LAN Emulation, IP Over ATM and MPOA

Raj Jain
Professor of Computer and Information Sciences

Raj Jain is now at
Washington University in Saint Louis
Jain@cse.wustl.edu
http://www.cse.wustl.edu/~jain/
Overview

- LAN Emulation
- Classical IP over ATM
- Next Hop Resolution Protocol (NHRP)
- Multiprotocol over ATM (MPOA)
LAN Emulation: Features

- One ATM LAN can be $n$ virtual LANs
- Logical subnets interconnected via routers
- Need drivers in hosts to support each LAN
- Only IEEE 802.3 and IEEE 802.5 frame formats supported. (FDDI can be easily done.)
- Doesn't allow passive monitoring
- No token management (SMT), collisions, beacon frames.
- Allows larger frames.

| LE Header (2 Bytes) | IEEE 802.3 or 802.5 Frame |
LAN Emulation

- LAN Emulation driver replaces Ethernet driver and passes the networking layer packets to ATM driver.
- Each ATM host is assigned an Ethernet address.
- LAN Emulation Server translates Ethernet addresses to ATM addresses.
- Hosts set up a VC and exchange packets.
- All software that runs of Ethernet can run on LANE.
LAN Emulation

1. Client gets recipient's address from LES and sets up a VC.

2. Client sends messages on the VC.

3. Messages for ATM clients are delivered directly.

4. Messages for non-ATM clients are forwarded through bridges.
Protocol Layers

ATM Host

Applications

IP
IPX

NDIS
ODI

LAN Emulation

AAL5

ATM

Physical Layer

ATM

Phy Layer

ATM Switch

Bridge

LAN Host

Applications

IP
IPX

NDIS
ODI

LAN Emulation

AAL5

ATM

Phy Layer

Media Access Control

Physical Layer

The Ohio State University

Raj Jain
Protocol Layers (Cont)

- NDIS = Network Driver Interface Specification
- ODI = Open Datalink Interface
- IPX = NetWare Internetworking Protocol
- LAN Emulation Software:
  - LAN Emulation Clients in each host
  - LAN Emulation Servers
  - LAN Emulation Configuration server (LECS)
  - LAN Emulation Server (LES)
  - Broadcast and unknown server (BUS)
Operation

- **Initialization:**
  - Client gets address of LAN Emulation Configuration Server (LECS) from its switch, uses well-known LECS address, or well-known LECS PVC
  - Client gets Server's address from LECS

- **Registration:**
  - Client sends a list of its MAC addresses to Server.
  - Declares whether it wants ARP requests.
Operation (Cont)

- Address Resolution:
  - Client sends ARP request to Server.
  - Unresolved requests sent to clients, bridges.
  - Server, Clients, Bridges answer ARP
  - Client setups a direct connection

- Broadcast/Unknown Server (BUS):
  - Forwards multicast traffic to all members
  - Clients can also send unicast frames for unknown addresses
ATM Virtual LANs

- Physical View
  - Router
  - ATM Switch
  - LANE Server A
    - A1
    - B1
  - LANE Server B
    - A2
    - B2

- Logical View
  - Router
    - A1
    - A2
    - B1
    - B2
IP Over ATM
IP Over ATM: Issues

- How many VC’s do we need for n protocols?
  - Packet encapsulation [RFC1483]
- How to find ATM addresses from IP addresses
  - Address resolution [RFC1577]
- How to handle multicast? [MARS, RFC 2022]
- How do we go through $n$ subnets on a large ATM network? [NHRP]
Packet Encapsulation

[RFC1483]

Question: Given an ATM link between two routers, how many VC’s should we setup?

Answer 1: One VC per Layer 3 protocol. Null Encapsulation: No sharing. VC based multiplexing.
Encapsulation (Cont)

- **Answer 2**: Share a VC using Logical Link Control (LLC) Subnetwork Access Protocol (SNAP). LLC Encapsulation

- Protocol Types: 0x0800 = IP, 0x0806 = ARP, 0x809B = AppleTalk, 0x8137 = IPX
Address Resolution

- IP address: 123.145.134.65
  ATM address: 47.0000 1614 999 2345.00.00.AA....

- Issue: IP Address ⇔ ATM Address translation
  - Address Resolution Protocol (ARP)
  - Inverse ATM ARP: VC ⇒ IP Address

- Solution: ATMARP servers
Classical IP Over ATM

- ATM stations are divided into Logical IP Subnets (LIS)
- ATMARP server translates IP addresses to ATM addresses.
- Each LIS has an ATMARP server for resolution
- IP stations set up a direct VC with the destination or the router and exchange packets.
IP Multicast over ATM

- Multicast Address Resolution Servers (MARS)
- Internet Group Multicast Protocol (IGMP)
- Multicast group members send IGMP join/leave messages to MARS
- Hosts wishing to send a multicast send a resolution request to MARS
- MARS returns the list of addresses
- MARS distributes membership update information to all cluster members
Next Hop Resolution Protocol

- Routers assemble packets ⇒ Slow
- NHRP servers can provide ATM address for the edge device to any IP host
- Can avoid routers if both source and destination are on the same ATM network.
Multiprotocol Over ATM

- MPOA = LANE + “NHRP+”
- Extension of LANE
- Uses NHRP to find the shortcut to the next hop
- No routing (reassembly) in the ATM network

---

Multiprotocol Over ATM

Next Hop Resolution Protocol

Multicast Address Resolution Server

LAN Emulation

Routing

Bridging
MPOA (Cont)

- LANE operates at layer 2
- RFC 1577 operates at layer 3
- MPOA operates at both layer 2 and layer 3  
  ⇒ MPOA can handle non-routable as well as routable protocols
- Layer 3 protocol runs directly over ATM  
  ⇒ Can use ATM QoS
- MPOA uses LANE for its layer 2 forwarding
Summary

- LANE allows current applications to run on ATM
- Classical IP allows ARP using ATMARP servers
- NHRP removes the need for routing in an ATM net
- MPOA combines LANE and NHRP
Homework

- Read Chapter 11, 12, and 13 of Sackett and Metz