LAN Emulation, IP Switching and Label Switching

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Pro_____ces

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Overview
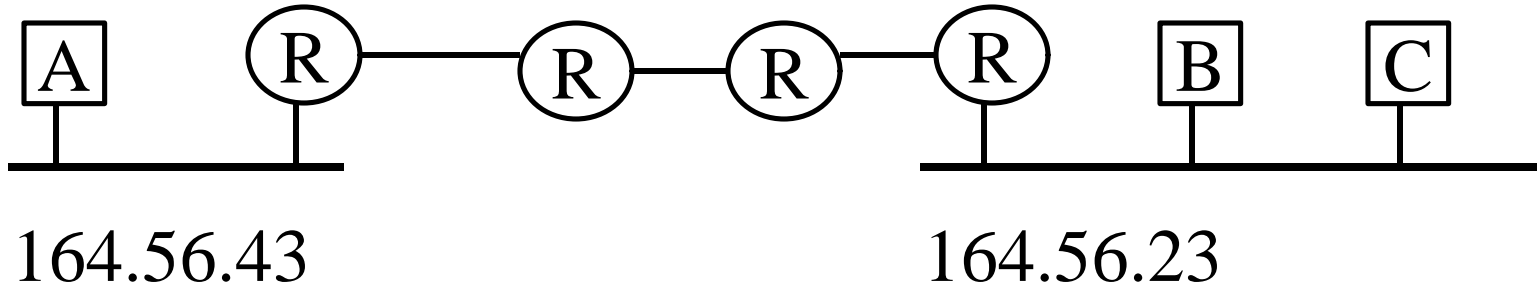
- LAN Emulation
- Classical IP over ATM
- Next Hop Resolution Protocol (NHRP)
- Multiprotocol over ATM (MPOA)
- IP Switching (Ipsilon)
- Tag Switching (CISCO)
- Multi-protocol label switching (MPLS)

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IP Forwarding:Fundamentals

To: 164.56.23.34	From: 164.56.43.96	

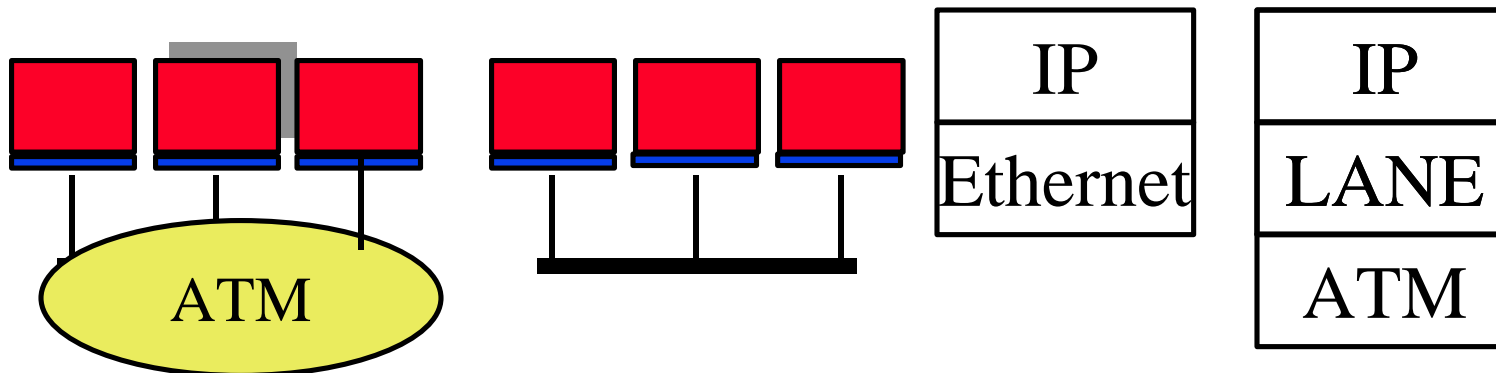164.56.43   164.56.23

❑ IP routers forward the packets towards the destination subnet

❑ On the same subnet, routers are not required.

❑ IP Addresses: 164.56.23.34
Ethernet Addresses: AA-23-56-34-C4-56
ATM : 47.0000 1 614 999 2345.00.00.AA....

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LAN Emulation

| IP |
|---|
| Ethernet |

IP
LANE
ATM

ATM

- ❑ 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
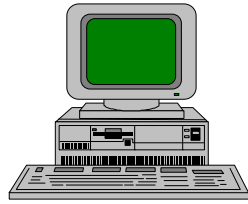- ❑ All software that runs of Ethernet can run on LANE

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LAN Emulation

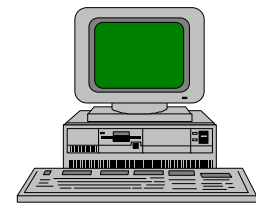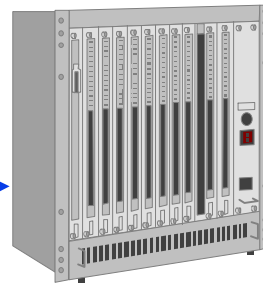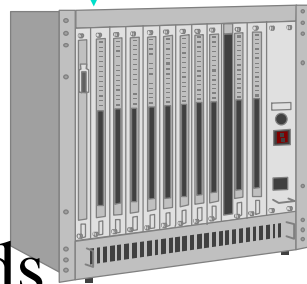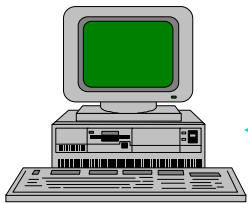1. Client gets recipient's address from LES and sets-up a VC.
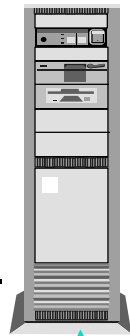
LAN Emulation Server

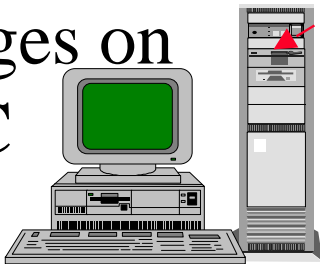3. Messages for ATM clients are delivered directly.
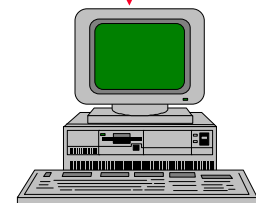
Switches

ATM client B
Bridge

2. Client sends messages on the VC

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

Broadcast/Unknown Server (BUS)

Non-ATM client

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ATM Virtual LANs

❏ Physical View

A1

Router

A2

LANE
Server A

ATM
Switch

LANE
Server B

B1

B2

❏ Logical View

A1

B1

Router

A2

B2
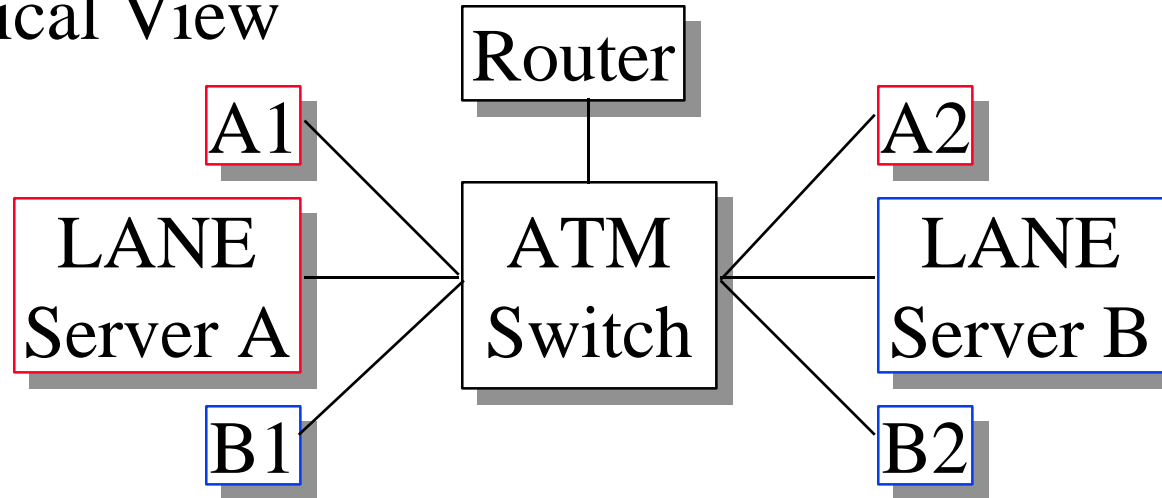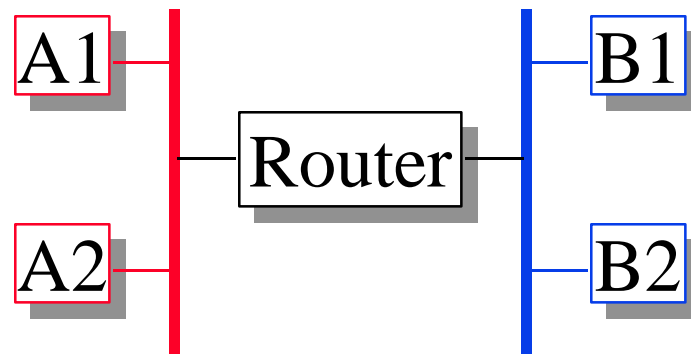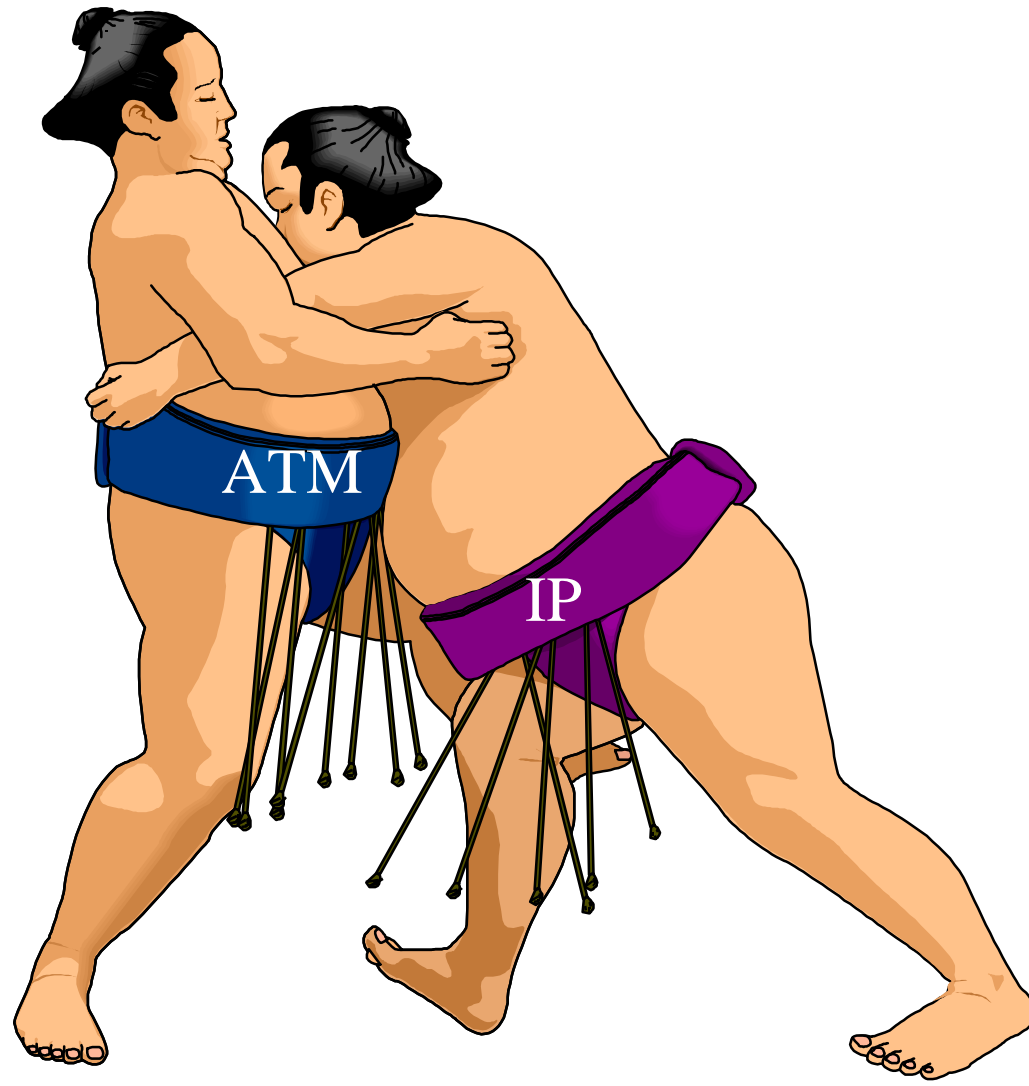
IP Over ATM

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Classical IP Over ATM

	ATMARP Server		Router	B1	ATMARP Server

A2

A1 — LIS 1 LIS 2 — B2
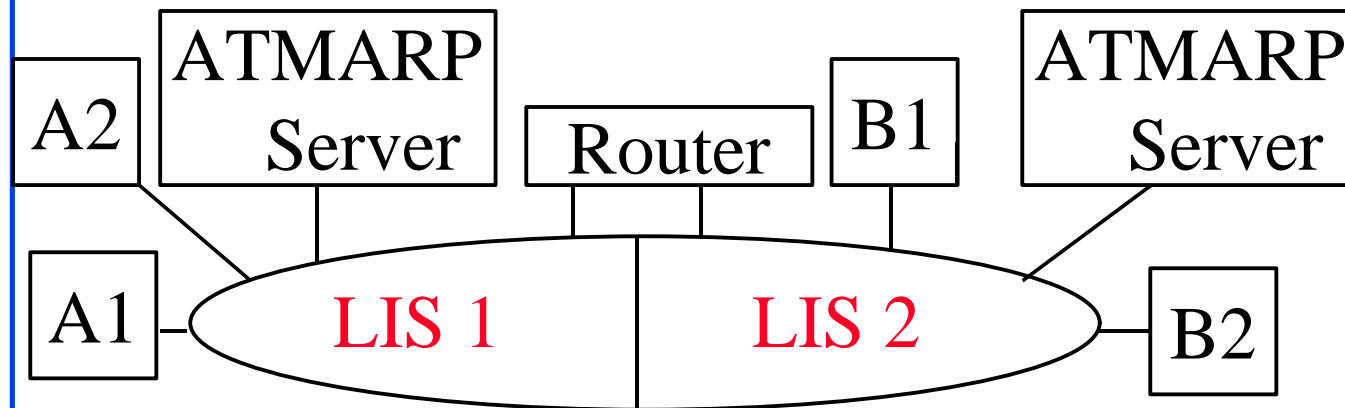
- ❑ ATM stations are divided in to Logical IP Subnets (LIS)

- ❑ 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.

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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 $\Rightarrow$ 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.
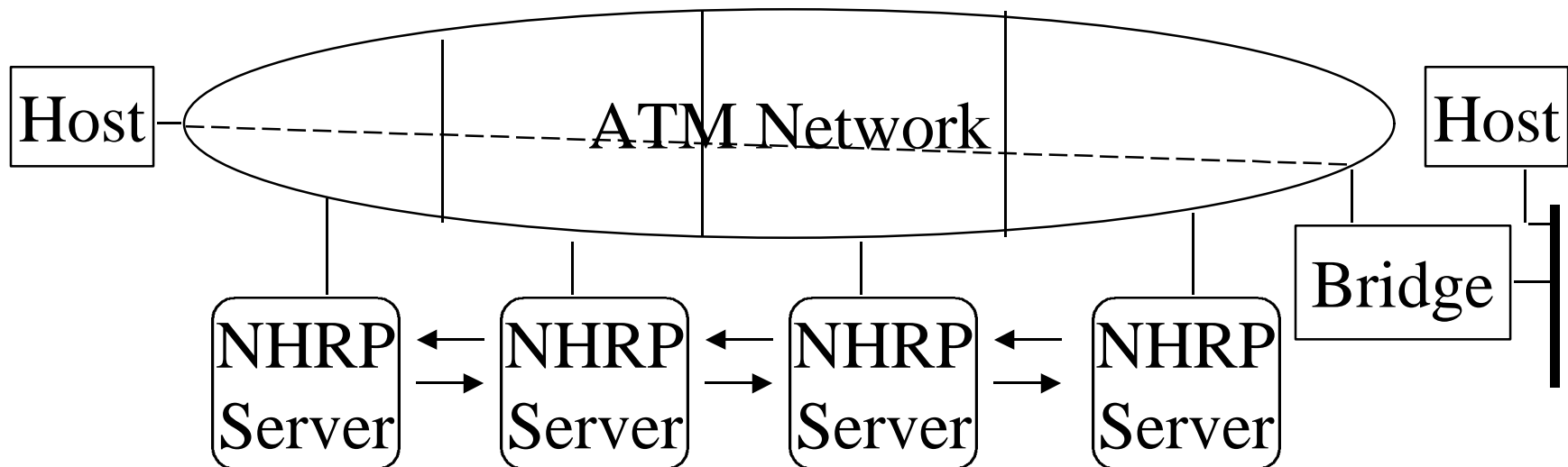
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Multiprotocol Over ATM

❑ 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 Address Resolution

Multicast Address Resolution Server

Routing

LAN Emulation

Bridging

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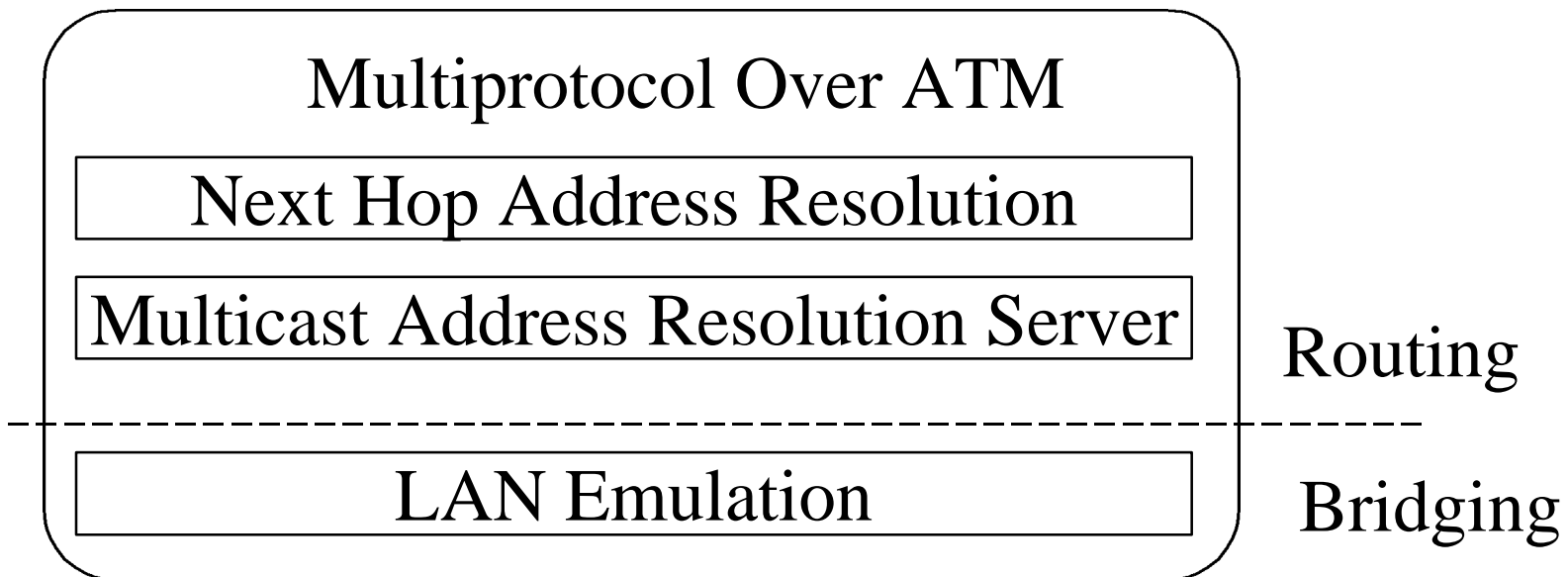
MPOA (Cont)

❑ LANE operates at layer 2

❑ RFC 1577 operates at layer 3

❑ MPOA operates at both layer 2 and layer 3
$\Rightarrow$ MPOA can handle non-routable as well as routable protocols

❑ Layer 3 protocol runs directly over ATM
$\Rightarrow$ Can use ATM QoS

❑ MPOA uses LANE for its layer 2 forwarding
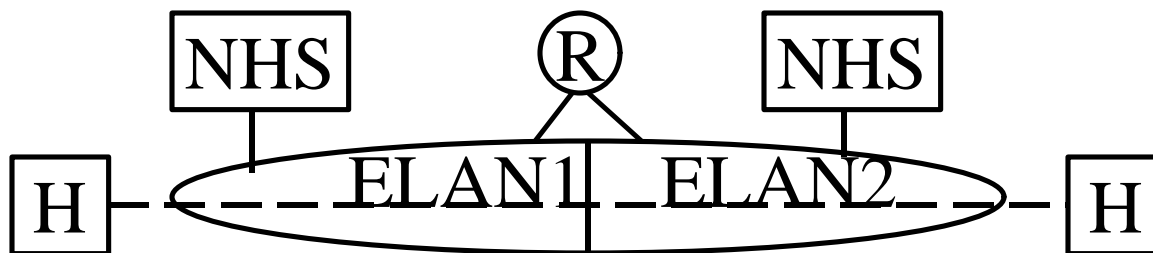
IP Switching

- Developed by Ipsilon
- Routing software in every ATM switch in the network
- Initially, packets are reassembled by the routing software and forwarded to the next hop
- Long term flows are transferred to separate VCs. Mapping of VCIs in the switch $\Rightarrow$ No reassembly
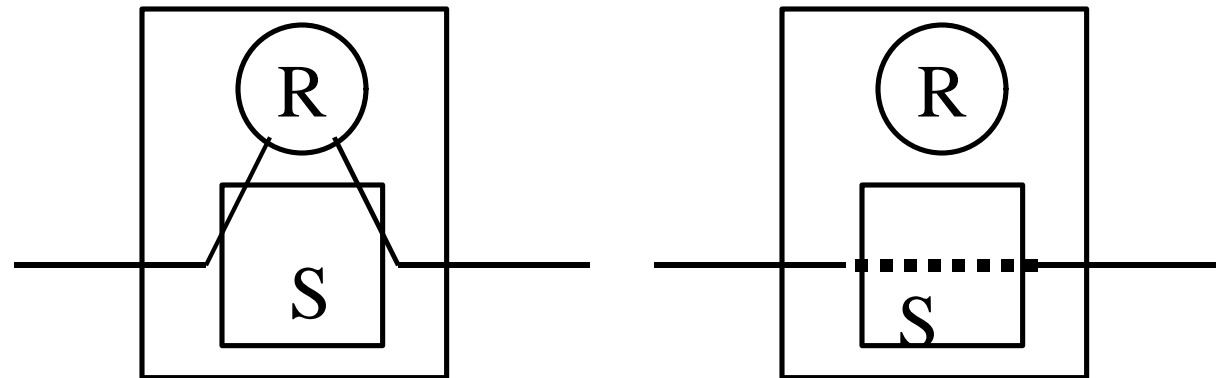
IP Switching (Cont)

❏ Flow-oriented traffic: FTP, Telnet, HTTP, Multimedia

❏ Short-lived Traffic: DNS query, SMTP, NTP, SNMP, request-response Ipsilon claims that 80% of packets and 90% of bytes are flow-oriented.

❏ IP switching implemented as a s/w layer over an ATM switch

❏ Ipsilon claims their Generic Switch Management Protocol (GSMP) to be 2000 lines, and Ipsilon Flow Management Protocol (IFMP) to be only 10,000 lines of code

Tag Switching

❑ Proposed by CISCO

❑ Similar to VLAN tags

❑ Tags can be explicit or implicit L2 header

L2 Header	**Tag**	

❑ Ingress router/host puts a tag. Exit router strips it off.

Untagged Packet

Tagged packet

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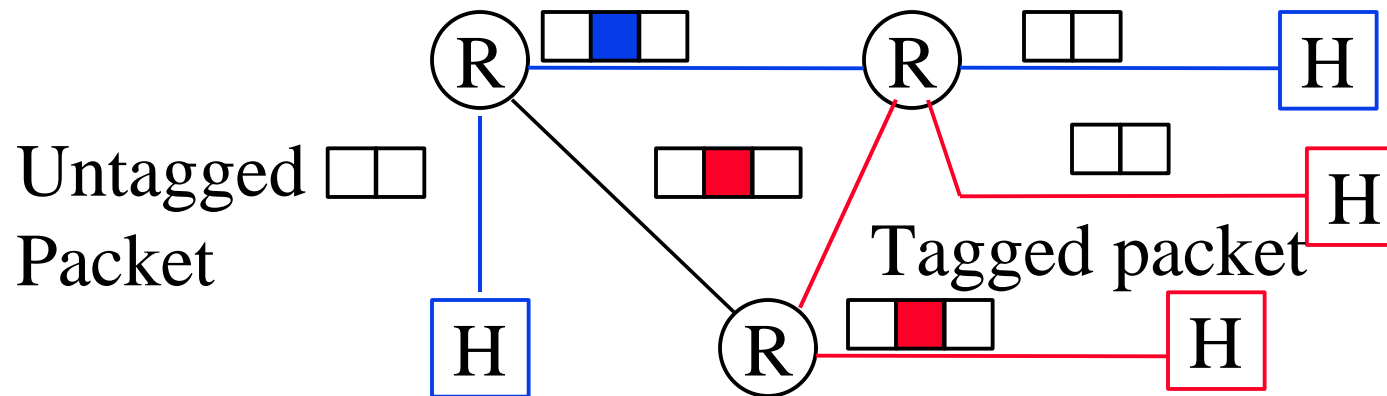
Tag Switching (Cont)

❑ Switches switch packets based on labels.
  Do not need to look inside $\Rightarrow$ Fast.

❑ One memory reference compared to 4-16
  in router

❑ Tags have local significance
  $\Rightarrow$ Different tag at each hop (similar to VC #)

Tag Switching (Cont)

❏ One VC per routing table entry
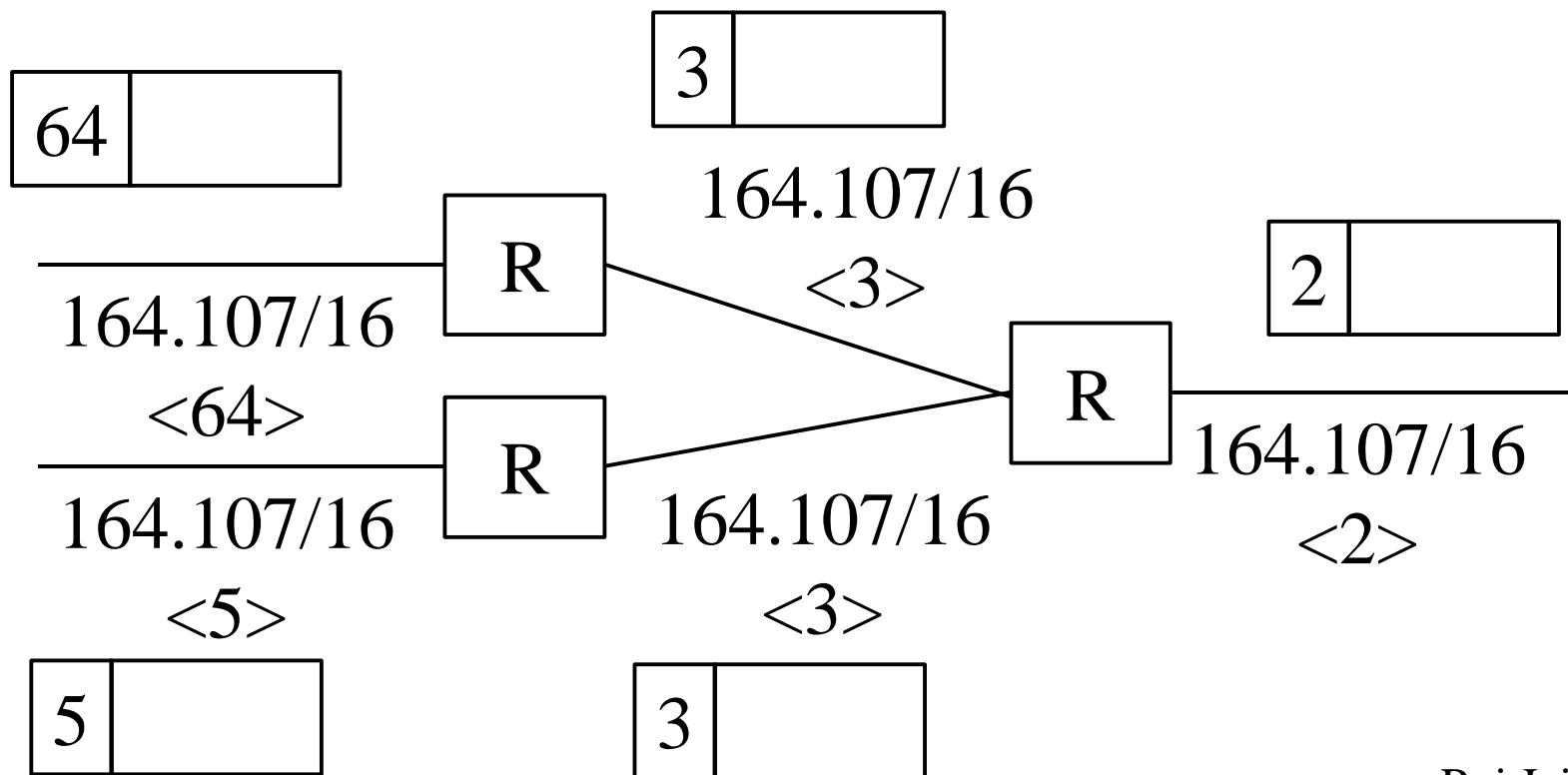
Alphabet Soup

❏ CSR Cell Switched Router

❏ ISR Integrated Switch and Router

❏ LSR Label Switching Router

❏ TSR Tag Switching Router

❏ Multi layer switches, Swoters

❏ DirectIP

❏ FastIP

❏ PowerIP

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MPLS

- Multiprotocol Label Switching
- IETF working group to develop switched IP forwarding
- Initially focused on IPv4 and IPv6. Technology extendible to other L3 protocols.
- Not specific to ATM. ATM or LAN.
- Not specific to a routing protocol (OSPF, RIP, ...)
- Optimization only. Labels do not affect the path. Only speed. Networks continue to work w/o labels

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Label Format

- Labels = Explicit or implicit L2 header
- TTL = Time to live
- CoS = Class of service
- SI = Stack indicator

L2 Header	Label		

| 20b	3b	1b	8b
Label	CoS	SI	TTL

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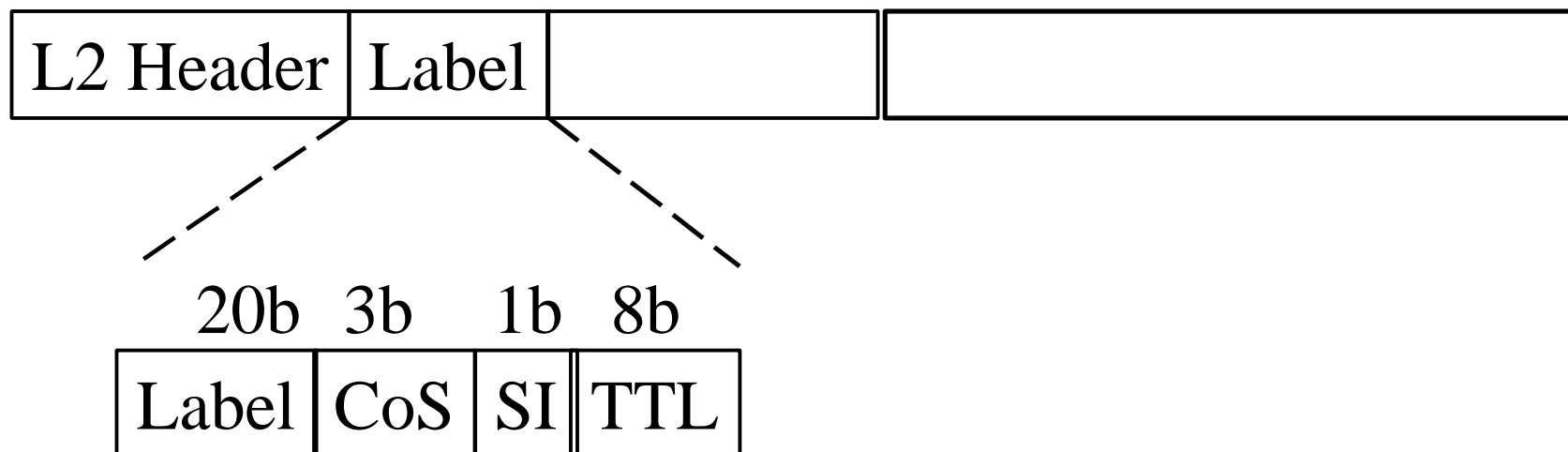
Label Stacks

❑ Labels are pushed/popped
  as they enter/leave MPLS domain

❑ Routers in the interior will use Interior Gateway
  Protocol (IGP) labels. Border gateway protocol (BGP)
  labels outside.

| L2 Header	Label 1	Label 2	•••	Label n	

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MPLS: Issues

❏ Loop prevention, detection, survival

❏ Multicast:
Multiple entries in label information base

❏ Multipath: Streams going to the same destination but different sources/port # may be assigned separate labels.

❏ Host involvement: Label-enabled hosts will avoid first hop reassembly

❏ Security: Label swapping may be terminated before firewall

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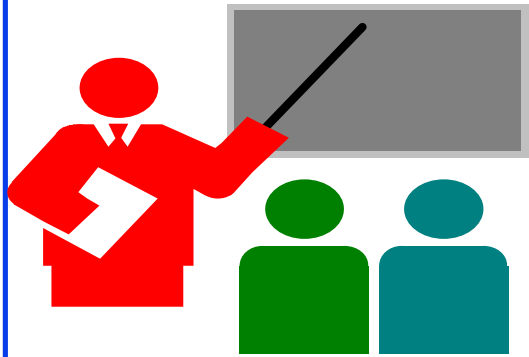
Summary

❏ 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

❏ IP Switching: Traffic-based, per-hop VCs, downstream originated

❏ Tag switching: Topology based, one VC per route

❏ MPLS combines various features of IP switching, CSR, Tag switching, ARIS

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Summary (Cont)

MPLS

MPOA

LANE

NHRP

RFC1577

MARS

Tag

ARIS

IP Switch

CSR

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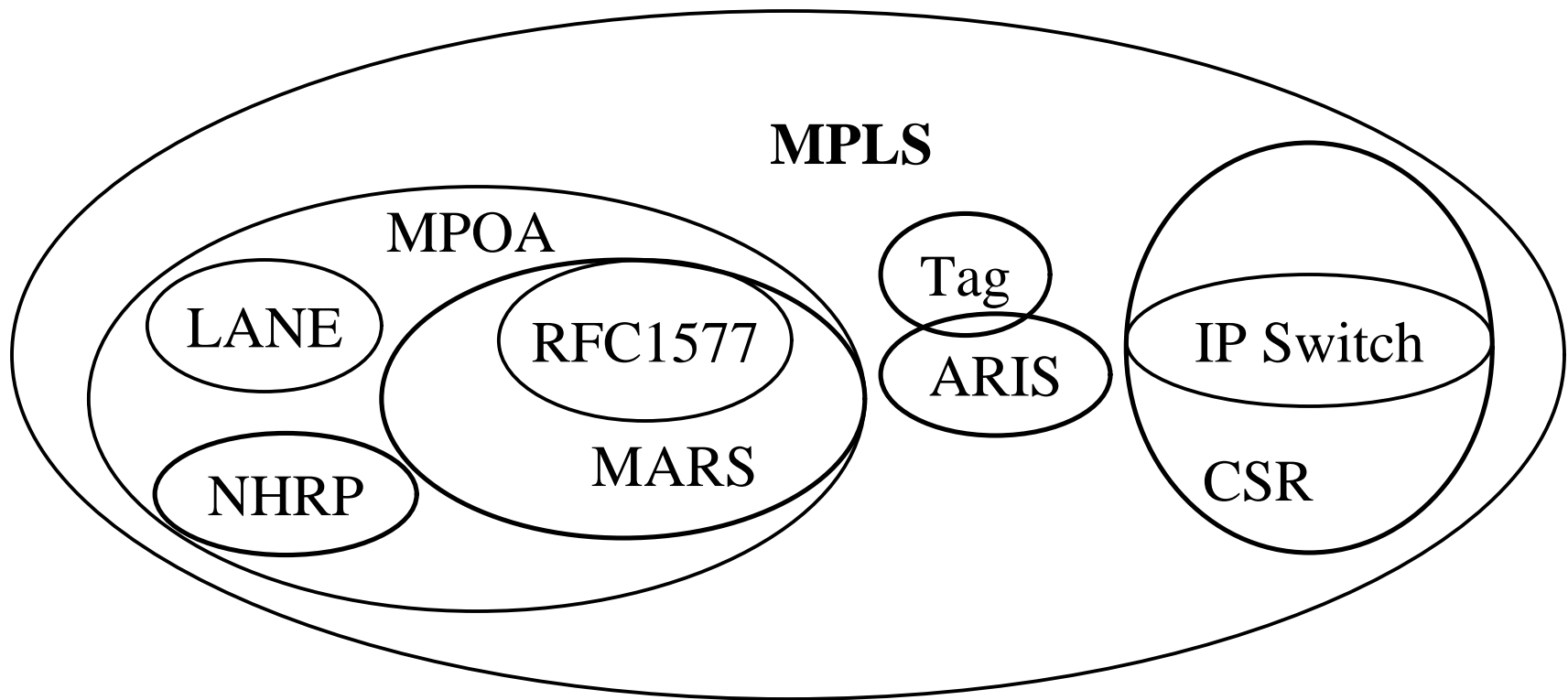
Key References

❑ See **http://www.cis.ohio-state.edu/~jain/refs/ ipoa_ref.htm** and **http://www.cis.ohio-state.edu/~jain/refs/ ipsw_ref.htm**

❑ "A Framework for Multiprotocol Label Switching", 11/26/1997, http://www.internic.net/internet-drafts/draft-ietf-mpls-framework-02.txt

❑ Multiprotocol Label Switching (mpls) working group at IETF. Email: mpls-request@cisco.com

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References (Cont)

❏ ATM Forum, "MPOA V1.0," July 1997, ftp://ftp.atmforum.com/pub/approved-specs/af-mpoa-0087.000.doc

❏ RFC 2332, "NBMA Next Hop Resolution Protocol (NHRP)", ftp://ftp.isi.edu/in-notes/rfc2322.txt , 2/6/98.

❏ RFC 2225, "Classical IP and ARP over ATM," 1/20/94, ftp://ftp.isi.edu/in-notes/rfc2225.txt

❏ LAN Emulation over ATM v1.0 Specification (Jan 1995), ftp://ftp.atmforum.com/pub/approved-specs/af-lane-0021.000.ps

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