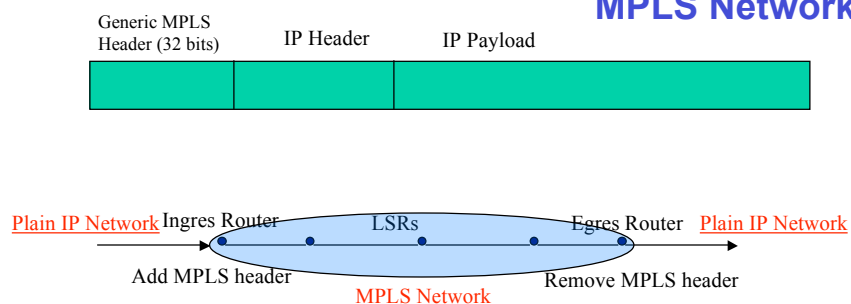


MPLS [RFC 3031]

- g IP Switching
 - Use labels; works with other protocols [not just with IP]
 - Use labels to determine forwarding action instead of 32/128 bit addresses
- g 20 bit label

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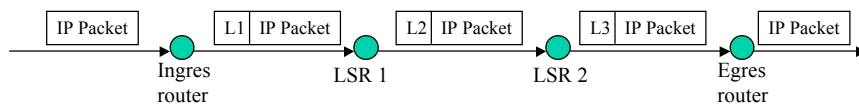
MPLS Network



Ingres Label Switched Router adds a label (header)
LSRs switch based on label values
Egres router removes the MPLS header

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MPLS Path



Examine LSR 2:

How does LSR2 process each packet with MPLS header?

Loot at interface it came on (why?), label L2

Consult forwarding table associated with incoming interface

Action: Replace L2 by L3, forward on output interface O_2

Other actions: Push new MPLS header; Pop MPLS header

Processing done in hardware (very fast)

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Layer 3 routing vs. MPLS

- g Lookup Time
 - Longest prefix matching
 - 20 bits vs. 32 or 128 bits
- g Label has local significance only
 - IP addresses have global significance

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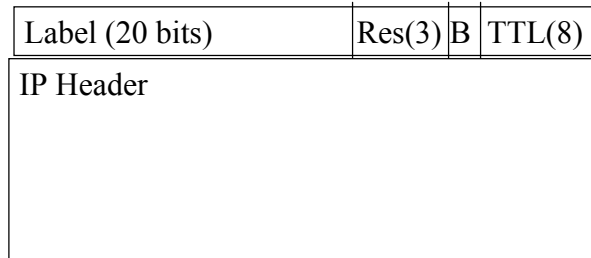
Two important questions

- g How does an ingress router select a label?
- g How do the intermediate routers make up their switching/forwarding tables?

Forwarding Equivalence Class

- g FEC:
 - Group of packets that receive same treatment by routers
- g FEC controls packet's path through network and packet's forwarding treatment on that path
- g Examine an Ingress router.
 - For each destination one FEC? (all packets to that destination will get same treatment)
 - What if some need to be treated differently?
 - Examine source, destination ids, application protocol, incoming link, QoS, current network condition, VPN requirements,... and find FEC
- g FEC and quick forwarding are two greatest advantages of MPLS
- g Force packets to go through a certain path

MPLS message format



B=1: Stack bottom (no more MPLS headers below)

Reserved Labels

- g Some labels have special significance
 - 0 to 15
 - 0: IPv4 null label (pop stack, treat rest as IPv4 packet)
 - 1: router alert: pkt needs special handling, route based on next label
 - 2: IPv6 null label
 - 3: Multicast null label
 - 4-15 reserved

TTL handling

- g Copy TTL from IP header to TTL of first MPLS header at first ingres
- g Decrement TTL for each hop
- g When popping, copy TTL of MPLS header into TTL of IP header
- g Same when pushing a stack of MPLS headers

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Packet handling at Ingres

- g Determine FEC
- g Map FEC to LSP
- g Assign a label (or encode FEC in a label)

- g Label binding: FEC -> Label

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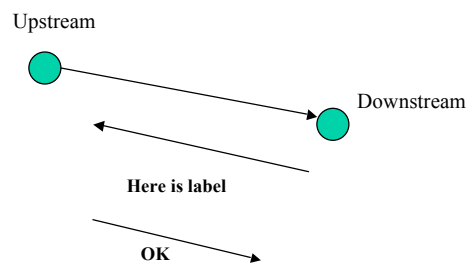
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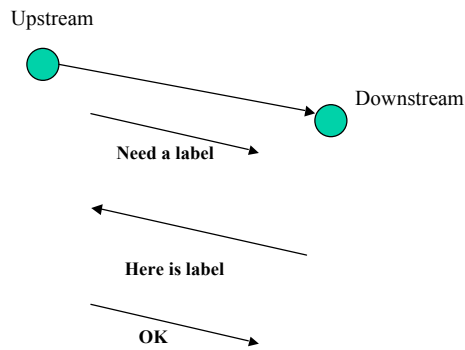
Label assignments

- g Always downstream assigned
 - Why?
- g Downstream unsolicited or
- g Downstream on demand

Downstream Unsolicited



Downstream on demand



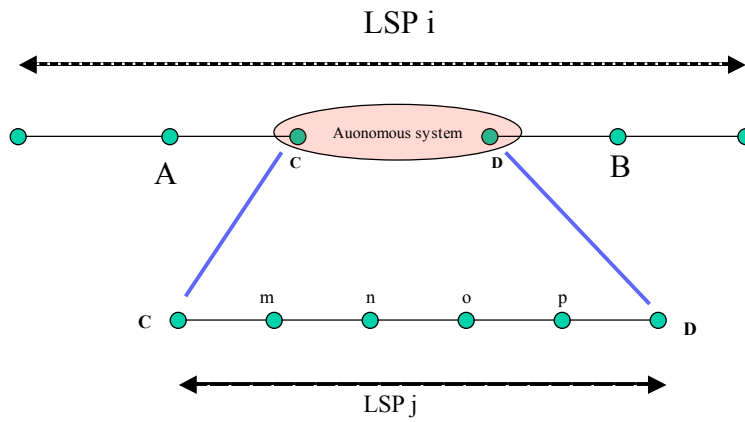
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Label Stack

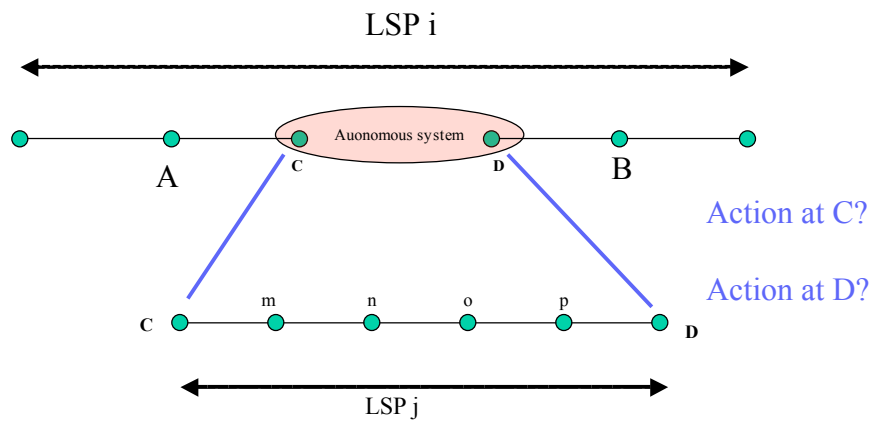
- g Hierarchical MPLS networks
 - One MPLS network completely inside another
 - Example

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Example



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Multiple MPLS headers

- g Multiple MPLS headers for an IP packet
- g Fragmentation because of this:
 - Ingres node must take care of this
- g Why not single MPLS header?
 - Don't mix LSP i and LSP j
 - AS does not need to know complete routing strategy

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LDP

- g Label Distribution Protocol
- g Similar to combination of OSPF and BGP
- g LSR does a neighbor discovery
 - Send hello messages containing LDP id on all interfaces; Use UDP to send messages to far away routers
- g LDP id identifies label space appropriate for this message
 - = IP address of LSP + 2 bytes to identify label space within same route
- g Loop detection/FEC merging

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LDP Messages

- g Discovery
 - Hello messages; find other LSRs
- g Session
 - Establish, maintain and terminate sessions
- g Advertisement
 - Create, change and delete mapping for FEC
- g Notification
 - Advisory info

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Misc

- g Loop detection
- g FEC merging/aggregation

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