IP Switching and Label Switching

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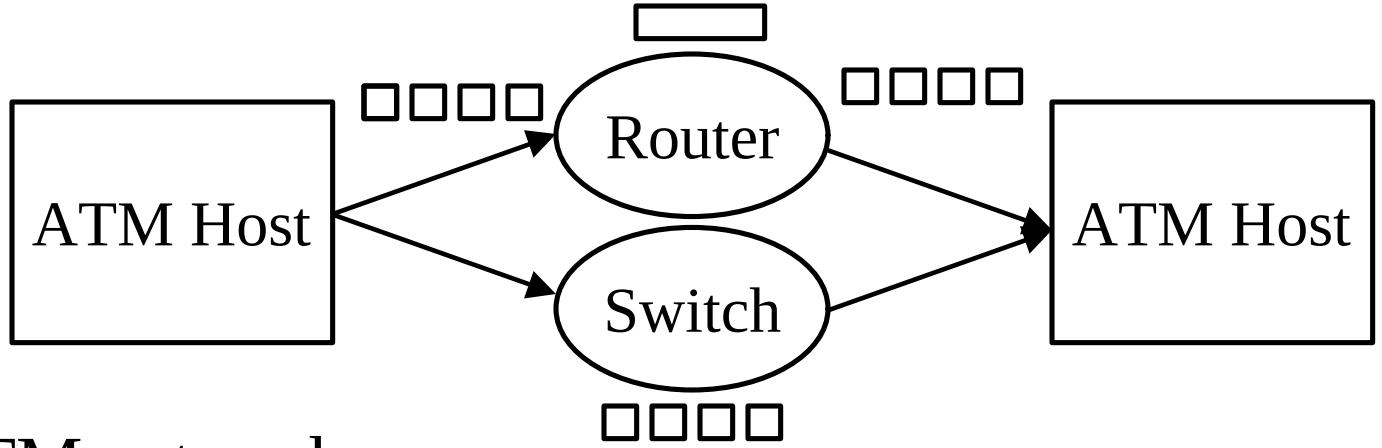
- Switching vs routing
- IP Switching (Ipsilon)
- Tag Switching (CISCO)
- Multi-protocol label switching

Routing vs Switching

- Routing: Based on address lookup. Max prefix match.
  ⇒ Search Operation
  ⇒ Complexity ≈ $O(\log_2 n)$
- Switching: Based on circuit numbers
  ⇒ Indexing operation
  ⇒ Complexity O(1)
  ⇒ Fast and Scalable for large networks and large address spaces
- These distinctions apply on all datalinks: ATM, Ethernet, SONET

Routing vs Switching (Cont)

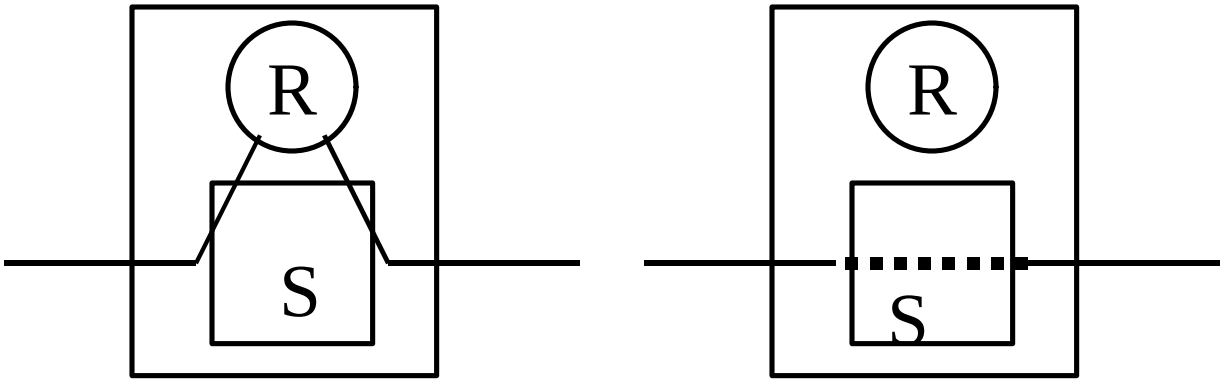


On ATM networks:

- IP routers use IP addresses
  ⇒ Reassemble IP datagrams from cells
- IP Switches use ATM Virtual circuit numbers
  ⇒ Switch cells
  ⇒ Do not need to reassemble IP datagrams
  ⇒ Fast

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 ⇒ No reassembly



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IP Switching (Cont)

- Flow-oriented traffic: FTP, Telnet, HTTP, Multimedia
- Short-lived Traffic: DNS query, SMTP, NTP, SNMP, request-response Ipsilon claimed that 80% of packets and 90% of bytes are flow-oriented.
- Ipsilon claimed their Generic Switch Management Protocol (GSMP) to be 2000 lines, and Ipsilon Flow Management Protocol (IFMP) to be only 10,000 lines of code
- Runs as added software on an ATM switch
- Implemented by several vendors

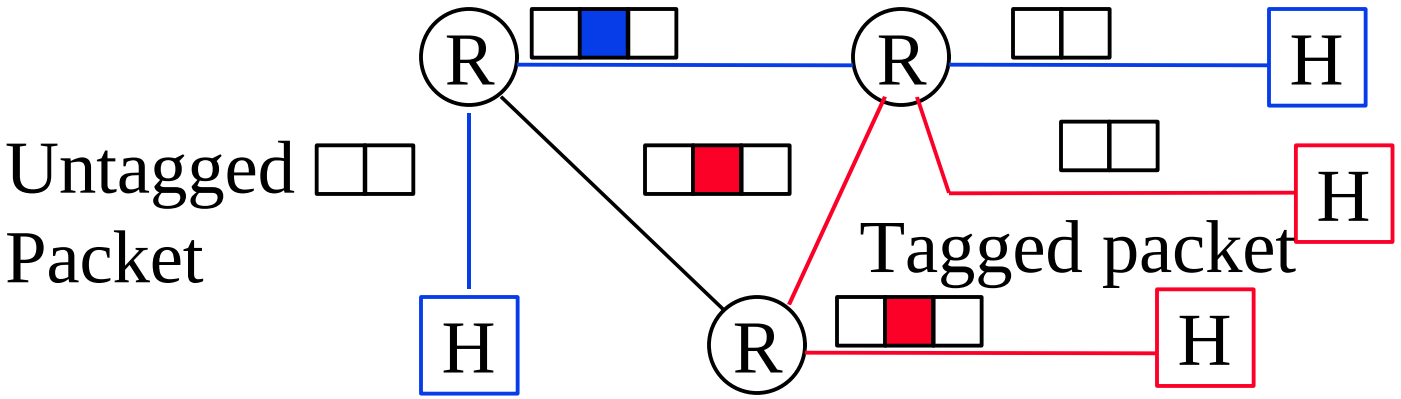
Ipsilon's IP Switching: Issues

- VCI field is used as ID.
  VPI/VCI change at switch
  ⇒ Must run on **every** ATM switch
  ⇒ non-IP switches not allowed between IP switches
  ⇒ Subnets limited to one switch
- Cannot support VLANs
- Scalability: Number of VC ≥ Number of flows.
  ⇒ **VC Explosion.** 1000 setups/sec.
- Quality of service determined implicitly by the flow class or by RSVP
- ATM Only

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.

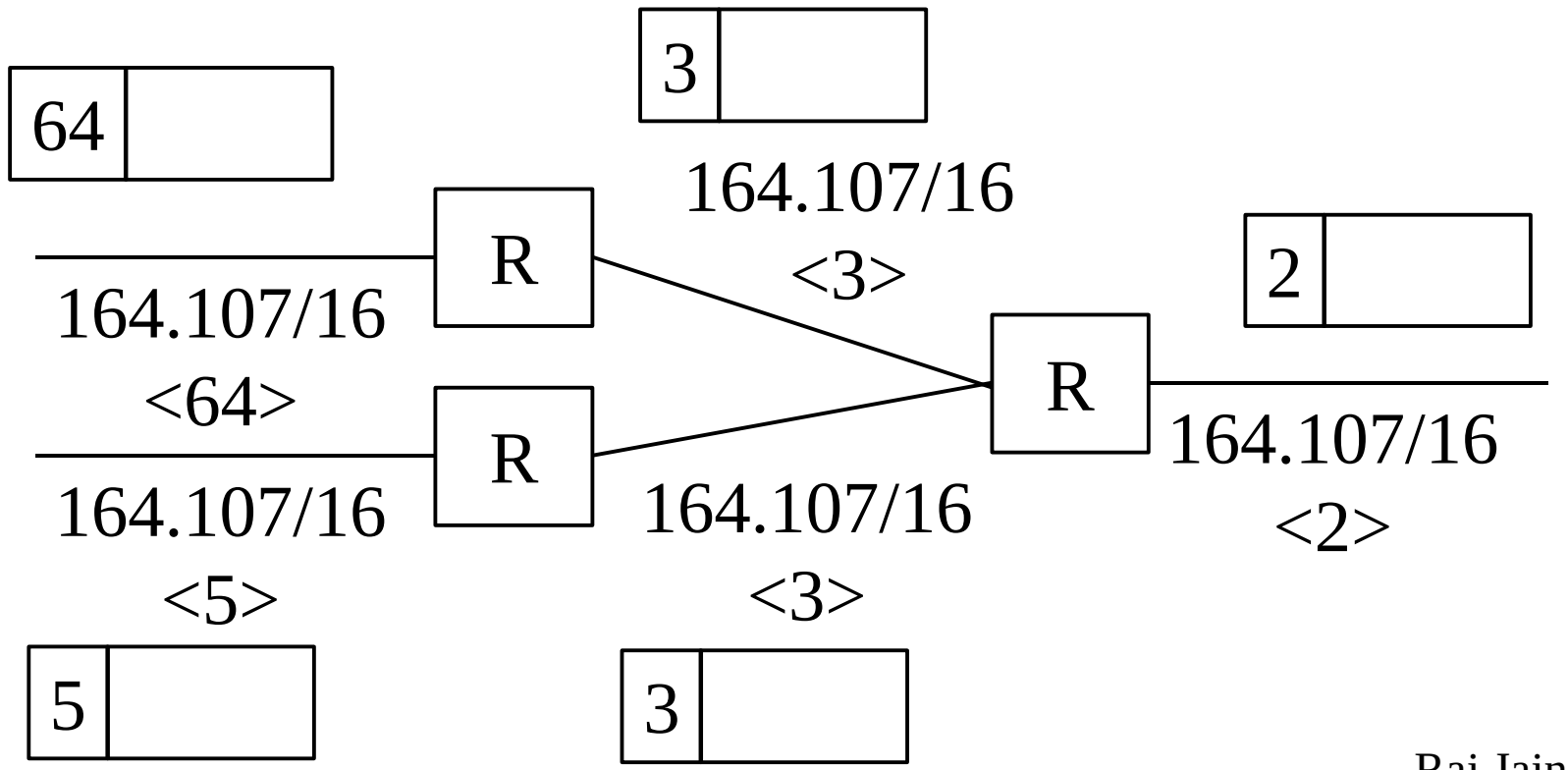


Tag Switching (Cont)

- 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

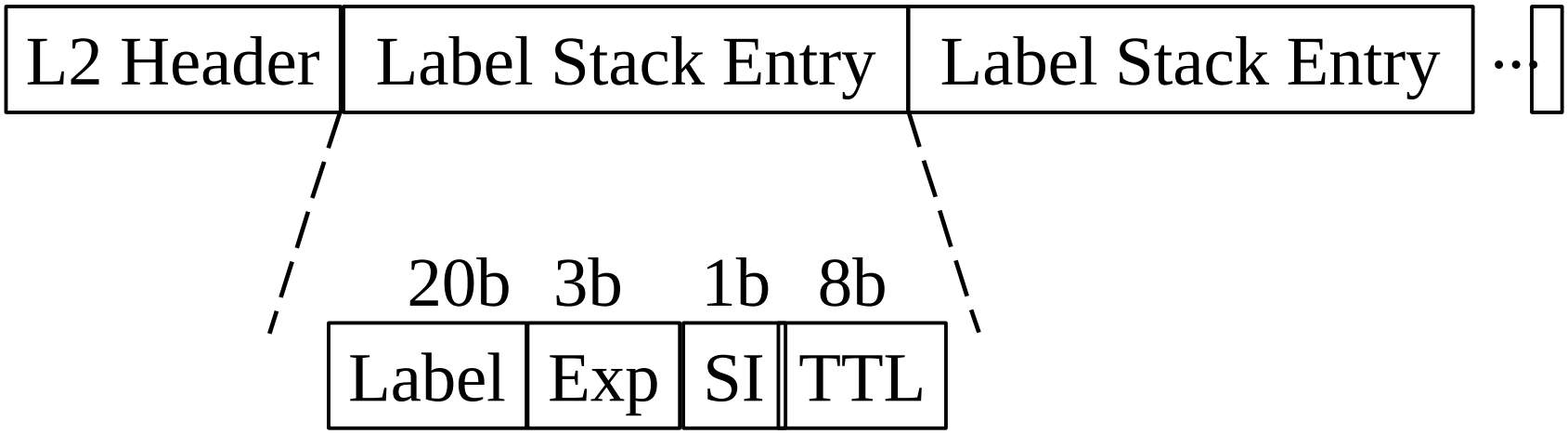
- CSR Cell Switched Router
- ISR Integrated Switch and Router
- LSR Label Switching Router
- TSR Tag Switching Router
- Multi layer switches, Swoters
- DirectIP
- FastIP
- PowerIP

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, ...)

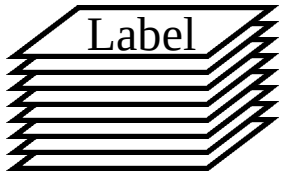
Label Stack Entry Format

- Labels = Explicit or implicit L2 header
- TTL = Time to live
- Exp = Experimental
- SI = Stack indicator

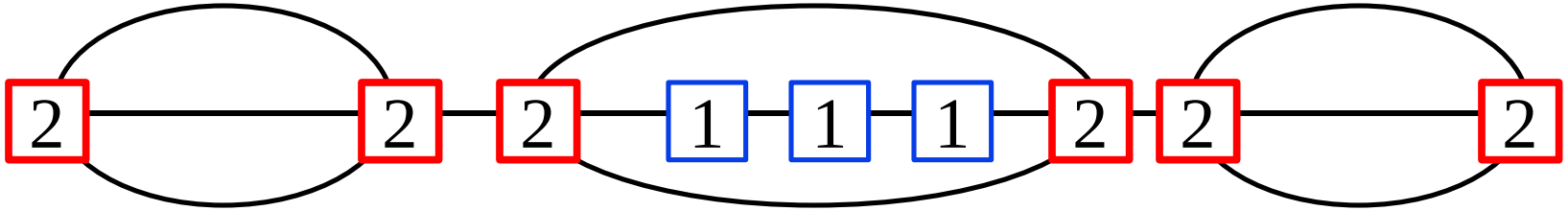


Label Stacks

- 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.
- Bottom label may indicate protocol (0=IPv4, 2=IPv6)



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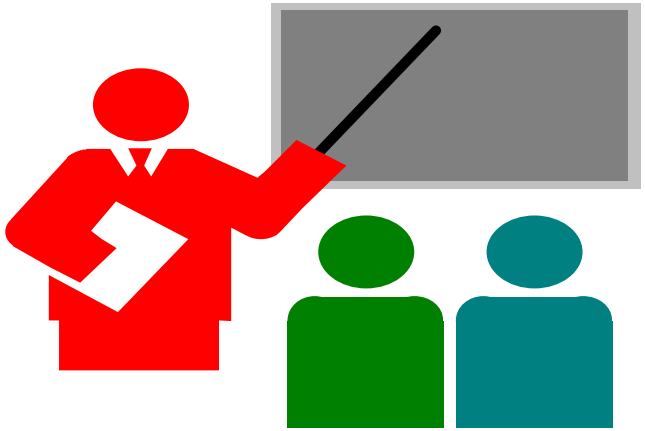
Summary



- IP Switching: Traffic-based, per-hop VCs, downstream originated
- Tag switching: Topology based, one VC per route
- MPLS combines various features of IP switching, Tag switching, and other proposals

Key References

- See **http://www.cis.ohio-state.edu/~jain/refs/ipsw_ref.htm**
- IP switching, http://www.cis.ohio-state.edu/~jain/cis788-97/ip_switching/index.htm
- Multiprotocol Label Switching (mpls) working group at IETF. Email: mpls-request@cisco.com