Configuring iCAM

This chapter contains the following sections:

About iCAM

Beginning with Cisco NX-OS Release 9.2(4), Cisco Nexus 3600 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.

- View health monitoring data (such as CPU, memory, power supply).

The iCAM feature:

• Does not require additional hardware or software.

• Provides useful traffic telemetry and analytics.

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 3600 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.

You can obtain traffic and scale (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

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, Intelligent Traffic Director (ITD), 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
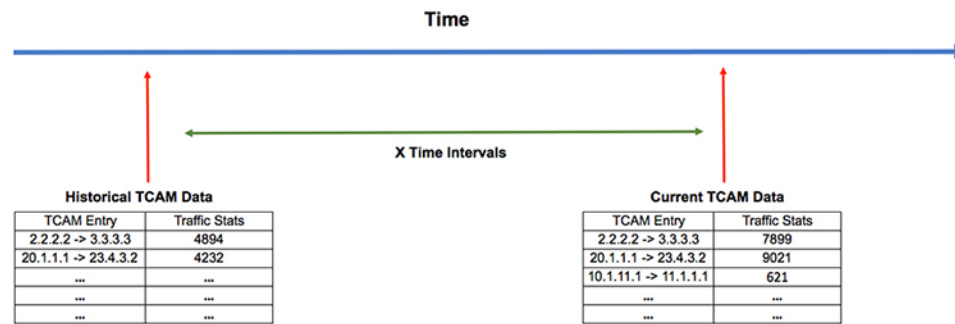
The following figure shows historical resource utilization:

Figure 2: Historical Resource Utilization
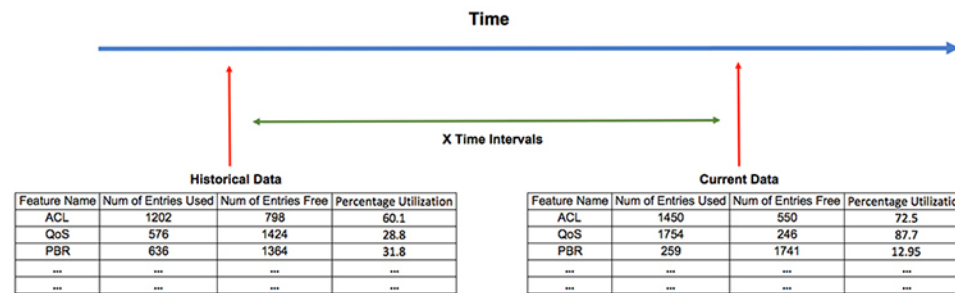
Predicting Traffic Analytics Using iCAM

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
...	...	...	...
...	...	...	...
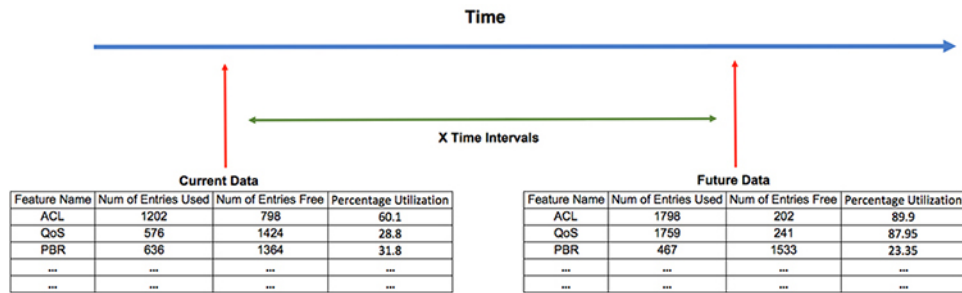
The following figure shows the predicted resource utilization:

Figure 4: Predicted Resource Utilization
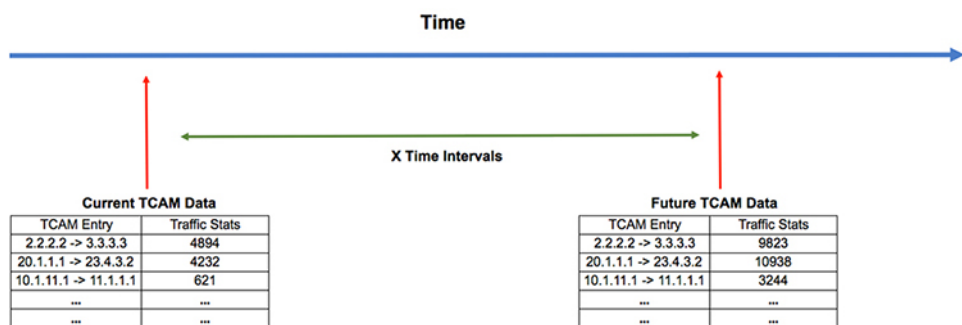
Current TCAM Data	
TCAM Entry	Traffic Stats
2.2.2.2 -> 3.3.3.3	4894
20.1.1.1 -> 23.4.3.2	4232
10.1.11.1 -> 11.1.1.1	621
...	...
...	...

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 iCAM

This table shows the licensing requirements for iCAM.

Product	License Requirement
Cisco NX-OS	iCAM requires a Network Services license. For an explanation of the Cisco NX-OS licensing scheme, see the *Cisco NX-OS Licensing 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 N3K-C36180YC-R, N3K-C3636C-R, and N3K-C36480LD-R2 switches.

- iCAM queries do not support FIB and multicast entries.

- Beginning with Cisco NX-OS Release 9.3(5), the iCAM feature is enabled by default. You cannot disable iCAM feature, configuring no iCAM feature. The iCAM scale monitor is enabled by default if there are no initial startup configurations.

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 3600 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. **feature icam**
3. [**no**]**icam monitor entries** *acl* **module** *module-number* **inst** *instance-number*
4. [**no**]**icam monitor resource** {**acl_tcam acl-tcam** | **fib_tcam fib-tcam** } **module** *module* **inst** *instance*
5. (Optional) **icam monitor interval** *interval-hours* **num_intervals history** *num-intervals*
6. **no feature icam**

DETAILED STEPS

	Command or Action	**Purpose**
Step 1	**configure terminal** **Example:** ``` switch# configure terminal switch(config)# ```	Enter global configuration mode.
Step 2	**feature icam**	Enables the iCAM feature.

	Command or Action	**Purpose**
	Example: switch(config)# feature icam	**Note** You must enable iCAM monitoring if you want to configure and record history and predict TCAM entries or resources.
Step 3	[**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 4	[**no**]**icam monitor resource** {**acl_tcam acl-tcam** | **fib_tcam fib-tcam** } **module** *module* **inst** *instance*	Monitor the **acl_tcam acl-tcam** or **fib_tcam fib-tcam** resource per module and instance.
Step 5	(Optional) **icam monitor interval** *interval-hours* **num_intervals history** *num-intervals* **Example:** switch# configure terminal switch(config)# icam monitor interval 2 num_intervals 90 switch(config)# exit 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).
Step 6	**no feature icam** **Example:** switch(config)# no feature icam	Disables the iCAM feature.

Example: Enabling and Configuring iCAM

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

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

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

```
switch# configure terminal
switch# no feature icam
switch# copy running-config startup-config
```

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. **feature icam**
3. (Optional) [**no**] **icam monitor interval** *interval-hours* **history** *number-of-intervals*
4. [**no**] **icam monitor scale**
5. (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*
6. (Optional) [**no**] **icam monitor scale multicast-routing {igmp {group} | pim {neighbor} | routing-forwarding {outgoing-interface | route-v4 | route-v6}}** **limit** *feature_limit*
7. (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*
8. (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*
9. (Optional) [**no**] **icam monitor scale threshold info** *info-threshold* **warning** *warning-threshold* **critical** *critical-threshold*
10. (Optional) **show icam scale**
11. (Optional) **show icam scale history** *number-of-intervals* **sort {current-scale {ascending | descending} | polled-timestamp {newest | oldest}}}**
12. (Optional) **show icam scale l2-switching**
13. (Optional) **show icam scale multicast-routing**
14. (Optional) **show icam scale thresholds**

15. (Optional) **show icam scale unicast-routing**
16. (Optional) **show icam scale utilization**
17. (Optional) **show icam scale vxlan**
18. (Optional) **show icam prediction scale**   *year month day time*
19. (Optional) **show icam prediction scale l2-switching**
20. (Optional) **show icam prediction scale multicast-routing**
21. (Optional) **show icam prediction scale unicast-routing**
22. (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	**feature icam** **Example:** `switch(config)# feature icam`	Enables the iCAM feature. The **no** version disables the iCAM feature. **Note** You must enable iCAM monitoring if you want to configure and record history and predict TCAM entries or resources.
Step 3	(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 4	[**no**] **icam monitor scale**	Enables all features with default limits and thresholds.

Step 5	(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 6	(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 7	(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 8	(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 9	(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 10	(Optional) **show icam scale** **Example:** switch(config)# **show icam scale**	Displays data from the default scale monitoring thresholds. • **Verified Scale** - CCO QA verified scale numbers that are based on software version and hardware.

	Command or Action	Purpose
		• **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 11	(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-timetamp value, with the newest or oldest record displayed first.
Step 12	(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 13	(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 14	(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 15	(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 16	(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.

	Command or Action	Purpose
Step 17	(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 18	(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 19	(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 20	(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 21	(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 22	(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.

Example: Scale Monitoring

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 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`
			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.

	Command or Action	Purpose
	Example: `switch# show icam entries acl module 1 inst 0 history 5 sort top 10`	**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. • **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%.

Generating a Chord Diagram to View Complex Traffic Flows

You can use the output of the commands to generate a chord diagram. A chord diagram provides a simple view of complex traffic flows. You can identify an anomalous traffic flow using a chord diagram.

The following chord diagram is a simple representation of a complex traffic flow, where the traffic flow between the various sources and destinations is uniform.

Figure 5: Chord Diagram Representing Uniform Traffic Flow
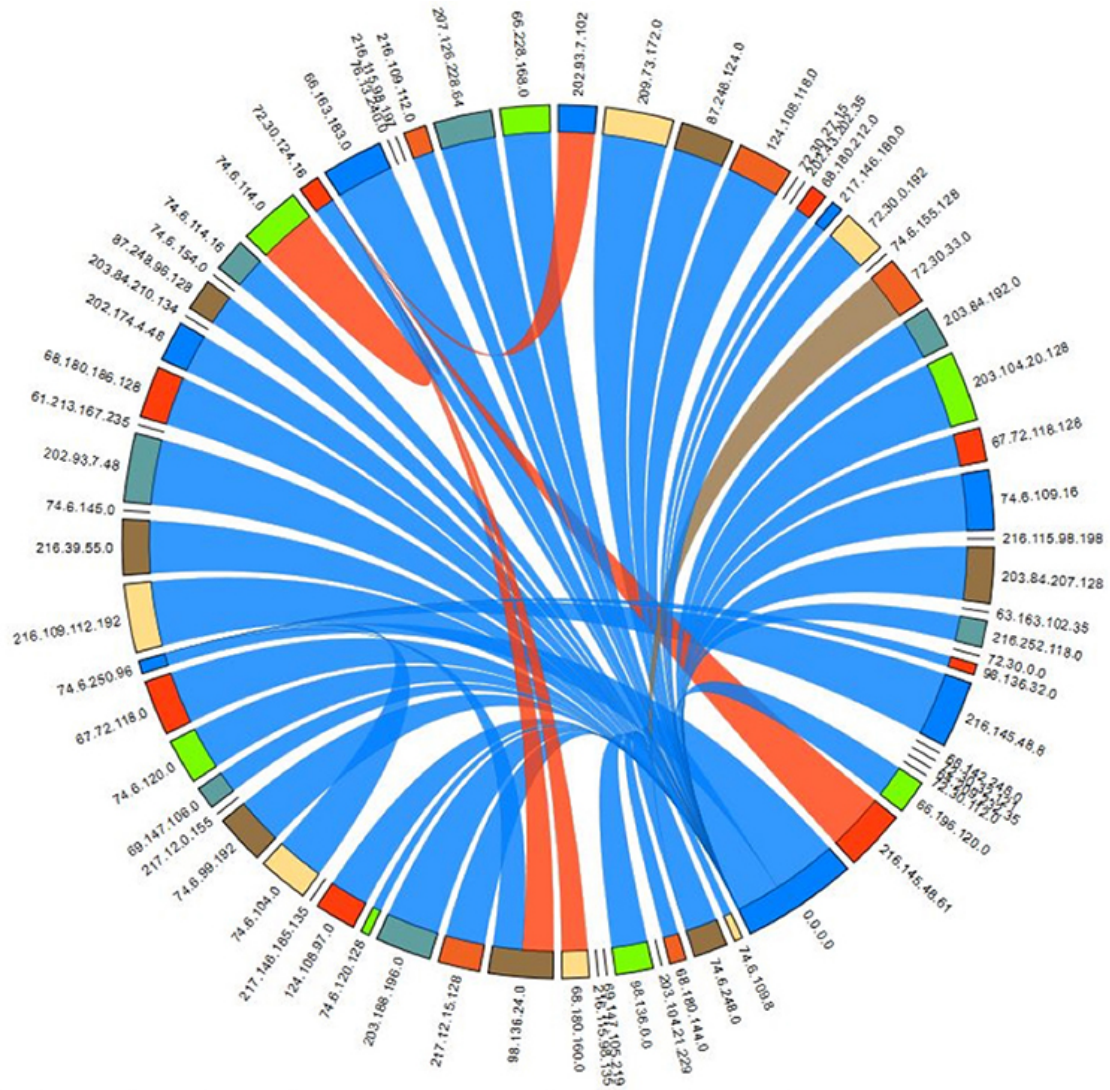
The following example shows how to view the top 2% traffic flow of the TCAM entries for a current date.

```
switch# show icam entries acl module 1 inst 0 sort top 2

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 1.1.1.1/32     2.2.2.1/32     Permit    Ethernet1/17   109099390
RACL      IPv4        ip 1.1.1.100/32   2.2.2.100/32     Permit    Ethernet1/17    94447216
RACL      IPv4         ip 1.1.1.99/32    2.2.2.99/32     Permit    Ethernet1/17    94447210
RACL      IPv4         ip 1.1.1.98/32    2.2.2.98/32     Permit    Ethernet1/17    94447204
RACL      IPv4         ip 1.1.1.97/32    2.2.2.97/32     Permit    Ethernet1/17    94447198
```

```
RACL      IPv4          ip 1.1.1.96/32      2.2.2.96/32      Permit    Ethernet1/17      94447192
RACL      IPv4          ip 1.1.1.95/32      2.2.2.95/32      Permit    Ethernet1/17      94447186
```

The following figure shows the traffic flow that is generated using the output in this example:

Figure 6: Chord Diagram
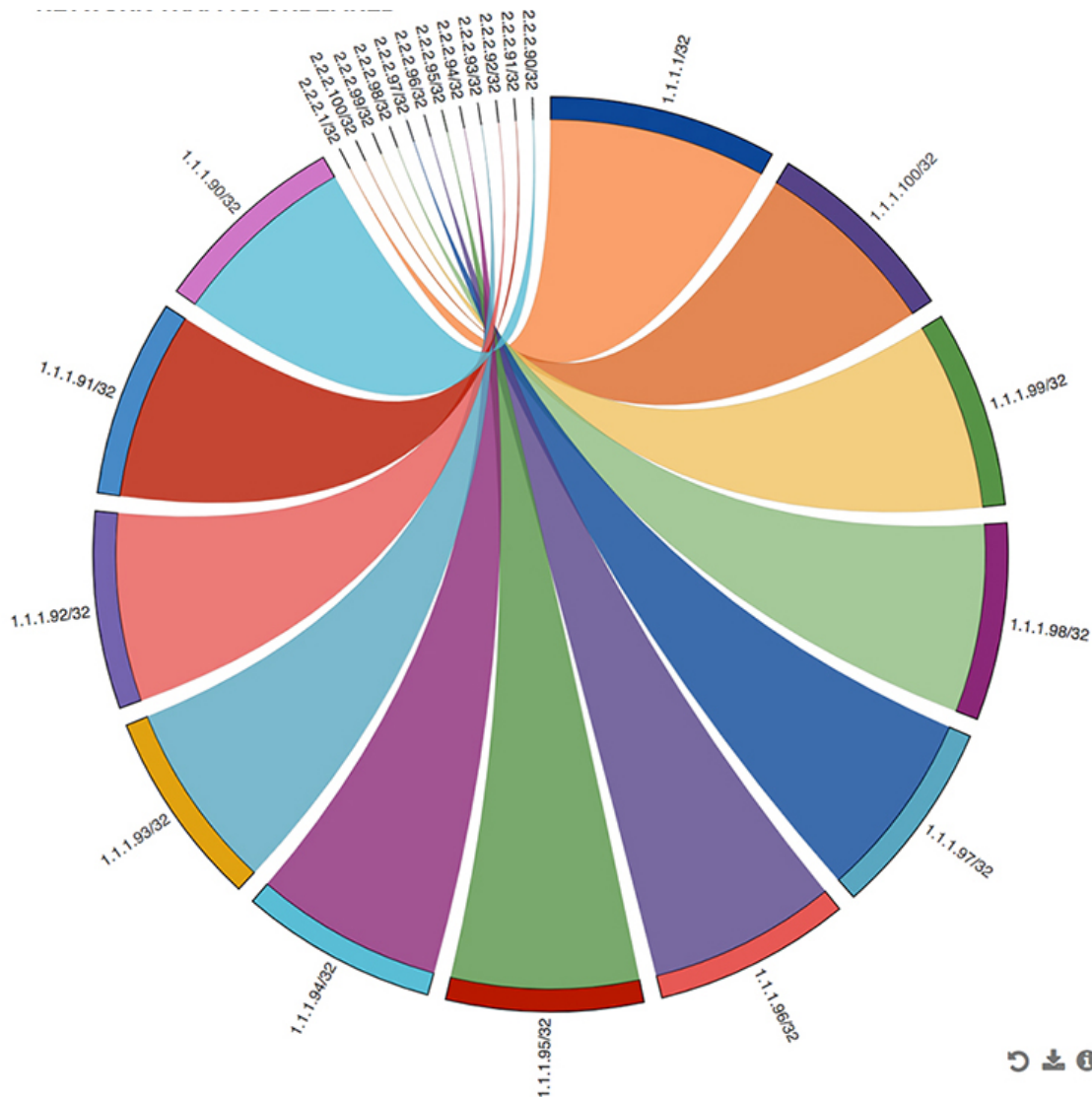
Every arc in the chord diagram represents the traffic flow from a source address to a destination address. The thick end of the chord represents the source address and the thin end represents the destination address. The thickness of the arc represents the percentage of the traffic. The statistics field in the output of the **show icam entries** command shows the number of packets or traffic hitting a TCAM entry. You can view traffic from a single source to multiple destinations and from multiple sources to single destination.

The following figure shows an anomalous traffic flow:

Figure 7: Anomaly Visualization
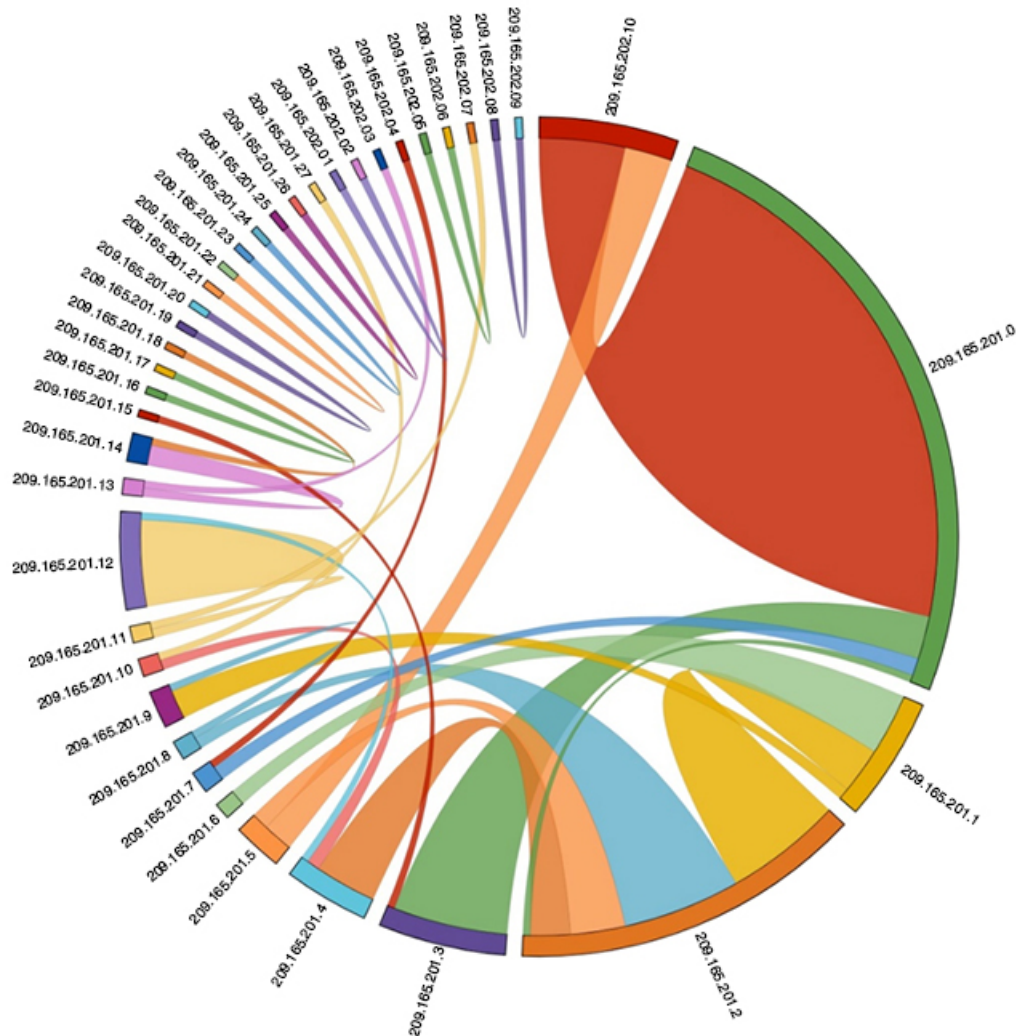
In the figure, the arcs with traffic from 209.165.201.0 to 209.165.202.10 can be easily identified as an anomalous traffic pattern.

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

DETAILED STEPS

	Command or Action	Purpose
Step 1	**feature icam** **Example:** `switch(config)# feature icam`	Enables the iCAM feature
Step 2	**show icam resource acl_tcam acl-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. • *num-intervals*—Number of intervals in the history.

	Command or Action	Purpose
| | ```
switch# show icam resource acl-tcam module 1 inst 0
```<br><br>**Example:**<br>```
switch# show icam resource acl_tcam module 1 inst 0 history 5
```<br>```
switch# show icam resource acl-tcam module 1 inst 0 history 5
``` | |
| **Step 3** | **show icam resource** {**acl_tcam acl-tcam** \| **fib_tcam fib-tcam** } **module** *module* **inst** *instance* [**history** *num-intervals*]<br><br>**Example:**<br>```
switch# show icam resource acl_tcam module 1 inst 0
```<br>```
switch# show icam resource acl-tcam module 1 inst 0
```<br>**Example:**<br>```
switch# show icam resource acl_tcam module 1 inst 0 history 5
```<br>```
switch# show icam resource acl-tcam module 1 inst 0 history 5
```<br>**Example:**<br>```
switch# show icam resource fib_tcam module 1 inst 0
```<br>```
switch# show icam resource fib-tcam module 1 inst 0
```<br>**Example:**<br>```
switch# show icam resource fib_tcam module 1 inst 0 history 3
```<br>```
switch# show icam resource fib-tcam module 1 inst 0 history 3
``` | Displays analytics per module and per instance for resources.<br><br>• **history**—Displays historical snapshots of resource usage for the specified number of intervals.<br><br>• *num-intervals*—Number of intervals in the history. |
| **Step 4** | **show icam prediction resource acl_tcam acl-tcam module** *module* **inst** *inst year month day time*<br><br>**Example:**<br>```
switch# show icam prediction resource acl_tcam module 1 inst 0 2020 Jul 20 10:45:00
```<br>```
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.<br><br>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.<br><br>• *year*—Specifies the year in the YYYY format. The values range from 1970 to 2030.<br><br>• *month*—Specifies the month as Jan, Feb, or so on.<br><br>   **Note**    The values are case sensitive.<br><br>• *day*—Specifies the day of the month in the DD format. The values range from 1 to 31. |

	Command or Action	Purpose
		• *time*—Specifies the time in the HH:MM:SS format.

Step 5	**show icam prediction resource** {**acl_tcam acl-tcam** | **fib_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`
	
	`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`
	
	`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.
		
		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.

Generating Charts or Graphs to View Predictive Resource Usage

Using the output of predictive commands, you can generate a donut chart or a bar graph. The following figure shows the TCAM resource usage per feature:

Figure 8: Donut Chart Representing TCAM Resource Usage per Feature

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 0show 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
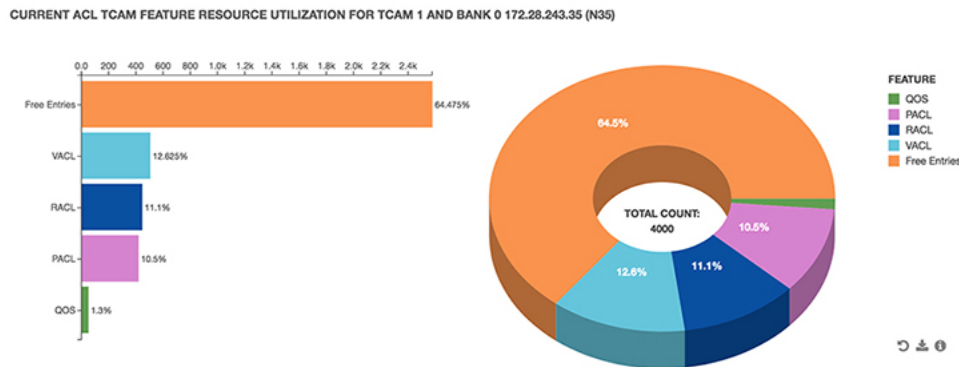
Egress Resources
--------------------------------------------------------------------------------------------
Feature TCAM# BANK# Feature_Entries   Free_Entries    Percent_Util     Timestamp (UTC)
--------------------------------------------------------------------------------------------
RACL    8     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 3show 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 Layer 2 Table resources.

switch# **show icam resource l2_table module 1 inst 0**
```
====================================================================
L2 Table Resource Utilization (Mod 1,Inst 0)
--------------------------------------------------------------------
  Total_entries   Used_entries   Percent_Util        Timestamp (UTC)
--------------------------------------------------------------------
        98304           5444           5.53    2017-11-07 19:41:53
```

This example shows a view of the history of iCAM monitoring of Layer 2 Table resources.

switch# **show icam resource l2_table module 1 inst 0 history 4**
```
====================================================================
L2 Table Resource Utilization (Mod 1,Inst 0)
--------------------------------------------------------------------
Total_entries Used_entries Percent_Util Timestamp (UTC)
--------------------------------------------------------------------
98304 5444 5.53 2017-11-07 19:36:11
98304 5444 5.53 2017-11-07 20:36:12
98304 5444 5.53 2017-11-07 21:36:13
98304 5444 5.53 2017-11-07 22:36:13
```

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

switch# **show icam resource fib_tcam module 1 inst 0 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 3show 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 10:45:00show
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 10:45:00show 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
```

This example displays the predictive analytics of the Layer 2 Table resources.

```
switch# show icam prediction resource l2_table module 1 inst 0 2020 Jan 11 10:45:00
Generating predictions, this may take some time ...

=============================================
L2 TABLE Resource Prediction (Mod 1,Inst 0)
---------------------------------------------
          Used          Free    Percent_Util
```

```
           ----------------------------------------
                5444          92860           5.53
```

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.

Displaying Data on Device Health

iCAM provides selected device health information through the **show icam health** CLI command. Device health data includes information on CPU, memory, and power supply.

Command	Purpose
show icam health	Displays the device health output in tabular format.
show icam health | **json**	Displays the device health output in JSON format.
show icam health | **json-pretty**	Displays the device health output in JSON pretty print format.
show icam health | **xml**	Displays the device health output in XML format.

This example shows sample output in JSON:

```
n9k-11# show icam health | json-pretty
{
    "Version": "1.0.0",
    "TABLE_cpu": {
        "ROW_cpu": [
            {
                "CpuTypeName": "User",
                "CpuTypeValue": "2.52"
            },
            {
                "CpuTypeName": "Kernel",
                "CpuTypeValue": "1.38"
            },
            {
                "CpuTypeName": "Idle",
                "CpuTypeValue": "96.09"
            }
        ]
    },
    "TABLE_mem": {
        "ROW_mem": [
            {
                "MemTypeName": "Total",
                "MemTypeValue": "24632684"
            },
            {
                "MemTypeName": "Used",
                "MemTypeValue": "6066372"
            },
```

```
            {
                "MemTypeName": "Free",
                "MemTypeValue": "18566312"
            }
        ]
    },
    "TABLE_ps": {
        "ROW_ps": [
            {
                "PsTypeName": "Capacity",
                "PsTypeValue": "650.00"
            },
            {
                "PsTypeName": "Actual Input Draw",
                "PsTypeValue": "149.00"
            },
            {
                "PsTypeName": "Actual Output Draw",
                "PsTypeValue": "130.00"
            }
        ]
    }
}
n9k-11#
```

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 3show 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_tcam module 1 inst 0 | json-pshow 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

switch(config)# telemetry
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```

```
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```