CHAPTER 17

Configuring Layer 2 Local Switching

The Layer 2 Local Switching feature allows you to switch Layer 2 data between two physical or virtual interfaces of the same type on the same router. The interfaces can be on the same line card or on two different line cards. In local switching, the Layer 2 address is used, not a Layer 3 address.

Local switching can be used by incumbent local exchange carriers (ILECs) who use an interexchange carrier (IXC) to carry traffic between two local exchange carriers. Telecom regulations require the ILECs to pay the IXCs to carry that traffic. At times, the ILECs cannot terminate customer connections that are in different local access and transport areas (LATAs). In other cases, customer connections terminate in the same LATA, which may also be on the same router.

For example, Company A has more than 50 LATAs across the country and uses three routers for each LATA. Company A uses Companies B and C to carry traffic between local exchange carriers. Local switching of Layer 2 frames on the same router might be required.

The Layer 2 Local Switching feature is described in the following topics:

Feature History for Layer 2 Local Switching

Cisco IOS Release	Description	Required PRE
12.2(28)SB	This feature was introduced on the Cisco 10000 series router.	PRE2
12.2(31)SB2	This feature was enhanced to provide Ethernet to VLAN over AToM (Bridged) functionality and support for the PRE3.	PRE3

Restrictions for Layer 2 Local Switching

The Layer 2 Local Switching feature is supported only between:

- PVCs on ATM interfaces in AAL5 SDU mode
- Frame Relay interfaces

Standards

Standards[1]	Title
draft-ietf-ppvpn-l2vpn-00.txt	*An Architecture for L2VPNs*

1. Not all supported standards are listed.

MIBs

The Cisco Frame Relay Management Information Base (MIB) adds extensions to the standard Frame Relay MIB (RFC 1315). It provides additional link-level and virtual circuit-level information and statistics that are mostly specific to Cisco Frame Relay implementation. This MIB provides Simple Network Management Protocol (SNMP) network management access to most of the information covered by the **show frame-relay** commands, such as **show frame-relay lmi**, **show frame-relay pvc**, **show frame-relay map**, and **show frame-relay svc**.

Configuring ATM-to-ATM PVC Local Switching

The following ATM line cards are supported for Cisco 10000 series routers:

- 4-Port OC-3/STM-1
- 8-Port E3/DS3
- 1-Port OC-12

To configure ATM-to-ATM PVC local switching, enter the following commands, beginning in global configuration mode:

	Command	Purpose
Step 1	`Router(config)# interface atm slot/port`	Specifies an ATM interface and enters interface configuration mode.
Step 2	`Router(config-if)# pvc vpi/vci l2transport`	Assigns a virtual path identifier (VPI) and virtual channel identifier (VCI). The **l2transport** keyword indicates that the permanent virtual circuit (PVC) is a switched PVC instead of a terminated PVC.

	Command	Purpose
Step 3	`Router(cfg-if-atm-l2trans-pvc)# encapsulation layer-type`	Specifies the encapsulation type for the PVCs, AAL5 is the only layer type supported. Repeat Steps 1, 2, and 3 for another ATM PVC on the same router.
Step 4	`Router(config)# connect connection-name interface pvc interface pvc`	Creates a local connection between the two specified PVCs.

Example 17-1 shows how to enable ATM AAL5 SDU mode Layer 2 local switching.

Example 17-1 Enabling ATM AAL5 SDU Mode Layer 2 Local Switching

```
interface atm 1/0/0
   pvc 0/100 l2transport
     encapsulation aal5

interface atm 2/0/0
   pvc 0/50 l2transport
     encapsulation aal5

connect conn1 atm 1/0/0 0/100 atm 2/0/0 0/50
```

Configuring OAM Cell Emulation for Layer 2 Local Switching

If a provider edge (PE) router does not support the transport of Operation, Administration, and Maintenance (OAM) cells across a Link State Protocol (LSP) data unit, you can use OAM cell emulation to locally terminate or loop back the OAM cells. You configure OAM cell emulation on both PE routers, which emulates a VC by forming two unidirectional LSPs. You use the **oam-ac emulation-enable** and **oam-pvc manage** commands on both PE routers to enable OAM cell emulation.

After you enable OAM cell emulation on a router, you can configure and manage the ATM VC in the same manner as you would a terminated VC. A VC that has been configured with OAM cell emulation can send loopback cells at configured intervals toward the local customer edge (CE) router.

The endpoint can be either of the following:

- End-to-end loopback, which sends OAM cells to the local CE router.
- Segment loopback, which responds to OAM cells to a device along the path between the PE and CE routers.

The OAM cells include the following:

- Alarm indication signal (AIS)
- Remote defect indication (RDI)

These cells identify and report defects along a VC. When a physical link or interface failure occurs, intermediate nodes insert OAM AIS cells into all the downstream devices affected by the failure. When a router receives an AIS cell, it marks the ATM VC down and sends an RDI cell to let the remote end know about the failure.

Note For AAL5 over Multiprotocol Label Switching (MPLS), you can configure the **oam-pvc manage** command only after you issue the **oam-ac emulation-enable** command.

You can configure OAM cell emulation for ATM AAL5 SDU support over MPLS in the following ways:

- Configuring OAM Cell Emulation for ATM AAL5 SDU Support over MPLS on PVCs, page 17-4
- Configuring OAM Cell Emulation for ATM AAL5 SDU Support over MPLS in VC Class Configuration Mode, page 17-6

Configuring OAM Cell Emulation for ATM AAL5 SDU Support over MPLS on PVCs

To configure OAM cell emulation for ATM AAL5 SDU support over MPLS on a PVC, enter the following commands, beginning in global configuration mode:

	Command	Purpose
Step 1	`Router(config)# interface type slot/port`	Specifies the interface by type, slot, and port number, and enters interface configuration mode.
Step 2	`Router(config-if)# pvc [name] vpi/vci l2transport`	Creates or assigns a name to an ATM PVC and enters L2 Transport VC configuration mode. The **l2transport** keyword indicates that the PVC is a switched PVC instead of a terminated PVC.
Step 3	`Router(config-if-atm-l2trans-pvc)# encapsulation aal5`	Specifies ATM AAL5 encapsulation for the PVC. Make sure you specify the same encapsulation type on the PE and CE routers.
Step 4	`Router(config-if-atm-l2trans-pvc)# xconnect peer-router-id vcid encapsulation mpls`	Binds the attachment circuit to a pseudowire VC.
Step 5	`Router(config-if-atm-l2trans-pvc)# oam-ac emulation-enable [ais-rate]`	Enables OAM cell emulation for AAL5 over MPLS. The *ais-rate* variable lets you specify the rate at which AIS cells are sent. The range is 0 to 60 seconds. The default is 1 second, which means that one AIS cell is sent every second.
Step 6	`Router(config-if-atm-l2trans-pvc)# oam-pvc manage [frequency]`	Enables the PVC to generate end-to-end OAM loopback cells that verify connectivity on the virtual circuit. The optional *frequency* variable is the interval between the transmission of loopback cells and ranges from 0 to 600 seconds. The default is 10 seconds.

Example 17-2 shows how to enable OAM cell emulation on an ATM PVC.

Example 17-2 Enabling OAM Cell Emulation on an ATM PVC

```
interface ATM 1/0/0
pvc 1/200 l2transport
encapsulation aal5
xconnect 13.13.13.13 100 encapsulation mpls
oam-ac emulation-enable
oam-pvc manage
```

Example 17-3 shows how to set the rate at which an AIS cell is sent to every 30 seconds.

Example 17-3 Setting the AIS Send Rate in OAM Cell Emulation on an ATM PVC

```
interface ATM 1/0/0
pvc 1/200 l2transport
encapsulation aal5
xconnect 13.13.13.13 100 encapsulation mpls
oam-ac emulation-enable 30
oam-pvc manage
```

Verifying OAM Cell Emulation on an ATM PVC

In Example 17-4, the **show atm pvc** command shows that OAM cell emulation is enabled on the ATM PVC.

Example 17-4 OAM Cell Emulation Is Enabled

```
Router# show atm pvc 5/500

ATM4/1/0.200: VCD: 6, VPI: 5, VCI: 500
UBR, PeakRate: 1
AAL5-LLC/SNAP, etype:0x0, Flags: 0x34000C20, VCmode: 0x0
OAM Cell Emulation: enabled, F5 End2end AIS Xmit frequency: 1 second(s)
OAM frequency: 0 second(s), OAM retry frequency: 1 second(s)
OAM up retry count: 3, OAM down retry count: 5
OAM Loopback status: OAM Disabled
OAM VC state: Not ManagedVerified
ILMI VC state: Not Managed
InPkts: 564, OutPkts: 560, InBytes: 19792, OutBytes: 19680
InPRoc: 0, OutPRoc: 0
InFast: 4, OutFast: 0, InAS: 560, OutAS: 560
InPktDrops: 0, OutPktDrops: 0
CrcErrors: 0, SarTimeOuts: 0, OverSizedSDUs: 0
Out CLP=1 Pkts: 0
OAM cells received: 26
F5 InEndloop: 0, F5 InSegloop: 0, F5 InAIS: 0, F5 InRDI: 26
OAM cells sent: 77
F5 OutEndloop: 0, F5 OutSegloop: 0, F5 OutAIS: 77, F5 OutRDI: 0
OAM cell drops: 0
Status: UP
```

Example 17-5 shows the output of the **show connection** command.

Example 17-5 Output of the show connection Command

```
Router# show connection

ID Name          Segment 1              Segment 2              State
=================================================================
2 atm_conn_1     AT6/0/0.1 AAL5 1/100   AT6/0/1.1 AAL5 1/100   UP
```

Example 17-6 shows that the ATM PVCs are up.

Example 17-6 Output of the show atm pvc Command

```
Router# show atm pvc

            VCD/                                          Peak    Avg/Min   Burst
Interface   Name   VPI   VCI   Type   Encaps       SC    Kbps    Kbps      Cells     Sts
6/0/0.1     4      1     100   PVC    AAL5         UBR   149760                      UP
6/0/1.1     2      1     100   PVC    AAL5         UBR   149760                      UP
```

Configuring OAM Cell Emulation for ATM AAL5 SDU Support over MPLS in VC Class Configuration Mode

The following steps explain how to configure OAM cell emulation as part of a VC class. You can then apply the VC class to an interface, a subinterface, or a VC. When you configure OAM cell emulation in VC class configuration mode and then apply the VC class to an interface, the settings in the VC class apply to all the VCs on the interface; unless you specify a different OAM cell emulation value at a lower level, such as the subinterface or VC level.

For example, you can create a VC class that specifies OAM cell emulation and sets the rate of AIS cells to every 30 seconds. You can apply the VC class to an interface. Then, for one PVC, you can enable OAM cell emulation and set the rate of AIS cells to every 15 seconds. All the PVCs on the interface use the cell rate of 30 seconds, except for the one PVC that was set to 15 seconds.

To enable OAM cell emulation as part of a VC class and apply it to an interface, enter the following commands, beginning in global configuration mode:

	Command	Purpose
Step 1	`Router(config)# vc-class atm` *name*	Creates a VC class and enters VC class configuration mode.
Step 2	`Router(config-vc-class)# encapsulation` *layer-type*	Configures the AAL5 and encapsulation type.
Step 3	`Router(config-vc-class)# oam-ac emulation-enable` [*ais-rate*]	Enables OAM cell emulation for AAL5 over MPLS. The *ais-rate* variable lets you specify the rate at which AIS cells are sent. The range is 0 to 60 seconds. The default is 1 second, which means that one AIS cell is sent every second.
Step 4	`Router(config-vc-class)# oam-pvc manage` [*frequency*]	Enables the PVC to generate end-to-end OAM loopback cells that verify connectivity on the virtual circuit. The optional *frequency* variable is the interval between transmission of loopback cells and ranges from 0 to 600 seconds. The default is 10 seconds.
Step 5	`Router(config-vc-class)# exit`	Returns to global configuration mode.
Step 6	`Router(config)# interface` *type slot/port*	Specifies the interface by type, slot, and port number, and enters interface configuration mode.

Step 7	`Router(config-if)# class-int vc-class-name`	Applies a VC class to the ATM main interface or subinterface. **Note** You can also apply a VC class to a PVC.
Step 8	`Router(config-if)# pvc [name] vpi/vci l2transport`	Creates or assigns a name to an ATM PVC and enters L2 Transport VC configuration mode. The **l2transport** keyword indicates that the PVC is a switched PVC instead of a terminated PVC.
Step 9	`Router(config-if-atm-l2trans-pvc)# xconnect peer-router-id vcid encapsulation mpls`	Binds the attachment circuit to a pseudowire VC.

Example 17-7 configures OAM cell emulation for ATM AAL5 SDU support over MPLS in VC class configuration mode. The VC class is then applied to an interface.

Example 17-7 Enabling OAM Cell Emulation for ATM AAL5 SDU Support over MPLS in VC Class Configuration Mode—VC Class Applied to an Interface with an AIS Rate of 30

```
vc-class atm oamclass
encapsulation aal5
oam-ac emulation-enable 30
oam-pvc manage
interface atm1/0
class-int oamclass
pvc 1/200 l2transport
xconnect 13.13.13.13 100 encapsulation mpls
```

Example 17-8 configures OAM cell emulation for ATM AAL5 over MPLS in VC class configuration mode. The VC class is then applied to a PVC.

Example 17-8 Enabling OAM Cell Emulation for ATM AAL5 SDU Support over MPLS in VC Class Configuration Mode—VC Class Applied to a PVC

```
vc-class atm oamclass
encapsulation aal5
oam-ac emulation-enable 30
oam-pvc manage
interface atm1/0
pvc 1/200 l2transport
class-vc oamclass
xconnect 13.13.13.13 100 encapsulation mpls
```

Example 17-9 configures OAM cell emulation for ATM AAL5 over MPLS in VC class configuration mode. The VC class is then applied to an interface. One PVC is configured with OAM cell emulation at an AIS rate of 10. That PVC uses the AIS rate of 10 instead of 30.

Example 17-9 Enabling OAM Cell Emulation for ATM AAL5 SDU Support over MPLS in VC Class Configuration Mode—VC Class Applied to an Interface with an AIS Rate of 10

```
vc-class atm oamclass
encapsulation aal5
oam-ac emulation-enable 30
oam-pvc manage
interface atm1/0
class-int oamclass
pvc 1/200 l2transport
```

```
oam-ac emulation-enable 10
xconnect 13.13.13.13 100 encapsulation mpls
```

Configuring Frame Relay-to-Frame Relay Local Switching

Frame Relay switching is a means of switching packets based upon the data link connection identifier (DLCI), which can be looked upon as the Frame Relay equivalent of a MAC address. You perform the switching by configuring your router or access server as a Frame Relay network. There are two parts to a Frame Relay network: the Frame Relay data terminal equipment (DTE) (the router or access server) and the Frame Relay data communications equipment (DCE) switch.

Local switching allows you to switch Layer 2 data between two interfaces of the same type for example, ATM-to-ATM, or Frame-Relay-to-Frame-Relay.

For background information about Frame-Relay-to-Frame-Relay Local Switching, see the *Distributed Frame Relay Switching* feature guide.

You can switch between virtual circuits on the same port, as detailed in the "Configuring Frame Relay Same-Port Switching" section on page 17-9.

The following channelized line cards are supported for the Cisco 10000 series routers:

- 1-Port Channelized OC-12/STM-4
- 4-Port Channelized OC-3/STM-1
- 6-Port Channelized T3
- 24-Port Channelized E1/T1

The following packet over SONET line cards are supported for the Cisco 10000 series routers:

- 1-Port OC-12 Packet over SONET
- 1-Port OC-48/STM-16 Packet over SONET
- 6-Port OC-3/STM-1 Packet over SONET

The Frame Relay-to-Frame Relay Local Switching feature is described in the following topics:

Configuring Frame Relay for Local Switching

To configure Frame Relay for local switching, enter the following commands, beginning in global configuration mode.

	Command	Purpose
Step 1	`Router(config)# frame-relay switching`	Enables Permanent Virtual Circuits (PVCs) switching on a Frame Relay DCE device or a Network-to-Network Interface (NNI).
Step 2	`Router(config)# interface type number`	Specifies an interface and enters interface configuration mode.

	Command	Purpose
Step 3	`Router(config-if)# encapsulation frame-relay [cisco | ietf]`	Enables Frame Relay encapsulation. • **cisco**—Cisco's own encapsulation (default) • **ietf**—Internet Engineering Task Force (IETF) standard (RFC 1490). Use this keyword when connecting to another vendor's equipment across a Frame Relay network.
Step 4	`Router(config-if)# frame-relay interface-dlci dlci switched`	(Optional) Creates a switched PVC and enters Frame Relay DLCI configuration mode. Repeat Step 1 through Step 4 for each switched PVC. If you do not create a Frame Relay PVC in this step, it is automatically created in Step 6 by the **connect** command.
Step 5	`Router(config-fr-dlci)# exit`	Exits Frame Relay DLCI configuration mode and returns to global configuration mode.
Step 6	`Router(config)# connect connection-name interface dlci interface dlci`	Defines a connection between Frame Relay PVCs.

Example 17-10 configures Frame-Relay-to-Frame-Relay for local switching.

Example 17-10 Configuring Frame Relay-to-Frame Relay for Local Switching

```
frame-relay switching
interface serial 1/0/0.1/1:0
encapsulation frame-relay
frame-relay interface-dlci 100 switched
exit
connect connection1 serial1/0/0.1/1:0 100 serial2/0/0.1/2:0 101
```

Configuring Frame Relay Same-Port Switching

Use the following steps to configure local Frame Relay same-port switching on a single interface, beginning in global configuration mode.

	Command	Purpose
Step 1	`Router(config)# frame-relay switching`	Enables PVC switching on a Frame Relay DCE device or a NNI.
Step 2	`Router(config)# interface type number`	Specifies the interface and enters interface configuration mode.
Step 3	`Router(config-if)# encapsulation frame-relay [cisco | ietf]`	Enables Frame Relay encapsulation. • **cisco**—Cisco's own encapsulation (default) • **ietf**—Internet Engineering Task Force (IETF) standard (RFC 1490). Use this keyword when connecting to another vendor's equipment across a Frame Relay network.

	Command	Purpose
Step 4	`Router(config-if)# frame-relay intf-type {dce | dte | nni}`	(Optional) Enables support for a particular type of connection. • **dce**—data communications equipment • **dte**—data terminal equipment • **nni**—network-to-network interface
Step 5	`Router(config-if)# frame-relay interface-dlci dlci switched`	(Optional) Creates a switched PVC and enters Frame Relay DLCI configuration mode. Repeat Step 1 through Step 5 for each switched PVC. If you do not create a Frame Relay PVC in this step, it is automatically created in Step 8 by the **connect** command.
Step 6	`Router(config-fr-dlci)# exit`	Exits Frame Relay DLCI configuration mode and returns to interface configuration mode.
Step 7	`Router(config-if)# exit`	Exits interface configuration mode and returns to global configuration mode.
Step 8	`Router(config)# connect connection-name interface dlci interface dlci`	Defines a connection between the two data links.

Example 17-11 configures Frame Relay same-port switching.

Example 17-11 Configuring Frame Relay Same-Port Switching

```
frame-relay switching
interface serial 1/0/0.1/1:0
encapsulation frame-relay
frame-relay intf-type nni
frame-relay interface-dlci 100 switched
exit
exit
connect connection1 serial1/0 100 serial1/0 200
```

Verifying Layer 2 Local Switching for Frame Relay

To verify configuration of the Layer 2 Local Switching feature, use the **show connection frame-relay-to-frame-relay** command and the **show frame-relay pvc** command in privileged EXEC mode.

Example 17-12 shows the output of the **show connection frame-relay-to-frame-relay** command, which displays the local connection between a Frame Relay interface and a Frame Relay local switching interface.

Example 17-12 Output of the show connection frame-relay-to-frame-relay Command

```
Router# show connection frame-relay-to-frame-relay
ID  Name            Segment 1              Segment 2           State
=====================================================================
1   fr2fr           Se3/0/0.1/1:0 100       Se3/0/0.1/2:0 200  UP
```

Example 17-13 shows the output of the **show frame-relay pvc** command, which shows a switched Frame Relay PVC.

Example 17-13 Output of the show frame-relay pvc Command

```
Router# show frame-relay pvc 16
PVC Statistics for interface POS5/0 (Frame Relay NNI)
DLCI = 16, DLCI USAGE = SWITCHED, PVC STATUS = UP, INTERFACE = POS5/0
LOCAL PVC STATUS = UP, NNI PVC STATUS = ACTIVE
input pkts 0 output pkts 0 in bytes 0
out bytes 0 dropped pkts 100 in FECN pkts 0
in BECN pkts 0 out FECN pkts 0 out BECN pkts 0
in DE pkts 0 out DE pkts 0
out bcast pkts 0 out bcast bytes 0
switched pkts 0
Detailed packet drop counters:
no out intf 0 out intf down 100 no out PVC 0
in PVC down 0 out PVC down 0 pkt too big 0
pvc create time 00:25:32, last time pvc status changed 00:06:31
```

Configuring QoS Features

For information about configuring QoS features on the Cisco 10000 series router, see the *Cisco 10000 Series Router Quality of Service Configuration Guide*.

Table 17-1 and Table 17-2 outline the level of support for modular QoS CLI (MQC) commands as they relate to Frame Relay DLCI interfaces.

The values shown in the tables are as follows:

- No—You cannot perform this policy map action
- Yes—You can perform this policy map action
- N/A (not applicable)—You can apply the policy map action but it will not have any effect on packets

Table 17-1 Frame Relay DLCI Input Policy Map Actions

Policy Map Actions	Frame Relay DLCI Interface
bandwidth	no
queue-limit	no
priority	no
shape	no
random-detect	no
set ip prec/dscp	N/A
set qos-group	yes
set discard class	yes
set atm-clp	N/A
set fr-de	no
set cos	no
police	yes

Table 17-1 Frame Relay DLCI Input Policy Map Actions

Policy Map Actions	Frame Relay DLCI Interface
set mpls-exp topmost	N/A
set mpls-exp imposition	N/A

Table 17-2 Frame Relay Output (Disposition Router) Policy Map Actions

Policy Map Actions	Frame Relay DLCI Interface
bandwidth	yes
queue-limit	yes
priority	yes
shape	yes
random-detect	yes (discard class only)
set ip prec/dscp	N/A
set qos-group	N/A
set discard class	yes
set atm-clp	no
set fr-de	not supported
set cos	no
police	yes
set mpls-exp topmost	N/A

Monitoring and Maintaining Layer 2 Local Switching

To monitor and maintain the configuration of the Layer 2 Local Switching feature, use the following commands in privileged EXEC mode.

Command	Description
show atm pvc	Displays ATM permanent virtual circuits (PVCs) and traffic information.
show connection	Displays configured connections.
show connection frame-relay-to-frame-relay	Displays the local connection between a Frame Relay interface and a Frame Relay local switching interface.
show frame-relay pvc	Displays a switched Frame Relay PVC.
debug atm l2transport	Displays information related to the operation of ATM over MPLS.

Command	Description
debug conn	Displays information from the connection manager, time-division multiplexing (TDM) and digital signal processor (DSP) clients.
debug frame-relay pseudowire	Displays information from the Frame Relay attachment circuit in Layer 2 VPN pseudowire redundancy.

Caution Because debugging output is assigned high priority in the CPU process, it can render the system unusable. For this reason, use debug commands only to troubleshoot specific problems or during troubleshooting sessions with Cisco Systems technical support personnel. It is best to use debug commands during periods of lower network traffic and fewer users. Debugging during these periods decreases the likelihood that increased debug command processing overhead will affect system use.