LAN Emulation, IP Switching and Label Switching

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- 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)
IP Forwarding: Fundamentals

- 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....
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

Broadcast/Unknown Server (BUS)  Non-ATM client
ATM client B  Bridge
LAN Emulation Server
Switches

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ATM Virtual LANs

- Physical View

- Logical View
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.

![Diagram of NHRP servers and hosts connected through 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

Multicast Address Resolution Server

Routing

Bridging

Next Hop Address Resolution

LAN Emulation
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
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 VCIIs in the switch ⇒ 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

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

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Tag Switching (Cont)

- Switches switch packets based on labels. Do not need to look inside ⇒ Fast.
- One memory reference compared to 4-16 in router
- Tags have local significance ⇒ 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
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
Label Format

- Labels = Explicit or implicit L2 header
- TTL = Time to live
- CoS = Class of service
- SI = Stack indicator
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 |
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
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
Summary (Cont)

- RFC1577
- MARS
- ARIS
- Tag
- NHRP
- LANE
- MPOA
- MPLS
- CSR
- IP Switch
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


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