4. Multiprotocol Over ATM (MPOA)

MPOA has been defined by The ATM Forum as the standard on July 1997 for transport network layer protocols (IP, IPX, AppleTalk) across an ATM network . MPOA integrates LANE, which is a bridging standard operating at layer 2, and NHRP, which is used to resolve destination network address into ATM address (explained above in section 3.2), while allowing inter-subnet, internetwork communication over ATM VCCs without requiring routers in the data path through mechanism known as cut-through or zero-hop routing. MPOA operates at layer 2 (the LANE is building block of MPOA) and layer 3, and hence is both a bridging and routing service. Contrary to LANE, which required no modification to protocol stack and hides both ATM and QoS, MPOA requires modification and provides QoS to higher layers.

The general concept involves splitting, forwarding and routing functions traditionally supported within conventional multi-protocol routers between MPOA Clients (MPCs) (resides in an ATM host and edge device) and MPOA Servers (MPSs) (resides in an ATM switch-router or ATM route server). Address management and topology discovery are performed by the MPSs while traffic forwarding is provided by MPCs via ATM switched fabric.
This separation provides a number of key benefits [MPOA]:

- uses a multi-gigabit ATM infrastructure to physical routing process (traditional routers are limited by the speed of back-planes
- increases manageability (by decreasing the number of devices configured to perform routing)
- increases scalability (by decreasing the number of devices participating in routing calculation)
- reducing the complexity of edge devices (cost effective)

This architecture is known as *virtual routing* (see figure 4.1).

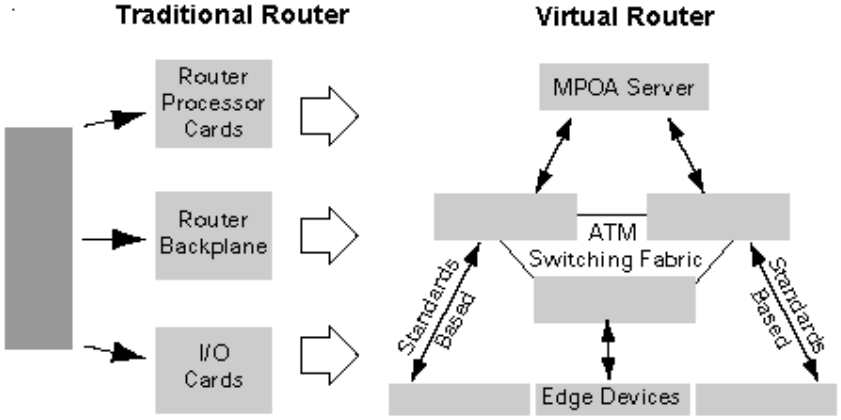

Figure 4.1 Virtual Router

These three elements the LANE v2, NHRP and concept of a virtual router are basic elements of MPOA.

The interoperability with the existing routing protocols is made through the MPSs, that run standard internetwork layer routing protocols.

3.1 MPOA Components

MPOA is designed with a client/server architecture. MPOA Client and their MPOA Server(s) are connected via LANE. MPOA defines logical components that can be implemented in various hardware configurations. (Figure 3.1.1)

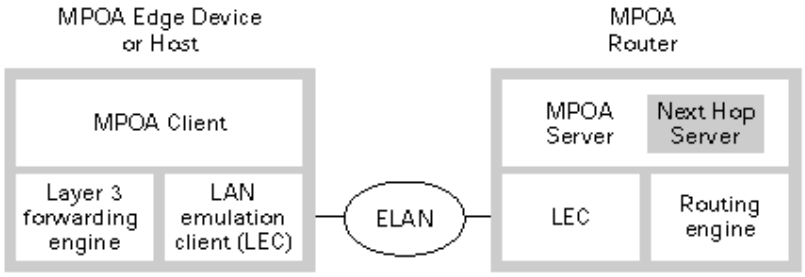

Figure 3.1.1 The Component in an MPOA System

Edge Device

Edge device is typically LAN-ATM switch that support one or more ports to legacy LAN or WAN networks with end systems. The function of edge device is forwarding packets between legacy LAN segments and ATM interface based on the destination network layer address and MAC layer address. MPC is the component of an edge device.

MPOA Client

The primary function of the MPC is to act as a point of entry and exit for traffic using internetwork shortcuts. MPC performs layer 3 forwarding of packets, but does not run layer 3 routing protocols.

In its entry role, MPC detects flows of packets forwarded to a default router. MPC sees only packets sent by the higher layers to the LEC or packets received by shortcut relayed to the higher protocols. It is because the MPC lies between a LANE LEC and its higher layer. When the MPC recognizes a flow that could have a benefit from a shortcut (the path without router), MPC requests its serving MPS to provide the information required to establish a shortcut to the destination. If a connection is available, the MPC caches the information, sets up a shortcut SVC and forwards frames over the shortcut. The SVC with no activity are inactivated upon the expiration of a variable time-out.

In its exit role, the MPC receives data frames from other MPCs, and if the frames have been received over a shortcut, the MPC adds the appropriate DLL encapsulation and forwards the frame to the higher layer.

The MPC and MPS communicate with each other using NHRP, the client caches the information for the future using. The MPC must be capable of obtaining configuration information from the LECS.

MPOA Router

The MPOA Router is a collection of functions that allow the mapping of network layer subnets to ATM. The MPOA router has to administrate large table of layer 3, MAC and ATM addresses of particular nodes additional with routing information. MPOA Routers communicate with each other via NHRP to resolve destination addresses. At the router routing

protocols run (RIP, OSPF) to communicate with traditional routers to allow interoperability with existing routed LAN and WAN.

MPOA Server (MPS)

A MPS is a logical component of the MPOA Router that provides Layer 3 forwarding information to MPCs. It includes a full NHRP server (NHS) function. The MPS interacts with its associated routing function and its NHS to identify a path represented by the destination ATM address and Layer 2 encapsulation information. It returns these in response to a query from the MPC.

The MPS must be capable of obtaining configuration information from the LECS.

A caching information is an important feature of the MPOA. It can be reused without having to issue address resolution request. The goal is to minimize the number of times the MPC must visit the MHS to retrieve this information. Therefore the MPC maintains its own cache table with effective cache management techniques, ensuring cache coherency between MPCs and MPSs.

3.2 MPOA Operations

A packet enters the MPOA system at the ingress MPC (MPC is in its entry role) and it is MPC that must make the decision process [MPOA]. This process occurs for each entering packet. By default, the packet is bridged via LANE to a router. If the packet is to be routed, it will contain the destination MAC address of the implicit MPOA Server interface. Then MPC examines the layer 3 destination address of the packet and looks up in its cache if it has cache entry for this address If not, MPC will make entry for <ATM MPS address, layer 3 destination address> pair and trigger counter which counts the number of packets of a flow. After it, MPC continues in forwarding of the next packets by the default router. But when the count for a given <ATM MPS address, layer 3 destination address> tuple exceeds the configured threshold for number of packets sent within a configured time period, then MPC sent a MPOA Resolution Request to its serving MPS to require the information need to establish direct connection (shortcut) to the destination or use the information in its cache (if it has some). The MPC will then establish a direct connection to the appropriate destination and forward the packet striped from the DLL encapsulation via a shortcut.

If the packet is destined to a host in the same subnet so that it can be bridged, the MPC will use LANE to resolve the ATM address and establish a virtual channel connection to the destination.

If the local MPS (ingress) does not know the appropriate ATM address, it translates MPOA Resolution Request of MPC to NHRP Resolution Request and forwards the Request on the routed path to the layer 3 destination address. When NHRP Request arrives to the appropriate MPS (egress, serving the destination MPC), the MPS (egress) obtains required information from the destination MPC via MPOA request/reply and will send the information in NHRP Resolution Reply back to the local MPS (ingress). It forwards this information to the appropriate MPC in MPOA Reply.

While MPC is waiting for a reply from MPS, it sends any data packets destined for that layer 3 address to its default router via LANE. This is made by local authoritative policies. The MPOA server learns from the first packet for which edge queries MPS should respond.

The process for getting layer 3 information and cut through connections can be triggered by the MPOA server. The MPS can tell to a client to issue a query for a layer 3 destination address. After MPC receives reply from the MPS , it updates its cache and sets up a direct connection . This mechanism is known as MPOA Trigger.

LLC/SNAP encapsulation has been chosen for the MPOA as default encapsulation (as it defined RFC 1483).

The MPOA allows to support QoS by LANE v2 which permits specified QoS for direct connections. The MPOA allows QoS for inter subnet connections allowing edge devices and MPOA servers to interpret such layer 3 QoS protocols as RSVP to determine the QoS needed for a direct connection between MPOA hosts.