LAN Emulation Overview

This overview chapter gives a high-level description of LAN Emulation (LANE). For specific configuration information, refer to the chapter called "Configuring LAN Emulation."

LAN Emulation (LANE)

Cisco's implementation of LANE makes an ATM interface look like one or more Ethernet interfaces.

LANE is an ATM service defined by the ATM Forum specification *LAN Emulation over ATM*, ATM_FORUM 94-0035. This service emulates the following LAN-specific characteristics:

- Connectionless services
- Multicast services
- LAN media access control (MAC) driver services

LANE service provides connectivity between ATM-attached devices and connectivity with LAN-attached devices. This includes connectivity between ATM-attached stations and LAN-attached stations and also connectivity between LAN-attached stations across an ATM network.

Because LANE connectivity is defined at the MAC layer, upper protocol layer functions of LAN applications can continue unchanged when the devices join emulated LANs. This feature protects corporate investments in legacy LAN applications.

An ATM network can support multiple independent emulated LAN networks. Membership of an end system in any of the emulated LANs is independent of the physical location of the end system. This characteristic enables easy hardware moves and location changes. In addition, the end systems can also move easily from one emulated LAN to another, whether or not the hardware moves.

LAN emulation in an ATM environment provides routing between emulated LANs for supported routing protocols and high-speed, scalable switching of local traffic.

The ATM LANE system has three servers that are single points of failure. These are the LECS (Configuration Server), the LES (emulated LAN server), and the BUS (the broadcast and unknown server). Beginning with Release 11.2, LANE fault tolerance or Simple LANE Service Replication on the emulated LAN provides backup servers to prevent problems if these servers fail.

The fault tolerance mechanism that eliminates these single points of failure is described in the "Configuring LANE" chapter. Although this scheme is proprietary, no new protocol additions have been made to the LANE subsystems.

LANE Components

Any number of emulated LANs can be set up in an ATM switch cloud. A router can participate in any number of these emulated LANs.

LANE is defined on a LAN client-server model. The following components are implemented in this release:

- LANE client

  A LANE client emulates a LAN interface to higher layer protocols and applications. It forwards data to other LANE components and performs LANE address resolution functions.

  Each LANE client is a member of only one emulated LAN. However, a router can include LANE clients for multiple emulated LANs: one LANE client for *each* emulated LAN of which it is a member.

  If a router has clients for multiple emulated LANs, the Cisco IOS software can route traffic between the emulated LANs.

- LANE server

  The LANE server for an emulated LAN is the control center. It provides joining, address resolution, and address registration services to the LANE clients in that emulated LAN. Clients can register destination unicast and multicast MAC addresses with the LANE server. The LANE server also handles LANE ARP (LE ARP) requests and responses.

  Our implementation has a limit of one LANE server per emulated LAN.

- LANE broadcast-and-unknown server

  The LANE broadcast-and-unknown server sequences and distributes multicast and broadcast packets and handles unicast flooding.

  In this release, the LANE server and the LANE broadcast-and-unknown server are combined and located in the same Cisco 7000 family or Cisco 4500 series router; one combined LANE server and broadcast-and-unknown server is required per emulated LAN.

- LANE configuration server

  The LANE configuration server contains the database that determines which emulated LAN a device belongs to (each configuration server can have a different named database). Each LANE client consults the LANE configuration server just once, when it joins an emulated LAN, to determine which emulated LAN it should join. The LANE configuration server returns the ATM address of the LANE server for that emulated LAN.

  One LANE configuration server is required per LANE ATM switch cloud.

  The LANE configuration server's database can have the following four types of entries:

  — Emulated LAN name-ATM address of LANE server pairs

  — LANE client MAC address-emulated LAN name pairs

  — LANE client ATM template-emulated LAN name pairs

  — Default emulated LAN name

Note Emulated LAN names must be unique on an interface. If two interfaces participate in LANE, the second interface may be in a different switch cloud.

LANE Operation and Communication

Communication among LANE components is ordinarily handled by several types of switched virtual circuits (SVCs). Some SVCs are unidirectional; others are bidirectional. Some are point-to-point and others are point-to-multipoint. Figure 17 illustrates the various virtual channel connections (VCCs)—also known as *virtual circuit connections*—that are used in LANE configuration. In this figure, *LE server* stands for the LANE server, *LECS* stands for the LANE configuration server, and *BUS* stands for the LANE broadcast-and-unknown server.

Figure 17 LANE VCC Types

The following section describes various processes that occur, starting with a client requesting to join an emulated LAN after the component routers have been configured.

Client Joining a Emulated LAN

The following process normally occurs after a LANE client has been enabled:

- Client requests to join an emulated LAN

  The client sets up a connection to the LANE configuration server—a bidirectional point-to-point Configure Direct VCC—to find the ATM address of the LANE server for its emulated LAN.

  LANE clients find the LANE configuration server by using the following methods in the listed order:

  — Locally configured ATM address

  — Interim Local Management Interface (ILMI)

  — Fixed address defined by the ATM Forum

  — PVC 0/17

- Configuration server identifies the LANE server

  Using the same VCC, the LANE configuration server returns the ATM address and the name of the LANE server for the client's emulated LAN.

- Client contacts the server for its LAN

  The client sets up a connection to the LANE server for its emulated LAN (a bidirectional point-to-point Control Direct VCC) to exchange control traffic.

  Once a Control Direct VCC is established between a LANE client and a LANE server, it remains up.

- Server verifies that the client is allowed to join the emulated LAN

  The server for the emulated LAN sets up a connection to the LANE configuration server to verify that the client is allowed to join the emulated LAN—a bidirectional point-to-point Configure Direct (server) VCC. The server's configuration request contains the client's MAC address, its ATM address, and the name of the emulated LAN. The LANE configuration server checks its database to determine whether the client can join that LAN; then it uses the same VCC to inform the server whether the client is or is not allowed to join.

- LANE server allows or disallows the client to join the emulated LAN

  If allowed, the LANE server adds the LANE client to the unidirectional point-to-multipoint Control Distribute VCC and confirms the join over the bidirectional point-to-point Control Direct VCC. If disallowed, the LANE server rejects the join over the bidirectional point-to-point Control Direct VCC.

- LANE client sends LE ARP packets for the broadcast address, which is all 1s

  Sending LE ARP packets for the broadcast address sets up the VCCs to and from the broadcast-and-unknown server.

Address Resolution

As communication occurs on the emulated LAN, each client dynamically builds a local LANE ARP (LE ARP) table. A client's LE ARP table can also have static, preconfigured entries. The LE ARP table maps MAC addresses to ATM addresses.

Note LE ARP is not the same as IP ARP. IP ARP maps IP addresses (Layer 3) to Ethernet MAC addresses (Layer 2); LE ARP maps emulated LAN MAC addresses (Layer 2) to ATM addresses (also Layer 2).

When a client first joins an emulated LAN, its LE ARP table has no dynamic entries and the client has no information about destinations on or behind its emulated LAN. To learn about a destination when a packet is to be sent, the client begins the following process to find the ATM address corresponding to the known MAC address:

- The client sends an LE ARP request to the LANE server for this emulated LAN (point-to-point Control Direct VCC).
- The LANE server forwards the LE ARP request to all clients on the emulated LAN (point-to-multipoint Control Distribute VCC).
- Any client that recognizes the MAC address responds with its ATM address (point-to-point Control Direct VCC).
- The LANE server forwards the response (point-to-multipoint Control Distribute VCC).

- The client adds the MAC address-ATM address pair to its LE ARP cache.
- Then the client can establish a VCC to the desired destination and transmit packets to that ATM address (bidirectional point-to-point Data Direct VCC).

For unknown destinations, the client sends a packet to the broadcast-and-unknown server, which forwards the packet to all clients via flooding. The broadcast-and-unknown server floods the packet because the destination might be behind a bridge that has not yet learned this particular address.

Multicast Traffic

When a LANE client has broadcast or multicast traffic, or unicast traffic with an unknown address to send, the following process occurs:

- The client sends the packet to the broadcast-and-unknown server (unidirectional point-to-point Multicast Send VCC).
- The broadcast-and-unknown server forwards (floods) the packet to all clients (unidirectional point-to-multipoint Multicast Forward VCC).

  This VCC branches at each ATM switch. The switch forwards such packets to multiple outputs. (The switch does not examine the MAC addresses; it simply forwards all packets it receives.)

Typical LANE Scenarios

In typical LANE cases, one or more Cisco 7000 family routers, or Cisco 4500 series routers are attached to a Cisco LightStream ATM switch. The LightStream ATM switch provides connectivity to the broader ATM network switch cloud. The routers are configured to support one or more emulated LANs. One of the routers is configured to perform the LANE configuration server functions. A router is configured to perform the server function and the broadcast-and-unknown server function for each emulated LAN. (One router can perform the server function and the broadcast-and-unknown server function for several emulated LANs.) In addition to these functions, each router also acts as a LANE client for one or more emulated LANs.

This section presents two scenarios using the same four Cisco routers and the same Cisco LightStream ATM switch. Figure 18 illustrates a scenario in which one emulated LAN is set up on the switch and routers. Figure 19 illustrates a scenario in which several emulated LANs are set up on the switch and routers.

The physical layout and the physical components of an emulated network might not differ for the single and the multiple emulated LAN cases. The differences are in the software configuration for the number of emulated LANs and the assignment of LANE components to the different physical components.

Single Emulated LAN Scenario

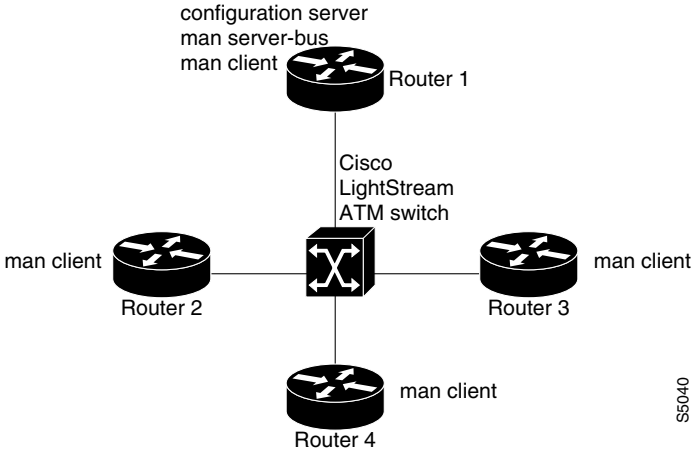
In a single emulated LAN scenario, the LANE components might be assigned as follows:

- Router 1 includes the following LANE components:
  - The LANE configuration server (one per LANE switch cloud)
  - The LANE server and broadcast-and-unknown server for the emulated LAN with the default name *man* (for Manufacturing)
  - The LANE client for the *man* emulated LAN.
- Router 2 includes a LANE client for the *man* emulated LAN.

- Router 3 includes a LANE client for the *man* emulated LAN.
- Router 4 includes a LANE client for the *man* emulated LAN.

Figure 18 illustrates this single emulated LAN configured across several routers.

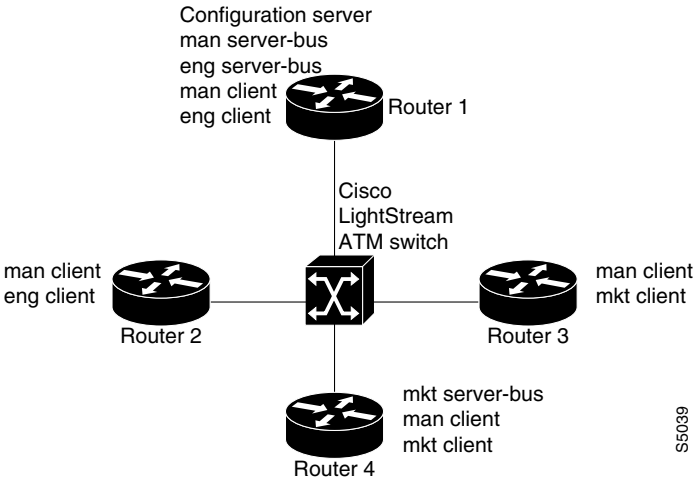
Figure 18 Single Emulated LAN Configured on Several Routers



Multiple Emulated LAN Scenario

In the multiple LAN scenario, the same switch and routers are used, but multiple emulated LANs are configured. See Figure 19.

Figure 19 Multiple Emulated LANs Configured on Several Routers



In the following scenario, three emulated LANs are configured on four routers:

- Router 1 includes following LANE components:
  - The LANE configuration server (one per LANE switch cloud)
  - The LANE server and broadcast-and-unknown server for the emulated LAN called *man* (for Manufacturing)
  - The LANE server and broadcast-and-unknown server functions for the emulated LAN called *eng* (for Engineering)
  - A LANE client for the *man* emulated LAN
  - A LANE client for the *eng* emulated LAN
- Router 2 includes only the LANE clients for the *man* and *eng* emulated LANs.
- Router 3 includes only the LANE clients for the *man* and *mkt* (for Marketing) emulated LANs.
- Router 4 includes the following LANE components:
  - The LANE server and broadcast-and-unknown server for the *mkt* emulated LAN
  - A LANE client for the *man* emulated LAN
  - A LANE client for the *mkt* emulated LANs

In this scenario, once routing is enabled and network level addresses are assigned, Router 1 and Router 2 can route between the *man* and the *eng* emulated LANs, and Router 3 and Router 4 can route between the *man* and the *mkt* emulated LANs.