

- The Switching Tables -

The Layer 2 Switching “Process”

Layer 2 switches contain **queues** where frames are stored after they are received and before they are sent.

When a Layer 2 switch receives a frame on a port, it places that frame in one of the port’s **ingress** queues. When the switch decides which port that frame should be sent out of, it places the frame in that port’s **egress** queue. If the destination MAC address in the frame is not in the MAC address table, the frame is placed in the egress queue of all ports and is flooded throughout the network.

Each port can be configured with multiple ingress or egress queues. Using **Quality of Service (QoS)**, each queue can be assigned a different **priority**. Thus, we can give a higher preference to more critical traffic, such as video conferencing, by placing that traffic in a high priority queue.

Before a Layer 2 switch can take a frame from one port’s ingress queue to another port’s egress queue, it must consult **two** tables:

- **Content Addressable Memory (CAM)**, which is Cisco’s term for the MAC address table. It can also be referred to as the Layer 2 Forwarding Table.
- **Ternary Content Addressable Memory (TCAM)**, which contains access lists that can filter frames by MAC address, and QoS access-lists to prioritize traffic. In multi-layer switches, the TCAM also contains access lists to filter frames based on IP address or TCP/UDP port.

Both the CAM and TCAM are stored in RAM, so that information lookup is quick. Throughout the rest of this guide, the MAC address table will be referred to as the CAM.

* * *

All original material copyright © 2007 by Aaron Balchunas (aaron@routeralley.com), unless otherwise noted. All other material copyright © of their respective owners.

This material may be copied and used freely, but may not be altered or sold without the expressed written consent of the owner of the above copyright. Updated material may be found at <http://www.routeralley.com>.

Content Addressable Memory (CAM)

As stated before, Cisco refers to a Catalyst switch's MAC address table as Content Addressable Memory (CAM).

Remember that switches only place the **source** MAC address of a frame in the CAM. Additionally, the CAM stores which port and VLAN the frame was received from.

By default, dynamically learned MAC addresses are stored for 300 seconds in the CAM. After 300 seconds, if no activity is received from that MAC address, its entry is removed from the CAM. MAC address entries can also be statically entered into the CAM.

The following is a sample output of the CAM, using the command:

```
Switch# show mac address-table dynamic
```

Destination Address	Address Type	VLAN	Destination Port
0000.001e.2a52	Dynamic	1	FA1/1
0000.001e.345e	Dynamic	1	FA1/1
0000.001e.bb3a	Dynamic	1	FA1/1
0000.001e.eba3	Dynamic	1	FA1/2
0000.001e.face	Dynamic	1	FA1/3
0000.001e.3519	Dynamic	1	FA1/4
0000.001e.2dc1	Dynamic	1	FA1/5
0000.001e.8465	Dynamic	1	FA1/5
0000.001e.1532	Dynamic	1	FA1/5
0000.001e.8ab2	Dynamic	1	FA1/6
0000.001e.15b1	Dynamic	1	FA1/6
0000.005a.1b01	Dynamic	1	FA1/6
0000.005a.4214	Dynamic	1	FA1/7
0000.005a.5129	Dynamic	1	FA1/8
0000.00cc.bbe2	Dynamic	1	FA1/9
0000.00cc.2291	Dynamic	1	FA1/10

Don't be confused that the columns are labeled "destination" address and "destination" port. The MAC address is always learned from the source MAC. However, once the address is learned, that address is used as a possible "destination" address for any new frames the switch receives.

All original material copyright © 2007 by Aaron Balchunas (aaron@routeralley.com), unless otherwise noted. All other material copyright © of their respective owners.

This material may be copied and used freely, but may not be altered or sold without the expressed written consent of the owner of the above copyright. Updated material may be found at <http://www.routeralley.com>.

Configuring the CAM

To change the aging timer for dynamically learned MAC addresses in the CAM from its default of 300 seconds to 360 seconds:

```
Switch(config)# mac address-table aging-time 360
```

To statically add to the CAM a MAC address of 0011.2233.4455, which resides on Port FA0/0 on VLAN 1:

```
Switch(config)# mac address-table static 0011.2233.4455 vlan 1 interface fa0/0
```

Please note, in earlier versions of the Cisco IOS (prior to 12.1), the command syntax for the above commands contained an additional hyphen between “mac” and “address”:

```
Switch(config)# mac-address-table aging-time 360
Switch(config)# mac-address-table static 0011.2233.4455 vlan 1 interface fa0/0
```

To view all dynamic MAC entries in the CAM:

```
Switch# show mac address-table dynamic
```

To view a specific dynamic address in the CAM:

```
Switch# show mac address-table dynamic address 1234.5678.90ab
```

To view the number of MAC addresses per VLAN:

```
Switch# show mac address-table count
```

To clear the entire dynamic contents of the CAM:

```
Switch# clear mac address-table dynamic
```

To clear a single entry of the CAM:

```
Switch# clear mac address-table dynamic 1234.5678.90ab
```

* * *

All original material copyright © 2007 by Aaron Balchunas (aaron@routeralley.com), unless otherwise noted. All other material copyright © of their respective owners.

This material may be copied and used freely, but may not be altered or sold without the expressed written consent of the owner of the above copyright. Updated material may be found at <http://www.routeralley.com>.

Ternary Content Addressable Memory (TCAM)

The **TCAM** integrates access lists into its table, allowing filtering to occur on the fly. On multi-layer switches, the TCAM can filter not only MAC addresses, but also IP addresses and TCP/UDP ports. Additionally, QoS access lists can be integrated into the TCAM to prioritize traffic.

The TCAM consists of two components:

- **Feature Manager (FM)** – Integrates access lists into the TCAM
- **Switching Database Manager (SDM)** – Maintains TCAM partitions

Multiple TCAMs can exist on a single router. For example, there are TCAMs for inbound traffic, outbound traffic, and for QoS information.

The TCAM table is more complex than the CAM. The CAM is a flat table containing only MAC address, VLAN, and port information. Entries in the TCAM table contain three parameters:

- **Values** – consists of the addresses or ports that must be matched
- **Masks** – dictates how much of the address to match
- **Result** – what action to take when a match occurs

For example, if we created the following access list:

```
access-list 150 permit tcp 172.16.0.0 0.0.255.255 host 172.17.1.1 eq 23
access-list 150 deny tcp 172.16.0.0 0.0.255.255 host 172.17.1.1 eq 80
```

The Feature Manager (FM) will automatically integrate the access-lists into the TCAM. Configuring the TCAM consists *solely* of creating the necessary access-lists.

The **values** are the source of 172.16.0.0, and the destination of 172.17.1.1.

The **masks** in this case are 0.0.255.255 for the 172.16.0.0 source network, dictating that the last two octets can be anything. A mask of 0.0.0.0 is given to the destination host 172.17.1.1, indicating it must be an exact match.

The **result** in this case is either permit or deny. However, other results are possible when using QoS access-lists, which is more concerned with prioritizing traffic than filtering it.

* * *

All original material copyright © 2007 by Aaron Balchunas (aaron@routeralley.com), unless otherwise noted. All other material copyright © of their respective owners.

This material may be copied and used freely, but may not be altered or sold without the expressed written consent of the owner of the above copyright. Updated material may be found at <http://www.routeralley.com>.