You can adjust the percentage of a module’s CAM that can store Layer 2, Layer 3, or Layer 4 entries. In releases prior to 07.6.01b, CAM partitioning was not configurable. Starting in release 07.6.01b, you can specify the percentage of CAM assigned to each of the CAM entry types, both on a global and per-module basis. After you reboot the HP device, the user-specified CAM partitions take effect.

This chapter is divided into the following sections:

- “CAM Overview” on page 5-1 below
- “Using the CLI to Configure CAM Partitioning” on page 5-2
- “Displaying CAM Partitioning Information” on page 5-4

**CAM Overview**

Content Addressable Memory (CAM) is a component of HP modules that facilitates hardware forwarding. As packets flow through the HP device from a given source to a given destination, the management processor records forwarding information about the flow in CAM entries. A CAM entry generally contains next-hop information, such as the outgoing port, the MAC address of the next-hop router, VLAN tag, and so on. Once the HP device has this information in its CAM, packets with the same source and destination can be forwarded by hardware without the aid of the management processor, speeding up forwarding time.

CAM entries can contain Layer 2, Layer 3, or Layer 4 information. Each type of CAM entry has its own format. Layer 2 CAM entries contain destination MAC information; Layer 3 CAM entries contain destination IP information; Layer 4 CAM entries contain destination IP, destination TCP/UDP port, source IP, and source TCP/UDP port information. Layer 2 entries also deal with 802.1p (priority), and VLAN information.

When the HP device is initialized, the software partitions the available CAM into segments for Layer 2, Layer 3, or Layer 4 information. The percentage of CAM devoted to each type of CAM entry depends on the software image running on the device. For example, Routing Switch software may assign a percentage of CAM to Layer 3 and a percentage to Layer 2/4.

On 9300 series routers, the CAM lookup mechanism involves longest prefix match with up to three levels of overlapping prefixes. The Layer 3 CAM partition on these devices is divided into three levels of “supernet” host routes, designated Level1, Level2, and Level3. For Layer 3 IP network routes, Level1 routes precede Level2 routes, and Level2 routes precede Level3 routes. For example, given three routes to program into the CAM, 110.23.24.0/24, 110.23.0.0/16 and 110.0.0.0/8, the device programs 110.23.24.0/24 in Level1, 110.23.0.0/16 in Level2, and 110.0.0.0/8 in Level3.

The Layer 4 CAM partition is divided into four pools, designated Pool0, Pool1, Pool2, and Pool3. Pools 1 – 3 store Layer 4 session CAM entries. When no match for an IP packet is found in Pools 1 – 3, an entry for the packet is made in Pool0. IP packets with CAM entries in Pool0 are sent to the CPU. By default, entries for all packet types
CAM partitioning also depends on the device type and module used: 9300 series devices have different amounts of CAM available, and Standard (non-EP), Enhanced Performance, and 10 Gigabit Ethernet modules use different CAM partitioning mechanisms. The following sections list the CAM entry size, amount of CAM, and default CAM partition size for each of these modules for software images.

### CAM Partitioning on Standard Modules

In the Standard architecture, all CAM entries are 64-bits wide, regardless of type.

9300 series Gigabit modules have 1 Mbit of CAM for each set of four ports, for a total of 2 Mbits. 10/100-T modules have 1 Mbit of CAM for all 24 ports.

For router software images, the default CAM partition is 50 percent Layer 2 entries and 50 percent Layer 3 entries. In unicast high-performance mode (the default for release 7.5.04 and above) the CAM partition is 75 percent Layer 3 entries and 25 percent Layer 2 entries. On Standard modules, Layer 4 CAM entries are part of the Layer 2 partition.

### CAM Partitioning on Enhanced Performance Modules

On EP modules, CAM entries can be 64 bits (for Layer 2 entries) 64 bits (for Layer 3 entries), or 128 bits (for Layer 4 entries). Each 64-bit Layer 3 CAM entry contains two 32-bit IP route entries.

EP module ports are managed by two kinds of custom ASICs:

- Integrated Gigabit Controllers (IGCs) – Ethernet packet controllers for Gigabit ports. Each Gigabit Ethernet module contains two IGCs.
- Integrated Packet Controllers (IPCs) – Ethernet packet controllers for 10/100 ports. Each 10/100 Ethernet module contains two IPCs.

Each IGC or IPC has its own CAM space. An IPC or IGC has 2 Mbits for 9300 series modules. An 8-port Gigabit module has 4 Mbits of CAM and a 16-port Gigabit module has 8 Mbits.

For router software images, the default CAM partition is 50 percent Layer 3 entries, 25 percent Layer 2 entries, and 25 percent Layer 4 entries. Note that these percentages refer to the amount of CAM space allotted to each type of CAM entry, not to the actual number of CAM entries, since on EP modules CAM entries of different types can be different sizes.

### CAM Partitioning on 10 Gigabit Ethernet Modules

As with other EP modules, CAM entries on 10 Gigabit Ethernet modules are 64 bits (for Layer 2 entries) 64 bits (for Layer 3 entries), or 128 bits (for Layer 4 entries). Unlike the other EP modules, 10 Gigabit Ethernet modules have two CAM banks of 4 Mbits each. One CAM bank is used for Layer 2 destination address entries and Layer 3 entries, and the other CAM bank is used for Layer 2 source address entries and Layer 4 entries.

The amount of CAM space allotted to Layer 2 source address entries must be equal to the amount allotted to Layer 2 destination address entries. Consequently, if you increase the amount of Layer 2 CAM space, it will reduce the amount of CAM space for both Layer 3 and Layer 4 entries.

For router software images, one bank of CAM is divided into 25 percent Layer 2 destination address entries and 75 percent Layer 3 entries. The other CAM bank is divided into 25 percent Layer 2 source address entries and 75 percent Layer 4 entries.

### Using the CLI to Configure CAM Partitioning

You can configure CAM partitioning on a global or per-module basis. On a Routing Switch image, you can specify percentages for Layer 2, Layer 3, and Layer 4 CAM entries.
Changing CAM Partitions

For example, the following command specifies CAM percentages to be applied to all the modules on a ProCurve Routing Switch running a router image.

ProCurveRS(config)# cam-partition l2 0 l3 100 l4 0
Slot 1 (DMA 0) CAM Partition:
   Standard Module, Total Size 1Mbits
   L2 232.530029Mbits 88789.002929%, L3 0.75Mbits 75%, L4 232.655029Mbits 88801 .502929%
   L3 = 12288 (level2 = 2048, level3 = 2048), Pool0 = 2048, Pool1 = 2048, Pool2 = 544488408, Pool3 = 0
Slot 1 (DMA 2) CAM Partition:
   Standard Module, Total Size 1Mbits
   L2 232.530029Mbits 88789.002929%, L3 0.75Mbits 75%, L4 232.655029Mbits 88801 .502929%
   L3 = 12288 (level2 = 2048, level3 = 2048), Pool0 = 2048, Pool1 = 2048, Pool2 = 544488408, Pool3 = 0
Cold start required. Please write memory and then reload or power cycle.

**Syntax:** cam-partition l2 <percent> l3 <percent> l4 <percent>

On devices running a router image, you cannot set CAM to zero percent (0%). Also, the minimum value for Layer 4 CAM is one-fourth or 25% of the total CAM.

When you enter the `cam-partition` command, the HP device attempts to partition the available CAM into the percentages you specify. Due to internal hardware restrictions, the resulting CAM partitions may not exactly match the percentages you specify. The device attempts to come as close as possible to match the user-specified partitions. The new CAM partitioning takes effect after you enter the `write memory` command and restart the HP device.

The percentages you specify must add up to 100 percent. When you are globally setting CAM partitions on 10 Gigabit Ethernet Modules, the percentage assigned to Layer 3 must equal the percentage assigned to Layer 4.

To specify CAM partitions on an individual module, enter commands such as the following:

ProCurveRS(config)# hw-module 3
ProCurveRS(config-module-3/8)# cam-part l2 10 l3 70 l4 20
Slot 3 (DMA 8) CAM Partition:
   Standard Module, Total Size 1Mbits
   L2 232.530029Mbits 88789.002929%, L3 0.75Mbits 75%, L4 232.655029Mbits 88801 .502929%
   L3 = 12288 (level2 = 2048, level3 = 2048), Pool0 = 2048, Pool1 = 2048, Pool2 = 544488408, Pool3 = 0
Cold start required. Please write memory and then reload or power cycle.

**Syntax:** hw-module <module>
Displaying CAM Partitioning Information

CAM is shared among multiple DMAs on an HP module. The CAM is accessible by one of the DMAs, called a master DMA. The `show version` command displays which DMAs are master DMAs. For example:

```
HP9304# show version
  SW: Version 07.6.04T53 Hewlett-Packard Company
  Compiled on Jun 27 2003 at 23:32:30 labeled as H2R07604
    (2870842 bytes) from Primary h2r07604.bin
  J4139A HP ProCurve Routing Switch 9304M
  HW: ProCurve HP9304 Routing Switch, SYSIF version 21, Serial #: Non-exist
```

SL 1: J4889A EP 48 port 10/100-TX telco Module, SYSIF 2
      Serial #: SA29020286
        4096 KB BRAM, EP ASIC IPC version 43, BIA version 89
        8192 KB FRAM and 2M-Bit*1 CAM for IPC 0, version 1843
        8192 KB FRAM and 2M-Bit*1 CAM for IPC 1, version 1843

SL 2: J4885A EP 8 port mini-GBIC Management Module, SYSIF 2 (Mini GBIC), M4, ACTIVE
      Serial #: CH21028091
        4096 KB BRAM, EP ASIC IGC version 47, BIA version 89
        32768 KB FRAM and 2M-Bit*1 CAM for IGC 4, version 0447
        32768 KB FRAM and 2M-Bit*1 CAM for IGC 5, version 0447

SL 3: J4891A 2 Port 10Gig 10km Module, SYSIF 2
      Serial #: SA18030021
        32768 KB BRAM, XPP version 58, XTM version 59
        4096 KB FRAM(4096+0K) and 65536*1 CAM entries for DMA 8, version 0158
        4096 KB FRAM(4096+0K) and 65536*1 CAM entries for DMA 9, version 0158

SL 4: J4885A EP 8 port mini-GBIC Management Module, SYSIF 2 (Mini GBIC), M4, STANDBY
      Serial #: US90020086
        4096 KB BRAM, EP ASIC IGC version 49, BIA version 89
        32768 KB FRAM and 2M-Bit*1 CAM for IGC 12, version 0449
        32768 KB FRAM and 2M-Bit*1 CAM for IGC 13, version 0449

Active management module:
  466 MHz Power PC processor 750 (version 8/8302) 66 MHz bus
  512 KB boot flash memory
  16384 KB code flash memory
  256 KB SRAM
  512 MB DRAM

Standby management module:
  466 MHz Power PC processor 750 (version 8/8302) 66 MHz bus
  512 KB boot flash memory
  16384 KB code flash memory
  256 KB SRAM
  512 MB DRAM

The system uptime is 2 days 1 hours 26 minutes 21 seconds
The system : started=cold start
Changing CAM Partitions

**Syntax:** show version

In the example at the beginning of this section, on the module in slot 1, DMAs 0 and 1 are master DMAs, and on the module in slot 3, DMA 8 is a master DMA. You can display CAM partitioning information for each master DMA. For example:

ProCurveRS# show cam-partition brief

==== SLOT 1 CAM PARTITION ====

DMA: 0 (0x00)
Number of CAM devices per DMA:  8
Number of hw entries per CAM:  0x00800
Total size of CAM = 1Mbits
complete CAM index range per DMA:
  (sw) 1 - 16383  (1 - 0x03fff), total entries: 16383 (0x03fff)
  (hw) 0 - 16383  (0 - 0x03fff), total entries: 16384 (0x04000)
Percentage of CAM hardware entries for each partition:
  Level3 l3 = 2047 (0.124938Mbits)      (12.493896%)
  Level3 l3 = 2048 (0.125Mbits) (12.5%)
  Level3 l3 = 8192 (0.5Mbits) (50%)
  Level4  = 4096 (0.25Mbits)  (25%)

DMA: 2 (0x02)
Number of CAM devices per DMA:  8
Number of hw entries per CAM:  0x00800
Total size of CAM = 1Mbits
complete CAM index range per DMA:
  (sw) 1 - 16383  (1 - 0x03fff), total entries: 16383 (0x03fff)
  (hw) 0 - 16383  (0 - 0x03fff), total entries: 16384 (0x04000)
Percentage of CAM hardware entries for each partition:
  Level3 l3 = 2047 (0.124938Mbits)      (12.493896%)
  Level3 l3 = 2048 (0.125Mbits) (12.5%)
  Level3 l3 = 8192 (0.5Mbits) (50%)
  Level4  = 4096 (0.25Mbits)  (25%)

**Syntax:** show cam-partition brief
To display the index range for each kind of CAM entry, enter the following command:

ProCurveRS# show cam-partition detail

=== SLOT 1 CAM PARTITION ===

DMA: 0 (0x00)
Number of CAM devices per DMA:  8
Number of hw entries per CAM:  0x00800
Total size of CAM = 1Mbits
complete CAM index range per DMA:
  (sw) 1 - 16383 (1 - 0x03fff), total entries: 16383 (0x03fff)
  (hw) 0 - 16383 (0 - 0x03fff), total entries: 16384 (0x04000)
Percentage of CAM hardware entries for each partition:
  Level3  l3 = 2047 (0.124938Mbits) (12.493896%)
  Level3  l3 = 2048 (0.125Mbits) (12.5%)
  Level3  l3 = 8192 (0.5Mbits) (50%)
  Level4  = 4096 (0.25Mbits) (25%)

L3 level 3 index range:
  (sw) 1 - 2047 (0x00001 - 0x007ff), free 2047 (0x007ff)
  (hw) 1 - 2047 (0x00001 - 0x007ff)
L3 level 2 index range:
  (sw) 2048 - 4095 (0x00800 - 0x00fff), free 2048 (0x00800)
  (hw) 2048 - 4095 (0x00800 - 0x00fff)
L3 index range:
  (sw) 4096 - 12287 (0x01000 - 0x02fff), free 8189 (0x01fffd)
  (hw) 4096 - 12287 (0x01000 - 0x02fff)
L4 pool 0 index range:
  (sw) 12288 - 14335 (0x03000 - 0x037ff), free 2044 (0x007fc)
  (hw) 12288 - 14335 (0x03000 - 0x037ff)
L2/L4 pool 1 index range:
  (sw) 14336 - 16383 (0x03800 - 0x03fff), free 2047 (0x007ff)
  (hw) 14336 - 16383 (0x03800 - 0x03fff)

Syntax: show cam-partition detail

To display CAM partitioning information for a specified module, enter a command such as the following:

ProCurveRS# show cam-partition module 3 brief

=== SLOT 3 CAM PARTITION ===

DMA: 8 (0x08)
Number of CAM devices per DMA:  8
Number of hw entries per CAM:  0x00800
Total size of CAM = 0.9375Mbits
complete CAM index range per DMA:
  (sw) 1 - 15359 (1 - 0x03bff), total entries: 15359 (0x03bff)
  (hw) 0 - 15359 (0 - 0x03bff), total entries: 15360 (0x03c00)
Percentage of CAM hardware entries for each partition:
  Level3  l3 = 2047 (0.124938Mbits) (13.326822%)
  Level3  l3 = 2048 (0.125Mbits) (13.333333%)
  Level3  l3 = 8192 (0.5Mbits) (53.333333%)
  Level4  = 3072 (0.1875Mbits) (20%)

Syntax: show cam-partition module <module> brief | detail
Changing CAM Partitions

The following sections describe features that allow you to modify the way the HP device manages the CAM:

- Programming directly connected routes into CAM as network routes
- CAM aggregation for supernet routes

**NOTE:** These features apply to HP devices running Enterprise software release 07.8.00 or higher.

### CAM Support for Directly Connected Routes

By default, for supernet routes of directly connected routes, the HP device creates 32-bit host CAM entries for traffic using these routes. If a network has traffic destined to a large number of different hosts, creating the 32-bit supernet routes can consume a large portion of CAM space.

To configure the device to program directly connected routes as supernet routes in CAM, enter the following command:

```
ProCurveRS(config)# ip supernet connected
```

**Syntax:** `[no] ip supernet connected`

This feature takes effect immediately after you enter the `ip supernet connected` command. CAM entries that have already been programmed are not affected; however, you may want to save the configuration and restart the HP device after enabling the feature.

The following is an example of how this feature works. In the example, 20.20.20.0/24 is a locally connected subnet. Two static routes, 20.0.0.0/8 and 20.20.0.0/16 are configured. Traffic is sent to host 20.1.1.1 using the first parent route.

Without the `ip supernet connected` command configured, the following 32-bit host CAM entries are created:

```
ProCurveRS# show cam ip 3/1
Slot Index  IP_Address       MAC Age VLAN  Out Port
3 4097  20.1.1.1/32  00e0.52da.c347  1  1 ether 3/9
3 4099  20.20.20.10/32  0050.da27.62cb  1  1 ether 3/1
```

With the `ip supernet connected` command configured, the following network CAM entries are created:

```
ProCurveRS# show cam ip 3/1
Slot Index      IP_Address  MAC        Age  VLAN  Out Port
3 1    20.0.0.0/8    00e0.52da.c347  0 1 ether 3/9
3 2048    20.20.0.0/16  00e0.52da.c347  dis 1 ether 3/9
3 4096    20.20.20.0/24 0000.0000.0000  1 N/A FID unused
```

Note that in the second CAM entry displayed (20.20.0.0/16), the age is shown as disabled. This is because this CAM entry is created when its parent is created, but since the entry is never used, it would normally be timed out eventually. However, since its parent is still in the CAM, it should not be timed out. Instead, aging for the CAM entry is disabled.

For the third CAM entry, created for the locally connected route (20.20.0.0/24), the outgoing interface is shown as "FID unused". This indicates that packets using this route are forwarded by the CPU.

In addition, if a host CAM entry for the supernet route had already existed prior to when the `ip supernet connected` command was configured, it is not removed by enabling this feature. In the example above, if a host entry for 20.20.20.10/32 had already existed, enabling this feature does not remove this entry. When the CAM entry ages out, traffic for this destination would be forwarded using the network CAM entries.