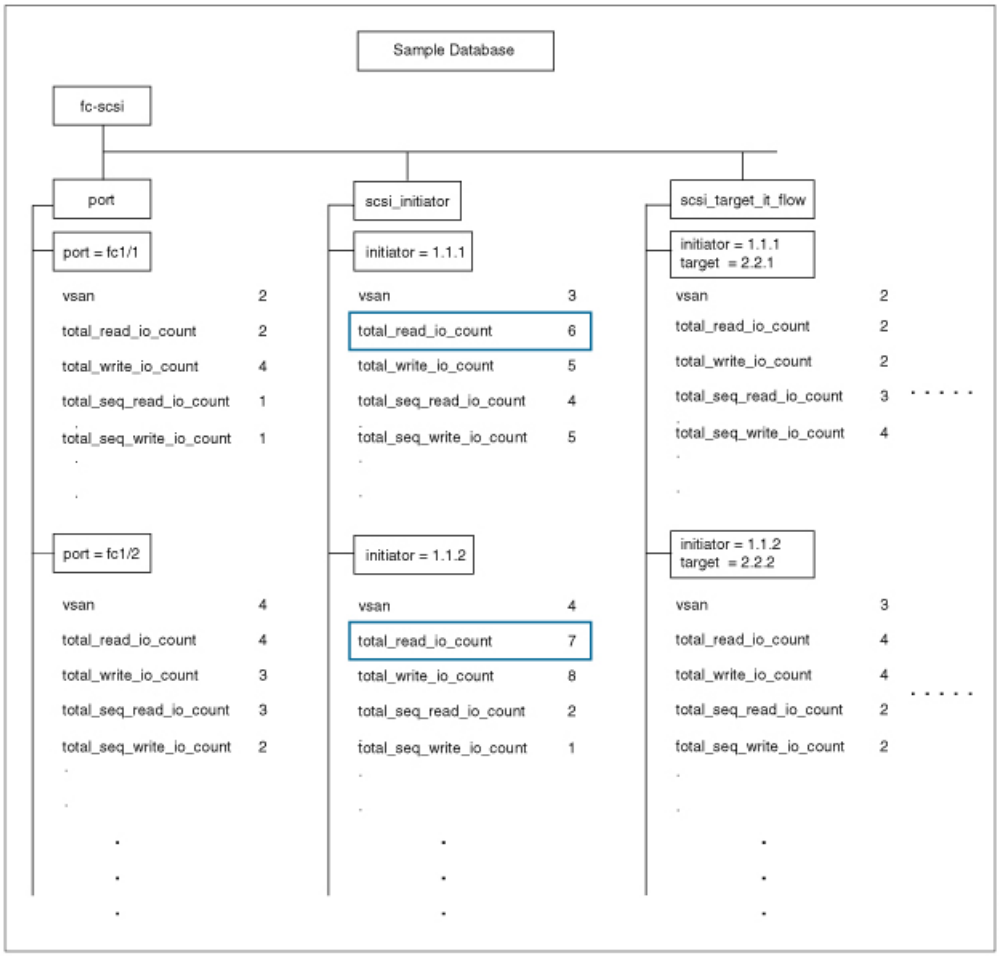
The **show analytics query 'select all from fc-scsi.scsi_initiator'** command provides an output of the flow metrics of all the initiators, as seen in the sample database shown in the following image:

*Figure 27: Flow Metrics of all the Initiators*



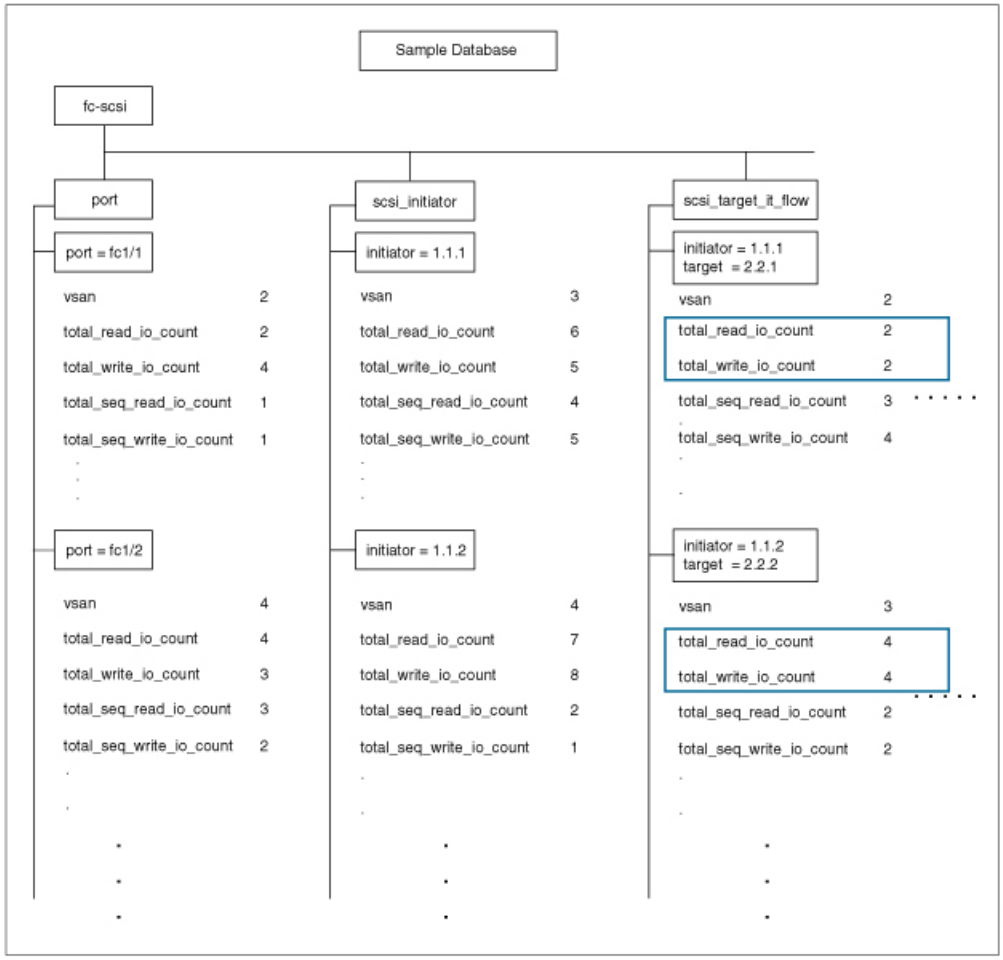

The **show analytics query 'select total_read_io_count from fc-scsi.scsi_initiator'** command provides an output of a target's total_read_io_count flow metrics, as seen in the sample database in the following image:

*Figure 28: Flow Metrics of a Target's Total Read IO Count*



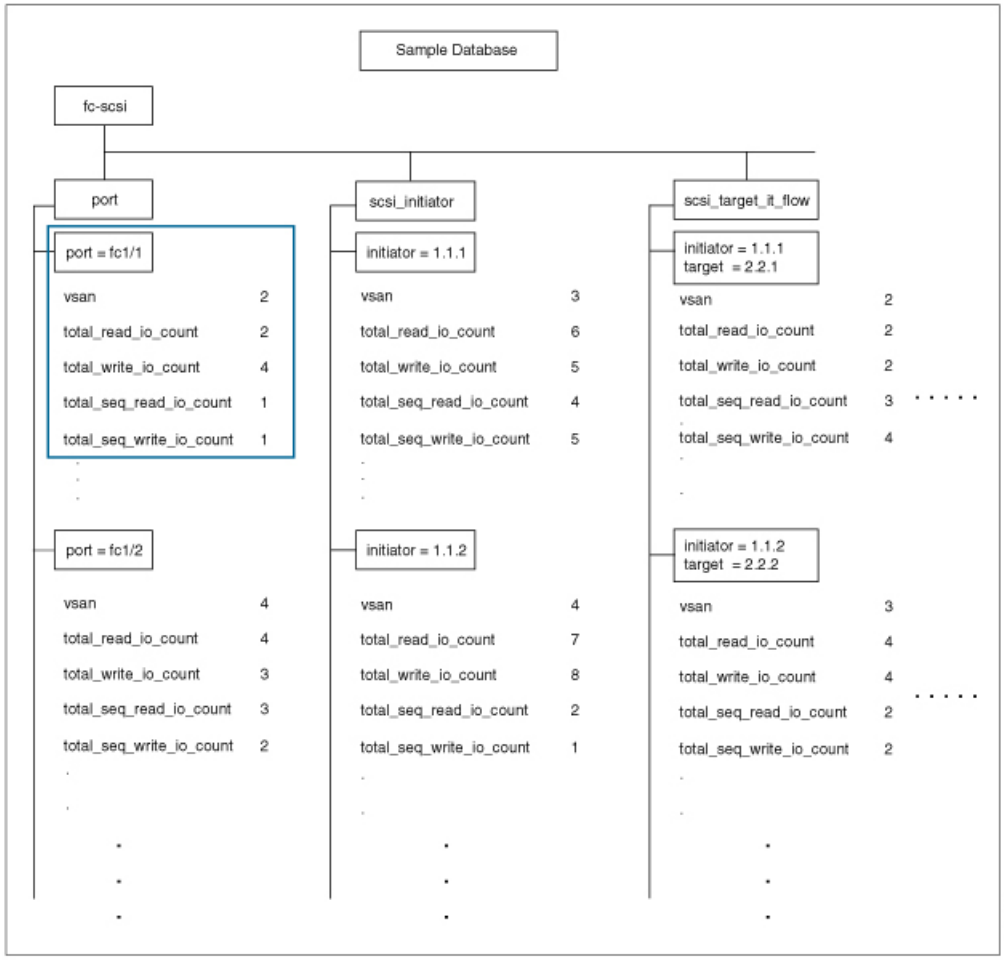

The **show analytics query 'select total_read_io_count,total_write_io_count from fc-scsi.scsi_target_it_flow'** command provides an output of an initiator's and a target's total_read_io_count and total_write_io_count flow metrics viewed from the target, as seen in the sample database in the following image:

*Figure 29: Flow Metrics of an Initiator's and Target's Total Read IO Count and Total Write IO Count*



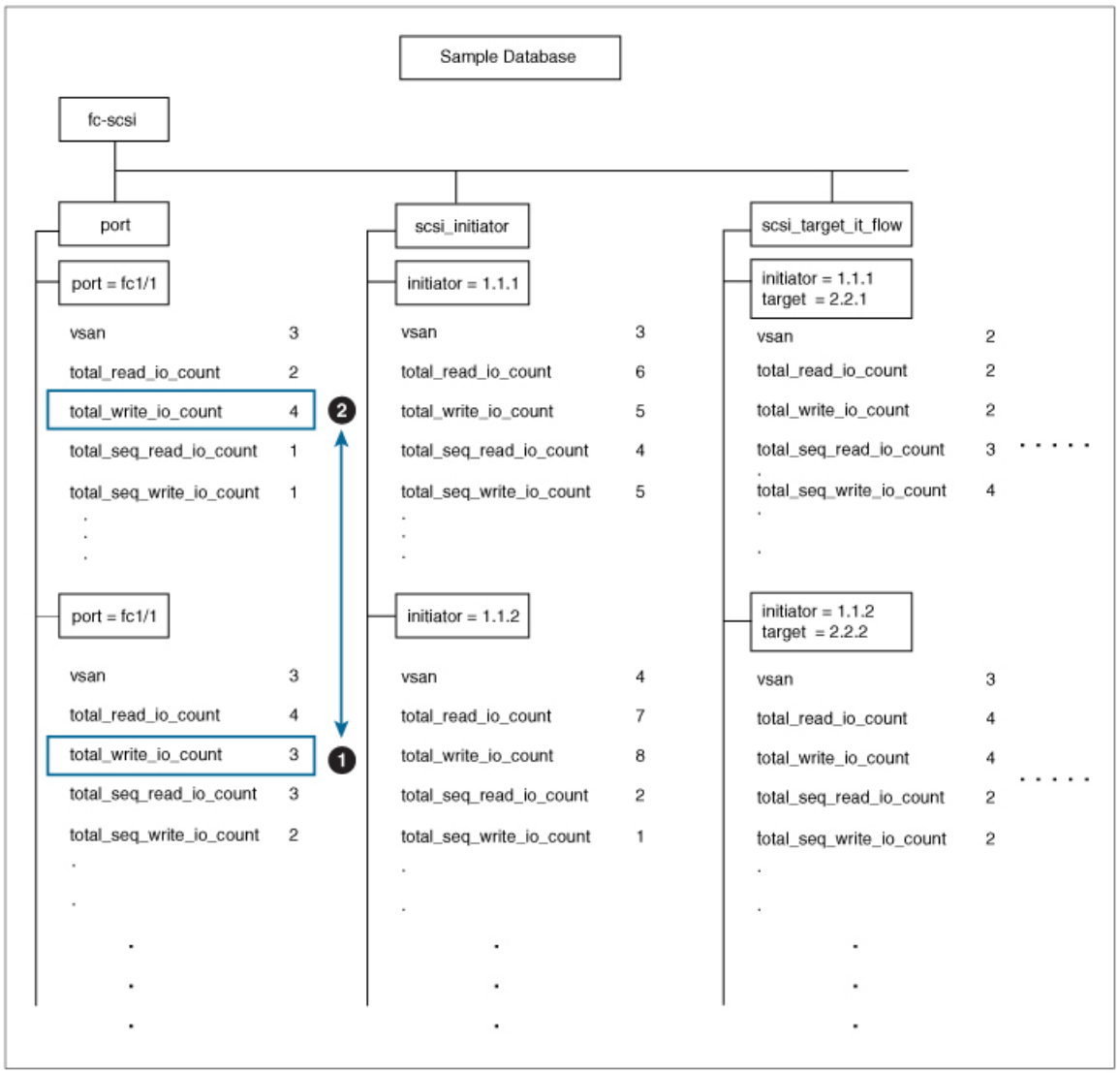

The **show analytics query 'select all from fc-scsi.port where port=fc1/1 and vsan=2 limit 1'** command provides an output of a port's flow metrics that are a part of port fc1/1, VSAN 2, with the number of records is limited to one, as seen in the sample database in the following image:

*Figure 30: Flow Metrics of the Port FC 1/1 That Belongs to VSAN 2 With the Number of Records Limited to One*




The **show analytics query 'select all from fc-scsi.scsi_initiator where port=fc1/1 and vsan=3 sort total_write_io_count'** command provides an output of an initiator's total_write_io_count flow metrics that are a part of port fc1/1 and VSAN 3, and the output is sorted, as seen in the sample database in the following image:

*Figure 31: Flow Metrics of an Initiator's Total Write IO Count That Belongs to Port FC1/1 and VSAN 3 With the Output Sorted*




# Constructing and Using Queries

Flow metrics are analyzed by using a *query_string* that is in the form of a query syntax.

## Displaying the Installed Push Queries

To display the installed push queries, run this command:

switch# **show analytics query** {**all** | **name** *query_name*}

# Displaying the Results of a Push Query

To display the results of a push query, run this command:

switch# **show analytics query name** *query_name* **result**

# Executing a Pull Query

To execute a pull query, run this command:

switch# **show analytics query** *"query_string"* [**clear**] [**differential**]

**Note** Use the *"query_string"* to specify query semantics, such as **select**, **table**, **limit**, and so on, for example, *"select all from fc-scsi.port"*.

# Configuring a Push Query

To configure a push query, perform these steps:

**Procedure**

**Step 1** Enter global configuration mode:

switch# **configure terminal**

**Step 2** Specify a query string and a timer value for the flow metrics to be displayed at specific intervals:

switch(config)# **analytics query** *"query_string"* **name** *query_name* **type periodic** [**interval** *seconds*] [**clear**] [**differential**]

Only one push query using a *"query_string"* is allowed at a time. If you try to configure a duplicate push query name, a message is returned stating that the current configuration is a duplicate.

**Note** Pull query, push query, and overlay CLI are applicable only on interfaces where the SAN Analytics feature is enabled.

# Removing a Configured Push Query

To remove a configured push query, perform these steps:

**Procedure**

**Step 1** Enter global configuration mode:

switch# **configure terminal**

**Step 2** Remove a configured push query:

switch(config)# **no analytics name** *query_name*

# Clearing Metrics

To reset all the flow metrics for a view instance that match the query string, run this command:

switch# **clear analytics query** *"query_string"*

**Note**

- The *"query_string"* must have the format *"select all from <view-name>"*.
- You can clear the flow metrics without installing a push query.
- The **clear analytics query** command is different from the **clear** option that is used in a push query. The **clear analytics query** command resets all the metrics that meet the query syntax and the **clear** option that is used in a push query resets the minimum, maximum, and peak flow metrics.

# Purging Views

To delete a specific view instance and its associated metrics, run this command:

switch# **purge analytics query** *"query_string"*

**Note**

- The *"query_string"* must have the format *"select all from <view-name>"*.
- You can clear the flow metrics without installing a push query.
- The **where** clause in the purge query can accept only the *port* key field.

# Displaying the Results of a Configured Push Query

The flow metrics that are displayed using the **show analytics query name** *query_name* **result** command are the refreshed metrics at the time interval when this command was executed. For example, if a push query is configured to refresh at an interval of every 30 seconds, and the **show analytics query name** *query_name* **result** command is executed after 35 seconds, the push query displays the flow metrics that were refreshed when the time interval was 30 seconds.

To display the flow metrics of a configured push query, run this command:

switch# **show analytics query name** *query_name* **result**

# Example: Constructing and Using Queries

**Note**

- The number after *"values"* in the output indicates the corresponding number of a record.
- New metrics are added in Cisco MDS NX-OS Release 8.3(1) because of which the query results may vary slightly between Cisco MDS NX-OS Release 8.3(1) and later releases and Cisco MDS NX-OS Release 8.2(1).

This example shows the output of all the flow metrics of the SCSI initiator ITL flow view instance:

```
switch#  show analytics query 'select all from fc-scsi.scsi_initiator_itl_flow'
{ "values": {
        "1": {
                "port": "fc1/1",
                "vsan": "10",
                "app_id": "255",
                "initiator_id": "0xe80041",
                "target_id": "0xd60200",
                "lun": "0000-0000-0000-0000",
                "active_io_read_count": "0",
                "active_io_write_count": "1",
                "total_read_io_count": "0",
                "total_write_io_count": "1162370362",
                "total_seq_read_io_count": "0",
                "total_seq_write_io_count": "1",
                "total_read_io_time": "0",
                "total_write_io_time": "116204704658",
                "total_read_io_initiation_time": "0",
                "total_write_io_initiation_time": "43996934029",
                "total_read_io_bytes": "0",
                "total_write_io_bytes": "595133625344",
                "total_read_io_inter_gap_time": "0",
                "total_write_io_inter_gap_time": "41139462314556",
                "total_time_metric_based_read_io_count": "0",
                "total_time_metric_based_write_io_count": "1162370358",
                "total_time_metric_based_read_io_bytes": "0",
                "total_time_metric_based_write_io_bytes": "595133623296",
                "read_io_rate": "0",
                "peak_read_io_rate": "0",
                "write_io_rate": "7250",
                "peak_write_io_rate": "7304",
                "read_io_bandwidth": "0",
                "peak_read_io_bandwidth": "0",
                "write_io_bandwidth": "3712384",
                "peak_write_io_bandwidth": "3739904",
                "read_io_size_min": "0",
                "read_io_size_max": "0",
                "write_io_size_min": "512",
                "write_io_size_max": "512",
                "read_io_completion_time_min": "0",
                "read_io_completion_time_max": "0",
                "write_io_completion_time_min": "89",
                "write_io_completion_time_max": "416",
                "read_io_initiation_time_min": "0",
                "read_io_initiation_time_max": "0",
                "write_io_initiation_time_min": "34",
                "write_io_initiation_time_max": "116",
                "read_io_inter_gap_time_min": "0",
```

```
            "read_io_inter_gap_time_max": "0",
            "write_io_inter_gap_time_min": "31400",
            "write_io_inter_gap_time_max": "118222",
            "peak_active_io_read_count": "0",
            "peak_active_io_write_count": "5",
            "read_io_aborts": "0",
            "write_io_aborts": "0",
            "read_io_failures": "0",
            "write_io_failures": "0",
            "read_io_scsi_check_condition_count": "0",
            "write_io_scsi_check_condition_count": "0",
            "read_io_scsi_busy_count": "0",
            "write_io_scsi_busy_count": "0",
            "read_io_scsi_reservation_conflict_count": "0",
            "write_io_scsi_reservation_conflict_count": "0",
            "read_io_scsi_queue_full_count": "0",
            "write_io_scsi_queue_full_count": "0",
            "sampling_start_time": "1528535447",
            "sampling_end_time": "1528697457"
    },
.
.
.
    "5": {
            "port": "fc1/8",
            "vsan": "10",
            "app_id": "255",
            "initiator_id": "0xe80001",
            "target_id": "0xe800a1",
            "lun": "0000-0000-0000-0000",
            "active_io_read_count": "0",
            "active_io_write_count": "1",
            "total_read_io_count": "0",
            "total_write_io_count": "1138738309",
            "total_seq_read_io_count": "0",
            "total_seq_write_io_count": "1",
            "total_read_io_time": "0",
            "total_write_io_time": "109792480881",
            "total_read_io_initiation_time": "0",
            "total_write_io_initiation_time": "39239145641",
            "total_read_io_bytes": "0",
            "total_write_io_bytes": "583034014208",
            "total_read_io_inter_gap_time": "0",
            "total_write_io_inter_gap_time": "41479779998852",
            "total_time_metric_based_read_io_count": "0",
            "total_time_metric_based_write_io_count": "1138738307",
            "total_time_metric_based_read_io_bytes": "0",
            "total_time_metric_based_write_io_bytes": "583034013184",
            "read_io_rate": "0",
            "peak_read_io_rate": "0",
            "write_io_rate": "7074",
            "peak_write_io_rate": "7903",
            "read_io_bandwidth": "0",
            "peak_read_io_bandwidth": "0",
            "write_io_bandwidth": "3622144",
            "peak_write_io_bandwidth": "4046336",
            "read_io_size_min": "0",
            "read_io_size_max": "0",
            "write_io_size_min": "512",
            "write_io_size_max": "512",
            "read_io_completion_time_min": "0",
            "read_io_completion_time_max": "0",
            "write_io_completion_time_min": "71",
            "write_io_completion_time_max": "3352",
```

```
                "read_io_initiation_time_min": "0",
                "read_io_initiation_time_max": "0",
                "write_io_initiation_time_min": "26",
                "write_io_initiation_time_max": "2427",
                "read_io_inter_gap_time_min": "0",
                "read_io_inter_gap_time_max": "0",
                "write_io_inter_gap_time_min": "25988",
                "write_io_inter_gap_time_max": "868452",
                "peak_active_io_read_count": "0",
                "peak_active_io_write_count": "5",
                "read_io_aborts": "0",
                "write_io_aborts": "0",
                "read_io_failures": "0",
                "write_io_failures": "0",
                "read_io_scsi_check_condition_count": "0",
                "write_io_scsi_check_condition_count": "0",
                "read_io_scsi_busy_count": "0",
                "write_io_scsi_busy_count": "0",
                "read_io_scsi_reservation_conflict_count": "0",
                "write_io_scsi_reservation_conflict_count": "0",
                "read_io_scsi_queue_full_count": "0",
                "write_io_scsi_queue_full_count": "0",
                "sampling_start_time": "1528535447",
                "sampling_end_time": "1528697457"
        }
}}
```


This example shows the output of all the flow metrics of the NVMe initiator ITN flow view instance:

```
switch# show analytics query 'select all from fc-nvme.nvme_initiator_itn_flow'
{ "values": {
        "1": {
                "port": "fc1/9",
                "vsan": "5",
                "app_id": "255",
                "initiator_id": "0xa40160",
                "target_id": "0xa4018c",
                "connection_id": "0000-0000-0000-0000",
                "namespace_id": "1",
                "active_io_read_count": "0",
                "active_io_write_count": "0",
                "total_read_io_count": "414106348",
                "total_write_io_count": "0",
                "total_seq_read_io_count": "0",
                "total_seq_write_io_count": "0",
                "total_read_io_time": "204490863437",
                "total_write_io_time": "0",
                "total_read_io_initiation_time": "132775579977",
                "total_write_io_initiation_time": "0",
                "total_read_io_bytes": "16226866588672",
                "total_write_io_bytes": "0",
                "total_read_io_inter_gap_time": "19198018763772",
                "total_write_io_inter_gap_time": "0",
                "total_time_metric_based_read_io_count": "414106244",
                "total_time_metric_based_write_io_count": "0",
                "total_time_metric_based_read_io_bytes": "16226860198912",
                "total_time_metric_based_write_io_bytes": "0",
                "read_io_rate": "0",
                "peak_read_io_rate": "16826",
                "write_io_rate": "0",
                "peak_write_io_rate": "0",
                "read_io_bandwidth": "0",
                "peak_read_io_bandwidth": "656438400",
```

```
            "write_io_bandwidth": "0",
            "peak_write_io_bandwidth": "0",
            "read_io_size_min": "1024",
            "read_io_size_max": "262144",
            "write_io_size_min": "0",
            "write_io_size_max": "0",
            "read_io_completion_time_min": "16",
            "read_io_completion_time_max": "7057",
            "write_io_completion_time_min": "0",
            "write_io_completion_time_max": "0",
            "read_io_initiation_time_min": "16",
            "read_io_initiation_time_max": "5338",
            "write_io_initiation_time_min": "0",
            "write_io_initiation_time_max": "0",
            "read_io_inter_gap_time_min": "32",
            "read_io_inter_gap_time_max": "83725169",
            "write_io_inter_gap_time_min": "0",
            "write_io_inter_gap_time_max": "0",
            "peak_active_io_read_count": "11",
            "peak_active_io_write_count": "0",
            "read_io_aborts": "24",
            "write_io_aborts": "0",
            "read_io_failures": "80",
            "write_io_failures": "0",
            "read_io_timeouts": "0",
            "write_io_timeouts": "0",
            "read_io_nvme_lba_out_of_range_count": "0",
            "write_io_nvme_lba_out_of_range_count": "0",
            "read_io_nvme_ns_not_ready_count": "0",
            "write_io_nvme_ns_not_ready_count": "0",
            "read_io_nvme_reservation_conflict_count": "0",
            "write_io_nvme_reservation_conflict_count": "0",
            "read_io_nvme_capacity_exceeded_count": "0",
            "write_io_nvme_capacity_exceeded_count": "0",
            "sampling_start_time": "1512847422",
            "sampling_end_time": "1513166516"
    },
.
.
.
    "5": {
            "port": "fc1/9",
            "vsan": "5",
            "app_id": "255",
            "initiator_id": "0xa40165",
            "target_id": "0xa40190",
            "connection_id": "0000-0000-0000-0000",
            "namespace_id": "1",
            "active_io_read_count": "0",
            "active_io_write_count": "0",
            "total_read_io_count": "33391955",
            "total_write_io_count": "643169087",
            "total_seq_read_io_count": "0",
            "total_seq_write_io_count": "0",
            "total_read_io_time": "13005795783",
            "total_write_io_time": "131521212441",
            "total_read_io_initiation_time": "5696099596",
            "total_write_io_initiation_time": "71938348902",
            "total_read_io_bytes": "1309083368448",
            "total_write_io_bytes": "329302572544",
            "total_read_io_inter_gap_time": "19175084866843",
            "total_write_io_inter_gap_time": "19182318062480",
            "total_time_metric_based_read_io_count": "33391919",
            "total_time_metric_based_write_io_count": "643168808",
```

```
                "total_time_metric_based_read_io_bytes": "1309074355200",
                "total_time_metric_based_write_io_bytes": "329302429696",
                "read_io_rate": "0",
                "peak_read_io_rate": "574",
                "write_io_rate": "0",
                "peak_write_io_rate": "9344",
                "read_io_bandwidth": "0",
                "peak_read_io_bandwidth": "19122176",
                "write_io_bandwidth": "0",
                "peak_write_io_bandwidth": "4784384",
                "read_io_size_min": "1024",
                "read_io_size_max": "262144",
                "write_io_size_min": "512",
                "write_io_size_max": "512",
                "read_io_completion_time_min": "16",
                "read_io_completion_time_max": "5123",
                "write_io_completion_time_min": "27",
                "write_io_completion_time_max": "2254",
                "read_io_initiation_time_min": "16",
                "read_io_initiation_time_max": "3650",
                "write_io_initiation_time_min": "12",
                "write_io_initiation_time_max": "1377",
                "read_io_inter_gap_time_min": "32",
                "read_io_inter_gap_time_max": "3234375975",
                "write_io_inter_gap_time_min": "32",
                "write_io_inter_gap_time_max": "38886219",
                "peak_active_io_read_count": "6",
                "peak_active_io_write_count": "16",
                "read_io_aborts": "6",
                "write_io_aborts": "18",
                "read_io_failures": "30",
                "write_io_failures": "261",
                "read_io_timeouts": "0",
                "write_io_timeouts": "0",
                "read_io_nvme_lba_out_of_range_count": "0",
                "write_io_nvme_lba_out_of_range_count": "0",
                "read_io_nvme_ns_not_ready_count": "0",
                "write_io_nvme_ns_not_ready_count": "0",
                "read_io_nvme_reservation_conflict_count": "0",
                "write_io_nvme_reservation_conflict_count": "0",
                "read_io_nvme_capacity_exceeded_count": "0",
                "write_io_nvme_capacity_exceeded_count": "0",
                "sampling_start_time": "1512847422",
                "sampling_end_time": "1513166516"
        }
}}
```


This example shows the output of specific flow metrics for a specific initiator ID of an initiator ITL flow view instance:

```
switch#   show analytics query 'select
port,initiator_id,target_id,lun,total_read_io_count,total_write_io_count,read_io_rate,write_io_rate
 from fc-scsi.scsi_initiator_itl_flow where initiator_id=0xe80001'
```


```
{ "values": {
        "1": {
                "port": "fc1/8",
                "initiator_id": "0xe80001",
                "target_id": "0xe800a1",
                "lun": "0000-0000-0000-0000",
                "total_read_io_count": "0",
                "total_write_io_count": "1139010960",
```

```
                "read_io_rate": "0",
                "write_io_rate": "7071",
                "sampling_start_time": "1528535447",
                "sampling_end_time": "1528697495"
        }
}}
```

This example shows the output of specific flow metrics for a specific initiator ID and LUN of an initiator ITL flow view instance:

```
switch#   show analytics query 'select
port,initiator_id,target_id,lun,total_read_io_count,total_write_io_count,read_io_rate,write_io_rate
 from fc-scsi.scsi_initiator_itl_flow where initiator_id=0xe80001 and lun=0000-0000-0000-0000'
{ "values": {
        "1": {
                "port": "fc1/8",
                "initiator_id": "0xe80001",
                "target_id": "0xe800a1",
                "lun": "0000-0000-0000-0000",
                "total_read_io_count": "0",
                "total_write_io_count": "1139453979",
                "read_io_rate": "0",
                "write_io_rate": "7070",
                "sampling_start_time": "1528535447",
                "sampling_end_time": "1528697559"
        }
}}
```

This example shows the output of specific flow metrics for a specific LUN, with the output sorted for the write_io_rate metrics of a target ITL flow view instance:

```
switch#   show analytics query 'select
port,initiator_id,target_id,lun,total_read_io_count,total_write_io_count,read_io_rate,write_io_rate
 from fc-scsi.scsi_target_itl_flow where lun=0000-0000-0000-0000 sort write_io_rate'
{ "values": {
        "1": {
                "port": "fc1/6",
                "initiator_id": "0xe80020",
                "target_id": "0xd60040",
                "lun": "0000-0000-0000-0000",
                "total_read_io_count": "0",
                "total_write_io_count": "1103394068",
                "read_io_rate": "0",
                "write_io_rate": "6882",
                "sampling_start_time": "1528535447",
                "sampling_end_time": "1528697630"
        },
        "2": {
                "port": "fc1/6",
                "initiator_id": "0xe80021",
                "target_id": "0xe80056",
                "lun": "0000-0000-0000-0000",
                "total_read_io_count": "0",
                "total_write_io_count": "1119199742",
                "read_io_rate": "0",
                "write_io_rate": "6946",
                "sampling_start_time": "1528535447",
                "sampling_end_time": "1528697630"
        },
        "3": {
                "port": "fc1/8",
```

```
                "initiator_id": "0xe80000",
                "target_id": "0xe80042",
                "lun": "0000-0000-0000-0000",
                "total_read_io_count": "0",
                "total_write_io_count": "1119506589",
                "read_io_rate": "0",
                "write_io_rate": "6948",
                "sampling_start_time": "1528535447",
                "sampling_end_time": "1528697630"
        },
        "4": {
                "port": "fc1/8",
                "initiator_id": "0xe80001",
                "target_id": "0xe800a1",
                "lun": "0000-0000-0000-0000",
                "total_read_io_count": "0",
                "total_write_io_count": "1139953183",
                "read_io_rate": "0",
                "write_io_rate": "7068",
                "sampling_start_time": "1528535447",
                "sampling_end_time": "1528697630"
        },
        "5": {
                "port": "fc1/1",
                "initiator_id": "0xe80041",
                "target_id": "0xd60200",
                "lun": "0000-0000-0000-0000",
                "total_read_io_count": "0",
                "total_write_io_count": "1163615698",
                "read_io_rate": "0",
                "write_io_rate": "7247",
                "sampling_start_time": "1528535447",
                "sampling_end_time": "1528697630"
        }
}}
```


This example shows the output of specific flow metrics for a specific LUN, with the output limited to three records and sorted for the write_io_rate metrics of an initiator ITL flow view instance:

```
switch#   show analytics query 'select
port,initiator_id,target_id,lun,total_read_io_count,total_write_io_count,read_io_rate,write_io_rate
 from fc-scsi.scsi_initiator_itl_flow where lun=0000-0000-0000-0000 sort write_io_rate limit
 3'
```


```
{ "values": {
        "1": {
                "port": "fc1/6",
                "initiator_id": "0xe80020",
                "target_id": "0xd60040",
                "lun": "0000-0000-0000-0000",
                "total_read_io_count": "0",
                "total_write_io_count": "1103901828",
                "read_io_rate": "0",
                "write_io_rate": "6885",
                "sampling_start_time": "1528535447",
                "sampling_end_time": "1528697704"
        },
        "2": {
                "port": "fc1/8",
                "initiator_id": "0xe80000",
                "target_id": "0xe80042",
                "lun": "0000-0000-0000-0000",
                "total_read_io_count": "0",
```

```
                "total_write_io_count": "1120018575",
                "read_io_rate": "0",
                "write_io_rate": "6940",
                "sampling_start_time": "1528535447",
                "sampling_end_time": "1528697704"
        },
        "3": {
                "port": "fc1/6",
                "initiator_id": "0xe80021",
                "target_id": "0xe80056",
                "lun": "0000-0000-0000-0000",
                "total_read_io_count": "0",
                "total_write_io_count": "1119711583",
                "read_io_rate": "0",
                "write_io_rate": "6942",
                "sampling_start_time": "1528535447",
                "sampling_end_time": "1528697704"
        }
}}
```

This example shows the output of specific flow metrics for a specific LUN and target ID of an initiator ITL flow view instance:

```
switch#   show analytics query 'select
port,initiator_id,target_id,lun,total_read_io_count,total_write_io_count,read_io_rate,write_io_rate
 from fc-scsi.scsi_initiator_itl_flow where lun=0000-0000-0000-0000 and target_id=0xe800a1'
{ "values": {
        "1": {
                "port": "fc1/8",
                "initiator_id": "0xe80001",
                "target_id": "0xe800a1",
                "lun": "0000-0000-0000-0000",
                "total_read_io_count": "0",
                "total_write_io_count": "1139010960",
                "read_io_rate": "0",
                "write_io_rate": "7071"
                "sampling_start_time": "1528535447",
                "sampling_end_time": "1528697495"
        }
}}
```

This example shows the output of specific flow metrics for VMID 4 and initiator ID 0x0900e0 for initiator ITL flow view instance:

```
switch#   show analytics query "select port,vsan,initiator_id,vmid from
fc-scsi.scsi_initiator_itl_flow where initiator_id=0x0900e0 and vmid=4"
{ "values": {
        "1": {
                "port": "fc2/9",
                "vsan": "1",
                "initiator_id": "0x0900e0",
                "vmid": "4",
                "sampling_start_time": "1589269530",
        }
}}
```

This example shows how to configure a push query when the duration to refresh the flow metrics is set to the default duration of 30 seconds:

```
switch# configure terminal
switch(config)# analytics query 'select all from fc-scsi.scsi_initiator_itl_flow' name
initiator_itl_flow type periodic
switch(config)# show analytics query name initiator_itl_flow result
{ "values": {
        "1": {
                "port": "fc1/1",
                "vsan": "10",
                "app_id": "255",
                "initiator_id": "0xe80041",
                "target_id": "0xd60200",
                "lun": "0000-0000-0000-0000",
                "active_io_read_count": "0",
                "active_io_write_count": "1",
                "total_read_io_count": "0",
                "total_write_io_count": "1162370362",
                "total_seq_read_io_count": "0",
                "total_seq_write_io_count": "1",
                "total_read_io_time": "0",
                "total_write_io_time": "116204704658",
                "total_read_io_initiation_time": "0",
                "total_write_io_initiation_time": "43996934029",
                "total_read_io_bytes": "0",
                "total_write_io_bytes": "595133625344",
                "total_read_io_inter_gap_time": "0",
                "total_write_io_inter_gap_time": "41139462314556",
                "total_time_metric_based_read_io_count": "0",
                "total_time_metric_based_write_io_count": "1162370358",
                "total_time_metric_based_read_io_bytes": "0",
                "total_time_metric_based_write_io_bytes": "595133623296",
                "read_io_rate": "0",
                "peak_read_io_rate": "0",
                "write_io_rate": "7250",
                "peak_write_io_rate": "7304",
                "read_io_bandwidth": "0",
                "peak_read_io_bandwidth": "0",
                "write_io_bandwidth": "3712384",
                "peak_write_io_bandwidth": "3739904",
                "read_io_size_min": "0",
                "read_io_size_max": "0",
                "write_io_size_min": "512",
                "write_io_size_max": "512",
                "read_io_completion_time_min": "0",
                "read_io_completion_time_max": "0",
                "write_io_completion_time_min": "89",
                "write_io_completion_time_max": "416",
                "read_io_initiation_time_min": "0",
                "read_io_initiation_time_max": "0",
                "write_io_initiation_time_min": "34",
                "write_io_initiation_time_max": "116",
                "read_io_inter_gap_time_min": "0",
                "read_io_inter_gap_time_max": "0",
                "write_io_inter_gap_time_min": "31400",
                "write_io_inter_gap_time_max": "118222",
                "peak_active_io_read_count": "0",
                "peak_active_io_write_count": "5",
                "read_io_aborts": "0",
                "write_io_aborts": "0",
                "read_io_failures": "0",
                "write_io_failures": "0",
                "read_io_scsi_check_condition_count": "0",
                "write_io_scsi_check_condition_count": "0",
                "read_io_scsi_busy_count": "0",
```

```
        "write_io_scsi_busy_count": "0",
        "read_io_scsi_reservation_conflict_count": "0",
        "write_io_scsi_reservation_conflict_count": "0",
        "read_io_scsi_queue_full_count": "0",
        "write_io_scsi_queue_full_count": "0",
        "sampling_start_time": "1528535447",
        "sampling_end_time": "1528697457"
},
.
.
.
"5": {
        "port": "fc1/8",
        "vsan": "10",
        "app_id": "255",
        "initiator_id": "0xe80001",
        "target_id": "0xe800a1",
        "lun": "0000-0000-0000-0000",
        "active_io_read_count": "0",
        "active_io_write_count": "1",
        "total_read_io_count": "0",
        "total_write_io_count": "1138738309",
        "total_seq_read_io_count": "0",
        "total_seq_write_io_count": "1",
        "total_read_io_time": "0",
        "total_write_io_time": "109792480881",
        "total_read_io_initiation_time": "0",
        "total_write_io_initiation_time": "39239145641",
        "total_read_io_bytes": "0",
        "total_write_io_bytes": "583034014208",
        "total_read_io_inter_gap_time": "0",
        "total_write_io_inter_gap_time": "41479779998852",
        "total_time_metric_based_read_io_count": "0",
        "total_time_metric_based_write_io_count": "1138738307",
        "total_time_metric_based_read_io_bytes": "0",
        "total_time_metric_based_write_io_bytes": "583034013184",
        "read_io_rate": "0",
        "peak_read_io_rate": "0",
        "write_io_rate": "7074",
        "peak_write_io_rate": "7903",
        "read_io_bandwidth": "0",
        "peak_read_io_bandwidth": "0",
        "write_io_bandwidth": "3622144",
        "peak_write_io_bandwidth": "4046336",
        "read_io_size_min": "0",
        "read_io_size_max": "0",
        "write_io_size_min": "512",
        "write_io_size_max": "512",
        "read_io_completion_time_min": "0",
        "read_io_completion_time_max": "0",
        "write_io_completion_time_min": "71",
        "write_io_completion_time_max": "3352",
        "read_io_initiation_time_min": "0",
        "read_io_initiation_time_max": "0",
        "write_io_initiation_time_min": "26",
        "write_io_initiation_time_max": "2427",
        "read_io_inter_gap_time_min": "0",
        "read_io_inter_gap_time_max": "0",
        "write_io_inter_gap_time_min": "25988",
        "write_io_inter_gap_time_max": "868452",
        "peak_active_io_read_count": "0",
        "peak_active_io_write_count": "5",
        "read_io_aborts": "0",
        "write_io_aborts": "0",
```

```
                "read_io_failures": "0",
                "write_io_failures": "0",
                "read_io_scsi_check_condition_count": "0",
                "write_io_scsi_check_condition_count": "0",
                "read_io_scsi_busy_count": "0",
                "write_io_scsi_busy_count": "0",
                "read_io_scsi_reservation_conflict_count": "0",
                "write_io_scsi_reservation_conflict_count": "0",
                "read_io_scsi_queue_full_count": "0",
                "write_io_scsi_queue_full_count": "0",
                "sampling_start_time": "1528535447",
                "sampling_end_time": "1528697457"
        }
}}
```


These examples show how to clear all the minimum, maximum, and peak flow metrics:

- This example shows the output before clearing all the minimum, maximum, and peak flow metrics:

```
switch# show analytics query "select all from  fc-scsi.scsi_target_itl_flow where
port=fc1/17" clear
{ "values": {
        "1": {
                "port": "fc1/17",
                "vsan": "1",
                "app_id": "255",
                "target_id": "0xef0040",
                "initiator_id": "0xef0000",
                "lun": "0000-0000-0000-0000",
                "active_io_read_count": "0",
                "active_io_write_count": "1",
                "total_read_io_count": "0",
                "total_write_io_count": "84701",
                "total_seq_read_io_count": "0",
                "total_seq_write_io_count": "1",
                "total_read_io_time": "0",
                "total_write_io_time": "7007132",
                "total_read_io_initiation_time": "0",
                "total_write_io_initiation_time": "2421756",
                "total_read_io_bytes": "0",
                "total_write_io_bytes": "86733824",
                "total_read_io_inter_gap_time": "0",
                "total_write_io_inter_gap_time": "2508109021",
                "total_time_metric_based_read_io_count": "0",
                "total_time_metric_based_write_io_count": "84701",
                "total_time_metric_based_read_io_bytes": "0",
                "total_time_metric_based_write_io_bytes": "86733824",
                "read_io_rate": "0",
                "peak_read_io_rate": "0",
                "write_io_rate": "8711",
                "peak_write_io_rate": "8711",
                "read_io_bandwidth": "0",
                "peak_read_io_bandwidth": "0",
                "write_io_bandwidth": "8920576",
                "peak_write_io_bandwidth": "8920576",
                "read_io_size_min": "0",
                "read_io_size_max": "0",
                "write_io_size_min": "1024",
                "write_io_size_max": "1024",
                "read_io_completion_time_min": "0",
                "read_io_completion_time_max": "0",
                "write_io_completion_time_min": "74",
                "write_io_completion_time_max": "844",
```

```
                "read_io_initiation_time_min": "0",
                "read_io_initiation_time_max": "0",
                "write_io_initiation_time_min": "24",
                "write_io_initiation_time_max": "775",
                "read_io_inter_gap_time_min": "0",
                "read_io_inter_gap_time_max": "0",
                "write_io_inter_gap_time_min": "26903",
                "write_io_inter_gap_time_max": "287888",
                "peak_active_io_read_count": "0",
                "peak_active_io_write_count": "3",
                "read_io_aborts": "0",
                "write_io_aborts": "0",
                "read_io_failures": "0",
                "write_io_failures": "0",
                "read_io_scsi_check_condition_count": "0",
                "write_io_scsi_check_condition_count": "0",
                "read_io_scsi_busy_count": "0",
                "write_io_scsi_busy_count": "0",
                "read_io_scsi_reservation_conflict_count": "0",
                "write_io_scsi_reservation_conflict_count": "0",
                "read_io_scsi_queue_full_count": "0",
                "write_io_scsi_queue_full_count": "0",
                "sampling_start_time": "1530683133",
                "sampling_end_time": "1530684301"
        },
}}
```


**Note** The **show analytics query** *"query_string"* **clear** command is a clear-on-push or clear-on-pull command. Therefore, this command is not applicable when this command is executed for the first time.

- This example shows the output after clearing all the minimum, maximum, and peak flow metrics. The metrics that were cleared are highlighted in the output.

```
switch# show analytics query "select all from  fc-scsi.scsi_target_itl_flow where
port=fc1/17" clear
```


```
{ "values": {
        "1": {
                "port": "fc1/17",
               "vsan": "1",
                "app_id": "255",
                "target_id": "0xef0040",
                "initiator_id": "0xef0000",
                "lun": "0000-0000-0000-0000",
                "active_io_read_count": "0",
                "active_io_write_count": "0",
                "total_read_io_count": "0",
                "total_write_io_count": "800615",
                "total_seq_read_io_count": "0",
                "total_seq_write_io_count": "1",
                "total_read_io_time": "0",
                "total_write_io_time": "66090290",
                "total_read_io_initiation_time": "0",
                "total_write_io_initiation_time": "22793874",
                "total_read_io_bytes": "0",
                "total_write_io_bytes": "819829760",
                "total_read_io_inter_gap_time": "0",
                "total_write_io_inter_gap_time": "23702347887",
```

```
                    "total_time_metric_based_read_io_count": "0",
                    "total_time_metric_based_write_io_count": "800615",
                    "total_time_metric_based_read_io_bytes": "0",
                    "total_time_metric_based_write_io_bytes": "819829760",
                    "read_io_rate": "0",
                    "peak_read_io_rate": "0",
                    "write_io_rate": "0",
                    "peak_write_io_rate": "0",
                    "read_io_bandwidth": "0",
                    "peak_read_io_bandwidth": "0",
                    "write_io_bandwidth": "0",
                    "peak_write_io_bandwidth": "0",
                    "read_io_size_min": "0",
                    "read_io_size_max": "0",
                    "write_io_size_min": "0",
                    "write_io_size_max": "0",
                    "read_io_completion_time_min": "0",
                    "read_io_completion_time_max": "0",
                    "write_io_completion_time_min": "0",
                    "write_io_completion_time_max": "0",
                    "read_io_initiation_time_min": "0",
                    "read_io_initiation_time_max": "0",
                    "write_io_initiation_time_min": "0",
                    "write_io_initiation_time_max": "0",
                    "read_io_inter_gap_time_min": "0",
                    "read_io_inter_gap_time_max": "0",
                    "write_io_inter_gap_time_min": "0",
                    "write_io_inter_gap_time_max": "0",
                    "peak_active_io_read_count": "0",
                    "peak_active_io_write_count": "0",
                    "read_io_aborts": "0",
                    "write_io_aborts": "0",
                    "read_io_failures": "0",
                    "write_io_failures": "0",
                    "read_io_scsi_check_condition_count": "0",
                    "write_io_scsi_check_condition_count": "0",
                    "read_io_scsi_busy_count": "0",
                    "write_io_scsi_busy_count": "0",
                    "read_io_scsi_reservation_conflict_count": "0",
                    "write_io_scsi_reservation_conflict_count": "0",
                    "read_io_scsi_queue_full_count": "0",
                    "write_io_scsi_queue_full_count": "0",
                    "sampling_start_time": "1530683133",
                    "sampling_end_time": "1530684428"
            },
}}
```

These examples show how to stream only the ITL flow metrics that have changed between streaming-sample intervals:

- This example shows the output before using the differential option:

```
switch# show analytics query "select port, target_id,
initiator_id,lun,total_write_io_count from fc-scsi.scsi_target_itl_flow where port=fc1/17"
 differential
{ "values": {
        "1": {
                "port": "fc1/17",
                "target_id": "0xef0040",
                "initiator_id": "0xef0000",
                "lun": "0001-0000-0000-0000",
```

```
                "total_write_io_count": "1515601",
                "sampling_start_time": "1530683133",
                "sampling_end_time": "1530683484"
        },
        "2": {
                "port": "fc1/17",
                "target_id": "0xef0040",
                "initiator_id": "0xef0020",
                "lun": "0000-0000-0000-0000",
                "total_write_io_count": "1515601",
                "sampling_start_time": "1530683133",
                "sampling_end_time": "1530683484"
        },
        "3": {
                "port": "fc1/17",
                "target_id": "0xef0040",
                "initiator_id": "0xef0020",
                "lun": "0001-0000-0000-0000",
                "total_write_io_count": "1515600",
                "sampling_start_time": "1530683133",
                "sampling_end_time": "1530683484"
        },
        "4": {
                "port": "fc1/17",
                "target_id": "0xef0040",
                "initiator_id": "0xef0000",
                "lun": "0000-0000-0000-0000",
                "total_write_io_count": "1515600",
                "sampling_start_time": "1530683133",
                "sampling_end_time": "1530683484"
        }
}}
```

- This example shows the output with the differential option and only the records that have changed:

```
switch# show analytics query "select port, target_id,
initiator_id,lun,total_write_io_count from fc-scsi.scsi_target_itl_flow where port=fc1/17"
 differential
{ "values": {
       "1": {
                "port": "fc1/17",
                "target_id": "0xef0040",
                "initiator_id": "0xef0000",
                "lun": "0001-0000-0000-0000",
                "total_write_io_count": "1892021",
                "sampling_start_time": "1530683133",
                "sampling_end_time": "1530683534"
        },
        "2": {
                "port": "fc1/17",
                "target_id": "0xef0040",
                "initiator_id": "0xef0020",
                "lun": "0000-0000-0000-0000",
                "total_write_io_count": "1892021",
                "sampling_start_time": "1530683133",
                "sampling_end_time": "1530683534"
        },
        "3": {
                "port": "fc1/17",
                "target_id": "0xef0040",
                "initiator_id": "0xef0000",
                "lun": "0000-0000-0000-0000",
                "total_write_io_count": "1892021",
```

```
                    "sampling_start_time": "1530683133",
                    "sampling_end_time": "1530683534"
            }
    }}
```

This example shows how to remove an installed query name:

```
switch(config)# no analytics name initiator_itl_flow
```

The following example show how to clear the flow metrics:

1. This example show the output before clearing the flow metrics:

```
switch# show analytics query "select port,target_id,total_write_io_count,
total_write_io_bytes,total_time_metric_based_write_io_count,write_io_rate,
peak_write_io_rate,write_io_bandwidth,peak_write_io_bandwidth,
write_io_size_min,write_io_size_max,write_io_completion_time_min,
write_io_completion_time_max,write_io_initiation_time_min,
write_io_initiation_time_max,write_io_inter_gap_time_min,write_io_inter_gap_time_max
from fc-scsi.scsi_target where
target_id=0x650060"
{ "values": {
        "1": {
                "port": "fc3/17",
                "target_id": "0x650060",
                "total_write_io_count": "67350021",
                "total_write_io_bytes": "17655403905024",
                "total_time_metric_based_write_io_count": "67349761",
                "write_io_rate": "0",
                "peak_write_io_rate": "6300",
                "write_io_bandwidth": "0",
                "peak_write_io_bandwidth": "1651572736",
                "write_io_size_min": "262144",
                "write_io_size_max": "262144",
                "write_io_completion_time_min": "192",
                "write_io_completion_time_max": "9434",
                "write_io_initiation_time_min": "21",
                "write_io_initiation_time_max": "199",
                "write_io_inter_gap_time_min": "2553",
                "write_io_inter_gap_time_max": "358500",
                "sampling_start_time": "1531204359",
                "sampling_end_time": "1531215327"
        }
```

2. This example shows how to clear the flow metrics:

**Note** Clearing metrics is allowed only on view instances and not on individual flow metrics.

```
switch# clear analytics query "select all from fc-scsi.scsi_target where
target_id=0x650060"
```

3. This example shows the output after clearing the flow metrics:

```
switch# show analytics query "select port,target_id,total_write_io_count,
total_write_io_bytes,total_time_metric_based_write_io_count,write_io_rate,
```

```
peak_write_io_rate,write_io_bandwidth,peak_write_io_bandwidth,
write_io_size_min,write_io_size_max,write_io_completion_time_min,
write_io_completion_time_max,write_io_initiation_time_min,
write_io_initiation_time_max,write_io_inter_gap_time_min,write_io_inter_gap_time_max
from fc-scsi.scsi_target where target_id=0x650060"
{ "values": {
        "1": {
                "port": "fc3/17",
                "target_id": "0x650060",
                "total_write_io_count": "0",
                "total_write_io_bytes": "0",
                "total_time_metric_based_write_io_count": "0",
                "write_io_rate": "0",
                "peak_write_io_rate": "0",
                "write_io_bandwidth": "0",
                "peak_write_io_bandwidth": "0",
                "write_io_size_min": "0",
                "write_io_size_max": "0",
                "write_io_completion_time_min": "0",
                "write_io_completion_time_max": "0",
                "write_io_initiation_time_min": "0",
                "write_io_initiation_time_max": "0",
                "write_io_inter_gap_time_min": "0",
                "write_io_inter_gap_time_max": "0",
                "sampling_start_time": "1531204359",
                "sampling_end_time": "1531215464"
        }
```

This example shows the output after purging the flow metrics:

**Note** Only the *port* key value is allowed with the **where** clause for purging metrics.

```
switch# purge analytics query "select all from fc-scsi.scsi_target where port=fc3/17"
switch# show analytics query "select all from fc-scsi.scsi_target where port=fc3/17"
Table is empty for query "select all from fc-scsi.scsi_target where port=fc3/17"
```

# Using the ShowAnalytics Overlay CLI

The **ShowAnalytics** overlay CLI is used to interpret the analytics data that is in JSON format in a user-friendly tabular format. The **ShowAnalytics** overlay CLI has a "Linux like" syntax and uses the inbuilt NX-OS Python interpreter to execute a script to convert the JSON output of the pull query into a tabular format. Currently, only a small subset of the flow metrics is displayed.

**Note**

- To execute Overlay CLIs, you must login as **network-admin**.
- The **ShowAnalytics** overlay command displays cumulative data about the Exchange Completion Time (ECT) for the *--initiator-itl* and *--target-itl* options under the *--info* option. However, it displays instantaneous data for rate and bandwidth metrics.
- If the active ITL count exceeds the documented limit, the **ShowAnalytics** overlay command displays a warning and exits. For information on the ITL count limit, see the Cisco MDS NX-OS Configuration Limits, Release 8.x document.
- If you configure a push query with the **clear** keyword as recommended by Virtual Instruments or Cisco DCNM, the minimum and maximum flow metrics will not have accurate values.
- The options under the ShowAnalytics command support only the SCSI analytics type, except the **--evaluate-npuload** option that supports both SCSI and NVMe analytics types.
- Run the **--evaluate-npuload** option before configuring the *analytics type* on interfaces. The **--evaluate-npuload** option does not work on a module even if one of the interface on the module is configured with an analytic type.
- The **--outstanding-io** option works only on F ports.

To display the analytics information in a tabular format, run this command:

switch# **ShowAnalytics** *–help*.

For more information, see the Cisco MDS 9000 Series Command Reference, Release 8.x.

# Examples: Using the ShowAnalytics Overlay CLI

This example shows the options under the overlay CLI:

**Note** The option to display the available keywords and variables under the overlay CLI and its options that are added from Cisco MDS NX-OS Release 8.4(2) and later.

```
switch# ShowAnalytics ?
  ShowAnalytics              Aliased to 'source sys/analytics.py'
  ShowAnalyticsConsistency   Aliased to 'source sys/analytics_pss_consistency_checker.py'
  --errors                   To display errors stats in all IT(L/N) pairs
  --errorsonly               To display IT(L/N) flows with errors
  --evaluate-npuload         To evaluate npuload on system
  --help                     To display help and exit
  --info                     To display information about IT(L/N) flows
  --minmax                   To display min max and peak info about IT(L/N) flows
  --outstanding-io           To display outstanding io for an interface
  --top                      To display top 10 IT(L/N) Flow
  --version                  To display version of utility and exit
  --vsan-thput               To display per vsan throughput for interface
```

This example shows how to display the overlay CLI version:

```
switch# ShowAnalytics --version
ShowAnalytics 4.0.0
```

This example shows how to display the flow metrics of an initiator ITL:

```
switch# ShowAnalytics --info --initiator-itl
2021-02-09 09:01:39.714290

Interface fc3/1
+-------------------------------------------------------------------------------------------------------------------------------------------------------------+
| VSAN |Initiator|VMID| Target |       LUN          |Avg IOPS| Avg Throughput  |  Avg ECT   |Avg Data Access Latency|  Avg IO Size  |
+-------------------------------------------------------------------------------------------------------------------------------------------------------------+
|                                                    |Read|Write|Read |   Write |Read| Write |   Read    |   Write   |Read | Write   |
|                                                    |    |     |     |         |    |       |           |           |       |         |
| 2200 |0x641547|  1  |0x641227|0006-0000-0000-0000|  0 | 19  |0 B/s|76.0 KB/s|0 ns|17.7 ms|   0 ns    |   4.7 ms  |0 B/s|9.1 KB/s |
| 2200 |0x64154a|  6  |0x64122a|003b-0000-0000-0000|  0 | 20  |0 B/s|83.0 KB/s|0 ns|13.2 ms|   0 ns    |   4.4 ms  |0 B/s|10.1 KB/s|
| 2200 |0x641542|  2  |0x641222|0013-0000-0000-0000|  0 | 22  |0 B/s|88.0 KB/s|0 ns|15.2 ms|   0 ns    |   4.5 ms  |0 B/s|10.1 KB/s|
| 2200 |0x641545|  3  |0x641225|001c-0000-0000-0000|  0 | 23  |0 B/s|93.0 KB/s|0 ns|18.7 ms|   0 ns    |   4.9 ms  |0 B/s|7.5 KB/s |
| 2200 |0x641543|  1  |0x641223|0003-0000-0000-0000|  0 | 13  |0 B/s|53.0 KB/s|0 ns|13.6 ms|   0 ns    |   4.5 ms  |0 B/s|7.0 KB/s |
| 2200 |0x641546|  4  |0x641226|0027-0000-0000-0000|  0 | 24  |0 B/s|99.0 KB/s|0 ns|18.1 ms|   0 ns    |   4.7 ms  |0 B/s|7.6 KB/s |
| 2200 |0x641545|  4  |0x641225|0021-0000-0000-0000|  0 | 20  |0 B/s|82.0 KB/s|0 ns|15.2 ms|   0 ns    |   5.1 ms  |0 B/s|7.9 KB/s |
| 2200 |0x641548|  5  |0x641228|002d-0000-0000-0000|  0 | 21  |0 B/s|84.0 KB/s|0 ns|16.0 ms|   0 ns    |   4.5 ms  |0 B/s|9.9 KB/s |
| 2200 |0x641547|  5  |0x641227|002f-0000-0000-0000|  0 | 24  |0 B/s|96.0 KB/s|0 ns|14.3 ms|   0 ns    |   3.7 ms  |0 B/s|9.1 KB/s |
| 2200 |0x641545|  6  |0x641225|003a-0000-0000-0000|  0 | 15  |0 B/s|61.0 KB/s|0 ns|17.0 ms|   0 ns    |   4.2 ms  |0 B/s|9.4 KB/s |
+-------------------------------------------------------------------------------------------------------------------------------------------------------------+
```

This example shows how to display the flow metrics of an initiator for NVMe:

```
switch# ShowAnalytics --info --initiator-itn
2021-02-09 09:01:39.714290

 Interface fc16/12
+-----------------------------------+----------+-------------------+-------------------+-----------+-------------+-----------+-------------+
|VSAN | Initiator |  Target   | Namespace |   Avg IOPS   |      Avg Throughput      |       Avg ECT       |       Avg DAL       |     Avg IO Size
      | Avg Host Delay | Avg Array Delay |
+-----------------------------------+----------+-------------------+-------------------+-----------+-------------+-----------+-------------+
|                                   |          | Read | Write |     Read   |   Write     |   Read    |   Write   |   Read    |   Write   |   Read    |
Write   |     Write      |      Write      |
|                                   |          |      |       |            |             |           |           |           |           |           |
       |                |                 |
|3300 | 0xc80002  | 0xed0002  |  1       | 2531 | 2478  | 158.2 MB/s | 154.9 MB/s  | 781.0 us |   2.0 ms | 636.0 us | 633.0 us |  64.0 KB |
64.0 KB  |    690.0 us    |     562.0 us    |
|3300 | 0xc80007  | 0xed0007  |  1       | 2508 | 2497  | 156.8 MB/s | 156.1 MB/s  | 764.0 us |   2.0 ms | 622.0 us | 630.0 us |  64.0 KB |
64.0 KB  |    683.0 us    |     572.0 us    |
|3300 | 0xc80005  | 0xed0005  |  1       | 2421 | 2548  | 151.3 MB/s | 159.3 MB/s  | 785.0 us |   2.0 ms | 640.0 us | 625.0 us |  64.0 KB |
64.0 KB  |    686.0 us    |     561.0 us    |
|3300 | 0xc80001  | 0xed0001  |  1       | 2060 | 2149  | 128.8 MB/s | 134.3 MB/s  | 764.0 us |   1.9 ms | 621.0 us | 596.0 us |  64.0 KB |
64.0 KB  |    649.0 us    |     537.0 us    |
|3300 | 0xc80000  | 0xed0000  |  1       | 333  | 364    |  20.8 MB/s |  22.8 MB/s  |  14.8 ms |  16.1 ms |  14.6 ms |  15.3 ms |  64.0 KB |
64.0 KB  |    190.0 us    |     521.0 us    |
|3300 | 0xc80008  | 0xed0008  |  1       | 2483 | 2503  | 155.2 MB/s | 156.4 MB/s  | 771.0 us |   2.0 ms | 626.0 us | 639.0 us |  64.0 KB |
64.0 KB  |    685.0 us    |     571.0 us    |
|3300 | 0xc80009  | 0xed0009  |  1       | 2545 | 2474  | 159.1 MB/s | 154.6 MB/s  | 786.0 us |   2.0 ms | 641.0 us | 627.0 us |  64.0 KB |
64.0 KB  |    683.0 us    |     570.0 us    |
|3300 | 0xc80004  | 0xed0004  |  1       | 2506 | 2498  | 156.6 MB/s | 156.1 MB/s  | 769.0 us |   2.0 ms | 625.0 us | 642.0 us |  64.0 KB |
64.0 KB  |    680.0 us    |     575.0 us    |
|3300 | 0xc80006  | 0xed0006  |  1       | 2456 | 2512  | 153.5 MB/s | 157.0 MB/s  | 793.0 us |   2.0 ms | 650.0 us | 624.0 us |  64.0 KB |
64.0 KB  |    696.0 us    |     558.0 us    |
|3300 | 0xc80000  | 0xed0001  |  1       | 1926 | 1848  | 120.4 MB/s | 115.5 MB/s  | 734.0 us |   1.8 ms | 593.0 us | 572.0 us |  64.0 KB |
64.0 KB  |    533.0 us    |     512.0 us    |
|3300 | 0xc80003  | 0xed0003  |  1       | 2553 | 2472  | 159.6 MB/s | 154.5 MB/s  | 786.0 us |   2.0 ms | 641.0 us | 622.0 us |  64.0 KB |
64.0 KB  |    691.0 us    |     560.0 us    |
+-----------------------------------+----------+-------------------+-------------------+-----------+-------------+-----------+-------------+
Total number of ITNs: 11
```

This example shows how to display the flow metrics of an initiator for SCSI:

```
switch# ShowAnalytics --info --initiator-itl
2021-02-09 09:01:39.714290

Interface fc2/22
+-----------------------------------+----------+-------------------+-------------------+-----------+-------------+-----------+-------------+
|VSAN | Initiator | VMID |  Target   |         LUN          |   Avg IOPS   |      Avg Throughput      |       Avg ECT       |       Avg DAL       |
     Avg IO Size      | Avg Host Delay | Avg Array Delay |
+-----------------------------------+----------+-------------------+-------------------+-----------+-------------+-----------+-------------+
|                                   |          |                                      | Read | Write |     Read   |   Write     |   Read    |   Write   |   Read    |   Write   |
   Read   |   Write   |     Write      |      Write      |
|                                   |          |                                      |      |       |            |             |           |           |           |           |
                       |                |                 |
|2200 | 0xe80ee0  |   - | 0xc809a0  | 0001-0000-0000-0000  |    0 | 0     |      0 B/s |    0 B/s   |   0 ns  |    0 ns  |   0 ns  |    0 ns  |
      0 B |    0 B    |      0 ns      |       0 ns      |
|2200 | 0xe80ee0  |   - | 0xe80622  | 0007-0000-0000-0000  |    0 | 0     |      0 B/s |    0 B/s   |   0 ns  |    0 ns  |   0 ns  |    0 ns  |
      0 B |    0 B    |      0 ns      |       0 ns      |
|2200 | 0xe80ee0  |   - | 0xc809a0  | 0002-0000-0000-0000  |    0 | 0     |      0 B/s |    0 B/s   |   0 ns  |    0 ns  |   0 ns  |    0 ns  |
      0 B |    0 B    |      0 ns      |       0 ns      |
|2200 | 0xe80ee0  |   - | 0xc809a0  | 0003-0000-0000-0000  |    0 | 0     |      0 B/s |    0 B/s   |   0 ns  |    0 ns  |   0 ns  |    0 ns  |
      0 B |    0 B    |      0 ns      |       0 ns      |
|2200 | 0xe80ee0  |   - | 0xe80622  | 0002-0000-0000-0000  |    0 | 0     |      0 B/s |    0 B/s   |   0 ns  |    0 ns  |   0 ns  |    0 ns  |
      0 B |    0 B    |      0 ns      |       0 ns      |
|2200 | 0xe80ee0  |  18 | 0xc809a0  | 0003-0000-0000-0000  |    0 | 5     |      0 B/s |  21.0 KB/s |   0 ns  | 702.0 us |   0 ns  | 251.0 us |
      0 B |  4.2 KB   |      7.0 us    |      441.0 us   |
|2200 | 0xe80ee0  |   - | 0xe80623  | 0004-0000-0000-0000  |    0 | 0     |      0 B/s |    0 B/s   |   0 ns  |    0 ns  |   0 ns  |    0 ns  |
```

```
      0 B |    0 B    |      0 ns      |       0 ns      |
|2200 | 0xe80ee0  |   - | 0xe80622  | 0000-0000-0000-0000  |    0 | 0     |      0 B/s |    0 B/s    |   0 ns  |    0 ns  |   0 ns  |    0 ns  |
      0 B |    0 B    |      0 ns      |       0 ns      |
+-----------------------------------------+-----------+-------------------+-------------+-------------+-------------+-----------+-----------+
Total number of ITLs: 8
```

This example shows how to display the flow metrics of a target ITL:

```
switch# ShowAnalytics --info --target-itl
2021-02-09 12:14:59.285397

Interface fc1/1
+-----------------------------------------------------------------------------------------------------------------------------------------------+
|VSAN|Initiator|VMID| Target |       LUN         | Avg IOPS | Avg Throughput |  Avg ECT  |Avg Data Access Latency|  Avg IO Size   |
+-----------------------------------------------------------------------------------------------------------------------------------------------+
|                                               |Read|Write|Read | Write    |Read|Write |   Read     |   Write  | Read| Write    |
|                                               |    |     |     |          |    |      |            |          |     |          |
| 20| 0x1c0020 | 89 |0x1c0000|0000-0000-0000-0000| 0  |1761 |0 B/s|220.2 MB/s|0 ns|5.5 ms|   0 ns     |  2.5 ms  |0 B/s|128.0 KB/s|
+-----------------------------------------------------------------------------------------------------------------------------------------------+
```

This example shows how to display the flow metrics of a target for NVMe:

```
switch# ShowAnalytics --info --target-itn
2021-02-09 12:14:59.285397

Interface fc3/15
+-----------------------------------+-----------+---------------------+-----------------+-----------------+-------------+-------------+-------------+-------------+
|VSAN | Initiator |  Target   | Namespace |   Avg IOPS   |      Avg Throughput      |       Avg ECT       |      Avg DAL        |     Avg IO Size
      | Avg Host Delay | Avg Array Delay |
+-----------------------------------+-----------+---------------------+-----------------+-----------------+-------------+-------------+-------------+-------------+
|                                   | Read | Write |     Read    |    Write    |   Read    |   Write   |  Read   |   Write   |   Read    |
Write   |     Write      |      Write      |
|                                   |      |       |             |             |           |           |         |           |           |
      |                |                 |
|3300 | 0xc80005  | 0xed0005  |  1        | 2545 | 2457  | 159.1 MB/s | 153.6 MB/s  | 112.0 us |   1.5 ms | 44.0 us |  40.0 us |  64.0 KB |  64.0
 KB  |     1.3 ms     |      5.0 us     |
|3300 | 0xc80000  | 0xed0001  |  1        | 2036 | 2026  | 127.3 MB/s | 126.6 MB/s  | 110.0 us |   1.3 ms | 44.0 us |  39.0 us |  64.0 KB |  64.0
 KB  |     1.1 ms     |      5.0 us     |
|3300 | 0xc80004  | 0xed0004  |  1        | 2464 | 2492  | 154.0 MB/s | 155.8 MB/s  | 113.0 us |   1.5 ms | 45.0 us |  40.0 us |  64.0 KB |  64.0
 KB  |     1.3 ms     |      5.0 us     |
|3300 | 0xc80001  | 0xed0001  |  1        | 2036 | 2020  | 127.2 MB/s | 126.2 MB/s  | 112.0 us |   1.3 ms | 44.0 us |  40.0 us |  64.0 KB |  64.0
 KB  |     1.1 ms     |      5.0 us     |
|3300 | 0xc80003  | 0xed0003  |  1        | 2460 | 2491  | 153.8 MB/s | 155.7 MB/s  | 114.0 us |   1.5 ms | 45.0 us |  39.0 us |  64.0 KB |  64.0
 KB  |     1.3 ms     |      5.0 us     |
|3300 | 0xc80000  | 0xed0000  |  1        | 335  | 360   |  20.9 MB/s |  22.5 MB/s  |  14.1 ms |  15.6 ms | 14.1 ms |  14.7 ms |  64.0 KB |  64.0
 KB  |    784.0 us    |      5.0 us     |
|3300 | 0xc80007  | 0xed0007  |  1        | 2476 | 2488  | 154.8 MB/s | 155.5 MB/s  | 114.0 us |   1.5 ms | 46.0 us |  39.0 us |  64.0 KB |  64.0
 KB  |     1.3 ms     |      5.0 us     |
|3300 | 0xc80008  | 0xed0008  |  1        | 2484 | 2489  | 155.3 MB/s | 155.6 MB/s  | 114.0 us |   1.5 ms | 46.0 us |  40.0 us |  64.0 KB |  64.0
 KB  |     1.3 ms     |      5.0 us     |
|3300 | 0xc80002  | 0xed0002  |  1        | 2472 | 2490  | 154.5 MB/s | 155.6 MB/s  | 112.0 us |   1.5 ms | 45.0 us |  40.0 us |  64.0 KB |  64.0
 KB  |     1.3 ms     |      5.0 us     |
|3300 | 0xc80006  | 0xed0006  |  1        | 2449 | 2507  | 153.1 MB/s | 156.7 MB/s  | 116.0 us |   1.5 ms | 46.0 us |  39.0 us |  64.0 KB |  64.0
 KB  |     1.3 ms     |      5.0 us     |
|3300 | 0xc80009  | 0xed0009  |  1        | 2471 | 2485  | 154.4 MB/s | 155.3 MB/s  | 114.0 us |   1.5 ms | 45.0 us |  40.0 us |  64.0 KB |  64.0
 KB  |     1.3 ms     |      5.0 us     |
+-----------------------------------+-----------+---------------------+-----------------+-----------------+-------------+-------------+-------------+-------------+
Total number of ITNs: 11
```

This example shows how to display the flow metrics of a target for SCSI:

```
switch# ShowAnalytics --info --target-itl
2021-02-09 12:14:59.285397

Interface fc5/21
+-----------------------------------+-----------+---------+-------------------+-----------+-----------------+-------------+-------------+-------------+-------------+
|VSAN | Initiator | VMID |  Target   |        LUN        |   Avg IOPS   |      Avg Throughput      |       Avg ECT       |      Avg DAL        |
     Avg IO Size      | Avg Host Delay | Avg Array Delay |
+-----------------------------------+-----------+---------+-------------------+-----------+-----------------+-------------+-------------+-------------+-------------+
|                                   |           |         |                   | Read | Write |     Read    |    Write    |   Read    |   Write   |  Read   |   Write   |
   Read    |    Write    |      Write      |      Write      |
|                                   |           |         |                   |      |       |             |             |           |           |         |           |
                  |                 |                 |
|2200 | 0xe902e0  |   - | 0xe805a0  | 0002-0000-0000-0000  |  0   | 9236  |      0 B/s |  4.5 MB/s   |   0 ns  |  75.0 us |   0 ns  |  25.0 us |
      0 B |  512.0 B  |      0 ns       |       0 ns      |
|2200 | 0xe902e0  |   - | 0xe805a0  | 0003-0000-0000-0000  |  0   | 9235  |      0 B/s |  4.5 MB/s   |   0 ns  |  75.0 us |   0 ns  |  25.0 us |
      0 B |  511.0 B  |      0 ns       |       0 ns      |
|2200 | 0xe902e0  |   - | 0xe805a0  | 0001-0000-0000-0000  |  0   | 9235  |      0 B/s |  4.5 MB/s   |   0 ns  |  75.0 us |   0 ns  |  25.0 us |
      0 B |  512.0 B  |      0 ns       |       0 ns      |
+-----------------------------------+-----------+---------+-------------------+-----------+-----------------+-------------+-------------+-------------+-------------+
Total number of ITLs: 3
```

This example shows how to display all target ITLs and limit the output to 10 random records:

```
switch# ShowAnalytics --info --target-itl --interface fc8/15 --limit 10
2019-04-09 11:11:24.652190

 Interface fc8/15
+-----------------------------------------+-------------+-----------------+----------------+
|         VSAN|Initiator|Target|LUN          |  Avg IOPS    |  Avg Throughput  |   Avg ECT      |
+-----------------------------------------+-------------+-----------------+----------------+
|                                         | Read | Write |  Read |   Write  | Read |  Write  |
|                                         |      |       |       |          |      |         |
| 3300|0x040001|0x030033|0000-0000-0000-0000 |  0   | 4047  |  0    |15.8 MB/s |  0   | 84.0 us |
| 3300|0x040003|0x030035|0000-0000-0000-0000 |  0   | 4045  |  0    |15.8 MB/s |  0   | 85.0 us |
```

```
| 3300|0x040005|0x030037|0000-0000-0000-0000 |  0   | 4033  |  0    |15.8 MB/s |  0   | 85.0 us |
| 3300|0x040007|0x030039|0000-0000-0000-0000 |  0   | 4041  |  0    |15.8 MB/s |  0   | 86.0 us |
| 3300|0x040009|0x03003b|0000-0000-0000-0000 |  0   | 4048  |  0    |15.8 MB/s |  0   | 86.0 us |
| 3300|0x04000b|0x03003d|0000-0000-0000-0000 |  0   | 4040  |  0    |15.8 MB/s |  0   | 86.0 us |
| 3300|0x04000d|0x03003f|0000-0000-0000-0000 |  0   | 4055  |  0    |15.8 MB/s |  0   | 86.0 us |
| 3300|0x04000f|0x030041|0000-0000-0000-0000 |  0   | 4052  |  0    |15.8 MB/s |  0   | 86.0 us |
| 3300|0x040011|0x030043|0000-0000-0000-0000 |  0   | 4055  |  0    |15.8 MB/s |  0   | 86.0 us |
| 3300|0x040013|0x030045|0000-0000-0000-0000 |  0   | 4056  |  0    |15.8 MB/s |  0   | 86.0 us |
+-------------------------------------------+--------------+-----------------+----------------+
```

This example shows how to display all target ITNs and limit the output to 5 random records for NVMe:

```
switch# ShowAnalytics --info --target-itn --interface fc8/15 --limit 5
2019-04-09 11:11:24.652190

  Interface fc3/15
+-----------------------------------+-----------+-----------+-----------------+-----------------+-----------+-----------+-----------+-----------+-----------+
|VSAN | Initiator |  Target   | Namespace |   Avg IOPS    |      Avg Throughput       |       Avg ECT       |      Avg DAL        |     Avg IO Size
      | Avg Host Delay | Avg Array Delay |
+-----------------------------------+-----------+-----------+-----------------+-----------------+-----------+-----------+-----------+-----------+-----------+
|                                   | Read | Write |     Read    |    Write      |   Read    |   Write   |  Read     |   Write   |   Read    |
Write   |      Write      |      Write      |
|                                   |      |       |             |               |           |           |           |           |           |
       |                 |                 |
|3300 | 0xc80005  | 0xed0005  |  1        | 2396 | 2473  | 149.8 MB/s | 154.6 MB/s  | 111.0 us |   1.5 ms | 45.0 us |  40.0 us |  64.0 KB |  64.0
 KB  |     1.3 ms      |      5.0 us     |
|3300 | 0xc80000  | 0xed0001  |  1        | 2180 | 2250  | 136.3 MB/s | 140.7 MB/s  | 110.0 us |   1.2 ms | 43.0 us |  39.0 us |  64.0 KB |  64.0
 KB  |     1.1 ms      |      5.0 us     |
|3300 | 0xc80004  | 0xed0004  |  1        | 2424 | 2463  | 151.5 MB/s | 154.0 MB/s  | 114.0 us |   1.5 ms | 46.0 us |  39.0 us |  64.0 KB |  64.0
 KB  |     1.3 ms      |      5.0 us     |
|3300 | 0xc80001  | 0xed0001  |  1        | 2129 | 2202  | 133.1 MB/s | 137.6 MB/s  | 110.0 us |   1.2 ms | 43.0 us |  37.0 us |  64.0 KB |  64.0
 KB  |    992.0 us     |      5.0 us     |
|3300 | 0xc80003  | 0xed0003  |  1        | 2457 | 2462  | 153.6 MB/s | 153.9 MB/s  | 114.0 us |   1.5 ms | 46.0 us |  38.0 us |  64.0 KB |  64.0
 KB  |     1.3 ms      |      5.0 us     |
+-----------------------------------+-----------+-----------+-----------------+-----------------+-----------+-----------+-----------+-----------+-----------+
Total number of ITNs: 5
```

This example shows how to display all target ITLs and limit the output to 10 random records for SCSI:

```
switch# ShowAnalytics --info --target-itl --interface fc8/15 --limit 10
2019-04-09 11:11:24.652190

 Interface fc5/21
+-----------------------------------+-----------+---------+-----------+-----------------+-----------+-----------+-----------+-----------+-----------+-----------+
|VSAN | Initiator | VMID |  Target   |         LUN         |   Avg IOPS    |      Avg Throughput       |       Avg ECT       |      Avg DAL        |
    Avg IO Size      | Avg Host Delay | Avg Array Delay |
+-----------------------------------+-----------+---------+-----------+-----------------+-----------+-----------+-----------+-----------+-----------+-----------+
|                                   |                     | Read | Write |     Read    |    Write      |   Read    |   Write   |  Read     |   Write   |
   Read    |   Write    |     Write      |      Write      |
|                                   |                     |      |       |             |               |           |           |           |           |
                |                |                 |
|2200 | 0xe902e0  |   - | 0xe805a0  | 0002-0000-0000-0000  |  0   | 9235  |      0 B/s |  4.5 MB/s   |   0 ns  |  75.0 us |   0 ns  |  25.0 us |
      0 B |  512.0 B  |      0 ns      |       0 ns      |
|2200 | 0xe902e0  |   - | 0xe805a0  | 0003-0000-0000-0000  |  0   | 9235  |      0 B/s |  4.5 MB/s   |   0 ns  |  75.0 us |   0 ns  |  25.0 us |
      0 B |  512.0 B  |      0 ns      |       0 ns      |
|2200 | 0xe902e0  |   - | 0xe805a0  | 0001-0000-0000-0000  |  0   | 9235  |      0 B/s |  4.5 MB/s   |   0 ns  |  75.0 us |   0 ns  |  25.0 us |
      0 B |  512.0 B  |      0 ns      |       0 ns      |
+-----------------------------------+-----------+---------+-----------+-----------------+-----------+-----------+-----------+-----------+-----------+-----------+
Total number of ITLs: 3
```

This example shows how to display the flow metrics of VSAN 3300 of an initiator ITN for NVMe:

```
switch# ShowAnalytics --info --initiator-itn --vsan 3300
2019-04-08 11:26:23.074904

Interface fc16/12
+-----------------------------------+-----------+-----------+-----------------+-----------------+-----------+-----------+-----------+-----------+-----------+
|VSAN | Initiator |  Target   | Namespace |   Avg IOPS    |      Avg Throughput       |       Avg ECT       |      Avg DAL        |     Avg IO Size
      | Avg Host Delay | Avg Array Delay |
+-----------------------------------+-----------+-----------+-----------------+-----------------+-----------+-----------+-----------+-----------+-----------+
|                                   | Read | Write |     Read    |    Write      |   Read    |   Write   |  Read     |   Write   |   Read    |
Write   |      Write      |      Write      |
|                                   |      |       |             |               |           |           |           |           |           |
       |                 |                 |
|3300 | 0xc80002  | 0xed0002  |  1        | 2466 | 2458  | 154.2 MB/s | 153.6 MB/s  | 782.0 us |   2.1 ms | 635.0 us | 620.0 us |  64.0 KB |
64.0 KB  |    714.0 us     |     567.0 us    |
|3300 | 0xc80007  | 0xed0007  |  1        | 2466 | 2470  | 154.1 MB/s | 154.4 MB/s  | 786.0 us |   2.0 ms | 641.0 us | 620.0 us |  64.0 KB |
64.0 KB  |    712.0 us     |     561.0 us    |
|3300 | 0xc80005  | 0xed0005  |  1        | 2432 | 2484  | 152.0 MB/s | 155.3 MB/s  | 775.0 us |   2.1 ms | 629.0 us | 623.0 us |  64.0 KB |
64.0 KB  |    714.0 us     |     564.0 us    |
|3300 | 0xc80001  | 0xed0001  |  1        | 2066 | 2031  | 129.2 MB/s | 126.9 MB/s  | 723.0 us |   1.7 ms | 580.0 us | 569.0 us |  64.0 KB |
64.0 KB  |    470.0 us     |     507.0 us    |
|3300 | 0xc80000  | 0xed0000  |  1        | 339  | 347   |  21.2 MB/s |  21.7 MB/s  |  15.3 ms |  16.1 ms |  15.2 ms |  15.2 ms |  64.0 KB |
64.0 KB  |    190.0 us     |     518.0 us    |
|3300 | 0xc80008  | 0xed0008  |  1        | 2436 | 2480  | 152.2 MB/s | 155.0 MB/s  | 777.0 us |   2.0 ms | 632.0 us | 623.0 us |  64.0 KB |
64.0 KB  |    708.0 us     |     563.0 us    |
|3300 | 0xc80009  | 0xed0009  |  1        | 2475 | 2459  | 154.7 MB/s | 153.7 MB/s  | 772.0 us |   2.1 ms | 625.0 us | 630.0 us |  64.0 KB |
64.0 KB  |    700.0 us     |     569.0 us    |
|3300 | 0xc80004  | 0xed0004  |  1        | 2508 | 2448  | 156.8 MB/s | 153.0 MB/s  | 775.0 us |   2.0 ms | 630.0 us | 626.0 us |  64.0 KB |
64.0 KB  |    704.0 us     |     568.0 us    |
|3300 | 0xc80006  | 0xed0006  |  1        | 2427 | 2485  | 151.7 MB/s | 155.3 MB/s  | 778.0 us |   2.0 ms | 634.0 us | 623.0 us |  64.0 KB |
64.0 KB  |    713.0 us     |     561.0 us    |
|3300 | 0xc80000  | 0xed0001  |  1        | 2246 | 2218  | 140.4 MB/s | 138.7 MB/s  | 744.0 us |   1.8 ms | 600.0 us | 591.0 us |  64.0 KB |
64.0 KB  |    561.0 us     |     530.0 us    |
|3300 | 0xc80003  | 0xed0003  |  1        | 2439 | 2478  | 152.4 MB/s | 154.9 MB/s  | 776.0 us |   2.1 ms | 630.0 us | 628.0 us |  64.0 KB |
64.0 KB  |    711.0 us     |     564.0 us    |
```

```
+-----------------------------------+------------+--------------------+-----------------+-----------------+-----------------+-------------+-------------+
Total number of ITNs: 11
```

This example shows how to display the flow metrics of VSAN 2200 of an initiator ITL for SCSI:

```
switch# ShowAnalytics --info --initiator-itl --vsan 2200
2019-04-08 11:26:23.074904

Interface fc2/22
+-----------------------------------+------------+--------------------+-----------------+-----------------+-----------------+-------------+-------------+
|VSAN | Initiator | VMID |  Target   |         LUN          |   Avg IOPS   |      Avg Throughput      |       Avg ECT       |       Avg DAL       |
     Avg IO Size      | Avg Host Delay | Avg Array Delay |
+-----------------------------------+------------+--------------------+-----------------+-----------------+-----------------+-------------+-------------+
|                                                                        | Read | Write |     Read    |    Write     |  Read   |   Write   |  Read   |   Write   |
|                                                                        |              |                          |                     |                     |
   Read    |    Write    |      Write      |       Write      |
|                                                                        |              |                          |                     |                     |
                          |                 |                  |
|2200 | 0xe80ee0  |   - | 0xe80622  | 0007-0000-0000-0000  |    0 | 0     |      0 B/s |    0 B/s    |   0 ns  |    0 ns   |   0 ns  |    0 ns   |
      0 B |    0 B     |       0 ns      |        0 ns      |
|2200 | 0xe80ee0  |   - | 0xc809a0  | 0003-0000-0000-0000  |    0 | 0     |      0 B/s |    0 B/s    |   0 ns  |    0 ns   |   0 ns  |    0 ns   |
      0 B |    0 B     |       0 ns      |        0 ns      |
|2200 | 0xe80ee0  |   - | 0xe80622  | 0002-0000-0000-0000  |    0 | 0     |      0 B/s |    0 B/s    |   0 ns  |    0 ns   |   0 ns  |    0 ns   |
      0 B |    0 B     |       0 ns      |        0 ns      |
|2200 | 0xe80ee0  |  18 | 0xc809a0  | 0003-0000-0000-0000  |    0 | 0     |      0 B/s |  2.0 KB/s   |   0 ns  | 843.0 us  |   0 ns  | 179.0 us  |
      0 B |  4.0 KB    |      7.0 us     |      656.0 us    |
|2200 | 0xe80ee0  |   - | 0xe80622  | 0000-0000-0000-0000  |    0 | 0     |      0 B/s |    0 B/s    |   0 ns  |    0 ns   |   0 ns  |    0 ns   |
      0 B |    0 B     |       0 ns      |        0 ns      |
+-----------------------------------+------------+--------------------+-----------------+-----------------+-----------------+-------------+-------------+
Total number of ITLs: 5
```

This example shows how to display the flow metrics of interface fc3/15 of a target ITN for NVMe:

```
switch# ShowAnalytics --info --target-itn --interface fc3/15
2019-04-09 11:11:17.974991

 Interface fc3/15
+-----------------------------------+------------+--------------------+-----------------+-----------------+-----------------+-------------+-------------+
|VSAN | Initiator |  Target   | Namespace |   Avg IOPS   |      Avg Throughput      |       Avg ECT       |       Avg DAL       |     Avg IO Size
     | Avg Host Delay | Avg Array Delay |
+-----------------------------------+------------+--------------------+-----------------+-----------------+-----------------+-------------+-------------+
|                                                                        | Read | Write |     Read    |    Write     |  Read   |   Write   |  Read   |   Write   |    Read    |
Write   |     Write      |      Write      |
|                                                                        |              |                          |                     |                     |
                         |                 |
|3300 | 0xc80005  | 0xed0005  |  1        | 2475 | 2531  | 154.7 MB/s | 158.2 MB/s  | 112.0 us |   1.5 ms | 45.0 us |  40.0 us |  64.0 KB |  64.0
 KB  |     1.3 ms     |      5.0 us     |
|3300 | 0xc80000  | 0xed0001  |  1        | 2137 | 2158  | 133.6 MB/s | 134.9 MB/s  | 112.0 us |   1.4 ms | 46.0 us |  39.0 us |  64.0 KB |  64.0
 KB  |     1.2 ms     |      5.0 us     |
|3300 | 0xc80004  | 0xed0004  |  1        | 2465 | 2530  | 154.1 MB/s | 158.2 MB/s  | 115.0 us |   1.5 ms | 46.0 us |  39.0 us |  64.0 KB |  64.0
 KB  |     1.3 ms     |      5.0 us     |
|3300 | 0xc80001  | 0xed0001  |  1        | 1785 | 1796  | 111.6 MB/s | 112.2 MB/s  | 112.0 us |   1.3 ms | 45.0 us |  38.0 us |  64.0 KB |  64.0
 KB  |     1.1 ms     |      5.0 us     |
|3300 | 0xc80003  | 0xed0003  |  1        | 2512 | 2506  | 157.0 MB/s | 156.6 MB/s  | 113.0 us |   1.5 ms | 45.0 us |  40.0 us |  64.0 KB |  64.0
 KB  |     1.3 ms     |      5.0 us     |
|3300 | 0xc80000  | 0xed0000  |  1        | 355  | 329   |  22.2 MB/s |  20.6 MB/s  |  14.8 ms |  15.5 ms | 14.8 ms |  14.6 ms |  64.0 KB |  64.0
 KB  |    753.0 us    |      5.0 us     |
|3300 | 0xc80007  | 0xed0007  |  1        | 2465 | 2532  | 154.1 MB/s | 158.2 MB/s  | 115.0 us |   1.5 ms | 47.0 us |  40.0 us |  64.0 KB |  64.0
 KB  |     1.3 ms     |      5.0 us     |
|3300 | 0xc80008  | 0xed0008  |  1        | 2488 | 2520  | 155.5 MB/s | 157.5 MB/s  | 115.0 us |   1.5 ms | 47.0 us |  40.0 us |  64.0 KB |  64.0
 KB  |     1.3 ms     |      5.0 us     |
|3300 | 0xc80002  | 0xed0002  |  1        | 2548 | 2497  | 159.3 MB/s | 156.1 MB/s  | 113.0 us |   1.5 ms | 46.0 us |  40.0 us |  64.0 KB |  64.0
 KB  |     1.3 ms     |      5.0 us     |
|3300 | 0xc80006  | 0xed0006  |  1        | 2476 | 2523  | 154.8 MB/s | 157.7 MB/s  | 113.0 us |   1.5 ms | 46.0 us |  40.0 us |  64.0 KB |  64.0
 KB  |     1.3 ms     |      5.0 us     |
|3300 | 0xc80009  | 0xed0009  |  1        | 2487 | 2525  | 155.4 MB/s | 157.8 MB/s  | 114.0 us |   1.5 ms | 46.0 us |  40.0 us |  64.0 KB |  64.0
 KB  |     1.3 ms     |      5.0 us     |
+-----------------------------------+------------+--------------------+-----------------+-----------------+-----------------+-------------+-------------+
Total number of ITNs: 11
```

This example shows how to display the flow metrics of interface fc5/21 of a target ITL for SCSI:

```
switch# ShowAnalytics --info --target-itl --interface fc5/21
2019-04-09 11:11:17.974991

  Interface fc5/21
+-----------------------------------+------------+--------------------+-----------------+-----------------+-----------------+-------------+-------------+
|VSAN | Initiator | VMID |  Target   |         LUN          |   Avg IOPS   |      Avg Throughput      |       Avg ECT       |       Avg DAL       |
     Avg IO Size      | Avg Host Delay | Avg Array Delay |
+-----------------------------------+------------+--------------------+-----------------+-----------------+-----------------+-------------+-------------+
|                                                                        | Read | Write |     Read    |    Write     |  Read   |   Write   |  Read   |   Write   |
|                                                                        |              |                          |                     |                     |
   Read    |    Write    |      Write      |       Write      |
|                                                                        |              |                          |                     |                     |
                          |                 |                  |
|2200 | 0xe902e0  |   - | 0xe805a0  | 0002-0000-0000-0000  |  0   | 9231  |      0 B/s |  4.5 MB/s   |   0 ns  |  75.0 us  |   0 ns  |  25.0 us  |
      0 B |  512.0 B   |       0 ns      |        0 ns      |
|2200 | 0xe902e0  |   - | 0xe805a0  | 0003-0000-0000-0000  |  0   | 9231  |      0 B/s |  4.5 MB/s   |   0 ns  |  75.0 us  |   0 ns  |  25.0 us  |
      0 B |  512.0 B   |       0 ns      |        0 ns      |
|2200 | 0xe902e0  |   - | 0xe805a0  | 0001-0000-0000-0000  |  0   | 9230  |      0 B/s |  4.5 MB/s   |   0 ns  |  75.0 us  |   0 ns  |  25.0 us  |
      0 B |  512.0 B   |       0 ns      |        0 ns      |
+-----------------------------------+------------+--------------------+-----------------+-----------------+-----------------+-------------+-------------+
Total number of ITLs: 3
```

This example shows how to display the flow metrics and device alias information of interface fc3/15 of a target ITN and limit the output to 10 random records for NVMe:

```
switch# ShowAnalytics --info --target-itn --alias  --interface fc3/15  --limit 10
2019-04-09 12:04:07.032501

 Interface fc3/15
+-------------------------------------------+-----------+-----------------+-----------+-----------------+-----------------+-----------+-----------+-----------+
|VSAN |      Initiator       |        Target        | Namespace |   Avg IOPS    |      Avg Throughput      |       Avg ECT       |      Avg DAL
    |     Avg IO Size      | Avg Host Delay | Avg Array Delay |
+-------------------------------------------+-----------+-----------------+-----------+-----------------+-----------------+-----------+-----------+-----------+
|                                           |           |                 | Read | Write |     Read     |     Write     |   Read    |   Write   |  Read   |
Write  |   Read   |   Write   |     Write     |      Write      |
|                                           |           |                 |      |       |              |               |           |           |         |
     |          |           |               |                 |
|3300 |       0xc80005       |       0xed0005       |  1        | 2488 | 2514  | 155.5 MB/s | 157.1 MB/s  | 113.0 us |   1.5 ms | 46.0 us |  39.0
 us |  64.0 KB |  64.0 KB  |     1.3 ms    |      5.0 us     |
|3300 |       0xc80000       |       0xed0001       |  1        | 2122 | 2154  | 132.6 MB/s | 134.7 MB/s  | 111.0 us |   1.4 ms | 45.0 us |  40.0
 us |  64.0 KB |  64.0 KB  |     1.2 ms    |      5.0 us     |
|3300 |       0xc80004       |       0xed0004       |  1        | 2492 | 2509  | 155.8 MB/s | 156.8 MB/s  | 113.0 us |   1.5 ms | 46.0 us |  40.0
 us |  64.0 KB |  64.0 KB  |     1.3 ms    |      5.0 us     |
|3300 |       0xc80001       |       0xed0001       |  1        | 1847 | 1752  | 115.4 MB/s | 109.5 MB/s  | 112.0 us |   1.3 ms | 45.0 us |  39.0
 us |  64.0 KB |  64.0 KB  |     1.1 ms    |      5.0 us     |
|3300 |       0xc80003       |       0xed0003       |  1        | 2523 | 2495  | 157.7 MB/s | 155.9 MB/s  | 114.0 us |   1.5 ms | 46.0 us |  41.0
 us |  64.0 KB |  64.0 KB  |     1.3 ms    |      5.0 us     |
|3300 |       0xc80000       |       0xed0000       |  1        | 340  | 355   |  21.3 MB/s |  22.2 MB/s  |  14.3 ms |  15.3 ms | 14.2 ms |  14.4
 ms |  64.0 KB |  64.0 KB  |   801.0 us    |      5.0 us     |
|3300 |       0xc80007       |       0xed0007       |  1        | 2495 | 2510  | 156.0 MB/s | 156.9 MB/s  | 114.0 us |   1.5 ms | 47.0 us |  40.0
 us |  64.0 KB |  64.0 KB  |     1.3 ms    |      5.0 us     |
|3300 |       0xc80008       |       0xed0008       |  1        | 2515 | 2496  | 157.2 MB/s | 156.0 MB/s  | 114.0 us |   1.5 ms | 47.0 us |  40.0
 us |  64.0 KB |  64.0 KB  |     1.3 ms    |      5.0 us     |
|3300 |       0xc80002       |       0xed0002       |  1        | 2537 | 2484  | 158.6 MB/s | 155.3 MB/s  | 114.0 us |   1.5 ms | 46.0 us |  41.0
 us |  64.0 KB |  64.0 KB  |     1.3 ms    |      5.0 us     |
|3300 |       0xc80006       |       0xed0006       |  1        | 2502 | 2510  | 156.4 MB/s | 156.9 MB/s  | 113.0 us |   1.5 ms | 46.0 us |  41.0
 us |  64.0 KB |  64.0 KB  |     1.3 ms    |      5.0 us     |
+-------------------------------------------+-----------+-----------------+-----------+-----------------+-----------------+-----------+-----------+-----------+
Total number of ITNs: 10
```

This example shows how to display the flow metrics and device alias information of interface fc5/21 of a target ITL and limit the output to 10 random records for SCSI:

```
switch# ShowAnalytics --info --target-itl --alias  --interface fc5/21  --limit 10
2019-04-09 12:04:07.032501

 Interface fc5/21
+-------------------------------------------+-----------+-----------------+-----------+-----------+-----------+-----------+-----------+
|VSAN |      Initiator       | VMID |        Target        |        LUN          |   Avg IOPS    |      Avg Throughput      |       Avg ECT
|      Avg DAL       |     Avg IO Size      | Avg Host Delay | Avg Array Delay |
+-------------------------------------------+-----------+-----------------+-----------+-----------+-----------+-----------+-----------+
|                                           |           |                 | Read | Write |     Read     |     Write     |   Read    |   Write
|  Read   |   Write  |   Read   |   Write   |     Write     |      Write      |
|                                           |           |                 |      |       |              |               |           |
|                    |                     |               |                 |
|2200 |       0xe902e0       |   - | Tgt_9706_206_fc5_21_ | 0002-0000-0000-0000  |  0   | 5796  |      0 B/s |  2.8 MB/s  |   0 ns  |  84.0 us
|   0 ns  |  29.0 us |      0 B |  512.0 B  |      0 ns     |       0 ns      |
|2200 |       0xe902e0       |   - | Tgt_9706_206_fc5_21_ | 0003-0000-0000-0000  |  0   | 5797  |      0 B/s |  2.8 MB/s  |   0 ns  |  84.0 us
|   0 ns  |  29.0 us |      0 B |  512.0 B  |      0 ns     |       0 ns      |
|2200 |       0xe902e0       |   - | Tgt_9706_206_fc5_21_ | 0001-0000-0000-0000  |  0   | 5797  |      0 B/s |  2.8 MB/s  |   0 ns  |  84.0 us
|   0 ns  |  29.0 us |      0 B |  512.0 B  |      0 ns     |       0 ns      |
|2200 |       0xe90440       |   - | Tgt_9706_206_fc5_21_ | 0001-0000-0000-0000  |  0   | 5797  |      0 B/s |  2.8 MB/s  |   0 ns  | 122.0 us
|   0 ns  |  44.0 us |      0 B |  512.0 B  |      0 ns     |       0 ns      |
|2200 |       0xe90440       |   - | Tgt_9706_206_fc5_21_ | 0002-0000-0000-0000  |  0   | 5796  |      0 B/s |  2.8 MB/s  |   0 ns  | 124.0 us
|   0 ns  |  44.0 us |      0 B |  512.0 B  |      0 ns     |       0 ns      |
|2200 |       0xe906c0       |   - | Tgt_9706_206_fc5_21_ | 0001-0000-0000-0000  |  0   | 5797  |      0 B/s |  2.8 MB/s  |   0 ns  | 130.0 us
|   0 ns  |  47.0 us |      0 B |  512.0 B  |      0 ns     |       0 ns      |
|2200 |       0xe906c0       |   - | Tgt_9706_206_fc5_21_ | 0002-0000-0000-0000  |  0   | 5796  |      0 B/s |  2.8 MB/s  |   0 ns  | 131.0 us
|   0 ns  |  48.0 us |      0 B |  512.0 B  |      0 ns     |       0 ns      |
+-------------------------------------------+-----------+-----------------+-----------+-----------+-----------+-----------+-----------+
Total number of ITLs: 7
```

This example shows how to display the flow metrics of target ID 0xed0001 of a target ITN for NVMe:

```
switch# ShowAnalytics --info --target-itn --target 0xed0001
2019-04-09 11:16:26.246741

 Interface fc3/15
+-------------------------------------+-----------+-----------+-----------+-----------------+-----------+-----------+-----------+-----------+
|VSAN | Initiator |  Target   | Namespace |   Avg IOPS    |      Avg Throughput      |       Avg ECT       |      Avg DAL        |     Avg IO Size
      | Avg Host Delay | Avg Array Delay |
+-------------------------------------+-----------+-----------+-----------+-----------------+-----------------+-----------+-----------+-----------+
|                                     |           |           | Read | Write |     Read     |     Write     |   Read    |   Write   |  Read   |
Write   |     Write      |      Write      |
|                                     |           |           |      |       |              |               |           |           |         |
      |                |                 |
|3300 | 0xc80000  | 0xed0001  |  1        | 2100 | 2173  | 131.2 MB/s | 135.8 MB/s  | 110.0 us |   1.4 ms | 44.0 us |  38.0 us |  64.0 KB |  64.0
 KB  |     1.2 ms     |      5.0 us     |
|3300 | 0xc80001  | 0xed0001  |  1        | 1964 | 1943  | 122.8 MB/s | 121.4 MB/s  | 109.0 us |   1.2 ms | 43.0 us |  38.0 us |  64.0 KB |  64.0
 KB  |     1.0 ms     |      5.0 us     |
+-------------------------------------+-----------+-----------+-----------+-----------------+-----------+-----------+-----------+-----------+
Total number of ITNs: 2
```

This example shows how to display the flow metrics of target ID 0xe80b40 of a target ITL for SCSI:

```
switch# ShowAnalytics --info --target-itl --target 0xe80b40
2019-04-09 11:16:26.246741

 Interface fc5/21
+-------------------------------------+-----------+-----------+-----------+-----------+-----------+-----------+-----------+
```

```
|VSAN | Initiator | VMID |  Target   |         LUN          |   Avg IOPS   |      Avg Throughput      |      Avg ECT       |      Avg DAL       |
    Avg IO Size      | Avg Host Delay | Avg Array Delay |
+----+-----------+------+-----------+----------------------+--------------+--------------------------+--------------------+--------------------+
|                                                          | Read | Write |     Read     |    Write     |  Read   |   Write    |  Read   |   Write  |
   Read    |    Write    |      Write      |      Write      |
|                                                          |              |                          |                    |                    |
                          |                 |
|2200 | 0xe90440  |   - | 0xe80b40  | 0001-0000-0000-0000  |  0   | 5809  |      0 B/s |  2.8 MB/s   |   0 ns  | 128.0 us |   0 ns  |  48.0 us |
      0 B |  512.0 B  |       0 ns      |       0 ns      |
|2200 | 0xe90440  |   - | 0xe80b40  | 0002-0000-0000-0000  |  0   | 5809  |      0 B/s |  2.8 MB/s   |   0 ns  | 132.0 us |   0 ns  |  48.0 us |
      0 B |  511.0 B  |       0 ns      |       0 ns      |
+----+-----------+------+-----------+----------------------+--------------+--------------------------+--------------------+--------------------+
Total number of ITLs: 2
```

This example shows how to display the flow metrics of initiator ID 0xed0500, target ID 0xef0720, and LUN ID 0001-0000-0000-0000 of a target ITL:

```
switch# ShowAnalytics --info --target-itl --initiator 0xed0500 --target 0xef0720 --lun 0001-0000-0000-0000
2019-04-09 11:17:24.643292

B: Bytes, s: Seconds, Avg: Average, Acc: Accumulative,
ns: Nano Seconds, ms: Milli Seconds, us: Micro Seconds,
GB: Giga Bytes, MB: Mega Bytes, KB: Killo Bytes,
ECT: Exchange Completion Time, DAL: Data Access Latency


Interface : fc8/17
+--------------------------------+---------+---------+-----------+
| Metric                         |   Min   |   Max   |    Avg    |
+--------------------------------+---------+---------+-----------+
| Read  IOPS          (4sec Avg) |      NA |      NA |        39 |
| Write IOPS          (4sec Avg) |      NA |      NA |         0 |
| Read  Throughput    (4sec Avg) |      NA |      NA | 39.8 KB/s |
| Write Throughput    (4sec Avg) |      NA |      NA |         0 |
| Read  Size          (Acc Avg)  |  1024 B |  1024 B |    1024 B |
| Write Size          (Acc Avg)  |       0 |       0 |         0 |
| Read  DAL           (Acc Avg)  | 28.0 us | 30.0 ms |   23.8 ms |
| Write DAL           (Acc Avg)  |    0    |    0    |     0     |
| Read  ECT           (Acc Avg)  | 28.0 us | 30.0 ms |   23.8 ms |
| Write ECT           (Acc Avg)  |    0    |    0    |     0     |
| Read  Inter-IO-Gap  (Acc Avg)  | 73.2 us |   2.0 s |   25.0 ms |
| Write Inter-IO-Gap  (Acc Avg)  |    0    |    0    |     0     |
+--------------------------------+---------+---------+-----------+
```

This example shows how to display the flow metrics of initiator ID 0xc80004, target ID 0xed0004, and namespace 1 of a target ITN for NVMe:

```
switch# ShowAnalytics --info --target-itn --initiator 0xc80004 --target 0xed0004 --namespace 1
2019-04-09 11:17:24.643292

B: Bytes, s: Seconds, Avg: Average, Acc: Accumulative,
ns: Nano Seconds, ms: Milli Seconds, us: Micro Seconds,
GB: Giga Bytes, MB: Mega Bytes, KB: Killo Bytes,
ECT: Exchange Completion Time, DAL: Data Access Latency


Interface : fc3/15
+--------------------------------+----------+----------+------------+
| Metric                         |    Min   |    Max   |     Avg    |
+--------------------------------+----------+----------+------------+
| Read  IOPS          (4sec Avg) |       NA |       NA |       2391 |
| Write IOPS          (4sec Avg) |       NA |       NA |       2517 |
| Read  Throughput    (4sec Avg) |       NA |       NA | 149.5 MB/s |
| Write Throughput    (4sec Avg) |       NA |       NA | 157.3 MB/s |
| Read  Size          (Acc Avg)  |  65536 B |  65536 B |    65536 B |
| Write Size          (Acc Avg)  |  65536 B |  65536 B |    65536 B |
| Read  DAL           (Acc Avg)  |  12.0 us |   1.6 ms |    46.0 us |
| Write DAL           (Acc Avg)  |  10.0 us | 407.0 us |    40.1 us |
| Read  ECT           (Acc Avg)  |  39.0 us |   1.9 ms |   113.8 us |
| Write ECT           (Acc Avg)  | 123.0 us |   3.6 ms |     1.5 ms |
| Write Host Delay    (Acc Avg)  |  51.0 us |   3.5 ms |     1.3 ms |
| Write Array Delay   (Acc Avg)  |       NA |  31.0 us |     5.6 us |
| Write IO Seq count  (Acc Avg)  |        0 |        0 |          1 |
+--------------------------------+----------+----------+------------+
```

This example shows how to display the flow metrics of initiator ID 0xe90440, target ID 0xe80b40, and LUN ID 0001-0000-0000-0000 of a target ITL:

```
switch# ShowAnalytics --info --target-itl --initiator 0xe90440 --target 0xe80b40 --lun 0001-0000-0000-0000
2019-04-09 11:17:24.643292

B: Bytes, s: Seconds, Avg: Average, Acc: Accumulative,
ns: Nano Seconds, ms: Milli Seconds, us: Micro Seconds,
GB: Giga Bytes, MB: Mega Bytes, KB: Killo Bytes,
ECT: Exchange Completion Time, DAL: Data Access Latency


Interface : fc5/21
+--------------------------------+---------+--------+----------+
| Metric                         |   Min   |  Max   |    Avg   |
+--------------------------------+---------+--------+----------+
| Read  IOPS          (4sec Avg) |      NA |     NA |        0 |
| Write IOPS          (4sec Avg) |      NA |     NA |     4112 |
| Read  Throughput    (4sec Avg) |      NA |     NA |        0 |
```

```
| Write Throughput   (4sec Avg) |      NA |     NA | 2.0 MB/s |
| Read  Size         (Acc Avg)  |       0 |      0 |        0 |
| Write Size         (Acc Avg)  |   512 B |  512 B |    512 B |
| Read  DAL          (Acc Avg)  |    0 ns |  0 ns  |    0 ns  |
| Write DAL          (Acc Avg)  | 22.0 us | 2.4 ms |  46.1 us |
| Read  ECT          (Acc Avg)  |    0 ns |  0 ns  |    0 ns  |
| Write ECT          (Acc Avg)  | 68.0 us | 2.5 ms | 126.6 us |
| Write Host Delay   (Acc Avg)  |    0 ns |  0 ns  |    0 ns  |
| Write Array Delay  (Acc Avg)  |      NA |  0 ns  |    0 ns  |
| Write IO Seq count (Acc Avg)  |       0 |      0 |        0 |
+-------------------------------+---------+--------+----------+
```

This example shows how to display the flow metrics of initiator ID 0xc80005 and namespace 1 of a target ITN for NVMe:

```
switch# ShowAnalytics --info --target-itn --initiator 0xc80005  --namespace 1
2019-04-09 11:18:40.132828

 Interface fc3/15
+-------------------------------------+-------------+-------------------+-------------------+-------------------+-------------------+-------------+-------------+
|VSAN | Initiator |  Target   | Namespace |   Avg IOPS   |      Avg Throughput      |       Avg ECT       |      Avg DAL       |     Avg IO Size
      | Avg Host Delay | Avg Array Delay |
+-------------------------------------+-------------+-------------------+-------------------+-------------------+-------------------+-------------+-------------+
|                                     |             | Read | Write |     Read    |   Write     |   Read    |   Write   |  Read   |   Write   |   Read    |
Write   |     Write      |      Write      |
|                                     |             |              |                           |                   |                 |                 |
      |                |                 |
|3300 | 0xc80005  | 0xed0005  |  1        | 2451 | 2478  | 153.2 MB/s | 154.9 MB/s  | 114.0 us |   1.5 ms | 45.0 us |  40.0 us |  64.0 KB |  64.0
 KB  |     1.3 ms     |      5.0 us     |
+-------------------------------------+-------------+-------------------+-------------------+-------------------+-------------------+-------------+-------------+
Total number of ITNs: 1
```

This example shows how to display the flow metrics of initiator ID 0xe90440 and LUN ID 0001-0000-0000-0000 of a target ITL for SCSI:

```
switch# ShowAnalytics --info --target-itl --initiator 0xe90440  --lun 0001-0000-0000-0000
2019-04-09 11:18:40.132828

 Interface fc5/21
+-------------------------------------+-------------+-------+-----------------------+-------------+-------------------+-------------------+-------------------+-------------+-------------+
|VSAN | Initiator | VMID |  Target   |          LUN          |   Avg IOPS   |      Avg Throughput      |       Avg ECT       |      Avg DAL       |
     Avg IO Size      | Avg Host Delay | Avg Array Delay |
+-------------------------------------+-------------+-------+-----------------------+-------------+-------------------+-------------------+-------------------+-------------+-------------+
|                                                                                  | Read | Write |     Read    |   Write     |   Read    |   Write   |  Read   |   Write   |
   Read    |   Write    |     Write      |      Write      |
|                                                                                  |              |                           |                   |                 |                 |
                        |                |                 |
|2200 | 0xe90440  |   - | 0xe80b40  | 0001-0000-0000-0000  |  0   | 5816  |      0 B/s |  2.8 MB/s   |   0 ns  | 131.0 us |   0 ns  |  48.0 us |
      0 B |  512.0 B  |      0 ns      |       0 ns      |
+-------------------------------------+-------------+-------+-----------------------+-------------+-------------------+-------------------+-------------------+-------------+-------------+
Total number of ITLs: 1
```

For information on flow metrics, see Flow Metrics, on page 129.

This example shows how to display the top ITNs for I/O operations per second (IOPS) for NVMe:

```
switch# ShowAnalytics  --top  --nvme

2019-06-13 10:56:49.099069

+--------+-----------------------------------------+-------------------+
|  PORT  | VSAN | Initiator |  Target   | Namespace |      Avg IOPS     |
+--------+-----------------------------------------+-------------------+
|        |                                         |   Read  |  Write  |
| fc3/15 | 3300 | 0xc80004  | 0xed0004  |   1       |   2547  |  2474   |
| fc3/15 | 3300 | 0xc80002  | 0xed0002  |   1       |   2521  |  2486   |
| fc3/15 | 3300 | 0xc80008  | 0xed0008  |   1       |   2506  |  2499   |
| fc3/15 | 3300 | 0xc80009  | 0xed0009  |   1       |   2516  |  2483   |
| fc3/15 | 3300 | 0xc80006  | 0xed0006  |   1       |   2516  |  2482   |
| fc3/15 | 3300 | 0xc80007  | 0xed0007  |   1       |   2508  |  2484   |
| fc3/15 | 3300 | 0xc80005  | 0xed0005  |   1       |   2481  |  2505   |
| fc3/15 | 3300 | 0xc80003  | 0xed0003  |   1       |   2469  |  2517   |
| fc3/15 | 3300 | 0xc80000  | 0xed0001  |   1       |   2057  |  2021   |
| fc3/15 | 3300 | 0xc80001  | 0xed0001  |   1       |   1893  |  1953   |
+--------+-----------------------------------------+-------------------+
```

This example shows how to display the top ITLs for I/O operations per second (IOPS):

```
switch# ShowAnalytics  --top

2019-06-13 10:56:49.099069

+--------+-----------------------------------------+-------------------+
|  PORT  |        VSAN|Initiator|Target|LUN        |      Avg IOPS     |
+--------+-----------------------------------------+-------------------+
|        |                                         |   Read  |  Write  |
| fc8/10 | 5|0xed04b2|0xef0680|0001-0000-0000-0000 |   118   |   0     |
| fc8/10 | 5|0xed04b2|0xef0680|0003-0000-0000-0000 |   118   |   0     |
| fc8/10 | 5|0xed04b2|0xef0680|0002-0000-0000-0000 |   118   |   0     |
| fc8/10 | 5|0xed04b2|0xef0680|0005-0000-0000-0000 |   118   |   0     |
| fc8/10 | 5|0xed04b2|0xef0680|0006-0000-0000-0000 |   118   |   0     |
| fc8/10 | 5|0xed04b2|0xef0680|0007-0000-0000-0000 |   118   |   0     |
```

```
| fc8/10 | 5|0xed04b2|0xef0680|0008-0000-0000-0000 |   118   |   0     |
| fc8/10 | 5|0xed04b2|0xef0680|0009-0000-0000-0000 |   118   |   0     |
| fc8/10 | 5|0xed04b2|0xef0680|000a-0000-0000-0000 |   118   |   0     |
| fc8/10 | 5|0xed04b2|0xef0680|000b-0000-0000-0000 |   118   |   0     |
+--------+-----------------------------------------+-----------------+
```

This example shows how to display the top ITLs with I/O size:

```
switch# ShowAnalytics --top --key IOSIZE
Data collected at : Tue, 07 Jun 2022 12:16:09 +0530

+--------+-------+-----------------------------------------------+---------------------+
|  PORT  | VSAN | Initiator |  Target   |         LUN           |     Avg IO Size     |
+--------+-------+-----------------------------------------------+---------------------+
|        |                                                       |   Read  |  Write    |
| fc2/2  | 2200 | 0xc80760  | 0xee0000  | 0003-0000-0000-0000   |      0 B |  5.8 KB   |
| fc2/19 | 2200 | 0xee024b  | 0xe80441  | 000c-0000-0000-0000   |      0 B |  4.0 KB   |
| fc2/19 | 2200 | 0xee0252  | 0xe80926  | 0018-0000-0000-0000   |      0 B |  4.0 KB   |
| fc2/19 | 2200 | 0xee024c  | 0xe80920  | 002f-0000-0000-0000   |      0 B |  4.0 KB   |
| fc2/20 | 2200 | 0xee0253  | 0xe80927  | 0051-0000-0000-0000   |      0 B |  4.0 KB   |0
| fc2/20 | 2200 | 0xee0253  | 0xe80927  | 000f-0000-0000-0000   |      0 B |  4.0 KB   |
| fc2/19 | 2200 | 0xee024c  | 0xe80920  | 0006-0000-0000-0000   |      0 B |  4.0 KB   |
| fc2/20 | 2200 | 0xee024c  | 0xe80920  | 0049-0000-0000-0000   |      0 B |  4.0 KB   |
| fc2/19 | 2200 | 0xee0250  | 0xe80924  | 0029-0000-0000-0000   |      0 B |  4.0 KB   |
| fc2/19 | 2200 | 0xee0251  | 0xe80925  | 0034-0000-0000-0000   |      0 B |  4.0 KB   |
+--------+-------+-----------------------------------------------+---------------------+
```

This example shows how to display the initiator flow of ITLs :

```
switch# ShowAnalytics --top --initiator-flow

Data collected at : Tue, 07 Jun 2022 12:20:28 +0530

+---------+-------+-------------------+--------------------+
|   PORT  | VSAN | Initiator  |       Avg IOPS      |
+---------+-------+-------------------+--------------------+
|         |                   |   Read  |  Write   |
|  fc1/29 | 2200 | 0xc803e0   |    0    | 29037    |
|  fc1/29 | 2200 | 0xc803e1   |    0    | 19919    |
|  fc2/2  | 2200 | 0xc80760   |    0    |   31     |
| fc12/17 | 2200 | 0xc80600   |    0    |   0      |
|  fc2/20 | 2200 | 0xee01cc   |    0    |   0      |
|  fc2/20 | 2200 | 0xee006e   |    0    |   0      |
|  fc2/19 | 2200 | 0xee0272   |    0    |   0      |
|  fc2/20 | 2200 | 0xee02b2   |    0    |   0      |
|  fc2/20 | 2200 | 0xee02d1   |    0    |   0      |
|  fc2/19 | 2200 | 0xee02b3   |    0    |   0      |
+---------+-------+-------------------+--------------------+
```

This example shows how to display the target flow of ITLs :

```
switch# ShowAnalytics --top --target-flow

Data collected at : Tue, 07 Jun 2022 12:20:42 +0530

+--------+-------+-------------------+--------------------+
|  PORT  | VSAN |  Target    |       Avg IOPS      |
+--------+-------+-------------------+--------------------+
|        |                   |   Read  |  Write   |
| fc1/22 | 2200 | 0xc80329   |    0    | 20269    |
| fc1/23 | 2200 | 0xc80349   |    0    | 20262    |
| fc1/24 | 2200 | 0xc80369   |    0    | 20196    |
| fc1/34 | 2200 | 0xc804a9   |    0    | 20177    |
| fc1/36 | 2200 | 0xc804c9   |    0    | 20165    |
| fc1/35 | 2200 | 0xc80589   |    0    | 20095    |
| fc1/33 | 2200 | 0xc80469   |    0    | 20042    |
| fc1/1  | 2200 | 0xc80029   |    0    | 18684    |
```

```
| fc1/2  | 2200 | 0xc80069   |    0    | 18663   |
| fc1/15 | 2200 | 0xc80249   |    0    | 18654   |
+--------+------------------+------------------+
```

This example shows how to display the flow of ITLs :

```
switch# ShowAnalytics --top --it-flow
Data collected at : Tue, 07 Jun 2022 12:21:58 +0530

+--------+--------------------------------+------------------+
|  PORT  | VSAN | Initiator |  Target     |      Avg IOPS    |
+--------+--------------------------------+------------------+
|        |                                |   Read  |  Write |
| fc1/29 | 2200 | 0xc803e0  |  0xc80700  |    0    | 28321  |
| fc1/22 | 2200 | 0xc809e9  |  0xc80329  |    0    | 20274  |
| fc1/24 | 2200 | 0xc80a29  |  0xc80369  |    0    | 20244  |
| fc1/23 | 2200 | 0xc80a09  |  0xc80349  |    0    | 20244  |
| fc1/34 | 2200 | 0xc80b49  |  0xc804a9  |    0    | 20181  |
| fc1/36 | 2200 | 0xc80b89  |  0xc804c9  |    0    | 20173  |
| fc1/35 | 2200 | 0xc80b69  |  0xc80589  |    0    | 20054  |
| fc1/33 | 2200 | 0xc80b29  |  0xc80469  |    0    | 20019  |
| fc1/29 | 2200 | 0xc803e1  |  0xc80701  |    0    | 19425  |
| fc1/1  | 2200 | 0xc80ac9  |  0xc80029  |    0    | 18659  |
+--------+--------------------------------+------------------+
```

This example shows how to display the initiator, target and LUN flow of ITLs :

```
switch# ShowAnalytics --top --noclear
Data collected at : Tue, 07 Jun 2022 12:27:38 +0530

+--------+-------------------------------------------------------+------------------+
|  PORT  | VSAN | Initiator |  Target   |         LUN           |      Avg IOPS
   |
+--------+-------------------------------------------------------+------------------+
|        |                                                       |   Read  |  Write
  |
| fc1/29 | 2200 | 0xc803e0  | 0xc80700  | 0064-0000-0000-0000   |    0    |  567
   |
| fc1/29 | 2200 | 0xc803e1  | 0xc80701  | 003b-0000-0000-0000   |    0    |  283
   |
| fc1/29 | 2200 | 0xc803e0  | 0xc80700  | 004e-0000-0000-0000   |    0    |  283
   |
| fc1/29 | 2200 | 0xc803e0  | 0xc80700  | 0043-0000-0000-0000   |    0    |  283
   |
| fc1/29 | 2200 | 0xc803e1  | 0xc80701  | 0038-0000-0000-0000   |    0    |  283
   |
| fc1/29 | 2200 | 0xc803e1  | 0xc80701  | 0040-0000-0000-0000   |    0    |  283
   |
| fc1/29 | 2200 | 0xc803e0  | 0xc80700  | 0061-0000-0000-0000   |    0    |  283
   |
| fc1/29 | 2200 | 0xc803e0  | 0xc80700  | 0014-0000-0000-0000   |    0    |  283
   |
| fc1/29 | 2200 | 0xc803e1  | 0xc80701  | 001e-0000-0000-0000   |    0    |  283
   |
| fc1/29 | 2200 | 0xc803e0  | 0xc80700  | 001d-0000-0000-0000   |    0    |  283
   |
+--------+-------------------------------------------------------+------------------+
```

```
Data collected at : Tue, 07 Jun 2022 12:27:45 +0530

+--------+-----------------------------------------------------+--------------------+
|  PORT  | VSAN | Initiator |  Target   |         LUN          |      Avg IOPS
   |
+--------+-----------------------------------------------------+--------------------+
|        |                                                     |   Read  |  Write
  |
| fc1/29 | 2200 | 0xc803e0  | 0xc80700  | 0064-0000-0000-0000  |    0    |  554
   |
| fc1/29 | 2200 | 0xc803e1  | 0xc80701  | 003b-0000-0000-0000  |    0    |  277
   |
| fc1/29 | 2200 | 0xc803e0  | 0xc80700  | 004e-0000-0000-0000  |    0    |  277
   |
| fc1/29 | 2200 | 0xc803e0  | 0xc80700  | 0043-0000-0000-0000  |    0    |  277
   |
| fc1/29 | 2200 | 0xc803e1  | 0xc80701  | 0038-0000-0000-0000  |    0    |  277
   |
| fc1/29 | 2200 | 0xc803e1  | 0xc80701  | 0040-0000-0000-0000  |    0    |  277
   |
| fc1/29 | 2200 | 0xc803e0  | 0xc80700  | 0061-0000-0000-0000  |    0    |  277
   |
| fc1/29 | 2200 | 0xc803e0  | 0xc80700  | 0014-0000-0000-0000  |    0    |  277
   |
| fc1/29 | 2200 | 0xc803e1  | 0xc80701  | 001e-0000-0000-0000  |    0    |  277
   |
| fc1/29 | 2200 | 0xc803e0  | 0xc80700  | 001d-0000-0000-0000  |    0    |  277
   |
+--------+-----------------------------------------------------+--------------------+
```

This example shows how to display the top ITNs for throughput progressively for NMVe:

```
switch# ShowAnalytics  --top --key thput  --progress --nvme

2019-06-13 10:58:16.015546

+--------+-----------------------------------------+-------------------------+
|  PORT  | VSAN | Initiator |  Target   | Namespace |      Avg Throughput     |
+--------+-----------------------------------------+-------------------------+
|        |                                         |     Read    |   Write   |
| fc3/15 | 3300 | 0xc80003  | 0xed0003  |   1       | 159.1 MB/s | 154.6 MB/s |
| fc3/15 | 3300 | 0xc80002  | 0xed0002  |   1       | 157.4 MB/s | 155.0 MB/s |
| fc3/15 | 3300 | 0xc80006  | 0xed0006  |   1       | 157.7 MB/s | 154.3 MB/s |
| fc3/15 | 3300 | 0xc80004  | 0xed0004  |   1       | 157.1 MB/s | 154.8 MB/s |
| fc3/15 | 3300 | 0xc80007  | 0xed0007  |   1       | 155.5 MB/s | 155.4 MB/s |
| fc3/15 | 3300 | 0xc80009  | 0xed0009  |   1       | 153.8 MB/s | 156.6 MB/s |
| fc3/15 | 3300 | 0xc80008  | 0xed0008  |   1       | 152.2 MB/s | 157.1 MB/s |
| fc3/15 | 3300 | 0xc80005  | 0xed0005  |   1       | 150.9 MB/s | 158.1 MB/s |
| fc3/15 | 3300 | 0xc80000  | 0xed0001  |   1       | 133.7 MB/s | 133.3 MB/s |
| fc3/15 | 3300 | 0xc80001  | 0xed0001  |   1       | 118.4 MB/s | 120.2 MB/s |
+--------+-----------------------------------------+-------------------------+
```

This example shows how to display the top ITLs for throughput progressively:

```
switch# ShowAnalytics  --top --key thput  --progress

2019-06-13 10:58:16.015546

+--------+-----------------------------------------+-------------------------+
|  PORT  |        VSAN|Initiator|Target|LUN        |      Avg THROUGHPUT     |
+--------+-----------------------------------------+-------------------------+
|        |                                         |     Read    |   Write   |
| fc8/10 | 5|0xed04b2|0xef0680|000f-0000-0000-0000 | 133.8 KB/s |     0     |
| fc8/10 | 5|0xed04b3|0xef0681|000a-0000-0000-0000 | 133.8 KB/s |     0     |
| fc8/10 | 5|0xed04b3|0xef0681|0014-0000-0000-0000 | 133.8 KB/s |     0     |
| fc8/10 | 5|0xed04b4|0xef0682|000f-0000-0000-0000 | 133.8 KB/s |     0     |
| fc8/10 | 5|0xed04b5|0xef0683|000a-0000-0000-0000 | 133.8 KB/s |     0     |
| fc8/10 | 5|0xed04b5|0xef0683|000f-0000-0000-0000 | 133.8 KB/s |     0     |
| fc8/10 | 5|0xed04b5|0xef0683|0013-0000-0000-0000 | 133.8 KB/s |     0     |
| fc8/10 | 5|0xed04b6|0xef0684|0013-0000-0000-0000 | 133.8 KB/s |     0     |
| fc8/10 | 5|0xed04b2|0xef0680|0004-0000-0000-0000 | 133.5 KB/s |     0     |
| fc8/10 | 5|0xed04b3|0xef0681|0009-0000-0000-0000 | 133.5 KB/s |     0     |
```

```
+--------+-----------------------------------------+------------------------+
```

This example shows how to display the ITNs with the highest I/O operations per second (IOPS) for NVMe. The **--alias** option causes initiator and target device alias information is displayed.

```
switch# ShowAnalytics --top --alias --nvme

2021-02-09 09:15:25.445815

+--------+-------+-----------------------+-----------------------+-----------+-------------------+
|  PORT  | VSAN |      Initiator        |        Target         | Namespace |      Avg IOPS     |
+--------+-------+-----------------------+-----------------------+-----------+-------------------+
|        |                                                                    |   Read   |  Write   |
| fc3/15 | 3300 | sanblaze-147-port7-p | sanblaze-147-port6-p |   1       |   2518   |  2459    |
| fc3/15 | 3300 | sanblaze-147-port7-p | sanblaze-147-port6-p |   1       |   2499   |  2470    |
| fc3/15 | 3300 | sanblaze-147-port7-p | sanblaze-147-port6-p |   1       |   2491   |  2472    |
| fc3/15 | 3300 | sanblaze-147-port7-p | sanblaze-147-port6-p |   1       |   2491   |  2471    |
| fc3/15 | 3300 | sanblaze-147-port7-p | sanblaze-147-port6-p |   1       |   2457   |  2487    |
| fc3/15 | 3300 | sanblaze-147-port7-p | sanblaze-147-port6-p |   1       |   2445   |  2496    |
| fc3/15 | 3300 | sanblaze-147-port7-p | sanblaze-147-port6-p |   1       |   2440   |  2495    |
| fc3/15 | 3300 | sanblaze-147-port7-p | sanblaze-147-port6-p |   1       |   2434   |  2499    |
| fc3/15 | 3300 | sanblaze-147-port7-p | sanblaze-147-port6-p |   1       |   2197   |  2199    |
| fc3/15 | 3300 | sanblaze-147-port7-p | sanblaze-147-port6-p |   1       |   1987   |  1982    |
+--------+-------+-----------------------+-----------------------+-----------+-------------------+
```

This example shows how to display the ITLs with the highest I/O operations per second (IOPS) for SCSI. The **--alias** option causes initiator and target device alias information is displayed.

```
switch# ShowAnalytics --top --alias

2021-02-09 09:15:25.445815

+--------+-------+-----------------+-------+-----------------------+-----------------------+-----------+-------------------+
|  PORT  | VSAN |      Initiator   | VMID |        Target         |         LUN           |      Avg IOPS     |
+--------+-------+-----------------+-------+-----------------------+-----------------------+-----------+-------------------+
|        |                                                                                  |   Read   |  Write   |
| fc5/22 | 2200 |       0xe90460   |   - |       0xe80b60        | 0002-0000-0000-0000   |    0     |  9124    |
| fc5/22 | 2200 |       0xe90460   |   - |       0xe80b60        | 0003-0000-0000-0000   |    0     |  9124    |
| fc5/22 | 2200 |       0xe90460   |   - |       0xe80b60        | 0001-0000-0000-0000   |    0     |  9123    |
| fc5/21 | 2200 |       0xe902e0   |   - | Tgt_9706_206_fc5_21_ | 0003-0000-0000-0000   |    0     |  5718    |
| fc5/21 | 2200 |       0xe902e0   |   - | Tgt_9706_206_fc5_21_ | 0001-0000-0000-0000   |    0     |  5718    |
| fc5/21 | 2200 |       0xe906c0   |   - | Tgt_9706_206_fc5_21_ | 0002-0000-0000-0000   |    0     |  5718    |
| fc5/21 | 2200 |       0xe902e0   |   - | Tgt_9706_206_fc5_21_ | 0002-0000-0000-0000   |    0     |  5717    |
| fc5/21 | 2200 |       0xe90440   |   - | Tgt_9706_206_fc5_21_ | 0001-0000-0000-0000   |    0     |  5717    |
| fc5/21 | 2200 |       0xe90440   |   - | Tgt_9706_206_fc5_21_ | 0002-0000-0000-0000   |    0     |  5717    |
| fc5/21 | 2200 |       0xe906c0   |   - | Tgt_9706_206_fc5_21_ | 0001-0000-0000-0000   |    0     |  5717    |
+--------+-------+-----------------+-------+-----------------------+-----------------------+-----------+-------------------+
```

This example shows how to display the ITLs with the highest I/O operations per second (IOPS). The **--alias** option causes initiator and target device alias information is displayed.

```
switch# ShowAnalytics --top --alias

2021-02-09 09:15:25.445815

+-------+-------+-----------------+-------+-----------------------+-----------------------+-----------+-------------------+
|  PORT | VSAN |      Initiator   | VMID |        Target         |         LUN           |      Avg IOPS     |
+-------+-------+-----------------+-------+-----------------------+-----------------------+-----------+-------------------+
|       |                                                                                  |   Read   |  Write   |
| fc1/2 |   20 | tie-2000012341newdev |  89 | tie-2000012341newdev | 0000-0000-0000-0000   |    0     |  1769    |
| fc1/1 |   20 | tie-2000012341newdev |  89 | tie-2000012341newdev | 0000-0000-0000-0000   |    0     |  1769    |
+-------+-------+-----------------+-------+-----------------------+-----------------------+-----------+-------------------+
```

This example shows how to display the errors for all target ITNs and limit the output to ten random records for NVMe:

```
switch# ShowAnalytics --errors --target-itn --limit 10
2019-05-23 11:28:34.926267

 Interface fc3/15
+-----------------------------------------+---------------------+-----------------+
| VSAN | Initiator |  Target   | Namespace  | Total NVMe Failures | Total FC Aborts |
+-----------------------------------------+---------------------+-----------------+
|                                         |     Read | Write    |   Read | Write  |
|                                         |                     |                 |
| 3300 | 0xc80005  | 0xed0005  |   1        |        0 | 0        |    0   |  0     |
| 3300 | 0xc80000  | 0xed0001  |   1        |        0 | 0        |    0   |  0     |
| 3300 | 0xc80004  | 0xed0004  |   1        |        0 | 0        |    0   |  0     |
| 3300 | 0xc80001  | 0xed0001  |   1        |        0 | 0        |    0   |  0     |
| 3300 | 0xc80003  | 0xed0003  |   1        |        0 | 0        |    0   |  0     |
| 3300 | 0xc80000  | 0xed0000  |   1        |        0 | 0        |   1260 | 1210   |
| 3300 | 0xc80007  | 0xed0007  |   1        |        0 | 0        |    0   |  0     |
| 3300 | 0xc80008  | 0xed0008  |   1        |        0 | 0        |    0   |  0     |
| 3300 | 0xc80002  | 0xed0002  |   1        |        0 | 0        |    0   |  0     |
| 3300 | 0xc80006  | 0xed0006  |   1        |        0 | 0        |    0   |  0     |
+-----------------------------------------+---------------------+-----------------+
```

This example shows how to display the errors for all target ITLs and limit the output to ten random records:

```
switch# ShowAnalytics --errors --target-itl --limit 10
2019-05-23 11:28:34.926267

 Interface fc8/7
+-----------------------------------------+---------------------+-----------------+
|        VSAN|Initiator|Target|LUN        | Total SCSI Failures | Total FC Aborts |
+-----------------------------------------+---------------------+-----------------+
|                                         |     Read | Write    |   Read | Write  |
|                                         |                     |                 |
| 5|0xed0332|0xef0592|000f-0000-0000-0000 |        0 | 0        |      0 | 0      |
| 5|0xed0342|0xef05a2|000a-0000-0000-0000 |        0 | 0        |      0 | 0      |
| 5|0xed0332|0xef0592|0008-0000-0000-0000 |        0 | 0        |      0 | 0      |
| 5|0xed0340|0xef05a0|0010-0000-0000-0000 |        0 | 0        |      0 | 0      |
| 5|0xed0322|0xef0582|0008-0000-0000-0000 |        0 | 0        |      0 | 0      |
| 5|0xed032c|0xef058c|0014-0000-0000-0000 |        0 | 0        |      0 | 0      |
| 5|0xed033a|0xef059a|000d-0000-0000-0000 |        0 | 0        |      0 | 0      |
| 5|0xed034a|0xef05aa|0005-0000-0000-0000 |        0 | 0        |      0 | 0      |
| 5|0xed033a|0xef059a|0007-0000-0000-0000 |        0 | 0        |      0 | 0      |
| 5|0xed034a|0xef05aa|0013-0000-0000-0000 |        0 | 0        |      0 | 0      |
+-----------------------------------------+---------------------+-----------------+
```

This example shows how to display all ITNs with nonzero NVMe failure and revert counts:

```
switch# ShowAnalytics --errorsonly --initiator-itn
2019-04-09 11:27:42.496294

 Interface fc16/12
+-----------------------------------------+---------------------+-----------------+
| VSAN | Initiator |  Target   | Namespace  | Total NVMe Failures | Total FC Aborts |
+-----------------------------------------+---------------------+-----------------+
|                                         |     Read | Write    |   Read | Write  |
|                                         |                     |                 |
| 3300 | 0xc80000  | 0xed0000  |   1        |        0 | 0        |   1635 | 1631   |
+-----------------------------------------+---------------------+-----------------+
```

This example shows how to display all ITLs with nonzero SCSI failure and revert counts:

```
switch# ShowAnalytics --errorsonly --initiator-itl
2019-04-09 11:27:42.496294

 Interface fc8/27
+-----------------------------------------+---------------------+-----------------+
|         VSAN|Initiator|Target|LUN         | Total SCSI Failures | Total FC Aborts |
+-----------------------------------------+---------------------+-----------------+
|                                         |     Read | Write    |   Read | Write  |
|                                         |                     |                 |
| 311|0x900000|0xc90000|0000-0000-0000-0000 |       0  | 42       |      0 | 0      |
+-----------------------------------------+---------------------+-----------------+
```

This example shows how to display 10 random ITLs with nonzero SCSI failure and revert counts. The device-alias (if any) is included for both the initiator and target.

```
switch# ShowAnalytics --errorsonly --initiator-itl --alias --limit 10
2019-04-09 12:06:19.847350

Interface fc1/26
+-----------------------------------------+---------------------+---------------+----------------------+-------------------+
|         VSAN|Initiator|Target|LUN         |Total SCSI Failures|Total FC Aborts|Initiator Device alias|Target Device alias|
+-----------------------------------------+---------------------+---------------+----------------------+-------------------+
|                                         |     Read | Write    |   Read | Write|                      |                   |
|                                         |                     |               |                      |                   |
| 108|0xee0467|0x70039b|0001-0000-0000-0000 |       0  | 1        |      0 | 0    |                      | SB_112_port_T_18_7|
| 108|0xee0401|0xbc092b|0002-0000-0000-0000 |       10 | 16       |      0 | 0    |                      | SB_112_port_T_0_1 |
| 108|0xee0441|0xbc092b|0003-0000-0000-0000 |       3  | 13       |      0 | 0    |   SB_112_port_I_7_1  | SB_112_port_T_0_1 |
| 108|0xee0401|0xbc0996|0001-0000-0000-0000 |       3  | 0        |      0 | 0    |                      |                   |
| 108|0xee0441|0xbc0996|0002-0000-0000-0000 |       0  | 3        |      0 | 0    |   SB_112_port_I_7_1  |                   |
| 108|0xee0481|0xbc0996|0004-0000-0000-0000 |       0  | 4        |      0 | 0    |                      |                   |
| 108|0xee0403|0xbc092d|0000-0000-0000-0000 |       12 | 8        |      0 | 0    |                      | SB_112_port_T_0_3 |
| 108|0xee0443|0xbc092d|0001-0000-0000-0000 |       3  | 12       |      0 | 0    |   SB_112_port_I_7_3  | SB_112_port_T_0_3 |
| 108|0xee0443|0xbc0998|0000-0000-0000-0000 |       1  | 0        |      0 | 0    |   SB_112_port_I_7_3  |                   |
+-----------------------------------------+---------------------+---------------+----------------------+-------------------+
```

This example shows how to display 10 random ITNs with nonzero NVMe failure and revert counts. The device-alias (if any) is included for both the initiator and target.

```
switch# ShowAnalytics --errorsonly --initiator-itn --alias --limit 10
2019-04-09 12:06:19.847350
 Interface fc16/12
+-----------------------------------------------------------------+---------------------+-----------------+
| VSAN |      Initiator       |        Target        | Namespace  | Total NVMe Failures | Total FC Aborts |
+-----------------------------------------------------------------+---------------------+-----------------+
|                                                                 |     Read | Write    |   Read | Write  |
|                                                                 |                     |                 |
| 3300 | sanblaze-147-port7-p | sanblaze-147-port6-p |   1        |        0 | 0        |   1635 | 1631   |
+-----------------------------------------------------------------+---------------------+-----------------+
```

This example shows how to display 10 random ITLs with nonzero SCSI failure and terminate counts. The device-alias (if any) is included for both the initiator and target.

```
switch# ShowAnalytics --errorsonly --initiator-itl --alias --limit 10
2019-04-09 12:06:19.847350

 Interface fc7/16
+-------------------------------------------------------------------------+-------------------+-----------------+
| VSAN |      Initiator       |        Target        |         LUN          | Total SCSI Failures | Total FC Aborts |
+-------------------------------------------------------------------------+-------------------+-----------------+
|                                                                         |     Read | Write    |   Read | Write  |
|                                                                         |                     |                 |
| 2200 |       0xe90440       | Tgt_9706_206_fc5_21_ | 0001-0000-0000-0000  |      0   | 5928     |      0 | 0      |
| 2200 |       0xe90440       | Tgt_9706_206_fc5_21_ | 0002-0000-0000-0000  |      0   | 5926     |      0 | 0      |
+-------------------------------------------------------------------------+-------------------+-----------------+
```

This example shows how to display the minimum, maximum, and peak flow metrics of target ID 0xef0720 of a target ITL:

```
switch# ShowAnalytics --minmax --target-itl --target 0xef0720
2019-04-09 11:22:08.652598

 Interface fc8/17
+-----------------------------------------+--------------+-----------------+-------------------+--------------+
|        VSAN|Initiator|Target|LUN         |   Peak IOPS*  | Peak Throughput* |   Read ECT*       |   Write ECT* |
+-----------------------------------------+--------------+-----------------+-------------------+--------------+
|                                         |  Read | Write |    Read   | Write |   Min    |  Max     | Min |  Max   |
|                                         |               |                 |                   |              |
| 5|0xed0500|0xef0720|0001-0000-0000-0000 | 11106 |  0    |10.8 MB/s |   0   | 28.0 us | 30.0 ms |  0  |   0    |
| 5|0xed0500|0xef0720|0002-0000-0000-0000 |  9232 |  0    | 9.0 MB/s |   0   | 28.0 us | 30.0 ms |  0  |   0    |
| 5|0xed0500|0xef0720|0003-0000-0000-0000 |  7421 |  0    | 7.2 MB/s |   0   | 28.0 us | 30.0 ms |  0  |   0    |
| 5|0xed0500|0xef0720|0004-0000-0000-0000 |  5152 |  0    | 5.0 MB/s |   0   | 29.0 us | 30.0 ms |  0  |   0    |
| 5|0xed0500|0xef0720|0005-0000-0000-0000 |  5163 |  0    | 5.0 MB/s |   0   | 30.0 us | 30.0 ms |  0  |   0    |
| 5|0xed0500|0xef0720|0006-0000-0000-0000 |  5154 |  0    | 5.0 MB/s |   0   | 30.0 us | 30.0 ms |  0  |   0    |
| 5|0xed0500|0xef0720|0007-0000-0000-0000 |  4801 |  0    | 4.7 MB/s |   0   | 29.0 us | 30.0 ms |  0  |   0    |
| 5|0xed0500|0xef0720|0008-0000-0000-0000 |  3838 |  0    | 3.7 MB/s |   0   | 64.0 us | 30.0 ms |  0  |   0    |
| 5|0xed0500|0xef0720|0009-0000-0000-0000 |  3053 |  0    | 3.0 MB/s |   0   | 40.0 us | 30.0 ms |  0  |   0    |
| 5|0xed0500|0xef0720|000a-0000-0000-0000 |  3061 |  0    | 3.0 MB/s |   0   | 33.0 us | 30.0 ms |  0  |   0    |
| 5|0xed0500|0xef0720|000b-0000-0000-0000 |  3053 |  0    | 3.0 MB/s |   0   | 30.0 us | 30.0 ms |  0  |   0    |
| 5|0xed0500|0xef0720|000c-0000-0000-0000 |  3058 |  0    | 3.0 MB/s |   0   | 37.0 us | 30.0 ms |  0  |   0    |
| 5|0xed0500|0xef0720|000d-0000-0000-0000 |  3058 |  0    | 3.0 MB/s |   0   | 29.0 us | 30.0 ms |  0  |   0    |
| 5|0xed0500|0xef0720|000e-0000-0000-0000 |  2517 |  0    | 2.5 MB/s |   0   | 29.0 us | 30.0 ms |  0  |   0    |
| 5|0xed0500|0xef0720|000f-0000-0000-0000 |  2405 |  0    | 2.3 MB/s |   0   | 29.0 us | 30.0 ms |  0  |   0    |
| 5|0xed0500|0xef0720|0010-0000-0000-0000 |  2410 |  0    | 2.4 MB/s |   0   | 36.0 us | 30.0 ms |  0  |   0    |
| 5|0xed0500|0xef0720|0011-0000-0000-0000 |  2405 |  0    | 2.3 MB/s |   0   | 33.0 us | 30.0 ms |  0  |   0    |
| 5|0xed0500|0xef0720|0012-0000-0000-0000 |  2411 |  0    | 2.4 MB/s |   0   | 30.0 us | 30.0 ms |  0  |   0    |
| 5|0xed0500|0xef0720|0013-0000-0000-0000 |  2408 |  0    | 2.4 MB/s |   0   | 37.0 us | 30.0 ms |  0  |   0    |
| 5|0xed0500|0xef0720|0014-0000-0000-0000 |  2284 |  0    | 2.2 MB/s |   0   | 29.0 us | 30.0 ms |  0  |   0    |
+-----------------------------------------+--------------+-----------------+-------------------+--------------+
*These values are calculated since the metrics were last cleared.
```

This example shows how to display the minimum, maximum, and peak flow metrics of target ID 0xed0000 of a target ITN for NVMe:

```
switch# ShowAnalytics --minmax --target-itn --target 0xed0000
2019-04-09 11:22:08.652598
  Interface fc3/15
+-------------------------------+-------------+-------------+-----------------+-----------------+-----------------+-----------------+-----------------+-----------------+
|VSAN | Initiator |  Target     | Namespace |      Peak IOPS*     |     Peak Throughput*      |     Read ECT*       |     Write ECT*      |    Host
Delay*      |    Array Delay*    | Write IO sequence* |
+-------------------------------+-------------+-------------+-----------------+-----------------+-----------------+-----------------+-----------------+-----------------+
|                               |             |  Read   |  Write  |     Read    |     Write       |     Min     |     Max     |     Min     |     Max     |     Min
    Max    |    Min     |     Max    |    Min     |    Max    |
|                               |             |         |         |             |                 |             |             |             |             |
          |            |            |            |
|3300 | 0xc80000  | 0xed0000  |  1          |   383   |   379   |  24.0 MB/s  |  23.7 MB/s  |  2.6 ms  |  26.7 ms  |  3.5 ms  |  28.7 ms  | 12.0 us
   3.1 ms |    NA     |   1.4 ms |     0      |     0     |
+-------------------------------+-------------+-------------+-----------------+-----------------+-----------------+-----------------+-----------------+-----------------+
Total number of ITNs: 1
*These values are calculated since the metrics were last cleared.
```

This example shows how to display the minimum, maximum, and peak flow metrics of target ID 0xe80b40 of a target ITL for SCSI:

```
switch# ShowAnalytics --minmax --target-itl --target 0xe80b40
2019-04-09 11:22:08.652598

 Interface fc5/21
+-------------------------------+-------------+-------------+-----------------+-----------------+-----------------+-----------------+-----------------+-----------------+
|VSAN | Initiator | VMID |  Target     |         LUN          |  Peak IOPS* |     Peak Throughput*      |     Read ECT*       |     Write ECT*      |
   Host Delay*      |    Array Delay*    | Write IO sequence* |
+-------------------------------+-------------+-------------+-----------------+-----------------+-----------------+-----------------+-----------------+-----------------+
|                               |             |                                |Read | Write |     Read    |     Write       |     Min     |     Max     |     Min     |     Max
 Min     |    Max     |  Min     |    Max     |  Min     |    Max    |
|                               |             |                                |     |       |             |                 |             |             |             |
          |            |            |            |
|2200 | 0xe90440  |   - | 0xe80b40  | 0001-0000-0000-0000  |  0  | 8361 |      0 B/s  |  4.1 MB/s   |   0 ns   |    0 ns   | 68.0 us  |   2.6 ms
  0 ns  |    0 ns   |   NA     |    0 ns   |    0     |    0      |
|2200 | 0xe90440  |   - | 0xe80b40  | 0002-0000-0000-0000  |  0  | 7814 |      0 B/s  |  3.8 MB/s   |   0 ns   |    0 ns   | 69.0 us  |   2.6 ms
  0 ns  |    0 ns   |   NA     |    0 ns   |    0     |    0      |
+-------------------------------+-------------+-------------+-----------------+-----------------+-----------------+-----------------+-----------------+-----------------+
Total number of ITLs: 2
*These values are calculated since the metrics were last cleared.
```

This example shows how to display the device alias information, minimum, maximum, and peak flow metrics of interface fc3/15 of a target ITN and limit the output to 10 random records for NVMe:

```
switch# ShowAnalytics --minmax --target-itn --alias  --interface fc3/15 --limit 10
2019-04-09 12:01:40.609197

 Interface fc3/15
+-------------------------------------------------------+-----------------+---------------------+-----------------+-----------------+-----------------+-----------------+-----------------+
|VSAN |      Initiator       |        Target         | Namespace |       Peak IOPS*      |     Peak Throughput*    |      Read ECT*      |      Write ECT*     |    Host Delay*
    |    Array Delay*    | Write IO sequence* |
+-------------------------------------------------------+-----------------+---------------------+-----------------+-----------------+-----------------+-----------------+-----------------+
|                                                       |                 |   Read    |   Write   |     Read    |    Write    |   Min   |    Max   |   Min   |    Max   |  Min    |    Max
   |  Min    |    Max   |  Min    |    Max   |
|                                                       |                 |           |           |             |             |         |          |         |          |         |
    |                      |                      |
|3300 | sanblaze-147-port7-p | sanblaze-147-port6-p |  1        |   2674    |   2595    | 167.1 MB/s | 162.2 MB/s  | 38.0 us |   2.3 ms |  69.0 us |   3.9 ms | 12.0 us |   3.7
 ms |   NA    |  36.0 us |    0    |    0     |
|3300 | sanblaze-147-port7-p | sanblaze-147-port6-p |  1        |   10199   |   10163   | 637.4 MB/s | 635.2 MB/s  |  9.0 us |   2.4 ms |  65.0 us |   3.9 ms | 12.0 us |   3.7
 ms |   NA    |  32.0 us |    0    |    0     |
|3300 | sanblaze-147-port7-p | sanblaze-147-port6-p |  1        |   2618    |   2587    | 163.6 MB/s | 161.7 MB/s  | 39.0 us |   2.4 ms |  69.0 us |   3.8 ms | 12.0 us |   3.6
 ms |   NA    |  34.0 us |    0    |    0     |
|3300 | sanblaze-147-port7-p | sanblaze-147-port6-p |  1        |   2288    |   2287    | 143.0 MB/s | 143.0 MB/s  | 37.0 us |   2.4 ms |  69.0 us |   4.0 ms | 12.0 us |   3.7
 ms |   NA    |  35.0 us |    0    |    0     |
|3300 | sanblaze-147-port7-p | sanblaze-147-port6-p |  1        |   2624    |   2583    | 164.0 MB/s | 161.4 MB/s  | 38.0 us |   2.5 ms | 108.0 us |   3.6 ms | 12.0 us |   3.4
 ms |   NA    |  33.0 us |    0    |    0     |
|3300 | sanblaze-147-port7-p | sanblaze-147-port6-p |  1        |    383    |    379    |  24.0 MB/s |  23.7 MB/s  |  2.6 ms |  27.0 ms |   3.5 ms |  28.7 ms | 12.0 us |   3.1
 ms |   NA    |   1.4 ms |    0    |    0     |
|3300 | sanblaze-147-port7-p | sanblaze-147-port6-p |  1        |   2624    |   2587    | 164.0 MB/s | 161.7 MB/s  | 38.0 us |   2.4 ms |  69.0 us |   3.7 ms | 12.0 us |   3.5
 ms |   NA    |  39.0 us |    0    |    0     |
|3300 | sanblaze-147-port7-p | sanblaze-147-port6-p |  1        |   2621    |   2597    | 163.8 MB/s | 162.3 MB/s  | 38.0 us |   2.4 ms |  77.0 us |   3.9 ms | 12.0 us |   3.5
 ms |   NA    |  31.0 us |    0    |    0     |
|3300 | sanblaze-147-port7-p | sanblaze-147-port6-p |  1        |   2646    |   2590    | 165.4 MB/s | 161.9 MB/s  | 38.0 us |   2.6 ms |  69.0 us |   3.8 ms | 12.0 us |   3.6
 ms |   NA    |  33.0 us |    0    |    0     |
|3300 | sanblaze-147-port7-p | sanblaze-147-port6-p |  1        |   2651    |   2594    | 165.7 MB/s | 162.2 MB/s  | 39.0 us |   2.6 ms |  69.0 us |   3.6 ms | 12.0 us |   3.5
 ms |   NA    |  32.0 us |    0    |    0     |
+-------------------------------------------------------+-----------------+---------------------+-----------------+-----------------+-----------------+-----------------+-----------------+
Total number of ITNs: 10
*These values are calculated since the metrics were last cleared.
```

This example shows how to display the device alias information, minimum, maximum, and peak flow metrics of interface fc5/21 of a target ITL and limit the output to 10 random records for SCSI:

```
switch# ShowAnalytics --minmax --target-itl --alias  --interface fc5/21 --limit 10
2019-04-09 12:01:40.609197

 Interface fc5/21
+-------------------------------------------------------------------+-----------+---------------------+-----------------+-----------------+-----------------+-----------------+-----------------+
|VSAN |      Initiator       | VMID |        Target         |         LUN          |  Peak IOPS* |     Peak Throughput*    |      Read ECT*      |      Write ECT*     |    Host
Delay*     |    Array Delay*    | Write IO sequence* |
+-------------------------------------------------------------------+-----------+---------------------+-----------------+-----------------+-----------------+-----------------+-----------------+
|                                                                   |           |Read | Write |     Read    |    Write    |   Min   |    Max   |   Min   |    Max   |  Min    |
   Max    |  Min    |    Max   |  Min    |    Max   |
|                                                                   |           |     |       |             |             |         |          |         |          |         |
          |                      |                      |
|2200 |       0xe902e0       |   - | Tgt_9706_206_fc5_21_ | 0002-0000-0000-0000  |  0  | 9242 |      0 B/s |  4.5 MB/s  |  0 ns   |   0 ns   | 66.0 us |   2.6 ms |  0 ns   |
    0 ns  |   NA    |    0 ns  |    0    |    0     |
|2200 |       0xe902e0       |   - | Tgt_9706_206_fc5_21_ | 0003-0000-0000-0000  |  0  | 9243 |      0 B/s |  4.5 MB/s  |  0 ns   |   0 ns   | 66.0 us |   2.6 ms |  0 ns   |
    0 ns  |   NA    |    0 ns  |    0    |    0     |
|2200 |       0xe902e0       |   - | Tgt_9706_206_fc5_21_ | 0001-0000-0000-0000  |  0  | 9242 |      0 B/s |  4.5 MB/s  |  0 ns   |   0 ns   | 66.0 us |   2.6 ms |  0 ns   |
    0 ns  |   NA    |    0 ns  |    0    |    0     |
|2200 |       0xe90440       |   - | Tgt_9706_206_fc5_21_ | 0001-0000-0000-0000  |  0  | 8361 |      0 B/s |  4.1 MB/s  |  0 ns   |   0 ns   | 68.0 us |   2.6 ms |  0 ns   |
    0 ns  |   NA    |    0 ns  |    0    |    0     |
|2200 |       0xe90440       |   - | Tgt_9706_206_fc5_21_ | 0002-0000-0000-0000  |  0  | 7814 |      0 B/s |  3.8 MB/s  |  0 ns   |   0 ns   | 69.0 us |   2.6 ms |  0 ns   |
    0 ns  |   NA    |    0 ns  |    0    |    0     |
|2200 |       0xe906c0       |   - | Tgt_9706_206_fc5_21_ | 0001-0000-0000-0000  |  0  | 7779 |      0 B/s |  3.8 MB/s  |  0 ns   |   0 ns   | 69.0 us |   2.7 ms |  0 ns   |
    0 ns  |   NA    |    0 ns  |    0    |    0     |
|2200 |       0xe906c0       |   - | Tgt_9706_206_fc5_21_ | 0002-0000-0000-0000  |  0  | 7779 |      0 B/s |  3.8 MB/s  |  0 ns   |   0 ns   | 69.0 us |   2.6 ms |  0 ns   |
    0 ns  |   NA    |    0 ns  |    0    |    0     |
+-------------------------------------------------------------------+-----------+---------------------+-----------------+-----------------+-----------------+-----------------+-----------------+
Total number of ITLs: 7
*These values are calculated since the metrics were last cleared.
```

This example shows how to display the NPU load for a range of interfaces:

```
switch# ShowAnalytics --evaluate-npuload --interface fc8/7-8
2019-05-09 10:56:54.021234
There are 2 interfaces to be evaluated. Expected time is 2 minutes 0 seconds
Do you want to continue [Yes|No]? [n]y
+-----------+--------+--------+---------+------+------+-------+------------+----------+
| Interface |        ITL/N Count        |      NPU Load %     |  Analyis   | Analysis |
|           |  SCSI  |  NVMe  |  Total  | SCSI | NVMe | Total | Start Time | End Time |
+-----------+--------+--------+---------+------+------+-------+------------+----------+
|   fc8/7   |  1000  |   0    |   1000  | 8.1  | 0.0  |  8.1  |  10:57:20  | 10:57:52 |
|   fc8/8   |  1000  |   0    |   1000  | 8.1  | 0.0  |  8.1  |  10:58:20  | 10:58:51 |
|           |        |        |         |      |      |       |            |          |
|   *Total  |  2000  |   0    |   2000  | 16.2 | 0.0  |  16.2 |            |          |
+-----------+--------+--------+---------+------+------+-------+------------+----------+
* This total is an indicative reference based on evaluated ports
```

**Note** Evaluating NPU load takes some time. If the connection to the switch is lost during the evaluation process, the process continues to run in the background until completion and the output is saved in a file. A syslog message is generated after the process is complete with the filename and the location of the file where the output is saved.

This example shows how to duplicate the output to a file named *output.txt* on bootflash:

**Note** You can use the **--outfile** option with all the **ShowAnalytics** command options to duplicate the command output to a file.

```
switch# ShowAnalytics --evaluate-npuload --outfile output.txt
2020-11-24 13:42:19.510351
There are 4 interfaces to be evaluated. Expected time is 4 minutes 0 seconds
Do you want to continue [Yes|No]? [n]y
Module 1
+-----------+-----------+--------+--------+---------+------+------+-------+------------+----------+
| Interface |    Type   |        ITL/N Count        |      NPU Load %     |  Analyis   | Analysis |
|           |           |  SCSI  |  NVMe  |  Total  | SCSI | NVMe | Total | Start Time | End Time |
+-----------+-----------+--------+--------+---------+------+------+-------+------------+----------+
|   fc1/1   |   Target  |   1    |   0    |    1    | 0.6  | 0.0  |  0.6  |  13:42:40  | 13:43:11 |
|   fc1/2   | Initiator |   1    |   0    |    1    | 0.6  | 0.0  |  0.6  |  13:43:40  | 13:44:11 |
|           |           |        |        |         |      |      |       |            |          |
|   *Total  |           |   2    |   0    |    2    | 1.2  | 0.0  |  1.2  |            |          |
+-----------+-----------+--------+--------+---------+------+------+-------+------------+----------+
Recommended port sampling size: 48

* This total is an indicative reference based on evaluated ports

Errors:
------

Traffic is not running on port fc1/47
Traffic is not running on port fc1/48
```

This example shows how to append the output to a file named *output.txt* on bootflash: that already contains some output:

```
switch# ShowAnalytics --evaluate-npuload --appendfile  output.txt
2020-11-24 13:45:07.535440
There are 4 interfaces to be evaluated. Expected time is 4 minutes 0 seconds
Do you want to continue [Yes|No]? [n]y
Module 1
+-----------+-----------+--------+--------+---------+------+------+-------+------------+----------+
| Interface |    Type   |        ITL/N Count        |      NPU Load %     |  Analyis   | Analysis |
|           |           |  SCSI  |  NVMe  |  Total  | SCSI | NVMe | Total | Start Time | End Time |
+-----------+-----------+--------+--------+---------+------+------+-------+------------+----------+
|   fc1/1   |   Target  |   1    |   0    |    1    | 0.6  | 0.0  |  0.6  |  13:45:40  | 13:46:11 |
|   fc1/2   | Initiator |   1    |   0    |    1    | 0.6  | 0.0  |  0.6  |  13:46:40  | 13:47:11 |
|           |           |        |        |         |      |      |       |            |          |
|   *Total  |           |   2    |   0    |    2    | 1.2  | 0.0  |  1.2  |            |          |
+-----------+-----------+--------+--------+---------+------+------+-------+------------+----------+
Recommended port sampling size: 48

* This total is an indicative reference based on evaluated ports

Errors:
------

Traffic is not running on port fc1/47
Traffic is not running on port fc1/48
```

This example shows how to display the VSAN throughput information for NVMe:

```
switch# ShowAnalytics --vsan-thput --nvme
2019-05-09 14:02:07.940600

 Interface fc16/12
+------+--------+--------+--------+
| VSAN |   Throughput (4s avg)    |
|      | Read   | Write  | Total  |
|      | (MBps) | (MBps) | (MBps) |
+------+--------+--------+--------+
| 3300 | 1605.8 | 1626.8 | 3232.6 |
+------+--------+--------+--------+
Note: This data is only for NVMe
```

This example shows how to display the VSAN throughput information for SCSI:

```
switch# ShowAnalytics --vsan-thput
2019-05-09 14:02:07.940600

Interface fc8/17
+------+--------+--------+--------+
| VSAN |   Throughput (4s avg)    |
|      | Read   | Write  | Total  |
|      | (MBps) | (MBps) | (MBps) |
+------+--------+--------+--------+
| 5    | 0.0    | 0.0    | 0.0    |
+------+--------+--------+--------+

Interface fc8/18
+------+--------+--------+--------+
| VSAN |   Throughput (4s avg)    |
|      | Read   | Write  | Total  |
|      | (MBps) | (MBps) | (MBps) |
+------+--------+--------+--------+
| 5    | 0.0    | 0.0    | 0.0    |
+------+--------+--------+--------+

Interface fc8/19
+------+--------+--------+--------+
| VSAN |   Throughput (4s avg)    |
|      | Read   | Write  | Total  |
|      | (MBps) | (MBps) | (MBps) |
+------+--------+--------+--------+
| 5    | 0.0    | 0.0    | 0.0    |
+------+--------+--------+--------+

Interface fc8/20
+------+--------+--------+--------+
| VSAN |   Throughput (4s avg)    |
|      | Read   | Write  | Total  |
|      | (MBps) | (MBps) | (MBps) |
+------+--------+--------+--------+
| 5    | 0.0    | 0.0    | 0.0    |
+------+--------+--------+--------+

Interface fc8/21
+------+--------+--------+--------+
| VSAN |   Throughput (4s avg)    |
|      | Read   | Write  | Total  |
|      | (MBps) | (MBps) | (MBps) |
+------+--------+--------+--------+
| 3500 | 301.9  | 302.8  | 604.7  |
+------+--------+--------+--------+

Interface fc8/22
+------+--------+--------+--------+
| VSAN |   Throughput (4s avg)    |
|      | Read   | Write  | Total  |
|      | (MBps) | (MBps) | (MBps) |
+------+--------+--------+--------+
| 3500 | 302.7  | 304.8  | 607.5  |
+------+--------+--------+--------+
Note: This data is only for SCSI
```

This example shows how to display the VSAN throughput information for a port channel:

```
switch# ShowAnalytics --vsan-thput --interface port-channel108
2019-05-09 15:01:32.538121

Interface port-channel108
+------+--------+--------+--------+
| VSAN |   Throughput (4s avg)    |
|      | Read   | Write  | Total  |
|      | (MBps) | (MBps) | (MBps) |
+------+--------+--------+--------+
| 1    | 0.0    | 0.0    | 0.0    |
| 5    | 145.9  | 0.0    | 145.9  |
| 3500 | 561.9  | 558.6  | 1120.5 |
+------+--------+--------+--------+
Note: This data is only for SCSI
```

This example shows how to display the outstanding IO per ITN for an interface for NVMe:

```
switch# ShowAnalytics --outstanding-io --interface fc16/12 --nvme
2019-05-20 11:59:48.306396
 Interface : fc16/12  VSAN : 3300  FCNS_type : Initiator

+--------------------------------------+----------------+
| Initiator |  Target   | Namespace  | Outstanding IO |
+--------------------------------------+----------------+
|                                      |  Read | Write  |
|                                      |               |
| 0xc80002  | 0xed0002  |   1        |    3  |  6     |
| 0xc80007  | 0xed0007  |   1        |    5  |  5     |
| 0xc80005  | 0xed0005  |   1        |    1  | 10     |
| 0xc80001  | 0xed0001  |   1        |    2  |  7     |
| 0xc80000  | 0xed0000  |   1        |    6  |  5     |
| 0xc80008  | 0xed0008  |   1        |    1  |  7     |
| 0xc80009  | 0xed0009  |   1        |    3  |  4     |
```

```
| 0xc80004  | 0xed0004  |   1        |    3  |  6     |
| 0xc80006  | 0xed0006  |   1        |    2  |  5     |
| 0xc80000  | 0xed0001  |   1        |    3  |  4     |
| 0xc80003  | 0xed0003  |   1        |    4  |  4     |
+-----------------------------------+----------------+
Instantaneous Qdepth : 96
```

This example shows how to display the outstanding IO per ITL for an interface for SCSI:

```
switch# ShowAnalytics --outstanding-io --interface fc8/7
2019-05-20 11:59:48.306396

Interface : fc8/7  VSAN : 5  FCNS_type : Target

+-----------------------------------+----------------+
|          Initiator|Target|LUN         | Outstanding IO |
+-----------------------------------+----------------+
|                                   |  Read | Write  |
|                                   |                |
| 0xed0320|0xef0580|0001-0000-0000-0000 |    2  |  0     |
| 0xed0320|0xef0580|0002-0000-0000-0000 |    1  |  0     |
| 0xed0320|0xef0580|0003-0000-0000-0000 |    1  |  0     |
| 0xed0320|0xef0580|0004-0000-0000-0000 |    1  |  0     |
| 0xed0320|0xef0580|0005-0000-0000-0000 |    1  |  0     |
| 0xed0320|0xef0580|0006-0000-0000-0000 |    1  |  0     |
| 0xed0320|0xef0580|0007-0000-0000-0000 |    1  |  0     |
| 0xed0320|0xef0580|0008-0000-0000-0000 |    1  |  0     |
| 0xed0320|0xef0580|0009-0000-0000-0000 |    1  |  0     |
| 0xed0320|0xef0580|000a-0000-0000-0000 |    1  |  0     |
+-----------------------------------+----------------+
Instantaneous Qdepth : 11
```

**Note** The *Instantaneous Qdepth* value in the output represents the number of IOs that are currently active in the specified interface.

This example shows how to display the outstanding IO per ITN for an interface, limit the output to 10 records, and refresh the data periodically for NVMe:

```
switch# ShowAnalytics --outstanding-io --interface fc8/7  --limit 10 --refresh --nvme
2019-05-20 12:00:21.028228
 Interface : fc16/12  VSAN : 3300  FCNS_type : Initiator

+-----------------------------------+----------------+
| Initiator |  Target   | Namespace  | Outstanding IO |
+-----------------------------------+----------------+
|                                   |  Read | Write  |
|                                   |                |
| 0xc80002  | 0xed0002  |   1        |    2  |  7     |
| 0xc80007  | 0xed0007  |   1        |    3  |  5     |
| 0xc80005  | 0xed0005  |   1        |    1  |  8     |
| 0xc80001  | 0xed0001  |   1        |    1  |  0     |
| 0xc80000  | 0xed0000  |   1        |    5  |  6     |
+-----------------------------------+----------------+
```

This example shows how to display the outstanding IO per ITL for an interface, limit the output to 10 records, and refresh the data periodically for SCSI:

```
switch# ShowAnalytics --outstanding-io --interface fc8/7  --limit 10 --refresh
2019-05-20 12:00:21.028228

Interface : fc8/7  VSAN : 5  FCNS_type : Target

+-----------------------------------+----------------+
|          Initiator|Target|LUN         | Outstanding IO |
+-----------------------------------+----------------+
|                                   |  Read | Write  |
|                                   |                |
| 0xed0320|0xef0580|0001-0000-0000-0000 |    0  |  0     |
| 0xed0320|0xef0580|0002-0000-0000-0000 |    1  |  0     |
| 0xed0320|0xef0580|0003-0000-0000-0000 |    1  |  0     |
| 0xed0320|0xef0580|0004-0000-0000-0000 |    1  |  0     |
| 0xed0320|0xef0580|0005-0000-0000-0000 |    0  |  0     |
| 0xed0320|0xef0580|0006-0000-0000-0000 |    0  |  0     |
| 0xed0320|0xef0580|0007-0000-0000-0000 |    1  |  0     |
| 0xed0320|0xef0580|0008-0000-0000-0000 |    0  |  0     |
| 0xed0320|0xef0580|0009-0000-0000-0000 |    1  |  0     |
| 0xed0320|0xef0580|000a-0000-0000-0000 |    1  |  0     |
+-----------------------------------+----------------+
Estimated Qdepth : 6
```

This example shows how to display the histogram of a initiator ID 0xee008e, target ID 0xe80b22, and LUN ID 0060-0000-0000-0000 of a target ITL

```
switch# ShowAnalytics --histogram --initiator-itl --initiator 0xee008e --target 0xe80b22 --lun 0060-0000-0000-0000


Starting histogram monitor session
Session ID: 15789
+----------------+------------+
|                | 25-05-2022 |
| Metric         |  15:29:30  |
+----------------+------------+
| IOPS Read      |     0      |
| IOPS Write     |     11     |
| ECT Read       |   0 ns     |
| ECT Write      |  28.1 ms   |
| DAL Read       |   0 ns     |
| DAL Write      |  13.7 ms   |
| FAILURES Read  |     0      |
| FAILURES Write |     0      |
| ABORTS Read    |     0      |
| ABORTS Write   |     0      |
+----------------+------------+
Histogram data will get updated every 5 mins
```

This example shows how to display the histogram of a initiator ID 0xee008e and target ID 0xe80b22 of a target ITL

```
switch# ShowAnalytics --histogram --initiator-it --initiator 0xee008e --target 0xe80b22

Starting histogram monitor session
Session ID: 16205
+----------------+------------+
|                | 25-05-2022 |
| Metric         |  15:30:13  |
+----------------+------------+
| IOPS Read      |     0      |
| IOPS Write     |    106     |
| ECT Read       |   0 ns     |
| ECT Write      |  28.1 ms   |
| DAL Read       |   0 ns     |
| DAL Write      |  13.7 ms   |
| FAILURES Read  |     0      |
| FAILURES Write |     0      |
| ABORTS Read    |     0      |
| ABORTS Write   |     0      |
+----------------+------------+
Histogram data will get updated every 5 mins
```

This example shows how to display the histogram of all sessions.

```
switch# ShowAnalytics --histogram --show-sessions

+------------+-------------------------------------------------------------------------------------------------------------------------------------------+
| Session ID | Arguments                                                                                                                                 |
+------------+-------------------------------------------------------------------------------------------------------------------------------------------+
|      15789 | --initiator-itl --initiator 0xee008e --target 0xe80b22 --lun 0060-0000-0000-0000 --interval 5 --metric IOPS,ECT,DAL,ERRORS               |
|      16205 | --initiator-it --initiator 0xee008e --target 0xe80b22 --interval 5 --metric IOPS,ECT,DAL,ERRORS                                           |
|      20924 | --target-itl --initiator 0xc80ba3 --target 0xc804e3 --lun 0002-0000-0000-0000 --interval 5 --metric IOPS,ECT,DAL,ERRORS                   |
+------------+-------------------------------------------------------------------------------------------------------------------------------------------+

Analytic-scale184# ShowAnalytics --histogram --sessionId 16205
+----------------+------------+------------+------------+
|                | 25-05-2022 | 25-05-2022 | 25-05-2022 |
| Metric         |  15:40:15  |  15:35:14  |  15:30:13  |
+----------------+------------+------------+------------+
| IOPS Read      |     0      |     0      |     0      |
| IOPS Write     |     95     |    142     |    106     |
| ECT Read       |   0 ns     |   0 ns     |   0 ns     |
| ECT Write      |  28.2 ms   |  27.7 ms   |  28.1 ms   |
| DAL Read       |   0 ns     |   0 ns     |   0 ns     |
| DAL Write      |  13.7 ms   |  13.6 ms   |  13.7 ms   |
| FAILURES Read  |     0      |     0      |     0      |
| FAILURES Write |     0      |     0      |     0      |
| ABORTS Read    |     0      |     0      |     0      |
| ABORTS Write   |     0      |     0      |     0      |
+----------------+------------+------------+------------+
```

This example shows how to display the histogram of a specific session 15789 that is stopped.

```
switch# ShowAnalytics --histogram --stop-session --sessionId 15789

Stopping session id: 15789

Analytic-scale184# ShowAnalytics --histogram --initiator-itn --initiator 0xc80960 --target 0xe80641 --namespace 3
Starting histogram monitor session
Session ID: 27792
+----------------+------------+
|                | 25-05-2022 |
| Metric         |  15:47:11  |
+----------------+------------+
| IOPS Read      |     0      |
| IOPS Write     |     0      |
| ECT Read       |  433.0 us  |
| ECT Write      |   1.0 ms   |
| DAL Read       |  421.0 us  |
| DAL Write      |  339.0 us  |
| FAILURES Read  |     0      |
```

```
| FAILURES Write |     0      |
| ABORTS Read    |     0      |
| ABORTS Write   |     0      |
+----------------+------------+
Histogram data will get updated every 5 mins
```

This example shows how to display the histogram with metric details such as IOPS, ECT, DAL, and Errors for an initiator ID 0xee008e and target ID 0xe80b22 every five minutes.

```
switch# ShowAnalytics --histogram --initiator-it --initiator 0xee008e --target 0xe80b22 --interval 5 --metric IOPS,ECT,DAL,ERRORS

Data collected at : Wed, 25 May 2022 16:20:12 +0530

+----------------+------------+------------+------------+------------+------------+------------+------------+------------+------------+------------+
|                | 25-05-2022 | 25-05-2022 | 25-05-2022 | 25-05-2022 | 25-05-2022 | 25-05-2022 | 25-05-2022 | 25-05-2022 | 25-05-2022 | 25-05-2022
 |
| Metric         |  16:15:22  |  16:10:21  |  16:05:19  |  16:00:18  |  15:55:18  |  15:50:17  |  15:45:16  |  15:40:15  |  15:35:14  |  15:30:13
  |
+----------------+------------+------------+------------+------------+------------+------------+------------+------------+------------+------------+
| IOPS Read      |     0      |     0      |     0      |     0      |     0      |     0      |     0      |     0      |     0      |     0
  |
| IOPS Write     |    138     |    104     |     50     |    135     |     68     |     74     |     89     |     95     |    142     |    106
  |
| ECT Read       |   0 ns     |   0 ns     |   0 ns     |   0 ns     |   0 ns     |   0 ns     |   0 ns     |   0 ns     |   0 ns     |   0 ns
  |
| ECT Write      |  28.2 ms   |  27.8 ms   |  28.3 ms   |  28.0 ms   |  28.0 ms   |  28.0 ms   |  27.9 ms   |  28.2 ms   |  27.7 ms   |  28.1 ms
  |
| DAL Read       |   0 ns     |   0 ns     |   0 ns     |   0 ns     |   0 ns     |   0 ns     |   0 ns     |   0 ns     |   0 ns     |   0 ns
  |
| DAL Write      |  13.7 ms   |  13.6 ms   |  13.8 ms   |  13.7 ms   |  13.7 ms   |  13.7 ms   |  13.7 ms   |  13.7 ms   |  13.6 ms   |  13.7 ms
  |
| FAILURES Read  |     0      |     0      |     0      |     0      |     0      |     0      |     0      |     0      |     0      |     0
  |
| FAILURES Write |     0      |     0      |     0      |     0      |     0      |     0      |     0      |     0      |     0      |     0
  |
| ABORTS Read    |     0      |     0      |     0      |     0      |     0      |     0      |     0      |     0      |     0      |     0
  |
| ABORTS Write   |     0      |     0      |     0      |     0      |     0      |     0      |     0      |     0      |     0      |     0
  |
+----------------+------------+------------+------------+------------+------------+------------+------------+------------+------------+------------+
```

This example shows how to display the histogram for an initiator ID 0xee008e and target ID 0xe80b22 with an refresh time of 120 minutes.

```
switch# ShowAnalytics --histogram --initiator-it --initiator 0xee008e --target 0xe80b22 --interval 120

Starting histogram monitor session
Session ID: 21352
+----------------+------------+
|                | 25-05-2022 |
| Metric         |  16:21:29  |
+----------------+------------+
| IOPS Read      |     0      |
| IOPS Write     |     84     |
| ECT Read       |   0 ns     |
| ECT Write      |  28.1 ms   |
| DAL Read       |   0 ns     |
| DAL Write      |  13.7 ms   |
| FAILURES Read  |     0      |
| FAILURES Write |     0      |
| ABORTS Read    |     0      |
| ABORTS Write   |     0      |
+----------------+------------+
Histogram data will get updated every 120 mins
```

This example shows how to display the histogram with metric details such as ECT and DAL for an initiator ID 0xee008e and target ID 0xe80b22 every five minutes.

```
switch# ShowAnalytics --histogram --initiator-it --initiator 0xee008e --target 0xe80b22 --metric ECT,DAL

Starting histogram monitor session
Session ID: 22073
+-----------+------------+
|           | 25-05-2022 |
| Metric    |  16:22:35  |
+-----------+------------+
| ECT Read  |   0 ns     |
| ECT Write |  28.1 ms   |
| DAL Read  |   0 ns     |
| DAL Write |  13.7 ms   |
+-----------+------------+
Histogram data will get updated every 5 mins
```

This example shows how to display the histogram for an initiator ID 0xee008e every five minutes.

```
switch# ShowAnalytics --histogram --initiator 0xee008e

Starting histogram monitor session
Session ID: 23254
+----------------+------------+
|                | 25-05-2022 |
| Metric         |  16:24:10  |
```

```
+----------------+------------+
| IOPS Read      |     0      |
| IOPS Write     |    124     |
| ECT Read       |   0 ns     |
| ECT Write      |  28.2 ms   |
| DAL Read       |   0 ns     |
| DAL Write      |  13.8 ms   |
| FAILURES Read  |     0      |
| FAILURES Write |     0      |
| ABORTS Read    |     0      |
| ABORTS Write   |     0      |
+----------------+------------+
Histogram data will get updated every 5 mins
```

This example shows how to display the histogram for a target 0xc804e3 every five minutes.

```
switch# ShowAnalytics --histogram --target 0xc804e3

Starting histogram monitor session
Session ID: 24003
+----------------+------------+
|                | 25-05-2022 |
| Metric         |  16:25:07  |
+----------------+------------+
| IOPS Read      |     0      |
| IOPS Write     |    3939    |
| ECT Read       |   0 ns     |
| ECT Write      |  23.3 ms   |
| DAL Read       |   0 ns     |
| DAL Write      |  10.7 ms   |
| FAILURES Read  |     0      |
| FAILURES Write |   30429    |
| ABORTS Read    |     0      |
| ABORTS Write   |     0      |
+----------------+------------+
Histogram data will get updated every 5 mins
```

# Displaying Congestion Drops Per Flow

The SAN Analytics feature displays packet timeout drops on a per-flow basis. The number of packets dropped along with the time stamp for ports is displayed.

To display the packet drops on a per-flow basis, run this command:

switch# **show analytics flow congestion-drops**

**Note** From Cisco MDS NX-OS Release 9.4(1), the command **show analytics flow congestion-drops** is available as part of the **show tech-support slowdrain commands** as **slot <slot number> show analytics flow congestion-drops**. The command is available on MDS switches that are capable of performing analytic.

## Examples: Displaying Congestion Drops Per Flow

This example shows flows where frames are dropped due to congestion. The source and destination FCID, differential frame drop count for the IT pair, and timestamp of the drops are displayed.

```
switch# show analytics flow congestion-drops

|=================================================================================|
| Source       |Destination            | Congestion    |     Timestamp               |
| INTF  | VSAN |  FCID     |  FCID     | Drops(delta)  |                             |
|=================================================================================|
| fc2/13| 0002 | 0x9900E1  | 0x640000  |  00000105     | 1. 09/13/17 11:09:48.762    |
| fc2/13| 0002 | 0x9900E1  | 0x640000  |  00000002     | 2. 09/13/17 09:05:39.527    |
| fc2/13| 0002 | 0x990000  | 0x640020  |  00000002     | 3. 09/13/17 09:05:39.527    |
|=================================================================================|
| fc2/31| 0002 | 0x640000  | 0x9900E1  |  00000084     | 1. 09/12/17 08:17:11.905    |
| fc2/31| 0002 | 0x640000  | 0x9900E1  |  00000076     | 2. 09/12/17 05:50:37.721    |
```

```
| fc2/31| 0002 | 0x640000  | 0x9900E1  |  00000067     | 3. 09/12/17 03:24:03.319     |
| fc2/31| 0002 | 0x640000  | 0x9900E1  |  00000088     | 4. 09/12/17 00:57:28.019     |
| fc2/31| 0002 | 0x640000  | 0x9900E1  |  00000088     | 5. 09/11/17 22:30:53.723     |
| fc2/31| 0002 | 0x640000  | 0x9900E1  |  00000086     | 6. 09/11/17 20:04:18.001     |
| fc2/31| 0002 | 0x640000  | 0x9900E1  |  00000026     | 7. 09/11/17 17:37:24.273     |
| fc2/31| 0002 | 0x640000  | 0x9900E1  |  00000076     | 8. 09/11/17 15:10:50.240     |
| fc2/31| 0002 | 0x640000  | 0x9900E1  |  00000074     | 9. 09/11/17 12:44:15.866     |
| fc2/31| 0002 | 0x640000  | 0x9900E1  |  00000087     |10. 09/11/17 10:17:41.402     |
| fc2/31| 0002 | 0x640000  | 0x9900E1  |  00000086     |11. 09/11/17 07:51:10.412     |
| fc2/31| 0002 | 0x640000  | 0x9900E1  |  00000084     |12. 09/11/17 05:24:35.981     |
| fc2/31| 0002 | 0x640000  | 0x9900E1  |  00000083     |13. 09/11/17 02:58:01.067     |
| fc2/31| 0002 | 0x640000  | 0x9900E1  |  00000086     |14. 09/11/17 00:31:26.709     |
| fc2/31| 0002 | 0x640000  | 0x9900E1  |  00000079     |15. 09/10/17 22:04:51.399     |
| fc2/31| 0002 | 0x640000  | 0x9900E1  |  00000084     |16. 09/10/17 19:38:17.217     |
| fc2/31| 0002 | 0x640000  | 0x9900E1  |  00000082     |17. 09/10/17 17:11:42.594     |
| fc2/31| 0002 | 0x640000  | 0x9900E1  |  00000086     |18. 09/10/17 14:44:52.786     |
| fc2/31| 0002 | 0x640000  | 0x9900E1  |  00000089     |19. 09/10/17 12:18:18.394     |
| fc2/31| 0002 | 0x640000  | 0x9900E1  |  00000087     |20. 09/10/17 09:51:44.067     |
|=============================================================================================|
```

This example shows the use of the command in the **show tech-support slowdrain commands**.

```
switch# show tech-support slowdrain commands  | inc congestion
slot 1 show analytics flow congestion-drops
switch#slot 1 show analytics flow congestion-drops
|=============================================================================================|
|       |      | Source    |Destination| Congestion    |     Timestamp                 |
| INTF  | VSAN |  FCID     |  FCID     | Drops(delta)  |                               |
|=============================================================================================|
| fc1/3 | 0063 | 0xD70000  | 0x410000  |  00000374     | 1. 07/08/23 12:40:37.054     |
|=============================================================================================|
| fc1/12| 0063 | 0xD70000  | 0x420000  |  00000697     | 1. 07/08/23 12:40:37.054     |
| fc1/12| 0063 | 0xD70000  | 0x420000  |  00001024     | 2. 07/08/23 12:40:32.063     |
| fc1/12| 0063 | 0x660000  | 0x420000  |  00000314     | 3. 07/08/23 12:40:32.063     |
|=============================================================================================|
```

# Verifying SAN Analytics

This example shows the list of interfaces that have the SAN Analytics feature enabled:

```
switch# show running-config analytics

!Command: show running-config analytics
!Running configuration last done at: Mon Apr  1 05:27:54 2019
!Time: Mon Apr  1 05:28:42 2019

version 8.4(0)SK(1)
feature analytics
analytics port-sampling module 4 size 12 interval 30

analytics query "select all from fc-scsi.scsi_target_itl_flow" name VI_scsi type periodic
interval 30  differential clear
analytics query "select all from fc-nvme.nvme_target_itn_flow" name nvme-184 type periodic
 interval 30  differential clear

interface fc4/25
  analytics type fc-scsi

interface fc4/26
  analytics type fc-nvme
```

```
interface fc12/44
  analytics type fc-scsi
  analytics type fc-nvme
```

This example shows the list of configured push queries that are installed on a switch:

```
switch# show analytics query all
Total queries:2
============================
Query Name      :VI_scsi
Query String    :select all from fc-scsi.scsi_target_itl_flow
Query Type      :periodic, interval 30
Query Options   :differential clear

Query Name      :nvme-184
Query String    :select all from fc-nvme.nvme_target_itn_flow
Query Type      :periodic, interval 30
Query Options   :differential clear
```

This example shows how to display the NPU load, ITL, and ITN count per module:

```
switch# show analytics system-load
 n/a - not applicable
 ---------------------------------- Analytics System Load Info -------------------------------
 | Module | NPU Load (in %) | ITLs   ITNs   Both  |        Hosts         |       Targets       |
 |        | SCSI NVMe Total | SCSI   NVMe   Total | SCSI   NVMe   Total | SCSI   NVMe   Total |
 ---------------------------------------------------------------------------------------------
 |   1    | 0    0    0     | 0      0      0     | 0      0      0     | 0      0      0     |
 |   4    | 64   0    64    | 20743  0      20743 | 0      0      0     | 346    0      346   |
 |   5    | 0    0    0     | 0      0      0     | 0      0      0     | 0      0      0     |
 |   8    | 0    0    0     | 0      0      0     | 0      0      0     | 0      0      0     |
 |   12   | 0    12   12    | 0      300    300   | 0      0      0     | 0      40     40    |
 |   13   | 0    0    0     | 0      0      0     | 0      0      0     | 0      0      0     |
 |   18   | 0    13   13    | 1      1      2     | 1      1      2     | 0      0      0     |
 | Total  | n/a  n/a  n/a   | 20744  301    21045 | 1      1      2     | 346    40     386   |

As of Mon Apr  1 05:31:10 2019
```

**Note** The **show analytics system-load** command provides the system load information based on all ITL counts, including active and inactive ITL counts. Hence, we recommend that you use the **purge analytics query** *"query_string"* command to remove the inactive ITL counts, and then run this command to get the active ITL counts.

This example displays the NPU load, ITL, and ITN of all active modules:

```
switch# ShowAnalytics --systemload-active

This will run differential query on scsi_initiator_itl_flow, scsi_target_itl_flow,
nvme_initiator_itn_flow, nvme_target_itn_flow, scsi_initiator, scsi_target,
nvme_initiator and nvme_target  or use the result of installed query if present
 Do you want to continue [Yes|No]? [n]y

Data collected at : Wed, 25 May 2022 16:29:24 +0530

Using result of installed queries: dcnmtgtITN,dcnmtgtITL

+--------+--------+--------+---------+------+------+-------+-------+-------+--------+
| Module |        ITL/N Count        |      Initiators     |        Targets         |
|        |  SCSI  |  NVMe  |  Total  | SCSI | NVMe | Total |  SCSI |  NVMe |  Total |
+--------+--------+--------+---------+------+------+-------+-------+-------+--------+
|   1    |  5571  |    0   |   5571  |   2  |   0  |    2  |   55  |    0  |   55   |
|   2    |  14904 |    1   |   14905 |  191 |   1  |   192 |   191 |    0  |   191  |
```

```
|   3    |  7588  |    0   |   7588  |  128 |   0  |   128 |   128 |    0  |   128  |
|   5    |    0   |    0   |     0   |  56  |   0  |   56  |    0  |    0  |    0   |
|   12   |    0   |    0   |     0   |   0  |   0  |    0  |    0  |    1  |    1   |
| Total  |  28063 |    1   |   28064 |  377 |   1  |   378 |   374 |    1  |   375  |
+--------+--------+--------+---------+------+------+-------+-------+-------+--------+
```

This example displays the NPU load, ITL, and ITN details for a particular active module:

```
switch# ShowAnalytics --systemload-active --module 1 --detail

This will run differential query on scsi_initiator_itl_flow, scsi_target_itl_flow,
nvme_initiator_itn_flow, nvme_target_itn_flow, scsi_initiator, scsi_target,
nvme_initiator and nvme_target  or use the result of installed query if present
 Do you want to continue [Yes|No]? [n]y

Data collected at : Wed, 25 May 2022 16:35:35 +0530

Using result of installed queries: dcnmtgtITN,dcnmtgtITL

+--------+--------+--------+---------+------+------+-------+-------+-------+--------+
| Module |        ITL/N Count        |      Initiators     |        Targets         |
|        |  SCSI  |  NVMe  |  Total  | SCSI | NVMe | Total |  SCSI |  NVMe |  Total |
+--------+--------+--------+---------+------+------+-------+-------+-------+--------+
|   1    |  5571  |    0   |   5571  |   2  |   0  |    2  |   55  |    0  |   55   |
| Total  |  5571  |    0   |   5571  |   2  |   0  |    2  |   55  |    0  |   55   |
+--------+--------+--------+---------+------+------+-------+-------+-------+--------+

Detailed output for DS-X9748-3072K9 modules
Module : 1
+-----------------------------+--------+--------+---------+------+------+-------+-------+-------+--------+
|           Ports             |        ITL/N Count        |      Initiators     |        Targets         |
|                             |  SCSI  |  NVMe  |  Total  | SCSI | NVMe | Total |  SCSI |  NVMe |  Total |
+-----------------------------+--------+--------+---------+------+------+-------+-------+-------+--------+
|   fc1/1,fc1/3,fc1/5,fc1/7   |  186   |   0    |   186   |  0   |  0   |   0   |   2   |   0   |   2    |
|   fc1/2,fc1/4,fc1/6,fc1/8   |  186   |   0    |   186   |  0   |  0   |   0   |   2   |   0   |   2    |
|  fc1/9,fc1/11,fc1/13,fc1/15 |  185   |   0    |   185   |  0   |  0   |   0   |   2   |   0   |   2    |
| fc1/10,fc1/12,fc1/14,fc1/16 |   93   |   0    |    93   |  0   |  0   |   0   |   1   |   0   |   1    |
| fc1/17,fc1/19,fc1/21,fc1/23 |  186   |   0    |   186   |  0   |  0   |   0   |   2   |   0   |   2    |
| fc1/18,fc1/20,fc1/22,fc1/24 |  186   |   0    |   186   |  0   |  0   |   0   |   2   |   0   |   2    |
| fc1/25,fc1/27,fc1/29,fc1/31 |  171   |   0    |   171   |  2   |  0   |   2   |   0   |   0   |   0    |
| fc1/33,fc1/35,fc1/37,fc1/39 |  2188  |   0    |   2188  |  0   |  0   |   0   |   22  |   0   |   22   |
| fc1/34,fc1/36,fc1/38,fc1/40 |  2190  |   0    |   2190  |  0   |  0   |   0   |   22  |   0   |   22   |
|           Total             |  5571  |   0    |   5571  |  2   |  0   |   2   |   55  |   0   |   55   |
+-----------------------------+--------+--------+---------+------+------+-------+-------+-------+--------+
```

This example shows how to check the port sampling status and the instantaneous NPU load:

```
switch# show analytics port-sampling module 1
Sampling Window Size: 12
Rotation Interval: 30
NPU LOAD : 64%      [SCSI 64%, NVMe 0%]
================================================================================
  Port                Monitored Start Time            Monitored End Time
================================================================================
  fc4/25              04/01/19 - 05:25:29             04/01/19 - 05:25:59
  fc4/26              04/01/19 - 05:25:29             04/01/19 - 05:25:59
  fc4/27              04/01/19 - 05:25:29             04/01/19 - 05:25:59
  fc4/28              04/01/19 - 05:25:29             04/01/19 - 05:25:59
  fc4/29              04/01/19 - 05:25:29             04/01/19 - 05:25:59
  fc4/30              04/01/19 - 05:25:29             04/01/19 - 05:25:59
  fc4/31              04/01/19 - 05:25:29             04/01/19 - 05:25:59
  fc4/32              04/01/19 - 05:25:29             04/01/19 - 05:25:59
  fc4/33              04/01/19 - 05:25:29             04/01/19 - 05:25:59
  fc4/34              04/01/19 - 05:25:29             04/01/19 - 05:25:59
  fc4/35              04/01/19 - 05:25:29             04/01/19 - 05:25:59
  fc4/36              04/01/19 - 05:25:29             04/01/19 - 05:25:59
  fc4/37*             04/01/19 - 05:25:59             -
  fc4/38*             04/01/19 - 05:25:59             -
  fc4/39*             04/01/19 - 05:25:59             -
  fc4/40*             04/01/19 - 05:25:59             -
  fc4/41*             04/01/19 - 05:25:59             -
  fc4/42*             04/01/19 - 05:25:59             -
  fc4/43*             04/01/19 - 05:25:59             -
  fc4/44*             04/01/19 - 05:25:59             -
```

```
  fc4/45*            04/01/19 - 05:25:59            -
  fc4/46*            04/01/19 - 05:25:59            -
  fc4/47*            04/01/19 - 05:25:59            -
  fc4/48*            04/01/19 - 05:25:59            -
================================================================================
! - Denotes port is link down but analytics enabled.
* - Denotes port in active analytics port sampling window.
```

The star symbol (*) next to a port indicates that the port is currently being sampled.

This example shows the output of a push query that has already been configured:

```
switch# show analytics query name iniitl result
{ "values": {
        "1": {
                "port": "fc1/6",
                "vsan": "10",
                "app_id": "255",
                "initiator_id": "0xe800a0",
                "target_id": "0xd601e0",
                "lun": "0000-0000-0000-0000",
                "active_io_read_count": "0",
                "active_io_write_count": "7",
                "total_read_io_count": "0",
                "total_write_io_count": "1008608573",
                "total_seq_read_io_count": "0",
                "total_seq_write_io_count": "1",
                "total_read_io_time": "0",
                "total_write_io_time": "370765952314",
                "total_read_io_initiation_time": "0",
                "total_write_io_initiation_time": "52084968152",
                "total_read_io_bytes": "0",
                "total_write_io_bytes": "2065630357504",
                "total_read_io_inter_gap_time": "0",
                "total_write_io_inter_gap_time": "16171468343166",
                "total_time_metric_based_read_io_count": "0",
                "total_time_metric_based_write_io_count": "1008608566",
                "total_time_metric_based_read_io_bytes": "0",
                "total_time_metric_based_write_io_bytes": "2065630343168",
                "read_io_rate": "0",
                "peak_read_io_rate": "0",
                "write_io_rate": "16070",
                "peak_write_io_rate": "32468",
                "read_io_bandwidth": "0",
                "peak_read_io_bandwidth": "0",
                "write_io_bandwidth": "32912384",
                "peak_write_io_bandwidth": "66494976",
                "read_io_size_min": "0",
                "read_io_size_max": "0",
                "write_io_size_min": "2048",
                "write_io_size_max": "2048",
                "read_io_completion_time_min": "0",
                "read_io_completion_time_max": "0",
                "write_io_completion_time_min": "111",
                "write_io_completion_time_max": "9166",
                "read_io_initiation_time_min": "0",
                "read_io_initiation_time_max": "0",
                "write_io_initiation_time_min": "36",
                "write_io_initiation_time_max": "3265",
                "read_io_inter_gap_time_min": "0",
                "read_io_inter_gap_time_max": "0",
                "write_io_inter_gap_time_min": "100",
```

```
            "write_io_inter_gap_time_max": "1094718",
            "peak_active_io_read_count": "0",
            "peak_active_io_write_count": "23",
            "read_io_aborts": "0",
            "write_io_aborts": "0",
            "read_io_failures": "0",
            "write_io_failures": "0",
            "read_io_scsi_check_condition_count": "0",
            "write_io_scsi_check_condition_count": "0",
            "read_io_scsi_busy_count": "0",
            "write_io_scsi_busy_count": "0",
            "read_io_scsi_reservation_conflict_count": "0",
            "write_io_scsi_reservation_conflict_count": "0",
            "read_io_scsi_queue_full_count": "0",
            "write_io_scsi_queue_full_count": "0",
            "sampling_start_time": "1529993232",
            "sampling_end_time": "1529993260"
    },
    "2": {
            "port": "fc1/6",
            "vsan": "10",
            "app_id": "255",
            "initiator_id": "0xe800a1",
            "target_id": "0xd601e1",
            "lun": "0000-0000-0000-0000",
            "active_io_read_count": "0",
            "active_io_write_count": "8",
            "total_read_io_count": "0",
            "total_write_io_count": "1004271260",
            "total_seq_read_io_count": "0",
            "total_seq_write_io_count": "1",
            "total_read_io_time": "0",
            "total_write_io_time": "370004164726",
            "total_read_io_initiation_time": "0",
            "total_write_io_initiation_time": "51858511487",
            "total_read_io_bytes": "0",
            "total_write_io_bytes": "2056747540480",
            "total_read_io_inter_gap_time": "0",
            "total_write_io_inter_gap_time": "16136686881766",
            "total_time_metric_based_read_io_count": "0",
            "total_time_metric_based_write_io_count": "1004271252",
            "total_time_metric_based_read_io_bytes": "0",
            "total_time_metric_based_write_io_bytes": "2056747524096",
            "read_io_rate": "0",
            "peak_read_io_rate": "0",
            "write_io_rate": "16065",
            "peak_write_io_rate": "16194",
            "read_io_bandwidth": "0",
            "peak_read_io_bandwidth": "0",
            "write_io_bandwidth": "32901632",
            "peak_write_io_bandwidth": "33165824",
            "read_io_size_min": "0",
            "read_io_size_max": "0",
            "write_io_size_min": "2048",
            "write_io_size_max": "2048",
            "read_io_completion_time_min": "0",
            "read_io_completion_time_max": "0",
            "write_io_completion_time_min": "114",
            "write_io_completion_time_max": "9019",
            "read_io_initiation_time_min": "0",
            "read_io_initiation_time_max": "0",
            "write_io_initiation_time_min": "37",
            "write_io_initiation_time_max": "3158",
            "read_io_inter_gap_time_min": "0",
```

```
                "read_io_inter_gap_time_max": "0",
                "write_io_inter_gap_time_min": "101",
                "write_io_inter_gap_time_max": "869035",
                "peak_active_io_read_count": "0",
                "peak_active_io_write_count": "19",
                "read_io_aborts": "0",
                "write_io_aborts": "0",
                "read_io_failures": "0",
                "write_io_failures": "0",
                "read_io_scsi_check_condition_count": "0",
                "write_io_scsi_check_condition_count": "0",
                "read_io_scsi_busy_count": "0",
                "write_io_scsi_busy_count": "0",
                "read_io_scsi_reservation_conflict_count": "0",
                "write_io_scsi_reservation_conflict_count": "0",
                "read_io_scsi_queue_full_count": "0",
                "write_io_scsi_queue_full_count": "0",
                "sampling_start_time": "1529993232",
                "sampling_end_time": "1529993260"
        }
}}
```


**Note** The output of these queries are in JSON format.

This example shows the list of view instances supported in the *fc-scsi* analytics type:

```
switch# show analytics schema fc-scsi views

fc-scsi db schema tables:
        port
        logical_port
        app
        scsi_target
        scsi_initiator
        scsi_target_app
        scsi_initiator_app
        scsi_target_tl_flow
        scsi_target_it_flow
        scsi_initiator_it_flow
        scsi_target_itl_flow
        scsi_initiator_itl_flow
        scsi_target_io
        scsi_initiator_io
```

This example shows the list of view instances supported in the *fc-nvme* analytics type:

```
switch# show analytics schema fc-nvme views

fc-nvme db schema tables:
        port
        logical_port
        app
        nvme_target
        nvme_initiator
        nvme_target_app
        nvme_initiator_app
        nvme_target_tn_flow
```

```
        nvme_target_it_flow
        nvme_initiator_it_flow
        nvme_target_itn_flow
        nvme_initiator_itn_flow
        nvme_target_io
        nvme_initiator_io
```

This example shows the list of flow metrics supported in the *fc-scsi.port* view instance:

**Note** The *exceed_count* counters in the output will be supported in a future Cisco MDS NX-OS Release.

```
switch# show analytics schema fc-scsi view-instance port

fc-scsi.port table schema columns:
        *port
         scsi_target_count
         scsi_initiator_count
         io_app_count
         logical_port_count
         scsi_target_app_count
         scsi_initiator_app_count
         active_io_read_count
         active_io_write_count
         scsi_target_it_flow_count
         scsi_initiator_it_flow_count
         scsi_target_itl_flow_count
         scsi_initiator_itl_flow_count
         scsi_target_tl_flow_count
         total_abts_count
         total_read_io_count
         total_write_io_count
         total_seq_read_io_count
         total_seq_write_io_count
         total_read_io_time
         total_write_io_time
         total_read_io_initiation_time
         total_write_io_initiation_time
         total_read_io_bytes
         total_write_io_bytes
         total_read_io_inter_gap_time
         total_write_io_inter_gap_time
         total_time_metric_based_read_io_count
         total_time_metric_based_write_io_count
         total_time_metric_based_read_io_bytes
         total_time_metric_based_write_io_bytes
         read_io_rate
         peak_read_io_rate
         write_io_rate
         peak_write_io_rate
         read_io_bandwidth
         peak_read_io_bandwidth
         write_io_bandwidth
         peak_write_io_bandwidth
         read_io_size_min
         read_io_size_max
         write_io_size_min
         write_io_size_max
         read_io_completion_time_min
```

```
read_io_completion_time_max
write_io_completion_time_min
write_io_completion_time_max
read_io_initiation_time_min
read_io_initiation_time_max
write_io_initiation_time_min
write_io_initiation_time_max
read_io_inter_gap_time_min
read_io_inter_gap_time_max
write_io_inter_gap_time_min
write_io_inter_gap_time_max
peak_active_io_read_count
peak_active_io_write_count
read_io_aborts
write_io_aborts
read_io_failures
write_io_failures
read_io_timeouts
write_io_timeouts
read_io_scsi_check_condition_count
write_io_scsi_check_condition_count
read_io_scsi_busy_count
write_io_scsi_busy_count
read_io_scsi_reservation_conflict_count
write_io_scsi_reservation_conflict_count
read_io_scsi_queue_full_count
write_io_scsi_queue_full_count
read_io_rate_exceed_count
write_io_rate_exceed_count
read_io_bandwidth_exceed_count
write_io_bandwidth_exceed_count
read_io_size_min_exceed_count
read_io_size_max_exceed_count
write_io_size_min_exceed_count
write_io_size_max_exceed_count
read_io_initiation_time_min_exceed_count
read_io_initiation_time_max_exceed_count
write_io_initiation_time_min_exceed_count
write_io_initiation_time_max_exceed_count
read_io_completion_time_min_exceed_count
read_io_completion_time_max_exceed_count
write_io_completion_time_min_exceed_count
write_io_completion_time_max_exceed_count
read_io_inter_gap_time_min_exceed_count
read_io_inter_gap_time_max_exceed_count
write_io_inter_gap_time_min_exceed_count
write_io_inter_gap_time_max_exceed_count
read_io_abort_exceed_count
write_io_abort_exceed_count
read_io_failure_exceed_count
write_io_failure_exceed_count
sampling_start_time
sampling_end_time

(* - indicates the metric is a 'key' for the table)
```

This example shows the list of flow metrics supported in the *fc-nvme.port* view instance:

**Note** The *exceed_count* counters in the output will be supported in a future Cisco MDS NX-OS Release.

```
switch# show analytics schema fc-nvme view-instance port

fc-nvme.port table schema columns:
        *port
         nvme_target_count
         nvme_initiator_count
         io_app_count
         logical_port_count
         nvme_target_app_count
         nvme_initiator_app_count
         active_io_read_count
         active_io_write_count
         nvme_target_it_flow_count
         nvme_initiator_it_flow_count
         nvme_target_itn_flow_count
         nvme_initiator_itn_flow_count
         nvme_target_tn_flow_count
         total_abts_count
         total_read_io_count
         total_write_io_count
         total_seq_read_io_count
         total_seq_write_io_count
         total_read_io_time
         total_write_io_time
         total_read_io_initiation_time
         total_write_io_initiation_time
         total_read_io_bytes
         total_write_io_bytes
         total_read_io_inter_gap_time
         total_write_io_inter_gap_time
         total_time_metric_based_read_io_count
         total_time_metric_based_write_io_count
         total_time_metric_based_read_io_bytes
         total_time_metric_based_write_io_bytes
         read_io_rate
         peak_read_io_rate
         write_io_rate
         peak_write_io_rate
         read_io_bandwidth
         peak_read_io_bandwidth
         write_io_bandwidth
         peak_write_io_bandwidth
         read_io_size_min
         read_io_size_max
         write_io_size_min
         write_io_size_max
         read_io_completion_time_min
         read_io_completion_time_max
         write_io_completion_time_min
         write_io_completion_time_max
         read_io_initiation_time_min
         read_io_initiation_time_max
         write_io_initiation_time_min
         write_io_initiation_time_max
         read_io_inter_gap_time_min
         read_io_inter_gap_time_max
         write_io_inter_gap_time_min
         write_io_inter_gap_time_max
         peak_active_io_read_count
         peak_active_io_write_count
         read_io_aborts
         write_io_aborts
         read_io_failures
```

```
write_io_failures
read_io_timeouts
write_io_timeouts
read_io_nvme_lba_out_of_range_count
write_io_nvme_lba_out_of_range_count
read_io_nvme_ns_not_ready_count
write_io_nvme_ns_not_ready_count
read_io_nvme_reservation_conflict_count
write_io_nvme_reservation_conflict_count
read_io_nvme_capacity_exceeded_count
write_io_nvme_capacity_exceeded_count
read_io_rate_exceed_count
write_io_rate_exceed_count
read_io_bandwidth_exceed_count
write_io_bandwidth_exceed_count
read_io_size_min_exceed_count
read_io_size_max_exceed_count
write_io_size_min_exceed_count
write_io_size_max_exceed_count
read_io_initiation_time_min_exceed_count
read_io_initiation_time_max_exceed_count
write_io_initiation_time_min_exceed_count
write_io_initiation_time_max_exceed_count
read_io_completion_time_min_exceed_count
read_io_completion_time_max_exceed_count
write_io_completion_time_min_exceed_count
write_io_completion_time_max_exceed_count
read_io_inter_gap_time_min_exceed_count
read_io_inter_gap_time_max_exceed_count
write_io_inter_gap_time_min_exceed_count
write_io_inter_gap_time_max_exceed_count
read_io_abort_exceed_count
write_io_abort_exceed_count
read_io_failure_exceed_count
write_io_failure_exceed_count
sampling_start_time
sampling_end_time

(* - indicates the metric is a 'key' for the table)
```

# Troubleshooting SAN Analytics

Due to an ASIC issue, it is possible that the ITO table is not flushed, if the response to an exchange is received on another link (due to port channel flap or such rare occasions). This event itself does not affect analytics. But if this happens for a large number of ITLs and if there is a lot of churn in the fabric (such that the ITLs which had an ITO table hitare now quiet and a fresh set of ITLs are now active in the fabric), then scale can be affected. An error can occur in AMC when the scale limits are exceeded. On 64G modules and switches the analytics are collected via the AlertMgrCollector(AMC).

The AMC reset feature provides a non-disruptive recovery of analytics by resetting only the ASIC analytics. You can reset the AMC on the line card using the **analytics reset module** <*module-number*> command. For scale limits, see the *Cisco MDS NX-OS Configuration Limits, Release 9.x*.

This command resets only the AMC modules and flushes all the entries in the table and recover the AMC from ITO_HIT_ON_CMD.

For example:

```
switch # analytics reset module 6
switch # 2022 Jun 15 12:24:48 sw184-9706
%ANALYTICS_LC_MGR-SLOT6-5-ANALYTICS_LC_MGR_RESET_SUCCESS:
Analytics reset successful on module 6
```

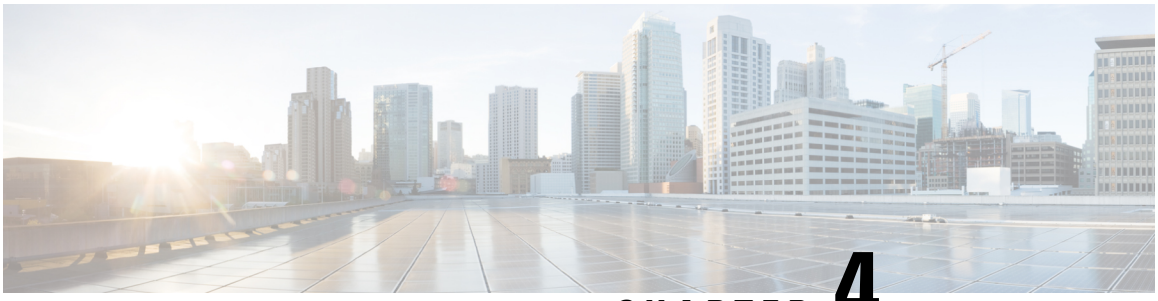
On a successful reset, following syslog will be seen:

```
switch# 2022 Mar 13 22:35:54 switch
       %ANALYTICS_LC_MGR-SLOT6-5-ANALYTICS_LC_MGR_RESET_SUCCESS: Reset of Analytics engine

        succeeded.
```

On failure to reset, following syslog will be seen:

```
switch# 2022 Mar 13 22:35:54 switch
       %ANALYTICS_LC_MGR-SLOT6-3-ANALYTICS_LC_MGR_RESET_FAILURE: Reset of Analytics engine

        failed
```

If a failure syslog is seen, collect the tech-support and reload the module for recovery.



CHAPTER 4

# Configuring SAN Telemetry Streaming

This chapter provides information about the SAN Telemetry Streaming feature and how to configure it:


- Feature History for Configuring SAN Telemetry Streaming, on page 107
- SAN Telemetry Streaming Overview, on page 108
- Guidelines and Restrictions for SAN Telemetry Streaming, on page 110
- gRPC Error Behavior, on page 112
- SAN Telemetry Streaming Encoding, on page 112
- Configuring SAN Telemetry Streaming, on page 113
- Examples: Configuring SAN Telemetry Streaming, on page 116
- Displaying SAN Telemetry Streaming Configuration and Statistics, on page 119
- Troubleshooting SAN Telemetry Streaming, on page 125


# Feature History for Configuring SAN Telemetry Streaming

***Table 16: Feature History for Configuring SAN Telemetry Streaming***

| Feature Name | Release | Feature Information |
|---|---|---|
| Transceiver parameters streaming | 9.2(2) | Added support for FC transceiver parameters streaming. |
| SAN Telemetry Streaming | 8.4(1) | Updated the *fabric_telemetry.proto* file with NVMe flow metrics. |
| SAN Telemetry Streaming | 8.3(2) | Supports compact Google Protocol Buffers (GPB) encoding. |

| Feature Name | Release | Feature Information |
|---|---|---|
| SAN Telemetry Streaming | 8.3(1) | Provides capability to stream analytics and interface statistics to receivers such as Cisco DCNM.<br>The following commands have been introduced:<br>• **certificate** *certificate_path host_name*<br>• **destination-group** *id*<br>• **destination-profile**<br>• **dst-grp** *id*<br>• **feature telemetry**<br>• {**ip** \| **ipv6**} **address** *address* **port** *number* [**protocol** *procedural-protocol* **encoding** *encoding-protocol*]<br>• **path** *sensor_path*<br>• **sensor-group** *id*<br>• **show run telemetry**<br>• **show telemetry** {**control** {**database** [**destination-groups** \| **destinations** \| **sensor-groups** \| **sensor-paths** \| **subscriptions**] \| **stats**} \| **data collector** {**brief** \| **details**} \| **pipeline stats** \| **transport** *session_id* [**errors** \| **stats**]}<br>• **snsr-grp** *id* **sample-interval** *interval*<br>• **subscription** *id*<br>• **telemetry**<br>• **use-retry size** *buffer_size* |
| Interface Statistics | 8.3(1) | Allows you to stream traffic and error counters data from Fibre Channel interfaces. |

# SAN Telemetry Streaming Overview

Cisco NX-OS provides several mechanisms such as Simple Network Management Protocol (SNMP), CLI, and syslog to collect data from a network. The SAN Telemetry Streaming feature is used to stream the data of interest to one or more upstream receivers such as Cisco DCNM for analysis. The pull model that is used in SAN analytics is used to send data from the server only when clients request for it.

In general, data is collected from switches using the push (fetch) model streams data to the client continuously. SAN Telemetry Streaming enables the push model, which provides near-real-time access to monitor data.

Data collected from sensors can be streamed to Cisco DCNM or third-party devices or apps, by adding a sensor path to a sensor group in the SAN Telemetry Streaming configuration. For more information, see Configuring SAN Telemetry Streaming, on page 113.

**Note** In Cisco MDS NX-OS Release 8.3(1), the version number added in the telemetry payload is 1.0.0.1.

# Interface Statistics Streaming

Interface statistics streaming allows you to stream traffic and error counters data from Fibre Channel interfaces. Collection of traffic and error counters are enabled by default and cannot be configured or disabled. There are more than 65 interface statistics counters available. For information on the modules that support interface statistics, see Hardware Requirements for SAN Analytics, on page 11.

For information on the list of supported interface counters, see Interface Counters, on page 258.

# Transceiver Parameters Streaming

Transceiver parameters streaming periodically collects information about transceivers and streams it to receivers. The information is comprised of both operational Diagnostic Optical Monitoring (DOM) data as well as static data about the vendor name, model number, and serial number of each monitored transceiver, along with the switch timestamp. This allows centralized and enhanced transceiver monitoring over the local NX-OS on-switch transceiver parameter threshold monitoring.

Analyzing transceiver DOM operating parameters over time can be used to identify transceiver performance issues. For example, correlating interface errors such as bit errors or frame CRCs with transceiver receive power level could lead to identification of intermittent cable issues which might otherwise be difficult to identify. The timestamp can be used for time sequencing and correlation with other data or logs.

Transceiver parameters streaming sensors may be defined to collect either local switch transceiver data only, or both local and peer transceiver data.

**Note** Monitoring peer transceiver data requires that the peer device supports inband FC Read Diagnostic Parameters (RDP) ELS requests.

This feature is comprised of the following components:

- Collection on the switch: The transceiver parameters listed in Table 17: Streamed Transceiver Parameters, on page 110 are periodically collected. These are monitored locally by NX-OS on the switch, independently of transceiver parameter streaming.
- Streaming to receivers: Telemetry configuration commands are used to specify the range of interfaces to stream and the streaming interval for the transceiver parameters. Streaming starts from 10 minutes after the transceiver is operational to avoid stale data being streamed. The receiver may then monitor and analyze the data.

**Note** Transceiver parameters streaming is supported only on Fibre Channel ports.

Table 17: Streamed Transceiver Parameters, on page 110 displays the list of transceiver parameters that are streamed:

*Table 17: Streamed Transceiver Parameters*

| Transceiver Parameters | Unit |
|---|---|
| Temperature | Celsius (C) |
| Voltage | Volts (V) |
| Current | Milliampere (mA) |
| Tx Power | Decibel milliwatt (dBm) |
| Rx Power | Decibel milliwatt (dBm) |
| Vendor Name | — |
| Model Number | — |
| Serial Number | — |
| Switch Timestamp | — |

# Guidelines and Restrictions for SAN Telemetry Streaming

- If the **feature telemetry** command is enabled, ensure that you disable this feature using the **no feature telemetry** command before downgrading to a release earlier than Cisco MDS NX-OS Release 8.3(1).
- Before Cisco MDS NX-OS Release 8.3(2), SAN Telemetry Streaming only supported Google Protocol Buffers (GPB) encoding over Google remote procedure call (gRPC) transport. From Cisco MDS NX-OS Release 8.3(2), compact GPB encoding support was added. Ensure that all the destinations under a destination group and all the destination groups under a subscription are of the same encoding type.

**Note** GPB key value encoding is referred to as just GPB. GPB is used instead of GPB key value in configuration and show commands.

- If you are using Cisco DCNM SAN Insights, configure the SAN Telemetry Streaming feature in Cisco DCNM SAN Insights; there is no need to configure this feature on the switch. For more information, see the "Configuring SAN Insights" section in the Cisco DCNM SAN Management Configuration Guide.
- We recommend that the streaming-sample interval (**snsr-grp** *id* **sample-interval** *interval*), port-sampling interval (**analytics port-sampling module** *number* **size** *number* **interval** *seconds*), and push-query interval (**analytics query** *"query_string"* **name** *query_name* **type periodic** [**interval** *seconds*] [**clear**] [**differential**]) be configured with the same value. We also recommend that you change or configure the push-query interval first, then the port-sampling interval, and finally, the streaming-sample interval.
- The smallest streaming sample interval that is supported is 30 seconds. We recommend that you set the push query interval, port sampling interval, and streaming sample interval to be equal to or more than the minimum recommended value of 30 seconds and to be the same value. Configuring intervals below the minimum value may result in undesirable system behavior.

- Streaming of interface statistics is not supported on Cisco MDS 9132T switches that operate in the Cisco NPV mode.
- Up to two management receivers (destinations) are supported. However, we recommend that you configure only one receiver for optimal performance.
- If you are configuring multiple receivers (Cisco DCNM or third-party devices or apps), we recommend that you configure them under the same destination group. If there are multiple Cisco DCNM receivers, you must manually configure the receivers in the same destination group.
- When an SAN Telemetry Streaming receiver stops functioning, other receivers experience interruption in data flow. Restart the failed receiver. For information on how to restart the receiver, see your receiver documentation.

  Telemetry data streaming is uniform if the receiver is running without any delays and the management port is free from packet drops. If there are gRPC transport delays because of slowness in the receiver or network, there is a possibility of data collection getting interrupted, and the data getting dropped on the switch because of system memory limitations. The occurrence of this issue depends on the number of ITLs being streamed out and the delay in or slowness of the network. Use the **show telemetry control database sensor-groups**, **show telemetry transport** *session_id* **errors**, and any telemetry syslog command to check the drops at a sensor group level and transport status for transport delays, if any. For more information, see Troubleshooting SAN Telemetry Streaming, on page 125.

**Note** If the slowness in the network is not fixed, or if there are continuous network drops that are slowing the transmission or streaming of analytics data for a duration of 25 hours or more, the transport session is disabled permanently and a syslog message is generated. After you fix the issue, the streaming can be resumed by removing and configuring the IP address under the corresponding destination group. For configuration details, see Configuring SAN Telemetry Streaming, on page 113.

- SAN Telemetry and Streaming is supported on MDS 9124V and MDS 9148V from Release 9.4(1). To downgrade to an earlier release, you must disable SAN telemetry before the downgrade.
- In Releases before 9.4(1), read and write IO bandwidth metrics for line rate traffic of 64 Gbps was truncated. From Release 9.4(1), MDS NX-OS accurately reports bandwidth metrics of upto 64 Gbps line rate traffic.
- For telemetry, the original bandwidth fields are renamed to `*_deprecated` and the new bandwidth fields are renamed to the original names. Therefore, the bandwidth fields that are streamed are:
  - read_io_bandwidth
  - peak_read_io_bandwidth
  - write_io_bandwidth
  - peak_write_io_bandwidth
  - read_io_bandwidth_deprecated
  - peak_read_io_bandwidth_deprecated
  - write_io_bandwidth_deprecated

- peak_write_io_bandwidth_deprecated

# gRPC Error Behavior

A switch client disables connection to a gRPC receiver after the gRPC receiver sends 20 errors, one of the gRPC errors or both, to the switch. If the response from the receiver takes more than 30 seconds, and if this condition persists for 25 hours continuously, the respective transport session is marked as disabled. You must unconfigure and reconfigure the destination IP address under the destination group to enable the gRPC receiver. Use the **show telemetry transport** *session_id* **errors** command to view the errors generated. For configuration details, see Configuring SAN Telemetry Streaming, on page 113 and for errors, see Troubleshooting SAN Telemetry Streaming, on page 125.

The following are gRPC errors:

- The gRPC client sends the wrong certificate for secure connections.
- The gRPC receiver takes too long to handle client messages and incurs a timeout. Avoid timeouts by processing messages using a separate message-processing thread.

# SAN Telemetry Streaming Encoding

The following encoding are used in SAN Telemetry Streaming:

- GPB Key Value—Before Cisco MDS NX-OS Release 8.3(2), GPB key value was the only supported encoding. The key that is used in this encoding is a string and is self-describing. However, the data size that is used in this encoding is larger than the compact GPB encoding. In this type of encoding, the data can be easily analyzed without any intermediate process. For more information on the *key* fields, see Flow Metrics, on page 129.
- Compact GPB—From Cisco MDS NX-OS Release 8.3(2), compact GPB encoding support was added. The key that is used in this encoding is an integer. Hence, the data size that is used in this encoding is smaller than the GPB-KV encoding. However, a decoding table is required to decode integers to their respective metrics. The decoding table for compact GPB is a *.proto* file. With compact GPB, you must use the *telemetry_bis.proto* file for all **path** *analytics: query_name* queries and upload it to your collector for parsing the data stream.

**Note** For interface statistics streaming (*path show_stats*), only GPB-KV encoding is supported.

The following example displays a snippet of the telemetry fields that are used in compact GPB *.proto* file:

```
message Telemetry {
...
repeated TelemetryField data_gpbkv = 11;
TelemetryGPBTable data_gpb = 12;
...}
message TelemetryGPBTable {
repeated TelemetryRowGPB row = 1;
}
```

```
message TelemetryRowGPB {
uint64 timestamp = 1;
bytes keys = 10;
bytes content = 11;
}
```

In this example, the fields that are used in the *.proto* file of compact GPB are included under the *data_gpb* field. The *key* field in the TelemetryRowGPB message structure carries the *.proto* filename (fabric_telemetry) and the *content* field carries the fields from the *.proto* file.

For information on the *.proto* files that are used in compact GPB, see SAN Telemetry Streaming Proto Files — Prior to Release 9.4(1), on page 268.

# Configuring SAN Telemetry Streaming

**Note** If you are using Cisco NDFC or DCNM SAN Insights, you can configure the SAN Telemetry Streaming feature in Cisco DCNM SAN Insights; there is no need to configure this feature on the switch. There is no need to configure this feature on the switch as NDFC (or DCNM) does all the necessary switch configuration. For more information, see the "Configuring SAN Insights" section in the Cisco DCNM SAN Management Configuration Guide.

The following images display the different ways of configuring sensor and destination groups:

***Figure 32: Sensor Group Mapped to the Same Destination Group***

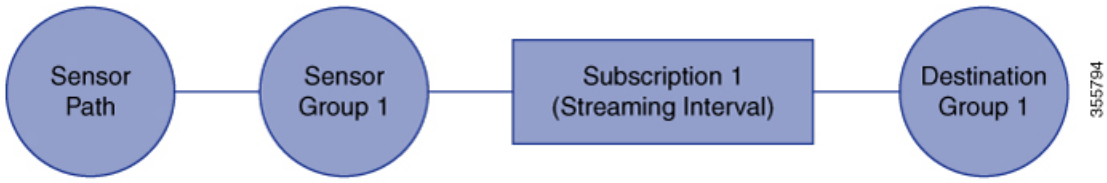



***Figure 33: Sensor Group Mapped to a Different Destination Group***

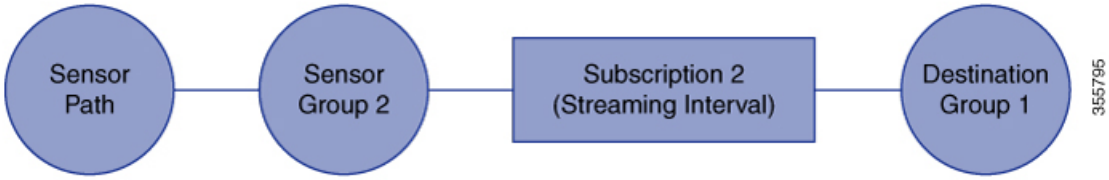


*Figure 34: One Sensor Group Mapped to Multiple Destination Groups*

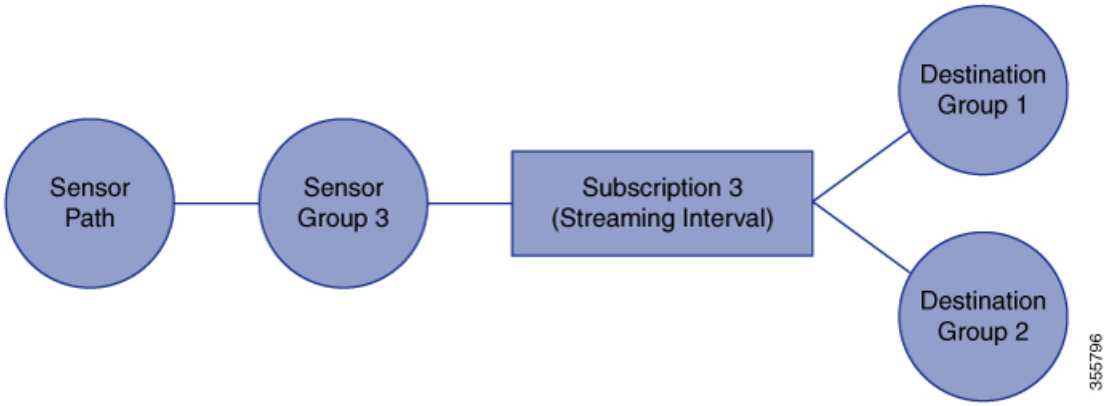
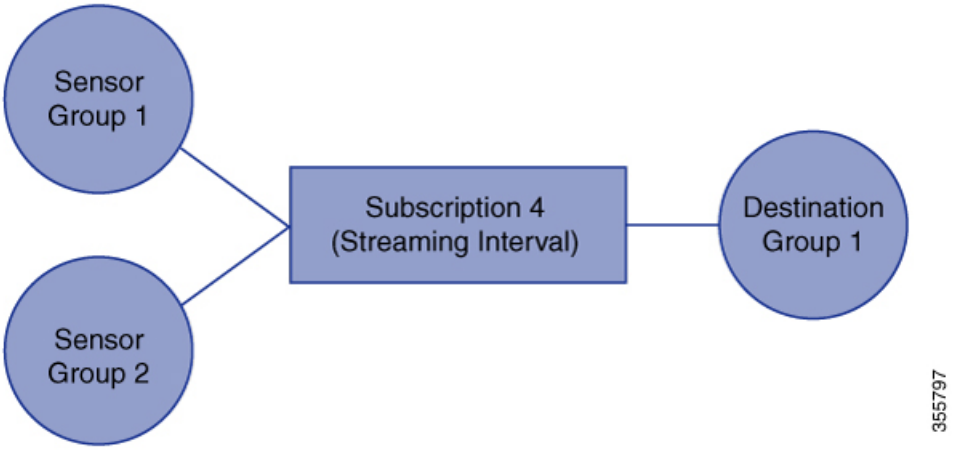



*Figure 35: Multiple Sensor Groups Mapped to a Single Destination Group*




To configure SAN Telemetry Streaming, perform the following procedure.

### Before you begin

- Ensure that your switch is running Cisco MDS NX-OS Release 8.3(1) or a later release.
- Enable the SAN Analytics feature. See Enabling SAN Analytics, on page 30.
- Ensure that the timezone on the telemetry source switch is set correctly with the **clock** configuration command. Otherwise, SAN telemetry receivers will be unable to correlate the received analytics timestamps. For more information about this command, see the Cisco MDS 9000 Series Command Reference.

### Procedure

**Step 1** Enter global configuration mode:

switch# **configure terminal**

**Step 2** Enable the SAN Telemetry Streaming feature:

switch(config)# **feature telemetry**

**Step 3** Enter SAN Telemetry Streaming configuration mode:

switch(config)# **telemetry**

**Step 4** (Optional) Use an existing SSL or TLS certificate:

switch(config-telemetry)# **certificate** *certificate_path host_name*

**Note** On Cisco MDS 9700 Series switches, ensure that the client certificate is available on both active and standby supervisors for secure telemetry configuration. Otherwise, the SAN Telemetry Streaming will fail after an upgrade or downgrade. Use the **copy bootflash:<client certificate file> bootflash://sup-standby/<client certificate file>** command to copy the client certificate from an active supervisor to the standby supervisor.

**Step 5** (Optional) Enter destination profile configuration mode and specify the send retry details for the gRPC transport protocol:

**a.** switch(config-telemetry)# **destination-profile**

**b.** switch(conf-tm-dest-profile)# **use-retry size** *buffer_size*

A destination profile can configure parameters, for example, the transport retry buffer size specific to all the destinations.

**Note** Buffer size is in MB and ranges from 10 to 1500.

**Step 6** Create a sensor group with an ID and enter sensor group configuration mode:

switch(conf-tm-dest-profile)# **sensor-group** *id*

A sensor group is a collection of one or more sensor paths.

Currently, only numeric sensor group ID values are supported. The sensor group defines nodes that are monitored for telemetry reporting.

**Step 7** Add a sensor path to the sensor group:

switch(conf-tm-sensor)# **path** *sensor_path*

A *sensor_path* is where the specific interface statistics and the push queries that are streamed are specified. Multiple sensor paths can be configured in a sensor group. Valid vaues are as follows:

- **path** *analytics:query_name*: This telemetry sensor path is for analytics. The query name is a configured analytics query or a push query.
- **path show_stats_fc** *slot/port[-end_port]*: This telemetry sensor path is for interface statistics streaming. *slot/port[-end_port]* specifies a single port or a range of ports on the slot (module) for which the interface statistics are streamed.
- **interface range**: This telemetry sensor path is for transceiver parameters streaming. Interface range is the range of fc interface that have the transceiver parameters streamed.

**Note** The syntax of the sensor path is not validated during configuration. Incorrect sensor path may result in data-streaming failure.

**Step 8** Create a destination group and enter destination group configuration mode:

switch(conf-tm-sensor)# **destination-group** *id*

Currently, destination group ID supports only numeric ID values.

**Note** A destination group is a collection of one or more destinations.

**Step 9** Create a destination profile for the outgoing data:

switch(conf-tm-dest)# {**ip | ipv6**} **address** *address* **port** *number* [**protocol** *procedural-protocol* **encoding** *encoding-protocol*]

**Note** As of Cisco MDS NX-OS Release 8.3(2), gRPC is the only supported transport protocol; GPB and compact GPB are the only supported encoding.

When the destination group is linked to a subscription node, telemetry data is sent to the IP address and port that are specified in the destination profile.

**Step 10** Create a subscription node with an ID and enter subscription configuration mode:

switch(conf-tm-dest)# **subscription** *id*

A subscription maps a sensor group to a destination group.

Currently, subscription ID supports only numeric ID values.

**Step 11** Link the sensor group with an ID to the subscription node and set the data streaming sample interval in milliseconds:

switch(conf-tm-sub)# **snsr-grp** *id* **sample-interval** *interval*

**Note** The minimum streaming sample interval that is recommended is 30000.

Currently, sensor group ID supports only numeric ID values. Specify the streaming sample interval value; the value must be in milliseconds. The minimum streaming sample interval that is supported is 30000 milliseconds. An interval value that is greater than the minimum value creates a frequency-based subscription where the telemetry data is sent periodically at the specified interval.

**Step 12** Link the destination group with an ID to this subscription:

switch(conf-tm-sub)# **dst-grp** *id*

Currently, destination group ID supports only numeric ID values.

# Examples: Configuring SAN Telemetry Streaming

This example displays how to create a subscription that streams data from Fibre Channel interface 3/1 and 4/1 every 30 seconds to IP 1.2.3.4 port 50003 and IP 1:1::1:1 port 50009, and encrypts the stream using GPB encoding that is verified using test.pem:

```
switch# configure terminal
switch(config)# telemetry
switch(config-telemetry)# certificate /bootflash/test.pem foo.test.google.fr
```

```
switch(conf-tm-telemetry)# destination-group 100
switch(conf-tm-dest)# ip address 1.2.3.4 port 50003 protocol gRPC encoding GPB

switch(conf-tm-dest)# destination-group 1
switch(conf-tm-dest)# ipv6 address 1:1::1:1 port 50009 protocol gRPC encoding GPB-compact

switch(config-dest)# sensor-group 100
switch(conf-tm-sensor)# path show_stats_fc3/1
switch(conf-tm-sensor)# subscription 100
switch(conf-tm-sub)# snsr-grp 100 sample-interval 30000
switch(conf-tm-sub)# dst-grp 100

switch(config-dest)# sensor-group 1
switch(conf-tm-sensor)# path show_stats_fc4/1
switch(conf-tm-sensor)# subscription 1
switch(conf-tm-sub)# snsr-grp 1 sample-interval 30000
switch(conf-tm-sub)# dst-grp 1
```

This example displays how to create a periodic collection of **show** command data every 30 seconds and sends it to receivers 1.2.3.4 and 1.1::1.1:

```
switch# configure terminal
switch(config)# telemetry

switch(config-telemetry)# destination-group 100
switch(conf-tm-dest)# ip address 1.2.3.4 port 60001 protocol gRPC encoding GPB

switch(conf-tm-sensor)# destination-group 1
switch(conf-tm-dest)# ipv6 address 1:1::1:1 port 60009 protocol gRPC encoding GPB-compact

switch(config-dest)# sensor-group 100
switch(conf-tm-sensor)# subscription 100
switch(conf-tm-sub)# snsr-grp 100 sample-interval 30000
switch(conf-tm-sub)# dst-grp 100

switch(conf-tm-dest)# sensor-group 1
switch(conf-tm-sensor)# subscription 1
switch(conf-tm-dest)# snsr-grp 1 sample-interval 30000
switch(conf-tm-sub)# dst-grp 1
```

This example displays that a sensor group can contain multiple paths, a destination group can contain multiple destination profiles, and a subscription can be linked to multiple sensor groups and destination groups:

```
switch# configure terminal
switch(config)# telemetry

switch(config-telemetry)# sensor-group 100
switch(conf-tm-sensor)# path analytics:init
switch(conf-tm-sensor)# path analytics:initit

switch(config-telemetry)# sensor-group 200
switch(conf-tm-sensor)# path analytics:inititl

switch(conf-tm-sensor)# destination-group 100
switch(conf-tm-dest)# ip address 1.2.3.4 port 50004
switch(conf-tm-dest)# ipv6 address 5:6::7:8 port 50005

switch(conf-tm-dest)# destination-group 200
switch(conf-tm-dest)# ip address 5.6.7.8 port 50001
```

```
switch(conf-tm-dest)# subscription 600
switch(conf-tm-sub)# snsr-grp 100 sample-interval 30000
switch(conf-tm-sub)# snsr-grp 200 sample-interval 30000
switch(conf-tm-sub)# dst-grp 100
switch(conf-tm-sub)# dst-grp 200

switch(conf-tm-dest)# subscription 900
switch(conf-tm-sub)# snsr-grp 200 sample-interval 30000
switch(conf-tm-sub)# dst-grp 100
```

**Note** The *sensor_path* is the location where the specific interface statistics and the push queries that are streamed are specified. Multiple sensor paths can be configured in a sensor group. The sensor path for telemetry streaming is **path** *analytics: query_name*, and for interface statistics streaming it is **path** *show_stats_fc slot/port*. The query names *init*, *initit*, and *inititl* that are specified in the sensor paths are configured in the SAN Analytics feature. For more information, see Configuring a Push Query, on page 56.

This example shows a sample configuration of transceiver streaming.

```
switch# configure terminal
switch(config)# telemetry

switch(config-telemetry)# sensor-group 200
switch(conf-tm-sensor)# path transceiver:fc1/1
switch(conf-tm-sensor)# path transceiver:fc13/1-48

switch(conf-tm-sensor)# show telemetry data collector details
------------------------------------------------------------------------------
Row ID          Successful      Failed          Skipped         Sensor Path(GroupId)
------------------------------------------------------------------------------
1               398             14              0               show_stats_fc3/1-48(100)
2               30488           0               1               analytics:dcnmtgtITL(2)
3               395             0               0               show_stats_fc5/1-48(100)
4               0               0               0               transceiver:fc1/1(200)
5               0               0               0               transceiver:fc13/1-48(200)
6               0               0               0               analytics:dcnmtgtITN(1)
```

This example shows a sample configuration and how to verify an SAN Telemetry Streaming configuration. You can also check the **show telemetry data collector details** and **show telemetry transport** *session_id* **stats** command outputs for verifying the SAN Telemetry Streaming configuration. For more information, see Displaying SAN Telemetry Streaming Configuration and Statistics, on page 119.

```
switch# configure terminal
switch(config)# telemetry

switch(config-telemetry)# destination-group 100
switch(conf-tm-dest)# ip address 1.2.3.4 port 50003 protocol gRPC encoding GPB
switch(conf-tm-dest)# ip address 1.2.3.4 port 50004 protocol gRPC encoding GPB

switch(config-telemetry)# destination-group 1
switch(conf-tm-dest)# ipv6 address 1:1::1:1 port 50008 protocol gRPC encoding GPB-compact
switch(conf-tm-dest)# ipv6 address 1:2::3:4 port 50009 protocol gRPC encoding GPB-compact

switch(conf-tm-dest)# end
```

```
switch# show running-config telemetry
!Command: show running-config telemetry
!Running configuration last done at: Thu Jun 14 08:14:24 2018
!Time: Thu Jun 14 08:14:40 2018
version 8.3(1)
feature telemetry
telemetry
 destination-group 1
  ipv6 address 1:2::3:4 port 50008 protocol gRPC encoding GPB-compact
  ipv6 address 1:1::1:1 port 50009 protocol gRPC encoding GPB-compact
 destination-group 100
  ip address 1.2.3.4 port 50003 protocol gRPC encoding GPB
  ip address 1.2.3.4 port 50004 protocol gRPC encoding GPB
```

**Note** NPU load is based on all ITLs, including the count of active and inactive ITLs. Hence, we recommend that you clear or purge queries before checking the NPU load.

# Displaying SAN Telemetry Streaming Configuration and Statistics

Use the following Cisco NX-OS CLI **show** commands to display SAN Telemetry Streaming configuration, statistics, errors, and session information:

This example displays the internal databases that are reflected in the SAN Telemetry Streaming configuration:

```
switch# show telemetry control database
Subscription Database size = 1
-------------------------------------------------------------------------------
Subscription ID      Data Collector Type
-------------------------------------------------------------------------------
100                  SDB

Sensor Group Database size = 1
-------------------------------------------------------------------------------------------------
Row ID  Sensor Group ID Sensor Group type Sampling interval(ms) Linked subscriptions SubID

-------------------------------------------------------------------------------------------------
1       100              Timer   /SDB       30000     /Running      1                 100

Collection Time in ms (Cur/Min/Max): 53/9/81
Encoding Time in ms (Cur/Min/Max): 21/6/33
Transport Time in ms (Cur/Min/Max): 10470/1349/11036
Streaming Time in ms (Cur/Min/Max): 10546/9/11112

Collection Statistics:
  collection_id_dropped      = 0
  last_collection_id_dropped = 0
  drop_count                 = 0


Sensor Path Database size = 4
-------------------------------------------------------------------------------------------------
Row ID  Subscribed Linked  Sec    Retrieve  Path                    Query:  Filter
                   Groups  Groups level     (GroupId):
```

```
--------------------------------------------------------------------------------
1       No         1       0      Self      analytics:inititl(100): NA :    NA
GPB Encoded Data size in bytes (Cur/Min/Max): 162310/162014/162320
JSON Encoded Data size in bytes (Cur/Min/Max): 0/0/0

2       No         1       0       Self      show_stats_fc1/3(100): NA :    NA
GPB Encoded Data size in bytes (Cur/Min/Max): 2390/2390/2390
JSON Encoded Data size in bytes (Cur/Min/Max): 0/0/0

3       No         1       0       Self      analytics:initit(100): NA :    NA
GPB Encoded Data size in bytes (Cur/Min/Max): 158070/157444/158082
JSON Encoded Data size in bytes (Cur/Min/Max): 0/0/0

4       No         1       0       Self      analytics:init(100):   NA :    NA
GPB Encoded Data size in bytes (Cur/Min/Max): 159200/158905/159212
JSON Encoded Data size in bytes (Cur/Min/Max): 0/0/0


Destination Group Database size = 1
> use-vrf : default
--------------------------------------------------------------------------------
Destination Group ID  Refcount
--------------------------------------------------------------------------------
100                   1

Destination Database size = 3
--------------------------------------------------------------------------------
Dst IP Addr     Dst Port   Encoding   Transport  Count
--------------------------------------------------------------------------------
10.30.217.80    50009      GPB        gRPC       1
2001:420:301:2005:3::11
                60003      GPB        gRPC       1
2001:420:54ff:a4::230:e5
                50013      GPB        gRPC       1

switch(conf-tm-dest)# show telemetry control database sensor-groups
Sensor Group Database size = 1
------------------------------------------------------------------------------------------------
Row ID Sensor Group ID Sensor Group type  Sampling interval(ms) Linked subscriptions SubID

------------------------------------------------------------------------------------------------
1      100              Timer   /SDB       30000     /Running     1                   100

Collection Time in ms (Cur/Min/Max): 53/9/81
Encoding Time in ms (Cur/Min/Max): 21/21/33
Transport Time in ms (Cur/Min/Max): 10304/461/15643
Streaming Time in ms (Cur/Min/Max): 10380/9/15720

Collection Statistics:
  collection_id_dropped      = 0
  last_collection_id_dropped = 0
  drop_count                 = 0
```

**Note** In the command output, SDB is a type of SAN data collector. Telemetry also supports DME, NX-API, and YANG data sources on other supported platforms.

This example displays the statistics of internal databases in the SAN Telemetry Streaming configuration:

```
switch# show telemetry control stats
```

```
show telemetry control stats entered

-------------------------------------------------------------------------------
Error Description                                                 Error Count
-------------------------------------------------------------------------------
Chunk allocation failures                                         0
Sensor path Database chunk creation failures                      0
Sensor Group Database chunk creation failures                     0
Destination Database chunk creation failures                      0
Destination Group Database chunk creation failures                0
Subscription Database chunk creation failures                     0
Sensor path Database creation failures                            0
Sensor Group Database creation failures                           0
Destination Database creation failures                            0
Destination Group Database creation failures                      0
Subscription Database creation failures                           0
Sensor path Database insert failures                              0
Sensor Group Database insert failures                             0
Destination Database insert failures                              0
Destination Group Database insert failures                        0
Subscription insert to Subscription Database failures             0
Sensor path Database delete failures                              0
Sensor Group Database delete failures                             0
Destination Database delete failures                              0
Destination Group Database delete failures                        0
Delete Subscription from Subscription Database failures           0
Sensor path delete in use                                         0
Sensor Group delete in use                                        0
Destination delete in use                                         0
Destination Group delete in use                                   0
Delete destination(in use) failure count                          0
Sensor path Sensor Group list creation failures                   0
Sensor path prop list creation failures                           0
Sensor path sec Sensor path list creation failures                0
Sensor path sec Sensor Group list creation failures               0
Sensor Group Sensor path list creation failures                   0
Sensor Group Sensor subs list creation failures                   0
Destination Group subs list creation failures                     0
Destination Group Destinations list creation failures             0
Destination Destination Groups list creation failures             0
Subscription Sensor Group list creation failures                  0
Subscription Destination Groups list creation failures            0
Sensor Group Sensor path list delete failures                     0
Sensor Group Subscriptions list delete failures                   0
Sensor Group Subscriptions unsupported data-source failures       0
Destination Group Subscriptions list delete failures              0
Destination Group Destinations list delete failures               0
Subscription Sensor Groups list delete failures                   0
Subscription Destination Groups list delete failures              0
Destination Destination Groups list delete failures               0
Failed to delete Destination from Destination Group               0
Failed to delete Destination Group from Subscription              0
Failed to delete Sensor Group from Subscription                   0
Failed to delete Sensor path from Sensor Group                    0
Failed to get encode callback                                     0
Failed to get transport callback                                  0
```

This example displays the statistic summary of the data collection:

```
switch# show telemetry data collector brief

-------------------------------------------------------------------------------
Row ID         Collector Type       Successful        Failed            Skipped
```

```
-------------------------------------------------------------------------------
1               NX-API              0                0                0
2               SDB                 1513             902              0
```

**Note** Row ID is the table index

This example displays detailed statistics of the data collection, including a breakdown of all sensor paths:

```
switch# show telemetry data collector details

-------------------------------------------------------------------------------
Row ID          Successful      Failed          Skipped         Sensor Path(GroupId)
-------------------------------------------------------------------------------
1               496             305             0               analytics:inititl(100)
2               16              0               0               show_stats_fc1/3(100)
3               507             294             0               analytics:initit(100)
4               498             303             0               analytics:init(100)
```

**Note**

- The *Successful* count displays the number of times data collection was successful for the sensor path.
- The *Failed* count displays the number of times data collection failed for the sensor path.
- The *Skipped* count displays the number of times the sensor path has no data or memory has reached the limits. It can also indicate the outstanding data collection for the sensor path is already in progress. When the sensor path refers to a differential query, the skipped count indicates there were no updated flow metrics in the present streaming interval.

This example displays the statistics of the SAN Telemetry Streaming pipeline. The SAN Telemetry Streaming pipeline provides statistics on collection and transport queues such as queue sizes, queue drops, and so on.

```
switch# show telemetry pipeline stats
Main Statistics:
    Timers:
        Errors:
            Start Fail        =     0

    Data Collector:
        Errors:
            Node Create Fail  =     0

    Event Collector:
        Errors:
            Node Create Fail  =     0    Node Add Fail     =     0
            Invalid Data      =     0

    Memory:
        Allowed Memory Limit               = 838860800 bytes
        Occupied Memory                    = 53399552 bytes

Queue Statistics:
    Request Queue:
        High Priority Queue:
            Info:
```

```
                Actual Size       =    50    Current Size      =     0
                Max Size          =     0    Full Count        =     0

            Errors:
                Enqueue Error     =     0    Dequeue Error     =     0

        Low Priority Queue:
            Info:
                Actual Size       =    50    Current Size      =     0
                Max Size          =     0    Full Count        =     0

            Errors:
                Enqueue Error     =     0    Dequeue Error     =     0

    Data Queue:
        High Priority Queue:
            Info:
                Actual Size       = 160000    Current Size      =     0
                Max Size          =     0    Full Count        =     0

            Errors:
                Enqueue Error     =     0    Dequeue Error     =     0

        Low Priority Queue:
            Info:
                Actual Size       =     2    Current Size      =     0
                Max Size          =     0    Full Count        =     0

            Errors:
                Enqueue Error     =     0    Dequeue Error     =     0
```

Telemetry uses gRPC connection for sending telemetry messages. The gRPC use HTTP2/TCP on port 50003. On MDS platforms the connection is established through mgmt0 interface using its IP address. Source port is picked by the linux kernel during connection. It uses long lived a TCP connection. This example displays all the configured transport sessions:

```
switch# show telemetry transport

Session Id      IP Address      Port       Encoding   Transport  Status
---------------------------------------------------------------------------
2               192.0.2.1    50009      GPB        gRPC       Connected
0               2001:420:301:2005:3::11
                             60003      GPB        gRPC       Connected
1               2001:420:54ff:a4::230:e5
                             50013      GPB        gRPC       Transmit Error
---------------------------------------------------------------------------

Retry buffer Size:             10485760
Event Retry Messages (Bytes):  0
Timer Retry Messages (Bytes):  10272300
Total Retries sent:            0
Total Retries Dropped:         5377
```

**Note** The IP Address is the destination IP address and the port is the source TCP port.

**Note** The *Transmit error* shows that the telemetry data send has failed. This can happen due to following reasons:

- Connection with receiver is down. gRPC error code is **UNAVAILABLE** in this case.
- Message send failures due to message drops. gRPC error code is **DEADLINE_EXCEEDED** in this case.
- The connection will be retried each time the sample-interval expires.

This example displays detailed session information for a specific transport session:

```
switch# show telemetry transport 0

Session Id:          2
IP Address:Port      192.0.2.1:50009
Transport:           GRPC
Status:              Connected
Last Connected:      Fri Jun 22 07:07:12.735 UTC
Last Disconnected:   Never
Tx Error Count:      0
Last Tx Error:       None
Event Retry Queue Bytes:       0
Event Retry Queue Size:        0
Timer Retry Queue Bytes:       0
Timer Retry Queue Size:        0
Sent Retry Messages:           0
Dropped Retry Messages:        0
```

**Note** The *Connected* status displays that the connection is established successfully and telemetry data send to receiver is successful.

This example displays details of a specific transport session:

```
switch# show telemetry transport 2 stats

Session Id:                    2
Connection Stats
   Connection Count            2
   Last Connected:             Fri Jun 22 07:07:12.735 UTC
   Disconnect Count            0
   Last Disconnected:          Never
Transmission Stats
   Compression:                disabled
   Source Interface:           not set()
   Transmit Count:             44
   Last TX time:               Fri Jun 22 07:14:16.533 UTC
   Min Tx Time:                227                ms
   Max Tx Time:                3511               ms
   Avg Tx Time:                1664               ms
   Cur Tx Time:                227                ms
```

**Note** The following table shows the description of command outputs in **show telemetry transport stats** command output:

*Table 18: Parameter Description*

| Command Output | Description |
|---|---|
| Min Tx Time | Minimum transmit time taken by telemetry to send the msg in that connection. |
| Max Tx Time | Maximum transmit time taken by telemetry to send the msg in that connection. |
| Avg Tx Time | Average transmit time taken by telemetry to send the msg in that connection. |
| Cur Tx Time | Transmit time taken by telemetry for the last message send the msg in that connection. |

This command displays detailed error statistics for a specific transport session:

```
switch# show telemetry transport 2 errors

Session Id:                    1
Connection Errors
   Connection Error Count:     0
Transmission Errors
   Tx Error Count:             1746
   Last Tx Error:              Fri Jun 22 07:15:07.970 UTC
   Last Tx Return Code:        UNAVAILABLE
```

**Note** The following is a description of the return codes in the **show telemetry transport errors** command output:

*Table 19: Parameter Description*

| Command Output | Description |
|---|---|
| OK | No errors were detected. |
| UNAVAILABLE | The configured IP address or port is not reachable. Check the configuration to verify if you have configured the correct IP address or port. |
| DEADLINE_EXCEEDED | Receiver has not responded for more than 30 seconds, or there are network delays. |

# Troubleshooting SAN Telemetry Streaming

Use the **show tech-support telemetry** command to collect telemetry data for troubleshooting. If you find any errors, check Configuring SAN Telemetry Streaming, on page 113 to verify the configuration.

Use the following information to troubleshooting telemetry status:

1. Using the **show analytics system-load** command, check the NPU load. If the NPU load is high, disable analytics on some ports.

```
switch# show analytics system-load
 n/a - not applicable
 ---------------------------------- Analytics System Load Info -------------------------------
 | Module | NPU Load (in %) | ITLs   ITNs   Both  |        Hosts         |       Targets       |
 |        | SCSI NVMe Total | SCSI   NVMe   Total | SCSI   NVMe   Total | SCSI   NVMe   Total |
 ---------------------------------------------------------------------------------------------
 |   1    | 0    0    0     | 0      0      0     | 0      0      0     | 0      0      0     |
 |   4    | 64   0    64    | 20743  0      20743 | 0      0      0     | 346    0      346   |
 |   5    | 0    0    0     | 0      0      0     | 0      0      0     | 0      0      0     |
 |   8    | 0    0    0     | 0      0      0     | 0      0      0     | 0      0      0     |
 |   12   | 0    12   12    | 0      300    300   | 0      0      0     | 0      40     40    |
 |   13   | 0    0    0     | 0      0      0     | 0      0      0     | 0      0      0     |
 |   18   | 0    13   13    | 1      1      2     | 1      1      2     | 0      0      0     |
 | Total  | n/a  n/a  n/a   | 20744  301    21045 | 1      1      2     | 346    40     386   |

As of Mon Apr  1 05:31:10 2019
```

2. Using the **show telemetry control database sensor-groups** command, check the command output to verify if the sample interval timer is running. If the timer is not running, check if the timer is configured properly.

```
switch# show telemetry control database sensor-groups
Sensor Group Database size = 3
-------------------------------------------------------------------------------------------------
Row ID     Sensor Group ID  Sensor Group type  Sampling interval(ms)  Linked subscriptions
  SubID
-------------------------------------------------------------------------------------------------
1          100              Timer   /SDB       5000      /Running      1
      100
Collection Time in ms (Cur/Min/Max): 0/0/1
Encoding Time in ms (Cur/Min/Max): 0/0/0
Transport Time in ms (Cur/Min/Max): 0/0/0
Streaming Time in ms (Cur/Min/Max): 1/1/4753

Collection Statistics:
  collection_id_dropped      = 0
  last_collection_id_dropped = 0
  drop_count                 = 0

2          1                Timer   /SDB       30000     /Running      1
      1
Collection Time in ms (Cur/Min/Max): 5/4/16
Encoding Time in ms (Cur/Min/Max): 2/2/11
Transport Time in ms (Cur/Min/Max): 644/635/1589
Streaming Time in ms (Cur/Min/Max): 3223/3168/4964

Collection Statistics:
  collection_id_dropped      = 0
  last_collection_id_dropped = 0
  drop_count                 = 0
```

3. Using the **show telemetry data collector details** command, check the command output to see if there are errors in collecting data. If you find errors, the *sensor_path* specified while configuring SAN Telemetry Streaming is incorrect and you must correct the sensor path.

```
switch# show telemetry data collector details

-----------------------------------------------------------------------
Row ID         Successful  Failed Skipped  Sensor Path(GroupId)
-----------------------------------------------------------------------
1              0           2994     0       analytics:panup(1)
```

```
2               2994          0         0       show_stats_fc2/2(1)
3               0             2994      0       analytics:port(1)
4               2994          0         0       show_stats_fc2/6(1)
5               2994          0         0       show_stats_fc2/1(1)
```

4. Using the **show logging logfile** | *grep -i telemetry* command, check for errors in the syslog message:

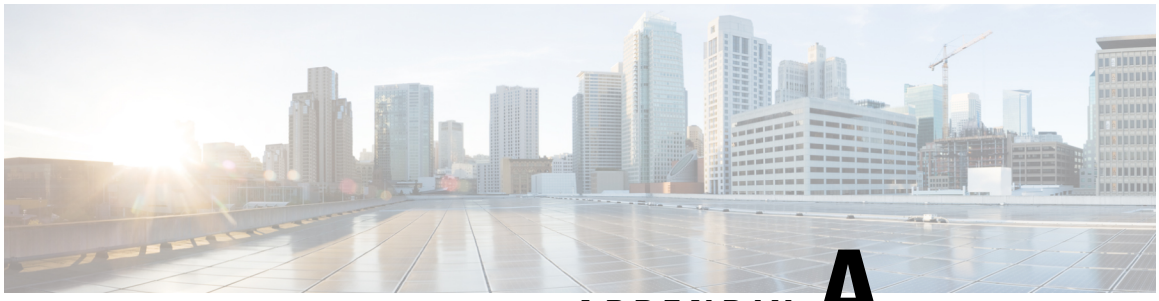
```
switch# show logging logfile | grep -i telemetry
2018 Jun 28 16:26:17 switch %TELEMETRY-4-TRANSPORT_SEND_ERROR: GRPC send to
172.20.30.129:60002 failed. (DEADLINE_EXCEEDED(len:2876013))
```

5. If no issues are found using in step 1, step 2, and step 3, the issue is likely to be with the transport protocol. Using the **show telemetry transport 0 errors** command, check the command output to see if there are any transport protocol errors.

   The following reasons can cause transport protocol errors:

   - Configuring an incorrect IP address or port in the destination profile or subscription. Correct the IP address or port in the destination profile or subscription.
   - Receiver has not started. Check if the receiver is active and listening to the gRPC port.
   - Receiver has started, but is not processing the message. Check the receiver application for errors.
   - Problems exists with the management IP. Use the **telnet** command to test if the IP address and port can be reached.

```
switch# show telemetry transport 1 errors

Session Id:                    1
Connection Errors
   Connection Error Count:     0
Transmission Errors
   Tx Error Count:             0
   Last Tx Error:              None
   Last Tx Return Code:        OK
```



APPENDIX A

# Appendix


- Flow Metrics, on page 129
- Interface Counters, on page 258
- SAN Telemetry Streaming Proto Files — Release 9.4(1), on page 263
- SAN Telemetry Streaming Proto Files — Prior to Release 9.4(1), on page 268


# Flow Metrics

This section provides detailed information about each flow metric. Long names in flow metrics are used for SAN analytics and short names are used for SAN Telemetry Streaming purposes.

**Note**

- The *total_abts_count* flow metrics is updated only for the SCSI analytics type.
- From Cisco MDS NX-OS Release 9.2(2), the following view instances were deprecated:
  - Application View Instance (app)
  - Target Application View Instance (scsi_target_app and nvme_target_app)
  - Initiator Application View Instance (scsi_initiator_app and nvme_initiator_app)
- From Cisco MDS NX-OS Release 9.2(2), the following metrics were deprecated:
  - total_seq_read_io_count
  - total_seq_write_io_count
  - read_io_inter_gap_time_min
  - read_io_inter_gap_time_max
  - write_io_inter_gap_time_min
  - write_io_inter_gap_time_max
- From Cisco MDS NX-OS Release 9.2(2), the following metrics are introduced:
  - total_busy_period
  - write_io_first_burst_count
  - write_io_array_delay_time
  - write_io_host_delay_time
  - write_io_array_delay_time_max
  - write_io_host_delay_time_max
  - write_io_host_delay_time_min
  - multisequence_exchange_write_io_sequences_max
  - multisequence_exchange_write_io_sequences_min
  - total_write_io_sequences_count

The following is the list of supported views:

- Port View Instance (port)
- Logical Port View Instance (logical_port)
- Application View Instance (app)
- Target View Instance (scsi_target and nvme_target)
- Initiator View Instance (scsi_initiator and nvme_initiator)

- Target Application View Instance (scsi_target_app and nvme_target_app)
- Initiator Application View Instance (scsi_initiator_app and nvme_initiator_app)
- Target IT Flow View Instance (scsi_target_it_flow and nvme_target_it_flow)
- Initiator IT Flow View Instance (scsi_initiator_it_flow and nvme_initiator_it_flow)
- Target TL Flow View Instance (scsi_target_tl_flow)
- Target TN Flow View Instance (nvme_target_tn_flow)
- Initiator ITL Flow View Instance (scsi_initiator_itl_flow)
- Initiator ITN Flow View Instance (nvme_initiator_itn_flow)
- Target ITL Flow View Instance (scsi_target_itl_flow)
- Target ITN Flow View Instance (nvme_target_itn_flow)
- Initiator IO Flow View Instance (scsi_initiator_io and nvme_initiator_io)
- Target IO Flow View Instance (scsi_target_io and nvme_target_io)


# List of Supported Flow Metrics

## Port View Instance (port)

*Table 20: Flow Metrics for Port View Instance*

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| port | port | Key | Text | No | A switch port where the SAN Analytics feature is enabled. |
| scsi_target_count | stc | Metadata | Count | No | Number of unique SCSI target FCIDs external to a switch port with IO since last clearing of metrics. |
| nvme_target_count | ntc | Metadata | Count | No | Number of unique NVMe target FCIDs external to a switch port with IO since last clearing of metrics. |
| scsi_initiator_count | sic | Metadata | Count | No | Number of initiators external to a switch port with IO since last clearing of metrics. |
| nvme_initiator_count | nic | Metadata | Count | No | Number of initiators external to a switch port with IO since last clearing of metrics. |

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| io_app_count | IOac | Metadata | Count | No | Number of applications hosted behind a switch port with IO since last clearing of metrics. |
| logical_port_count | lpc | Metadata | Count | No | Number of VSANs configured on a switch port with IO since last clearing of metrics. |
| scsi_target_app_count | stac | Metadata | Count | No | Number of applications for which data is hosted on targets external to a switch port. |
| nvme_target_app_count | ntac | Metadata | Count | No | Number of applications for which data is hosted on targets external to a switch port. |
| scsi_initiator_app_count | siac | Metadata | Count | No | Number of applications for which data is requested by the initiators external to a switch port. |
| nvme_initiator_app_count | niac | Metadata | Count | No | Number of applications for which data is requested by the initiators external to a switch port. |
| active_io_read_count | raIO | Metadata | Count | Yes | Number of outstanding **read** command counts associated with a switch port. |
| active_io_write_count | waIO | Metadata | Count | Yes | Number of outstanding **write** command counts associated with a switch port. |
| scsi_target_it_flow_count | stITfc | Metadata | Count | No | Number of IT flows associated with various targets external to a switch port. |
| nvme_target_it_flow_count | ntITfc | Metadata | Count | No | Number of IT flows associated with various targets external to a switch port. |
| scsi_initiator_it_flow_count | siITfc | Metadata | Count | No | Number of initiator-target (IT) flows associated with various initiators external to a switch port. |

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| nvme_initiator_it_flow_count | niITfc | Metadata | Count | No | Number of initiator-target (IT) flows associated with various initiators external to a switch port. |
| scsi_target_itl_flow_count | stITLfc | Metadata | Count | No | Number of ITL flows associated with various targets external to a switch port. |
| nvme_target_itn_flow_count | ntITNfc | Metadata | Count | No | Number of ITN flows associated with various targets external to a switch port. |
| scsi_initiator_itl_flow_count | siITLfc | Metadata | Count | No | Number of ITL flows associated with various initiators external to a switch port. |
| nvme_initiator_itn_flow_count | niITNfc | Metadata | Count | No | Number of ITN flows associated with various initiators external to a switch port. |
| scsi_target_tl_flow_count | stTLfc | Metadata | Count | No | Number of LUNs associated with various targets external to a switch port. |
| nvme_target_tn_flow_count | ntTNfc | Metadata | Count | No | Number of namespace IDs associated with various targets external to a switch port. |
| total_abts_count | totAbts | Metric | Count | Yes | Number of aborts observed. |
| total_read_io_count | rtIO | Metric | Count | Yes | Total **read** command data observed external to a switch port. |
| total_write_io_count | wtIO | Metric | Count | Yes | Total **write** command data observed external to a switch port. |
| total_seq_read_io_count | rstIOc | Metric | Count | No | Total sequential **read** command data observed external to a switch port. |
| total_seq_write_io_count | wrstIOc | Metric | Count | No | Total sequential **write** command data observed external to a switch port. |

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| total_read_io_time | rtIOt | Metric | Microseconds | No | Accumulated total **read** completion time for observed external to a switch port.<br>You can use this information to compute the average read IO completion time. |
| total_write_io_time | wtIOt | Metric | Microseconds | No | Accumulated total **write** command completion time observed external to a switch port.<br>You can use this information to compute the average write command completion time. |
| total_read_io_initiation_time | rtIOint | Metric | Microseconds | No | Accumulated total **read** command initiation time (time gap between the IO command and the first response from the storage; the first response can be the first data frame for READ commands or the first txfr_rdy for WRITE commands) observed external to a switch port. The initiation time is sometimes referred to as **data access latency**.<br>You can use this information to compute the average read IO initiation time. |
| total_write_io_initiation_time | wtIOint | Metric | Microseconds | No | Accumulated total **write** command initiation time (time gap between the IO command and the first response from the storage; the first response can be the first data frame for READ or txfer_rdy for WRITE) observed external to a switch port. The initiation time is sometimes referred to as **data access latency**.<br>You can use this information to compute the average write command initiation time. |

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| total_read_io_bytes | rtIOb | Metric | Bytes | Yes | Total **read** command data that is observed external to a switch port. |
| total_write_io_bytes | wtIOb | Metric | Bytes | Yes | Total **write** command data observed external to a switch port. |
| total_read_io_inter_gap_time | rtIOigt | Metric | Microseconds | No | Accumulated total **read** command intergap time observed external to a switch port.<br>You can use this information to compute the average read IO intergap time. |
| total_write_io_inter_gap_time | wtIOigt | Metric | Microseconds | No | Accumulated total **write** command intergap time observed external to a switch port.<br>You can use this information to compute the average write command intergap time. |
| total_time_metric_based_read_io_count | tmrtIOc | Metric | Count | No | Total completed **read** command data observed external to a switch port. |
| total_time_metric_based_write_io_count | tmwtIOc | Metric | Count | No | Total completed **write** command data observed external to a switch port. |
| total_time_metric_based_read_io_bytes | tmrtIOb | Metric | Count | No | Total completed **read** command data observed external to a switch port, in bytes. |
| total_time_metric_based_write_io_bytes | tmwtIOb | Metric | Count | No | Total completed **write** command data observed external to a switch port, in bytes. |

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| read_io_rate | rIOr | Metric | IOs per second | Yes | The rate of **read** commands observed external to a switch port.<br>This metric is the average value collected over a 4-second interval from the NPU. |
| peak_read_io_rate | prIOr | Metric | IOs per second | No | The peak rate of **read** commands observed external to a switch port. |
| write_io_rate | wIOr | Metric | IOs per second | Yes | The rate of **write** commands observed external to a switch port.<br>This metric is the average value collected over a 4-second interval from the NPU. |
| peak_write_io_rate | pwIOr | Metric | IOs per second | No | The peak rate of **write** commands observed external to a switch port. |
| read_io_bandwidth | rIObw | Metric | Bytes per second | Yes | The **read** command bandwidth observed external to a switch port.<br>This metric is the average value collected over a 4-second interval from the NPU. |
| peak_read_io_bandwidth | prIObw | Metric | Bytes per second | No | Peak **read** command bandwidth observed external to a switch port. |
| write_io_bandwidth | wIObw | Metric | Bytes per second | Yes | The **write** command bandwidth observed external to a switch port.<br>This metric is the average value collected over a 4-second interval from the NPU. |
| peak_write_io_bandwidth | pwIObw | Metric | Bytes per second | No | Peak **write** command bandwidth observed external to a switch port. |

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| read_io_size_min | rIOsMi | Metric | Bytes | Yes | Minimum **read** command size observed external to a switch port. |
| read_io_size_max | rIOsMa | Metric | Bytes | Yes | Maximum **read** command size observed external to a switch port. |
| write_io_size_min | wIOsMi | Metric | Bytes | Yes | Minimum **write** command size observed external to a switch port. |
| write_io_size_max | wIOsMa | Metric | Bytes | Yes | Maximum **write** command size observed external to a target external to a switch port. |
| read_io_completion_time_min | rIOctMi | Metric | Microseconds | Yes | Minimum **read** command completion time observed external to a switch port. |
| read_io_completion_time_max | rIOctMa | Metric | Microseconds | Yes | Maximum **read** command completion time observed external to a switch port. |
| write_io_completion_time_min | wIOctMi | Metric | Microseconds | Yes | Minimum **write** command completion time observed external to a switch port. |
| write_io_completion_time_max | wIOctMa | Metric | Microseconds | Yes | Maximum **write** command completion time observed external to a switch port. |
| read_io_initiation_time_min | rIOitMi | Metric | Microseconds | Yes | Minimum **read** command initiation time (time gap between the IO command and the first response from the storage; the first response can be the first data frame for READ or txfer_rdy for WRITE) observed external to a switch port. The initiation time is sometimes referred to as **data access latency**. |

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| read_io_initiation_time_max | rIOitMa | Metric | Microseconds | Yes | Maximum **read** command initiation time (time gap between the IO command and the first response from the storage; the first response can be the first data frame for READ or txfer_rdy for WRITE) observed external to a switch port. The initiation time is sometimes referred to as **data access latency**. |
| write_io_initiation_time_min | wIOitMi | Metric | Microseconds | Yes | Minimum **write** command initiation time (time gap between the IO command and the first response from the storage; the first response can be the first data frame for READ or txfer_rdy for WRITE) observed external to a switch port. The initiation time is sometimes referred to as **data access latency**. |
| write_io_initiation_time_max | wIOitMa | Metric | Microseconds | Yes | Maximum **write** command initiation time (time gap between the IO command and the first response from the storage; the first response can be the first data frame for READ or txfer_rdy for WRITE) observed external to a switch port. The initiation time is sometimes referred to as **data access latency**. |
| read_io_inter_gap_time_min | rIOigtMi | Metric | Microseconds | Yes | Minimum **read** command intergap time observed external to a switch port.<br>read_io_inter_gap_time_min is the duration between successive IO commands and is measured in 1/256th of a microsecond. |

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| read_io_inter_gap_time_max | rIOigtMa | Metric | Microseconds | Yes | Maximum **read** command intergap time observed external to a switch port.<br>read_io_inter_gap_time_max is the duration between successive IO commands and is measured in 1/256th of a microsecond. |
| write_io_inter_gap_time_min | wIOigtMi | Metric | Microseconds | Yes | Minimum **write** command intergap time observed external to a switch port.<br>write_io_inter_gap_time_min is the duration between successive IO commands and is measured in 1/256th of a microsecond. |
| write_io_inter_gap_time_max | wIOigtMa | Metric | Microseconds | Yes | Maximum **write** command intergap time observed external to a switch port.<br>write_io_inter_gap_time_max is the duration between successive IO commands and is measured in 1/256th of a microsecond. |
| read_io_aborts | rIOa | Metric | Count | Yes | Number of **read** command aborts observed external to a switch port. |
| write_io_aborts | wIOa | Metric | Count | Yes | Number of **write** command aborts observed external to an application that is hosted external to a switch port. |
| read_io_failures | rIOf | Metric | Count | Yes | Number of **read** command failures observed external to a switch port. |
| write_io_failures | wIOf | Metric | Count | Yes | Number of **write** command failures observed external to a switch port. |
| read_io_scsi_check_condition_count | rIOSchcoct | Metric | Count | No | Number of **read** command check conditions seen external to a switch port. |

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| write_io_scsi_check_condition_count | wIOSchcoct | Metric | Count | No | Number of **write** command check conditions seen external to a switch port. |
| read_io_scsi_busy_count | rIOsbc | Metric | Count | No | Number of **read** command busy status seen external to a switch port. |
| write_io_scsi_busy_count | wIOsbc | Metric | Count | No | Number of **write** command busy status seen external to a switch port. |
| read_io_nvme_lba_out_of_range_count | rIONLbaoorct | Metric | Count | No | Number of **read** command *lba out of range* errors seen. |
| write_io_nvme_lba_out_of_range_count | wIONLbaoorct | Metric | Count | No | Number of **write** command *lba out of range* errors seen. |
| read_io_nvme_ns_not_ready_count | rIOnNsnrc | Metric | Count | No | Number of **read** command *namespace not ready* errors seen. |
| write_io_nvme_ns_not_ready_count | wIOnNsnrc | Metric | Count | No | Number of **write** command *namespace not ready* errors seen. |
| read_io_scsi_reservation_conflict_count | rIOSrecct | Metric | Count | No | Number of **read** command reservation conflicts seen external to a switch port. |
| read_io_nvme_reservation_conflict_count | rIONrecct | Metric | Count | No | Number of **read** command reservation conflicts seen external to a switch port. |
| write_io_scsi_reservation_conflict_count | wIOSrecct | Metric | Count | No | Number of **write** command reservation conflicts seen external to a switch port. |
| write_io_nvme_reservation_conflict_count | wIONrecct | Metric | Count | No | Number of **write** command reservation conflicts seen external to a switch port. |
| read_io_scsi_queue_full_count | rIOSQfct | Metric | Count | No | Number of **read** command queue full status seen external to a switch port. |
| write_io_scsi_queue_full_count | wIOSQfct | Metric | Count | No | Number of **write** command queue full status seen external to a switch port. |

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| sampling_start_time | samStm | Metric | UNIX time | No | Start of the sampling time interval. |
| sampling_end_time | samEtm | Metric | UNIX time | No | End of the sampling time interval. |
| total_busy_period | totBsy | Metric | Count | No | The total time for which the view instances have been active. |
| total_write_io_first_burst_count | totWrFirBu | Metric | Count | No | Accumulated total **write** command first burst observed external to a switch port. |
| total_write_io_array_delay_time | totWrArrDel | Metric | Count | No | Accumulated total **write** command array delays observed external to a switch port. |
| total_write_io_host_delay_time | totWrHosDel | Metric | Count | No | Accumulated total **write** command host delays observed external to a switch port. |
| total_write_io_sequences_count | totWrSeq | Metric | Count | No | Accumulated total **write** command sequences observed external to a switch port. |
| write_io_host_delay_time_min | wrHosDelMn | Metric | Count | No | Minimum **write** command host delays observed external to a switch port. |
| write_io_host_delay_time_max | wrHosDelMx | Metric | Count | No | Maximum **write** command host delays observed external to a switch port. |
| write_io_array_delay_time_max | wrArrDelMx | Metric | Count | No | Maximum **write** command array delays observed external to a switch port. |
| multisequence_exchange_write_io_sequences_min | wrIoSeqMn | Metric | Count | No | Minimum **write** command multisequence exchange sequences observed external to a switch port. |
| multisequence_exchange_write_io_sequences_max | wrIoSeqMx | Metric | Count | No | Maximum **write** command multisequence exchange sequences observed external to a switch port. |

# Logical Port View Instance (logical_port)

*Table 21: Flow Metrics for Logical Port View Instance*

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| port | port | Key | Text | No | A switch port where the SAN Analytics feature is enabled. |
| vsan | vsan | Key | Number | No | VSAN that is configured on a switch port with IO since last clearing of metrics. |
| scsi_target_count | stc | Metadata | Count | No | Number of targets external to a switch port with IO since last clearing of metrics. |
| nvme_target_count | ntc | Metadata | Count | No | Number of targets external to a switch port with IO since last clearing of metrics. |
| scsi_initiator_count | sic | Metadata | Count | No | Number of initiators external to a switch port with IO since last clearing of metrics. |
| nvme_initiator_count | nic | Metadata | Count | No | Number of initiators external to a switch port with IO since last clearing of metrics. |
| scsi_target_app_count | stac | Metadata | Count | No | Number of applications for which data is hosted on targets external to a switch port. |
| nvme_target_app_count | ntac | Metadata | Count | No | Number of applications for which data is hosted on targets external to a switch port. |
| scsi_initiator_app_count | siac | Metadata | Count | No | Number of applications for which data is requested by the initiators external to a switch port. |
| nvme_initiator_app_count | niac | Metadata | Count | No | Number of applications for which data is requested by the initiators external to a switch port. |
| active_io_read_count | raIO | Metadata | Count | Yes | Number of outstanding **read** command counts associated with a switch port. |

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| active_io_write_count | waIO | Metadata | Count | Yes | Number of outstanding **write** command counts associated with a switch port. |
| scsi_target_it_flow_count | stITfc | Metadata | Count | No | Number of IT flows associated with various targets external to a switch port. |
| nvme_target_it_flow_count | ntITfc | Metadata | Count | No | Number of IT flows associated with various targets external to a switch port. |
| scsi_initiator_it_flow_count | siITfc | Metadata | Count | No | Number of initiator-target (IT) flows associated with various initiators external to a switch port. |
| nvme_initiator_it_flow_count | niITfc | Metadata | Count | No | Number of initiator-target (IT) flows associated with various initiators external to a switch port. |
| scsi_target_itl_flow_count | stITLfc | Metadata | Count | No | Number of ITL flows associated with various targets external to a switch port. |
| nvme_target_itn_flow_count | ntITNfc | Metadata | Count | No | Number of ITN flows associated with various targets external to a switch port. |
| scsi_initiator_itl_flow_count | siITLfc | Metadata | Count | No | Number of ITL flows associated with various initiators external to a switch port. |
| nvme_initiator_itn_flow_count | niITNfc | Metadata | Count | No | Number of ITN flows associated with various initiators external to a switch port. |
| scsi_target_tl_flow_count | stTLfc | Metadata | Count | No | Number of LUNs associated with various targets external to a switch port. |
| nvme_target_tn_flow_count | ntTNfc | Metadata | Count | No | Number of namespace IDs associated with various targets external to a switch port. |
| total_abts_count | totAbts | Metric | Count | Yes | Number of aborts observed. |

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| total_read_io_count | rtIO | Metric | Count | Yes | Total **read** command data observed external to a switch port. |
| total_write_io_count | wtIO | Metric | Count | Yes | Total **write** command data observed external to a switch port. |
| total_seq_read_io_count | rstIOc | Metric | Count | No | Total sequential **read** command data observed external to a switch port. |
| total_seq_write_io_count | wrstIOc | Metric | Count | No | Total sequential **write** command data observed external to a switch port. |
| total_read_io_time | rtIOt | Metric | Microseconds | No | Accumulated total **read** command completion time for read command data observed external to a switch port.<br>You can use this information to compute the average read IO completion time. |
| total_write_io_time | wtIOt | Metric | Microseconds | No | Accumulated total **write** command completion time observed external to a switch port.<br>You can use this information to compute the average write command completion time. |
| total_read_io_initiation_time | rtIOint | Metric | Microseconds | No | Accumulated total **read** command initiation time (time gap between the IO command and the first response from the storage; the first response can be the first data frame for READ commands or the first txfr_rdy for WRITE commands) observed external to a switch port. The initiation time is sometimes referred to as **data access latency**.<br>You can use this information to compute the average read IO initiation time. |

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| total_write_io_initiation_time | wtIOint | Metric | Microseconds | No | Accumulated total **write** command initiation time (time gap between the IO command and the first response from the storage; the first response can be the first data frame for READ or txfer_rdy for WRITE) observed external to a switch port. The initiation time is sometimes referred to as **data access latency**.<br>You can use this information to compute the average write command initiation time. |
| total_read_io_bytes | rtIOb | Metric | Bytes | Yes | Total **read** command data that is observed external to a switch port. |
| total_write_io_bytes | wtIOb | Metric | Bytes | Yes | Total **write** command data observed external to a switch port. |
| total_read_io_inter_gap_time | rtIOigt | Metric | Microseconds | No | Accumulated total **read** command intergap time observed external to a switch port.<br>You can use this information to compute the average read IO intergap time. |
| total_write_io_inter_gap_time | wtIOigt | Metric | Microseconds | No | Accumulated total **write** command intergap time observed external to a switch port.<br>You can use this information to compute the average write command intergap time. |
| total_time_metric_based_read_io_count | tmrtIOc | Metric | Count | No | Total completed **read** command data observed external to a switch port. |
| total_time_metric_based_write_io_count | tmwtIOc | Metric | Count | No | Total completed **write** command data observed external to a switch port. |

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| total_time_metric_based_read_io_bytes | tmrtIOb | Metric | Count | No | Total completed **read** command data observed external to a switch port, in bytes. |
| total_time_metric_based_write_io_bytes | tmwtIOb | Metric | Count | No | Total completed **write** command data observed external to a switch port, in bytes. |
| read_io_rate | rIOr | Metric | IOs per second | Yes | The rate of **read** commands observed external to a switch port.<br>This metric is the average value collected over a 4-second interval from the NPU. |
| peak_read_io_rate | prIOr | Metric | IOs per second | No | The peak rate of **read** command observed, external to a LUN, on a target external to a switch port. |
| write_io_rate | wIOr | Metric | IOs per second | Yes | The rate of **write** commands observed external to a switch port.<br>This metric is the average value collected over a 4-second interval from the NPU. |
| peak_write_io_rate | pwIOr | Metric | IOs per second | No | The peak rate of **write** commands observed, external to a LUN, on a target external to a switch port. |
| read_io_bandwidth | rIObw | Metric | Bytes per second | Yes | The **read** command bandwidth observed external to a switch port.<br>This metric is the average value collected over a 4-second interval from the NPU. |

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| peak_read_io_bandwidth | prIObw | Metric | Bytes per second | No | Peak read command bandwidth observed, external to a logical-unit-number (LUN), on a target external to a switch port. |
| write_io_bandwidth | wIObw | Metric | Bytes per second | Yes | The **write** command bandwidth observed external to a switch port.<br>This metric is the average value collected over a 4-second interval from the NPU. |
| peak_write_io_bandwidth | pwIObw | Metric | Bytes per second | No | Peak **write** command bandwidth observed, external to a LUN, on a target external to a switch port. |
| read_io_size_min | rIOsMi | Metric | Bytes | Yes | Minimum **read** command size observed external to a switch port. |
| read_io_size_max | rIOsMa | Metric | Bytes | Yes | Maximum **read** command size observed external to a switch port. |
| write_io_size_min | wIOsMi | Metric | Bytes | Yes | Minimum **write** command size observed external to a switch port. |
| write_io_size_max | wIOsMa | Metric | Bytes | Yes | Maximum **write** command size observed external to a target external to a switch port. |
| read_io_completion_time_min | rIOctMi | Metric | Microseconds | Yes | Minimum **read** command completion time observed external to a switch port. |
| read_io_completion_time_max | rIOctMa | Metric | Microseconds | Yes | Maximum read-command-completion time observed external to a switch port. |

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| read_io_initiation_time_min | rIOitMi | Metric | Microseconds | Yes | Minimum **read** command initiation time (time gap between the IO command and the first response from the storage; the first response can be the first data frame for READ or txfer_rdy for WRITE) observed external to a switch port. The initiation time is sometimes referred to as **data access latency**. |
| read_io_initiation_time_max | rIOitMa | Metric | Microseconds | Yes | Maximum **read** command initiation time (time gap between the IO command and the first response from the storage; the first response can be the first data frame for READ or txfer_rdy for WRITE) observed external to a switch port. The initiation time is sometimes referred to as **data access latency**. |
| write_io_initiation_time_min | wIOitMi | Metric | Microseconds | Yes | Minimum **write** command initiation time (time gap between the IO command and the first response from the storage; the first response can be the first data frame for READ or txfer_rdy for WRITE) observed external to a switch port. The initiation time is sometimes referred to as **data access latency**. |
| write_io_initiation_time_max | wIOitMa | Metric | Microseconds | Yes | Maximum **write** command initiation time (time gap between the IO command and the first response from the storage; the first response can be the first data frame for READ or txfer_rdy for WRITE) observed external to a switch port. The initiation time is sometimes referred to as **data access latency**. |

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| read_io_inter_gap_time_min | rIOigtMi | Metric | Microseconds | Yes | Minimum **read** command intergap time observed external to a switch port.<br>read_io_inter_gap_time_min is the duration between successive IO commands and is measured in 1/256th of a microsecond. |
| read_io_inter_gap_time_max | rIOigtMa | Metric | Microseconds | Yes | Maximum **read** command intergap time observed external to a switch port.<br>read_io_inter_gap_time_max is the duration between successive IO commands and is measured in 1/256th of a microsecond. |
| write_io_inter_gap_time_min | wIOigtMi | Metric | Microseconds | Yes | Minimum **write** command intergap time observed external to a switch port.<br>write_io_inter_gap_time_min is the duration between successive IO commands and is measured in 1/256th of a microsecond. |
| write_io_inter_gap_time_max | wIOigtMa | Metric | Microseconds | Yes | Maximum **write** command intergap time observed external to a switch port.<br>write_io_inter_gap_time_max is the duration between successive IO commands and is measured in 1/256th of a microsecond. |
| read_io_aborts | rIOa | Metric | Count | Yes | Number of **read** command aborts observed external to a switch port. |
| write_io_aborts | wIOa | Metric | Count | Yes | Number of **write** command aborts observed external to an application that is hosted behind a switch port. |

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| read_io_failures | rIOf | Metric | Count | Yes | Number of **read** command failures observed external to a switch port. |
| write_io_failures | wIOf | Metric | Count | Yes | Number of **write** command failures observed external to a switch port. |
| read_io_scsi_check_condition_count | rIOSchcoct | Metric | Count | No | Number of **read** command check conditions seen external to a switch port. |
| write_io_scsi_check_condition_count | wIOSchcoct | Metric | Count | No | Number of **write** command check conditions seen external to a switch port. |
| read_io_scsi_busy_count | rIOsbc | Metric | Count | No | Number of **read** command busy status seen external to a switch port. |
| write_io_scsi_busy_count | wIOsbc | Metric | Count | No | Number of **write** command busy status seen external to a switch port. |
| read_io_nvme_lba_out_of_range_count | rIONLbaoorct | Metric | Count | No | Number of **read** command *lba out of range* errors seen. |
| write_io_nvme_lba_out_of_range_count | wIONLbaoorct | Metric | Count | No | Number of **write** command *lba out of range* errors seen. |
| read_io_nvme_ns_not_ready_count | rIOnNsnrc | Metric | Count | No | Number of **read** command *namespace not ready* errors seen. |
| write_io_nvme_ns_not_ready_count | wIOnNsnrc | Metric | Count | No | Number of **write** command *namespace not ready* errors seen. |
| read_io_scsi_reservation_conflict_count | rIOSrecct | Metric | Count | No | Number of **read** command reservation conflicts seen external to a switch port. |
| read_io_nvme_reservation_conflict_count | rIONrecct | Metric | Count | No | Number of **read** command reservation conflicts seen external to a switch port. |
| write_io_scsi_reservation_conflict_count | wIOSrecct | Metric | Count | No | Number of **write** command reservation conflicts seen external to a switch port. |

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| write_io_nvme_reservation_conflict_count | wIONrecct | Metric | Count | No | Number of **write** command reservation conflicts seen external to a switch port. |
| read_io_scsi_queue_full_count | rIOSQfct | Metric | Count | No | Number of **read** command queue full status seen external to a switch port. |
| write_io_scsi_queue_full_count | wIOSQfct | Metric | Count | No | Number of **write** command queue full status seen external to a switch port. |
| sampling_start_time | samStm | Metric | UNIX time | No | Start of the sampling time interval. |
| sampling_end_time | samEtm | Metric | UNIX time | No | End of the sampling time interval. |
| total_busy_period | totBsy | Metric | Count | No | The total time for which the view instances have been active. |
| total_write_io_first_burst_count | totWrFirBu | Metric | Count | No | Accumulated total **write** command first burst observed external to a switch port. |
| total_write_io_array_delay_time | totWrArrDel | Metric | Count | No | Accumulated total **write** command array delays observed external to a switch port. |
| total_write_io_host_delay_time | totWrHosDel | Metric | Count | No | Accumulated total **write** command host delays observed external to a switch port. |
| total_write_io_sequences_count | totWrSeq | Metric | Count | No | Accumulated total **write** command sequences observed external to a switch port. |
| write_io_host_delay_time_min | wrHosDelMn | Metric | Count | No | Minimum **write** command host delays observed external to a switch port. |
| write_io_host_delay_time_max | wrHosDelMx | Metric | Count | No | Maximum **write** command host delays observed external to a switch port. |

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| write_io_array_delay_time_max | wrArrDelMx | Metric | Count | No | Maximum **write** command array delays observed external to a switch port. |
| multisequence_exchange_write_io_sequences_min | wrIoSeqMn | Metric | Count | No | Minimum **write** command multisequence exchange sequences observed external to a switch port. |
| multisequence_exchange_write_io_sequences_max | wrIoSeqMx | Metric | Count | No | Maximum **write** command multisequence exchange sequences observed external to a switch port. |

## Application View Instance (app)

***Table 22: Flow Metrics for Application View Instance***

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| port | port | Key | Text | No | A switch port where the SAN Analytics feature is enabled. |
| app_id | app_id | Key | Count | No | Application identifier for the application external to a switch port. |
| scsi_target_itl_flow_count | stITLfc | Metadata | Count | No | Number of target ITL flows associated with an application external to a switch port. |
| nvme_target_itn_flow_count | ntITNfc | Metadata | Count | No | Number of ITN flows associated with various targets external to a switch port. |
| scsi_initiator_itl_flow_count | siITLfc | Metadata | Count | No | Number of initiator ITL flows associated with an application external to a switch port. |
| nvme_initiator_itn_flow_count | niITNfc | Metadata | Count | No | Number of ITN flows associated with various initiators external to a switch port. |
| active_io_read_count | raIO | Metadata | Count | Yes | Number of outstanding **read** command counts associated with an application external to a switch port. |
| active_io_write_count | waIO | Metadata | Count | Yes | Number of outstanding **write** command counts associated with an application external to a switch port. |
| scsi_target_app_count | stac | Metadata | Count | No | Number of targets that host data for an application external to a switch port. |

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| nvme_target_app_count | ntac | Metadata | Count | No | Number of applications for which data is hosted on targets external to a switch port. |
| scsi_initiator_app_count | siac | Metadata | Count | No | Number of initiators that access data from an application external to a switch port. |
| nvme_initiator_app_count | niac | Metadata | Count | No | Number of applications for which data is requested by the initiators external to a switch port. |
| scsi_target_tl_flow_count | stTLfc | Metadata | Count | No | Number of LUNs associated with an application external to a switch port. |
| nvme_target_tn_flow_count | ntTNfc | Metadata | Count | No | Number of namespace IDs associated with various targets external to a switch port. |
| sampling_end_time | samEtm | Metric | UNIX time | No | End of the sampling time interval. |
| sampling_start_time | samStm | Metric | UNIX time | No | Start of the sampling time interval. |

## Target View Instance (scsi_target and nvme_target)

*Table 23: Flow Metrics for Target View Instance*

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| port | port | Key | Text | No | A switch port where the SAN Analytics feature is enabled. |
| vsan | vsan | Key | Count | No | VSAN configured on a switch port with IO since last clearing of metrics. |
| target_id | did | Key | Text | No | Target Fibre Channel ID that is external to a switch port with IO since last clearing of metrics. |
| scsi_target_app_count | stac | Metadata | Count | No | Number of applications for which data is hosted on a target external to a switch port. |
| nvme_target_app_count | ntac | Metadata | Count | No | Number of applications for which data is hosted on targets external to a switch port. |

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| scsi_target_lun_count | stLc | Metadata | Count | No | Number of LUNs seen on a target external to a switch port. |
| active_io_read_count | raIO | Metadata | Count | Yes | Number of outstanding **read** command counts associated with a target external to a switch port. |
| active_io_write_count | waIO | Metadata | Count | Yes | Number of outstanding **write** command counts associated with a target external to a switch port. |
| scsi_target_entity_it_flow_count | stITfc | Metadata | Count | No | Number of IT flows associated with a target external to a switch port. |
| nvme_target_entity_it_flow_count | ntITfc | Metadata | Count | No | Number of IT flows associated with a target external to a switch port. |
| scsi_target_entity_itl_flow_count | stITLfc | Metadata | Count | No | Number of ITL flows associated with a target external to a switch port. |
| nvme_target_entity_itn_flow_count | ntITNfc | Metadata | Count | No | Number of ITN flows associated with a target external to a switch port. |
| total_abts_count | totAbts | Metric | Count | Yes | Number of aborts observed. |
| total_read_io_count | rtIO | Metric | Count | Yes | Total **read** command data observed external to a target external to a switch port. |
| total_write_io_count | wtIO | Metric | Count | Yes | Total **write** command data observed external to a target external to a switch port. |
| total_seq_read_io_count | rstIOc | Metric | Count | No | Total sequential **read** command data observed external to a target external to a switch port. |
| total_seq_write_io_count | wrstIOc | Metric | Count | No | Total sequential **write** command data observed external to a target external to a switch port. |

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| total_read_io_time | rtIOt | Metric | Microseconds | No | Accumulated total **read** command completion time observed external to a target external to a switch port.<br>You can use this information to compute the average read IO completion time. |
| total_write_io_time | wtIOt | Metric | Microseconds | No | Accumulated total **write** command completion time observed external to a target external to a switch port.<br>You can use this information to compute average **write** command completion time. |
| total_read_io_initiation_time | rtIOint | Metric | Microseconds | No | Accumulated total **read** command initiation time (time gap between the IO command and the first response from the storage; the first response can be the first data frame for READ commands or the first txfr_rdy for WRITE commands) observed external to a target external to a switch port. The initiation time is sometimes referred to as **data access latency**.<br>You can use this information to compute average read IO initiation time. |

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| total_write_io_initiation_time | wtIOint | Metric | Microseconds | No | Accumulated total **write** command initiation time (time gap between the IO command and the first response from the storage; the first response can be the first data frame for READ or txfer_rdy for WRITE) observed external to a target external to a switch port. The initiation time is sometimes referred to as **data access latency**.<br>You can use this information to compute average **write** command initiation time. |
| total_read_io_bytes | rtIOb | Metric | Bytes | Yes | Total **read** command data that is observed external to a target external to a switch port. |
| total_write_io_bytes | wtIOb | Metric | Bytes | Yes | Total **write** command data observed external to a target external to a switch port. |
| total_read_io_inter_gap_time | rtIOigt | Metric | Microsecond | No | Accumulated total **read** command intergap time observed external to a target external to a switch port.<br>You can use this information to compute average read IO intergap time. |
| total_write_io_inter_gap_time | wtIOigt | Metric | Microseconds | No | Accumulated total **write** command intergap time data observed external to a target external to a switch port.<br>You can use this information to compute average **write** command intergap time. |
| total_time_metric_based_read_io_count | tmrtIOc | Metric | Count | No | Total completed **read** command data observed external to a target external to a switch port. |

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| **Long Name** | **Short Name** | | | | |
| total_time_metric_based_write_io_count | tmwtIOc | Metric | Count | No | Total completed **write** command data observed external to a target external to a switch port. |
| total_time_metric_based_read_io_bytes | tmrtIOb | Metric | Count | No | Total completed **read** command data observed external to a target external to a switch port, in bytes. |
| total_time_metric_based_write_io_bytes | tmwtIOb | Metric | Count | No | Total completed **write** command data observed external to a target external to a switch port, in bytes. |
| read_io_rate | rIOr | Metric | IOs per second | Yes | The rate of **read** commands observed external to a target external to a switch port.<br>This metric is the average value collected over a 4-second interval from the NPU. |
| peak_read_io_rate | prIOr | Metric | IOs per second | No | The peak rate of **read** commands observed external to a target external to a switch port. |
| write_io_rate | wIOr | Metric | IOs per second | Yes | The rate of **write** commands observed external to a target external to a switch port.<br>This metric is the average value collected over a 4-second interval from the NPU. |
| peak_write_io_rate | pwIOr | Metric | IOs per second | No | The peak rate of **write** commands observed external to a target external to a switch port. |

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| read_io_bandwidth | rIObw | Metric | Bytes per second | Yes | The **read** command bandwidth observed external to a target external to a switch port.<br>This metric is the average value collected over a 4-second interval from the NPU. |
| peak_read_io_bandwidth | prIObw | Metric | Bytes per second | No | Peak **read** command bandwidth observed external to a target external to a switch port. |
| write_io_bandwidth | wIObw | Metric | Bytes per second | Yes | The **write** command bandwidth observed external to a target external to a switch port.<br>This metric is the average value collected over a 4-second interval from the NPU. |
| peak_write_io_bandwidth | pwIObw | Metric | Bytes per second | No | Peak **write** command bandwidth observed external to a target external to a switch port. |
| read_io_size_min | rIOsMi | Metric | Bytes | Yes | Minimum **read** command size observed external to a target external to a switch port. |
| read_io_size_max | rIOsMa | Metric | Bytes | Yes | Maximum **read** command size observed external to a target external to a switch port. |
| write_io_size_min | wIOsMi | Metric | Bytes | Yes | Minimum **write** command size observed external to a target external to a switch port. |
| write_io_size_max | wIOsMa | Metric | Bytes | Yes | Maximum **write** command size observed external to a target external to a switch port. |
| read_io_completion_time_min | rIOctMi | Metric | Microseconds | Yes | Minimum **read** command completion time observed external to a target external to a switch port. |

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| read_io_completion_time_max | rIOctMa | Metric | Microseconds | Yes | Maximum **read** command completion time observed external to a target external to a switch port. |
| write_io_completion_time_min | wIOctMi | Metric | Microseconds | Yes | Minimum **write** command completion time observed external to a target external to a switch port. |
| write_io_completion_time_max | wIOctMa | Metric | Microseconds | Yes | Maximum **write** command completion time observed external to a target external to a switch port. |
| read_io_initiation_time_min | rIOitMi | Metric | Microseconds | Yes | Minimum **read** command initiation time (time gap between the IO command and the first response from the storage; the first response can be the first data frame for READ or txfer_rdy for WRITE) observed external to a target external to a switch port. The initiation time is sometimes referred to as **data access latency**. |
| read_io_initiation_time_max | rIOitMa | Metric | Microseconds | Yes | Maximum **read** command initiation time (time gap between the IO command and the first response from the storage; the first response can be the first data frame for READ or txfer_rdy for WRITE) observed external to a target external to a switch port. The initiation time is sometimes referred to as **data access latency**. |

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| write_io_initiation_time_min | wIOitMi | Metric | Microseconds | Yes | Minimum **write** command initiation time (time gap between the IO command and the first response from the storage; the first response can be the first data frame for READ or txfer_rdy for WRITE) observed external to a target external to a switch port. The initiation time is sometimes referred to as **data access latency**. |
| write_io_initiation_time_max | wIOitMa | Metric | Microseconds | Yes | Maximum **write** command initiation time (time gap between the IO command and the first response from the storage; the first response can be the first data frame for READ or txfer_rdy for WRITE) observed external to a target external to a switch port. The initiation time is sometimes referred to as **data access latency**. |
| read_io_inter_gap_time_min | rIOigtMi | Metric | Microsecond | Yes | Minimum **read** command intergap time observed external to a target external to a switch port.<br>read_io_inter_gap_time_min is the duration between successive IO commands and is measured in 1/256th of a microsecond. |
| read_io_inter_gap_time_max | rIOigtMa | Metric | Microsecond | Yes | Maximum **read** command intergap time observed external to a target external to a switch port.<br>read_io_inter_gap_time_max is the duration between successive IO commands and is measured in 1/256th of a microsecond. |

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| write_io_inter_gap_time_min | wIOigtMi | Metric | Microseconds | Yes | Minimum **write** command intergap time observed external to a target external to a switch port.<br>write_io_inter_gap_time_min is the duration between successive IO commands and is measured in 1/256th of a microsecond. |
| write_io_inter_gap_time_max | wIOigtMa | Metric | Microseconds | Yes | Maximum **write** command intergap time observed external to a target external to a switch port.<br>write_io_inter_gap_time_max is the duration between successive IO commands and is measured in 1/256th of a microsecond. |
| read_io_aborts | rIOa | Metric | Count | Yes | Number of **read** command aborts observed external to a target external to a switch port. |
| write_io_aborts | wIOa | Metric | Count | Yes | Number of **write** command aborts observed external to a target external to a switch port. |
| read_io_failures | rIOf | Metric | Count | Yes | Number of read-command failures observed external to a target external to a switch port. |
| write_io_failures | wIOf | Metric | Count | Yes | Number of **write** command failures observed external to a target external to a switch port. |
| read_io_scsi_check_condition_count | rIOSchcoct | Metric | Count | No | Number of **read** command check conditions seen external to a target external to a switch port. |
| write_io_scsi_check_condition_count | wIOSchcoct | Metric | Count | No | Number of **write** command check conditions seen external to a target external to a switch port. |

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| read_io_scsi_busy_count | rIOsbc | Metric | Count | No | Number of **read** command busy status seen external to a target external to a switch port. |
| write_io_scsi_busy_count | wIOsbc | Metric | Count | No | Number of **write** command busy status seen external to a target external to a switch port. |
| read_io_nvme_lba_out_of_range_count | rIONLbaoorct | Metric | Count | No | Number of **read** command *lba out of range* errors seen. |
| write_io_nvme_lba_out_of_range_count | wIONLbaoorct | Metric | Count | No | Number of **write** command *lba out of range* errors seen. |
| read_io_nvme_ns_not_ready_count | rIOnNsnrc | Metric | Count | No | Number of **read** command *namespace not ready* errors seen. |
| write_io_nvme_ns_not_ready_count | wIOnNsnrc | Metric | Count | No | Number of **write** command *namespace not ready* errors seen. |
| read_io_scsi_reservation_conflict_count | rIOSrecct | Metric | Count | No | Number of **read** command reservation conflicts seen external to a target external to a switch port. |
| read_io_nvme_reservation_conflict_count | rIONrecct | Metric | Count | No | Number of **read** command reservation conflicts seen external to a target external to a switch port. |
| write_io_scsi_reservation_conflict_count | wIOSrecct | Metric | Count | No | Number of **write** command reservation conflicts seen external to a target external to a switch port. |
| write_io_nvme_reservation_conflict_count | wIONrecct | Metric | Count | No | Number of **write** command reservation conflicts seen external to a target external to a switch port. |
| read_io_scsi_queue_full_count | rIOSQfct | Metric | Count | No | Number of **read** command queue full status seen external to a target external to a switch port. |

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| write_io_scsi_queue_full_count | wIOSQfct | Metric | Count | No | Number of **write** command queue full status seen external to a target external to a switch port. |
| sampling_start_time | samStm | Metric | UNIX time | No | Start of the sampling time interval. |
| sampling_end_time | samEtm | Metric | UNIX time | No | End of the sampling time interval. |
| total_busy_period | totBsy | Metric | Count | No | The total time for which the view instances have been active. |
| total_write_io_first_burst_count | totWrFirBu | Metric | Count | No | Accumulated total **write** command first burst observed external to a switch port. |
| total_write_io_array_delay_time | totWrArrDel | Metric | Count | No | Accumulated total **write** command array delays observed external to a switch port. |
| total_write_io_host_delay_time | totWrHosDel | Metric | Count | No | Accumulated total **write** command host delays observed external to a switch port. |
| total_write_io_sequences_count | totWrSeq | Metric | Count | No | Accumulated total **write** command sequences observed external to a switch port. |
| write_io_host_delay_time_min | wrHosDelMn | Metric | Count | No | Minimum **write** command host delays observed external to a switch port. |
| write_io_host_delay_time_max | wrHosDelMx | Metric | Count | No | Maximum **write** command host delays observed external to a switch port. |
| write_io_array_delay_time_max | wrArrDelMx | Metric | Count | No | Maximum **write** command array delays observed external to a switch port. |
| multisequence_exchange_write_io_sequences_min | wrIoSeqMn | Metric | Count | No | Minimum **write** command multisequence exchange sequences observed external to a switch port. |

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| multisequence_exchange_write_io_sequences_max | wrIoSeqMx | Metric | Count | No | Maximum **write** command multisequence exchange sequences observed external to a switch port. |

## Initiator View Instance (scsi_initiator and nvme_initiator)

*Table 24: Flow Metrics for Initiator View Instance*

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| port | port | Key | Text | No | A switch port where the SAN Analytics feature is enabled. |
| vsan | vsan | Key | Count | No | VSAN configured on a switch port with IO since last clearing of metrics. |
| initiator_id | sid | Key | Text | No | Initiator Fibre Channel ID that is external to a switch port where the IO transactions are observed. |
| scsi_initiator_app_count | siac | Metadata | Count | No | Number of applications for which data is hosted on an initiator external to a switch port. |
| nvme_initiator_app_count | niac | Metadata | Count | No | Number of applications for which data is requested by the initiators external to a switch port. |
| active_io_read_count | raIO | Metadata | Count | Yes | Number of outstanding **read** command counts associated with an initiator external to a switch port. |
| active_io_write_count | waIO | Metadata | Count | Yes | Number of outstanding **write** command counts associated with an initiator external to a switch port. |
| scsi_initiator_entity_it_flow_count | siITfc | Metadata | Count | No | Number of IT flows associated with an initiator external to a switch port. |

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| nvme_initiator_entity_it_flow_count | niITfc | Metadata | Count | No | Number of IT flows associated with an initiator external to a switch port. |
| scsi_initiator_entity_itl_flow_count | siITLfc | Metadata | Count | No | Number of ITL flows associated with an initiator external to a switch port. |
| nvme_initiator_entity_itn_flow_count | niITNfc | Metadata | Count | No | Number of ITN flows associated with an initiator external to a switch port. |
| total_abts_count | totAbts | Metric | Count | Yes | Number of aborts observed. |
| total_read_io_count | rtIO | Metric | Count | Yes | Total **read** command data observed external to an initiator external to a switch port. |
| total_write_io_count | wtIO | Metric | Count | Yes | Total **write** command data observed external to an initiator external to a switch port. |
| total_seq_read_io_count | rstIOc | Metric | Count | No | Total sequential **read** command data observed external to an initiator external to a switch port. |
| total_seq_write_io_count | wrstIOc | Metric | Count | No | Total sequential **write** command data observed external to an initiator external to a switch port. |
| total_read_io_time | rtIOt | Metric | Microseconds | No | Accumulated total **read** command completion time observed external to an initiator external to a switch port.<br>You can use this information to compute the average read IO completion time. |

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| total_write_io_time | wtIOt | Metric | Microseconds | No | Accumulated total **write** command completion time observed external to an initiator external to a switch port.<br>You can use this information to compute the average **write** command completion time. |
| total_read_io_initiation_time | rtIOint | Metric | Microseconds | No | Accumulated total **read** command initiation time (time gap between the IO command and the first response from the storage; the first response can be the first data frame for READ commands or the first txfr_rdy for WRITE commands) observed external to an initiator external to a switch port. The initiation time is sometimes referred to as **data access latency**.<br>You can use this information to compute the average read IO initiation time. |
| total_write_io_initiation_time | wtIOint | Metric | Microseconds | No | Accumulated total **write** command initiation time (time gap between the IO command and the first response from the storage; the first response can be the first data frame for READ or txfer_rdy for WRITE) observed external to an initiator external to a switch port. The initiation time is sometimes referred to as **data access latency**.<br>You can use this information to compute the average **write** command initiation time. |
| total_read_io_bytes | rtIOb | Metric | Bytes | Yes | Total **read** command data that is observed external to an initiator external to a switch port. |

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| total_write_io_bytes | wtIOb | Metric | Bytes | Yes | Total **write** command data observed external to an initiator external to a switch port. |
| total_read_io_inter_gap_time | rtIOigt | Metric | Microsecond | No | Accumulated total **read** command intergap time observed external to an initiator external to a switch port.<br>You can use this information to compute the average read IO intergap time. |
| total_write_io_inter_gap_time | wtIOigt | Metric | Microseconds | No | Accumulated total **write** command intergap time data observed external to an initiator external to a switch port.<br>You can use this information to compute the average **write** command intergap time. |
| total_time_metric_based_read_io_count | tmrtIOc | Metric | Count | No | Total completed **read** command data observed external to an initiator external to a switch port. |
| total_time_metric_based_write_io_count | tmwtIOc | Metric | Count | No | Total completed **write** command data observed external to an initiator external to a switch port. |
| total_time_metric_based_read_io_bytes | tmrtIOb | Metric | Count | No | Total completed **read** command data observed external to an initiator external to a switch port, in bytes. |
| total_time_metric_based_write_io_bytes | tmwtIOb | Metric | Count | No | Total completed **write** command data observed external to an initiator external to a switch port, in bytes. |

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| read_io_rate | rIOr | Metric | IOs per second | Yes | The rate of **read** commands observed external to an initiator external to a switch port.<br>This metric is the average value collected over a 4-second interval from the NPU. |
| peak_read_io_rate | prIOr | Metric | IOs per second | No | The peak rate of **read** commands observed external to an initiator external to a switch port. |
| write_io_rate | wIOr | Metric | IOs per second | Yes | The rate of **write** commands observed external to an initiator external to a switch port.<br>This metric is the average value collected over a 4-second interval from the NPU. |
| peak_write_io_rate | pwIOr | Metric | IOs per second | No | The peak rate of **write** commands observed external to an initiator external to a switch port. |
| read_io_bandwidth | rIObw | Metric | Bytes per second | Yes | The **read** command bandwidth observed external to an initiator external to a switch port.<br>This metric is the average value collected over a 4-second interval from the NPU. |
| peak_read_io_bandwidth | prIObw | Metric | Bytes per second | No | Peak **read** command bandwidth observed external to an initiator external to a switch port. |

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| write_io_bandwidth | wIObw | Metric | Bytes per second | Yes | The **write** command bandwidth observed external to an initiator external to a switch port.<br>This metric is the average value collected over a 4-second interval from the NPU. |
| peak_write_io_bandwidth | pwIObw | Metric | Bytes per second | No | Peak **write** command bandwidth observed external to an initiator external to a switch port. |
| read_io_size_min | rIOsMi | Metric | Bytes | Yes | Minimum **read** command size observed external to an initiator external to a switch port. |
| read_io_size_max | rIOsMa | Metric | Bytes | Yes | Maximum **read** command size observed external to an initiator external to a switch port. |
| write_io_size_min | wIOsMi | Metric | Bytes | Yes | Minimum **write** command size observed external to an initiator external to a switch port. |
| write_io_size_max | wIOsMa | Metric | Bytes | Yes | Maximum **write** command size observed external to an initiator external to a switch port. |
| read_io_completion_time_min | rIOctMi | Metric | Microseconds | Yes | Minimum **read** command completion time observed external to an initiator external to a switch port. |
| read_io_completion_time_max | rIOctMa | Metric | Microseconds | Yes | Maximum **read** command completion time observed external to an initiator external to a switch port. |
| write_io_completion_time_min | wIOctMi | Metric | Microseconds | Yes | Minimum **write** command completion time observed external to an initiator external to a switch port. |

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| write_io_completion_time_max | wIOctMa | Metric | Microseconds | Yes | Maximum **write** command completion time observed external to an initiator external to a switch port. |
| read_io_initiation_time_min | rIOitMi | Metric | Microseconds | Yes | Minimum **read** command initiation time (time gap between the IO command and the first response from the storage; the first response can be the first data frame for READ or txfer_rdy for WRITE) observed external to an initiator external to a switch port. The initiation time is sometimes referred to as **data access latency**. |
| read_io_initiation_time_max | rIOitMa | Metric | Microseconds | Yes | Maximum **read** command initiation time (time gap between the IO command and the first response from the storage; the first response can be the first data frame for READ or txfer_rdy for WRITE) observed external to an initiator external to a switch port. The initiation time is sometimes referred to as **data access latency**. |
| write_io_initiation_time_min | wIOitMi | Metric | Microseconds | Yes | Minimum **write** command initiation time (time gap between the IO command and the first response from the storage; the first response can be the first data frame for READ or txfer_rdy for WRITE) observed external to an initiator external to a switch port. The initiation time is sometimes referred to as **data access latency**. |

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| write_io_initiation_time_max | wIOitMa | Metric | Microseconds | Yes | Maximum **write** command initiation time (time gap between the IO command and the first response from the storage; the first response can be the first data frame for READ or txfer_rdy for WRITE) observed external to an initiator external to a switch port. The initiation time is sometimes referred to as **data access latency**. |
| read_io_inter_gap_time_min | rIOigtMi | Metric | Microsecond | Yes | Minimum **read** command intergap time observed external to an initiator external to a switch port.<br>read_io_inter_gap_time_min is the duration between successive IO commands and is measured in 1/256th of a microsecond. |
| read_io_inter_gap_time_max | rIOigtMa | Metric | Microsecond | Yes | Maximum **read** command intergap time observed external to an initiator external to a switch port.<br>read_io_inter_gap_time_max is the duration between successive IO commands and is measured in 1/256th of a microsecond. |
| write_io_inter_gap_time_min | wIOigtMi | Metric | Microseconds | Yes | Minimum **write** command intergap time observed external to an initiator external to a switch port.<br>write_io_inter_gap_time_min is the duration between successive IO commands and is measured in 1/256th of a microsecond. |

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| write_io_inter_gap_time_max | wIOigtMa | Metric | Microseconds | Yes | Maximum **write** command intergap time observed external to an initiator external to a switch port.<br>write_io_inter_gap_time_max is the duration between successive IO commands and is measured in 1/256th of a microsecond. |
| read_io_aborts | rIOa | Metric | Count | Yes | Number of **read** command aborts observed external to an initiator external to a switch port. |
| write_io_aborts | wIOa | Metric | Count | Yes | Number of **write** command aborts observed external to an initiator external to a switch port. |
| read_io_failures | rIOf | Metric | Count | Yes | Number of **read** command failures observed external to an initiator external to a switch port. |
| write_io_failures | wIOf | Metric | Count | Yes | Number of **write** command failures observed external to an initiator external to a switch port. |
| read_io_scsi_check_condition_count | rIOSchcoct | Metric | Count | No | Number of **read** command check conditions seen external to an initiator external to a switch port. |
| write_io_scsi_check_condition_count | wIOSchcoct | Metric | Count | No | Number of **write** command check conditions seen external to an initiator external to a switch port. |
| read_io_scsi_busy_count | rIOsbc | Metric | Count | No | Number of **read** command busy status seen external to an initiator external to a switch port. |
| write_io_scsi_busy_count | wIOsbc | Metric | Count | No | Number of **write** command busy status seen external to an initiator external to a switch port. |

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| read_io_nvme_lba_out_of_range_count | rIONLbaoorct | Metric | Count | No | Number of **read** command *lba out of range* errors seen. |
| write_io_nvme_lba_out_of_range_count | wIONLbaoorct | Metric | Count | No | Number of **write** command *lba out of range* errors seen. |
| read_io_nvme_ns_not_ready_count | rIOnNsnrc | Metric | Count | No | Number of **read** command *namespace not ready* errors seen. |
| write_io_nvme_ns_not_ready_count | wIOnNsnrc | Metric | Count | No | Number of **write** command *namespace not ready* errors seen. |
| read_io_scsi_reservation_conflict_count | rIOSrecct | Metric | Count | No | Number of **read** command reservation conflicts seen external to an initiator external to a switch port. |
| read_io_nvme_reservation_conflict_count | rIONrecct | Metric | Count | No | Number of **read** command reservation conflicts seen external to an initiator external to a switch port. |
| write_io_scsi_reservation_conflict_count | wIOSrecct | Metric | Count | No | Number of **write** command reservation conflicts seen external to an initiator external to a switch port. |
| write_io_nvme_reservation_conflict_count | wIONrecct | Metric | Count | No | Number of **write** command reservation conflicts seen external to an initiator external to a switch port. |
| read_io_scsi_queue_full_count | rIOSQfct | Metric | Count | No | Number of **read** command queue full status seen external to an initiator external to a switch port. |
| write_io_scsi_queue_full_count | wIOSQfct | Metric | Count | No | Number of **write** command queue full status seen external to an initiator external to a switch port. |
| sampling_start_time | samStm | Metric | UNIX time | No | Start of the sampling time interval. |
| sampling_end_time | samEtm | Metric | UNIX time | No | End of the sampling time interval. |

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| total_busy_period | totBsy | Metric | Count | No | The total time for which the view instances have been active. |
| total_write_io_first_burst_count | totWrFirBu | Metric | Count | No | Accumulated total **write** command first burst observed external to a switch port. |
| total_write_io_array_delay_time | totWrArrDel | Metric | Count | No | Accumulated total **write** command array delays observed external to a switch port. |
| total_write_io_host_delay_time | totWrHosDel | Metric | Count | No | Accumulated total **write** command host delays observed external to a switch port. |
| total_write_io_sequences_count | totWrSeq | Metric | Count | No | Accumulated total **write** command sequences observed external to a switch port. |
| write_io_host_delay_time_min | wrHosDelMn | Metric | Count | No | Minimum **write** command host delays observed external to a switch port. |
| write_io_host_delay_time_max | wrHosDelMx | Metric | Count | No | Maximum **write** command host delays observed external to a switch port. |
| write_io_array_delay_time_max | wrArrDelMx | Metric | Count | No | Maximum **write** command array delays observed external to a switch port. |
| multisequence_exchange_write_io_sequences_min | wrIoSeqMn | Metric | Count | No | Minimum **write** command multisequence exchange sequences observed external to a switch port. |
| multisequence_exchange_write_io_sequences_max | wrIoSeqMx | Metric | Count | No | Maximum **write** command multisequence exchange sequences observed external to a switch port. |

# Target Application View Instance (scsi_target_app and nvme_target_app)

*Table 25: Flow Metrics for Target Application View Instance*

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| port | port | Key | text | No | A switch port where the SAN Analytics feature is enabled. |
| vsan | vsan | Key | Count | No | VSAN configured on a switch port with IO since last clearing of metrics. |
| app_id | app_id | Key | Count | No | Application identifier for an application external to a switch port. |
| target_id | did | Key | text | No | Target Fibre Channel ID that is external to a switch port with IO since last clearing of metrics. |
| scsi_target_entity_itl_flow_count | stITLfc | Metadata | Count | No | Number of ITL flows associated with an application for which data is hosted on a target external to a switch port. |
| nvme_target_entity_itn_flow_count | ntITNfc | Metadata | Count | No | Number of ITN flows associated with an application for which data is hosted on a target external to a switch port. |
| scsi_target_lun_count | stLc | Metadata | Count | No | Number of LUNs seen external to an application on a target external to a switch port. |
| nvme_target_namespace_count | ntNc | Metadata | Count | No | Number of namespace IDs seen external to an application on a target external to a switch port. |
| active_io_read_count | raIO | Metadata | Count | Yes | Number of outstanding **read** command counts associated with an application external to a target external to a switch port. |
| active_io_write_count | waIO | Metadata | Count | Yes | Number of outstanding **write** command counts associated with an application external to a target external to a switch port. |
| sampling_start_time | samStm | Metric | UNIX time | No | Start of the sampling time interval. |
| sampling_end_time | samEtm | Metric | UNIX time | No | End of the sampling time interval. |

# Initiator Application View Instance (scsi_initiator_app and nvme_initiator_app)

*Table 26: Flow Metrics for Initiator Application View Instance*

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| port | port | Key | text | No | A switch port where the SAN Analytics feature is enabled. |
| vsan | vsan | Key | Count | No | VSAN configured on a switch port with IO since last clearing of metrics. |
| app_id | app_id | Key | Count | No | Application identifier for an application external to a switch port. |
| initiator_id | sid | Key | text | No | Initiator Fibre Channel ID external to a switch port where the IO transactions are observed. |
| scsi_initiator_entity_itl_flow_count | siITLfc | Metadata | Count | No | Number of ITL flows associated with an application for which data is accessed by an initiator external to a switch port. |
| nvme_initiator_entity_itn_flow_count | niITNfc | Metadata | Count | No | Number of ITN flows associated with an application for which data is accessed by an initiator external to a switch port. |
| active_io_read_count | raIO | Metadata | Count | Yes | Number of outstanding **read** command counts associated with an application for which the data is accessed by an initiator external to a switch port. |
| active_io_write_count | waIO | Metadata | Count | Yes | Number of outstanding **write** command counts associated with an application for which the data is accessed by an initiator external to a switch port. |
| sampling_start_time | samStm | Metric | UNIX time | No | Start of the sampling time interval. |
| sampling_end_time | samEtm | Metric | UNIX time | No | End of the sampling time interval. |

# Target IT Flow View Instance (scsi_target_it_flow and nvme_target_it_flow)

*Table 27: Flow Metrics for Target IT Flow View Instance*

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| port | port | Key | text | No | A switch port where the SAN Analytics feature is enabled. |

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| vsan | vsan | Key | Count | No | VSAN configured on a switch port with IO since last clearing of metrics. |
| target_id | did | Key | Text | No | Target Fibre Channel ID external to a switch port with IO since last clearing of metrics. |
| initiator_id | sid | Key | text | No | Initiator Fibre Channel ID where the IO transactions are being performed on a target external to a switch port. |
| active_io_read_count | raIO | Metadata | Count | Yes | Number of outstanding **read** command counts associated with a target-IT-flow record. |
| active_io_write_count | waIO | Metadata | Count | Yes | Number of outstanding **write** command counts associated with a target-IT-flow record. |
| scsi_target_entity_itl_flow_count | stITLfc | Metadata | Count | No | Number of ITL flows associated with a target-IT-flow record. |
| nvme_target_entity_itn_flow_count | ntITNfc | Metadata | Count | No | Number of ITN flows associated with a target-IT-flow record. |
| total_abts_count | totAbts | Metric | Count | Yes | Number of aborts observed. |
| total_read_io_count | rtIO | Metric | Count | Yes | Total **read** command data observed external to a target-IT-flow record. |
| total_write_io_count | wtIO | Metric | Count | Yes | Total **write** command data observed external to a target-IT-flow record. |
| total_seq_read_io_count | rstIOc | Metric | Count | No | Total sequential **read** command data observed external to a target-IT-flow record. |
| total_seq_write_io_count | wrstIOc | Metric | Count | No | Total sequential **write** command data observed external to a target-IT-flow record. |

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| total_read_io_time | rtIOt | Metric | Microseconds | No | Accumulated total **read** command completion time observed external to a target-IT-flow record.<br>You can use this information to compute the average read IO completion time. |
| total_write_io_time | wtIOt | Metric | Microseconds | No | Accumulated total **write** command completion time observed external to a target-IT-flow record.<br>You can use this information to compute the average **write** command completion time. |
| total_read_io_initiation_time | rtIOint | Metric | Microseconds | No | Accumulated total **read** command initiation time (time gap between the IO command and the first response from the storage; the first response can be the first data frame for READ commands or the first txfr_rdy for WRITE commands) observed external to a target-IT-flow record. The initiation time is sometimes referred to as **data access latency**.<br>You can use this information to compute the average read IO initiation time. |

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| total_write_io_initiation_time | wtIOint | Metric | Microseconds | No | Accumulated total **write** command initiation time (time gap between the IO command and the first response from the storage; the first response can be the first data frame for READ or txfer_rdy for WRITE) observed external to a target-IT-flow record. The initiation time is sometimes referred to as **data access latency**.<br>You can use this information to compute the average **write** command initiation time. |
| total_read_io_bytes | rtIOb | Metric | Bytes | Yes | Total **read** command data that is observed external to a target-IT-flow record. |
| total_write_io_bytes | wtIOb | Metric | Bytes | Yes | Total **write** command data observed external to a target-IT-flow record. |
| total_read_io_inter_gap_time | rtIOigt | Metric | Microsecond | No | Accumulated total **read** command intergap time observed external to a target-IT-flow record.<br>You can use this information to compute the average read IO intergap time. |
| total_write_io_inter_gap_time | wtIOigt | Metric | Microseconds | No | Accumulated total **write** command intergap time data observed external to a target-IT-flow record.<br>You can use this information to compute the average **write** command intergap time. |
| total_time_metric_based_read_io_count | tmrtIOc | Metric | Count | No | Total completed **read** command data observed external to a target-IT-flow record. |

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| total_time_metric_based_write_io_count | tmwtIOc | Metric | Count | No | Total completed **write** command data observed external to a target-IT-flow record. |
| total_time_metric_based_read_io_bytes | tmrtIOb | Metric | Count | No | Total completed **read** command data observed external to a target-IT-flow record, in bytes. |
| total_time_metric_based_write_io_bytes | tmwtIOb | Metric | Count | No | Total completed **write** command data observed external to a target-IT-flow record, in bytes. |
| read_io_rate | rIOr | Metric | IOs per second | Yes | The rate of **read** commands observed external to a target-IT-flow record.<br>This metric is the average value collected over a 4-second interval from the NPU. |
| peak_read_io_rate | prIOr | Metric | IOs per second | No | The peak rate of **read** commands observed external to a target-IT-flow record. |
| write_io_rate | wIOr | Metric | IOs per second | Yes | The rate of **write** commands observed external to a target-IT-flow record.<br>This metric is the average value collected over a 4-second interval from the NPU. |
| peak_write_io_rate | pwIOr | Metric | IOs per second | No | The rate of peak **write** commands observed external to a target-IT-flow record. |
| read_io_bandwidth | rIObw | Metric | Bytes per second | Yes | The **read** command bandwidth observed external to a target-IT-flow record.<br>This metric is the average value collected over a 4-second interval from the NPU. |

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| peak_read_io_bandwidth | prIObw | Metric | Bytes per second | No | Peak **read** command bandwidth observed external to a target-IT-flow record. |
| write_io_bandwidth | wIObw | Metric | Bytes per second | Yes | The **write** command bandwidth observed external to a target-IT-flow record.<br>This metric is the average value collected over a 4-second interval from the NPU. |
| peak_write_io_bandwidth | pwIObw | Metric | Bytes per second | No | Peak **write** command bandwidth observed external to a target-IT-flow record. |
| read_io_size_min | rIOsMi | Metric | Bytes | Yes | Minimum **read** command size observed external to a target-IT-flow record. |
| read_io_size_max | rIOsMa | Metric | Bytes | Yes | Maximum **read** command size observed external to a target-IT-flow record. |
| write_io_size_min | wIOsMi | Metric | Bytes | Yes | Minimum **write** command size observed external to a target-IT-flow record. |
| write_io_size_max | wIOsMa | Metric | Bytes | Yes | Maximum **write** command size observed external to a target-IT-flow record. |
| read_io_completion_time_min | rIOctMi | Metric | Microseconds | Yes | Minimum **read** command completion time observed external to a target-IT-flow record. |
| read_io_completion_time_max | rIOctMa | Metric | Microseconds | Yes | Maximum **read** command completion time observed external to a target-IT-flow record. |
| write_io_completion_time_min | wIOctMi | Metric | Microseconds | Yes | Minimum **write** command completion time observed external to a target-IT-flow record. |

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| write_io_completion_time_max | wIOctMa | Metric | Microseconds | Yes | Maximum **write** command completion time observed external to a target-IT-flow record. |
| read_io_initiation_time_min | rIOitMi | Metric | Microseconds | Yes | Minimum **read** command initiation time (time gap between the IO command and the first response from the storage; the first response can be the first data frame for READ or txfer_rdy for WRITE) observed external to a target-IT-flow record. The initiation time is sometimes referred to as **data access latency**. |
| read_io_initiation_time_max | rIOitMa | Metric | Microseconds | Yes | Maximum **read** command initiation time (time gap between the IO command and the first response from the storage; the first response can be the first data frame for READ or txfer_rdy for WRITE) observed external to a target-IT-flow record. The initiation time is sometimes referred to as **data access latency**. |
| write_io_initiation_time_min | wIOitMi | Metric | Microseconds | Yes | Minimum **write** command initiation time (time gap between the IO command and the first response from the storage; the first response can be the first data frame for READ or txfer_rdy for WRITE) observed external to a target-IT-flow record. The initiation time is sometimes referred to as **data access latency**. |

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| write_io_initiation_time_max | wIOitMa | Metric | Microseconds | Yes | Maximum **write** command initiation time (time gap between the IO command and the first response from the storage; the first response can be the first data frame for READ or txfer_rdy for WRITE) observed external to a target-IT-flow record. The initiation time is sometimes referred to as **data access latency**. |
| read_io_inter_gap_time_min | rIOigtMi | Metric | Microsecond | Yes | Minimum **read** command intergap time observed external to a target-IT-flow record.<br>read_io_inter_gap_time_min is the duration between successive IO commands and is measured in 1/256th of a microsecond. |
| read_io_inter_gap_time_max | rIOigtMa | Metric | Microsecond | Yes | Maximum **read** command intergap time observed external to a target-IT-flow record.<br>read_io_inter_gap_time_max is the duration between successive IO commands and is measured in 1/256th of a microsecond. |
| write_io_inter_gap_time_min | wIOigtMi | Metric | Microseconds | Yes | Minimum **write** command intergap time observed external to a target-IT-flow record.<br>write_io_inter_gap_time_min is the duration between successive IO commands and is measured in 1/256th of a microsecond. |

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| write_io_inter_gap_time_max | wIOigtMa | Metric | Microseconds | Yes | Maximum **write** command intergap time observed external to a target-IT-flow record.<br>write_io_inter_gap_time_max is the duration between successive IO commands and is measured in 1/256th of a microsecond. |
| read_io_aborts | rIOa | Metric | Count | Yes | Number of **read** command aborts observed external to a target-IT-flow record. |
| write_io_aborts | wIOa | Metric | Count | Yes | Number of **write** command aborts observed external to a target-IT-flow record. |
| read_io_failures | rIOf | Metric | Count | Yes | Number of **read** command failures observed external to a target-IT-flow record. |
| write_io_failures | wIOf | Metric | Count | Yes | Number of **write** command failures observed external to a target-IT-flow record. |
| read_io_scsi_check_condition_count | rIOSchcoct | Metric | Count | No | Number of **read** command check conditions seen external to a target-IT-flow record. |
| write_io_scsi_check_condition_count | wIOSchcoct | Metric | Count | No | Number of **write** command check conditions seen external to a target-IT-flow record. |
| read_io_scsi_busy_count | rIOsbc | Metric | Count | No | Number of **read** command busy status seen external to a target-IT-flow record. |
| write_io_scsi_busy_count | wIOsbc | Metric | Count | No | Number of **write** command busy status seen external to a target-IT-flow record. |
| read_io_nvme_lba_out_of_range_count | rIONLbaoorct | Metric | Count | No | Number of **read** command *lba out of range* errors seen. |
| write_io_nvme_lba_out_of_range_count | wIONLbaoorct | Metric | Count | No | Number of **write** command *lba out of range* errors seen. |

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| read_io_nvme_ns_not_ready_count | rIOnNsnrc | Metric | Count | No | Number of **read** command *namespace not ready* errors seen. |
| write_io_nvme_ns_not_ready_count | wIOnNsnrc | Metric | Count | No | Number of **write** command *namespace not ready* errors seen. |
| read_io_scsi_reservation_conflict_count | rIOSrecct | Metric | Count | No | Number of **read** command reservation conflicts seen external to a target-IT-flow record. |
| read_io_nvme_reservation_conflict_count | rIONrecct | Metric | Count | No | Number of **read** command reservation conflicts seen external to a target-IT-flow record. |
| write_io_scsi_reservation_conflict_count | wIOSrecct | Metric | Count | No | Number of **write** command reservation conflicts seen external to a target-IT-flow record. |
| write_io_nvme_reservation_conflict_count | wIONrecct | Metric | Count | No | Number of **write** command reservation conflicts seen external to a target-IT-flow record. |
| read_io_scsi_queue_full_count | rIOSQfct | Metric | Count | No | Number of **read** command queue full status seen external to a target-IT-flow record. |
| write_io_scsi_queue_full_count | wIOSQfct | Metric | Count | No | Number of **write** command queue full status seen external to a target-IT-flow record. |
| sampling_start_time | samStm | Metric | UNIX time | No | Start of the sampling time interval. |
| sampling_end_time | samEtm | Metric | UNIX time | No | End of the sampling time interval. |
| total_busy_period | totBsy | Metric | Count | No | The total time for which the view instances have been active. |
| total_write_io_first_burst_count | totWrFirBu | Metric | Count | No | Accumulated total **write** command first burst observed external to a switch port. |

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| total_write_io_array_delay_time | totWrArrDel | Metric | Count | No | Accumulated total **write** command array delays observed external to a switch port. |
| total_write_io_host_delay_time | totWrHosDel | Metric | Count | No | Accumulated total **write** command host delays observed external to a switch port. |
| total_write_io_sequences_count | totWrSeq | Metric | Count | No | Accumulated total **write** command sequences observed external to a switch port. |
| write_io_host_delay_time_min | wrHosDelMn | Metric | Count | No | Minimum **write** command host delays observed external to a switch port. |
| write_io_host_delay_time_max | wrHosDelMx | Metric | Count | No | Maximum **write** command host delays observed external to a switch port. |
| write_io_array_delay_time_max | wrArrDelMx | Metric | Count | No | Maximum **write** command array delays observed external to a switch port. |
| multisequence_exchange_write_io_sequences_min | wrIoSeqMn | Metric | Count | No | Minimum **write** command multisequence exchange sequences observed external to a switch port. |
| multisequence_exchange_write_io_sequences_max | wrIoSeqMx | Metric | Count | No | Maximum **write** command multisequence exchange sequences observed external to a switch port. |

## Initiator IT Flow View Instance (scsi_initiator_it_flow and nvme_initiator_it_flow)

***Table 28: Flow Metrics for Initiator IT Flow View Instance***

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| port | port | Key | Text | No | A switch port where the SAN Analytics feature is enabled. |

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| vsan | vsan | Key | Count | No | VSAN configured on a switch port with IO since last clearing of metrics. |
| initiator_id | sid | Key | Text | No | Initiator Fibre Channel ID external to a switch port where the IO transactions are observed. |
| target_id | did | Key | Text | No | Target Fibre Channel ID that is executing IO transactions initiated by an initiator external to a switch port. |
| active_io_read_count | raIO | Metadata | Count | Yes | Number of outstanding **read** command counts associated with an initiator-IT-flow record. |
| active_io_write_count | waIO | Metadata | Count | Yes | Number of outstanding **write** command counts associated with an initiator-IT-flow record. |
| scsi_initiator_entity_itl_flow_count | siITLfc | Metadata | Count | No | Number of ITL-flows associated with an initiator-IT-flow record. |
| nvme_initiator_entity_itn_flow_count | niITNfc | Metadata | Count | No | Number of ITN-flows associated with an initiator-IT-flow record. |
| total_abts_count | totAbts | Metric | Count | Yes | Number of aborts observed. |
| total_read_io_count | rtIO | Metric | Count | Yes | Total **read** command data observed external to an initiator-IT-flow record. |
| total_write_io_count | wtIO | Metric | Count | Yes | Total **write** command data observed external to an initiator-IT-flow record. |
| total_seq_read_io_count | rstIOc | Metric | Count | No | Total sequential **read** command data observed external to an initiator-IT-flow record. |

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| total_read_io_time | rtIOt | Metric | Microseconds | No | Accumulated total **read** command completion time observed external to an initiator-IT-flow record.<br>You can use this information to compute the average read IO completion time. |
| total_seq_write_io_count | wrstIOc | Metric | Count | No | Total sequential **write** command data observed external to an initiator-IT-flow record. |
| total_write_io_time | wtIOt | Metric | Microseconds | No | Accumulated total **write** command completion time observed external to an initiator-IT-flow record.<br>You can use this information to compute the average **write** command completion time. |
| total_read_io_initiation_time | rtIOint | Metric | Microseconds | No | Accumulated total **read** command initiation time (time gap between the IO command and the first response from the storage; the first response can be the first data frame for READ commands or the first txfr_rdy for WRITE commands) observed external to an initiator-IT-flow record. The initiation time is sometimes referred to as **data access latency**.<br>You can use this information to compute the average read IO initiation time. |

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| total_write_io_initiation_time | wtIOint | Metric | Microseconds | No | Accumulated total **write** command initiation time (time gap between the IO command and the first response from the storage; the first response can be the first data frame for READ or txfer_rdy for WRITE) observed external to an initiator-IT-flow record. The initiation time is sometimes referred to as **data access latency**.<br>You can use this information to compute the average **write** command initiation time. |
| total_read_io_bytes | rtIOb | Metric | Bytes | Yes | Total **read** command data that is observed external to an initiator-IT-flow record. |
| total_write_io_bytes | wtIOb | Metric | Bytes | Yes | Total **write** command data observed external to an initiator-IT-flow record. |
| total_read_io_inter_gap_time | rtIOigt | Metric | Microsecond | No | Accumulated total **read** command intergap time observed external to an initiator-IT-flow record.<br>You can use this information to compute the average read IO intergap time. |
| total_write_io_inter_gap_time | wtIOigt | Metric | Microseconds | No | Accumulated total **write** command intergap time data observed external to an initiator-IT-flow record.<br>You can use this information to compute the average **write** command intergap time. |
| total_time_metric_based_read_io_count | tmrtIOc | Metric | Count | No | Total completed **read** command data observed external to an initiator-IT-flow record. |

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| total_time_metric_based_write_io_count | tmwtIOc | Metric | Count | No | Total completed **write** command data observed external to an initiator-IT-flow record. |
| total_time_metric_based_read_io_bytes | tmrtIOb | Metric | Count | No | Total completed **read** command data observed external to an initiator-IT-flow record, in bytes. |
| total_time_metric_based_write_io_bytes | tmwtIOb | Metric | Count | No | Total completed **write** command data observed external to an initiator-IT-flow record, in bytes. |
| read_io_rate | rIOr | Metric | IOs per second | Yes | The rate of **read** commands observed external to an initiator-IT-flow record.<br>This metric is the average value collected over a 4-second interval from the NPU. |
| peak_read_io_rate | prIOr | Metric | IOs per second | No | The peak rate of **read** commands observed external to an initiator-IT-flow record. |
| write_io_rate | wIOr | Metric | IOs per second | Yes | The rate of **write** commands observed external to an initiator-IT-flow record.<br>This metric is the average value collected over a 4-second interval from the NPU. |
| peak_write_io_rate | pwIOr | Metric | IOs per second | No | The peak rate of **write** commands observed external to an initiator-IT-flow record. |
| read_io_bandwidth | rIObw | Metric | Bytes per second | Yes | The **read** command bandwidth observed external to an initiator-IT-flow record.<br>This metric is the average value collected over a 4-second interval from the NPU. |

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| peak_read_io_bandwidth | prIObw | Metric | Bytes per second | No | Peak **read** command bandwidth observed external to an initiator-IT-flow record. |
| write_io_bandwidth | wIObw | Metric | Bytes per second | Yes | The **write** command bandwidth observed external to an initiator-IT-flow record.<br>This metric is the average value collected over a 4-second interval from the NPU. |
| peak_write_io_bandwidth | pwIObw | Metric | Bytes per second | No | Peak **write** command bandwidth observed external to an initiator-IT-flow record. |
| read_io_size_min | rIOsMi | Metric | Bytes | Yes | Minimum **read** command size observed external to an initiator-IT-flow record. |
| read_io_size_max | rIOsMa | Metric | Bytes | Yes | Maximum **read** command size observed external to an initiator-IT-flow record. |
| write_io_size_min | wIOsMi | Metric | Bytes | Yes | Minimum **write** command size observed external to an initiator-IT-flow record. |
| write_io_size_max | wIOsMa | Metric | Bytes | Yes | Maximum **write** command size observed external to an initiator-IT-flow record. |
| read_io_completion_time_min | rIOctMi | Metric | Microseconds | Yes | Minimum **read** command completion time observed external to an initiator-IT-flow record. |
| read_io_completion_time_max | rIOctMa | Metric | Microseconds | Yes | Maximum **read** command completion time observed external to an initiator-IT-flow record. |
| write_io_completion_time_min | wIOctMi | Metric | Microseconds | Yes | Minimum **write** command completion time observed external to an initiator-IT-flow record. |

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| write_io_completion_time_max | wIOctMa | Metric | Microseconds | Yes | Maximum **write** command completion time observed external to an initiator-IT-flow record. |
| read_io_initiation_time_min | rIOitMi | Metric | Microseconds | Yes | Minimum **read** command initiation time (time gap between the IO command and the first response from the storage; the first response can be the first data frame for READ or txfer_rdy for WRITE) observed external to an initiator-IT-flow record. The initiation time is sometimes referred to as **data access latency**. |
| read_io_initiation_time_max | rIOitMa | Metric | Microseconds | Yes | Maximum **read** command initiation time (time gap between the IO command and the first response from the storage; the first response can be the first data frame for READ or txfer_rdy for WRITE) observed external to an initiator-IT-flow record. The initiation time is sometimes referred to as **data access latency**. |
| write_io_initiation_time_min | wIOitMi | Metric | Microseconds | Yes | Minimum **write** command initiation time (time gap between the IO command and the first response from the storage; the first response can be the first data frame for READ or txfer_rdy for WRITE) observed external to an initiator-IT-flow record. The initiation time is sometimes referred to as **data access latency**. |

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| write_io_initiation_time_max | wIOitMa | Metric | Microseconds | Yes | Maximum **write** command initiation time (time gap between the IO command and the first response from the storage; the first response can be the first data frame for READ or txfer_rdy for WRITE) observed external to an initiator-IT-flow record. The initiation time is sometimes referred to as **data access latency**. |
| read_io_inter_gap_time_min | rIOigtMi | Metric | Microsecond | Yes | Minimum **read** command intergap time observed external to an initiator-IT-flow record.<br>read_io_inter_gap_time_min is the duration between successive IO commands and is measured in 1/256th of a microsecond. |
| read_io_inter_gap_time_max | rIOigtMa | Metric | Microsecond | Yes | Maximum **read** command intergap time observed external to an initiator-IT-flow record.<br>read_io_inter_gap_time_max is the duration between successive IO commands and is measured in 1/256th of a microsecond. |
| write_io_inter_gap_time_min | wIOigtMi | Metric | Microseconds | Yes | Minimum **write** command intergap time observed external to an initiator-IT-flow record.<br>write_io_inter_gap_time_min is the duration between successive IO commands and is measured in 1/256th of a microsecond. |

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| write_io_inter_gap_time_max | wIOigtMa | Metric | Microseconds | Yes | Maximum **write** command intergap time observed external to an initiator-IT-flow record.<br>write_io_inter_gap_time_max is the duration between successive IO commands and is measured in 1/256th of a microsecond. |
| read_io_aborts | rIOa | Metric | Count | Yes | Number of **read** command aborts observed external to an initiator-IT-flow record. |
| write_io_aborts | wIOa | Metric | Count | Yes | Number of **write** command aborts observed external to an initiator-IT-flow record. |
| read_io_failures | rIOf | Metric | Count | Yes | Number of **read** command failures observed external to an initiator-IT-flow record. |
| write_io_failures | wIOf | Metric | Count | Yes | Number of **write** command failures observed external to an initiator-IT-flow record. |
| read_io_scsi_check_condition_count | rIOSchcoct | Metric | Count | No | Number of **read** command check conditions seen external to an initiator-IT-flow record. |
| write_io_scsi_check_condition_count | wIOSchcoct | Metric | Count | No | Number of **write** command check conditions seen external to an initiator-IT-flow record. |
| read_io_scsi_busy_count | rIOsbc | Metric | Count | No | Number of **read** command busy status seen external to an initiator-IT-flow record. |
| write_io_scsi_busy_count | wIOsbc | Metric | Count | No | Number of **write** command busy status seen external to an initiator-IT-flow record. |
| read_io_nvme_lba_out_of_range_count | rIONLbaoorct | Metric | Count | No | Number of **read** command *lba out of range* errors seen. |
| write_io_nvme_lba_out_of_range_count | wIONLbaoorct | Metric | Count | No | Number of **write** command *lba out of range* errors seen. |

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| **Long Name** | **Short Name** | | | | |
| read_io_nvme_ns_not_ready_count | rIOnNsnrc | Metric | Count | No | Number of **read** command *namespace not ready* errors seen. |
| write_io_nvme_ns_not_ready_count | wIOnNsnrc | Metric | Count | No | Number of **write** command *namespace not ready* errors seen. |
| read_io_scsi_reservation_conflict_count | rIOSrecct | Metric | Count | No | Number of **read** command reservation conflicts seen external to an initiator-IT-flow record. |
| read_io_nvme_reservation_conflict_count | rIONrecct | Metric | Count | No | Number of **read** command reservation conflicts seen external to an initiator-IT-flow record. |
| write_io_scsi_reservation_conflict_count | wIOSrecct | Metric | Count | No | Number of **write** command reservation conflicts seen external to an initiator-IT-flow record. |
| write_io_nvme_reservation_conflict_count | wIONrecct | Metric | Count | No | Number of **write** command reservation conflicts seen external to an initiator-IT-flow record. |
| read_io_scsi_queue_full_count | rIOSQfct | Metric | Count | No | Number of **read** command queue full status seen external to an initiator-IT-flow record. |
| write_io_scsi_queue_full_count | wIOSQfct | Metric | Count | No | Number of **write** command queue full status seen external to an initiator-IT-flow record. |
| sampling_start_time | samStm | Metric | UNIX time | No | Start of the sampling time interval. |
| sampling_end_time | samEtm | Metric | UNIX time | No | End of the sampling time interval. |
| total_busy_period | totBsy | Metric | Count | No | The total time for which the view instances have been active. |
| total_write_io_first_burst_count | totWrFirBu | Metric | Count | No | Accumulated total **write** command first burst observed external to a switch port. |

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| total_write_io_array_delay_time | totWrArrDel | Metric | Count | No | Accumulated total **write** command array delays observed external to a switch port. |
| total_write_io_host_delay_time | totWrHosDel | Metric | Count | No | Accumulated total **write** command host delays observed external to a switch port. |
| total_write_io_sequences_count | totWrSeq | Metric | Count | No | Accumulated total **write** command sequences observed external to a switch port. |
| write_io_host_delay_time_min | wrHosDelMn | Metric | Count | No | Minimum **write** command host delays observed external to a switch port. |
| write_io_host_delay_time_max | wrHosDelMx | Metric | Count | No | Maximum **write** command host delays observed external to a switch port. |
| write_io_array_delay_time_max | wrArrDelMx | Metric | Count | No | Maximum **write** command array delays observed external to a switch port. |
| multisequence_exchange_write_io_sequences_min | wrIoSeqMn | Metric | Count | No | Minimum **write** command multisequence exchange sequences observed external to a switch port. |
| multisequence_exchange_write_io_sequences_max | wrIoSeqMx | Metric | Count | No | Maximum **write** command multisequence exchange sequences observed external to a switch port. |

## Target TL Flow View Instance (scsi_target_tl_flow)

**Note** The flow metrics for *Target TL Flow View Instance* are applicable only for the SCSI analytics type.

*Table 29: Flow Metrics for Target TL Flow View Instance*

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| port | port | Key | Text | No | A switch port where the SAN Analytics feature is enabled. |
| vsan | vsan | Key | Count | No | VSAN configured on a switch port with IO since last clearing of metrics. |
| target_id | did | Key | Text | No | Target Fibre Channel ID that is external to a switch port with IO since last clearing of metrics. |
| lun | lun | Key | Unit | No | Logical-unit-number (LUN) that is associated with a target where IOs are performed. |
| scsi_target_entity_itl_flow_count | stITLfc | Metadata | Count | No | Number of ITL flows associated with a LUN on a target external to a switch port. |
| active_io_read_count | raIO | Metadata | Count | Yes | Number of outstanding **read** command counts associated with a LUN on a target external to a switch port. |
| active_io_write_count | waIO | Metadata | Count | Yes | Number of outstanding **write** command counts associated with a LUN on a target external to a switch port. |
| total_read_io_count | rtIO | Metric | Count | Yes | Total **read** command data observed external to a LUN on a target external to a switch port. |
| total_write_io_count | wtIO | Metric | Count | Yes | Total **write** command data observed external to a LUN on a target external to a switch port. |
| total_seq_read_io_count | rstIOc | Metric | Count | No | Total sequential **read** command data observed external to a LUN on a target external to a switch port. |
| total_seq_write_io_count | wrstIOc | Metric | Count | No | Total sequential **write** command data observed external to a LUN on a target external to a switch port. |

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| total_read_io_time | rtIOt | Metric | Microseconds | No | Accumulated total **read** command completion time observed external to a LUN on a target external to a switch port.<br>You can use this information to compute the average read IO completion time. |
| total_write_io_time | wtIOt | Metric | Microseconds | No | Accumulated total **write** command completion time observed external to a LUN on a target external to a switch port.<br>You can use this information to compute the average **write** command completion time. |
| total_read_io_initiation_time | rtIOint | Metric | Microseconds | No | Accumulated total **read** command initiation time (time gap between the IO command and the first response from the storage; the first response can be the first data frame for READ commands or the first txfr_rdy for WRITE commands) observed external to a LUN on a target external to a switch port. The initiation time is sometimes referred to as **data access latency**.<br>You can use this information to compute the average read IO initiation time. |

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| total_write_io_initiation_time | wtIOint | Metric | Microseconds | No | Accumulated total **write** command initiation time (time gap between the IO command and the first response from the storage; the first response can be the first data frame for READ or txfer_rdy for WRITE) observed external to a LUN on a target external to a switch port. The initiation time is sometimes referred to as **data access latency**.<br>You can use this information to compute the average **write** command initiation time. |
| total_read_io_bytes | rtIOb | Metric | Bytes | Yes | Total **read** command data that is observed external to a LUN on a target external to a switch port. |
| total_write_io_bytes | wtIOb | Metric | Bytes | Yes | Total **write** command data observed external to a LUN on a target external to a switch port. |
| total_read_io_inter_gap_time | rtIOigt | Metric | Microsecond | No | Accumulated total **read** command intergap time observed external to a LUN on a target external to a switch port.<br>You can use this information to compute the average read IO intergap time. |
| total_write_io_inter_gap_time | wtIOigt | Metric | Microseconds | No | Accumulated total **write** command intergap time data observed external to a LUN on a target external to a switch port.<br>You can use this information to compute the average **write** command intergap time. |

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| total_time_metric_based_read_io_count | tmrtIOc | Metric | Count | No | Total completed **read** command data observed external to a LUN on a target external to a switch port. |
| total_time_metric_based_write_io_count | tmwtIOc | Metric | Count | No | Total completed **write** command data observed external to a LUN on a target external to a switch port. |
| total_time_metric_based_read_io_bytes | tmrtIOb | Metric | Count | No | Total completed **read** command data observed external to a LUN on a target external to a switch port, in bytes. |
| total_time_metric_based_write_io_bytes | tmwtIOb | Metric | Count | No | Total completed **write** command data observed external to a LUN on a target external to a switch port, in bytes. |
| read_io_rate | rIOr | Metric | IOs per second | Yes | The rate of **read** command observed external to a LUN on a target external to a switch port.<br>This metric is the average value collected over a 4-second interval from the NPU. |
| peak_read_io_rate | prIOr | Metric | IOs per second | No | The peak rate of **read** commands observed external to a LUN on a target external to a switch port. |
| write_io_rate | wIOr | Metric | IOs per second | Yes | The rate of **write** commands observed external to a LUN on a target external to a switch port.<br>This metric is the average value collected over a 4-second interval from the NPU. |
| peak_write_io_rate | pwIOr | Metric | IOs per second | No | The peak rate of **write** commands observed external to a LUN on a target external to a switch port. |

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| read_io_bandwidth | rIObw | Metric | Bytes per second | Yes | The **read** command bandwidth observed external to a LUN on a target external to a switch port.<br>This metric is the average value collected over a 4-second interval from the NPU. |
| peak_read_io_bandwidth | prIObw | Metric | Bytes per second | No | Peak **read** command bandwidth observed external to a LUN on a target external to a switch port. |
| write_io_bandwidth | wIObw | Metric | Bytes per second | Yes | The **write** command bandwidth observed external to a LUN on a target external to a switch port.<br>This metric is the average value collected over a 4-second interval from the NPU. |
| peak_write_io_bandwidth | pwIObw | Metric | Bytes per second | No | Peak **write** command bandwidth observed external to a LUN on a target external to a switch port. |
| read_io_size_min | rIOsMi | Metric | Bytes | Yes | Minimum **read** command size observed external to a LUN on a target external to a switch port. |
| read_io_size_max | rIOsMa | Metric | Bytes | Yes | Maximum **read** command size observed external to a LUN on a target external to a switch port. |
| write_io_size_min | wIOsMi | Metric | Bytes | Yes | Minimum **write** command size observed external to a LUN on a target external to a switch port. |
| write_io_size_max | wIOsMa | Metric | Bytes | Yes | Maximum **write** command size observed external to a LUN on a target external to a switch port. |

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| read_io_completion_time_min | rIOctMi | Metric | Microseconds | Yes | Minimum **read** command completion time observed external to a LUN on a target external to a switch port. |
| read_io_completion_time_max | rIOctMa | Metric | Microseconds | Yes | Maximum **read** command completion time observed external to a LUN on a target external to a switch port. |
| write_io_completion_time_min | wIOctMi | Metric | Microseconds | Yes | Minimum **write** command completion time observed external to a LUN on a target external to a switch port. |
| write_io_completion_time_max | wIOctMa | Metric | Microseconds | Yes | Maximum **write** command completion time observed external to a LUN on a target external to a switch port. |
| read_io_initiation_time_min | rIOitMi | Metric | Microseconds | Yes | Minimum **read** command initiation time (time gap between the IO command and the first response from the storage; the first response can be the first data frame for READ or txfer_rdy for WRITE) observed external to a LUN on a target external to a switch port. The initiation time is sometimes referred to as **data access latency**. |
| read_io_initiation_time_max | rIOitMa | Metric | Microseconds | Yes | Maximum **read** command initiation time (time gap between the IO command and the first response from the storage; the first response can be the first data frame for READ or txfer_rdy for WRITE) observed external to a LUN on a target external to a switch port. The initiation time is sometimes referred to as **data access latency**. |

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| write_io_initiation_time_min | wIOitMi | Metric | Microseconds | Yes | Minimum **write** command initiation time (time gap between the IO command and the first response from the storage; the first response can be the first data frame for READ or txfer_rdy for WRITE) observed external to a LUN on a target external to a switch port. The initiation time is sometimes referred to as **data access latency**. |
| write_io_initiation_time_max | wIOitMa | Metric | Microseconds | Yes | Maximum **write** command initiation time (time gap between the IO command and the first response from the storage; the first response can be the first data frame for READ or txfer_rdy for WRITE) observed external to a LUN on a target external to a switch port. The initiation time is sometimes referred to as **data access latency**. |
| read_io_inter_gap_time_min | rIOigtMi | Metric | Microsecond | Yes | Minimum **read** command intergap time observed external to a LUN on a target external to a switch port.<br>read_io_inter_gap_time_min is the duration between successive IO commands and is measured in 1/256th of a microsecond. |
| read_io_inter_gap_time_max | rIOigtMa | Metric | Microsecond | Yes | Maximum **read** command intergap time observed external to a LUN on a target external to a switch port.<br>read_io_inter_gap_time_max is the duration between successive IO commands and is measured in 1/256th of a microsecond. |

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| write_io_inter_gap_time_min | wIOigtMi | Metric | Microseconds | Yes | Minimum **write** command intergap time observed external to a LUN on a target external to a switch port.<br>write_io_inter_gap_time_min is the duration between successive IO commands and is measured in 1/256th of a microsecond. |
| write_io_inter_gap_time_max | wIOigtMa | Metric | Microseconds | Yes | Maximum **write** command intergap time observed external to a LUN on a target external to a switch port.<br>write_io_inter_gap_time_max is the duration between successive IO commands and is measured in 1/256th of a microsecond. |
| read_io_aborts | rIOa | Metric | Count | Yes | Number of **read** command aborts observed external to a LUN on a target external to a switch port. |
| write_io_aborts | wIOa | Metric | Count | Yes | Number of **write** command aborts observed external to a LUN on a target external to a switch port. |
| read_io_failures | rIOf | Metric | Count | Yes | Number of **read** command failures observed external to a LUN on a target external to a switch port. |
| write_io_failures | wIOf | Metric | Count | Yes | Number of **write** command failures observed external to a LUN on a target external to a switch port. |
| read_io_scsi_check_condition_count | rIOSchcoct | Metric | Count | No | Number of **read** command check conditions seen external to a LUN on a target external to a switch port. |

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| write_io_scsi_check_condition_count | wIOSchcoct | Metric | Count | No | Number of **write** command check conditions seen external to a LUN on a target external to a switch port. |
| read_io_scsi_busy_count | rIOsbc | Metric | Count | No | Number of **read** command busy status seen external to a LUN on a target external to a switch port. |
| write_io_scsi_busy_count | wIOsbc | Metric | Count | No | Number of **write** command busy status seen external to a LUN on a target external to a switch port. |
| read_io_scsi_reservation_conflict_count | rIOSrecct | Metric | Count | No | Number of **read** command reservation conflicts seen external to a LUN on a target external to a switch port. |
| write_io_scsi_reservation_conflict_count | wIOSrecct | Metric | Count | No | Number of **write** command reservation conflicts seen external to a LUN on a target external to a switch port. |
| read_io_scsi_queue_full_count | rIOSQfct | Metric | Count | No | Number of **read** command queue full status seen external to a LUN on a target external to a switch port. |
| write_io_scsi_queue_full_count | wIOSQfct | Metric | Count | No | Number of **write** command queue full status seen external to a LUN on a target external to a switch port. |
| sampling_start_time | samStm | Metric | UNIX time | No | Start of the sampling time interval. |
| sampling_end_time | samEtm | Metric | UNIX time | No | End of the sampling time interval. |
| total_busy_period | totBsy | Metric | Count | No | The total time for which the view instances have been active. |
| total_write_io_first_burst_count | totWrFirBu | Metric | Count | No | Accumulated total **write** command first burst observed external to a switch port. |

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| total_write_io_array_delay_time | totWrArrDel | Metric | Count | No | Accumulated total **write** command array delays observed external to a switch port. |
| total_write_io_host_delay_time | totWrHosDel | Metric | Count | No | Accumulated total **write** command host delays observed external to a switch port. |
| total_write_io_sequences_count | totWrSeq | Metric | Count | No | Accumulated total **write** command sequences observed external to a switch port. |
| write_io_host_delay_time_min | wrHosDelMn | Metric | Count | No | Minimum **write** command host delays observed external to a switch port. |
| write_io_host_delay_time_max | wrHosDelMx | Metric | Count | No | Maximum **write** command host delays observed external to a switch port. |
| write_io_array_delay_time_max | wrArrDelMx | Metric | Count | No | Maximum **write** command array delays observed external to a switch port. |
| multisequence_exchange_write_io_sequences_min | wrIoSeqMn | Metric | Count | No | Minimum **write** command multisequence exchange sequences observed external to a switch port. |
| multisequence_exchange_write_io_sequences_max | wrIoSeqMx | Metric | Count | No | Maximum **write** command multisequence exchange sequences observed external to a switch port. |

## Target TN Flow View Instance (nvme_target_tn_flow)

**Note** The flow metrics for *Target TN Flow View Instance* are applicable only for the NVMe analytics type.

***Table 30: Flow Metrics for Target TN Flow View Instance***

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| port | port | Key | Text | No | A switch port where the SAN Analytics feature is enabled. |

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| vsan | vsan | Key | Count | No | VSAN configured on a switch port with IO since last clearing of metrics. |
| target_id | did | Key | Text | No | Target Fibre Channel ID that is external to a switch port with IO since last clearing of metrics. |
| connection_id | ci | Key | Count | No | The NVMe connection id that is external to a switch port with IO since last clearing of metrics. |
| namespace_id | ni | Key | Count | No | The namespace ID is the NVMe controller's unique identifier for the namespace and can be set to a value between 1 and 255. It is analogous to a logical unit number (LUN) in SCSI. |
| nvme_target_entity_itn_flow_count | ntITNfc | Metadata | Count | No | Number of ITN flows associated with a namespace ID on a target external to a switch port. |
| active_io_read_count | raIO | Metadata | Count | Yes | Number of outstanding **read** command counts associated with a LUN on a target external to a switch port. |
| active_io_write_count | waIO | Metadata | Count | Yes | Number of outstanding **write** command counts associated with a LUN on a target external to a switch port. |
| total_read_io_count | rtIO | Metric | Count | Yes | Total **read** command data observed external to a LUN on a target external to a switch port. |
| total_write_io_count | wtIO | Metric | Count | Yes | Total **write** command data observed external to a LUN on a target external to a switch port. |

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| total_seq_read_io_count | rstIOc | Metric | Count | No | Total sequential **read** command data observed external to a LUN on a target external to a switch port. |
| total_seq_write_io_count | wrstIOc | Metric | Count | No | Total sequential **write** command data observed external to a LUN on a target external to a switch port. |
| total_read_io_time | rtIOt | Metric | Microseconds | No | Accumulated total **read** command completion time observed external to a LUN on a target external to a switch port.<br>You can use this information to compute the average read IO completion time. |
| total_write_io_time | wtIOt | Metric | Microseconds | No | Accumulated total **write** command completion time observed external to a LUN on a target external to a switch port.<br>You can use this information to compute the average **write** command completion time. |
| total_read_io_initiation_time | rtIOint | Metric | Microseconds | No | Accumulated total **read** command initiation time (time gap between the IO command and the first response from the storage; the first response can be the first data frame for READ commands or the first txfr_rdy for WRITE commands) observed external to a LUN on a target external to a switch port. The initiation time is sometimes referred to as **data access latency**.<br>You can use this information to compute the average read IO initiation time. |

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| total_write_io_initiation_time | wtIOint | Metric | Microseconds | No | Accumulated total **write** command initiation time (time gap between the IO command and the first response from the storage; the first response can be the first data frame for READ or txfer_rdy for WRITE) observed external to a LUN on a target external to a switch port. The initiation time is sometimes referred to as **data access latency**.<br>You can use this information to compute the average **write** command initiation time. |
| total_read_io_bytes | rtIOb | Metric | Bytes | Yes | Total **read** command data that is observed external to a LUN on a target external to a switch port. |
| total_write_io_bytes | wtIOb | Metric | Bytes | Yes | Total **write** command data observed external to a LUN on a target external to a switch port. |
| total_read_io_inter_gap_time | rtIOigt | Metric | Microsecond | No | Accumulated total **read** command intergap time observed external to a LUN on a target external to a switch port.<br>You can use this information to compute the average read IO intergap time. |
| total_write_io_inter_gap_time | wtIOigt | Metric | Microseconds | No | Accumulated total **write** command intergap time data observed external to a LUN on a target external to a switch port.<br>You can use this information to compute the average **write** command intergap time. |

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| total_time_metric_based_read_io_count | tmrtIOc | Metric | Count | No | Total completed **read** command data observed external to a LUN on a target external to a switch port. |
| total_time_metric_based_write_io_count | tmwtIOc | Metric | Count | No | Total completed **write** command data observed external to a LUN on a target external to a switch port. |
| total_time_metric_based_read_io_bytes | tmrtIOb | Metric | Count | No | Total completed **read** command data observed external to a LUN on a target external to a switch port, in bytes. |
| total_time_metric_based_write_io_bytes | tmwtIOb | Metric | Count | No | Total completed **write** command data observed external to a LUN on a target external to a switch port, in bytes. |
| read_io_rate | rIOr | Metric | IOs per second | Yes | The rate of **read** commands observed external to a LUN on a target external to a switch port.<br>This metric is the average value collected over a 4-second interval from the NPU. |
| peak_read_io_rate | prIOr | Metric | IOs per second | No | The peak rate of **read** commands observed external to a LUN on a target external to a switch port. |
| write_io_rate | wIOr | Metric | IOs per second | Yes | The read of **write** commands observed external to a LUN on a target external to a switch port.<br>This metric is the average value collected over a 4-second interval from the NPU. |

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| peak_write_io_rate | pwIOr | Metric | IOs per second | No | The peak rate of **write** commands observed external to a LUN on a target external to a switch port. |
| read_io_bandwidth | rIObw | Metric | Bytes per second | Yes | The **read** command bandwidth observed external to a LUN on a target external to a switch port.<br>This metric is the average value collected over a 4-second interval from the NPU. |
| peak_read_io_bandwidth | prIObw | Metric | Bytes per second | No | Peak **read** command bandwidth observed external to a LUN on a target external to a switch port. |
| write_io_bandwidth | wIObw | Metric | Bytes per second | Yes | The **write** command bandwidth observed external to a LUN on a target external to a switch port.<br>This metric is the average value collected over a 4-second interval from the NPU. |
| peak_write_io_bandwidth | pwIObw | Metric | Bytes per second | No | Peak **write** command bandwidth observed external to a LUN on a target external to a switch port. |
| read_io_size_min | rIOsMi | Metric | Bytes | Yes | Minimum **read** command size observed external to a LUN on a target external to a switch port. |
| read_io_size_max | rIOsMa | Metric | Bytes | Yes | Maximum **read** command size observed external to a LUN on a target external to a switch port. |
| write_io_size_min | wIOsMi | Metric | Bytes | Yes | Minimum **write** command size observed external to a LUN on a target external to a switch port. |

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| write_io_size_max | wIOsMa | Metric | Bytes | Yes | Maximum **write** command size observed external to a LUN on a target external to a switch port. |
| read_io_completion_time_min | rIOctMi | Metric | Microseconds | Yes | Minimum **read** command completion time observed external to a LUN on a target external to a switch port. |
| read_io_completion_time_max | rIOctMa | Metric | Microseconds | Yes | Maximum **read** command completion time observed external to a LUN on a target external to a switch port. |
| write_io_completion_time_min | wIOctMi | Metric | Microseconds | Yes | Minimum **write** command completion time observed external to a LUN on a target external to a switch port. |
| write_io_completion_time_max | wIOctMa | Metric | Microseconds | Yes | Maximum **write** command completion time observed external to a LUN on a target external to a switch port. |
| read_io_initiation_time_min | rIOitMi | Metric | Microseconds | Yes | Minimum **read** command initiation time (time gap between the IO command and the first response from the storage; the first response can be the first data frame for READ or txfer_rdy for WRITE) observed external to a LUN on a target external to a switch port. The initiation time is sometimes referred to as **data access latency**. |

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| read_io_initiation_time_max | rIOitMa | Metric | Microseconds | Yes | Maximum **read** command initiation time (time gap between the IO command and the first response from the storage; the first response can be the first data frame for READ or txfer_rdy for WRITE) observed external to a LUN on a target external to a switch port. The initiation time is sometimes referred to as **data access latency**. |
| write_io_initiation_time_min | wIOitMi | Metric | Microseconds | Yes | Minimum **write** command initiation time (time gap between the IO command and the first response from the storage; the first response can be the first data frame for READ or txfer_rdy for WRITE) observed external to a LUN on a target external to a switch port. The initiation time is sometimes referred to as **data access latency**. |
| write_io_initiation_time_max | wIOitMa | Metric | Microseconds | Yes | Maximum **write** command initiation time (time gap between the IO command and the first response from the storage; the first response can be the first data frame for READ or txfer_rdy for WRITE) observed external to a LUN on a target external to a switch port. The initiation time is sometimes referred to as **data access latency**. |
| read_io_inter_gap_time_min | rIOigtMi | Metric | Microsecond | Yes | Minimum **read** command intergap time observed external to a LUN on a target external to a switch port.<br>read_io_inter_gap_time_min is the duration between successive IO commands and is measured in 1/256th of a microsecond. |

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| read_io_inter_gap_time_max | rIOigtMa | Metric | Microsecond | Yes | Maximum **read** command intergap time observed external to a LUN on a target external to a switch port.<br>read_io_inter_gap_time_max is the duration between successive IO commands and is measured in 1/256th of a microsecond. |
| write_io_inter_gap_time_min | wIOigtMi | Metric | Microseconds | Yes | Minimum **write** command intergap time observed external to a LUN on a target external to a switch port.<br>write_io_inter_gap_time_min is the duration between successive IO commands and is measured in 1/256th of a microsecond. |
| write_io_inter_gap_time_max | wIOigtMa | Metric | Microseconds | Yes | Maximum **write** command intergap time observed external to a LUN on a target external to a switch port.<br>write_io_inter_gap_time_max is the duration between successive IO commands and is measured in 1/256th of a microsecond. |
| read_io_aborts | rIOa | Metric | Count | Yes | Number of **read** command aborts observed external to a LUN on a target external to a switch port. |
| write_io_aborts | wIOa | Metric | Count | Yes | Number of **write** command aborts observed external to a LUN on a target external to a switch port. |
| read_io_failures | rIOf | Metric | Count | Yes | Number of **read** command failures observed external to a LUN on a target external to a switch port. |

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| **Long Name** | **Short Name** | | | | |
| write_io_failures | wIOf | Metric | Count | Yes | Number of **write** command failures observed external to a LUN on a target external to a switch port. |
| read_io_nvme_lba_out_of_range_count | rIONLbaoorct | Metric | Count | No | Number of **read** command *lba out of range* errors seen. |
| write_io_nvme_lba_out_of_range_count | wIONLbaoorct | Metric | Count | No | Number of **write** command *lba out of range* errors seen. |
| read_io_nvme_ns_not_ready_count | rIOnNsnrc | Metric | Count | No | Number of **read** command *namespace not ready* errors seen. |
| write_io_nvme_ns_not_ready_count | wIOnNsnrc | Metric | Count | No | Number of **write** command *namespace not ready* errors seen. |
| read_io_nvme_reservation_conflict_count | rIONrecct | Metric | Count | No | Number of **read** command reservation conflicts seen external to a namespace ID on a target external to a switch port. |
| write_io_nvme_reservation_conflict_count | wIONrecct | Metric | Count | No | Number of **write** command reservation conflicts seen external to a namespace ID on a target external to a switch port. |
| sampling_start_time | samStm | Metric | UNIX time | No | Start of the sampling time interval. |
| sampling_end_time | samEtm | Metric | UNIX time | No | End of the sampling time interval. |
| total_busy_period | totBsy | Metric | Count | No | The total time for which the view instances have been active. |
| total_write_io_first_burst_count | totWrFirBu | Metric | Count | No | Accumulated total **write** command first burst observed external to a switch port. |
| total_write_io_array_delay_time | totWrArrDel | Metric | Count | No | Accumulated total **write** command array delays observed external to a switch port. |

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| total_write_io_host_delay_time | totWrHosDel | Metric | Count | No | Accumulated total **write** command host delays observed external to a switch port. |
| total_write_io_sequences_count | totWrSeq | Metric | Count | No | Accumulated total **write** command sequences observed external to a switch port. |
| write_io_host_delay_time_min | wrHosDelMn | Metric | Count | No | Minimum **write** command host delays observed external to a switch port. |
| write_io_host_delay_time_max | wrHosDelMx | Metric | Count | No | Maximum **write** command host delays observed external to a switch port. |
| write_io_array_delay_time_max | wrArrDelMx | Metric | Count | No | Maximum **write** command array delays observed external to a switch port. |
| multisequence_exchange_write_io_sequences_min | wrIoSeqMn | Metric | Count | No | Minimum **write** command multisequence exchange sequences observed external to a switch port. |
| multisequence_exchange_write_io_sequences_max | wrIoSeqMx | Metric | Count | No | Maximum **write** command multisequence exchange sequences observed external to a switch port. |

## Initiator ITL Flow View Instance (scsi_initiator_itl_flow)

**Note** The flow metrics for *Initiator ITL Flow View Instance* are applicable only for the SCSI analytics type.

***Table 31: Flow Metrics for Initiator ITL Flow View Instance***

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| port | port | Key | Text | No | A switch port where the SAN Analytics feature is enabled. |

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| vsan | vsan | Key | Count | No | VSAN configured on a switch port with IO since last clearing of metrics. |
| app_id | app_id | Key | Count | No | Application identifier for an application external to a switch port. |
| initiator_id | sid | Key | Text | No | Initiator Fibre Channel ID that is external to a switch port where the IO transactions are observed. |
| target_id | did | Key | Text | No | Target Fibre Channel ID that is executing IO transactions initiated by an initiator external to switch port. |
| lun | lun | Key | Count | No | Logical-unit-number (LUN) that is associated with an initiator where IOs are performed. |
| active_io_read_count | raIO | Metadata | Count | Yes | Number of outstanding **read** command counts associated with an initiator-ITL-flow record. |
| active_io_write_count | waIO | Metadata | Count | Yes | Number of outstanding **write** command counts associated with an initiator-ITL-flow record. |
| total_read_io_count | rtIO | Metric | Count | Yes | Total **read** command data observed external to an initiator-ITL-flow record. |
| total_write_io_count | wtIO | Metric | Count | Yes | Total **write** command data observed external to an initiator-ITL-flow record. |
| total_seq_read_io_count | rstIOc | Metric | Count | No | Total sequential **read** command data observed external to an initiator-ITL-flow record. |
| total_seq_write_io_count | wrstIOc | Metric | Count | No | Total sequential **write** command data observed external to an initiator-ITL-flow record. |

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| total_read_io_time | rtIOt | Metric | Microseconds | No | Accumulated total **read** command completion time observed external to an initiator-ITL-flow record.<br>You can use this information to compute the average read IO completion time. |
| total_write_io_time | wtIOt | Metric | Microseconds | No | Accumulated total **write** command completion time observed external to an initiator-ITL-flow record.<br>You can use this information to compute the average **write** command completion time. |
| total_read_io_initiation_time | rtIOint | Metric | Microseconds | No | Accumulated total **read** command initiation time (time gap between the IO command and the first response from the storage; the first response can be the first data frame for READ commands or the first txfr_rdy for WRITE commands) observed external to an initiator-ITL-flow record. The initiation time is sometimes referred to as **data access latency**.<br>You can use this information to compute the average read IO initiation time. |

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| total_write_io_initiation_time | wtIOint | Metric | Microseconds | No | Accumulated total **write** command initiation time (time gap between the IO command and the first response from the storage; the first response can be the first data frame for READ or txfer_rdy for WRITE) observed external to an initiator-ITL-flow record. The initiation time is sometimes referred to as **data access latency**.<br>You can use this information to compute the average **write** command initiation time. |
| total_read_io_bytes | rtIOb | Metric | Bytes | Yes | Total **read** command data that is observed external to an initiator-ITL-flow record. |
| total_write_io_bytes | wtIOb | Metric | Bytes | Yes | Total **write** command data observed external to an initiator-ITL-flow record. |
| total_read_io_inter_gap_time | rtIOigt | Metric | Microsecond | No | Accumulated total **read** command intergap time observed external to an initiator-ITL-flow record.<br>You can use this information to compute the average read IO intergap time. |
| total_write_io_inter_gap_time | wtIOigt | Metric | Microseconds | No | Accumulated total **write** command intergap time data observed external to an initiator-ITL-flow record.<br>You can use this information to compute the average **write** command intergap time. |
| total_time_metric_based_read_io_count | tmrtIOc | Metric | Count | No | Total completed **read** command data observed external to an initiator-ITL-flow record. |

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| total_time_metric_based_write_io_count | tmwtIOc | Metric | Count | No | Total completed **write** command data observed external to an initiator-ITL-flow record. |
| total_time_metric_based_read_io_bytes | tmrtIOb | Metric | Count | No | Total completed **read** command data observed external to an initiator-ITL-flow record, in bytes. |
| total_time_metric_based_write_io_bytes | tmwtIOb | Metric | Count | No | Total completed **write** command data observed external to an initiator-ITL-flow record, in bytes. |
| read_io_rate | rIOr | Metric | IOs per second | Yes | The rate of **read** commands observed external to an initiator-ITL-flow record.<br>This metric is the average value collected over a 4-second interval from the NPU. |
| peak_read_io_rate | prIOr | Metric | IOs per second | No | The peak rate of **read** commands observed external to an initiator-ITL-flow record. |
| write_io_rate | wIOr | Metric | IOs per second | Yes | The rate of **write** commands observed external to an initiator-ITL-flow record.<br>This metric is the average value collected over a 4-second interval from the NPU. |
| peak_write_io_rate | pwIOr | Metric | IOs per second | No | The peak rate of **write** commands observed external to an initiator-ITL-flow record. |
| read_io_bandwidth | rIObw | Metric | Bytes per second | Yes | The **read** command bandwidth observed external to an initiator-ITL-flow record.<br>This metric is the average value collected over a 4-second interval from the NPU. |
| peak_read_io_bandwidth | prIObw | Metric | Bytes per second | No | Peak **read** command bandwidth observed external to an initiator-ITL-flow record. |

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| write_io_bandwidth | wIObw | Metric | Bytes per second | Yes | The **write** command bandwidth observed external to an initiator-ITL-flow record.<br>This metric is the average value collected over a 4-second interval from the NPU. |
| peak_write_io_bandwidth | pwIObw | Metric | Bytes per second | No | Peak **write** command bandwidth observed external to an initiator-ITL-flow record. |
| read_io_size_min | rIOsMi | Metric | Bytes | Yes | Minimum **read** command size observed external to an initiator-ITL-flow record. |
| read_io_size_max | rIOsMa | Metric | Bytes | Yes | Maximum **read** command size observed external to an initiator-ITL-flow record. |
| write_io_size_min | wIOsMi | Metric | Bytes | Yes | Minimum **write** command size observed external to an initiator-ITL-flow record. |
| write_io_size_max | wIOsMa | Metric | Bytes | Yes | Maximum **write** command size observed external to an initiator-ITL-flow record. |
| read_io_completion_time_min | rIOctMi | Metric | Microseconds | Yes | Minimum **read** command completion time observed external to an initiator-ITL-flow record. |
| read_io_completion_time_max | rIOctMa | Metric | Microseconds | Yes | Maximum **read** command completion time observed external to an initiator-ITL-flow record. |
| write_io_completion_time_min | wIOctMi | Metric | Microseconds | Yes | Minimum **write** command completion time observed external to an initiator-ITL-flow record. |
| write_io_completion_time_max | wIOctMa | Metric | Microseconds | Yes | Maximum **write** command completion time observed external to an initiator-ITL-flow record. |

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| read_io_initiation_time_min | rIOitMi | Metric | Microseconds | Yes | Minimum **read** command initiation time (time gap between the IO command and the first response from the storage; the first response can be the first data frame for READ or txfer_rdy for WRITE) observed external to an initiator-ITL-flow record. The initiation time is sometimes referred to as **data access latency**. |
| read_io_initiation_time_max | rIOitMa | Metric | Microseconds | Yes | Maximum **read** command initiation time (time gap between the IO command and the first response from the storage; the first response can be the first data frame for READ or txfer_rdy for WRITE) observed external to an initiator-ITL-flow record. The initiation time is sometimes referred to as **data access latency**. |
| write_io_initiation_time_min | wIOitMi | Metric | Microseconds | Yes | Minimum **write** command initiation time (time gap between the IO command and the first response from the storage; the first response can be the first data frame for READ or txfer_rdy for WRITE) observed external to an initiator-ITL-flow record. The initiation time is sometimes referred to as **data access latency**. |

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| write_io_initiation_time_max | wIOitMa | Metric | Microseconds | Yes | Maximum **write** command initiation time (time gap between the IO command and the first response from the storage; the first response can be the first data frame for READ or txfer_rdy for WRITE) observed external to an initiator-ITL-flow record. The initiation time is sometimes referred to as **data access latency**. |
| read_io_inter_gap_time_min | rIOigtMi | Metric | Microsecond | Yes | Minimum **read** command intergap time observed external to an initiator-ITL-flow record.<br>read_io_inter_gap_time_min is the duration between successive IO commands and is measured in 1/256th of a microsecond. |
| read_io_inter_gap_time_max | rIOigtMa | Metric | Microsecond | Yes | Maximum **read** command intergap time observed external to an initiator-ITL-flow record.<br>read_io_inter_gap_time_max is the duration between successive IO commands and is measured in 1/256th of a microsecond. |
| write_io_inter_gap_time_min | wIOigtMi | Metric | Microseconds | Yes | Minimum **write** command intergap time observed external to an initiator-ITL-flow record.<br>write_io_inter_gap_time_min is the duration between successive IO commands and is measured in 1/256th of a microsecond. |
| write_io_inter_gap_time_max | wIOigtMa | Metric | Microseconds | Yes | Maximum **write** command intergap time observed external to an initiator-ITL-flow record.<br>write_io_inter_gap_time_max is the duration between successive IO commands and is measured in 1/256th of a microsecond. |

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| read_io_aborts | rIOa | Metric | Count | Yes | Number of **read** command aborts observed external to an initiator-ITL-flow record. |
| write_io_aborts | wIOa | Metric | Count | Yes | Number of **write** command aborts observed external to an initiator-ITL-flow record. |
| read_io_failures | rIOf | Metric | Count | Yes | Number of **read** command failures observed external to an initiator-ITL-flow record. |
| write_io_failures | wIOf | Metric | Count | Yes | Number of **write** command failures observed external to an initiator-ITL-flow record. |
| read_io_scsi_check_condition_count | rIOSchcoct | Metric | Count | No | Number of **read** command check conditions seen external to an initiator-ITL-flow record. |
| write_io_scsi_check_condition_count | wIOSchcoct | Metric | Count | No | Number of **write** command check conditions seen external to an initiator-ITL-flow record. |
| read_io_scsi_busy_count | rIOsbc | Metric | Count | No | Number of **read** command busy status seen external to an initiator-ITL-flow record. |
| write_io_scsi_busy_count | wIOsbc | Metric | Count | No | Number of **write** command busy status seen external to an initiator-ITL-flow record. |
| read_io_scsi_reservation_conflict_count | rIOSrecct | Metric | Count | No | Number of **read** command reservation conflicts seen external to an initiator-ITL-flow record. |
| write_io_scsi_reservation_conflict_count | wIOSrecct | Metric | Count | No | Number of **write** command reservation conflicts seen external to an initiator-ITL-flow record. |
| read_io_scsi_queue_full_count | rIOSQfct | Metric | Count | No | Number of **read** command queue full status seen external to an initiator-ITL-flow record. |
| write_io_scsi_queue_full_count | wIOSQfct | Metric | Count | No | Number of **write** command queue full status seen external to an initiator-ITL-flow record. |

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| sampling_start_time | samStm | Metric | UNIX time | No | Start of the sampling time interval. |
| sampling_end_time | samEtm | Metric | UNIX time | No | End of the sampling time interval. |
| total_busy_period | totBsy | Metric | Count | No | The total time for which the view instances have been active. |
| total_write_io_first_burst_count | totWrFirBu | Metric | Count | No | Accumulated total **write** command first burst observed external to a switch port. |
| total_write_io_array_delay_time | totWrArrDel | Metric | Count | No | Accumulated total **write** command array delays observed external to a switch port. |
| total_write_io_host_delay_time | totWrHosDel | Metric | Count | No | Accumulated total **write** command host delays observed external to a switch port. |
| total_write_io_sequences_count | totWrSeq | Metric | Count | No | Accumulated total **write** command sequences observed external to a switch port. |
| write_io_host_delay_time_min | wrHosDelMn | Metric | Count | No | Minimum **write** command host delays observed external to a switch port. |
| write_io_host_delay_time_max | wrHosDelMx | Metric | Count | No | Maximum **write** command host delays observed external to a switch port. |
| write_io_array_delay_time_max | wrArrDelMx | Metric | Count | No | Maximum **write** command array delays observed external to a switch port. |
| multisequence_exchange_write_io_sequences_min | wrIoSeqMn | Metric | Count | No | Minimum **write** command multisequence exchange sequences observed external to a switch port. |
| multisequence_exchange_write_io_sequences_max | wrIoSeqMx | Metric | Count | No | Maximum **write** command multisequence exchange sequences observed external to a switch port. |

# Initiator ITN Flow View Instance (nvme_initiator_itn_flow)

**Note** The flow metrics for *Initiator ITN Flow View Instance* are applicable only for the NVMe analytics type.

***Table 32: Flow Metrics for Initiator ITN Flow View Instance***

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| **Long Name** | **Short Name** | | | | |
| port | port | Key | Text | No | A switch port where the SAN Analytics feature is enabled. |
| vsan | vsan | Key | Count | No | VSAN configured on a switch port with IO since last clearing of metrics. |
| app_id | app_id | Key | Count | No | Application identifier for an application external to a switch port. |
| initiator_id | sid | Key | Text | No | Initiator Fibre Channel ID that is external to a switch port where the IO transactions are observed. |
| connection_id | ci | Key | Count | No | The NVMe connection id that is external to a switch port with IO since last clearing of metrics. |
| namespace_id | ni | Key | Count | No | The namespace ID is the NVMe controller's unique identifier for the namespace and can be set to a value between 1 and 255. It is analogous to a logical unit number (LUN) in SCSI. |
| target_id | did | Key | Text | No | Target Fibre Channel ID that is executing IO transactions initiated by an initiator external to a switch port. |
| connection_id | ci | Key | Count | No | The NVMe connection id that is external to a switch port with IO since last clearing of metrics. |

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| namespace_id | ni | Key | Count | No | The namespace ID is the NVMe controller's unique identifier for the namespace and can be set to a value between 1 and 255. It is analogous to a logical unit number (LUN) in SCSI. |
| active_io_read_count | raIO | Metadata | Count | Yes | Number of outstanding **read** command counts associated with an initiator-ITL-flow record. |
| active_io_write_count | waIO | Metadata | Count | Yes | Number of outstanding **write** command counts associated with an initiator-ITL-flow record. |
| total_read_io_count | rtIO | Metric | Count | Yes | Total **read** command data observed external to an initiator-ITL-flow record. |
| total_write_io_count | wtIO | Metric | Count | Yes | Total **write** command data observed external to an initiator-ITL-flow record. |
| total_seq_read_io_count | rstIOc | Metric | Count | No | Total sequential **read** command data observed external to an initiator-ITL-flow record. |
| total_seq_write_io_count | wrstIOc | Metric | Count | No | Total sequential **write** command data observed external to an initiator-ITL-flow record. |
| total_read_io_time | rtIOt | Metric | Microseconds | No | Accumulated total **read** command completion time observed external to an initiator-ITL-flow record.<br>You can use this information to compute the average read IO completion time. |

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| total_write_io_time | wtIOt | Metric | Microseconds | No | Accumulated total **write** command completion time observed external to an initiator-ITL-flow record.<br>You can use this information to compute the average **write** command completion time. |
| total_read_io_initiation_time | rtIOint | Metric | Microseconds | No | Accumulated total **read** command initiation time (time gap between the IO command and the first response from the storage; the first response can be the first data frame for READ commands or the first txfr_rdy for WRITE commands) observed external to an initiator-ITL-flow record. The initiation time is sometimes referred to as **data access latency**.<br>You can use this information to compute the average read IO initiation time. |
| total_write_io_initiation_time | wtIOint | Metric | Microseconds | No | Accumulated total **write** command initiation time (time gap between the IO command and the first response from the storage; the first response can be the first data frame for READ or txfer_rdy for WRITE) observed external to an initiator-ITL-flow record. The initiation time is sometimes referred to as **data access latency**.<br>You can use this information to compute the average **write** command initiation time. |
| total_read_io_bytes | rtIOb | Metric | Bytes | Yes | Total **read** command data that is observed external to an initiator-ITL-flow record. |

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| total_write_io_bytes | wtIOb | Metric | Bytes | Yes | Total **write** command data observed external to an initiator-ITL-flow record. |
| total_read_io_inter_gap_time | rtIOigt | Metric | Microsecond | No | Accumulated total **read** command intergap time observed external to an initiator-ITL-flow record.<br>You can use this information to compute the average read IO intergap time. |
| total_write_io_inter_gap_time | wtIOigt | Metric | Microseconds | No | Accumulated total **write** command intergap time data observed external to an initiator-ITL-flow record.<br>You can use this information to compute the average **write** command intergap time. |
| total_time_metric_based_read_io_count | tmrtIOc | Metric | Count | No | Total completed **read** command data observed external to an initiator-ITL-flow record. |
| total_time_metric_based_write_io_count | tmwtIOc | Metric | Count | No | Total completed **write** command data observed external to an initiator-ITL-flow record. |
| total_time_metric_based_read_io_bytes | tmrtIOb | Metric | Count | No | Total completed **read** command data observed external to an initiator-ITL-flow record, in bytes. |
| total_time_metric_based_write_io_bytes | tmwtIOb | Metric | Count | No | Total completed **write** command data observed external to an initiator-ITL-flow record, in bytes. |

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| read_io_rate | rIOr | Metric | IOs per second | Yes | The rate of **read** commands observed external to an initiator-ITL-flow record.<br>This metric is the average value collected over a 4-second interval from the NPU. |
| peak_read_io_rate | prIOr | Metric | IOs per second | No | The peak rate of **read** commands observed external to an initiator-ITL-flow record. |
| write_io_rate | wIOr | Metric | IOs per second | Yes | The rate of **write** commands observed external to an initiator-ITL-flow record.<br>This metric is the average value collected over a 4-second interval from the NPU. |
| peak_write_io_rate | pwIOr | Metric | IOs per second | No | The peak rate of **write** commands observed external to an initiator-ITL-flow record. |
| read_io_bandwidth | rIObw | Metric | Bytes per second | Yes | The **read** command bandwidth observed external to an initiator-ITL-flow record.<br>This metric is the average value collected over a 4-second interval from the NPU. |
| peak_read_io_bandwidth | prIObw | Metric | Bytes per second | No | Peak **read** command bandwidth observed external to an initiator-ITL-flow record. |
| write_io_bandwidth | wIObw | Metric | Bytes per second | Yes | The **write** command bandwidth observed external to an initiator-ITL-flow record.<br>This metric is the average value collected over a 4-second interval from the NPU. |

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| peak_write_io_bandwidth | pwIObw | Metric | Bytes per second | No | Peak **write** command bandwidth observed external to an initiator-ITL-flow record. |
| read_io_size_min | rIOsMi | Metric | Bytes | Yes | Minimum **read** command size observed external to an initiator-ITL-flow record. |
| read_io_size_max | rIOsMa | Metric | Bytes | Yes | Maximum **read** command size observed external to an initiator-ITL-flow record. |
| write_io_size_min | wIOsMi | Metric | Bytes | Yes | Minimum **write** command size observed external to an initiator-ITL-flow record. |
| write_io_size_max | wIOsMa | Metric | Bytes | Yes | Maximum **write** command size observed external to an initiator-ITL-flow record. |
| read_io_completion_time_min | rIOctMi | Metric | Microseconds | Yes | Minimum **read** command completion time observed external to an initiator-ITL-flow record. |
| read_io_completion_time_max | rIOctMa | Metric | Microseconds | Yes | Maximum **read** command completion time observed external to an initiator-ITL-flow record. |
| write_io_completion_time_min | wIOctMi | Metric | Microseconds | Yes | Minimum **write** command completion time observed external to an initiator-ITL-flow record. |
| write_io_completion_time_max | wIOctMa | Metric | Microseconds | Yes | Maximum **write** command completion time observed external to an initiator-ITL-flow record. |

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| read_io_initiation_time_min | rIOitMi | Metric | Microseconds | Yes | Minimum **read** command initiation time (time gap between the IO command and the first response from the storage; the first response can be the first data frame for READ or txfer_rdy for WRITE) observed external to an initiator-ITL-flow record. The initiation time is sometimes referred to as **data access latency**. |
| read_io_initiation_time_max | rIOitMa | Metric | Microseconds | Yes | Maximum **read** command initiation time (time gap between the IO command and the first response from the storage; the first response can be the first data frame for READ or txfer_rdy for WRITE) observed external to an initiator-ITL-flow record. The initiation time is sometimes referred to as **data access latency**. |
| write_io_initiation_time_min | wIOitMi | Metric | Microseconds | Yes | Minimum **write** command initiation time (time gap between the IO command and the first response from the storage; the first response can be the first data frame for READ or txfer_rdy for WRITE) observed external to an initiator-ITL-flow record. The initiation time is sometimes referred to as **data access latency**. |

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| write_io_initiation_time_max | wIOitMa | Metric | Microseconds | Yes | Maximum **write** command initiation time (time gap between the IO command and the first response from the storage; the first response can be the first data frame for READ or txfer_rdy for WRITE) observed external to an initiator-ITL-flow record. The initiation time is sometimes referred to as **data access latency**. |
| read_io_inter_gap_time_min | rIOigtMi | Metric | Microsecond | Yes | Minimum **read** command intergap time observed external to an initiator-ITL-flow record.<br>read_io_inter_gap_time_min is the duration between successive IO commands and is measured in 1/256th of a microsecond. |
| read_io_inter_gap_time_max | rIOigtMa | Metric | Microsecond | Yes | Maximum **read** command intergap time observed external to an initiator-ITL-flow record.<br>read_io_inter_gap_time_max is the duration between successive IO commands and is measured in 1/256th of a microsecond. |
| write_io_inter_gap_time_min | wIOigtMi | Metric | Microseconds | Yes | Minimum **write** command intergap time observed external to an initiator-ITL-flow record.<br>write_io_inter_gap_time_min is the duration between successive IO commands and is measured in 1/256th of a microsecond. |

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| write_io_inter_gap_time_max | wIOigtMa | Metric | Microseconds | Yes | Maximum **write** command intergap time observed external to an initiator-ITL-flow record.<br>write_io_inter_gap_time_max is the duration between successive IO commands and is measured in 1/256th of a microsecond. |
| read_io_aborts | rIOa | Metric | Count | Yes | Number of **read** command aborts observed external to an initiator-ITL-flow record. |
| write_io_aborts | wIOa | Metric | Count | Yes | Number of **write** command aborts observed external to an initiator-ITL-flow record. |
| read_io_failures | rIOf | Metric | Count | Yes | Number of **read** command failures observed external to an initiator-ITL-flow record. |
| write_io_failures | wIOf | Metric | Count | Yes | Number of **write** command failures observed external to an initiator-ITL-flow record. |
| read_io_nvme_lba_out_of_range_count | rIONLbaoorct | Metric | Count | No | Number of **read** command *lba out of range* errors seen. |
| write_io_nvme_lba_out_of_range_count | wIONLbaoorct | Metric | Count | No | Number of **write** command *lba out of range* errors seen. |
| read_io_nvme_ns_not_ready_count | rIOnNsnrc | Metric | Count | No | Number of **read** command *namespace not ready* errors seen. |
| write_io_nvme_ns_not_ready_count | wIOnNsnrc | Metric | Count | No | Number of **write** command *namespace not ready* errors seen. |
| read_io_nvme_reservation_conflict_count | rIONrecct | Metric | Count | No | Number of **read** command reservation conflicts seen external to an initiator-ITN-flow record. |
| write_io_nvme_reservation_conflict_count | wIONrecct | Metric | Count | No | Number of **write** command reservation conflicts seen external to an initiator-ITN-flow record. |

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| sampling_start_time | samStm | Metric | UNIX time | No | Start of the sampling time interval. |
| sampling_end_time | samEtm | Metric | UNIX time | No | End of the sampling time interval. |
| total_busy_period | totBsy | Metric | Count | No | The total time for which the view instances have been active. |
| total_write_io_first_burst_count | totWrFirBu | Metric | Count | No | Accumulated total **write** command first burst observed external to a switch port. |
| total_write_io_array_delay_time | totWrArrDel | Metric | Count | No | Accumulated total **write** command array delays observed external to a switch port. |
| total_write_io_host_delay_time | totWrHosDel | Metric | Count | No | Accumulated total **write** command host delays observed external to a switch port. |
| total_write_io_sequences_count | totWrSeq | Metric | Count | No | Accumulated total **write** command sequences observed external to a switch port. |
| write_io_host_delay_time_min | wrHosDelMn | Metric | Count | No | Minimum **write** command host delays observed external to a switch port. |
| write_io_host_delay_time_max | wrHosDelMx | Metric | Count | No | Maximum **write** command host delays observed external to a switch port. |
| write_io_array_delay_time_max | wrArrDelMx | Metric | Count | No | Maximum **write** command array delays observed external to a switch port. |
| multisequence_exchange_write_io_sequences_min | wrIoSeqMn | Metric | Count | No | Minimum **write** command multisequence exchange sequences observed external to a switch port. |
| multisequence_exchange_write_io_sequences_max | wrIoSeqMx | Metric | Count | No | Maximum **write** command multisequence exchange sequences observed external to a switch port. |

# Target ITL Flow View Instance (scsi_target_itl_flow)

**Note** The flow metrics for *Target ITL Flow View Instance* are applicable only for the SCSI analytics type.

***Table 33: Flow Metrics for Target ITL Flow View Instance***

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| **Long Name** | **Short Name** | | | | |
| port | port | Key | Text | No | A switch port where the SAN Analytics feature is enabled. |
| vsan | vsan | Key | Count | No | VSAN configured on a switch port with IO since last clearing of metrics. |
| app_id | app_id | Key | Count | No | Application identifier for an application external to a switch port. |
| target_id | did | Key | Text | No | Target Fibre Channel ID that is external to a switch port with IO since last clearing of metrics. |
| initiator_id | sid | Key | Text | No | Initiator Fibre Channel ID where the IO transactions are being performed on a target external to a switch port. |
| lun | lun | Key | Unit | No | Logical-unit-number (LUN) that is associated with a target where IOs are performed. |
| active_io_read_count | raIO | Metadata | Count | Yes | Number of outstanding **read** command counts associated with a target-ITL-flow record. |
| active_io_write_count | waIO | Metadata | Count | Yes | Number of outstanding **write** command counts associated with a target-ITL-flow record. |
| total_read_io_count | rtIO | Metric | Count | Yes | Total **read** command data observed external to a target-ITL-flow record. |
| total_write_io_count | wtIO | Metric | Count | Yes | Total **write** command data observed external to a target-ITL-flow record. |

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| **Long Name** | **Short Name** | | | | |
| total_seq_read_io_count | rstIOc | Metric | Count | No | Total sequential **read** command data observed external to a target-ITL-flow record. |
| total_seq_write_io_count | wrstIOc | Metric | Count | No | Total sequential **write** command data observed external to a target-ITL-flow record. |
| total_read_io_time | rtIOt | Metric | Microseconds | No | Accumulated total **read** command completion time observed external to a target-ITL-flow record.<br>You can use this information to compute the average read IO completion time. |
| total_write_io_time | wtIOt | Metric | Microseconds | No | Accumulated total **write** command completion time observed external to a target-ITL-flow record.<br>You can use this information to compute the average **write** command completion time. |
| total_read_io_initiation_time | rtIOint | Metric | Microseconds | no | Accumulated total **read** command initiation time (time gap between the IO command and the first response from the storage; the first response can be the first data frame for READ commands or the first txfr_rdy for WRITE commands) observed external to a target-ITL-flow record. The initiation time is sometimes referred to as **data access latency**.<br>You can use this information to compute the average read IO initiation time. |

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| total_write_io_initiation_time | wtIOint | Metric | Microseconds | No | Accumulated total **write** command initiation time (time gap between the IO command and the first response from the storage; the first response can be the first data frame for READ or txfer_rdy for WRITE) observed external to a target-ITL-flow record. The initiation time is sometimes referred to as **data access latency**.<br>You can use this information to compute the average **write** command initiation time. |
| total_read_io_bytes | rtIOb | Metric | Bytes | Yes | Total **read** command data that is observed external to a target-ITL-flow record. |
| total_write_io_bytes | wtIOb | Metric | Bytes | Yes | Total **write** command data observed external to a target-ITL-flow record. |
| total_read_io_inter_gap_time | rtIOigt | Metric | Microsecond | No | Accumulated total **read** command intergap time observed external to a target-ITL-flow record.<br>You can use this information to compute the average read IO intergap time. |
| total_write_io_inter_gap_time | wtIOigt | Metric | Microseconds | No | Accumulated total **write** command intergap time data observed external to a target-ITL-flow record.<br>You can use this information to compute the average **write** command intergap time. |
| total_time_metric_based_read_io_count | tmrtIOc | Metric | Count | No | Total completed **read** command data observed external to a target-ITL-flow record. |

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| total_time_metric_based_write_io_count | tmwtIOc | Metric | Count | No | Total completed **write** command data observed external to a target-ITL-flow record. |
| total_time_metric_based_read_io_bytes | tmrtIOb | Metric | Count | No | Total completed **read** command data observed external to a target-ITL-flow record, in bytes. |
| total_time_metric_based_write_io_bytes | tmwtIOb | Metric | Count | No | Total completed **write** command data observed external to a target-ITL-flow record, in bytes. |
| read_io_rate | rIOr | Metric | IOs per second | Yes | The rate of **read** commands observed external to a LUN on a target-ITL-flow record.<br>This metric is the average value collected over a 4-second interval from the NPU. |
| peak_read_io_rate | prIOr | Metric | IOs per second | No | The peak rate of **read** commands observed external to a target-ITL-flow record. |
| write_io_rate | wIOr | Metric | IOs per second | Yes | The rate of **write** commands observed external to a target-ITL-flow record.<br>This metric is the average value collected over a 4-second interval from the NPU. |
| peak_write_io_rate | pwIOr | Metric | IOs per second | No | The peak rate of **write** commands observed external to a target-ITL-flow record. |
| read_io_bandwidth | rIObw | Metric | Bytes per second | Yes | The **read** command bandwidth observed external to a target-ITL-flow record.<br>This metric is the average value collected over a 4-second interval from the NPU. |
| peak_read_io_bandwidth | prIObw | Metric | Bytes per second | No | Peak **read** command bandwidth observed external to a target-ITL-flow record. |

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| write_io_bandwidth | wIObw | Metric | Bytes per second | Yes | The **write** command bandwidth observed external to a target-ITL-flow record.<br>This metric is the average value collected over a 4-second interval from the NPU. |
| peak_write_io_bandwidth | pwIObw | Metric | Bytes per second | No | Peak **write** command bandwidth observed external to a target-ITL-flow record. |
| read_io_size_min | rIOsMi | Metric | Bytes | Yes | Minimum **read** command size observed external to a target-ITL-flow record. |
| read_io_size_max | rIOsMa | Metric | Bytes | Yes | Maximum **read** command size observed external to a target-ITL-flow record. |
| write_io_size_min | wIOsMi | Metric | Bytes | Yes | Minimum **write** command size observed external to a target-ITL-flow record. |
| write_io_size_max | wIOsMa | Metric | Bytes | Yes | Maximum **write** command size observed external to a target-ITL-flow record. |
| read_io_completion_time_min | rIOctMi | Metric | Microseconds | Yes | Minimum **read** command completion time observed external to a target-ITL-flow record. |
| read_io_completion_time_max | rIOctMa | Metric | Microseconds | Yes | Maximum **read** command completion time observed external to a target-ITL-flow record. |
| write_io_completion_time_min | wIOctMi | Metric | Microseconds | Yes | Minimum **write** command completion time observed external to a target-ITL-flow record. |
| write_io_completion_time_max | wIOctMa | Metric | Microseconds | Yes | Maximum **write** command completion time observed external to a target-ITL-flow record. |

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| read_io_initiation_time_min | rIOitMi | Metric | Microseconds | Yes | Minimum **read** command initiation time (time gap between the IO command and the first response from the storage; the first response can be the first data frame for READ or txfer_rdy for WRITE) observed external to a target-ITL-flow record. The initiation time is sometimes referred to as **data access latency**. |
| read_io_initiation_time_max | rIOitMa | Metric | Microseconds | Yes | Maximum **read** command initiation time (time gap between the IO command and the first response from the storage; the first response can be the first data frame for READ or txfer_rdy for WRITE) observed external to a target-ITL-flow record. The initiation time is sometimes referred to as **data access latency**. |
| write_io_initiation_time_min | wIOitMi | Metric | Microseconds | Yes | Minimum **write** command initiation time (time gap between the IO command and the first response from the storage; the first response can be the first data frame for READ or txfer_rdy for WRITE) observed external to a target-ITL-flow record. The initiation time is sometimes referred to as **data access latency**. |

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| write_io_initiation_time_max | wIOitMa | Metric | Microseconds | Yes | Maximum **write** command initiation time (time gap between the IO command and the first response from the storage; the first response can be the first data frame for READ or txfer_rdy for WRITE) observed external to a target-ITL-flow record. The initiation time is sometimes referred to as **data access latency**. |
| read_io_inter_gap_time_min | rIOigtMi | Metric | Microsecond | Yes | Minimum **read** command intergap time observed external to a target-ITL-flow record.<br>read_io_inter_gap_time_min is the duration between successive IO commands and is measured in 1/256th of a microsecond. |
| read_io_inter_gap_time_max | rIOigtMa | Metric | Microsecond | Yes | Maximum **read** command intergap time observed external to a target-ITL-flow record.<br>read_io_inter_gap_time_max is the duration between successive IO commands and is measured in 1/256th of a microsecond. |
| write_io_inter_gap_time_min | wIOigtMi | Metric | Microseconds | Yes | Minimum **write** command intergap time observed external to a target-ITL-flow record.<br>write_io_inter_gap_time_min is the duration between successive IO commands and is measured in 1/256th of a microsecond. |
| write_io_inter_gap_time_max | wIOigtMa | Metric | Microseconds | Yes | Maximum **write** command intergap time observed external to a target-ITL-flow record.<br>write_io_inter_gap_time_max is the duration between successive IO commands and is measured in 1/256th of a microsecond. |

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| read_io_aborts | rIOa | Metric | Count | Yes | Number of **read** command aborts observed external to a target-ITL-flow record. |
| write_io_aborts | wIOa | Metric | Count | Yes | Number of **write** command aborts observed external to a target-ITL-flow record. |
| read_io_failures | rIOf | Metric | Count | Yes | Number of **read** command failures observed external to a target-ITL-flow record. |
| write_io_failures | wIOf | Metric | Count | Yes | Number of **write** command failures observed external to a target-ITL-flow record. |
| read_io_scsi_check_condition_count | rIOSchcoct | Metric | Count | No | Number of **read** command check conditions seen external to a target-ITL-flow record. |
| write_io_scsi_check_condition_count | wIOSchcoct | Metric | Count | No | Number of **write** command check conditions seen external to a target-ITL-flow record. |
| read_io_scsi_busy_count | rIOsbc | Metric | Count | No | Number of **read** command busy status seen external to a target-ITL-flow record. |
| write_io_scsi_busy_count | wIOsbc | Metric | Count | No | Number of **write** command busy status seen external to a target-ITL-flow record. |
| read_io_scsi_reservation_conflict_count | rIOSrecct | Metric | Count | No | Number of **read** command reservation conflicts seen external to a target-ITL-flow record. |
| write_io_scsi_reservation_conflict_count | wIOSrecct | Metric | Count | No | Number of **write** command reservation conflicts seen external to a target-ITL-flow record. |
| read_io_scsi_queue_full_count | rIOSQfct | Metric | Count | No | Number of **read** command queue full status seen external to a target-ITL-flow record. |
| write_io_scsi_queue_full_count | wIOSQfct | Metric | Count | No | Number of **write** command queue full status seen external to a target-ITL-flow record. |

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| sampling_start_time | samStm | Metric | UNIX time | No | Start of the sampling time interval. |
| sampling_end_time | samEtm | Metric | UNIX time | No | End of the sampling time interval. |
| total_busy_period | totBsy | Metric | Count | No | The total time for which the view instances have been active. |
| total_write_io_first_burst_count | totWrFirBu | Metric | Count | No | Accumulated total **write** command first burst observed external to a switch port. |
| total_write_io_array_delay_time | totWrArrDel | Metric | Count | No | Accumulated total **write** command array delays observed external to a switch port. |
| total_write_io_host_delay_time | totWrHosDel | Metric | Count | No | Accumulated total **write** command host delays observed external to a switch port. |
| total_write_io_sequences_count | totWrSeq | Metric | Count | No | Accumulated total **write** command sequences observed external to a switch port. |
| write_io_host_delay_time_min | wrHosDelMn | Metric | Count | No | Minimum **write** command host delays observed external to a switch port. |
| write_io_host_delay_time_max | wrHosDelMx | Metric | Count | No | Maximum **write** command host delays observed external to a switch port. |
| write_io_array_delay_time_max | wrArrDelMx | Metric | Count | No | Maximum **write** command array delays observed external to a switch port. |
| multisequence_exchange_write_io_sequences_min | wrIoSeqMn | Metric | Count | No | Minimum **write** command multisequence exchange sequences observed external to a switch port. |
| multisequence_exchange_write_io_sequences_max | wrIoSeqMx | Metric | Count | No | Maximum **write** command multisequence exchange sequences observed external to a switch port. |

# Target ITN Flow View Instance (nvme_target_itn_flow)

**Note** The flow metrics for *Target ITN Flow View Instance* are applicable only for the NVMe analytics type.

***Table 34: Flow Metrics for Target ITN Flow View Instance***

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| **Long Name** | **Short Name** | | | | |
| port | port | Key | Text | No | A switch port where the SAN Analytics feature is enabled. |
| vsan | vsan | Key | Count | No | VSAN configured on a switch port with IO since last clearing of metrics. |
| app_id | app_id | Key | Count | No | Application identifier for an application external to a switch port. |
| target_id | did | Key | Text | No | Target Fibre Channel ID external to a switch port with IO since last clearing of metrics. |
| initiator_id | sid | Key | Text | No | Initiator Fibre Channel ID where the IO transactions are being performed on a target external to a switch port. |
| connection_id | ci | Key | Count | No | The NVMe connection id external to a switch port with IO since last clearing of metrics. |
| namespace_id | ni | Key | Count | No | The namespace ID is the NVMe controller's unique identifier for the namespace and can be set to a value between 1 and 255. It is analogous to a logical unit number (LUN) in SCSI. |
| active_io_read_count | raIO | Metadata | Count | Yes | Number of outstanding **read** command counts associated with a target-ITL-flow record. |
| active_io_write_count | waIO | Metadata | Count | Yes | Number of outstanding **write** command counts associated with a target-ITL-flow record. |

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| total_read_io_count | rtIO | Metric | Count | Yes | Total **read** command data observed external to a target-ITL-flow record. |
| total_write_io_count | wtIO | Metric | Count | Yes | Total **write** command data observed external to a target-ITL-flow record. |
| total_seq_read_io_count | rstIOc | Metric | Count | No | Total sequential **read** command data observed external to a target-ITL-flow record. |
| total_seq_write_io_count | wrstIOc | Metric | Count | No | Total sequential **write** command data observed external to a target-ITL-flow record. |
| total_read_io_time | rtIOt | Metric | Microseconds | No | Accumulated total **read** command completion time observed external to a target-ITL-flow record.<br>You can use this information to compute the average read IO completion time. |
| total_write_io_time | wtIOt | Metric | Microseconds | No | Accumulated total **write** command completion time observed external to a target-ITL-flow record.<br>You can use this information to compute the average **write** command completion time. |

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| total_read_io_initiation_time | rtIOint | Metric | Microseconds | no | Accumulated total **read** command initiation time (time gap between the IO command and the first response from the storage; the first response can be the first data frame for READ commands or the first txfr_rdy for WRITE commands) observed external to a target-ITL-flow record. The initiation time is sometimes referred to as **data access latency**.<br>You can use this information to compute the average read IO initiation time. |
| total_write_io_initiation_time | wtIOint | Metric | Microseconds | No | Accumulated total **write** command initiation time (time gap between the IO command and the first response from the storage; the first response can be the first data frame for READ or txfer_rdy for WRITE) observed external to a target-ITL-flow record. The initiation time is sometimes referred to as **data access latency**.<br>You can use this information to compute the average **write** command initiation time. |
| total_read_io_bytes | rtIOb | Metric | Bytes | Yes | Total **read** command data that is observed external to a target-ITL-flow record. |
| total_write_io_bytes | wtIOb | Metric | Bytes | Yes | Total **write** command data observed external to a target-ITL-flow record. |

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| total_read_io_inter_gap_time | rtIOigt | Metric | Microsecond | No | Accumulated total **read** command intergap time observed external to a target-ITL-flow record.<br>You can use this information to compute the average read IO intergap time. |
| total_write_io_inter_gap_time | wtIOigt | Metric | Microseconds | No | Accumulated total **write** command intergap time data observed external to a target-ITL-flow record.<br>You can use this information to compute the average **write** command intergap time. |
| total_time_metric_based_read_io_count | tmrtIOc | Metric | Count | No | Total completed **read** command data observed external to a target-ITL-flow record. |
| total_time_metric_based_write_io_count | tmwtIOc | Metric | Count | No | Total completed **write** command data observed external to a target-ITL-flow record. |
| total_time_metric_based_read_io_bytes | tmrtIOb | Metric | Count | No | Total completed **read** command data observed external to a target-ITL-flow record, in bytes. |
| total_time_metric_based_write_io_bytes | tmwtIOb | Metric | Count | No | Total completed **write** command data observed external to a target-ITL-flow record, in bytes. |
| read_io_rate | rIOr | Metric | IOs per second | Yes | The rate of **read** commands observed external to a LUN on a target-ITL-flow record.<br>This metric is the average value collected over a 4-second interval from the NPU. |
| peak_read_io_rate | prIOr | Metric | IOs per second | No | The peak rate of **read** commands observed external to a target-ITL-flow record. |

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| write_io_rate | wIOr | Metric | IOs per second | Yes | The rate of **write** commands observed external to a target-ITL-flow record.<br>This metric is the average value collected over a 4-second interval from the NPU. |
| peak_write_io_rate | pwIOr | Metric | IOs per second | No | The peak rate of **write** commands observed external to a target-ITL-flow record. |
| read_io_bandwidth | rIObw | Metric | Bytes per second | Yes | The **read** command bandwidth observed external to a target-ITL-flow record.<br>This metric is the average value collected over a 4-second interval from the NPU. |
| peak_read_io_bandwidth | prIObw | Metric | Bytes per second | No | Peak **read** command bandwidth observed external to a target-ITL-flow record. |
| write_io_bandwidth | wIObw | Metric | Bytes per second | Yes | The **write** command bandwidth observed external to a target-ITL-flow record.<br>This metric is the average value collected over a 4-second interval from the NPU. |
| peak_write_io_bandwidth | pwIObw | Metric | Bytes per second | No | Peak **write** command bandwidth observed external to a target-ITL-flow record. |
| read_io_size_min | rIOsMi | Metric | Bytes | Yes | Minimum **read** command size observed external to a target-ITL-flow record. |
| read_io_size_max | rIOsMa | Metric | Bytes | Yes | Maximum **read** command size observed external to a target-ITL-flow record. |
| write_io_size_min | wIOsMi | Metric | Bytes | Yes | Minimum **write** command size observed external to a target-ITL-flow record. |

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| write_io_size_max | wIOsMa | Metric | Bytes | Yes | Maximum **write** command size observed external to a target-ITL-flow record. |
| read_io_completion_time_min | rIOctMi | Metric | Microseconds | Yes | Minimum **read** command completion time observed external to a target-ITL-flow record. |
| read_io_completion_time_max | rIOctMa | Metric | Microseconds | Yes | Maximum **read** command completion time observed external to a target-ITL-flow record. |
| write_io_completion_time_min | wIOctMi | Metric | Microseconds | Yes | Minimum **write** command completion time observed external to a target-ITL-flow record. |
| write_io_completion_time_max | wIOctMa | Metric | Microseconds | Yes | Maximum **write** command completion time observed external to a target-ITL-flow record. |
| read_io_initiation_time_min | rIOitMi | Metric | Microseconds | Yes | Minimum **read** command initiation time (time gap between the IO command and the first response from the storage; the first response can be the first data frame for READ or txfer_rdy for WRITE) observed external to a target-ITL-flow record. The initiation time is sometimes referred to as **data access latency**. |
| read_io_initiation_time_max | rIOitMa | Metric | Microseconds | Yes | Maximum **read** command initiation time (time gap between the IO command and the first response from the storage; the first response can be the first data frame for READ or txfer_rdy for WRITE) observed external to a target-ITL-flow record. The initiation time is sometimes referred to as **data access latency**. |

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| write_io_initiation_time_min | wIOitMi | Metric | Microseconds | Yes | Minimum **write** command initiation time (time gap between the IO command and the first response from the storage; the first response can be the first data frame for READ or txfer_rdy for WRITE) observed external to a target-ITL-flow record. The initiation time is sometimes referred to as **data access latency**. |
| write_io_initiation_time_max | wIOitMa | Metric | Microseconds | Yes | Maximum **write** command initiation time (time gap between the IO command and the first response from the storage; the first response can be the first data frame for READ or txfer_rdy for WRITE) observed external to a target-ITL-flow record. The initiation time is sometimes referred to as **data access latency**. |
| read_io_inter_gap_time_min | rIOigtMi | Metric | Microsecond | Yes | Minimum **read** command intergap time observed external to a target-ITL-flow record.<br>read_io_inter_gap_time_min is the duration between successive IO commands and is measured in 1/256th of a microsecond. |
| read_io_inter_gap_time_max | rIOigtMa | Metric | Microsecond | Yes | Maximum **read** command intergap time observed external to a target-ITL-flow record.<br>read_io_inter_gap_time_max is the duration between successive IO commands and is measured in 1/256th of a microsecond. |

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| write_io_inter_gap_time_min | wIOigtMi | Metric | Microseconds | Yes | Minimum **write** command intergap time observed external to a target-ITL-flow record.<br>write_io_inter_gap_time_min is the duration between successive IO commands and is measured in 1/256th of a microsecond. |
| write_io_inter_gap_time_max | wIOigtMa | Metric | Microseconds | Yes | Maximum **write** command intergap time observed external to a target-ITL-flow record.<br>write_io_inter_gap_time_max is the duration between successive IO commands and is measured in 1/256th of a microsecond. |
| read_io_aborts | rIOa | Metric | Count | Yes | Number of **read** command aborts observed external to a target-ITL-flow record. |
| write_io_aborts | wIOa | Metric | Count | Yes | Number of **write** command aborts observed external to a target-ITL-flow record. |
| read_io_failures | rIOf | Metric | Count | Yes | Number of **read** command failures observed external to a target-ITL-flow record. |
| write_io_failures | wIOf | Metric | Count | Yes | Number of **write** command failures observed external to a target-ITL-flow record. |
| read_io_nvme_lba_out_of_range_count | rIONLbaoorct | Metric | Count | No | Number of **read** command *lba out of range* errors seen. |
| write_io_nvme_lba_out_of_range_count | wIONLbaoorct | Metric | Count | No | Number of **write** command *lba out of range* errors seen. |
| read_io_nvme_ns_not_ready_count | rIOnNsnrc | Metric | Count | No | Number of **read** command *namespace not ready* errors seen. |

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| write_io_nvme_ns_not_ready_count | wIOnNsnrc | Metric | Count | No | Number of **write** command *namespace not ready* errors seen. |
| read_io_nvme_reservation_conflict_count | rIONrecct | Metric | Count | No | Number of **read** command reservation conflicts seen external to a target-ITN-flow record. |
| write_io_nvme_reservation_conflict_count | wIONrecct | Metric | Count | No | Number of **write** command reservation conflicts seen external to a target-ITN-flow record. |
| sampling_start_time | samStm | Metric | UNIX time | No | Start of the sampling time interval. |
| sampling_end_time | samEtm | Metric | UNIX time | No | End of the sampling time interval. |
| total_busy_period | totBsy | Metric | Count | No | The total time for which the view instances have been active. |
| total_write_io_first_burst_count | totWrFirBu | Metric | Count | No | Accumulated total **write** command first burst observed external to a switch port. |
| total_write_io_array_delay_time | totWrArrDel | Metric | Count | No | Accumulated total **write** command array delays observed external to a switch port. |
| total_write_io_host_delay_time | totWrHosDel | Metric | Count | No | Accumulated total **write** command host delays observed external to a switch port. |
| total_write_io_sequences_count | totWrSeq | Metric | Count | No | Accumulated total **write** command sequences observed external to a switch port. |
| write_io_host_delay_time_min | wrHosDelMn | Metric | Count | No | Minimum **write** command host delays observed external to a switch port. |
| write_io_host_delay_time_max | wrHosDelMx | Metric | Count | No | Maximum **write** command host delays observed external to a switch port. |

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| write_io_array_delay_time_max | wrArrDelMx | Metric | Count | No | Maximum **write** command array delays observed external to a switch port. |
| multisequence_exchange_write_io_sequences_min | wrIoSeqMn | Metric | Count | No | Minimum **write** command multisequence exchange sequences observed external to a switch port. |
| multisequence_exchange_write_io_sequences_max | wrIoSeqMx | Metric | Count | No | Maximum **write** command multisequence exchange sequences observed external to a switch port. |

## Initiator IO Flow View Instance (scsi_initiator_io and nvme_initiator_io)

*Table 35: Flow Metrics for Initiator IO Flow View Instance*

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| port | port | Key | Text | No | A switch port where the SAN Analytics feature is enabled. |
| vsan | vsan | Key | Count | No | VSAN configured on a switch port with IO since last clearing of metrics. |
| app_id | app_id | Key | Count | No | Application identifier for an application external to a switch port. |
| initiator_id | sid | Key | Text | No | Initiator Fibre Channel ID where the IO transactions are being performed on an initiator external to a switch port. |
| target_id | did | Key | Text | No | Initiator Fibre Channel ID external to a switch port with IO since last clearing of metrics. |
| lun | lun | Key | Count | No | Logical-unit-number (LUN) that is associated with an initiator where IOs are performed. |

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| connection_id | ci | Key | Count | No | The NVMe connection id external to a switch port with IO since last clearing of metrics. |
| namespace_id | ni | Key | Count | No | The namespace ID is the NVMe controller's unique identifier for the namespace and can be set to a value between 1 and 255. It is analogous to a logical unit number (LUN) in SCSI. |
| exchange_id | oxid | Key | Count | No | Exchange ID, assigned by the originator, that is associated with an IO transaction. |
| extended_exchange_id | exXID | Metadata | Count | No | Extended exchange ID, assigned by the responder, that is associated with an IO transaction. |
| io_lba | iolba | Metadata | Count | No | Logical block address (LBA) where IO is performed. |
| io_size | iosize | Metadata | Count | No | Size of the IO, that is, the number of bytes of data involved in the IO. |
| io_start_time | iost | Metric | Count | Yes | Time stamp at which IO started. |
| sampling_start_time | samStm | Metric | UNIX time | No | Start of the sampling time interval. |
| sampling_end_time | samEtm | Metric | UNIX time | No | End of the sampling time interval. |
| total_busy_period | totBsy | Metric | Count | No | The total time for which the view instances have been active. |
| total_write_io_first_burst_count | totWrFirBu | Metric | Count | No | Accumulated total **write** command first burst observed external to a switch port. |
| total_write_io_array_delay_time | totWrArrDel | Metric | Count | No | Accumulated total **write** command array delays observed external to a switch port. |
| total_write_io_host_delay_time | totWrHosDel | Metric | Count | No | Accumulated total **write** command host delays observed external to a switch port. |

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| total_write_io_sequences_count | totWrSeq | Metric | Count | No | Accumulated total **write** command sequences observed external to a switch port. |
| write_io_host_delay_time_min | wrHosDelMn | Metric | Count | No | Minimum **write** command host delays observed external to a switch port. |
| write_io_host_delay_time_max | wrHosDelMx | Metric | Count | No | Maximum **write** command host delays observed external to a switch port. |
| write_io_array_delay_time_max | wrArrDelMx | Metric | Count | No | Maximum **write** command array delays observed external to a switch port. |
| multisequence_exchange_write_io_sequences_min | wrIoSeqMn | Metric | Count | No | Minimum **write** command multisequence exchange sequences observed external to a switch port. |
| multisequence_exchange_write_io_sequences_max | wrIoSeqMx | Metric | Count | No | Maximum **write** command multisequence exchange sequences observed external to a switch port. |

## Target IO Flow View Instance (scsi_target_io and nvme_target_io)

***Table 36: Flow Metrics for Target IO Flow View Instance***

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| port | port | Key | Text | No | A switch port where the SAN Analytics feature is enabled. |
| vsan | vsan | Key | Count | No | VSAN configured on a switch port with IO since last clearing of metrics. |
| app_id | app_id | Key | Count | No | Application identifier for an application external to a switch port. |
| target_id | did | Key | Text | No | Target Fibre Channel ID external to a switch port with IO since last clearing of metrics. |
| initiator_id | sid | Key | Text | No | Initiator Fibre Channel ID where the IO transactions are being performed on a target external to a switch port. |

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| lun | lun | Key | Count | No | Logical-unit-number (LUN) that is associated with a target where IOs are performed. |
| connection_id | ci | Key | Count | No | The NVMe connection id external to a switch port with IO since last clearing of metrics. |
| namespace_id | ni | Key | Count | No | The namespace ID is the NVMe controller's unique identifier for the namespace and can be set to a value between 1 and 255. It is analogous to a logical unit number (LUN) in SCSI. |
| exchange_id | oxid | Key | Count | No | Exchange ID, assigned by the originator, that is associated with an IO transaction. |
| extended_exchange_id | exXID | Metadata | Count | No | Extended exchange ID, assigned by the responder, that is associated with an IO transaction. |
| io_lba | iolba | Metadata | Count | No | Logical block address (LBA) where IO is performed. |
| io_size | iosize | Metadata | Count | No | Size of the IO, that is, the number of bytes of data involved in the IO. |
| io_start_time | iost | Metric | Count | Yes | Time stamp at which IO started. |
| total_busy_period | totBsy | Metric | Count | No | The total time for which the view instances have been active. |
| total_write_io_first_burst_count | totWrFirBu | Metric | Count | No | Accumulated total **write** command first burst observed external to a switch port. |
| total_write_io_array_delay_time | totWrArrDel | Metric | Count | No | Accumulated total **write** command array delays observed external to a switch port. |
| total_write_io_host_delay_time | totWrHosDel | Metric | Count | No | Accumulated total **write** command host delays observed external to a switch port. |
| total_write_io_sequences_count | totWrSeq | Metric | Count | No | Accumulated total **write** command sequences observed external to a switch port. |
| write_io_host_delay_time_min | wrHosDelMn | Metric | Count | No | Minimum **write** command host delays observed external to a switch port. |

| Flow Metric | | Type | Unit | Sortable? | Description |
|---|---|---|---|---|---|
| Long Name | Short Name | | | | |
| write_io_host_delay_time_max | wrHosDelMx | Metric | Count | No | Maximum **write** command host delays observed external to a switch port. |
| write_io_array_delay_time_max | wrArrDelMx | Metric | Count | No | Maximum **write** command array delays observed external to a switch port. |
| multisequence_exchange_write_io_sequences_min | wrIoSeqMn | Metric | Count | No | Minimum **write** command multisequence exchange sequences observed external to a switch port. |
| multisequence_exchange_write_io_sequences_max | wrIoSeqMx | Metric | Count | No | Maximum **write** command multisequence exchange sequences observed external to a switch port. |

# Interface Counters

The following table provides information about the list of supported interface counters:

***Table 37: Interface Counters***

| Counter Name | Description |
|---|---|
| BB_SCr Tx credit increment actions | The number of times port detected lost R_RDYs and corrected the local credit accounting by incrementing *TX B2B credit available* status. |
| BB_SCs credit resend actions | The number of times port detected lost frames and corrected the peer credit accounting by resending extra credits (R_RDYs). |
| CTS SPI Mismatch | FCSP-ESP frames having mismatched security association identifier. |
| Delimiter Errors | The number of times frames are received with delimiter (start-of-frame [So]) or end-of-frame [EoF]) errors. |
| Diag Generated Frames | Test frames generated by an internal packet generator. |
| ELS Frames Discard | The number of times Extended Link Service (ELS) frames were discarded. |
| EOF Frames | The number of times invalid EoF frames were received. |
| FC2 Discards | The number of times Class 2 frames were dropped at egress due to timeout, abort, offline, and so on. |
| FC2 InFrames | The number of times Class 2 frames were received. |
| FC2 InOctets | The number of Class 2 ingress octets. |
| FC2 OutFrames | The number of times Class 2 frames were transmitted. |

| Counter Name | Description |
|---|---|
| FC2 OutOctets | The number of Class 2 egress octets. |
| FC2 PRJT Frames | The number of Class 2 received frames rejected by port. |
| FC3 Discards | The number of times Class 3 frames were dropped at egress due to timeout, abort, offline, and so on. |
| FC3 InFrames | The number of times Class 3 frames were received. |
| FC3 InOctets | The number of Class 3 ingress octets. |
| FC3 OutFrames | The number of times Class 3 frames were transmitted. |
| FC3 OutOctets | The number of Class 3 egress octets. |
| FCF Discards | The number of times Class F frames were dropped at egress due to timeout, abort, offline, and so on. |
| FCF InFrames | The number of times Class F frames were received. |
| FCF InOctets | The number of Class F ingress octets. |
| FCF OutFrames | The number of times Class F frames were transmitted. |
| FCF OutOctets | The number of Class F egress octets. |
| FC Out Errors | The number of times Fibre Channel errors were transmitted. |
| FIB Drops | The number of frames that were dropped due to forwarding lookup miss on a port group. |
| FLRR In | The number of times a Fibre Channel port received Link Reset Responses (LRR) primitive sequences when the port was active. |
| FLRR Out | The number of times a Fibre Channel port transmitted Link Reset Responses (LRR) primitive sequences when the port was active. |
| Frames Too Long | The number of times long frames were received beyond the configured maximum Fibre Channel frame size. |
| Frames Too Short | The number of times short frames were received below the configured minimum Fibre Channel frame size. |
| Framing Error Frames | The number of times framing error frames were received. |
| HC InBroadcast Pkts | The number of times broadcast packets were received. |
| HC InMulticast Pkts | The number of times multicast packets were received. |
| HC InOctets | The number of high-capacity ingress octets. |
| HC InUcast Pkts | The number of times unicast packets were received. |
| HC OutBroadcast Pkts | The number of times broadcast packets were transmitted. |

| Counter Name | Description |
|---|---|
| HC OutMulticast Pkts | The number of times multicast packets were transmitted. |
| HC OutOctets | The number of high-capacity egress octets. |
| HC OutUCast Pkts | The number of times unicast packets were transmitted. |
| IfIn Discards | The number of times ingress frames were dropped. |
| IfIn Errors | The number of ingress errors. |
| IfIn Frames | The number of ingress frames. |
| IfIn Octets | The number of ingress frames, in bytes. |
| IfOut Discards | The number of times egress frames were dropped. |
| IfOut Errors | The number of egress errors. |
| IfOut Frames | The number of egress frames. |
| IfOut Octets | The number of egress frames, in bytes. |
| In Broadcast Pkts | The number of times broadcast frames were received. |
| In Discards | The number of times discards were received. |
| In Errors | The number of errors received. |
| In Multicast Pkts | The number of times multicast frames were received. |
| InOctets | The number of ingress octets. |
| In UCast Pkts | The number of times unicast packets were received. |
| Invalid CRCs | The number of times frames with Internal Cyclic Redundancy Check (CRC) errors were received by a port. |
| Invalid Tx Words | The number of times invalid Tx words were received by a port. |
| Jabber Frames In | The number of times a Fibre Channel port receives frames that are longer than the maximum frame length and also have a CRC or FCS error. |
| Link Failures | The number of times a Fibre Channel link was down because of the received Offline Sequence (OLS) or Not Operational Sequence (NOS) errors. |
| Link Reset Ins | The number of times a Fibre Channel port received Link Reset (LR) primitive sequences when the port was active. |
| Link Reset Outs | The number of times a Fibre Channel port transmitted LR primitive sequences when the port was active. |
| LIP F8 In | The number of times Loop Initiation Protocol (LIP) F8 primitives were received. |

| Counter Name | Description |
|---|---|
| LIP F8 Out | The number of times LIP F8 primitives were transmitted. |
| Non Lip F8 In | The number of times non-LIP F8 primitives were received. |
| Non Lip F8 Out | The number of times non-LIP F8 primitives were transmitted. |
| NOS In | The number of times NOS were received by a port. |
| NOS Out | The number of times NOS were transmitted by a port. |
| OLS Ins | The number of times a Fibre Channel port received OLS primitive sequences. |
| OLS Outs | The number of times a Fibre Channel port transmitted OLS primitive sequences. |
| Other Drops | The number of frames that were dropped due to other errors on a port group. |
| Out Broadcast Pkts | The number of times broadcast frames were transmitted. |
| Out Discards | The number of times discards were transmitted. |
| Out Multicast Pkts | The number of times multicast frames were transmitted. |
| Out Octets | The number of egress octets. |
| Out Ucast Pkts | The number of times unicast packets were transmitted. |
| Runt Frames In | The number of times a Fibre Channel port receives frames that are shorter than the minimum allowable frame length regardless of the CRC or FCS error. |
| Rx B2B credit transitions to zero for VL 0 | The number of times the interface was at zero Rx BB_credits remaining for virtual link 0. |
| Rx B2B credit transitions to zero for VL 1 | The number of times the interface was at zero Rx BB_credits remaining for virtual link 1. |
| Rx B2B credit transitions to zero for VL 2 | The number of times the interface was at zero Rx BB_credits remaining for virtual link 2. |
| Rx B2B credit transitions to zero for VL 3 | The number of times the interface was at zero Rx BB_credits remaining for virtual link 3. |
| Rx BBCredit Transition to Zero | The number of times the interface was at zero Rx BB_credits remaining. |
| Rx BBZ VL0 | Rx B2B credit transitions to zero for VL 0. |
| Rx BBZ VL1 | Rx B2B credit transitions to zero for VL 1. |
| Rx BBZ VL2 | Rx B2B credit transitions to zero for VL 2. |
| Rx BBZ VL3 | Rx B2B credit transitions to zero for VL 3. |
| Sig Loss | The number of times a Fibre Channel port experienced loss of laser signal. |

| Counter Name | Description |
|---|---|
| Sync Loss | The number of times a Fibre Channel port experienced loss of synchronization in Rx. |
| Timeout Discards | Any frame dropped in the switch due to congestion-drop timeout or no-credit-drop timeout is accounted as timeout discard. Increment in timeout discard indicates congestion in transmit direction. |
| Tx B2B credit transitions to zero for VL 0 | The number of times the interface was at zero Tx BB_credits remaining and unable to transmit on virtual link 0. |
| Tx B2B credit transitions to zero for VL 1 | The number of times the interface was at zero Tx BB_credits remaining and unable to transmit on virtual link 1. |
| Tx B2B credit transitions to zero for VL 2 | The number of times the interface was at zero Tx BB_credits remaining and unable to transmit on virtual link 2. |
| Tx B2B credit transitions to zero for VL 3 | The number of times the interface was at zero Tx BB_credits remaining and unable to transmit on virtual link 3. |
| Tx BBCredit Transition to Zero | The number of times the interface was at zero Tx BB_credits remaining and unable to transmit. |
| Tx BBZ VL0 | Tx B2B credit transitions to zero for VL 0. |
| Tx BBZ VL1 | Tx B2B credit transitions to zero for VL 1. |
| Tx BBZ VL2 | Tx B2B credit transitions to zero for VL 2. |
| Tx BBZ VL3 | Tx B2B credit transitions to zero for VL 3. |
| TxWait | TxWait counter is an aggregate time counter that counts the transmit wait time of a port. Transmit wait is a condition when a port lacks transmit credit available (tx b2b = 0) and frames are waiting for transmission. Counter is in increments 2.5 microseconds. To calculate the count value in seconds, multiply the TxWait count by 2.5 and divide by 1,000,000. |
| TxWait 2.5us due to lack of transmit credits | The number of times an interface was at zero Tx credits for 2.5 microseconds. |
| TxWait 2.5us due to lack of transmit credits for VL 0 | The number of times an interface was at zero Tx credits for 2.5 microseconds on virtual link 0. |
| TxWait 2.5us due to lack of transmit credits for VL 1 | The number of times an interface was at zero Tx credits for 2.5 microseconds on virtual link 1. |
| TxWait 2.5us due to lack of transmit credits for VL 2 | The number of times an interface was at zero Tx credits for 2.5 microseconds on virtual link 2. |
| TxWait 2.5us due to lack of transmit credits for VL 3 | The number of times an interface was at zero Tx credits for 2.5 microseconds on virtual link 3. |
| TxWait VL0 | TxWait 2.5us due to lack of transmit credits for VL 0. |

| Counter Name | Description |
|---|---|
| TxWait VL1 | TxWait 2.5us due to lack of transmit credits for VL 1. |
| TxWait VL2 | TxWait 2.5us due to lack of transmit credits for VL 2. |
| TxWait VL3 | TxWait 2.5us due to lack of transmit credits for VL 3. |
| Unknown Class Frames | The number of times unknown class frames were received. |
| Xbar Drops | The number of frames that were dropped due to fabric switching (crossbar) errors on a port group. |
| Zone Drops | The number of frames that were dropped due to zoning not configured for a device on a port group. |

# SAN Telemetry Streaming Proto Files — Release 9.4(1)

This section provides information about the *.proto* files that are used in compact GPB.

The following information displays the contents of the *telemetry_bis.proto* file:

```
/* ------------------------------------------------------------------------------
 * telemetry_bis.proto - Telemetry protobuf definitions
 *
 * August 2023
 *
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 *
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 *
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 * distributed under the License is distributed on an "AS IS" BASIS,
 * WITHOUT WARRANTIES OR CONDITIONS OF ANY KIND, either express or implied.
 * See the License for the specific language governing permissions and
 * limitations under the License.
 * ------------------------------------------------------------------------------
 */

syntax = "proto3";

option go_package = "telemetry_bis";

option cc_enable_arenas = true;

 /*
  * Common message used as a header to both compact and self-describing
  * telemetry messages.
  */

message Telemetry {
  oneof node_id {
    string node_id_str = 1;
    //  bytes node_id_uuid = 2;              // not produced
```

```
  }
  oneof subscription {
    string   subscription_id_str = 3;
    //  uint32   subscription_id = 4;        // not produced
  }
  // string   sensor_path = 5;               // not produced
  string   encoding_path = 6;
  // string   model_version = 7;             // not produced
  uint64   collection_id = 8;
  uint64   collection_start_time = 9;
  uint64   msg_timestamp = 10;
  repeated TelemetryField data_gpbkv = 11;
  TelemetryGPBTable data_gpb = 12;
  uint64   collection_end_time = 13;
  // uint64   heartbeat_sequence_number = 14; // not produced
}

/*
 * Messages used to export content in GPB K/V form.
 *
 * The set of messages in this .proto are sufficient to decode all
 * telemetry messages.
 */

message TelemetryField {
  uint64         timestamp = 1;
  string         name = 2;
  oneof value_by_type {
    bytes          bytes_value = 4;
    string         string_value = 5;
    bool           bool_value = 6;
    uint32         uint32_value = 7;
    uint64         uint64_value = 8;
    sint32         sint32_value = 9;
    sint64         sint64_value = 10;
    double         double_value = 11;
    float          float_value = 12;
  }
  repeated TelemetryField fields = 15;
}

/*
 * Messages used to export content in compact GPB form
 *
 * Per encoding-path .proto files are required to decode keys/content
 * pairs below.
 */

message TelemetryGPBTable {
  repeated TelemetryRowGPB row = 1;
}

message TelemetryRowGPB {
   uint64 timestamp = 1;
   bytes keys = 10;
   bytes content = 11;
}
```

The following information displays the contents of the *fabric_telemetry.proto* file in Release 9.4(1):

```
/* ------------------------------------------------------------------------------
* fabric_telemetry.proto - Fabric Telemetry protobuf definitions
*
```

```
* July 2023
*
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*
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*
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* distributed under the License is distributed on an "AS IS" BASIS,
* WITHOUT WARRANTIES OR CONDITIONS OF ANY KIND, either express or implied.
* See the License for the specific language governing permissions and
* limitations under the License.
* ------------------------------------------------------------------------------
*/

syntax = "proto3";

option go_package = "fabric_telemetry";

option cc_enable_arenas = true;

message ControlInformation {
    string version = 1;
    uint32 chunk_sequence = 2;
    uint32 total_chunks_count = 3;
}

message FlowRecordsTable {
    ControlInformation control_info = 1;
    repeated FlowRecordRow row = 2;
}

message FlowRecordRow {
    string port = 1;
    uint32 app_id = 2;
    uint32 vsan = 3;
    string target_id = 4;
    string initiator_id = 5;
    string lun = 6;
    string exchange_id = 7;
    uint32 scsi_target_count = 8;
    uint32 scsi_initiator_count = 9;
    uint32 io_app_count = 10;
    uint32 logical_port_count = 11;
    uint32 scsi_target_app_count = 12;
    uint32 scsi_initiator_app_count = 13;
    uint32 active_io_read_count = 14;
    uint32 active_io_write_count = 15;
    uint32 scsi_target_tl_flow_count = 16;
    uint32 scsi_target_it_flow_count = 17;
    uint32 scsi_initiator_it_flow_count = 18;
    uint32 scsi_target_itl_flow_count = 19;
    uint32 scsi_initiator_itl_flow_count = 20;
    uint32 scsi_target_lun_count = 21;
    uint32 scsi_target_entity_it_flow_count = 22;
    uint32 scsi_initiator_entity_it_flow_count = 23;
    uint32 scsi_target_entity_itl_flow_count = 24;
    uint32 scsi_initiator_entity_itl_flow_count = 25;
    uint64 sampling_start_time = 26;
    uint64 sampling_end_time = 27;
    string extended_exchange_id = 28;
```

```
string io_lba = 29;
uint32 io_size = 30;
uint64 total_read_io_count = 31;
uint64 total_write_io_count = 32;
uint64 total_seq_read_io_count = 33;
uint64 total_seq_write_io_count = 34;
uint64 total_read_io_time = 35;
uint64 total_write_io_time = 36;
uint64 total_read_io_initiation_time = 37;
uint64 total_write_io_initiation_time = 38;
uint64 total_read_io_bytes = 39;
uint64 total_write_io_bytes = 40;
uint64 total_read_io_inter_gap_time = 41;
uint64 total_write_io_inter_gap_time = 42;
uint64 total_time_metric_based_read_io_count = 43;
uint64 total_time_metric_based_write_io_count = 44;
uint64 total_time_metric_based_read_io_bytes = 45;
uint64 total_time_metric_based_write_io_bytes = 46;
uint64 io_start_time = 47;
uint32 read_io_rate = 48;
uint32 peak_read_io_rate = 49;
uint32 write_io_rate = 50;
uint32 peak_write_io_rate = 51;
uint32 read_io_bandwidth_deprecated = 52;          /* modified in Release 9.4(1)*/
uint32 peak_read_io_bandwidth_deprecated = 53;     /* modified in Release 9.4(1)*/
uint32 write_io_bandwidth_deprecated = 54;         /* modified in Release 9.4(1)*/
uint32 peak_write_io_bandwidth_deprecated = 55;    /* modified in Release 9.4(1)*/
uint32 read_io_size_min = 56;
uint32 read_io_size_max = 57;
uint32 write_io_size_min = 58;
uint32 write_io_size_max = 59;
uint32 read_io_completion_time_min = 60;
uint32 read_io_completion_time_max = 61;
uint32 write_io_completion_time_min = 62;
uint32 write_io_completion_time_max = 63;
uint32 read_io_initiation_time_min = 64;
uint32 read_io_initiation_time_max = 65;
uint32 write_io_initiation_time_min = 66;
uint32 write_io_initiation_time_max = 67;
uint32 read_io_inter_gap_time_min = 68;
uint32 read_io_inter_gap_time_max = 69;
uint32 write_io_inter_gap_time_min = 70;
uint32 write_io_inter_gap_time_max = 71;
uint32 peak_active_io_read_count = 72;
uint32 peak_active_io_write_count = 73;
uint32 read_io_aborts = 74;
uint32 write_io_aborts = 75;
uint32 read_io_failures = 76;
uint32 write_io_failures = 77;
uint32 read_io_timeouts = 78;
uint32 write_io_timeouts = 79;
uint32 read_io_scsi_check_condition_count = 80;
uint32 write_io_scsi_check_condition_count = 81;
uint32 read_io_scsi_busy_count = 82;
uint32 write_io_scsi_busy_count = 83;
uint32 read_io_scsi_reservation_conflict_count = 84;
uint32 write_io_scsi_reservation_conflict_count = 85;
uint32 read_io_scsi_queue_full_count = 86;
uint32 write_io_scsi_queue_full_count = 87;
uint32 read_io_rate_exceed_count = 88;
uint32 write_io_rate_exceed_count = 89;
uint32 read_io_bandwidth_exceed_count = 90;
uint32 write_io_bandwidth_exceed_count = 91;
uint32 read_io_size_min_exceed_count = 92;
```

```
uint32 read_io_size_max_exceed_count = 93;
uint32 write_io_size_min_exceed_count = 94;
uint32 write_io_size_max_exceed_count = 95;
uint32 read_io_initiation_time_min_exceed_count = 96;
uint32 read_io_initiation_time_max_exceed_count = 97;
uint32 write_io_initiation_time_min_exceed_count = 98;
uint32 write_io_initiation_time_max_exceed_count = 99;
uint32 read_io_completion_time_min_exceed_count = 100;
uint32 read_io_completion_time_max_exceed_count = 101;
uint32 write_io_completion_time_min_exceed_count = 102;
uint32 write_io_completion_time_max_exceed_count = 103;
uint32 read_io_inter_gap_time_min_exceed_count = 104;
uint32 read_io_inter_gap_time_max_exceed_count = 105;
uint32 write_io_inter_gap_time_min_exceed_count = 106;
uint32 write_io_inter_gap_time_max_exceed_count = 107;
uint32 read_io_abort_exceed_count = 108;
uint32 write_io_abort_exceed_count = 109;
uint32 read_io_failure_exceed_count = 110;
uint32 write_io_failure_exceed_count = 111;
uint64 total_abts_count = 112;
uint32 namespace_id = 113;
string connection_id = 114;
uint32 nvme_target_count = 115;
uint32 nvme_initiator_count = 116;
uint32 nvme_target_app_count = 117;
uint32 nvme_initiator_app_count = 118;
uint32 nvme_target_tn_flow_count = 119;
uint32 nvme_target_it_flow_count = 120;
uint32 nvme_initiator_it_flow_count = 121;
uint32 nvme_target_itn_flow_count = 122;
uint32 nvme_initiator_itn_flow_count = 123;
uint32 nvme_target_namespace_count = 124;
uint32 nvme_target_entity_it_flow_count = 125;
uint32 nvme_initiator_entity_it_flow_count = 126;
uint32 nvme_target_entity_itn_flow_count = 127;
uint32 nvme_initiator_entity_itn_flow_count = 128;
uint32 read_io_nvme_lba_out_of_range_count = 129;
uint32 write_io_nvme_lba_out_of_range_count = 130;
uint32 read_io_nvme_ns_not_ready_count = 131;
uint32 write_io_nvme_ns_not_ready_count = 132;
uint32 read_io_nvme_reservation_conflict_count = 133;
uint32 write_io_nvme_reservation_conflict_count = 134;
uint32 read_io_nvme_capacity_exceeded_count = 135;
uint32 write_io_nvme_capacity_exceeded_count = 136;
uint64 total_host_delay_time = 137;
uint64 total_write_sequences = 138;
uint32 host_delay_time_min = 139;
uint32 host_delay_time_max = 140;
uint32 write_sequences_min = 141;
uint32 write_sequences_max = 142;
uint32 read_io_initiate_miss_count = 143;
uint32 write_io_initiate_miss_count = 144;
uint32 read_write_io_rate_exceed_count = 145;
uint32 read_write_io_bandwidth_exceed_count = 146;
uint32 read_write_io_abort_exceed_count = 147;
uint32 read_write_io_failure_exceed_count = 148;
uint32 active_read_write_io_exceed_count = 149;
uint32 read_io_size_min_max_exceed_count = 150;
uint32 write_io_size_min_max_exceed_count = 151;
uint32 read_io_initiation_time_min_max_exceed_count = 152;
uint32 write_io_initiation_time_min_max_exceed_count = 153;
uint32 read_io_completion_time_min_max_exceed_count = 154;
uint32 write_io_completion_time_min_max_exceed_count = 155;
uint32 read_io_inter_gap_time_min_max_exceed_count = 156;
```

```
    uint32 write_io_inter_gap_time_min_max_exceed_count = 157;
    uint32 host_delay_time_min_max_exceed_count = 158;
    uint32 write_sequences_min_max_exceed_count = 159;
    uint64 creation_time = 160;
    uint64 last_update_time = 161;
    uint64 last_export_time = 162;
    uint64 last_clear_on_export_time = 163;
    uint64 last_clear_time = 164;
    uint64 last_set_time = 165;
    string vmid = 166;
    f64specific f64metrics=167;
    uint64 read_io_bandwidth = 168;                        /* new in Release 9.4(1)*/
    uint64 peak_read_io_bandwidth = 169;                   /* new in Release 9.4(1)*/
    uint64 write_io_bandwidth = 170;                       /* new in Release 9.4(1)*/
    uint64 peak_write_io_bandwidth = 171;                  /* new in Release 9.4(1)*/

}
```

# SAN Telemetry Streaming Proto Files — Prior to Release 9.4(1)

This section provides information about the *.proto* files that are used in compact GPB.

The following information displays the contents of the *telemetry_bis.proto* file:

```
/* ------------------------------------------------------------------------------
 * telemetry_bis.proto - Telemetry protobuf definitions
 *
 * August 2016
 *
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 *
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 * You may obtain a copy of the License at
 *
 *     http://www.apache.org/licenses/LICENSE-2.0
 *
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 * distributed under the License is distributed on an "AS IS" BASIS,
 * WITHOUT WARRANTIES OR CONDITIONS OF ANY KIND, either express or implied.
 * See the License for the specific language governing permissions and
 * limitations under the License.
 * ------------------------------------------------------------------------------
 */

syntax = "proto3";

option go_package = "telemetry_bis";

option cc_enable_arenas = true;

 /*
  * Common message used as a header to both compact and self-describing
  * telemetry messages.
  */

message Telemetry {
  oneof node_id {
    string node_id_str = 1;
    //  bytes node_id_uuid = 2;              // not produced
  }
```

```
  oneof subscription {
    string   subscription_id_str = 3;
    //  uint32   subscription_id = 4;        // not produced
  }
  // string   sensor_path = 5;               // not produced
  string   encoding_path = 6;
  // string   model_version = 7;             // not produced
  uint64   collection_id = 8;
  uint64   collection_start_time = 9;
  uint64   msg_timestamp = 10;
  repeated TelemetryField data_gpbkv = 11;
  TelemetryGPBTable data_gpb = 12;
  uint64   collection_end_time = 13;
  // uint64   heartbeat_sequence_number = 14; // not produced
}

/*
 * Messages used to export content in GPB K/V form.
 *
 * The set of messages in this .proto are sufficient to decode all
 * telemetry messages.
 */

message TelemetryField {
  uint64         timestamp = 1;
  string         name = 2;
  oneof value_by_type {
    bytes          bytes_value = 4;
    string         string_value = 5;
    bool           bool_value = 6;
    uint32         uint32_value = 7;
    uint64         uint64_value = 8;
    sint32         sint32_value = 9;
    sint64         sint64_value = 10;
    double         double_value = 11;
    float          float_value = 12;
  }
  repeated TelemetryField fields = 15;
}

/*
 * Messages used to export content in compact GPB form
 *
 * Per encoding-path .proto files are required to decode keys/content
 * pairs below.
 */

message TelemetryGPBTable {
  repeated TelemetryRowGPB row = 1;
}

message TelemetryRowGPB {
   uint64 timestamp = 1;
   bytes keys = 10;
   bytes content = 11;
}
```

The following information displays the contents of the *fabric_telemetry.proto* file for Release prior to 9.4(1):

**Note** The *exceed_count* counters in the output will be supported in a future Cisco MDS NX-OS Release.

```
/* ------------------------------------------------------------------------------
* fabric_telemetry.proto - Fabric Telemetry protobuf definitions
*
* July 2018
*
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*
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* distributed under the License is distributed on an "AS IS" BASIS,
* WITHOUT WARRANTIES OR CONDITIONS OF ANY KIND, either express or implied.
* See the License for the specific language governing permissions and
* limitations under the License.
* ------------------------------------------------------------------------------
*/

syntax = "proto3";

option go_package = "fabric_telemetry";

option cc_enable_arenas = true;

message ControlInformation {
    string version = 1;
    uint32 chunk_sequence = 2;
    uint32 total_chunks_count = 3;
}

message FlowRecordsTable {
    ControlInformation control_info = 1;
    repeated FlowRecordRow row = 2;
}

message FlowRecordRow {
    string port = 1;
    uint32 app_id = 2;
    uint32 vsan = 3;
    string target_id = 4;
    string initiator_id = 5;
    string lun = 6;
    string exchange_id = 7;
    uint32 scsi_target_count = 8;
    uint32 scsi_initiator_count = 9;
    uint32 io_app_count = 10;
    uint32 logical_port_count = 11;
    uint32 scsi_target_app_count = 12;
    uint32 scsi_initiator_app_count = 13;
    uint32 active_io_read_count = 14;
    uint32 active_io_write_count = 15;
    uint32 scsi_target_tl_flow_count = 16;
    uint32 scsi_target_it_flow_count = 17;
    uint32 scsi_initiator_it_flow_count = 18;
    uint32 scsi_target_itl_flow_count = 19;
    uint32 scsi_initiator_itl_flow_count = 20;
    uint32 scsi_target_lun_count = 21;
    uint32 scsi_target_entity_it_flow_count = 22;
    uint32 scsi_initiator_entity_it_flow_count = 23;
    uint32 scsi_target_entity_itl_flow_count = 24;
```

```
uint32 scsi_initiator_entity_itl_flow_count = 25;
uint64 sampling_start_time = 26;
uint64 sampling_end_time = 27;
string extended_exchange_id = 28;
string io_lba = 29;
uint32 io_size = 30;
uint64 total_read_io_count = 31;
uint64 total_write_io_count = 32;
uint64 total_seq_read_io_count = 33;
uint64 total_seq_write_io_count = 34;
uint64 total_read_io_time = 35;
uint64 total_write_io_time = 36;
uint64 total_read_io_initiation_time = 37;
uint64 total_write_io_initiation_time = 38;
uint64 total_read_io_bytes = 39;
uint64 total_write_io_bytes = 40;
uint64 total_read_io_inter_gap_time = 41;
uint64 total_write_io_inter_gap_time = 42;
uint64 total_time_metric_based_read_io_count = 43;
uint64 total_time_metric_based_write_io_count = 44;
uint64 total_time_metric_based_read_io_bytes = 45;
uint64 total_time_metric_based_write_io_bytes = 46;
uint64 io_start_time = 47;
uint32 read_io_rate = 48;
uint32 peak_read_io_rate = 49;
uint32 write_io_rate = 50;
uint32 peak_write_io_rate = 51;
uint32 read_io_bandwidth = 52;
uint32 peak_read_io_bandwidth = 53;
uint32 write_io_bandwidth = 54;
uint32 peak_write_io_bandwidth = 55;
uint32 read_io_size_min = 56;
uint32 read_io_size_max = 57;
uint32 write_io_size_min = 58;
uint32 write_io_size_max = 59;
uint32 read_io_completion_time_min = 60;
uint32 read_io_completion_time_max = 61;
uint32 write_io_completion_time_min = 62;
uint32 write_io_completion_time_max = 63;
uint32 read_io_initiation_time_min = 64;
uint32 read_io_initiation_time_max = 65;
uint32 write_io_initiation_time_min = 66;
uint32 write_io_initiation_time_max = 67;
uint32 read_io_inter_gap_time_min = 68;
uint32 read_io_inter_gap_time_max = 69;
uint32 write_io_inter_gap_time_min = 70;
uint32 write_io_inter_gap_time_max = 71;
uint32 peak_active_io_read_count = 72;
uint32 peak_active_io_write_count = 73;
uint32 read_io_aborts = 74;
uint32 write_io_aborts = 75;
uint32 read_io_failures = 76;
uint32 write_io_failures = 77;
uint32 read_io_timeouts = 78;
uint32 write_io_timeouts = 79;
uint32 read_io_scsi_check_condition_count = 80;
uint32 write_io_scsi_check_condition_count = 81;
uint32 read_io_scsi_busy_count = 82;
uint32 write_io_scsi_busy_count = 83;
uint32 read_io_scsi_reservation_conflict_count = 84;
uint32 write_io_scsi_reservation_conflict_count = 85;
uint32 read_io_scsi_queue_full_count = 86;
uint32 write_io_scsi_queue_full_count = 87;
uint32 read_io_rate_exceed_count = 88;
```

```
uint32 write_io_rate_exceed_count = 89;
uint32 read_io_bandwidth_exceed_count = 90;
uint32 write_io_bandwidth_exceed_count = 91;
uint32 read_io_size_min_exceed_count = 92;
uint32 read_io_size_max_exceed_count = 93;
uint32 write_io_size_min_exceed_count = 94;
uint32 write_io_size_max_exceed_count = 95;
uint32 read_io_initiation_time_min_exceed_count = 96;
uint32 read_io_initiation_time_max_exceed_count = 97;
uint32 write_io_initiation_time_min_exceed_count = 98;
uint32 write_io_initiation_time_max_exceed_count = 99;
uint32 read_io_completion_time_min_exceed_count = 100;
uint32 read_io_completion_time_max_exceed_count = 101;
uint32 write_io_completion_time_min_exceed_count = 102;
uint32 write_io_completion_time_max_exceed_count = 103;
uint32 read_io_inter_gap_time_min_exceed_count = 104;
uint32 read_io_inter_gap_time_max_exceed_count = 105;
uint32 write_io_inter_gap_time_min_exceed_count = 106;
uint32 write_io_inter_gap_time_max_exceed_count = 107;
uint32 read_io_abort_exceed_count = 108;
uint32 write_io_abort_exceed_count = 109;
uint32 read_io_failure_exceed_count = 110;
uint32 write_io_failure_exceed_count = 111;
uint64 total_abts_count = 112;
uint32 namespace_id = 113;
string connection_id = 114;
uint32 nvme_target_count = 115;
uint32 nvme_initiator_count = 116;
uint32 nvme_target_app_count = 117;
uint32 nvme_initiator_app_count = 118;
uint32 nvme_target_tn_flow_count = 119;
uint32 nvme_target_it_flow_count = 120;
uint32 nvme_initiator_it_flow_count = 121;
uint32 nvme_target_itn_flow_count = 122;
uint32 nvme_initiator_itn_flow_count = 123;
uint32 nvme_target_namespace_count = 124;
uint32 nvme_target_entity_it_flow_count = 125;
uint32 nvme_initiator_entity_it_flow_count = 126;
uint32 nvme_target_entity_itn_flow_count = 127;
uint32 nvme_initiator_entity_itn_flow_count = 128;
uint32 read_io_nvme_lba_out_of_range_count = 129;
uint32 write_io_nvme_lba_out_of_range_count = 130;
uint32 read_io_nvme_ns_not_ready_count = 131;
uint32 write_io_nvme_ns_not_ready_count = 132;
uint32 read_io_nvme_reservation_conflict_count = 133;
uint32 write_io_nvme_reservation_conflict_count = 134;
uint32 read_io_nvme_capacity_exceeded_count = 135;
uint32 write_io_nvme_capacity_exceeded_count = 136;
uint64 total_host_delay_time = 137;
uint64 total_write_sequences = 138;
uint32 host_delay_time_min = 139;
uint32 host_delay_time_max = 140;
uint32 write_sequences_min = 141;
uint32 write_sequences_max = 142;
uint32 read_io_initiate_miss_count = 143;
uint32 write_io_initiate_miss_count = 144;
uint32 read_write_io_rate_exceed_count = 145;
uint32 read_write_io_bandwidth_exceed_count = 146;
uint32 read_write_io_abort_exceed_count = 147;
uint32 read_write_io_failure_exceed_count = 148;
uint32 active_read_write_io_exceed_count = 149;
uint32 read_io_size_min_max_exceed_count = 150;
uint32 write_io_size_min_max_exceed_count = 151;
uint32 read_io_initiation_time_min_max_exceed_count = 152;
```

```
    uint32 write_io_initiation_time_min_max_exceed_count = 153;
    uint32 read_io_completion_time_min_max_exceed_count = 154;
    uint32 write_io_completion_time_min_max_exceed_count = 155;
    uint32 read_io_inter_gap_time_min_max_exceed_count = 156;
    uint32 write_io_inter_gap_time_min_max_exceed_count = 157;
    uint32 host_delay_time_min_max_exceed_count = 158;
    uint32 write_sequences_min_max_exceed_count = 159;
    uint64 creation_time = 160;
    uint64 last_update_time = 161;
    uint64 last_export_time = 162;
    uint64 last_clear_on_export_time = 163;
    uint64 last_clear_time = 164;
    uint64 last_set_time = 165;
    string vmid = 166;
    f64specific f64metrics=167;

}
```

Appendix