39 Multi-Protocol Over ATM (MPOA)

Introduction

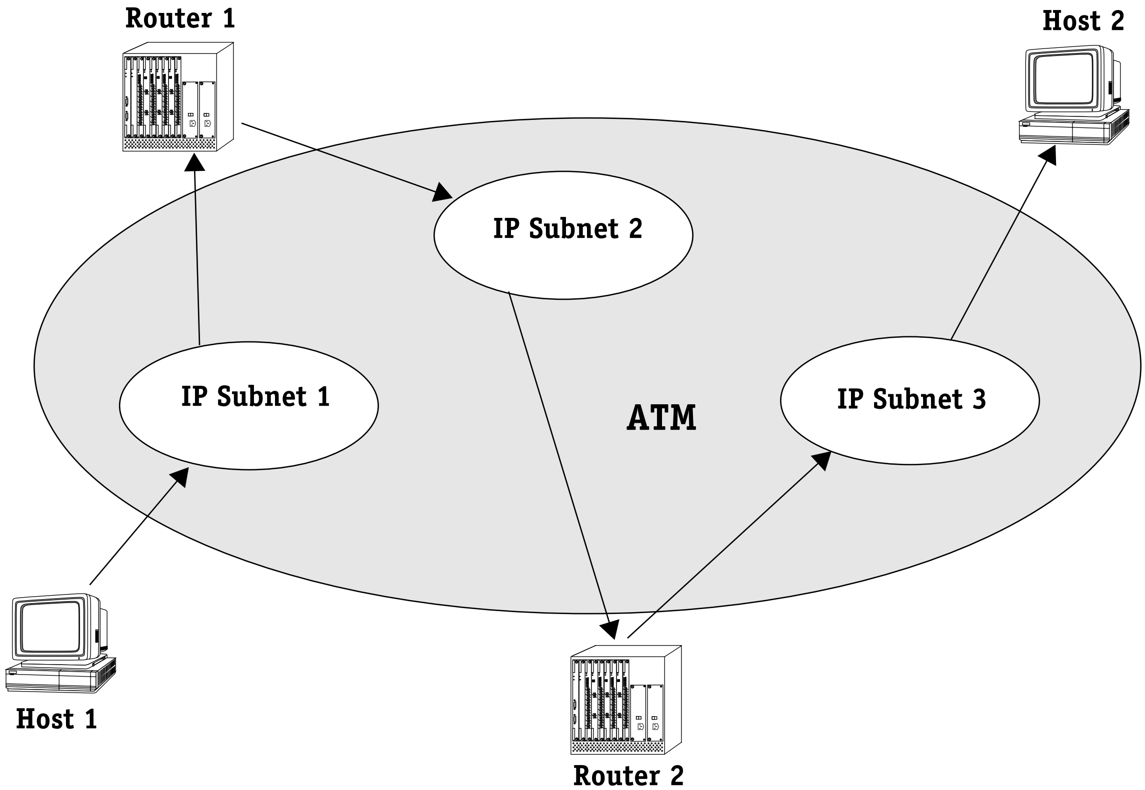
Multi-Protocol Over ATM (MPOA) eliminates problems with latency and increases throughput by reducing router hops in an IP or IPX network. In an MPOA based network, routing functionality is only required at the MPOA Server, hence reducing the number of devices participating in the routed network and reducing the need for complex configurations.

In regular router networks, each network device must participate in routing updates. Bringing routing functionality to the edge of the network increases configuration complexity and limits network scalability, since multiple devices participate in routing network traffic. An MPOA network is not required to participate in the routing functionality.

As a result, MPOA delivers manageable routing functionality in multi-gigabit networks by enabling existing and new applications to use the maximum available capacity in that network.

Network Functionality and MPOA

In an IP (or IPX) network, the path between a source network or host, and a destination network or host, can include multiple routed hops. In a routed network across ATM, additional latency is introduced when each router hop performs a frame-to-cell and cell-to-frame conversion. Due to the increased latency, router hops are a potential bottleneck. The following diagram demonstrates how Host 1 sends traffic in an IP network through two separate routers in order to communicate with Host 2:



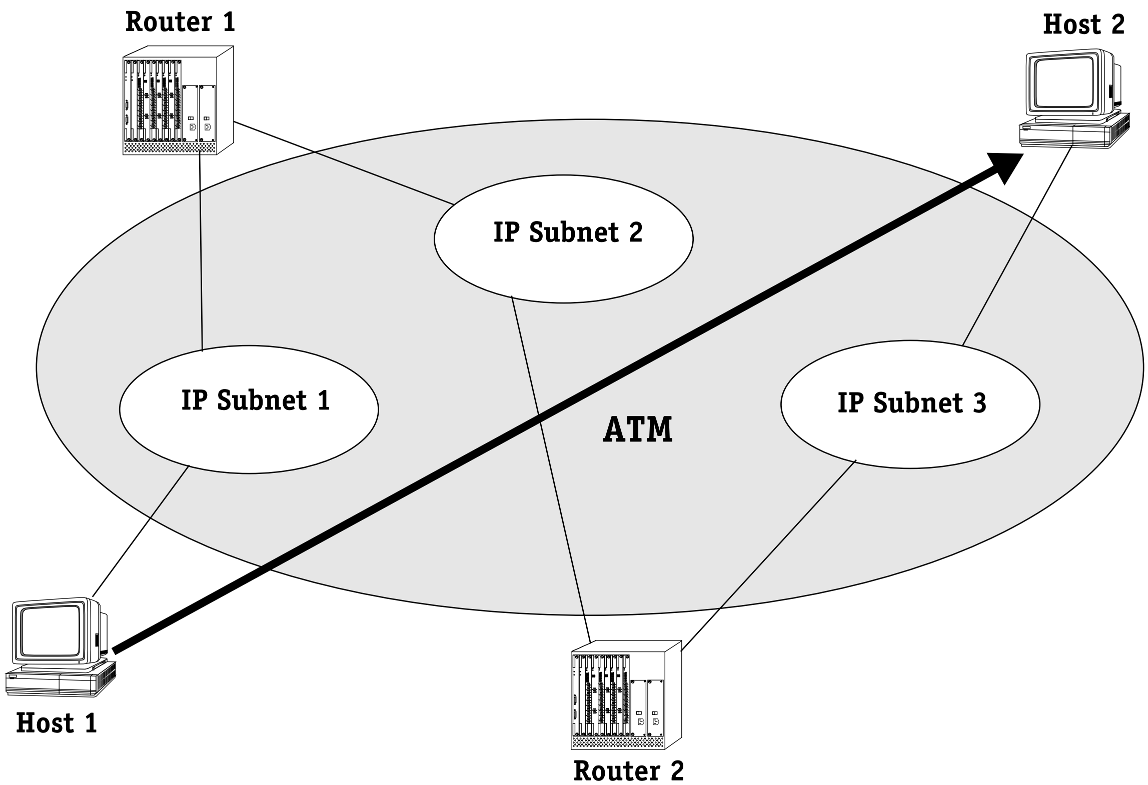
Traditional IP Routed Network

When Host 1 sends traffic to Host 2, it must go through Subnet 1, be routed by Router 1 to Subnet 2, be routed by Router 2 to Subnet 3, where it final is passed to Host 2. This process gets very complicated as more subnets are added to the network.

♦ Note ♦

Though these diagrams show an IP network, MPOA works with both IP and IPX networks.

Since all networking components are attached directly to the same physical ATM network, Host 1 should be capable of establishing a direct connection (i.e., a Virtual Channel Connection, or VCC) with Host 2. This connection is called a shortcut and optimizes the data path between Host 1 and Host 2, since no router hops are used. Using shortcuts to bypass traditional routing in networks is called Cut-Through routing, as demonstrated in the diagram below:



Cut-Through Routing

Though the network is still connected using the routed path described earlier, the router hops are avoided by when Host 1 can establish a direct path to Host 2 using Cut-Through routing, thus reducing latency and improving through-put times. This can be effectively done using Multi-Protocol over ATM (MPOA).

MPOA Requirements

MPOA is a Client/Server protocol with four main components:

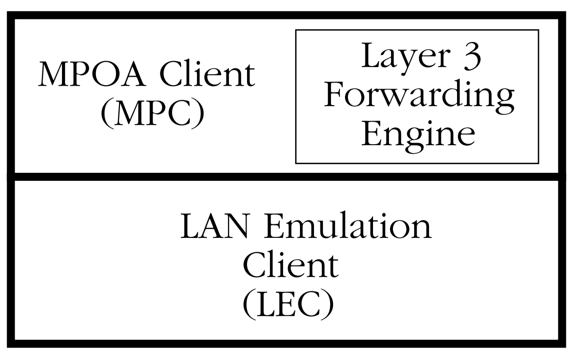
- The MPOA Client (MPC)
- The MPOA Server (MPS)
- LANE V2.0 for communication between network devices in the same subnet and for communication between the MPC and MPS.
- NHRP (Next Hop Resolution Protocol) for ATM address resolution of hosts in the network.

♦ Note ♦

The OmniSwitch, OmniStack, and Omni Switch/Router require their respective versions of the High-speed Routing Engine (HRE, HRE-OSTK, and HRE-X) for MPOA to function

The MPOA Client (MPC)

The MPOA Client (MPC) resides on the edge device (a switch) or on a server directly attached to ATM. The primary function of the MPC is to control and monitor traffic that passes through the ATM uplink, and to setup a shortcut virtual circuit (VC) between two edge devices (switches). The MPC sets up short-cut VCs by providing address resolution obtained from the MPOA Server (MPS). The MPC also relies on a Layer 3 forwarding engine to format IP or IPX frames before they are transmitted on the shortcut VC.



MPC Components

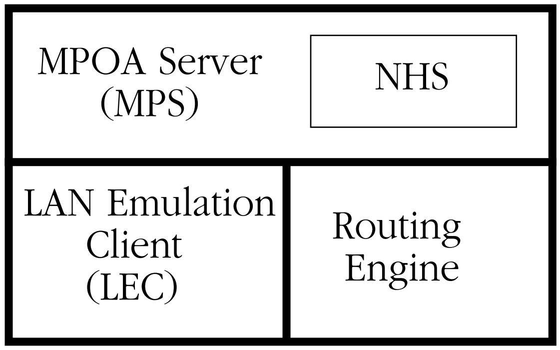
In the MPC's ingress role (sending data to another MPC or MPS), it detects traffic that is being forwarded over an ELAN to a router that contains an MPS. If the flow could benefit from a shortcut (i.e., bypass a routed path) the MPC initiates a query-response request to to the MPS to get the information required to establish a shortcut to the destination. If a shortcut is available, the MPC caches the information in it ingress cache, sets up a shortcut Virtual Channel Connection (VCC), and forwards the traffic to its destination using the established shortcut.

In the MPC's egress role (receiving data from other MPOA objects), it forwards information from other MPCs to its local interfaces or users. For data received over a shortcut, it adds the appropriate Data Link Layer (DLL) encapsulation and forwards them to higher layers. The DLL encapsulation information is provided by an egress MPS and stored in the MPC's egress cache.

An MPC can service one or more LECs and communicate with multiple MPSs.

MPOA Server (MPS)

The MPOA Server (MPS) communicates with other MPSs and the MPCs in its ELAN. Typically, one MPS is assigned to a single subnet, or ELAN. For redundancy purposes, more MPSs can be assigned to a single subnet. The MPS provides a routing functionality and works with routing protocols (such as RIP, RIP II and OSPF) to find other subnets in the network. The MPS resolves the ATM address of a Layer 3 address. This resolution is required by the MPCs to set up the shortcut VCs. MPOA uses Next Hop Resolution Protocol (NHRP) to gather the address information from other subnets in the network.



MPS Components

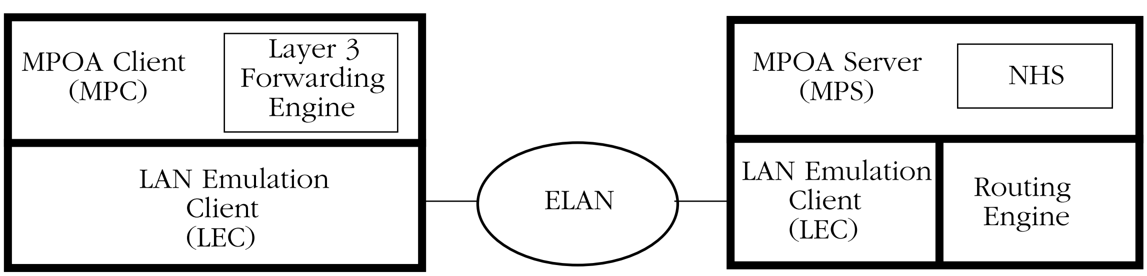
An MPS is the logical component of a router that provides internetwork layer forwarding to MPCs. It includes a full Next Hop Server (NHS) as defined by NHRP. The MPS interacts with its local NHS and routing functions to answer queries from ingress MPCs and provides Data Link Layer (DLL) encapsulation information to egress MPCs.

An MPS converts between MPOA requests and replies, and NHRP requests and replies for MPCs.

♦ Important Note ♦

The rest of this chapter describes the commands for configuring the MPOA client. Alcatel provides an optional MPOA server with the OmniMSS product. The MPOA server functionality is not described in this chapter.

The relationship of the MPC to the MPS and their respective components is shown below:



An MPOA Client and Server Connected Through an Emulated LAN

The MPC and MPS are connected by LANE, using locally configured LECs that communicate via an ELAN.

LAN Emulation (LANE)

LAN Emulation (LANE) version 2 is a requirement of MPOA. LANE is used for intra-subnet communications and is a Layer 2 framework that makes a connection-oriented ATM network seem like a shared connectionless Ethernet or Token Ring LAN segment.

LANE uses a client/server model with Emulated LANs (ELANs) made up of multiple LANE clients (LECs) and a LANE Server (LES). The LES provides a MAC to ATM address resolution and broadcast service to the LECs. Clients are implemented on ATM/LAN edge devices and ATM attached hosts, while the LESs can be implemented in a router, LAN or ATM switch, or in a stand alone ATM equipped device.

LANE still requires tradition network layer routers to interconnect these workgroups, or ELANS, significantly limiting the overall performance and scalability of the network. As the number of hosts and subnets grow, routers tend to be overwhelmed by complex routing paths and memory requirements.

For more specific information on LANE and LANE services, see Chapter 37, "LANE Server Configuration," and Chapter 38, "Configuring ATM Services."

Next Hop Resolution Protocol (NHRP)

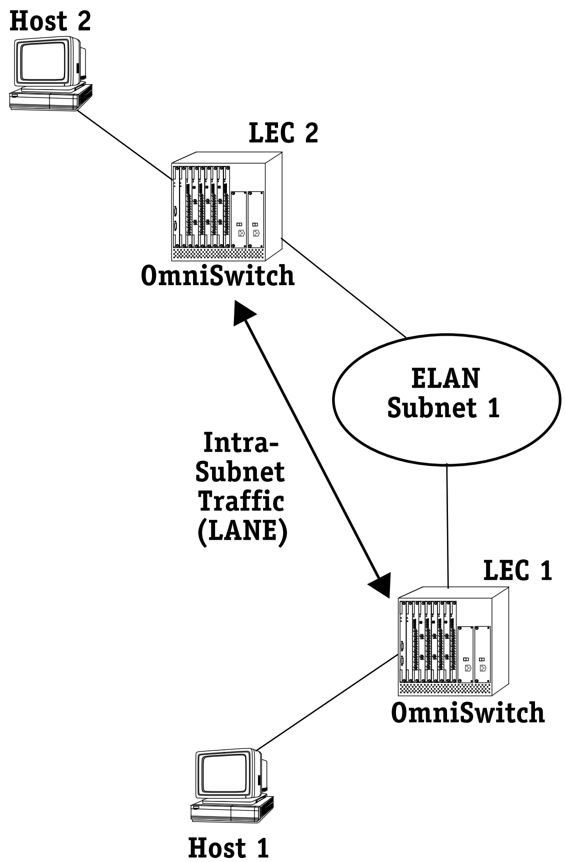
MPOA servers use Next Hop Resolution Protocol (NHRP) to learn network addresses. These addresses allow MPOA to create the shortcuts necessary for Cut-Through routing. NHRP provides an extended address resolution protocol that permits Next Hop Clients (NHCs) to send queries between different logical IP subnets (LISs), sometimes referred to as Local Address Groups (LAGs).

Once network address are learned and cached, ATM Switched Virtual Circuits (SVCs) can be established across subnet boundaries, allowing inter-subnet communication without intermediate routers.

An MPC transmitting data sends queries to an MPS for an address resolution for the destination MPC. The MPS's Next Hop Server (NHSs) obtains address information for the query through the standard routing path. Once the address is resolved, the MPS replies to the MPC query with the address of the destination MPC.

The MPOA Network

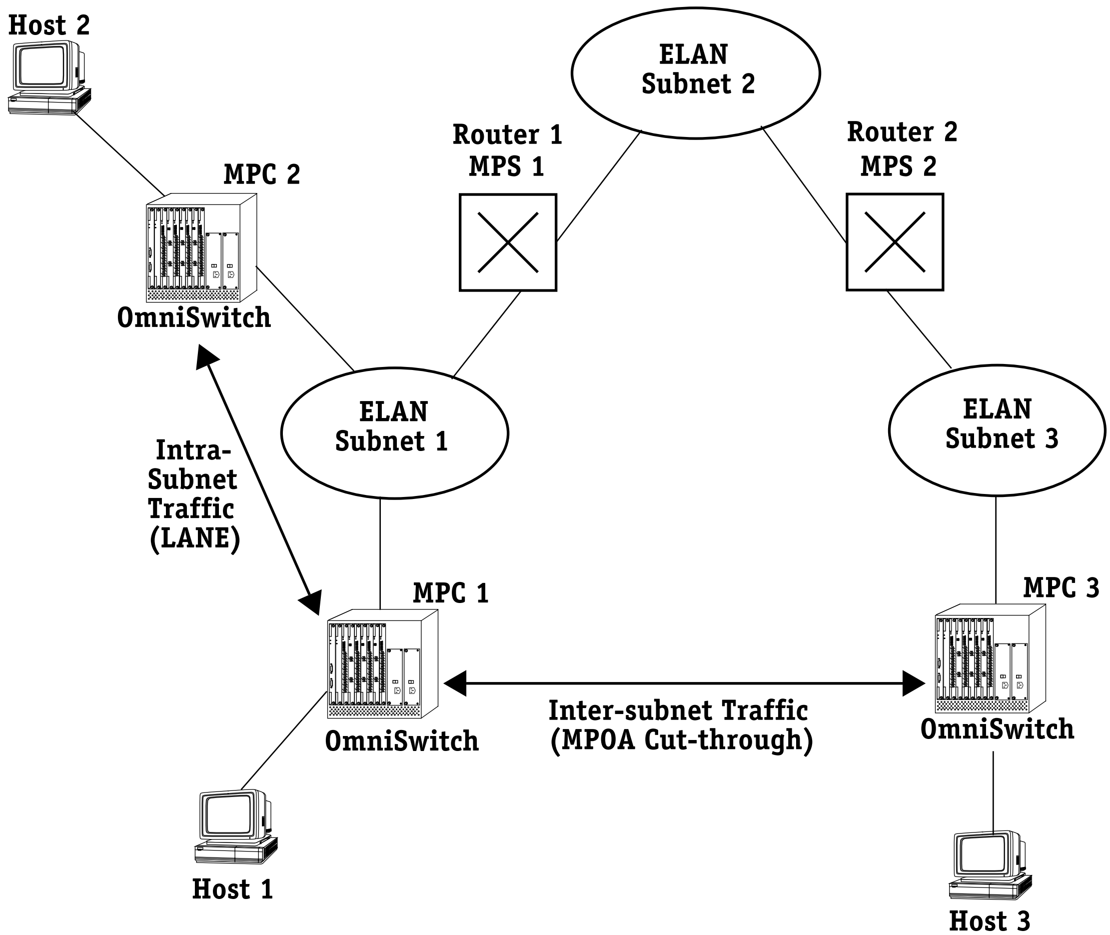
LAN Emulation (LANE) allows for intra-subnet Virtual Circuits (VCs) to be created. These VCs provide end devices with specific entry points of destination devices. This is useful when more than one switch is attached to a subnet, as demonstrated in the following diagram:



Simple LANE Configuration

LAN Emulation Clients (LECs) sit on the switches and communicate through an Emulated LAN (ELAN) address for Subnet 1. When Host 1 sends traffic to Host 2, any intra-subnet switching that would normally take place within Subnet 1 is now bypassed because the LECs provide points of access for the switches directly responsible for the hosts in question. Using the points of access, a VC is created.

MPOA allows for similar connections to be made between different subnets using cut-through routing. The MPOA Clients (MPCs) sit on the switches along side the LANE clients, and uses the same functionality as the LECs to communicate with other MPCs or MPSs in the network. By adding to the above diagram, we can illustrate this idea:



MPOA Network

This diagram is a simple MPOA network with three subnets. Subnet 1 has two edge device switches and Subnet 3 has one. The three subnets are connected by two routers (Routers 1 and 2) that each have an MPS.

Three hosts are used in this example. Host 1 and 2 are part of Subnet 1 (hosts can be connected to their edge device switches using specific protocol such as Ethernet). Host 3 is part of Subnet 3.

♦ Note ♦

The MPSs could be co-located with the MPCs on one of the switches or can reside in a separate device. The functionality of the network remains the same either way. A single MPS device can have multiple MPS instances. Each MPS is responsible for its own subnet and the MPC's servicing that subnet.

This model works as follows:

1. If Host 1 wants to communicate with Host 3, the standard traffic path without MPOA is through Subnet 1 to Router 1 (co-located with MPS 1) via the edge device (i.e., ATM access module). Router 1 forwards the data to Router 2 via Subnet 2, and the data is received by Host 3 through the switch for Subnet 3. As more routers are involved, this process can slow down traffic speeds.

2. MPOA addresses this problem. Outward bound traffic is monitored by MPC 1. When a preset threshold (in number of packets per set time period) is exceeded, MPC 1 tries to use a shortcut between MPC 1 and MPC 3 (or another remote destination).

3. If no shortcut exists, MPC 1 requests the resolution of MPC 3's ATM address from MPS 1. If MPS 1 has the resolution in its cache, it returns it immediately to MPC 1. When no cache information is available, MPS 1 resolves the requests and sends it to MPS 2. MPS 2 returns the information to MPS 1 and MPS 1 forwards the response to MPC 1. MPC 1 uses the ATM address to create a short-cut to MPC 3, bypassing all the router hops. MPC 3 sends the received data to Host 3.

4. Entries are created in the ingress and egress cache tables of MPC 1 and MPC 3, so that it is not necessary to reinitiate address resolution for this destination.

5. If Host 2 wants to communicate with Host 3, the process is the same as above. Note that communications between Host 1 and Host 2 is handled by LANE, as they are part of the same subnet, or ELAN.

If another host is connected to the edge device MPC 1 and sends data to Host 3, the same short-cut can be used. This avoids the resolution phase and saves on VC resources.

Alcatel's implementation of MPOA follows the above design. The MPC resides on the edge device (i.e., ATM access module). And works together with the local LEC V2.0 defined on the ATM uplink port.

♦ Important Note ♦

The MPOA Client requires the HRE or HRE-X to perform the MPOA encapsulation (Ethernet or Token Ring to RFC1483 routed BPDU).

Since most users in a routed internetwork connect to repetitive or habitual external addresses, the edge device can save (cache) VC information to be reused without having to address resolution requests for every flow. To this end, the MPC maintains an ingress (for outward bound data) and egress (for inward bound data) cache tables for routing on shortcuts. For information on viewing the ingress and egress caches, see *Viewing Entries in the Ingress Cache Table* on page 39-19 and *Viewing Entries in the Egress Cache Table* on page 39-20, respectively.

♦ Important Note ♦

The OmniMSS does not support the MPOA server using IPX at this time.

The MPOA Management Menu

The user interface commands for configuring and monitoring the MPOA Client (MPC) are listed in the **mpc** submenu. To access this submenu, enter

mpc

followed by **<return>**, at the system prompt. If you are in verbose mode, a screen similar to the following is displayed. Otherwise, enter a question mark (**?**) to see the **mpc** menu commands:

```
Command              MPC Service Menu
-------------------- -----------------------------------------------------
mpccfg               Configuration of MPC Service
vmpc                 Show status of a MPC Service
vmpcst               Show statistics of a MPC Service
vmpci                Show Ingress Cache Table of a MPC Service
vmpce                Show Egress Cache Table of a MPC Service
vmpcs                List all MPOA servers per MPC

   Main        File        Summary     VLAN        Networking
   Interface   Security    System      Services    Help
```

To use a command from the menu enter it at the command prompt. The commands are used in the following manner:

mpccfg. Allows you to enable, disable, or configure an MPOA client service for a particular port. See *Configuring an MPOA Client Service* on page 39-11 for more information.

vmpc. Displays the current status of an MPOA client service. See *Viewing Client Service Status* on page 39-14 for more information.

vmpcst. Displays the statistics of an MPOA client service. See *Viewing Client Service Statistics* on page 39-15 for more information.

vmpci. Displays all entries in the Ingress Cache Table for an MPOA client service. The Ingress Cache Table is a list of records for routing outgoing traffic. Each record consists of a network address, an ATM address, a VSC, and a hold time. See *Viewing Entries in the Ingress Cache Table* on page 39-19 for more information.

vmpce. Displays all records in the Egress Cache Table for an MPOA client service. The Egress Cache Table is a list of records for routing incoming traffic. Each record consists of a network address, an ATM address, a VSC, and a hold time. See *Viewing Entries in the Egress Cache Table* on page 39-20 for more information.

vmpcs. Displays all the MPOA servers (MPSs) associated with this client. Each MPS entry shows the ATM address, MAC address, and the MPC associated ELAN. See *Viewing MPOA Servers* on page 39-21 for more information.

Configuring an MPOA Client Service

The MPOA client (MPC) resides on the edge device, or switch, and monitors traffic from its associated ELANs. Along with the MPOA Server (MPS), it can create internetwork shortcuts to reduce the number of router hops necessary for data traffic by maintaining egress and ingress tables for routing outgoing and incoming traffic.

The MPC automatically detects if there are any LANE client services (LEC services) on a given slot and port. If so, it creates an MPOA Client service for each LEC service. You can let the MPC service be configured automatically based on the network LANE configuration, or configure it manually on a slot and port basis. To configure a service:

1. From the **mpc** menu, enter the **mpccfg** command as follows:

   mpccfg <slot>/<port>

   where **<slot>** is the slot number of the board on which the port is located and **<port>** is the port number on the selected board you want to modify. For example, to configure an MPOA client service on port 2 of slot 3, you would enter

   mpccfg 3/2

   The following menu appears for all services automatically generated by the MPOA client:

   ```
   1) Enable Service {No(1), Yes(2)}               : Yes
   2) Configuration Mode {Auto(1), Manual(2)}      : Auto

   Enter (option=value/save/cancel) :
   ```

2. If you want the MPC service to be configured automatically (based on the LEC configurations), make sure the service is enabled, leave the **Configuration Mode** set to **Auto**, and then save the configuration (if any changes were made). It uses configuration information from the LEC service, and can now route traffic.

3. If you wish to manually configure the service, then change the **Configuration Mode** to **Manual**. This is done by entering **2** (the line number for **Configuration Mode**), and equal sign (**=**), then a **2** (the value for **Manual**), as shown:

   2=2

4. The menu is now expanded to include options that are manually configurable, as shown below:

```
1)  Enable Service {No(1), Yes(2)}                 : Yes
2)  Configuration Mode {Auto(1), Manual(2)}        : Manual
3)  Setup Frame Count {1-65535}                    : 10
4)  Setup Frame Time {1-60 sec.}                   : 1
5)  Initial Retry Time {1-300 sec.}                : 5
6)  Retry Time Maximum {10-300 sec.}               : 40
7)  Hold Down Time {30-1200 sec.}                  : 160
8)  IP Protocol Enable {Disable(1), Enable(2)}     : Enable
9)  IPX Protocol Enable {Disable(1), Enable(2)}    : Disable
10) VCC Aging Time {10-300 sec.}                   : 300

Enter (option=value/save/cancel) :
```

To change a field value, type the line number, an equals sign, and the new value at the system prompt. For example, to change the **Setup Frame Count** to **20**, you would enter **3** (the line number for **Setup Frame Count**), an equal sign (**=**), and then **20**, as follows:

```
3=20
```

The **Setup Frame Count** would now be set to **20**.

5. When you are finished making changes to the service configuration, remember to save the configuration by typing **save** and then **<return>** at the system prompt.

♦ Important Note ♦

There can be multiple services created on a single slot/port by the MPC, depending on the configuration of your LANE environment. When you configure or change settings for a slot and port, all services on that slot and port are affected. You must reboot the switch to apply the changes.

Field Descriptions

The following sections describe the configurable options in the **mpccfg** menu.

Enable Service {No(1), Yes(2)}

This field allows you to enable or disable a service. An enabled service is active and can transmit or receive data, while a disabled service is inactive and nonfunctional. **Yes (2)** enables the service and **No (1)** disables it.

Configuration Mode {Auto(1), Manual(2)}

This field allows you to select the configuration mode, either **Auto (1)** or **Manual (2)**. In automatic configuration mode, the service uses the settings of the LEC for its configuration options. If set to manual, the user can change the default settings for the available options.

Setup Frame Count {1-65535}

The field, combined with the **Setup Frame Time**, determines when the MPC attempts to create a internetwork shortcut. This field represents the number of frames necessary in a data flow before a shortcut attempt is made. (A data flow is a uni-directional flow of data packets to a single destination.) If this field is set to **1**, a shortcut attempt is made for every data flow regardless of size, however this is not advisable as it is a waste of network resources.

Setup Frame Time {1-60 sec.}

This field, combined with the **Setup Frame Count**, determines when the MPC attempts to create an internetwork shortcut. This field represents a period of time (in seconds) during which the number of frames in a data flow are counted. If the number of frames during this time period equals or exceeds the value set in the **Setup Frame Count**, an internetwork shortcut is attempted.

Initial Retry Time {1-300 sec.}

This field is the initial number of seconds allowed for a MPC resolution request before the operation times out. The retry time consists of the number of seconds set in this field multiplied by a retry multiplier (a constant value of 2). If a resolution request times out, a new request is sent with the same value, until the maximum retry time is matched or exceeded.

Retry Time Maximum {10-300 sec.}

The maximum number of seconds allowed for MPC resolution request retries.

Hold Down Time {30-1200 sec.}

The number of seconds the MPC must wait before reinitiating a failed resolution attempt.

IP Protocol Enable {Disable(1), Enable(2)}

If your network uses IP to route data, set this field to **Enable**. If this field is set to **Disable**, IP traffic is not routed.

IPX Protocol Enable {Disable(1), Enable(2)}

If your network uses Internet Package Exchange (IPX) to route data, set this field to **Enable**. If this field is set to **Disable**, IPX traffic is not routed.

VCC Aging Time {10-300 sec.}

The number of seconds an idle Virtual Channel Connection (VCC) is allowed to remain open. VCCs are shortcuts created by MPCs to transmit and receive internetwork data flows. If a VCC is open and idle (no data transmitted or received) for a period of time greater then the number of seconds specified in this field, it is shut down.

Viewing Client Service Status

Once you have configured a client service, you can view the status of the service with the **vmpc** command. To view the status of a service enter the **vmpc** command as follows:

vmpc <slot>/<port>

where **<slot>** is the slot number of the board on which the port is located and **<port>** is the port number on the selected board you want to modify. For example, to view the status of an MPOA client service on port 2 of slot 3, you would enter:

vmpc 3/2

A screen similar to the following appears:

```
Control ATM Address      : 3903488001bc900001019657700020da9c6c2c03
Operation State          : Up
Data ATM Address         : 3903488001bc900001019657700020da9c6c2cbf

*Current Configuration*
Configuration Mode              : Manual
Setup Frame Count               : 10
Setup Frame Time {sec.}         : 5
Initial Retry Time {sec.}       : 300
Retry Time Maximum {sec.}       : 40
Hold Down Time {sec.}           : 160
IP Protocol Enable              : Enable
IPX Protocol Enable             : Disable
VCC Aging Time {sec.}           : 20

*ELANs with the MPC*
1) 180_1_4
```

None of these fields can be modified on this screen. To modify the configuration of a service, see *Configuring an MPOA Client Service* on page 39-11.

Field descriptions

The following section describes the fields associated with the **vmpc** command.

Control ATM Address. The address used to set up a switch virtual circuit (SVC) for sending control packets to an MPS. This address may be different from the Data ATM Address.

Operational State. Shows whether the service is running or not. **Up** means the service is operational and can pass data, and **Down** means the service is not running. See *Configuring an MPOA Client Service* on page 39-11 for information on changing the service status.

Data ATM Address. An ATM address used to set up a shortcut for data traffic between MPCs on the network. This address may be different from the Control ATM Address.

Current Configuration. For a description of these fields, see *Configuring an MPOA Client Service* on page 39-11.

ELANs with the MPC. Shows all ELANs names associated with this MPC service.

Viewing Client Service Statistics

You can view the statistics for an MPC service once it has been configured using the **vmpcst** command. To view service statistics, enter the **vmpcst** command as follows:

vmpcst <slot>/<port>

where **<slot>** is the slot number of the board on which the port is located and **<port>** is the port number on the selected board you want to modify. For example, to view the statistics of an MPOA client service on port 2 of slot 3, you would enter:

vmpcst 3/2

A screen similar to the following appears:

```
txMpoaResolveRequests                    : 0
rxMpoaResolveReplyAcks                   : 0
rxMpoaResolveReplyInsufECResources       : 0
rxMpoaResolveReplyInsufSCResources       : 0
rxMpoaResolveReplyInsufEitherResources   : 0
rxMpoaResolveReplyUnsupportedInetProt    : 0
rxMpoaResolveReplyUnsupportedMacEncaps   : 0
rxMpoaResolveReplyUnspecifiedOther       : 0
rxMpoaImpRequests                        : 0
txMpoaImpReplyAcks                       : 0
txMpoaImpReplyInsufECResources           : 0
txMpoaImpReplyInsufSCResources           : 0
txMpoaImpReplyInsufEitherResources       : 0
txMpoaImpReplyUnsupportedInetProt        : 0
txMpoaImpReplyUnsupportedMacEncaps       : 0
txMpoaImpReplyUnspecifiedOther           : 0
txMpoaEgressCachePurgeRequests           : 0
rxMpoaEgressCachePurgeReplies            : 0
rxMpoaKeepAlives                         : 0
rxMpoaTriggers                           : 0
rxMpoaDataPlanePurges                    : 0
txMpoaDataPlanePurges                    : 0
rxNhrpPurgeRequests                      : 0
txNhrpPurgeReplies                       : 0
rxErrUnrecognizedExtensions              : 0
rxErrLoopDetecteds                       : 0
rxErrProtoAddrUnreachables               : 0
rxErrProtoErrors                         : 0
rxErrSduSizeExceededs                    : 0
rxErrInvalidExtensions                   : 0
rxErrInvalidReplies                      : 0
rxErrAuthenticationsFailures             : 0
r xErrHopCountExceededs                  : 0
```

You cannot modify the fields displayed in this screen.

Field descriptions

The following section describes the various fields in the **vmpcst** command.

♦ Note ♦

The values for these counters are reset to zero when the management system or the MPC device is re-initialized.

txMpoaResolveRequests. The number of MPOA Resolution Requests transmitted by this client to other MPOA objects on the network. An MPOA Resolution Request is sent from an ingress MPC to an ingress MPS to request the egress ATM address corresponding to an internetwork layer destination address.

rxMpoaResolveReplyAcks. The number of positively acknowledged successful MPC Resolution Replies received by this MPC. An MPOA Resolution Reply is sent from an ingress MPS to an ingress MPC in reply to a corresponding MPOA Resolution Request upon receiving an NHRP Resolution Reply from the egress MPS.

rxMpoaResolveReplyInsufECResources. The number of MPOA Resolve Replies received with the message “Insufficient resources to accept egress cache entry.” This could refer to lack of memory or other resources.

rxMpoaResolveReplyInsufSCResources. The number of MPOA Resolve Replies received with the message “Insufficient resources to accept the shortcut.” This could refer to lack of memory or other resources.

rxMpoaResolveReplyInsufEitherResources. The number of MPOA Resolve Replies received with the message “Insufficient resources to accept either shortcut or egress cache entry.” This could refer to lack of memory or other resources.

rxMpoaResolveReplyUnsupportedInetProt. The number of MPOA Resolve Replies received with the message “Unsupported Internetwork Layer protocol.” This includes anything other than IP or IPX.

rxMpoaResolveReplyUnsupportedMacEncaps. The number of MPOA Resolve Replies received with the message “Unsupported MAC layer encapsulation.” Supported protocols include Ethernet, 802.3, 802.2 SNAP, and Token Ring.

rxMpoaResolveReplyUnspecifiedOther. The number of MPOA Resolve Replies received with the message “Unspecified other.”

rxMpoaImpRequests. The number of MPOA Cache Imposition Requests received by this MPC. An MPOA Cache Imposition Request is sent from an ingress cache MPS to an egress MPC to record an egress cache entry upon the receipt of an NHRP Resolution Request from the ingress MPS.

txMpoaImpReplyAcks. The number of successful MPOA Cache Imposition replies transmitted by this MPC.

txMpoaImpReplyInsufECResources. The number of successful MPOA Cache Imposition replies transmitted by this MPC denying the egress table entry because of insufficient resources to accept an egress cache entry.

txMpoaImpReplyInsufSCResources. The number of successful MPOA Cache Imposition replies transmitted by this MPC informing the MPS that a shortcut was not made due to insufficient resources.

txMpoaImpReplyInsufEitherResources. The number of successful MPOA Cache Imposition replies transmitted by this MPC denying the egress table entry because of insufficient resources to accept either a shortcut or egress cache entry.

txMpoaImpReplyUnsupportedInetProt. The number of successful MPOA Cache Imposition replies transmitted by this MPC denying the egress cache entry because of an unsupported Internetwork Layer protocol.

txMpoaImpReplyUnsupportedMacEncaps. The number of successful MPOA Cache Imposition replies transmitted by this MPC denying the egress cache entry because of an unsupported MAC Layer encapsulation.

txMpoaImpReplyUnspecifiedOther. The number of successful MPOA Cache Imposition replies transmitted by this MPC denying the egress cache entry because of some unspecified reason.

txMpoaEgressCachePurgeRequests. The number of MPOA Egress Cache Purge Requests transmitted by this MPC. An MPOA Egress Cache Purge Request is sent from an egress MPC to and egress MPS to purge an egress cache entry.

rxMpoaEgressCachePurgeReplies.The number of MPOA Egress Cache Purge Replies received by this MPC. An MPOA Cache Purge Reply is sent from an egress MPS to an egress MPC in reply to an MPOA Egress Cache Purge Request.

rxMpoaKeepAlives. The number of MPOA Keep Alive messages received by this MPC. A Keep Alive message is sent from the MPC to MPSs to make sure the MPSs that have supplied cache entries are alive and able to maintain those cache entries.

rxMpoaTriggers. The number of MPOA Trigger messages received by this MPC. An MPOA trigger is sent from an ingress MPS to an ingress MPC to request the ingress MPC to issue MPOA Resolution Requests.

rxMpoaDataPlanePurges. The number of MPOA Data Plane Purge messages received by this MPC. A Data Plane Purge is an NHRP Purge message sent on the data plane by an egress MPC to an ingress MPC to purge ingress cache entries.

txMpoaDataPlanePurges. The number of MPOA Data Plane Purge messages sent by this MPC.

rxNhrpPurgeRequests. The number of Purge Requests received by this MPC. A Purge Request is sent by an ingress MPS to an ingress MPC to purge ingress cache entries.

txNhrpPurgeReplies. The number of Purge Replies sent by this MPC.

rxErrUnrecognizedExtensions. The number of Error Indication packets received by this MPC with the error code “Unrecognized Extension.” An Error Indication packet is sent to the sender of an NHRP packet to convey error indications. All MPOA control packets have extensions that control receiving component function or provide information. Examples of extension are DLL headers, egress cache tags, or hop counts.

rxErrLoopDetecteds. The number of Error Indication packets received by this MPC with the error code “Loop Detected.” A Loop Detected error is generated when it is determined that an NHRP packet is being forwarded in a loop.

rxErrProtoAddrUnreachables. The number of Error Indication packets received by this MPC with the error code "Protocol Address Unreachable." A Protocol Address Unreachable error is generated when a packet is moving along the routed path and it reaches a point where the protocol address of interest is not reachable.

rxErrProtoErrors. The number of Error Indication packets received by this MPC with the error code "Protocol Errors." A Protocol Errors error is sent when a generic packet processing error has occurred.

rxErrSduSizeExceededs. The number of Error Indication packets received by this MPC with the error code "SDU Size Exceeded."

rxErrInvalidExtensions. The number of Error Indication packets received by this MPC with the error code "Invalid Extensions." Invalid extensions are any extension received by the MPOA client that is supported, but the content is wrong or undecipherable.

rxErrInvalidReplies. The number of Error Indication packets received by this MPC with the error code "Invalid Replies." Replies are sent by other MPOA components in response to requests by this MPC. An invalid reply is a reply that contains unexpected or undecipherable data.

rxErrAuthenticationsFailures. The number of Error Indication packets received by this MPC with the error code "Authentication Failure." This occurs if a request is denied because it failed security authentication.

r**xErrHopCountExceededs**. The number of Error Indication packets received by this MPC with the error code "Hop Count Exceeded."

Viewing Entries in the Ingress Cache Table

When the MPC uses a shortcut to route traffic between subnets, it looks up the address for the point of entry into the other subnet and records the address in its ingress cache table. To view entries in the MPC service ingress cache table enter the **vmpci** command as follows:

vmpci <slot>/<port>

where **<slot>** is the slot number of the board on which the port is located and **<port>** is the port number on the selected board you want to modify. For example, to view the ingress cache table of an MPC service on port 2 of slot 3, you would enter:

vmpci 3/2

A screen similar to the following appears:

Type	Network Address	ATM Address	VPI/VCI	Hold Time
IP	208.7.8.5	3903488001bc900001000100010020da048731c0	0/100	4

You cannot modify this screen with the **vmpci** command.

Field descriptions

The following section describes the fields available in the **vmpci** command.

Type. The routing type employed by the MPC service. It can be IP, Internetwork Packet Exchange (IPX), or both. If both IP and IPX are valid, then the **Type** display reads as follows:

IP/IPX

Network Address. The network address (IP) for this record in the ingress cache table of the MPC service. If the client is configured for IPX, an IPX address is displayed.

ATM Address. The ATM address for this record in the ingress cache table of the MPC service.

VPI/VCI. The Virtual Path Indicator (VPI) and Virtual Channel Indicator (VCI) for this record in the ingress cache table of the MPC service. These combined numbers act as an address for a Virtual Channel Connection (VCC).

Hold Time. The hold time, in seconds, between attempts to establish a connection with the destination listed in this record.

♦ Note ♦

The entries in the ingress cache table refer *entry points* into other remote subnets (i.e., another MPC or MPS). whereas entries in the egress cache table refer to *destinations* in the subnet or subnets managed by the local MPC service.

Viewing Entries in the Egress Cache Table

When the MPC receives routed traffic from another MPOA component, it looks up the address for the destination of the traffic in its egress cache table. To view entries in the MPC service egress cache table enter the **vmpce** command as follows:

vmpce <slot>/<port>

where **<slot>** is the slot number of the board on which the port is located and **<port>** is the port number on the selected board you want to modify. For example, to view the egress cache table of an MPC service on port 2 of slot 3, you would enter:

vmpce 3/2

A screen similar to the following appears:

Type	Network Address	ATM Address	VPI/VCI	Hold Time
IP	208.6.8.1	3903488001bc900001000100010020da048730c0	0/153	4

You cannot modify this screen with the **vmpce** command.

For a definition of the fields displayed with the **vmpce** command, see *Viewing Entries in the Ingress Cache Table* on page 39-19.

♦ Note ♦

The entries in the egress cache table refer to *destinations* in the subnet or subnets managed by the local MPC service, whereas entries in the ingress cache table refer to *entry points* into other remote subnets (i.e., another MPC or MPS).

Viewing MPOA Servers

When an MPC service is established and active, it notes its own MPOA server (MPS) as well as any other MPS it becomes aware of while routing traffic. You can view all MPSs associated with an MPC service. To view a list of all MPSs associated with an MPC service, enter the **vmpcs** command as follows:

vmpcs <slot>/<port>

where **<slot>** is the slot number of the board on which the port is located and **<port>** is the port number on the selected board you want to modify. For example, to view associated servers for an MPC service on port 2 of slot 3, you would enter:

vmpcs 3/2

A screen similar to the following appears:

```
MPS ATM Address                             MAC Address    ELAN
------------------------------------------ -------------- ------------
3903488001bc900001000100010020da048733c1  0020da048799  elan1_802.3
```

You cannot modify this screen with the **vmpcs** command.

Field descriptions

The following section describes the fields displayed with the **vmpcs** command.

MPS ATM Address. The ATM address of this MPS.

MAC Address. The Media Access Control (MAC) address of this MPS.

ELAN. The Emulated LAN associated with this MPS.