Configuring iCAM

This chapter contains the following sections:

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
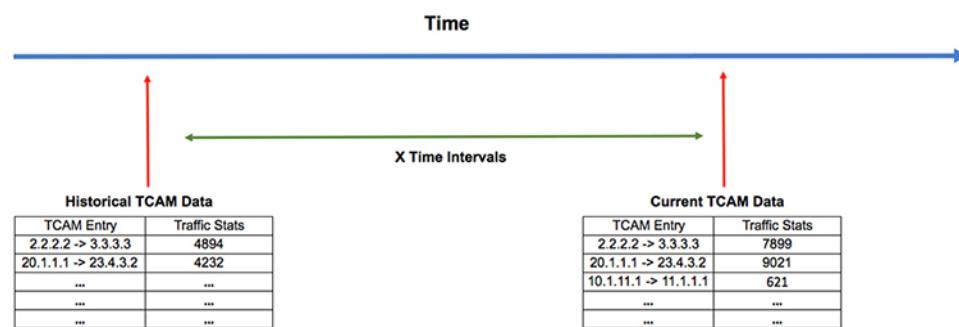
The following figure shows historical resource utilization:

Figure 2: Historical Resource Utilization

Historical 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
...	...	...	...
...	...	...	...

Current Data

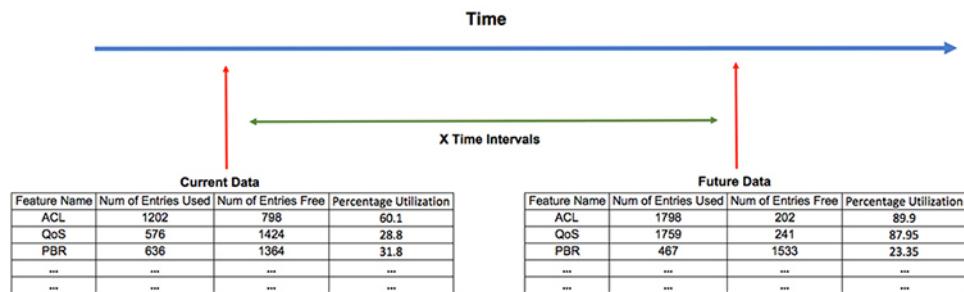| Feature Name	Num of Entries Used	Num of Entries Free	Percentage Utilization
ACL	1450	550	72.5
QoS	1754	246	87.7
PBR	259	1741	12.95
...	...	...	...
...	...	...	...
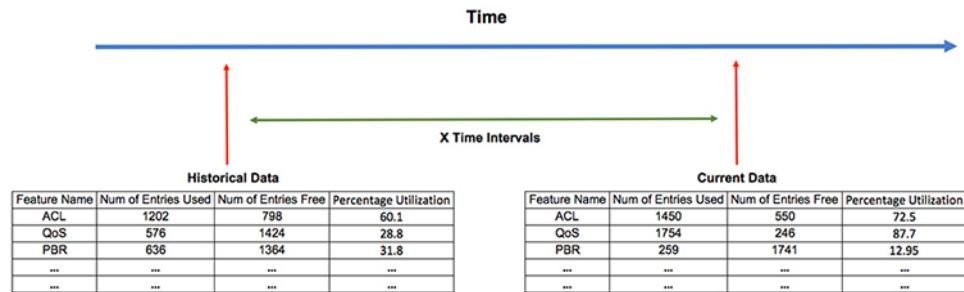
Predicting Traffic Analytics Using iCAM

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

Current 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
...	...	...	...
...	...	...	...

Future Data

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

Current TCAM Data

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
...	...
...	...

Future TCAM Data

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
...	...
...	...
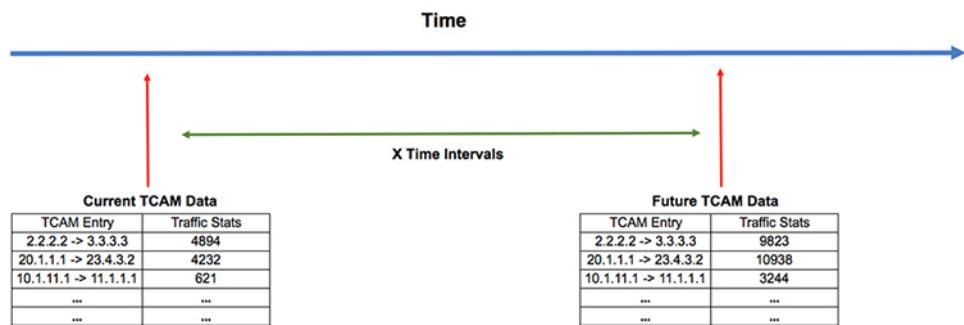
Health Monitoring

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.

• Cisco Nexus 9000 platform switches do not support NetFlow.

• 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

	Command or Action	**Purpose**

Step 1	**configure terminal**
	
	Example:
	<pre>switch# configure terminal
	switch(config)#</pre>
		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:
	<pre>switch# configure terminal
	switch(config)# icam monitor interval 2 history 90
	switch(config)# exit</pre>
		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 Scale	Config Scale	Cur Scale	Cur Util	Threshold Exceeded	Polled 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 Scale	Config Scale	Cur Scale	Cur Util	Threshold Exceeded	Polled 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 Scale	Config Scale	Cur Scale	Cur Util	Threshold Exceeded	Polled 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

	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 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:
					 `switch(config)# icam monitor scale`
					`multicast-routing pim neighbor limit 2500`
						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
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:** `switch(config)# show icam  scale`	Displays data from the default scale monitoring thresholds. **Note** **show icam scale** displays the current scale values from iCAM's data cache. The data cache is constantly refreshed.

	Command or Action	Purpose
		• **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.
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.

	Command or Action	Purpose
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

	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.
			
			• **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.

	Command or Action	Purpose
		• **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

	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`
		
		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`
			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.

	Command or Action	**Purpose**
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
```