Cisco Nexus 9000 Series NX-OS iCAM Configuration Guide, Release 10.4(x)

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Preface

This preface includes the following sections:

- Audience, on page v
- Document Conventions, on page v
- Related Documentation for Cisco Nexus 9000 Series Switches, on page vi
- Documentation Feedback, on page vi
- Communications, Services, and Additional Information, on page vi

Audience

This publication is for network administrators who install, configure, and maintain Cisco Nexus switches.

Document Conventions

Command descriptions use the following conventions:

Convention	Description
bold	Bold text indicates the commands and keywords that you enter literally as shown.
Italic	Italic text indicates arguments for which you supply the values.
[x]	Square brackets enclose an optional element (keyword or argument).
[x | y]	Square brackets enclosing keywords or arguments that are separated by a vertical bar indicate an optional choice.
{x | y}	Braces enclosing keywords or arguments that are separated by a vertical bar indicate a required choice.
[x {y | z}]	Nested set of square brackets or braces indicate optional or required choices within optional or required elements. Braces and a vertical bar within square brackets indicate a required choice within an optional element.

Convention	Description
`variable`	Indicates a variable for which you supply values, in context where italics cannot be used.
string	A nonquoted set of characters. Do not use quotation marks around the string or the string includes the quotation marks.

Examples use the following conventions:

Convention	Description
`screen font`	Terminal sessions and information the switch displays are in screen font.
`boldface screen font`	Information that you must enter is in boldface screen font.
italic screen font	Arguments for which you supply values are in italic screen font.
< >	Nonprinting characters, such as passwords, are in angle brackets.
[ ]	Default responses to system prompts are in square brackets.
!, #	An exclamation point (!) or a pound sign (#) at the beginning of a line of code indicates a comment line.

Related Documentation for Cisco Nexus 9000 Series Switches

The entire Cisco Nexus 9000 Series switch documentation set is available at the following URL:

https://www.cisco.com/en/US/products/ps13386/tsd_products_support_series_home.html

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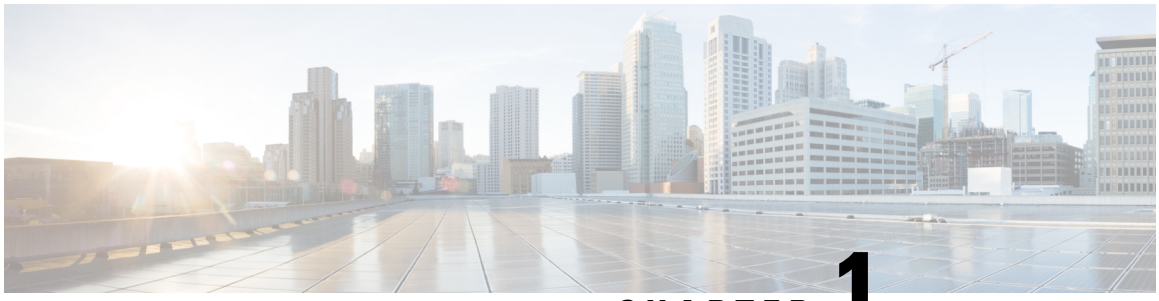


CHAPTER 1

New and Changed Information

- New and Changed Information, on page 1

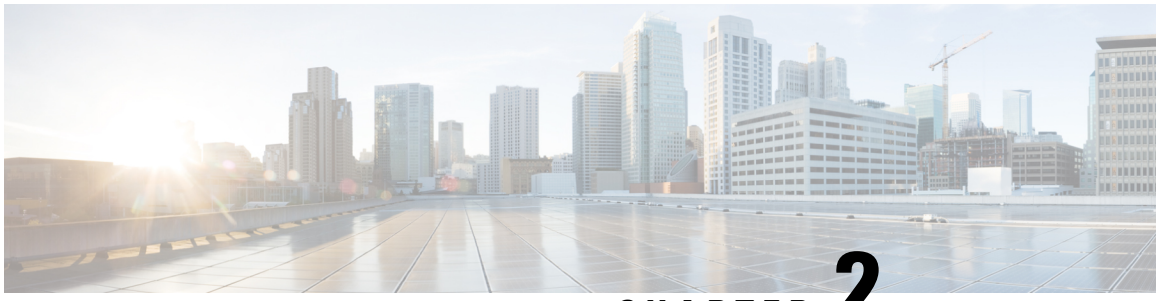
New and Changed Information

This table summarizes the new and changed features for the *Cisco Nexus 9000 Series NX-OS iCAM Configuration Guide, Release 10.4(x)* and where they are documented.

Table 1: New and Changed Features

Feature	Description	Changed in Release	Where Documented
NA	No new features added for this release.	10.4(1)F	NA

New and Changed Information



CHAPTER 2

Configuring iCAM

This chapter contains the following sections:

- About iCAM, on page 3
- Licensing Requirements, on page 7
- Supported Platforms, on page 7
- Guidelines and Limitations, on page 7
- About iCAM Monitoring, on page 7
- About Scale Monitoring, on page 16
- About Displaying TCAM Entries and Usage, on page 21
- Explanation of the Display Outputs, on page 30
- Example: Obtaining JSON Outputs for iCAM Configurations, on page 32
- About Streaming Telemetry, on page 35

About iCAM

Beginning with Cisco NX-OS Release 7.0(3)I7(1), Cisco Nexus 9000 Platform switches support the Intelligent CAM Analytics and Machine-learning (iCAM) feature. iCAM enables you to:

- View traffic and usage analytics per supported function, Ternary Content-Addressable Memory (TCAM) resources, and TCAM entries.
- Allows you to plan better by understanding the Ternary Content-Addressable Memory (TCAM) usage per feature, enabling you to use TCAM space effectively.
- Verify, detect, plan, and predict your environment against Cisco-verified scale numbers for the different supported functions (Layer 2 switching, unicast routing, multicast routing, and VXLAN).
- Maintain historical usage, functional scale analytics of different supported functions, including entries and resource usage of FIB and ACL TCAM.
- Predict scale (usage level) monitoring for different supported functions in addition to predicted scale for ACL and FIB TCAM entries.
- Allows monitoring and maintenance of historical usage of process memory and shared memory.

The iCAM feature:

- Works on most Cisco Nexus 9000 Series switches, line cards and, fabric modules (FMs).

- Works on all Cisco Nexus 9000 Series switches, line cards and, beginning with Cisco Nexus 7.0(3)I7(3), fabric modules (FMs).
- Does not require additional hardware or software.
- Provides useful traffic telemetry and analytics.
- Beginning with Cisco NX-OS Release 9.3(5), iCAM feature is always enabled and users cannot disable feature through **no feature icam**. Also that **icam scale monitor** is enabled by default if no startup configuration is present.

This topic provides an overview on the different capabilities of iCAM.

Overview of iCAM

iCAM provides resource monitoring and analytics for different functions and features on Cisco Nexus 9000 Platform switches. Based on a default or user-configured scale level threshold on a per-function basis, iCAM generates alerts through system logging messages generation to notify network administrators.

Note Beginning with Cisco Nexus NX-OS Release 9.3(5), iCAM feature will be always-on and there is no need to enable feature through **feature icam**.

You can obtain traffic, scale and resource (usage level) monitoring for the following resources and functions:

- ACL TCAM entries
- ACL TCAM resource utilization
- Forward information base (FIB) TCAM resource utilization
- Layer 2 Switching
- Unicast routing
- Multicast Routing
- VXLAN
- Process memory
- Shared memory

The iCAM process runs on the supervisor module. It interacts with various components on the line card and collects hardware resource utilization statistics, performs data processing, and presents a summarized output. The iCAM process also provides insights about the top hitters and bottom hitters for each feature, such as ACL and PBR entries. Using iCAM, you can get packet counts per TCAM entry, sort and search, and get a specified percentage for either the top or bottom entries. Traffic telemetry and analytics about iCAM entries helps to understand network traffic and so better use TCAM space.

TCAM Monitoring

iCAM provides analytics related to network traffic, TCAM usage per feature, detailed analysis per TCAM bank. This helps you to use available TCAM space effectively.

As an example, in the ACL Classification TCAM, the resource entries used per feature can include: Router-ACL (RACL), Vlan-ACL (VACL), Port-ACL (PACL), Policy Based Routing (PBR), QoS (Quality of Service), NAT, and Web Cache Communication Protocol (WCCP). iCAM provides visibility into effective resource usage of TCAM entries.

Scale Monitoring

iCAM scale monitoring provides you the ability to verify, detect, plan, and predict your environment against Cisco verified scale numbers. You can configure all scale monitoring features with default limits and thresholds or customize the threshold values to your specific needs.

Scale monitoring capabilities include:

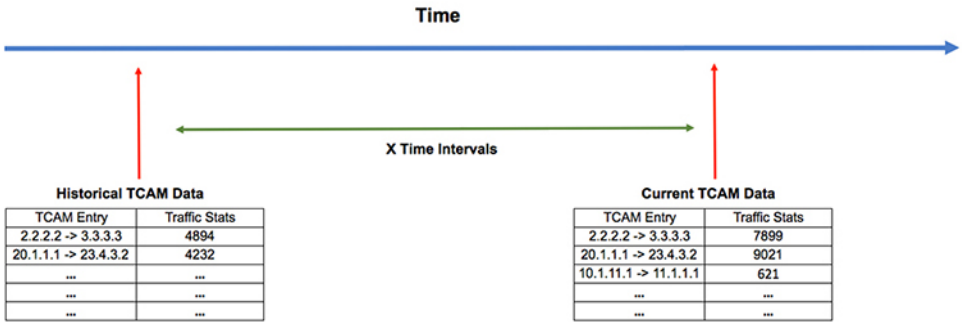
- Track system scale limits in comparison to Cisco verified limits.
- Two-hour polling interval by default, configurable to one-hour.
- Track average and peak utilizations, along with timestamps for peak utilizations.
- User-configurable scale limits and alert thresholds.
- JSON/XML compatible.

Historical Analytics Using iCAM

You can use iCAM to obtain historical traffic analytics of entries and resources. When iCAM monitoring is enabled for resources and entries, traffic data is periodically polled and stored in the iCAM database. The history option for iCAM entries displays the cumulative traffic statistics and average packets per second. The history option for TCAM resources displays the snapshots of TCAM statistics of the past.

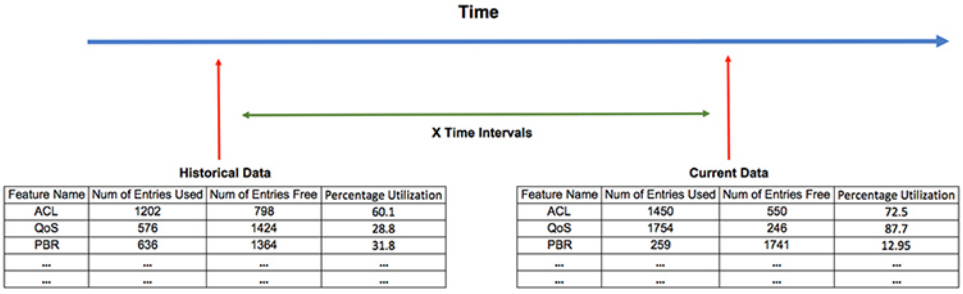
The following figure shows the historical traffic data:

Figure 1: Historical Traffic Data



The following figure shows historical resource utilization:

Figure 2: Historical Resource Utilization



Feature Name	Num of Entries Used	Num of Entries Free	Percentage Utilization
ACL	1202	798	60.1
QoS	576	1424	28.8
PBR	636	1364	31.8
...	...	...	...
...	...	...	...

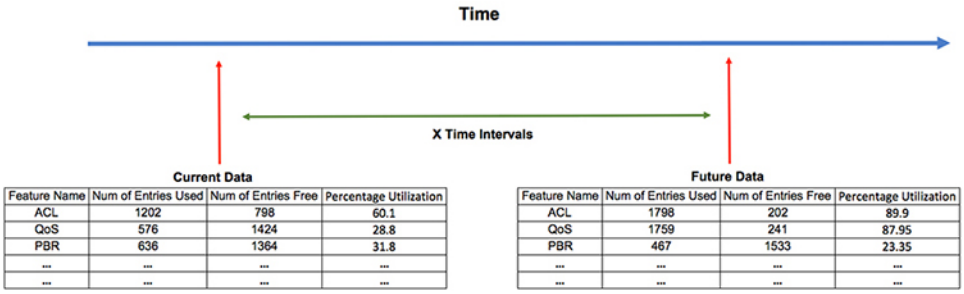
Feature Name	Num of Entries Used	Num of Entries Free	Percentage Utilization
ACL	1450	550	72.5
QoS	1754	246	87.7
PBR	259	1741	12.95
...	...	...	...
...	...	...	...

Predicting Traffic Analytics Using iCAM

You can use iCAM to predict the traffic on entries and resources for a future date. When you enable iCAM monitoring for resources and entries, iCAM polls the traffic data periodically and stores the information in the iCAM database. The iCAM feature uses machine-learning algorithms to analyze the historical data and predicts the TCAM usage for a future date and time.

The following figure shows the predicted traffic data:

Figure 3: Predicted Traffic Data

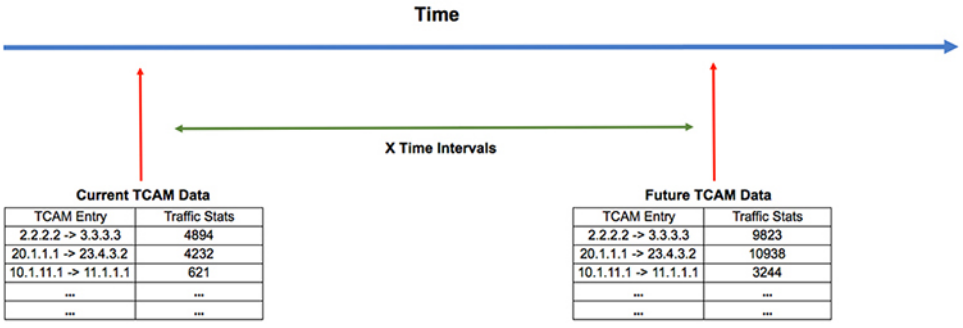


Feature Name	Num of Entries Used	Num of Entries Free	Percentage Utilization
ACL	1202	798	60.1
QoS	576	1424	28.8
PBR	636	1364	31.8
...	...	...	...
...	...	...	...

Feature Name	Num of Entries Used	Num of Entries Free	Percentage Utilization
ACL	1798	202	89.9
QoS	1759	241	87.95
PBR	467	1533	23.35
...	...	...	...
...	...	...	...

The following figure shows the predicted resource utilization:

Figure 4: Predicted Resource Utilization



TCAM Entry	Traffic Stats
2.2.2.2 -> 3.3.3.3	4894
20.1.1.1 -> 23.4.3.2	4232
10.1.11.1 -> 11.1.1.1	621
...	...
...	...

TCAM Entry	Traffic Stats
2.2.2.2 -> 3.3.3.3	9823
20.1.1.1 -> 23.4.3.2	10938
10.1.11.1 -> 11.1.1.1	3244
...	...
...	...

Health Monitoring

iCAM can operate as a data provider to health monitoring applications such as iCAM micro-service and DCNM, and can be streamed through Software Telemetry to external applications for off-switch analysis. Health data is available through the iCAM **show icam health** CLI command.

Licensing Requirements

For a complete explanation of Cisco NX-OS licensing recommendations and how to obtain and apply licenses, see the *Cisco NX-OS Licensing Guide* and the *Cisco NX-OS Licensing Options Guide*.

Supported Platforms

Starting with Cisco NX-OS release 7.0(3)I7(1), use the Nexus Switch Platform Support Matrix to know from which Cisco NX-OS releases various Cisco Nexus 9000 and 3000 switches support a selected feature.

Guidelines and Limitations

The general guidelines and limitations of iCAM are as follows:

- Beginning with Cisco Release, 9.2(4), iCAM is supported on Cisco Nexus N9K-X9636C-R, N9K-X9636Q-R, N9K-X9636C-RX and N9K-X96136YC-R line cards.
- Beginning with Cisco Release, 9.2(4), iCAM is supported on Cisco Nexus N9K-C9508-FM-R and N9K-C9504-FM-R fabric modules.
- iCAM is supported on Cisco Nexus 9500 platform switches, Cisco Nexus 9300 platform switches, and the Cisco Nexus 3000 series.
- iCAM queries do not support NetFlow entries.
- iCAM queries do not support FIB and multicast entries.
- Beginning with Cisco NX-OS Release 10.3(3)F, iCAM is supported on Cisco Nexus 9808 platform switches.
- Beginning with Cisco NX-OS Release 10.4(2)F, iCAM is supported on Cisco Nexus 9804 switches.

About iCAM Monitoring

This topic describes how to enable and configure iCAM monitoring.

Enabling and Configuring iCAM Monitoring

Use the following commands to configure iCAM entries for a module on the Cisco Nexus 9000 Platform switches:

Note We recommend that you have at least 1 GB of storage space for the iCAM database, preferably on logflash. Storage in memory and logflash is both supported. If logflash is not available, the iCAM database is created in memory and the database size is capped to1GB depending on the available memory storage space. If the iCAM DB is created in memory it may not be persistent upon switch reload.

SUMMARY STEPS

1. **configure terminal**
2. [**no**]**icam monitor entries** *acl* **module** *module-number* **inst** *instance-number*
3. [**no**]**icam monitor resource** { **acl-tcam** | **fib-tcam** } **module** *module* **inst** *instance*
4. (Optional) **icam monitor interval** *interval-hours* **history** *num-intervals*

DETAILED STEPS

Procedure

	Command or Action	Purpose

Step 1	**configure terminal**
	Example:
	`switch# configure terminal`
	`switch(config)#`
		Enter global configuration mode.

Step 2	[**no**]**icam monitor entries** *acl* **module** *module-number* **inst** *instance-number*	Monitor ACL entries per module and instance numbers: • *module-number*—The module-number to monitor. • *instance-number*—The instance-number you want to monitor.
Step 3	[**no**]**icam monitor resource** { **acl-tcam** | **fib-tcam** } **module** *module* **inst** *instance*	Monitor the **acl-tcam** or **fib-tcam** resource per module and instance.

Step 4	(Optional) **icam monitor interval** *interval-hours* **history** *num-intervals*
	Example:
	`switch# configure terminal`
	`switch(config)# icam monitor interval 2 history 90`
	`switch(config)# exit`
		Set iCAM monitor and global intervals history:
		• *interval-hours*—Configures global monitoring interval in hours. The default value is 2 hours.
		• *num-intervals*—Configures monitoring interval history. The default value is 168 (2 hours * 168 intervals = 14 days).

Example

The following example shows how to configure iCAM entries for a module:

```
switch# configure terminal
switch# copy running-config startup-config
```

Example: Scale Monitoring

This example displays sample data from Layer 2 switching scale monitoring thresholds.

```
switch# show icam scale l2-switching
Retrieving data.  This may take some time ...
================================================
Info Threshold =  80 percent (default)          |
Warning Threshold =  90 percent (default)       |
Critical Threshold = 100 percent (default)      |
All timestamps are in UTC                       |
================================================

-----------------------------------------------------------------------------------------------
Scale Limits for L2 Switching
-----------------------------------------------------------------------------------------------

             Feature  Verified    Config       Cur     Cur   Threshold               Polled

                         Scale     Scale     Scale    Util    Exceeded            Timestamp
-----------------------------------------------------------------------------------------------

       MAC Addresses         -         -         -      -           -                    -
        (Mod:1,FE:0)     90000     90000        16   0.01        None   2018-07-06 16:27:05

        (Mod:1,FE:1)     90000     90000         0   0.00        None   2018-07-06 16:27:05

               VLANs      3967      3967         1   0.02        None   2018-07-06 16:27:07

             (VDC:1)         -         -         1   0.02        None   2018-07-06 16:27:05
switch#
```

This example displays Layer 2 switching traffic history for a specified number of intervals.

```
switch# show icam scale l2-switching vlan vlan-count history 10

================================================
Info Threshold =  80 percent (default)          |
Warning Threshold =  90 percent (default)       |
Critical Threshold = 100 percent (default)      |
All timestamps are in UTC                       |
================================================

-----------------------------------------------------------------------------------------------
Scale Limits for L2 Switching
-----------------------------------------------------------------------------------------------

              Feature  Verified    Config       Cur     Cur   Threshold
Polled
                         Scale     Scale     Scale    Util    Exceeded            Timestamp
-----------------------------------------------------------------------------------------------

                VLANs      3967      3967         1   0.02        None     2019-04-09
08:11:50
                                                 1   0.02        None     2019-04-09
09:11:55
                                                 1   0.02        None     2019-04-09
10:11:59
                                                 1   0.02        None     2019-04-09
11:12:05
                                                 1   0.02        None     2019-04-09
12:12:09
```

```
                                                    1   0.02        None     2019-04-09
13:12:13
                                                    1   0.02        None     2019-04-09
14:12:18
                                                    1   0.02        None     2019-04-09
15:12:24
                                                    1   0.02        None     2019-04-09
16:12:29
                                                    1   0.02        None     2019-04-09
17:12:33
                (VDC:1)         -         -         1   0.02        None     2019-04-09
08:11:02
                                                    1   0.02        None     2019-04-09
09:11:07
                                                    1   0.02        None     2019-04-09
10:11:11
                                                    1   0.02        None     2019-04-09
11:11:16
                                                    1   0.02        None     2019-04-09
12:11:21
                                                    1   0.02        None     2019-04-09
13:11:25
                                                    1   0.02        None     2019-04-09
14:11:30
                                                    1   0.02        None     2019-04-09
15:11:35
                                                    1   0.02        None     2019-04-09
16:11:41
                                                    1   0.02        None     2019-04-09
17:11:45
switch#
```

This example displays Layer 2 switching utilization data including average and peak utilization data, peak timestamp, 7-day totals, and total counts.

```
switch# show icam scale l2-switching vlan vlan-count utilization

================================================
Info Threshold =  80 percent (default)          |
Warning Threshold =  90 percent (default)       |
Critical Threshold = 100 percent (default)      |
All timestamps are in UTC                       |
================================================

_____________________________________________________________________________________
Scale Limits for L2 Switching
_____________________________________________________________________________________

                 Feature  Verified    Config     Cur    Cur    Avg  7-Day      7-Day Peak
          Peak        Peak
                             Scale     Scale     Scale  Util   Util  Util      Timestamp
          Util    Timestamp
_____________________________________________________________________________________

                   VLANs      3967      3967        1   0.02   0.02   0.02   2019-04-08
22:34:25   0.02   2019-04-08 22:34:25
                 (VDC:1)         -         -         1   0.02   0.02   0.02   2019-04-08
22:33:36   0.02   2019-04-08 22:33:36
switch#
```

This example displays Layer 2 switching hit count and the last timestamp of the exceeding configured scale for each configured threshold.

```
switch# show icam scale l2-switching vlan vlan-count thresholds

==================================================
Info Threshold =  80 percent (default)           |
Warning Threshold =  90 percent (default)        |
Critical Threshold = 100 percent (default)       |
All timestamps are in UTC                        |
==================================================

------------------------------------------------------------------------------------------
Scale Limits for L2 Switching
------------------------------------------------------------------------------------------

       Feature  Verified   Config    Current     Info          Last  Info       Warning
   Last Warning      Critical Last Critical
                Scale      Scale      Scale     Exceeded    Exceeded Timestamp  Exceeded
 Exceeded Timestamp  Exceeded Exceeded Timestamp
------------------------------------------------------------------------------------------

        VLANs    3967      3967         1          0                 -             0
          -               0          -
switch#
```

System Monitoring

Beginning with Cisco NX-OS Release 9.3(5), monitoring of per process memory and shared-memory of components is supported.

```
icam monitor system <CR>
```

This command will enable monitoring of all categories under system monitoring. Beginning with Cisco Nexus NX-OS Release 9.3(5), it will be for Memory and Shared-memory on Active SUP only.

ICAM system monitoring feature allows monitoring of process memory usage against available virtual memory for the process and shared-memory usage against the maximum available shared-memory for the component.

```
1.2 icam monitor system threshold info <1-100> warning <1-100> critical <1-100>
```

This will set the threshold values for each level and will determine when Warning or Critical syslogs are generated. The default values are 80,90 and 100 for Info, Warning and Critical respectively. **icam monitor command system threshold** is applied for all processes memory and shared-memory usage level.

```
1.3 icam monitor interval <1-24> history <168-1344>
```

This command shows all monitoring and will determine the polling interval and the maximum polling samples will be kept at any time in the database.

show icam system output will be modeled similar to Scale features, i.e. show icam system for current values will be available without enabling **icam system monitoring**. For history related commands it will be similar to scale.

icam system monitoring needs to be enabled for history collection and related commands, show icam system [**history** *interval*] [**thresholds**] [**utilization**]

The **show icam system memory** command will display the process UUID, process name, Mem Limit (in Bytes), Mem Used (in Bytes) and the percentage of Utilization

Example output proposal:

```
switch# show icam system memory
Retrieving data. This may take some time ...
================================================
Info Threshold = 80 percent (default) |
Warning Threshold = 90 percent (default) |
Critical Threshold = 100 percent (default) |
All timestamps are in UTC |
================================================

Process Memory
==============

Process Instance Unit Value Limit Util. Alarm Timestamp
--------------------------------------------------------------------------------------------------
aaa UUID:0x000000B5 PID:4024 Bytes 619171840 4294967295 14.41 Warning 2020-01-25 08:06:25
acllog UUID:0x0000023C PID:6648 Bytes 614506496 25222676480 14.30 Warning 2020-01-25 08:06:25
aclmgr UUID:0x00000182 PID:4030 Bytes 629452800 25222676480 14.65 Warning 2020-01-25 08:06:25
```

The **show icam system shared-memory** command will display the component name, Shared-Mem limit, Shared-Mem Used (in KB) and the percentage of Utilization

```
switch# show icam system shared-memory
Retrieving data. This may take some time ...
================================================
Info Threshold = 80 percent (default) |
Warning Threshold = 90 percent (default) |
Critical Threshold = 100 percent (default) |
All timestamps are in UTC |
================================================

Shared Memory
=============

Component Instance Unit Value Limit Util. Alarm Timestamp
--------------------------------------------------------------------------------------------------
am VDC:1 MOD:27 KB 201 1028 19.55 Critical 2020-01-25 08:07:37
am_lim VDC:1 MOD:27 KB 1 68 1.47 None 2020-01-25 08:07:37
arp VDC:1 MOD:27 KB 92 4100 2.24 None 2020-01-25 08:07:37
arplib VDC:1 MOD:27 KB 129 24580 0.52 None 2020-01-25 08:07:37

arplib     (VDC:1, Mod: 6)    KB          -        23580       10             0.52
None          2019-11-06 08:08:49
```

Without the category specified, the **show icam system** command will display all monitored categories i.e. memory and shared-memory.

```
switch(config)# show icam system

Retrieving data.  This may take some time ...

================================================

Info Threshold =  80 percent (default)           |

Warning Threshold =  90 percent (default)        |

Critical Threshold = 100 percent (default)       |

All timestamps are in UTC                        |

================================================
```

```
Process Memory
==============

Process Instance Unit Value Limit Util. Alarm Timestamp
--------------------------------------------------------------------------------
aaa UUID:0x000000B5 PID:4024 Bytes 619171840 4294967295 14.41 Warning 2020-01-25 08:06:25
acllog UUID:0x0000023C PID:6648 Bytes 614506496 25222676480 14.30 Warning 2020-01-25 08:06:25
aclmgr UUID:0x00000182 PID:4030 Bytes 629452800 25222676480 14.65 Warning 2020-01-25 08:06:25

--------------------------------------------------------------------------------

Shared Memory
=============

Component Instance Unit Value Limit Util. Alarm Timestamp
--------------------------------------------------------------------------------
am VDC:1 MOD:27 KB 201 1028 19.55 Critical 2020-01-25 08:07:37
am_lim VDC:1 MOD:27 KB 1 68 1.47 None 2020-01-25 08:07:37
arp VDC:1 MOD:27 KB 92 4100 2.24 None 2020-01-25 08:07:37
arplib VDC:1 MOD:27 KB 129 24580 0.52 None 2020-01-25 08:07:37
```

In addition to above show commands when monitoring is enabled for system features, history/utilization/thresholds will be supported.

```
switch# show icam system ?
<CR>
> Redirect it to a file
>> Redirect it to a file in append mode
history Show usage history
memory Virtual Memory usage
shared-memory Shared Memory usage
thresholds Show thresholds statistics
utilization Show utilization statistics
| Pipe command output to filter

show icam system [memory | shared-memory] [history <1-1344>] [utilization | thresholds]
```

This example displays sample data from the default scale monitoring thresholds.

```
switch# show icam scale
Retrieving data.  This may take some time ...
================================================
Info Threshold =  80 percent (default)          |
Warning Threshold =  90 percent (default)       |
Critical Threshold = 100 percent (default)      |
All timestamps are in UTC                       |
================================================

------------------------------------------------------------------------------------------
Scale Limits for L2 Switching
------------------------------------------------------------------------------------------

            Feature  Verified    Config       Cur     Cur   Threshold              Polled

                       Scale     Scale     Scale    Util    Exceeded           Timestamp
------------------------------------------------------------------------------------------

       MAC Addresses         -         -         -      -          -                   -
        (Mod:1,FE:0)     90000     90000        16   0.01       None   2018-07-06 16:27:05

        (Mod:1,FE:1)     90000     90000         0   0.00       None   2018-07-06 16:27:05

               VLANs      3967      3967         1   0.02       None   2018-07-06 16:27:07
```

```
             (VDC:1)         -         -         1   0.02        None    2018-07-06 16:27:05
switch#
```

This example displays Layer 2 switching traffic history for a specified number of intervals.

```
switch# show icam scale l2-switching vlan vlan-count history 10

================================================
Info Threshold =  80 percent (default)           |
Warning Threshold =  90 percent (default)        |
Critical Threshold = 100 percent (default)       |
All timestamps are in UTC                        |
================================================

-----------------------------------------------------------------------------------------------
Scale Limits for L2 Switching
-----------------------------------------------------------------------------------------------

               Feature  Verified    Config       Cur     Cur   Threshold
Polled
                           Scale     Scale     Scale    Util    Exceeded            Timestamp
-----------------------------------------------------------------------------------------------

                 VLANs      3967      3967         1   0.02        None     2019-04-09
08:11:50
                                                  1   0.02        None     2019-04-09
09:11:55
                                                  1   0.02        None     2019-04-09
10:11:59
                                                  1   0.02        None     2019-04-09
11:12:05
                                                  1   0.02        None     2019-04-09
12:12:09
                                                  1   0.02        None     2019-04-09
13:12:13
                                                  1   0.02        None     2019-04-09
14:12:18
                                                  1   0.02        None     2019-04-09
15:12:24
                                                  1   0.02        None     2019-04-09
16:12:29
                                                  1   0.02        None     2019-04-09
17:12:33
                  (VDC:1)         -         -      1   0.02        None     2019-04-09
08:11:02
                                                  1   0.02        None     2019-04-09
09:11:07
                                                  1   0.02        None     2019-04-09
10:11:11
                                                  1   0.02        None     2019-04-09
11:11:16
                                                  1   0.02        None     2019-04-09
12:11:21
                                                  1   0.02        None     2019-04-09
13:11:25
                                                  1   0.02        None     2019-04-09
14:11:30
                                                  1   0.02        None     2019-04-09
15:11:35
                                                  1   0.02        None     2019-04-09
16:11:41
                                                  1   0.02        None     2019-04-09
```

```
17:11:45
switch#
```

This example displays Layer 2 switching utilization data including average and peak utilization data, peak timestamp, 7-day totals, and total counts.

```
switch# show icam scale l2-switching vlan vlan-count utilization

================================================
Info Threshold =  80 percent (default)          |
Warning Threshold =  90 percent (default)       |
Critical Threshold = 100 percent (default)      |
All timestamps are in UTC                       |
================================================

_____________________________________________________________________________________________
Scale Limits for L2 Switching
_____________________________________________________________________________________________

                 Feature  Verified    Config     Cur    Cur    Avg  7-Day      7-Day Peak
          Peak        Peak
                             Scale     Scale     Scale  Util   Util  Util      Timestamp
          Util    Timestamp
_____________________________________________________________________________________________

                   VLANs      3967      3967        1   0.02   0.02   0.02   2019-04-08
22:34:25   0.02   2019-04-08 22:34:25
                   (VDC:1)         -         -        1   0.02   0.02   0.02   2019-04-08
22:33:36   0.02   2019-04-08 22:33:36
switch#
```

This example displays Layer 2 switching hit count and the last timestamp of the exceeding configured scale for each configured threshold.

```
switch# show icam scale l2-switching vlan vlan-count thresholds

================================================
Info Threshold =  80 percent (default)          |
Warning Threshold =  90 percent (default)       |
Critical Threshold = 100 percent (default)      |
All timestamps are in UTC                       |
================================================

_____________________________________________________________________________________________
Scale Limits for L2 Switching
_____________________________________________________________________________________________

       Feature  Verified   Config    Current     Info          Last  Info       Warning
   Last Warning      Critical Last Critical
                Scale      Scale      Scale     Exceeded    Exceeded Timestamp  Exceeded
 Exceeded Timestamp  Exceeded Exceeded Timestamp
_____________________________________________________________________________________________

        VLANs    3967      3967         1          0                -            0
          -              0          -
switch#
```

About Scale Monitoring

This topic describes how to enable and configure iCAM scale monitoring.

Configuring Scale Monitoring

Use the following commands to configure all scale monitoring features with default limits and thresholds or customize the threshold values to your specific needs:

Note Changing the configured scale value does not change the supported value that has been verified for your hardware and software combination. Changing the configured scale only changes the value to which the default or configured threshold is measured against.

Note You can only display history and prediction for resources and entries on modules and instances that have monitoring enabled. The entries and resources are sorted based on the packet count.

SUMMARY STEPS

1. **configure terminal**
2. (Optional) [**no**] **icam monitor interval** *interval-hours* **history** *number-of-intervals*
3. [**no**] **icam monitor scale**
4. (Optional) [**no**] **icam monitor scale l2-switching {infra {mac} | stp {isolated-portvlan | mst-instance | mst-vport | rpvst-vlan | rpvst-vport} | vlan {vlan-count}} limit** *feature_limit*
5. (Optional) [**no**] **icam monitor scale multicast-routing {igmp {group} | pim {neighbor} | routing-forwarding {outgoing-interface | route-v4 | route-v6} } limit** *feature_limit*
6. (Optional) [**no**] **icam monitor scale unicast-routing {arp {arp-count} | bfd {session} | bgp {neighbor} | eigrp {neighbor | route} | hsrp {group} | ipv6-nd {nd-count} | isis {adjacency | bfd-session | route} | ospf {area | lsa | neighbor} | pbr {ace-v4 | ace-v4v6 | ace-v6 | intf | nh-per-policy | seq-per-policy} | routing {host-route-v4 | host-route-v6 | lpm-route-v4 | lpm-route-v6} | vrf {vrf-count} | vrrp {grp-per-intf} | vrrp3 {grp-and-path | grp-dft-timer | grp-per-intf | grp-relax-timer | path-dft-timer}} limit** *feature_limit*
7. (Optional) [**no**] **icam monitor scale vxlan {bgp {host-route-v4 | host-route-v6 | igmp-group | mac | overlay-lpm-route-v4 | overlay-lpm-route-v6 | svi | underlay-mcast-group | vlan-logical-port-vp | vlan-per-fex-port | vni | vrf | vtep} | bgp-ir {host-route-v4 | host-route-v6 | igmp-group | mac | overlay-lpm-route-v4 | overlay-lpm-route-v6 | svi | underlay-mcast-group | vlan-logical-port-vp | vlan-per-fex-port | vni | vrf | vtep} | fl {igmp-group | ir-mac | ir-peer | ir-vni | overlay-mac | static-mac-to-vtep | underlay-mcast-group | vlan-logical-port-vp | vlan-mapping-in-switch | vlan-mapping-under-intf | vni | vni-for-vpc-gw | vtep} igmp {underlay-mcast-group | vlan | vtep}} limit** *feature_limit*
8. (Optional) [**no**] **icam monitor scale threshold info** *info-threshold* **warning** *warning-threshold* **critical** *critical-threshold*
9. (Optional) **show icam scale**

10. (Optional) **show icam scale history** *number-of-intervals* **sort {current-scale {ascending | descending} | polled-timestamp {newest | oldest}}}**
11. (Optional) **show icam scale l2-switching**
12. (Optional) **show icam scale multicast-routing**
13. (Optional) **show icam scale thresholds**
14. (Optional) **show icam scale unicast-routing**
15. (Optional) **show icam scale utilization**
16. (Optional) **show icam scale vxlan**
17. (Optional) **show icam prediction scale** *year month day time*
18. (Optional) **show icam prediction scale l2-switching**
19. (Optional) **show icam prediction scale multicast-routing**
20. (Optional) **show icam prediction scale unicast-routing**
21. (Optional) **show icam prediction scale vxlan**

DETAILED STEPS

Procedure

	Command or Action	Purpose

Step 1	**configure terminal**
	Example:
	`switch# configure terminal`
	`switch(config)#`
		Enter global configuration mode.

Step 2	(Optional) [**no**] **icam monitor interval** *interval-hours* **history** *number-of-intervals* **Example:** `switch(config)# icam monitor interval 10 history 175`	Specifies the iCAM change percent threshold limits. • *interval-hours*— iCAM monitor interval in hours. The range is 1 to 24 hours. • *number-of-intervals*— iCAM monitor history. The range is 168 to 1344.
Step 3	[**no**] **icam monitor scale**	Enables all features with default limits and thresholds.
Step 4	(Optional) [**no**] **icam monitor scale l2-switching {infra {mac} | stp {isolated-portvlan | mst-instance | mst-vport | rpvst-vlan | rpvst-vport} | vlan {vlan-count}} limit** *feature_limit* **Example:** `switch(config)# icam monitor scale l2-switching vlan vlan-count limit 1000`	Enables you to customize the limit for a specific Layer 2 switching feature to override its default limit. Feature limit range is 1 to 4294967295.
Step 5	(Optional) [**no**] **icam monitor scale multicast-routing {igmp {group} | pim {neighbor} | routing-forwarding {outgoing-interface | route-v4 | route-v6} } limit** *feature_limit* **Example:**	Enables you to customize the limit for a specific multicast routing feature to override its default limit. Feature limit range is 1 to 4294967295.

	Command or Action	Purpose
	`switch(config)# icam monitor scale multicast-routing pim neighbor limit 2500`	
Step 6	(Optional) [**no**] **icam monitor scale unicast-routing {arp {arp-count} | bfd {session} | bgp {neighbor} | eigrp {neighbor | route} | hsrp {group} | ipv6-nd {nd-count} | isis {adjacency | bfd-session | route} | ospf {area | lsa | neighbor} | pbr {ace-v4 | ace-v4v6 | ace-v6 | intf | nh-per-policy | seq-per-policy} | routing {host-route-v4 | host-route-v6 | lpm-route-v4 | lpm-route-v6} | vrf {vrf-count} | vrrp {grp-per-intf} | vrrp3 {grp-and-path | grp-dft-timer | grp-per-intf | grp-relax-timer | path-dft-timer}} limit** *feature_limit* **Example:** `switch(config)# icam monitor scale unicast-routing ospf area limit 4000`	Enables you to customize the limit for a specific unicast-routing feature to override its default limit. Feature limit range is 1 to 4294967295.
Step 7	(Optional) [**no**] **icam monitor scale vxlan {bgp {host-route-v4 | host-route-v6 | igmp-group | mac | overlay-lpm-route-v4 | overlay-lpm-route-v6 | svi | underlay-mcast-group | vlan-logical-port-vp | vlan-per-fex-port | vni | vrf | vtep} | bgp-ir {host-route-v4 | host-route-v6 | igmp-group | mac | overlay-lpm-route-v4 | overlay-lpm-route-v6 | svi | underlay-mcast-group | vlan-logical-port-vp | vlan-per-fex-port | vni | vrf | vtep} | fl {igmp-group | ir-mac | ir-peer | ir-vni | overlay-mac | static-mac-to-vtep | underlay-mcast-group | vlan-logical-port-vp | vlan-mapping-in-switch | vlan-mapping-under-intf | vni | vni-for-vpc-gw | vtep} igmp {underlay-mcast-group | vlan | vtep}} limit** *feature_limit* **Example:** `switch(config)# icam monitor scale vxlan igmp vlan limit 1000`	Enables you to customize the limit for a specific VXLAN routing feature to override its default limit. Feature limit range is 1 to 4294967295. **Note** ICAM measures Unidimensional scale usage against the verified scale associate VxLan feature scale to specific group prefixes the features with FL/BGP/IR. **IR VNI** guides the user to the verified scale numbers are being used. IR VNI in this context does not intend to specify the type of VNI but category of scale being used. **FL** prefix implies ICAM is using scale limits listed in VXLAN flood and learn. **BGP** implies scale limits in VXLAN BGP eVPN are being used and IR implies VXLAN BGP. **eVPN** Ingress Replication scale limits are used.
Step 8	(Optional) [**no**] **icam monitor scale threshold info** *info-threshold* **warning** *warning-threshold* **critical** *critical-threshold* **Example:** `switch(config)# icam monitor scale threshold info 34 warning 50 critical 60`	Specifies the iCAM change percent threshold limits. • info—Configures the info threshold. The range is 1 to 100 percent, default value is 80 percent. • warning—Configures the warning threshold. The range is 1 to 100 percent, default value is 90 percent. • critical—Configures the critical threshold. The range is 1 to 100 percent, default value is 100 percent.
Step 9	(Optional) **show icam scale** **Example:**	Displays data from the default scale monitoring thresholds.

	Command or Action	Purpose
	`switch(config)# show icam scale`	**Note** **show icam scale** displays the current scale values from iCAM's data cache. The data cache is constantly refreshed. • **Verified Scale** - CCO QA verified scale numbers that are based on software version and hardware. • **Configured Scale** - Displays the customer configured scale value. **Note** The Configured Scale value does not change the "Verified Scale" (Cisco supported) value, but instead changes the value in which default or user-configured thresholds will be measured against. • **Threshold Exceeded** - Displays the highest threshold level exceeded.
Step 10	(Optional) **show icam scale history** *number-of-intervals* **sort {current-scale {ascending | descending} | polled-timestamp {newest | oldest}}}** **Example:** `switch(config)# show icam scale history 20 sort polled-timestamp newest`	Displays instance based-parameter details for a specified number of polling entries. Range is 1 to 1334 intervals in history. You can include the **sort** option to sort records by current-scale value or polled-timestamp. • **current-scale** - Sorts records by current-scale value, with records displayed in ascending or descending order. • **polled-timestamp** - Sorts records by polled-timestamp value, with the newest or oldest record displayed first.
Step 11	(Optional) **show icam scale l2-switching** **Example:** `switch(config)# show icam scale l2-switching`	Displays Layer 2 switching data. You can customize the display of Layer 2 switching data. Use **?** to display a list of supported Layer 2 switching keywords.
Step 12	(Optional) **show icam scale multicast-routing** **Example:** `switch(config)# show icam scale multicast-routing`	Displays multicast-routing data. You can customize the display of multicast-routing data. Use **?** to display a list of supported multicast-routing keywords.
Step 13	(Optional) **show icam scale thresholds** **Example:** `switch(config)# show icam scale thresholds`	Displays the hit count and the last timestamp of the exceeding configured scale for each configured threshold. Use the hit count for each threshold to determine if the event is an anomaly or frequently occurring. The **Last Info Exceeded Timestamp**- Displays the last timestamp of the exceeding configured scale.

	Command or Action	Purpose
Step 14	(Optional) **show icam scale unicast-routing** **Example:** `switch(config)# show icam scale unicast-routing`	Displays unicast-routing data. You can customize the display of unicast-routing data. Use **?** to display a list of supported unicast-routing keywords.
Step 15	(Optional) **show icam scale utilization** **Example:** `switch(config)# show icam scale utilization`	Displays utilization data including average and peak utilization data, peak timestamp, 7-day totals, and total counts.
Step 16	(Optional) **show icam scale vxlan** **Example:** `switch(config)# show icam scale vxlan`	Displays VXLAN data. You can customize the display of VXLAN data. Use **?** to display a list of supported VXLAN keywords.
Step 17	(Optional) **show icam prediction scale** *year month day time* **Example:** `switch# show icam prediction scale 2020 Jul 20 10:45:00`	Displays the traffic prediction of scale monitoring. • *year* —Specifies the year in the YYYY format. The values range from 1970 to 2030. • *month* —Specifies the month as Jan, Feb, or so on. **Note** The values are case sensitive. • *day* —Specifies the day of the month in the DD format. The values range from 1 to 31. • *time* —Specifies the time in the HH:MM:SS format.
Step 18	(Optional) **show icam prediction scale l2-switching** **Example:** `switch(config)# show icam prediction scale l2-switching`	Displays the traffic prediction of Layer 2 switching data. You can customize the display of Layer 2 switching data. Use **?** to display a list of supported Layer 2 switching keywords.
Step 19	(Optional) **show icam prediction scale multicast-routing** **Example:** `switch(config)# show icam prediction scale multicast-routing`	Displays the traffic prediction of multicast-routing data. You can customize the display of multicast-routing data. Use **?** to display a list of supported multicast-routing keywords.
Step 20	(Optional) **show icam prediction scale unicast-routing** **Example:** `switch(config)# show icam prediction scale unicast-routing`	Displays the traffic prediction of unicast-routing data. You can customize the display of unicast-routing data. Use **?** to display a list of supported unicast-routing keywords.
Step 21	(Optional) **show icam prediction scale vxlan** **Example:** `switch(config)# show icam prediction scale vxlan`	Displays the traffic prediction of VXLAN data. You can customize the display of VXLAN data. Use **?** to display a list of supported VXLAN keywords.

About Displaying TCAM Entries and Usage

You can display current, historical, and predictive information about TCAM, including traffic analytics of TCAM entries and TCAM resource per feature.

Displaying Current, Historical, and Predictive Traffic Analytics of TCAM Entries

The TCAM entries and traffic analytics are listed per module and per TCAM instance.

Note You can only display history and prediction for resources and entries on modules and instances that have monitoring enabled. The entries and resources are sorted based on the packet count.

To display the current, historical, or predictive traffic analytics of TCAM entries, use the following commands:

SUMMARY STEPS

1. **show icam entries** *acl* **module** *module* **inst** *instance* [**history** *num-intervals*] [**sort** { [**filter** *feature-name* [**exact**]] [**sort-order** [**ascending** | **descending**]] [**top** *top-percentage*] }]
2. **show icam prediction entries acl module** *module* **inst** *inst year month day time* [**top** *top-percentage*]

DETAILED STEPS

Procedure

	Command or Action	Purpose

Step 1	**show icam entries** *acl* **module** *module* **inst** *instance* [**history** *num-intervals*] [**sort** { [**filter** *feature-name* [**exact**]] [**sort-order** [**ascending** | **descending**]] [**top** *top-percentage*] }]
	Example:
	`switch# show icam entries acl module 1 inst 0`
	Example:
	`switch# show icam entries acl module 1 inst 0 sort filter RACL top 5 sort-order descending`
	Example:
	`switch# show icam entries acl module 1 inst 0 history 5 sort top 10`
		Displays the TCAM entries based on the options selected:
		• **history**—Displays the traffic history of entries for the specified number of intervals.
		• **sort**—Specifies how to filter or sort the list of TCAM entries. You must use at least one option if you filter TCAM entries using the **sort** keyword.
		• **filter** *feature-name*—Filters the TCAM entries based on the feature name.
		Note By default, all the features are displayed. Enclose the feature name in quotation marks if it contains more than one word, like QoS CoPP.
		• **exact**—Filters the TCAM entries based on the exact feature name.
		Note This keyword can be used only when filtering the TCAM entries by feature names.

	Command or Action	Purpose
		• **sort-order**—Sorts the entries in either ascending or descending order. **Note** The valid values are ascending and descending. Setting the value to ascending displays the list in ascending order and setting to descending displays the list in descending order. The entries are sorted in descending order by default. • **top** *top-percentage*—Displays the top TCAM entries, which are sorted by packet count, based on the specified percentage. **Note** The valid values are from 1 to 100. The default value is 1%.
Step 2	**show icam prediction entries acl module** *module* **inst** *inst year month day time* [**top** *top-percentage*] **Example:** `switch# show icam prediction entries acl module 1 inst 0 2020 Jul 20 10:45:00 top 5`	Displays the traffic prediction of TCAM entries: • *year*—Specifies the year in the YYYY format. The values range from 1970 to 2030. • *month*—Specifies the month as Jan, Feb, or so on. **Note** The values are case-sensitive. • *day*—Specifies the day of the month in the DD format. The values range from 1 to 31. • *time*—Specifies the time in the HH:MM:SS format. • **top** *top-percentage*—Displays the top TCAM entries, which are sorted by packet count, based on the specified percentage. **Note** Valid values are from 1 to 10. The default value is 1%.

Example: Displaying Traffic Analytics of TCAM Entries

The example shows the historical view for the top 1% of TCAM entries monitored by iCAM, and filters the entries by feature name. The **Stats** column shows the total number of packets hitting the entry for the last two intervals. The **Rate** column shows the average traffic rate in packets per second for the last two intervals.

```
switch# show icam entries acl module 1 inst 0 history 2 sort filter RACL top 1
================================================================================================
TCAM Entries (Mod 1,Inst 0): Cumulative stats for last 2 intervals
------------------------------------------------------------------------------------------------
Feature  Pkt_Type  Source IP/Mask  Dest IP/Mask  Action     Interface    Stats  Rate(pps)
------------------------------------------------------------------------------------------------
RACL     IPv4       ip 1.1.1.1/32    2.2.2.1/32   Permit  Ethernet1/17  359378      1497
RACL     IPv4       ip 1.1.1.2/32    2.2.2.2/32   Permit  Ethernet1/17  359378      1497
RACL     IPv4       ip 1.1.1.3/32    2.2.2.3/32   Permit  Ethernet1/17  359378      1497
```

This example shows a view of the top 10% of TCAM entries for a current date and filtered by feature name.

```
switch# show icam entries acl module 1 inst 0 sort filter RACL top 10

Retrieving data from linecard. This may take some time ...
================================================================================
TCAM Entries (Mod 1,Inst 0)
--------------------------------------------------------------------------------
Feature  Pkt_Type   Source IP/Mask   Dest IP/Mask   Action      Interface        Stats
--------------------------------------------------------------------------------
RACL     IPv4       ip 1.1.1.95/32    2.2.2.95/32    Permit   Ethernet1/17   664347410
RACL     IPv4       ip 1.1.1.96/32    2.2.2.96/32    Permit   Ethernet1/17   664347410
RACL     IPv4       ip 1.1.1.97/32    2.2.2.97/32    Permit   Ethernet1/17   664347410
RACL     IPv4       ip 1.1.1.98/32    2.2.2.98/32    Permit   Ethernet1/17   664347410
RACL     IPv4       ip 1.1.1.99/32    2.2.2.99/32    Permit   Ethernet1/17   664347410
RACL     IPv4      ip 1.1.1.100/32   2.2.2.100/32    Permit   Ethernet1/17   664347410
RACL     IPv4       ip 1.1.1.86/32    2.2.2.86/32    Permit   Ethernet1/17   664347409
RACL     IPv4       ip 1.1.1.87/32    2.2.2.87/32    Permit   Ethernet1/17   664347409
RACL     IPv4       ip 1.1.1.88/32    2.2.2.88/32    Permit   Ethernet1/17   664347409
RACL     IPv4       ip 1.1.1.89/32    2.2.2.89/32    Permit   Ethernet1/17   664347409
RACL     IPv4       ip 1.1.1.90/32    2.2.2.90/32    Permit   Ethernet1/17   664347409
RACL     IPv4       ip 1.1.1.91/32    2.2.2.91/32    Permit   Ethernet1/17   664347409
RACL     IPv4       ip 1.1.1.92/32    2.2.2.92/32    Permit   Ethernet1/17   664347409
RACL     IPv4       ip 1.1.1.93/32    2.2.2.93/32    Permit   Ethernet1/17   664347409
RACL     IPv4       ip 1.1.1.94/32    2.2.2.94/32    Permit   Ethernet1/17   664347409
RACL     IPv4       ip 1.1.1.78/32    2.2.2.78/32    Permit   Ethernet1/17   664347408
RACL     IPv4       ip 1.1.1.79/32    2.2.2.79/32    Permit   Ethernet1/17   664347408
RACL     IPv4       ip 1.1.1.80/32    2.2.2.80/32    Permit   Ethernet1/17   664347408
RACL     IPv4       ip 1.1.1.81/32    2.2.2.81/32    Permit   Ethernet1/17   664347408
RACL     IPv4       ip 1.1.1.82/32    2.2.2.82/32    Permit   Ethernet1/17   664347408
RACL     IPv4       ip 1.1.1.83/32    2.2.2.83/32    Permit   Ethernet1/17   664347408
RACL     IPv4       ip 1.1.1.84/32    2.2.2.84/32    Permit   Ethernet1/17   664347408
RACL     IPv4       ip 1.1.1.85/32    2.2.2.85/32    Permit   Ethernet1/17   664347408
RACL     IPv4       ip 1.1.1.69/32    2.2.2.69/32    Permit   Ethernet1/17   664347407
RACL     IPv4       ip 1.1.1.70/32    2.2.2.70/32    Permit   Ethernet1/17   664347407
```

This example shows a view of current TCAM entries that are filtered by a feature name using the **exact** keyword.

```
switch# show icam entries acl module 1 inst 0 sort filter PBR exact top 100

Retrieving data from linecard. This may take some time ...
================================================================================
TCAM Entries (Mod 1,Inst 0)
--------------------------------------------------------------------------------
Feature  Pkt_Type   Source IP/Mask    Dest IP/Mask    Action      Interface   Stats
--------------------------------------------------------------------------------
PBR      IPv4         ip 0.0.0.0/0     224.0.0.0/4     Permit   Ethernet1/19      0
PBR      IPv4       tcp 3.3.3.3/32       0.0.0.0/0   Redirect   Ethernet1/19      0
PBR      IPv4       tcp 3.3.3.3/32       0.0.0.0/0   Redirect   Ethernet1/19      0
PBR      IPv4     ip 100.10.1.2/32       2.2.2.4/32   Redirect   Ethernet1/19      0
PBR      IPv4       udp 3.3.3.4/32       2.2.2.2/32   Redirect   Ethernet1/19      0
PBR      IPv4       udp 3.3.3.4/32       2.2.2.2/32   Redirect   Ethernet1/19      0
PBR      IPv4       udp 3.3.3.4/32       2.2.2.2/32   Redirect   Ethernet1/19      0
PBR      IPv4       udp 3.3.3.4/32       2.2.2.2/32   Redirect   Ethernet1/19      0
PBR      IPv4       udp 3.3.3.4/32       2.2.2.2/32   Redirect   Ethernet1/19      0
PBR      IPv4       udp 3.3.3.4/32       2.2.2.2/32   Redirect   Ethernet1/19      0
PBR      IPv4       udp 3.3.3.4/32       2.2.2.2/32   Redirect   Ethernet1/19      0
PBR      IPv4        ip 1.1.1.2/32       2.2.2.2/32   Redirect   Ethernet1/19      0
PBR      IPv4        ip 1.1.1.1/32       2.2.2.2/32   Redirect   Ethernet1/19      0
PBR      IPv4         ip 0.0.0.0/0        0.0.0.0/0     Permit   Ethernet1/19      0
```

This example shows a view of the history of TCAM entries that are monitored by iCAM. The **Stats** column shows the total number of packets hitting the entry for the last five intervals. The **Rate** column shows the average traffic rate in packets per second for the last five intervals.

```
switch# show icam entries acl module 1 inst 0 history 5

================================================================================================
TCAM Entries (Mod 1,Inst 0): Cumulative stats for last 5 intervals
------------------------------------------------------------------------------------------------
Feature  Pkt_Type  Source IP/Mask  Dest IP/Mask   Action     Interface     Stats  Rate(pps)
------------------------------------------------------------------------------------------------
RACL     IPv4      ip 1.1.1.1/32     2.2.2.1/32   Permit  Ethernet1/17   8494611        471
RACL     IPv4      ip 1.1.1.2/32     2.2.2.2/32   Permit  Ethernet1/17   8494612        471
RACL     IPv4      ip 1.1.1.3/32     2.2.2.3/32   Permit  Ethernet1/17   8494612        471
RACL     IPv4      ip 1.1.1.4/32     2.2.2.4/32   Permit  Ethernet1/17   8494611        471
RACL     IPv4      ip 1.1.1.5/32     2.2.2.5/32   Permit  Ethernet1/17   8494611        471
RACL     IPv4     ip 1.1.1.20/32    2.2.2.20/32   Permit  Ethernet1/17   8494611        471
RACL     IPv4     ip 1.1.1.21/32    2.2.2.21/32   Permit  Ethernet1/17   8494611        471
RACL     IPv4     ip 1.1.1.22/32    2.2.2.22/32   Permit  Ethernet1/17   8494611        471
RACL     IPv4     ip 1.1.1.23/32    2.2.2.23/32   Permit  Ethernet1/17   8494611        471
RACL     IPv4       ip 0.0.0.0/0      0.0.0.0/0     Deny  Ethernet1/17 325164152      73620
RACL     IPv4      ip 2.2.2.1/32     1.1.1.1/32   Permit  Ethernet1/18    424732         23
RACL     IPv4      ip 2.2.2.2/32     1.1.1.2/32   Permit  Ethernet1/18    424732         23
RACL     IPv4      ip 2.2.2.3/32     1.1.1.3/32   Permit  Ethernet1/18    424732         23
RACL     IPv4      ip 2.2.2.4/32     1.1.1.4/32   Permit  Ethernet1/18    424732         23
RACL     IPv4      ip 2.2.2.5/32     1.1.1.5/32   Permit  Ethernet1/18    424732         23
RACL     IPv4      ip 2.2.2.6/32     1.1.1.6/32   Permit  Ethernet1/18    424732         23
RACL     IPv4      ip 2.2.2.2/32     1.1.1.1/32   Permit  Ethernet1/18         0          0
RACL     IPv4      ip 2.2.2.3/32     1.1.1.1/32   Permit  Ethernet1/18         0          0
RACL     IPv4      ip 2.2.2.4/32     1.1.1.1/32   Permit  Ethernet1/18         0          0
RACL     IPv4      ip 2.2.2.1/32     1.1.1.2/32   Permit  Ethernet1/18         0          0
RACL     IPv4       ip 0.0.0.0/0      0.0.0.0/0     Deny  Ethernet1/18  66258430       3681
QoS COPP IPv4      tcp 0.0.0.0/0      0.0.0.0/0 Redirect                       0          0
QoS COPP IPv4      tcp 0.0.0.0/0   224.0.0.0/24 Redirect                       0          0
QoS COPP IPv4      tcp 0.0.0.0/0      0.0.0.0/0 Redirect                       0          0
QoS COPP IPv4      tcp 0.0.0.0/0   224.0.0.0/24 Redirect                       0          0
QoS COPP IPv4       88 0.0.0.0/0      0.0.0.0/0 Redirect                       0          0
QoS COPP IPv4       88 0.0.0.0/0   224.0.0.0/24 Redirect                       0          0
QoS COPP IPv4       ip 0.0.0.0/0  224.0.1.39/32 Redirect                       0          0
QoS COPP IPv4       ip 0.0.0.0/0  224.0.1.39/32 Redirect                       0          0
QoS COPP IPv4       ip 0.0.0.0/0  224.0.1.40/32 Redirect                       0          0
QoS COPP IPv4       ip 0.0.0.0/0  224.0.1.40/32 Redirect                       0          0
QoS COPP IPv4      udp 0.0.0.0/0   224.0.0.0/24 Redirect                       0          0
```

This example displays the prediction for the usage statistics of TCAM entries on a module and an instance where iCAM monitoring is enabled.

```
switch# show icam prediction entries acl module 1 inst 0 2020 Nov 1 10:45:00

Generating predictions, this may take some time ...
================================================================================================
TCAM Entries Prediction (Mod 1,Inst 0)
------------------------------------------------------------------------------------------------
Feature  Pkt_Type  Source IP/Mask  Dest IP/Mask  Action     Interface     Stats  Prediction
------------------------------------------------------------------------------------------------
RACL     IPv4     ip 1.1.1.100/32  2.2.2.100/32  Permit  Ethernet1/17  664515047  664694822
RACL     IPv4      ip 1.1.1.94/32   2.2.2.94/32  Permit  Ethernet1/17  664515046  664694822
RACL     IPv4      ip 1.1.1.92/32   2.2.2.92/32  Permit  Ethernet1/17  664515046  664694818
RACL     IPv4      ip 1.1.1.93/32   2.2.2.93/32  Permit  Ethernet1/17  664515046  664694822
RACL     IPv4      ip 1.1.1.99/32   2.2.2.99/32  Permit  Ethernet1/17  664515047  664694822
```

This example displays the predictive analytics of the top 2% TCAM entries.

```
switch# show icam prediction entries acl module 1 inst 0 2020 Nov 1 10:45:00 sort top 2

Generating predictions, this may take some time ...
================================================================================================
TCAM Entries Prediction (Mod 1,Inst 0)
------------------------------------------------------------------------------------------------
Feature  Pkt_Type  Source IP/Mask  Dest IP/Mask  Action     Interface     Stats  Prediction
------------------------------------------------------------------------------------------------
RACL     IPv4       ip 1.1.1.1/32    2.2.2.2/32  Permit  Ethernet1/17  279886055  279886080
RACL     IPv4      ip 1.1.1.10/32   2.2.2.10/32  Permit  Ethernet1/17   93274142  100204095
RACL     IPv4       ip 1.1.1.2/32    2.2.2.2/32  Permit  Ethernet1/17   93274093   98354091
RACL     IPv4       ip 1.1.1.3/32    2.2.2.3/32  Permit  Ethernet1/17   93274099   98575099
RACL     IPv4       ip 1.1.1.4/32    2.2.2.4/32  Permit  Ethernet1/17   93274105   98811092
```

Displaying Current, Historical, and Predictive TCAM Resource per Feature

To view the predictive analytics on the resources and entries using iCAM, use the following commands:

SUMMARY STEPS

1. **show icam resource acl-tcam module** *module* **inst** *instance* [**history** *num-intervals*]
2. **show icam resource** { **acl-tcam** | **fib-tcam** } **module** *module* **inst** *instance* [**history** *num-intervals*]
3. **show icam prediction resource acl-tcam module** *module* **inst** *inst year month day time*
4. **show icam prediction resource** { **acl-tcam** | **fib-tcam** } **module** *module* **inst** *inst year month day time*

DETAILED STEPS

Procedure

	Command or Action	Purpose

Step 1	**show icam resource acl-tcam module** *module* **inst** *instance* [**history** *num-intervals*]
	Example:
	`switch# show icam resource acl-tcam module 1 inst 0`
	Example:
	`switch# show icam resource acl-tcam module 1 inst 0 history 5`
		Displays analytics per module and per instance for resources.
		• **history**—Displays historical snapshots of resource usage for the specified number of intervals.
		• *num-intervals*—Number of intervals in the history.

Step 2	**show icam resource** { **acl-tcam**	**fib-tcam** } **module** *module* **inst** *instance* [**history** *num-intervals*] **Example:** `switch# show icam resource acl-tcam module 1 inst 0`	Displays analytics per module and per instance for resources. • **history**—Displays historical snapshots of resource usage for the specified number of intervals.

	Command or Action	Purpose

	Example:
	`switch# show icam resource acl-tcam module 1 inst 0 history 5`
	Example:
	`switch# show icam resource fib-tcam module 1 inst 0`
	Example:
	`switch# show icam resource fib-tcam module 1 inst 0 history 3`
		• *num-intervals*—Number of intervals in the history.

Step 3	**show icam prediction resource acl-tcam module** *module* **inst** *inst year month day time* **Example:** `switch# show icam prediction resource acl-tcam module 1 inst 0 2020 Jul 20 10:45:00`	Displays the traffic prediction of the ACL-TCAM features such as ACL, QoS, PBR, WCCP, and so on. Also displays the traffic prediction of the FIB-TCAM feature. • *year*—Specifies the year in the YYYY format. The values range from 1970 to 2030. • *month*—Specifies the month as Jan, Feb, or so on. **Note** The values are case sensitive. • *day*—Specifies the day of the month in the DD format. The values range from 1 to 31. • *time*—Specifies the time in the HH:MM:SS format.

Step 4	**show icam prediction resource** { **acl-tcam** | **fib-tcam** } **module** *module* **inst** *inst year month day time*
	Example:
	`switch# show icam prediction resource acl-tcam module 1 inst 0 2020 Jul 20 10:45:00`
	Example:
	`switch# show icam prediction resource fib-tcam module 1 inst 0 2020 Jan 1 10:45:00`
		Displays the traffic prediction of the ACL-TCAM features such as ACL, QoS, PBR, WCCP, and so on. Also displays the traffic prediction of the FIB-TCAM feature.
		• *year*—Specifies the year in the YYYY format. The values range from 1970 to 2030.
		• *month*—Specifies the month as Jan, Feb, or so on.
		Note The values are case sensitive.
		• *day*—Specifies the day of the month in the DD format. The values range from 1 to 31.
		• *time*—Specifies the time in the HH:MM:SS format.

Example: Displaying TCAM Resource per Feature

This example shows a view of iCAM monitoring of the ACL TCAM resources for a current date.

```
switch# show icam resource acl-tcam module 1 inst 0
------------------------------------------------------------------------------------------
Feature Hardware Resource Utilization (Mod 1,Inst 0)
------------------------------------------------------------------------------------------
Ingress Resources
------------------------------------------------------------------------------------------
Feature TCAM# BANK# Feature_Entries   Free_Entries   Percent_Util     Timestamp (UTC)
```

```
-------------------------------------------------------------------------------------
RACL    1     1             244           1545          13.61 2017-10-18 17:22:27
PBR     1     1               1           1545           0.05 2017-10-18 17:22:27
CoPP    3     0             198             27          88.00 2017-10-18 17:22:27

Egress Resources
-------------------------------------------------------------------------------------
Feature TCAM# BANK# Feature_Entries   Free_Entries   Percent_Util     Timestamp (UTC)
-------------------------------------------------------------------------------------
RACL     8     1             457           1333          25.50 2017-10-18 27:22:27
=====================================================================================
ACL TCAM Resource Utilization (Mod 1,Inst 0)
-------------------------------------------------------------------------------------
Used                    Free        Percent_Util  Timestamp (UTC)
-------------------------------------------------------------------------------------
Tcam 0 Bank 0        0       0           0.00      2017-10-18 17:22:27
Tcam 0 Bank 1        0     256           0.00      2017-10-18 17:22:27
Tcam 0 Bank 2        0     256           0.00      2017-10-18 17:22:27
Tcam 0 Bank 3        0       0           0.00      2017-10-18 17:22:27
Tcam 1 Bank 0        0       0           0.00      2017-10-18 17:22:27
Tcam 1 Bank 1      247    1545          13.78      2017-10-18 17:22:27
Tcam 1 Bank 2        4     508           0.78      2017-10-18 17:22:27
Tcam 1 Bank 3        0     256           0.00      2017-10-18 17:22:27
```

This example shows the historical view of iCAM monitoring of ACL TCAM resource utilization as snapshots. Each snapshot displays the state of TCAM utilization in the corresponding time interval.

```
switch# show icam resource acl-tcam module 1 inst 0 history 3
-------------------------------------------------------------------------------------
Feature Hardware Resource Utilization (Mod 1,Inst 0)
-------------------------------------------------------------------------------------
Ingress Resources
-------------------------------------------------------------------------------------
Feature TCAM# BANK# Feature_Entries   Free_Entries   Percent_Util     Timestamp (UTC)
-------------------------------------------------------------------------------------
RACL     1     1             250           1539          13.61        2017-10-18 21:28:17
254                                          1535          13.61        2017-10-18 22:28:17
244                                          1545          13.61        2017-10-18 23:28:17
CoPP     3     0
198                                            27          88.00        2017-10-18 21:28:17
198                                            27          88.00        2017-10-18 22:28:17
198                                            27          88.00        2017-10-18 23:28:17
PBR      1     1               1           1545           0.05        2017-10-18 21:28:17
                               1           1545           0.05        2017-10-18 22:28:17
                               1           1545           0.05        2017-10-18 23:28:17

Egress Resources
-------------------------------------------------------------------------------------
Feature TCAM# BANK# Feature_Entries   Free_Entries   Percent_Util     Timestamp (UTC)
-------------------------------------------------------------------------------------
RACL     8     1             457           1333          25.50 2017-10-18 21:28:17
                             457           1333          25.50 2017-10-18 22:28:17
                             457           1333          25.50 2017-10-18 23:28:17


=====================================================================================
ACL TCAM Resource Utilization (Mod 1,Inst 0)
-------------------------------------------------------------------------------------
Used    Free    Percent_Util          Timestamp (UTC)
-------------------------------------------------------------------------------------
Tcam 0 Bank 0
0       0           0.00      2017-10-18 21:28:17
0       0           0.00      2017-10-18 22:28:17
```

```
0       0           0.00      2017-10-18 23:28:17
Tcam 0 Bank 1
0     256           0.00      2017-10-18 21:28:17
0     256           0.00      2017-10-18 22:28:17
0     256           0.00      2017-10-18 23:28:17
Tcam 0 Bank 2
0     256           0.00      2017-10-18 21:28:17
0     256           0.00      2017-10-18 22:28:17
0     256           0.00      2017-10-18 23:28:17
Tcam 0 Bank 3
0       0           0.00      2017-10-18 21:28:17
0       0           0.00      2017-10-18 22:28:17
0       0           0.00      2017-10-18 23:28:17
```

This example shows a view of iCAM monitoring of FIB TCAM resources.

```
switch# show icam resource fib-tcam module 1 inst 0

================================================================================================
FIB TCAM Resource Utilization (Mod 1,Inst 0)
------------------------------------------------------------------------------------------------

                     Type           Used            Max   Percent_Util          Timestamp
(UTC)
------------------------------------------------------------------------------------------------

         IPv4 Trie Routes              0         458752           0.00      2017-11-07
21:27:56
         IPv4 TCAM Routes             11           6144           0.17      2017-11-07
21:27:56
  IPv4 Native Host Routes            713          65536           1.08      2017-11-07
21:27:56
           IPv4 Multicast            254           8192           3.10      2017-11-07
21:27:56
         IPv6 Trie Routes              0         206438           0.00      2017-11-07
21:27:56
         IPv6 TCAM Routes              9           2048           0.43      2017-11-07
21:27:56
  IPv6 Native Host Routes              0          57344           0.00      2017-11-07
21:27:56
           IPv6 Multicast              1           2048           0.04      2017-11-07
21:27:56
```

This example shows a view of the history of iCAM monitoring of FIB TCAM resources.

```
switch# show icam resource fib-tcam module 1 inst 0 history 3

================================================================================================
FIB TCAM Resource Utilization (Mod 1,Inst 0)
------------------------------------------------------------------------------------------------

                     Type           Used            Max   Percent_Util          Timestamp
(UTC)
------------------------------------------------------------------------------------------------

         IPv4 Trie Routes              0         458752           0.00      2017-11-07
21:24:31
                                       0         458752           0.00      2017-11-07
22:24:31
                                       0         458752           0.00      2017-11-07
23:24:32
         IPv4 TCAM Routes             11           6144           0.17      2017-11-07
```

```
21:24:31
                                    11           6144           0.17      2017-11-07
22:24:31
                                    11           6144           0.17      2017-11-07
23:24:32
  IPv4 Native Host Routes          713          65536           1.08      2017-11-07
21:24:31
                                   713          65536           1.08      2017-11-07
22:24:31
                                   713          65536           1.08      2017-11-07
23:24:32
          IPv4 Multicast           254           8192           3.10      2017-11-07
21:24:31
                                   254           8192           3.10      2017-11-07
22:24:31
                                   254           8192           3.10      2017-11-07
23:24:32
        IPv6 Trie Routes             0         206438           0.00      2017-11-07
21:24:31
                                     0         206438           0.00      2017-11-07
22:24:31
                                     0         206438           0.00      2017-11-07
23:24:32
         IPv6 TCAM Routes            9           2048           0.43      2017-11-07
21:24:31
                                     9           2048           0.43      2017-11-07
22:24:31
                                     9           2048           0.43      2017-11-07
23:24:32
  IPv6 Native Host Routes            0          57344           0.00      2017-11-07
21:24:31
                                     0          57344           0.00      2017-11-07
22:24:31
                                     0          57344           0.00      2017-11-07
23:24:32
          IPv6 Multicast             1           2048           0.04      2017-11-07
21:24:31
                                     1           2048           0.04      2017-11-07
22:24:31
                                     1           2048           0.04      2017-11-07
23:24:32
```

This example displays the predictive analytics of the ACL TCAM resources.

```
switch# show icam prediction resource acl-tcam module 1 inst 0 2020 Jan 21 10:45:00
Generating predictions, this may take some time ...
-----------------------------------------------------------------------------------------
Feature Hardware Resource Prediction (Mod 1,Inst 0)
-----------------------------------------------------------------------------------------
Feature   Direction   TCAM#   BANK#   Feature_Entries    Free_Entries    Percent_Util
-----------------------------------------------------------------------------------------
RACL     ingress       1       1              244            1545           13.61
CoPP     ingress       3       0              198              27           88.00
PBR      ingress       1       1                1            1545            0.05
RACL      egress       8       1              457            1333           25.50
=========================================================================================
ACL TCAM Resource Prediction (Mod 1,Inst 0)
-----------------------------------------------------------------------------------------
Used    Free   Percent_Util
-----------------------------------------------------------------------------------------
Tcam 11 Bank 1        0       0           0.00
Tcam 11 Bank 0        0       0           0.00
Tcam 11 Bank 3        0       0           0.00
```

```
Tcam 11 Bank 2        0       0           0.00
Tcam 10 Bank 1        0       0           0.00
Tcam 10 Bank 0      128     128          50.00
```

This example displays the predictive analytics of the FIB TCAM resources.

```
switch# show icam prediction resource fib-tcam module 1 inst 0 2020 Jan 1 10:45:00
Generating predictions, this may take some time ...

======================================================================
FIB TCAM Resource Prediction (Mod 1,Inst 0)
----------------------------------------------------------------------
                     Type           Used            Max   Percent_Util
----------------------------------------------------------------------
         IPv6 TCAM Routes              9           2048           0.43
           IPv6 Multicast              1           2048           0.04
         IPv6 Trie Routes              0         206438           0.00
  IPv6 Native Host Routes              0          57344           0.00
  IPv4 Native Host Routes            713          65536           1.08
         IPv4 Trie Routes              0         458752           0.00
         IPv4 TCAM Routes             11           6144           0.17
           IPv4 Multicast            254           8192           3.10
```

Explanation of the Display Outputs

When you enable iCAM monitoring for an entry or a resource, the corresponding traffic statistics or resources usage snapshot is stored in the database once for every interval.

This example shows the historical view of the TCAM entries that are monitored by iCAM. The **Stats** column shows the total number of packets hitting the entry for the last five intervals. The **Rate** column shows the average traffic rate in packets per second for the last five intervals.

```
switch# show icam entries acl module 1 inst 0 history 5

================================================================================================
TCAM Entries (Mod 1,Inst 0): Cumulative stats for last 5 intervals
------------------------------------------------------------------------------------------------
Feature  Pkt_Type  Source IP/Mask  Dest IP/Mask   Action      Interface    Stats  Rate(pps)
------------------------------------------------------------------------------------------------
RACL     IPv4       ip 1.1.1.1/32     2.2.2.1/32   Permit  Ethernet1/17    8494611       471
RACL     IPv4       ip 1.1.1.2/32     2.2.2.2/32   Permit  Ethernet1/17    8494612       471
RACL     IPv4       ip 1.1.1.3/32     2.2.2.3/32   Permit  Ethernet1/17    8494612       471
RACL     IPv4       ip 1.1.1.4/32     2.2.2.4/32   Permit  Ethernet1/17    8494611       471
RACL     IPv4       ip 1.1.1.5/32     2.2.2.5/32   Permit  Ethernet1/17    8494611       471
RACL     IPv4     ip 1.1.1.20/32    2.2.2.20/32   Permit  Ethernet1/17    8494611       471
RACL     IPv4     ip 1.1.1.21/32    2.2.2.21/32   Permit  Ethernet1/17    8494611       471
RACL     IPv4     ip 1.1.1.22/32    2.2.2.22/32   Permit  Ethernet1/17    8494611       471
RACL     IPv4     ip 1.1.1.23/32    2.2.2.23/32   Permit  Ethernet1/17    8494611       471
RACL     IPv4       ip 0.0.0.0/0      0.0.0.0/0     Deny  Ethernet1/17  325164152     73620
RACL     IPv4      ip 2.2.2.1/32     1.1.1.1/32   Permit  Ethernet1/18     424732        23
RACL     IPv4      ip 2.2.2.2/32     1.1.1.2/32   Permit  Ethernet1/18     424732        23
RACL     IPv4      ip 2.2.2.3/32     1.1.1.3/32   Permit  Ethernet1/18     424732        23
RACL     IPv4      ip 2.2.2.4/32     1.1.1.4/32   Permit  Ethernet1/18     424732        23
RACL     IPv4      ip 2.2.2.5/32     1.1.1.5/32   Permit  Ethernet1/18     424732        23
RACL     IPv4      ip 2.2.2.6/32     1.1.1.6/32   Permit  Ethernet1/18     424732        23
RACL     IPv4      ip 2.2.2.2/32     1.1.1.1/32   Permit  Ethernet1/18          0         0
RACL     IPv4      ip 2.2.2.3/32     1.1.1.1/32   Permit  Ethernet1/18          0         0
RACL     IPv4      ip 2.2.2.4/32     1.1.1.1/32   Permit  Ethernet1/18          0         0
RACL     IPv4      ip 2.2.2.1/32     1.1.1.2/32   Permit  Ethernet1/18          0         0
```

```
RACL     IPv4       ip 0.0.0.0/0      0.0.0.0/0     Deny  Ethernet1/18   66258430      3681
QoS COPP IPv4      tcp 0.0.0.0/0      0.0.0.0/0 Redirect                          0         0
QoS COPP IPv4      tcp 0.0.0.0/0   224.0.0.0/24 Redirect                          0         0
QoS COPP IPv4      tcp 0.0.0.0/0      0.0.0.0/0 Redirect                          0         0
QoS COPP IPv4      tcp 0.0.0.0/0   224.0.0.0/24 Redirect                          0         0
QoS COPP IPv4       88 0.0.0.0/0      0.0.0.0/0 Redirect                          0         0
QoS COPP IPv4       88 0.0.0.0/0   224.0.0.0/24 Redirect                          0         0
QoS COPP IPv4       ip 0.0.0.0/0  224.0.1.39/32 Redirect                          0         0
QoS COPP IPv4       ip 0.0.0.0/0  224.0.1.39/32 Redirect                          0         0
QoS COPP IPv4       ip 0.0.0.0/0  224.0.1.40/32 Redirect                          0         0
QoS COPP IPv4       ip 0.0.0.0/0  224.0.1.40/32 Redirect                          0         0
QoS COPP IPv4      udp 0.0.0.0/0   224.0.0.0/24 Redirect                          0         0
```

This example shows the historical view of the TCAM resource utilization as snapshots. Each snapshot displays the state of TCAM utilization in the corresponding time interval.

```
switch# show icam resource acl-tcam module 1 inst 0 history 3
-----------------------------------------------------------------------------------------------
Feature Hardware Resource Utilization (Mod 1,Inst 0)
-----------------------------------------------------------------------------------------------
Ingress Resources
-----------------------------------------------------------------------------------------------

Feature TCAM# BANK# Feature_Entries   Free_Entries   Percent_Util     Timestamp (UTC)
-----------------------------------------------------------------------------------------------

RACL     1     1     250               1539          13.61             2017-10-18 21:28:17
                     254               1535          13.61             2017-10-18 22:28:17
                     244               1545          13.61             2017-10-18 23:28:17
CoPP     3     0     198                 27          88.00             2017-10-18 21:28:17
                     198                 27          88.00             2017-10-18 22:28:17
                     198                 27          88.00             2017-10-18 23:28:17

PBR      1     1       1               1545           0.05             2017-10-18 21:28:17
                       1               1545           0.05             2017-10-18 22:28:17
                       1               1545           0.05             2017-10-18 23:28:17
Egress Resources
-----------------------------------------------------------------------------------------------
Feature TCAM# BANK# Feature_Entries   Free_Entries   Percent_Util     Timestamp (UTC)
-----------------------------------------------------------------------------------------------

RACL     8     1    457               1333            25.50           2017-10-18 21:28:17
                    457               1333            25.50           2017-10-18 22:28:17
                    457               1333            25.50           2017-10-18 23:28:17
===============================================================================================
ACL TCAM Resource Utilization (Mod 1,Inst 0)
-----------------------------------------------------------------------------------------------

Used    Free   Percent_Util          Timestamp (UTC)
-----------------------------------------------------------------------------------------------
Tcam 0  Bank 0
0       0           0.00      2017-10-18 21:28:17
0       0           0.00      2017-10-18 22:28:17
0       0           0.00      2017-10-18 23:28:17
Tcam 0 Bank 1
0     256           0.00      2017-10-18 21:28:17
0     256           0.00      2017-10-18 22:28:17
0     256           0.00      2017-10-18 23:28:17
Tcam 0 Bank 2
0     256           0.00      2017-10-18 21:28:17
0     256           0.00      2017-10-18 22:28:17
```

```
0     256           0.00      2017-10-18 23:28:17
Tcam 0 Bank 3
0       0           0.00      2017-10-18 21:28:17
0       0           0.00      2017-10-18 22:28:17
0       0           0.00      2017-10-18 23:28:17
```

Example: Obtaining JSON Outputs for iCAM Configurations

This example shows how to view top 1% RACL entries for a current date in JSON format.

```
switch# show icam entries acl module 1 inst 0 sort filter RACL top 1 | json-pretty
{

    "module": "1",

    "instance": "0",

    "TABLE_ACL_entries": {

        "ROW_ACL_entries": [

            {

                "Feature": "RACL",

                "Pkt_Type": "IPv4",

                "SourceIP_Mask_DestIP_Mask": "ip 0.0.0.0/0 0.0.0.0/0",

                "Action": "Deny",

                "Intf_name": "Ethernet1/17",

                "Stats": "6124597284"

            },

            {

                "Feature": "RACL",

                "Pkt_Type": "IPv4",

                "SourceIP_Mask_DestIP_Mask": "ip 0.0.0.0/0 0.0.0.0/0",

                "Action": "Deny",

                "Intf_name": "Ethernet1/17",

                "Stats": "306239019"

            },

            {

                "Feature": "RACL",

                "Pkt_Type": "IPv4",

                "SourceIP_Mask_DestIP_Mask": "ip 1.1.1.100/32 2.2.2.100/32",
```

```
                    "Action": "Permit",
                    "Intf_name": "Ethernet1/17",
                    "Stats": "39260103"
                },
                {
                    "Feature": "RACL",
                    "Pkt_Type": "IPv4",
                    "SourceIP_Mask_DestIP_Mask": "ip 1.1.1.99/32 2.2.2.99/32",
                    "Action": "Permit",
                    "Intf_name": "Ethernet1/17",
                    "Stats": "39260096"
                },
                {
                    "Feature": "RACL",
                    "Pkt_Type": "IPv4",
                    "SourceIP_Mask_DestIP_Mask": "ip 1.1.1.98/32 2.2.2.98/32",
                    "Action": "Permit",
                    "Intf_name": "Ethernet1/17",
                    "Stats": "39260090"
                }
            ]
        }
}
```


This example shows how to view iCAM monitoring of the FIB TCAM resources for a current date in JSON format.


```
switch# show icam resource fib-cam module 1 inst 0 | json-pretty
{
    "module": "1",
    "instance": "0",
    "TABLE_fib_resource": {
        "ROW_fib_resource": [
            {
                "Class": "IPv4 Trie Routes",
                "TABLE_fib_stats": {
                    "ROW_fib_stats": {
                        "Used_Entries": "0",
                        "Max_Entries": "458752",
                        "Percent_Util": "0.00",
                        "Timestamp": "2017-10-26 18:54:20"
```

```
            }
        }
    },
    {
        "Class": "IPv4 TCAM Routes",
        "TABLE_fib_stats": {
            "ROW_fib_stats": {
                "Used_Entries": "11",
                "Max_Entries": "6144",
                "Percent_Util": "0.17",
                "Timestamp": "2017-10-26 18:54:20"
            }
        }
    },
    {
        "Class": "IPv4 Native Host Routes",
        "TABLE_fib_stats": {
            "ROW_fib_stats": {
                "Used_Entries": "713",
                "Max_Entries": "65536",
                "Percent_Util": "1.08",
                "Timestamp": "2017-10-26 18:54:20"
            }
        }
    },
    {
        "Class": "IPv4 Multicast",
        "TABLE_fib_stats": {
            "ROW_fib_stats": {
                "Used_Entries": "254",
                "Max_Entries": "8192",
                "Percent_Util": "3.10",
                "Timestamp": "2017-10-26 18:54:20"
            }
        }
    },
    {
        "Class": "IPv6 Trie Routes",
        "TABLE_fib_stats": {
            "ROW_fib_stats": {
                "Used_Entries": "0",
                "Max_Entries": "206438",
                "Percent_Util": "0.00",
                "Timestamp": "2017-10-26 18:54:20"
            }
        }
    },
    {
        "Class": "IPv6 TCAM Routes",
        "TABLE_fib_stats": {
            "ROW_fib_stats": {
                "Used_Entries": "9",
                "Max_Entries": "2048",
                "Percent_Util": "0.43",
                "Timestamp": "2017-10-26 18:54:20"
            }
        }
    },
    {
        "Class": "IPv6 Native Host Routes",
        "TABLE_fib_stats": {
            "ROW_fib_stats": {
                "Used_Entries": "0",
                "Max_Entries": "57344",
```

```
                        "Percent_Util": "0.00",
                        "Timestamp": "2017-10-26 18:54:20"
                    }
                }
            },
            {
                "Class": "IPv6 Multicast",
                "TABLE_fib_stats": {
                    "ROW_fib_stats": {
                        "Used_Entries": "1",
                        "Max_Entries": "2048",
                        "Percent_Util": "0.04",
                        "Timestamp": "2017-10-26 18:54:20"
                    }
                }
            }
        ]
    }
}
```


About Streaming Telemetry

Telemetry is an automated communications process where measurements and other data is collected at remote or inaccessible points and transmitted to receiving equipment for monitoring. In streaming network routing telemetry, devices stream data with incremental updates, thus helping to optimize, monitor, troubleshoot, and provide predictive analytics about traffic.

You can use the NX API feature to send iCAM CLI output to any server outside of the switch. You must configure the destination address and port and specify the CLI you want to send.

NX API uses either the HTTP or Google Remote Procedure Call (gRPC) as a transport medium. The CLIs are encoded using Google Protocol Buffer (GPB) or JSON.

You must enable the telemetry feature to configure streaming. You can configure a set of CLI commands to execute and the frequency of sending the desired CLI output.

You must also configure a telemetry receiver or an application that stores the telemetry data with a corresponding port open. You can verify the telemetry receiver using the **show telemetry policies** CLI command. The streaming telemetry receiver receives the data at the frequency that is configured in the policy file.

The following example shows a cadence-based collection of **show iCAM** data that is collected at 750-second intervals:

```
switch(config)# telemetry
switch(config-telemetry)# destination-group 1
switch(conf-tm-dest)# ip address 172.27.247.72 port 60001 protocol gRPC encoding GPB
switch(conf-tm-dest)# sensor-group 1
switch(conf-tm-sensor# data-source NX-API
switch(conf-tm-sensor)# path "show icam entries acl mod 1 inst 0” depth 0
switch(conf-tm-sensor)# path "show icam resource acl-tcam mod 1 inst 0” depth 0
switch(conf-tm-sensor)# subscription 1
switch(conf-tm-sub)# dst-grp 1
switch(conf-tm-dest)# snsr-grp 1 sample-interval 750000
```