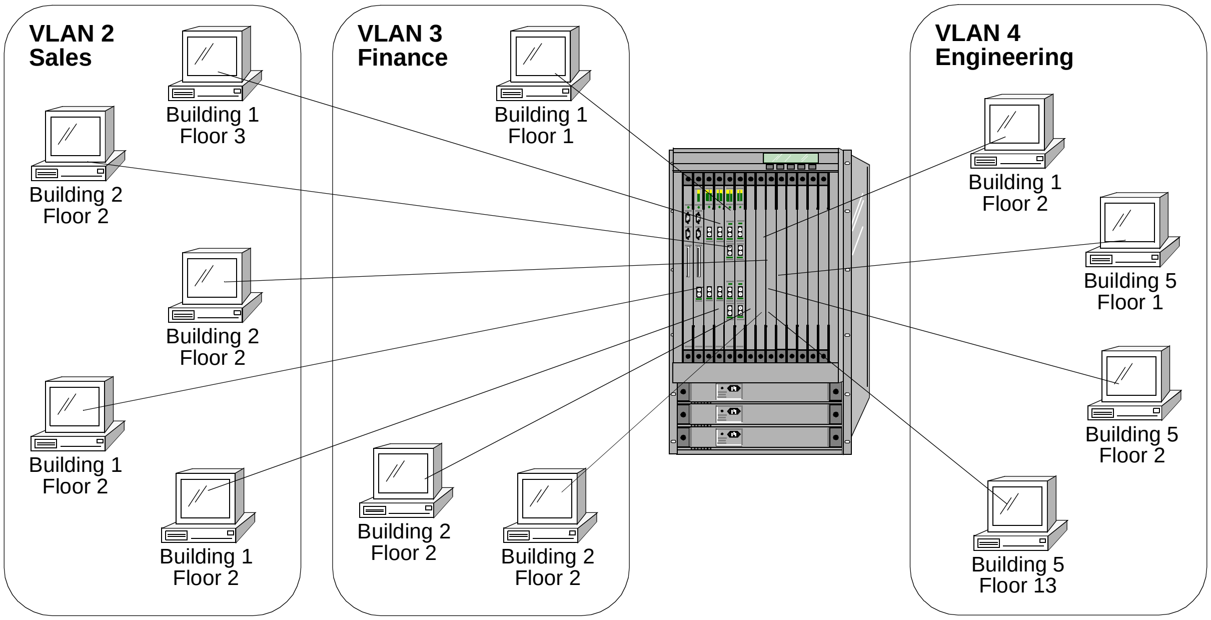
3 Configuring VLANs and Priority

Virtual Local Area Networks (VLANs) allow the user to partition broadcast domains within a switched environment. These domains can be used to create user groups or isolate certain types of traffic. The following figure is an example of how VLANs can be used to group together users who may or may not be in close physical proximity to one another, but need to belong to the same broadcast domain, i.e., workgroup.



Example of VLANs in a Network

The OmniCore routing switch supports 512 active port- and protocol-based VLANs, and supports the full range of IEEE 802.1Q tags, from 1 to 4,094.

The switch, by default, has one VLAN defined, VLAN 1, which includes all ports in the system. When a port is added to another VLAN it is automatically removed from VLAN 1. Deleting an untagged port from a VLAN will automatically add the port back to VLAN 1. A port may belong to multiple VLANs only if it is a tagged port, or if it is using protocol-based VLAN membership. Note that tagging and protocol-based memberships are mutually exclusive. A VLAN is automatically enabled upon creation. Disabling a VLAN does not turn off port connectivity within the VLAN.

VLAN Commands

The major VLAN commands in the OmniCore CLI are listed in the following table. Other commands are available for fine-tuning your VLAN configurations. To see a complete list of these commands or for more information regarding the commands used in this chapter, see the *OmniCore CLI Reference Manual*.

VLAN Commands

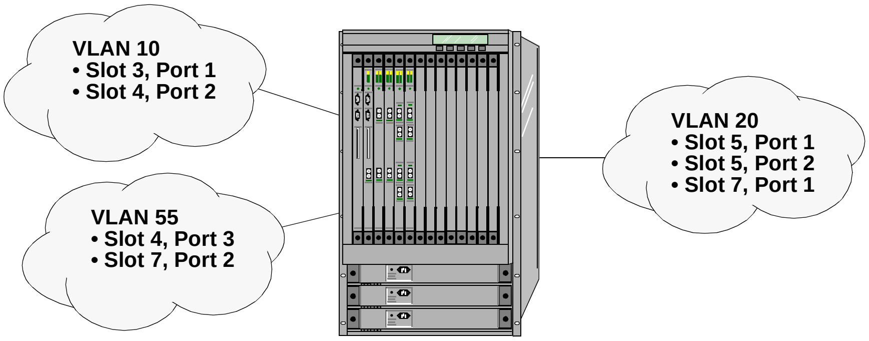
Command	Default	Description
slot port tagmode	disable	Activates tagging on specified port.
vlan	1	Defines a VLAN
vlan arp	no default	Creates an ARP cache entry.
vlan bcast-priority	default (none)	Defines a priority value for broadcast packets.
vlan flood-priority	default (none)	Defines a priority value for flooded packets.
vlan mac	no default	Creates a static MAC entry.
vlan member	no default	Adds a port to a VLAN
vlan name	VLAN-N	Defines a VLAN's name.
vlan priority	default (none)	Defines the priority value.
vlan tag	no default	Defines a tag value.

Configuring Port-Based VLANs

Port-based VLANs allow users to create broadcast domains based on port numbers on the switch and administer their membership. Ports that belong to the same VLAN have Layer 2 "connectivity," while ports in different VLANs do not.

Basic Port-Based VLAN Management

When configuring port-based VLAN membership, keep in mind that all ports must belong to at least one VLAN. By default, all ports on the OmniCore routing switch belong to VLAN 1. The following figure displays several different port-based VLANs operating within a OmniCore routing switch.



Example of Port-Based VLAN Interfaces within a OmniCore routing switch

You must perform these tasks to configure the port-based VLANs shown in the preceding illustration.

- Create a VLAN.
- Add ports to the VLAN.
- (Optional) Modify the VLAN's name.
- (Optional) Move ports from one VLAN to another.
- (Optional) Delete any unwanted VLANs.

Follow these steps to configure the port-based VLANs shown in the preceding illustration.

1. Create the VLANs.

```
OmniCore> vlan 10 tag 10 create

OmniCore> vlan 20 tag 20 create

OmniCore> vlan 55 tag 55 create

OmniCore> vlan show
Id Tag State   Pri   Bcast-pri Flood-pri # Ports OperStat Name
-- --- -----   ---   --------- --------- ------  -------- ----
1  1   enable  deflt default   default   27      up       VLAN-1
10 10  enable  deflt default   default   0       up       VLAN-10
20 20  enable  deflt default   default   0       up       VLAN-20
55 55  enable  deflt default   default   0       up       VLAN-55
```

2. Add ports to the VLANs.

```
OmniCore> vlan 10

OmniCore/vlan=10> member 3 1 default add

OmniCore/vlan=10> member 4 2 default add

OmniCore/vlan=10> show
Vlan Id                                   :10
Vlan Current State                        :enable
Name                                      :VLAN-10
Tag                                       :10
Priority                                  :default
Broadcast Priority                        :default
Flood Priority                            :default
Oper Status                               :up
Port Member List                          :3-1
                                           4-2

OmniCore/vlan=10> ..

OmniCore> vlan 20

OmniCore/vlan=20> member 5 1 default add

OmniCore/vlan=20> member 5 2 default add

OmniCore/vlan=20> member 7 1 default add

OmniCore/vlan=20> portlist show
Port Member List                          :5 - 1,2
                                           7 - 1

OmniCore/vlan=20> ..

OmniCore> vlan 55

OmniCore/vlan=55> member 4 3 default add

OmniCore/vlan=55> member 7 2 default add

OmniCore/vlan=55> portlist show
Port Member List                          :4 – 3
                                           7 - 2
```

3. (Optional) Modify a VLAN’s name. When a VLAN is created, it is assigned a default name of VLAN-N (where N is the VLAN ID). The following example changes the name for VLAN 10.

```
OmniCore/vlan=55> ..

OmniCore> vlan 10 name Sales

OmniCore> vlan 10 name show
Name                                      :Sales
```

4. (Optional) Move ports from one VLAN to another. When adding a port to a VLAN, the port is removed from its previous VLAN. This example moves two ports from VLAN 55 to VLAN 20.

```
OmniCore> vlan 55 portlist show
Port Member List                          :4 – 3
                                           7 - 2

OmniCore> vlan 20

OmniCore/vlan=20> member 4 3 default add

OmniCore/vlan=20> member 7 2 default add

OmniCore/vlan=20> portlist show
Port Member List                          :4 – 3
                                           5 – 1,2
                                           7– 1,2


OmniCore/vlan=20> ..

OmniCore> vlan 55 portlist show
Port Member List                          :
```

5. (Optional) Delete any unwanted VLANs. If you will no longer be using a particular VLAN, you may want to delete it. Please note that a VLAN can be deleted only if there are no port members assigned to it. In step 4, all ports in VLAN 55 were moved to VLAN 20. VLAN 55 can therefore be deleted.

```
OmniCore> vlan 55 delete

OmniCore> vlan show
Id Tag State   Pri   Bcast-pri Flood-pri # Ports OperStat Name
-- --- -----   ---   --------- --------- -------  -------- ----
1  1   enable  deflt default   default   20      up       VLAN-1
10 10  enable  deflt default   default   2       down     Sales
20 20  enable  deflt default   default   5       down     VLAN-20
```

Once you have completed the desired steps above, you can then enable ports for tagging (see *802.1Q Tagging*) or modify a VLAN's priority values (see *Configuring Priority for VLANs* on page 3-11).

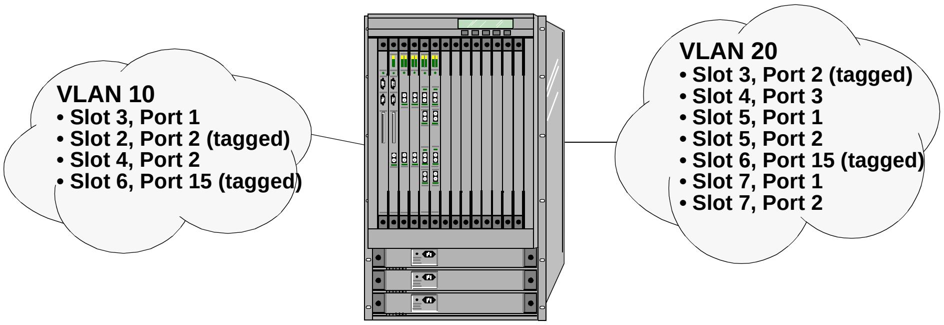
802.1Q Tagging

The use of 802.1Q tagging enables a switch to pass VLAN membership and priority information within each frame to another switch that supports tagging. Tagging a port allows it to be a member of multiple port-based VLANs. If a port is not tagged it can belong to only one port-based VLAN.

By default, tagging is disabled on all OmniCore routing switch ports. If a port is enabled for tagging, it will transmit tagged frames that have the appropriate VLAN membership and priority information embedded within the frames.

On the OmniCore routing switch, when an 802.1Q frame enters a tag-enabled port, the frame's priority takes precedence, unless it is tagged as priority 0. A priority value of 0 is treated as having no priority, and therefore the VLAN/port priority is used. The default VLAN/priority value is 0. For more information on priority, see *Configuring Priority for VLANs* on page 3-11.

Tagging is enabled on a per-port basis. The following figure shows two port-based VLANs with tagging enabled on some of their port members.



Example of Port-based VLANs with Tagging Enabled

For an example, follow these steps to enable tagging on the VLANs and ports shown in the preceding illustration.

1. Enable tagging on the desired ports.

```
OmniCore> gigabit 3 2 tagmode enable

OmniCore> ethernet 6 15 tagmode enable
```

2. Add the tagged ports to multiple VLANs.

```
OmniCore> vlan 10

OmniCore/vlan=10> member 3 2 default add

OmniCore/vlan=10> member 6 15 default add

OmniCore/vlan=10> portlist show
Port Member List                          :3 – 1,2
                                           4 – 2
                                           6 - 15

OmniCore> ..

OmniCore> vlan 20

OmniCore/vlan=20> member 6 15 default add

OmniCore/vlan=20> member 3 2 default add

OmniCore/vlan=20> portlist show
Port Member List                          :3 – 2
                                           4 – 3
                                           5 - 1,2
                                           6 - 15
                                           7 - 1,2
```

3. (Optional) Delete a tagged port. Tagged ports can simply be deleted from a VLAN as long as they have membership in at least one other VLAN.

```
OmniCore/vlan=20> member 3 2 delete

OmniCore/vlan=20> portlist show
Port Member List                          :4 – 3
                                           5 - 1,2
                                           6 - 15
                                           7 - 1,2
```

Configuring Protocol-Based VLANs

Protocol-based VLANs are used to build Layer 3 domains that include only the set of ports, which use a particular protocol or Ethertype. A protocol-based VLAN operates such that incoming packets of a particular protocol type are organized into a single logical grouping. Those ports that have been assigned membership to a protocol-based VLAN will receive all traffic identified with the VLAN's specified protocol.

For example, ports that have been assigned IP protocol membership will receive all IP traffic, ports that have been assigned AppleTalk protocol membership will receive all AppleTalk traffic, and so on.

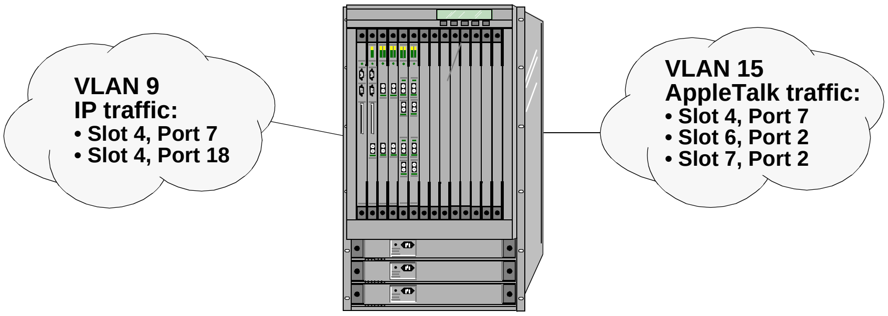
Protocol-based VLANs are layered on top of port-based VLANs such that traffic not belonging to the key protocols (i.e., IP, IPX, AppleTalk, or generic) is classified using port-based rules. Ports that use protocol-based VLAN membership cannot be tagged.

Basic Protocol-Based VLAN Management

Protocol-based VLAN membership may be assigned to ports with regard to the following types of traffic:

- Default (port will receive all traffic not classified as IP, IPX, AppleTalk, or generic)
- IP
- IPX
- AppleTalk
- Generic (see *Generic Protocol-Based VLAN Management* on page 3-9)

The following figure displays several different protocol-based VLANs operating within the OmniCore routing switch. Note that port 7 on slot 4 is assigned membership to both IP and AppleTalk traffic and is *not* tagged.



Example of Protocol-Based VLAN Interfaces within the OmniCore routing switch

Complete the following tasks to configure protocol-based VLANs.

- Create a VLAN.
- Add ports to the VLAN.
- (Optional) Modify the VLAN's name, move ports from one VLAN to another, or delete an unwanted VLAN.

Follow these steps to create the protocol-based VLANs shown in the preceding illustration.

1. Create the VLANs.

```
OmniCore> vlan 9 tag 9 create

OmniCore> vlan 15 tag 15 create
```

2. Add ports to the VLANs and specify their domain membership as default, IP, IPX, or AppleTalk. You must not enable tagging on a port if it is to become a member of multiple, protocol-based VLANs.

```
OmniCore> vlan 9

OmniCore/vlan=9> member 4 7 ip add

OmniCore/vlan=9> member 4 18 ip add

OmniCore/vlan=9> show
Vlan Id                                   :9
Vlan Current State                        :enable
Name                                      :VLAN-9
Tag                                       :9
Priority                                  :default
Broadcast Priority                        :default
Flood Priority                            :default
Oper Status                               :up
Port Member List                          :4 – 7,18


OmniCore/vlan=9> ..

OmniCore> vlan 15

OmniCore/vlan=15> member 4 7 appletalk add

OmniCore/vlan=15> member 6 2 appletalk add

OmniCore/vlan=15> member 7 2 appletalk add

OmniCore/vlan=15> member show
Slot   Port   Protocol      Status
----   ----   --------      ------
4      7      appletalk     active
6      2      appletalk     active
7      2      appletalk     active
```

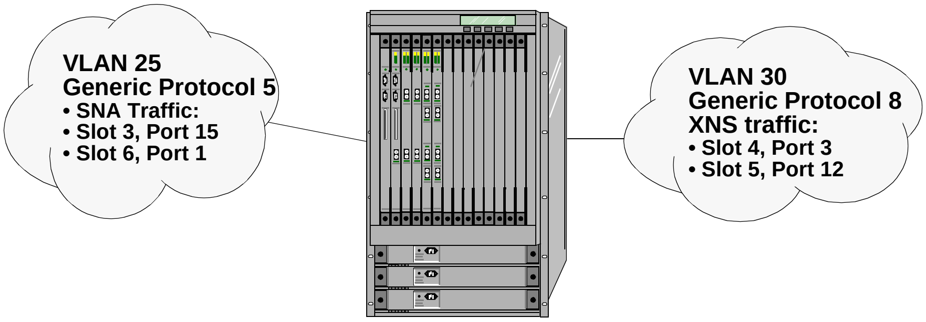
3. (Optional) Change a VLAN’s name, move ports from one VLAN to another, or delete an unwanted VLAN. The procedures for performing these tasks are identical to those for port-based VLANs. See steps 3-5 under *Basic Port-Based VLAN Management* on page 3-3.

Generic Protocol-Based VLAN Management

On the OmniCore routing switch, you may define up to eight additional VLAN protocol types, besides the standard IP, IPX, and AppleTalk protocol identifications. These additional memberships, known as generic (i.e., other user-specified) protocols, are based on a specified Ethertype and provide further flexibility when implementing protocol-based VLANs. The Ethertype determines the type of traffic (SNA, XNS, DECnet, etc.) that will be accepted by the VLAN.

Any port that is assigned membership to a generic protocol will receive all traffic associated with that protocol. For example, if generic protocol 3 has been defined for DECnet traffic, then ports assigned generic protocol 3 membership will receive all DECnet traffic.

The following figure shows several different generic protocols that could operated within an OmniCore routing switch.



Example of Generic Protocol-Based VLANs within the OmniCore routing switch

Complete the following tasks to configure generic protocol-based VLANs.

- Create the generic protocol instance by specifying its Ethertype code and name.
- Create a VLAN for the generic protocol.
- Assign generic protocol VLAN membership to the desired ports.
- (Optional) Change the generic protocol’s Ethertype code.
- (Optional) Change the generic protocol’s name.

Follow these steps to configure the generic protocol-based VLANs shown in the preceding illustration.

1. Create the generic protocol instance by specifying their Ethertype code and name.

```
OmniCore> generic-protocol 5 ethertype 80D5 name SNA

OmniCore> generic-protocol 5 show
Generic Id                               :5
Generic VLAN Proto Ethertype             :80D5
Generic VLAN Protocol Name               :SNA

OmniCore> generic-protocol 8 ethertype 0807 name XNS

OmniCore> generic-protocol 8 show
Generic Id                               :8
Generic VLAN Proto Ethertype             :0807
Generic VLAN Protocol Name               :XNS
```

2. Create a VLAN for each of the generic protocols.

```
OmniCore> vlan 25 tag 1 create

OmniCore> vlan 30 tag 3 create
```

3. Assign generic protocol VLAN membership to the desired ports.

```
OmniCore> vlan 25

OmniCore/vlan=25> member 3 15 gen5 add

OmniCore/vlan=25> member 6 1 gen5 add

OmniCore/vlan=25> member show
Slot   Port   Protocol      Status
----   ----   --------      ------
3      15     gen5          active
6      1      gen5          active


OmniCore/vlan=20> ..

OmniCore> vlan 30

OmniCore/vlan=30> member 4 3 gen8 add

OmniCore/vlan=30> member 5 12 gen8 add

OmniCore/vlan=30> member show
Slot   Port   Protocol      Status
----   ----   --------      ------
4      3      gen8          active
5      12     gen8          active
```

4. (Optional) Change a generic protocol’s Ethertype code.

```
OmniCore/vlan=30> ..

OmniCore> generic-protocol 8

OmniCore/generic-protocol=8> ethertype 6003

OmniCore/generic-protocol=8> ethertype show
Generic VLAN Proto Ethertype              :6003
```

5. (Optional) Change a generic protocol’s name.

```
OmniCore/generic-protocol=8> name “DECnet Building 5”

OmniCore/generic-protocol=8> name show
Generic VLAN Protocol Name                :DECnet Building 5
```

Configuring Priority for VLANs

Prioritization methods follow a hierarchy within the OmniCore routing switch, as described in *OmniCore Frame Prioritization* on page 1-37. The priorities assigned to VLANs (unless set to default) always supercede the priority within the 802.31p field of a frame or the priority assigned to the ingress port. As with port priority, VLAN priority is indicated to other switches via the 802.1p field on tag-enabled egress ports. Vlan priority can be assigned uniquely for unicast, broadcast, and flooded frames. VLAN priority can be defined as an integer from 0 (lowest) to 7 (highest) or as “default,” in which case the 802.1p or port priority is used.

The following example changes the priority (unicast), broadcast priority, and flood priority values for VLAN 20. When changing a VLAN’s priority value, you must first disable the VLAN, specify the desired priority, and then re-enable the VLAN.

```
OmniCore> vlan 20

OmniCore/vlan=20> disable

OmniCore/vlan=20> priority 3

OmniCore/vlan=20> bcast-priority 0

OmniCore/vlan=20> flood-priority 4

OmniCore/vlan=20> enable

OmniCore/vlan=20> show
Vlan Id                                   :20
Vlan Current State                        :enable
Name                                      :VLAN-20
Tag                                       :20
Priority                                  :3
Broadcast Priority                        :0
Flood Priority                            :4
Oper Status                               :up
Port Member List                          :4 – 3
                                           5 – 1,2
                                           6 - 15
                                           7 - 1,2
```

Queuing Mechanisms and PBQ

The OmniCore routing switch can service its eight-per-port priority-queues in three different ways: WFQ, Strict, and PBQ. WFQ (Weighted Fair Queuing) and Strict priority modes provide predefined settings for priority queue bandwidths, burst enabling, and burst bandwidth for the port. PBQ (Programmable Bandwidth Queuing) allows the user to modify the default WFQ settings for each of the eight individual priority queues.

WFQ and Strict Mode

The WFQ and Strict modes provide pre-configured queue bandwidths, burst enabling, and burst bandwidth for a port, as described below.

In **WFQ mode**, the highest priority queue (7) receives the highest ratio of servicing time with each of the lower priority queues receiving approximately half the bandwidth of the preceding queue, as shown in the table below. Note that the values for each queue are expressed in bandwidth “increments,” each increment representing 1.488 Mbits/s. Thus, Total Increments * 1.488 = Total bandwidth for the module.

	-------------Priority Queue-------------								
Interface Module	7	6	5	4	3	2	1	0	Total Increments (Bandwidth)
Gigabit Ethernet	336	168	84	42	21	11	6	4	672 (1000 Mbits/s)
POS OC12	208	105	52	26	13	7	4	2	417 (622 Mbits/s)
POS OC3	52	26	13	6	3	2	1	1	104 (155 Mbits/s)
FDDI	28	14	7	4	2	2	1	1	59 (88-100 Mbits/s)

In addition, WFQ sets the port burst to the maximum possible port bandwidth, and enables “burst” on all priority queues for the port.

In **Strict mode**, lower priorities will pass traffic only if the higher priorities have no traffic to send. All queues have a maximum port bandwidth based on the total increments available for the module type.

PBQ (Programmable Bandwidth Queuing) Mode

✧ Interface Module with a GPM2! ✧

PBQ mode is only available if the port you are configuring is on a later generation interface module. This module must contain a GPM2 ASIC chip. See *Interface Modules Part Numbers* on page C-10 for a list of interface modules and the ASIC chipsets they support.

In PBQ mode, you can individually configure the bandwidth for each of the eight priority queues of the interface module’s ports using the *port egress-priority* commands. You should not exceed the total bandwidth limit for the type of interface module being configured, as shown below.

Interface Module	Total Increments (Bandwidth)
Gigabit Ethernet	672 (1000 Mbits/s)
POS OC12	417 (622 Mbits/s)
POS OC3	104 (155 Mbits/s)
FDDI	59 (88-100 Mbits/s)

PBQ Commands

The PBQ port commands in the OmniCore CLI are listed in the following table. To see a complete list of these commands or for more information regarding the commands used in this chapter, see the *OmniCore CLI Reference Manual*.

PBQ Port Commands

Command	Default	Description
port burst-bandwidth	672	Sets the egress burst bandwidth allocated for a port. Expressed in increments of 1.488 Mbits/s.
port egress-priority bandwidth	varies depending on queuing mode	Sets the bandwidth allocation for an egress queue.
port egress-priority burst	enable	Enables or disables burst status for an egress priority queue.
port egress-priority de-lower	zero	Sets the percentage of total queue size defining the discard eligible PBN lower watermark.
port egress-priority de-upper	zero	Sets the percentage of total queue size defining the discard eligible PBN upper watermark.
port queuing-mode	wfq	Sets the egress bandwidth queuing mode for a port.

The PBQ POS commands in the OmniCore CLI are listed below. These commands operate identically to the port-based commands described above.

- pos burst-bandwidth
- pos egress-priority bandwidth
- pos egress-priority burst
- pos egress-priority de-lower
- pos egress-priority de-upper
- pos queuing-mode

The PBQ FDDI commands in the OmniCore CLI are listed below. These commands operate identically to the port-based commands described above.

- fddi burst-bandwidth
- fddi egress-priority bandwidth
- fddi egress-priority burst
- fddi egress-priority de-lower
- fddi egress-priority de-upper
- fddi queuing-mode

Configuring PBQ

Follow these steps to configure PBQ for a port.

1. Select the port whose egress queues you wish to configure. Note that the default Egress Bandwidth Queuing Mode is WFQ.

```
OmniCore> slot 4 port 2
```

```
OmniCore/slot=4/port=2> show
   Port Number                     :2
   Admin Status                    :enable
   MAC Address                     :00:E0:B1:45:25:81
   Vlan Tag Mode                   :disable
   Priority                        :0
   Flow Control                    :disable
   Port Type                       :gig
   Mirror Mode                     :ingress
   Mirror Status                   :disable
   Link Status                     :down
   Vlans This Port Belongs To      :1
   Ingress Bandwidth Limit Mode    :ingress
   Ingress Bandwidth Limit         :0
   Ingress Broadcast Limit         :0
   Jumbo Capable                   :no
   Egress Bandwidth Queuing Mode   :wfq
   Bandwidth Per Increment         :1.488 Mbps
   Bandwidth Increments for Bursts :672
   Bandwidth Allocated to Bursts   :(672 * 1.488 Mbps = 1000 Mbps)
```

❖ Measuring Bandwidth ❖

Port bandwidth is measured in increments of 1.488 Mbps. The total bandwidth for the gigabit ethernet port in the example above is 672 increments or 1000 Mbps. This calculation is made on Bandwidth Allocated to Bursts parameter.

2. Set the queuing mode for a selected port to “pbq”.

```
OmniCore/slot=4/port=2> queuing-mode pbq
```

❖ Valid PBQ Ports ❖

You can configure PBQ only on Gigabit, POS, and FDDI ports and only on those interface modules containing a GPM2 ASIC chip. Otherwise, this message is displayed: “Queuing mode is not valid for this card type.” See *Interface Modules Part Numbers* on page C-10 for a list of interface modules and the ASIC chipsets they support.

3. Display the current settings for each of the priority queues for this port. Note the default WFQ bandwidth values and that burst status is enabled for each queue.

```
OmniCore/slot=4/port=2> egress-priority show
```

```
Port  Pri  Burst    DE-Lower  DE-Upper  Bandwidth (Increment * Base)
----  ---  -------- --------  --------  ------------------------------
2     0    enable   0         0         (  4 * 1.488 Mbps = 5.952 Mbps)
2     1    enable   0         0         (  6 * 1.488 Mbps = 8.928 Mbps)
2     2    enable   0         0         ( 11 * 1.488 Mbps = 16.36 Mbps)
2     3    enable   0         0         ( 21 * 1.488 Mbps = 31.25 Mbps)
2     4    enable   0         0         ( 42 * 1.488 Mbps = 62.50 Mbps)
2     5    enable   0         0         ( 84 * 1.488 Mbps = 125.0 Mbps)
2     6    enable   0         0         (168 * 1.488 Mbps = 250.0 Mbps)
2     7    enable   0         0         (336 * 1.488 Mbps = 500.0 Mbps)
   Number of Entries Displayed: 8
```

4. Modify the bandwidth for each queue as desired. Note how the bandwidth is recalculated for the new settings with each show command.

```
OmniCore/slot=4/port=2> egress-priority 7

OmniCore/slot=4/port=2/egress-priority=7> bandwidth 200

OmniCore/slot=4/port=2/egress-priority=7> show
   Priority             :7
   Bandwidth            :200
   Queue Bandwidth Rate :(200 * 1.488 Mbps = 297.6 Mbps)
   Burst Status         :enable
   DE Watermark Lower   :0
   DE Watermark Upper   :0

OmniCore/slot=4/port=2/egress-priority=7> ..

OmniCore/slot=4/port=2> egress-priority 6 bandwidth 100

OmniCore/slot=4/port=2> egress-priority 5 bandwidth 100

OmniCore/slot=4/port=2> egress-priority show

Port  Pri  Burst     DE-Lower  DE-Upper  Bandwidth (Increment * Base)
----  ---  --------  --------  --------  -------------------------------
2     0    enable    0         0         (  4 * 1.488 Mbps = 5.952 Mbps)
2     1    enable    0         0         (  6 * 1.488 Mbps = 8.928 Mbps)
2     2    enable    0         0         ( 11 * 1.488 Mbps = 16.36 Mbps)
2     3    enable    0         0         ( 21 * 1.488 Mbps = 31.25 Mbps)
2     4    enable    0         0         ( 42 * 1.488 Mbps = 62.50 Mbps)
2     5    enable    0         0         (100 * 1.488 Mbps = 148.8 Mbps)
2     6    enable    0         0         (100 * 1.488 Mbps = 148.8 Mbps)
2     7    enable    0         0         (200 * 1.488 Mbps = 297.6 Mbps)
   Number of Entries Displayed: 8
```