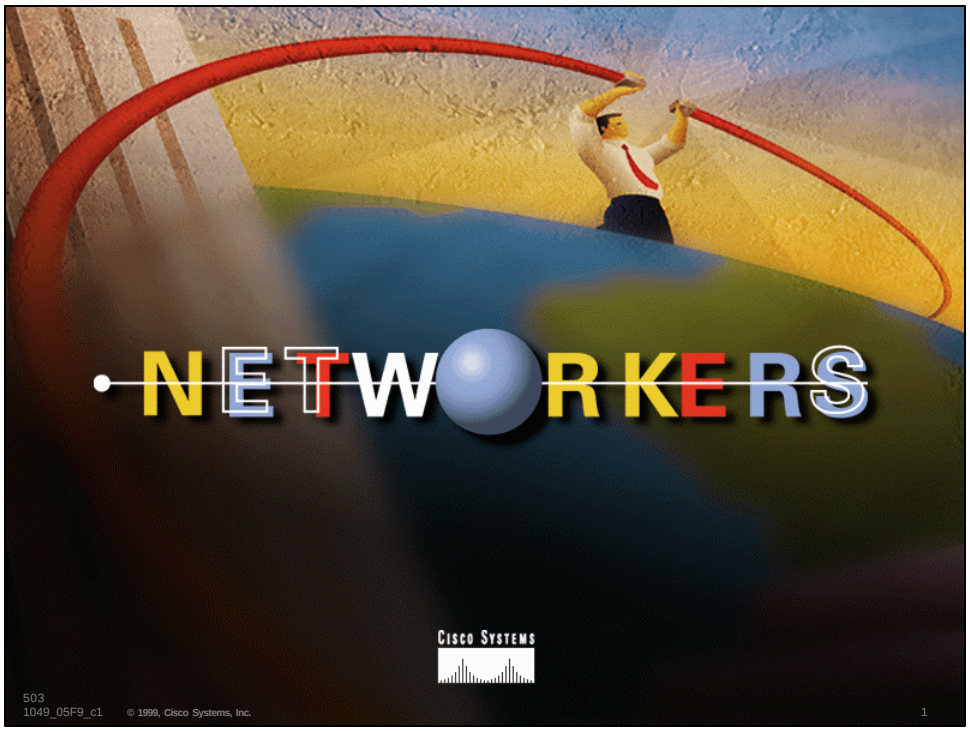
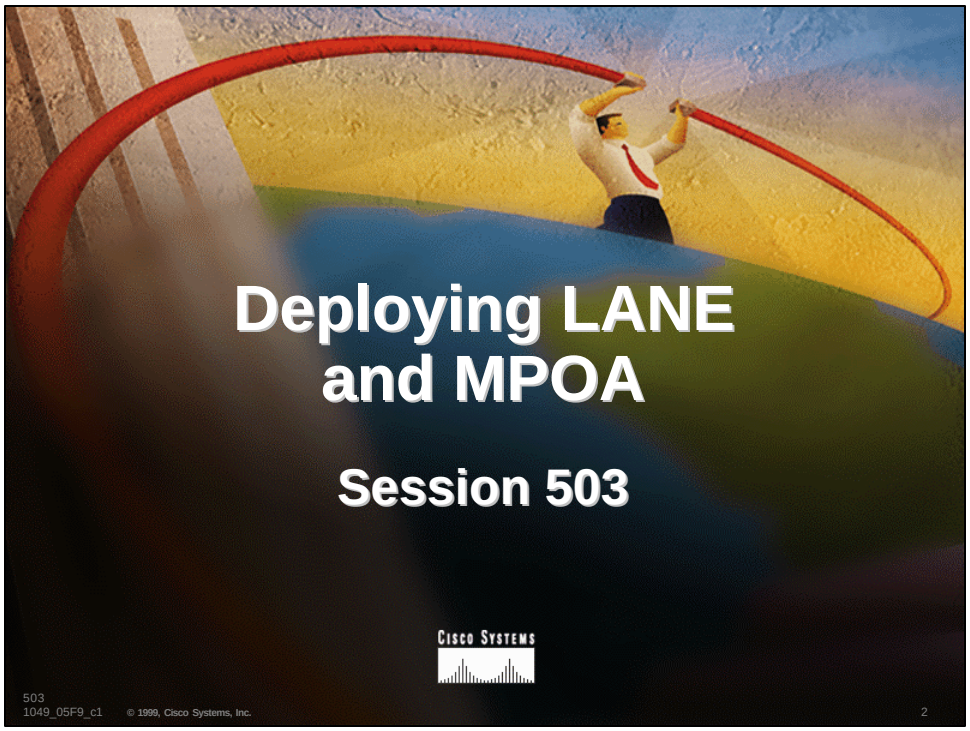




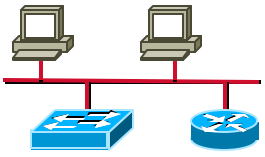
1049_05F9_c1.scr

Agenda

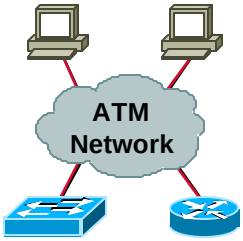
MPOA

- Introduction—LANE, SSRP, MPOA
- MPOA Building Blocks and Architecture
- MPOA Operation and Data Transfer
- MPOA Summary

LAN Emulation



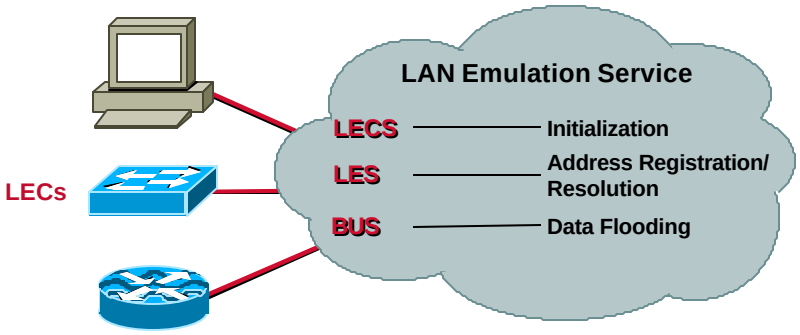
Physical LAN Segment



ELAN Segment

- Hides ATM to upper layers
- Makes ATM look like Ethernet/Token Ring
- Supported in NICs, LAN switches, ATM routers
  - Transparent to ATM switches

LANE Components and Services



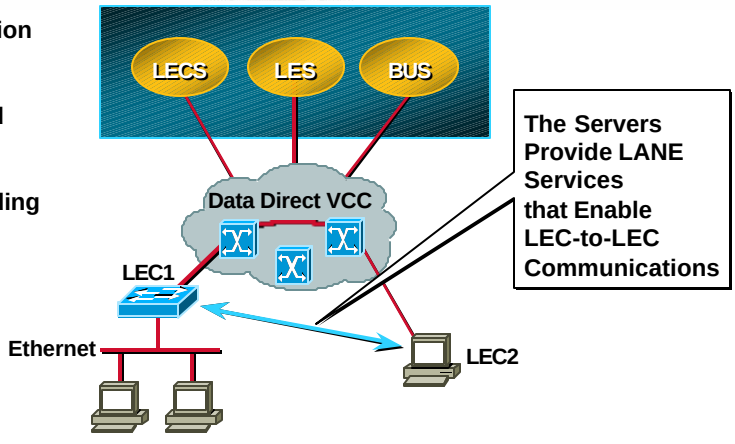
LEC	LAN Emulation Clients
LECS	LANE Configuration Server
BUS	Broadcast and Unknown Server
LES	LANE Server

LAN Emulation

LECS: Initialization

LES: Address Registration and Resolution

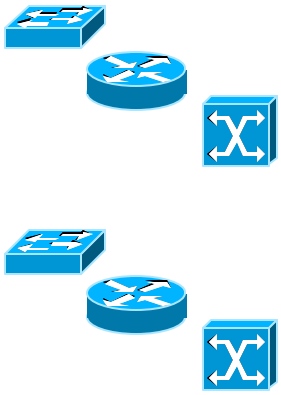
BUS: Data Flooding



- End goal—Data Direct VCC (SVC) between LEC1 and LEC2

Cisco Campus ATM LANE Products LANE Functionality Supported

- LEC
  - Catalyst® 5000, 5500, 3xxx, 28xx
  - Cisco 7xxx, 4xxx series
  - LightStream® 1010, Catalyst 85xx MSR
- LES, BUS, LECS
  - Catalyst 5000, 5500
  - Catalyst 3xxx (separate modules)
  - Cisco 7xxx, 4xxx series
  - LS1010, Catalyst 85xx MSR



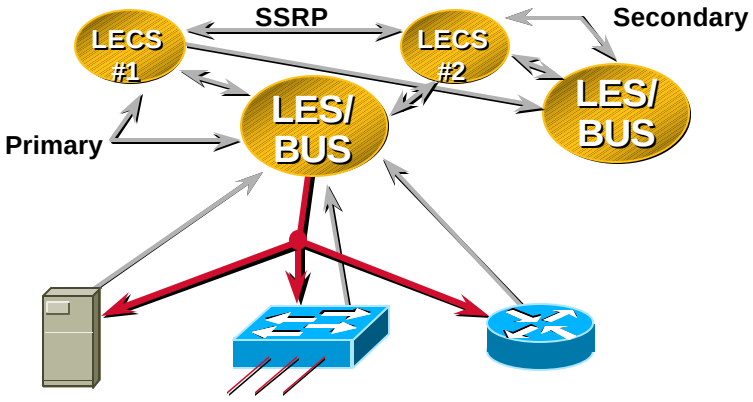
LANE v1.0—No Redundancy

- LANE 1.0 does not address service redundancy
  - More than one LES/BUS per ELAN is not allowed with LANE v1.0
- Cisco's SSRP addresses the redundancy issue

Cisco Redundancy Solutions

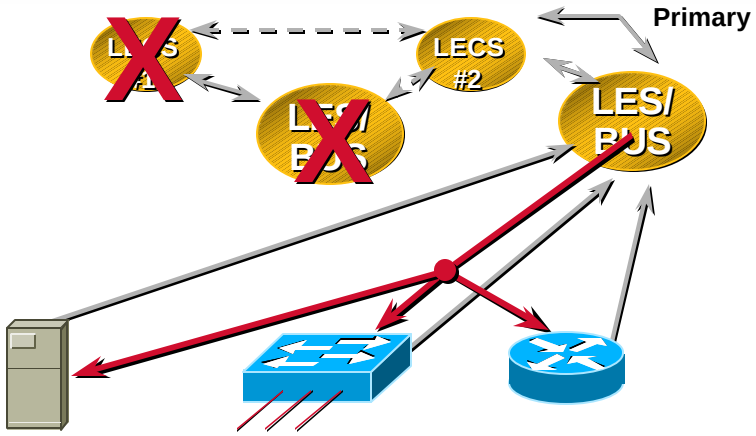
Feature	Benefit
• Cisco's Simple Server Redundancy Protocol (SSRP) • Cisco's HSRP for LAN Emulation • PNNI Parallel Links • Dual-Physical Catalyst 5000 LANE Card • Spanning Tree/VLAN	• LECS, LES/BUS Redundancy • Inter-VLAN Routing Redundancy • Link Redundancy • Dual-Homing in ATM Backbone • Loop Detection

Cisco LANE Service Redundancy—SSRP



- **Cisco-specific solutions for redundancy exist:**
  - **Cisco SSRP (Simple Server Redundancy Protocol)**
  - **An interim solution prior to LANE 2.0**

LANE—Cisco Server Redundancy



- Each LECS has a different set of LES/BUS in case the primary LES/BUS fails

Cisco SSRP

- Any standard LANE 1.0 LEC can participate:
  - Must support ILMI completely
  - Must contact successive LECSs should one not respond during initialization
- LECS discovery by LEC (in mandated order):
  - Preconfigured static definitions
  - Via ILMI
  - Via well known LECS ATM address
  - Via well known LECS VPI/VCI: 0/17
- Well known LECS mode requires Cisco's PNNI

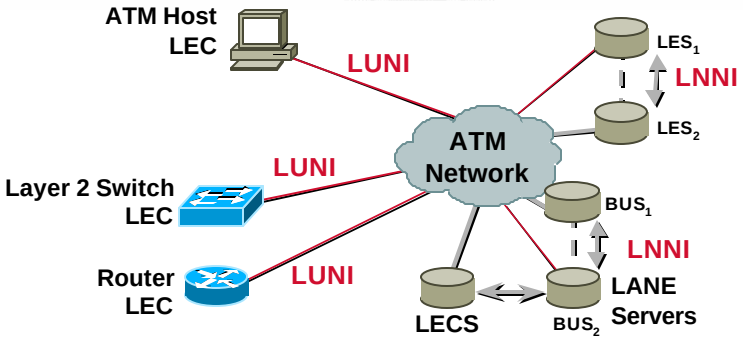
Cisco SSRP—Requirements

- SSRP requires Cisco platforms for LE services

- SSRP support in Cisco router platforms in Cisco IOS® software 11.2+

- SSRP support in Cisco Catalyst 5000 LANE module in software 3.1+

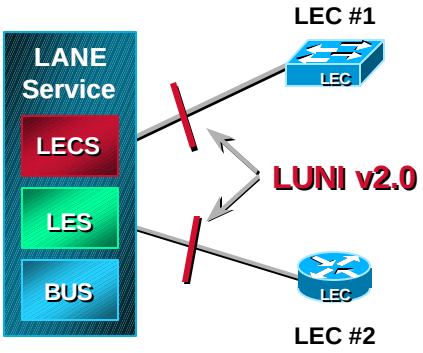
LANE v2.0—LUNI v2.0 + LNNI



- LANE 2.0—LUNIv2 + LNNI
  - LUNIv2—An update to LUNIv1
  - LNNI—Server-to-server interface
- LANE 2.0 supports a mix of v1 and v2 clients

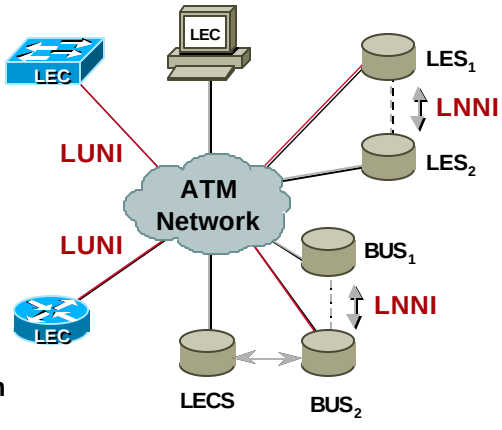
LANE 2.0—LUNI 2.0 Enhancements

- LUNI v2 adds scalability features to LANE 1.0
  - Flow multiplexing over a VC
  - QOS and ABR support
  - Allows for special multicasting service (SMS)

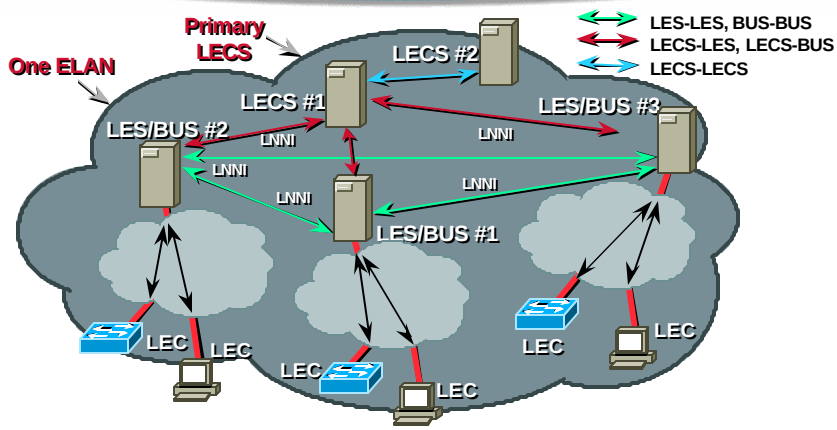


LANE 2.0—LNNI

- LNNI improve LANE robustness
  - LNNI allows for multiple servers
    - LES-LES, BUS-BUS
    - LES-LECS, BUS-LECS
  - LANE 1.0 has no mention of LNNI
  - Backward compatible with LUNI 1.0
- LECS redundancy—identical to Cisco's SSRP



LANE 2.0—Multiple Server Support

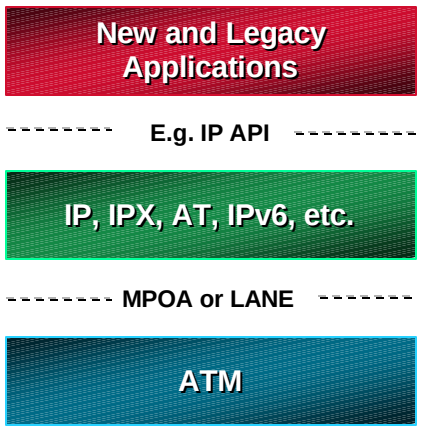


- The primary LECS is in communication with all LES/BUS servers
- Only one active LECS per ELAN
- LES/BUS communicate among themselves via LNNI

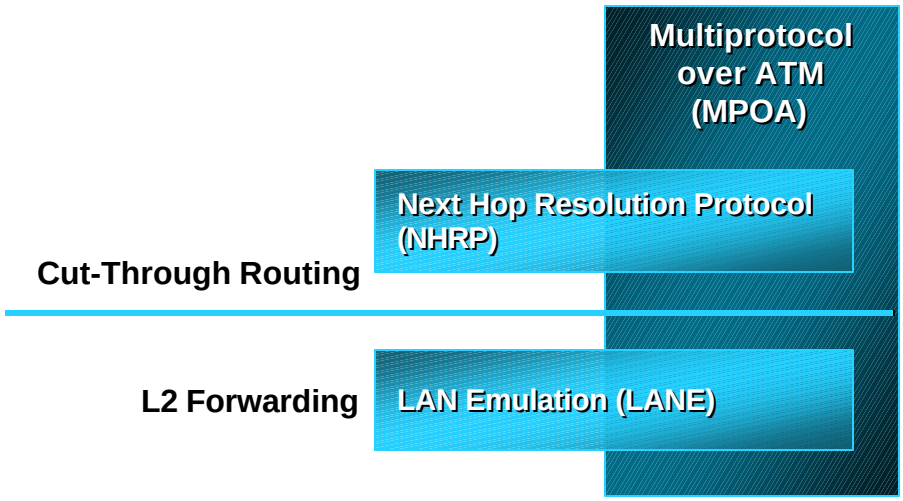
MPOA

- A standard approach to forwarding Layer 3 unicast packets directly over ATM network between ELANs (or subnets)

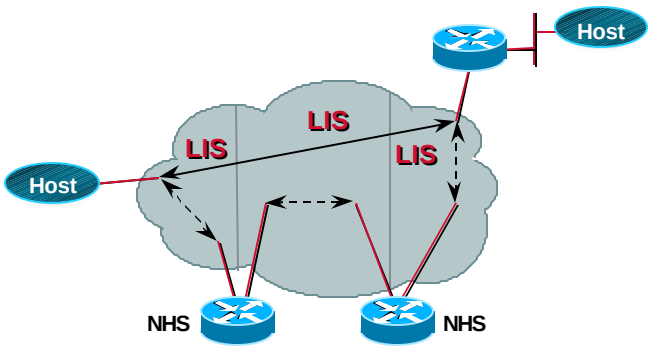
  ATM Forum MPOA was ratified in June 1997



MPOA—Building Blocks

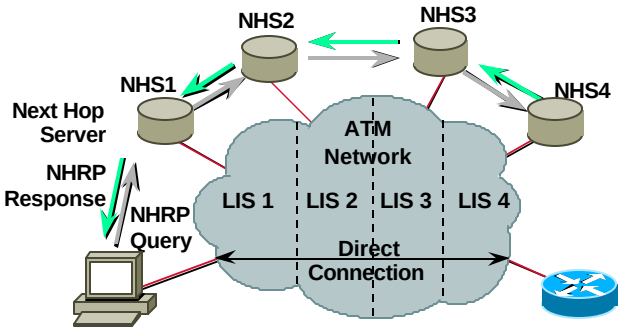


MPOA Building Blocks—NHRP



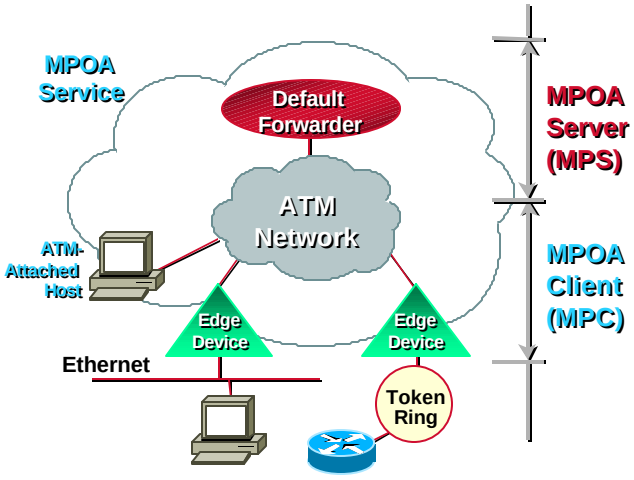
- NHRP allows direct connection between LIS's across the "ATM cloud"

NHRP Operation



- A query follows the routed path
- NHS—Similar to ARP servers, resolves IP to ATM

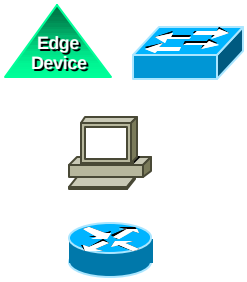
MPOA—Architecture



- MPOA has two logical components: MPC and MPS

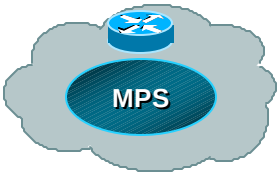
MPOA Client—MPC

- A protocol entity that implements the client side of the MPOA protocol
  - MPC has a LANE client (LEC)
  - To support intersubnet short-cut paths, the MPC must support L3 forwarding functions similar to those performed by a router
- MPC (and LEC 2.0) are backward compatible with LEC 1.0
  - They can coexist in the same ELAN/subnet
- MPC resides on edge devices where the LANE clients are
  - Such as the Catalyst 5xxx, ATM-attached host (file server) and Cisco 7xxx/4xxx routers



MPOA Server (MPS)

- A protocol entity that implements the server side of the MPOA protocol
- MPS answers MPOA resolution queries for L3 into ATM addresses
- MPS resides on a router
  - MPS must reside in the ELAN's default forwarder and where routing protocols are run (routers)
- Router acts as default data forwarder
- MPOA does not eliminate the need for routing in the network



Cisco MPS Platforms

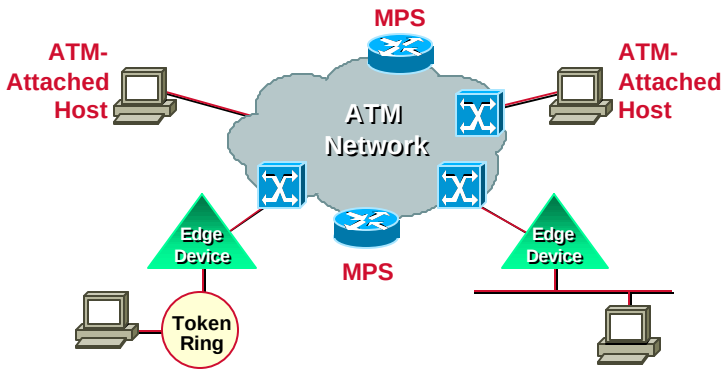
- The MPS functionality is available on the Route Switch Processor (RSP)-based router platforms and Cisco 4x00 routers only
- Cisco 7500 with either ATM Interface Processor (AIP) or Versatile Interface Processor (VIP)+ATM port adapter (PA)
- Cisco 7200 + ATM PA (not via the ATM circuit emulation services [CES] module)
- Cisco 4x00 + ATM interface module
- Catalyst 5x00 route switch module (RSM) with locally attached VIP + ATM PA

Cisco MPS Platforms

- Cisco 7000 with RSP or 7500

  (With AIP or VIP + ATM port adapter)
- Cisco 7200 with ATM port adapter
- Cisco 4x00 with ATM interface
- C5x00 RSM with local VIP + port adapter

MPOA—"Distributed Router" Concept



- Together the MPS and edge devices form a distributed router
  - MPSs run routing protocols and supply routes to the edge devices
  - MPOA clients (edge devices or ATM-attached hosts) do most of the switching

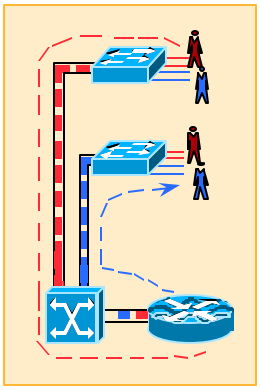
MPOA Operation—Data Transfer

- Intra-subnet (Intra-ELAN)
  - LANE operation
- Inter-subnet (Inter-ELAN)
  - For the Inter-subnet communication there are two data transfer modes:
  - 1. Default path—Router-to-router packet relay
  - 2. Shortcut path—Short-cut VCCs that bypass routers

MPOA Inter-ELAN Default Path

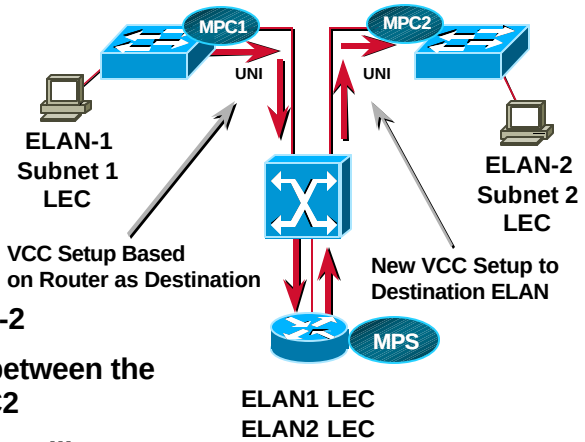
- **Initially packets routed between ELANs (by "the router)**

  The router now learns :the IP-to-MAC and the MAC-to-ATM address mappings which corresponds to how each host can be reached



MPOA Inter-ELAN Data Transfer: Default Path

- **VC setup from the MPC1 to the router**
- **MPC1 sends data to router**
- **Router routes the packet to ELAN-2**
- **Another VC setup between the router and the MPC2**
- **All inter-ELAN traffic will go through the router**

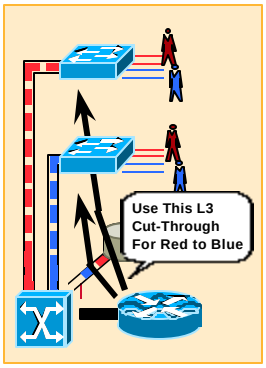


MPOA—Default Path

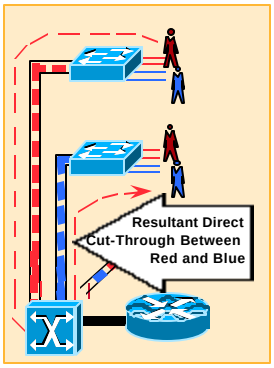
- There are diversity of TCP/IP applications. Some do not want the VC setup overhead nor require a dedicated VC
  - No VC—Connectionless packet forwarding (default path/default forwarder)
- Candidates for just sending the packet to the default forwarder:
  - Short duration traffic, e.g., DNS query, Ping, SNMP polling, SMTP
  - Inter-subnet multicast forwarding

MPOA Inter-ELAN Data Transfer: Shortcut Path

L3 Cut-Through Forwarding Info Given to Edge Devices



Inter-VLAN Traffic via Resultant Direct Cut-Through Connection



Flow—Definition

- When certain number of packets (ATM Forum default value is 10, Cisco default value is 10) are sent to the same destination in a given time (ATM Forum default value is 1 sec, Cisco default value is 1 sec), then the MPC detects a “significant” flow
  - When a “significant” flow is detected address resolution is requested

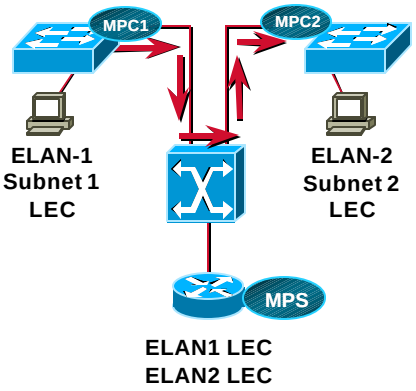
Flow Detection—MPC Ingress Cache

Interesting Dest MAC	Destination L3 Address	Count	ATM Address or VCC

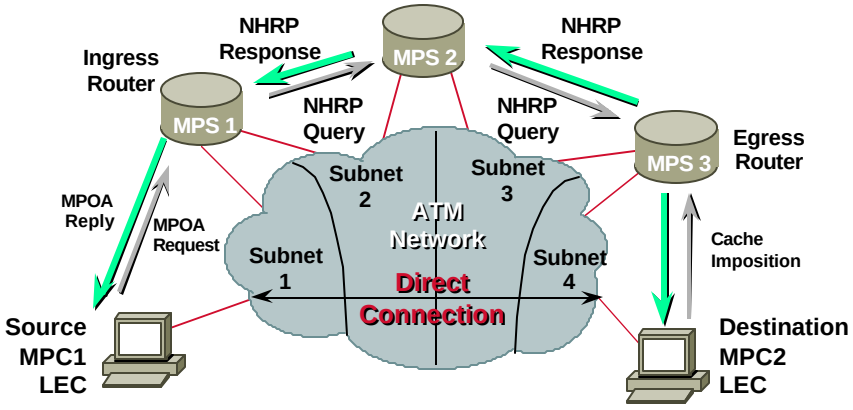
- MPC parses Dest MAC Address for “interesting address”
  - Interesting address—router (known from config. flow)
- If count below threshold, sends to router
  - Threshold is a configurable parameter
- If count above threshold, sends address resolution request to MPS to establish shortcut VCC

MPOA Inter-ELAN Data Transfer: Shortcut Path

- MPC1 detects a flow and issues a "MPOA resolution request" to MPS
- The MPS/router sends a reply (MPOA resolution response)
  - Before any reply is sent to a query, the MPS sends a cache imposition message to MPC2 to validate forwarding info
- Layer 3-to-ATM address gets resolved
- A shortcut SVC is set up directly



MPOA—Query and Response



- Multiple subnets operation
- MPOA intersubnet shortcut path

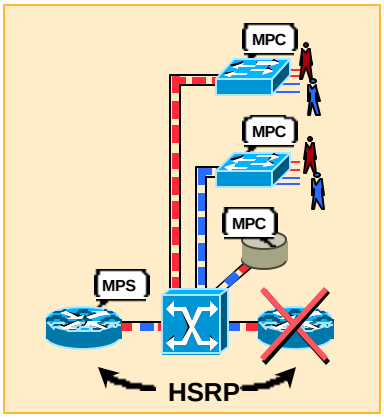
MPOA—Query and Response

- MPC1 detects the flow and wants a direct connection to MPC2
- MPC1 issues an MPOA-resolution-request to MPS1, but MPS 1 cannot see MPC2
- The query follows the routed path (from MPS1 to MPS2 to MPS3). MPS3 knows the ATM address of MPC2
- MPS3 sends a MPOA-resolution-response reply back along the same path
  - Before any reply is sent to a query, the MPS sends a cache imposition message to the destination MPC to validate forwarding information
- Layer 3-to-ATM address gets resolved
- A shortcut SVC across multiple subnets is established
- MPC1 diverts all subsequent data traffic from the default path to the shortcut SVC

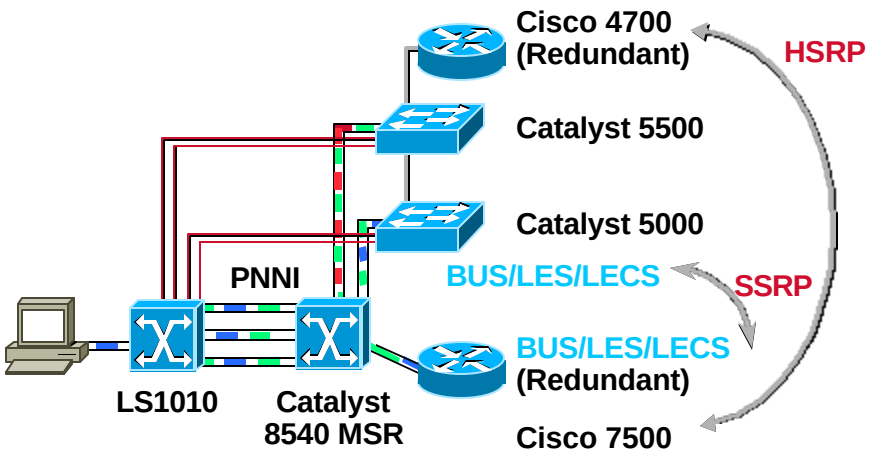
MPOA and HSRP

- Cisco's HSRP, operating on LANE, can provide for a backup MPS if the backup default router in HSRP over LANE has the MPS turned on
  - With HSRP, MPS is not a single point of failure
- The redundancy is facilitated by the fact that the MPC and MPS autodiscover each other during normal LANE (LE_ARP) operation

MPS/HSRP Redundancy

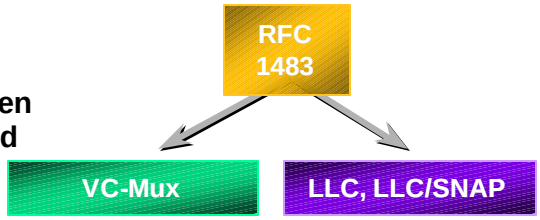


Cisco Redundancy Solutions



MPOA—Data Encapsulation

- **Flow multiplexing**
  - All data transfer between devices in MPOA-based network are encapsulated using LLC/SNAP as defined in RFC 1483
  - LLC/SNAP encapsulation mechanism allows sharing of VCs in MPOA environment



Catalyst 5XXX—ATM Uplink

- OC-3
  - OC-3 link redundancy (dual-phy)
  - LANE will not support MPC
  - Can coexist (MPOA is backwards compatible)
  - WS—X5156, WS—X5157, WS—X5158
- OC-12
  - OC-12 link redundancy (dual-phy)
  - WS—X5161

Catalyst 5xxx OC-12

- 4,096 virtual circuits
- As a standalone LANE 1.0 BUS, WS-X5161 can forward over 500,000+ pps
- ILMI
- PVC traffic shaping (GCRA) (future software upgrade)
- Requires supervisor release 3.2

WS-X5161 ATM Standards

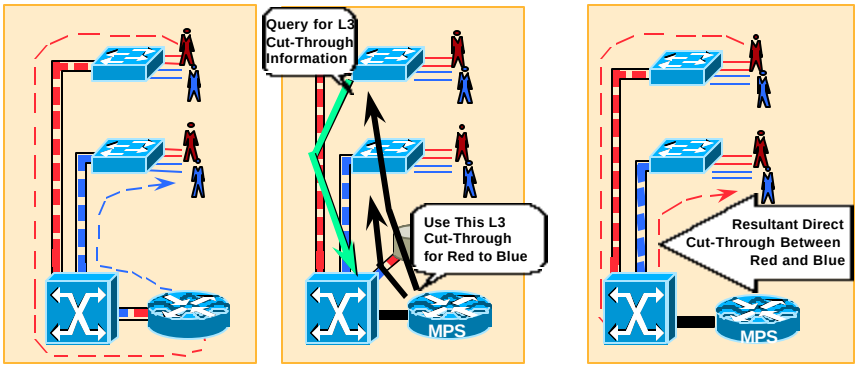
- LANE v1.0/v2.0 LEC, LECS, LES, BUS
- SSRP
- MPOA v1.0 MPC over Ethernet LANE

- UNI 3.0/3.1, Q.2931, UNI 4.0 (future software upgrade)
- RFC 1483 LLC/SNAP bridging encapsulation (PVC)

MPOA—Summary

- MPOA will use LANE as a L2 forwarding mechanism
- MPOA uses NHRP for inter-subnet address resolution
- LANE clients will interoperate with the MPOA architecture
  - MPCs (and LE clients 2.0) are backward compatible with LE clients 1.0
- MPOA doesn't specify a routing protocol
  - MPOA assumes a network-level routing protocol (e.g., IGRP, OSPF) is used between MPSs/route servers
- MPS/router forwards traffic between subnets
- Multicast traffic will go through default path

MPOA Operation—Summary



- MPS forwards and responds to MPOA/NHRP queries to provide the info needed for shortcut VC
- MPC detects flow and setup shortcut VCs

MPOA—References

- http://www.mpoa.com
  Many MPOA and MPOA-related white papers
- http://www.atmforum.com/atmforum/specs/approved.html
  An up to date listing of ATM Forum specs
- http://infonet.aist-nara.ac.jp/member/nori-d/mlr/
  Multilayer routing information
- http://www.cisco.com/univercd/cc/td/doc/product/software/ios112/sbook/satm.htm
  Describes the function and displays the syntax of ATM commands
- http://wwwin/Mkt/cc/cisco/mkt/switch/ls1010/mpoas_qa.htm
  MPOA questions and answers
- http://wwwin.cisco.com/Mkt/cc/sol/mkt/ent/atm/gen/atmgt_ov.htm
  Glossary of ATM terms and acronyms

Glossary

- **MPOA—Multiprotocol over ATM**
  - ATM Forum working group, specifying a generic solution for transport of routable and non-routable protocols over ATM
- **LANE—LAN Emulation**
  - ATM Forum working group, specified LANE V1.0 emulating an Ethernet or Token Ring over ATM; specifying LANE V2.0
- **PNNI—Private Network Node Interface**
  - ATM Forum working group, specified PNNI V1.0 which is an ATM Signaling and ATM routing protocol for ATM switch-to-ATM switch interface
- **MPC—MPOA Client**
  - MPOA component in an edge device (i.e., legacy to ATM) and in MPOA ATM attached hosts
- **MPS—MPOA Server**
  - MPOA component acting as route servers for MPOA target resolution by MPOA clients

Glossary

- **LIS—Logical IP Subnet**
  - Akin to subnet in classical IP (RFC1577) model over ATM
- **MCS—Multicast Server**
  - Server multicasting IP multicast packet using ATM point-to-multipoint connections for support of IP multicast over ATM
- **NHRP—Next-Hop Resolution Protocol**
  - Protocol for cut-through routing (i.e., avoiding multihop routing) over Non-Broadcast Multiple Access (NBMA) networks including ATM networks, specified in an IETF internet-draft
- **NHS—Next Hop Server**
  - Server handling NHRP queries