CSC 402 – Internet Technology

Recap

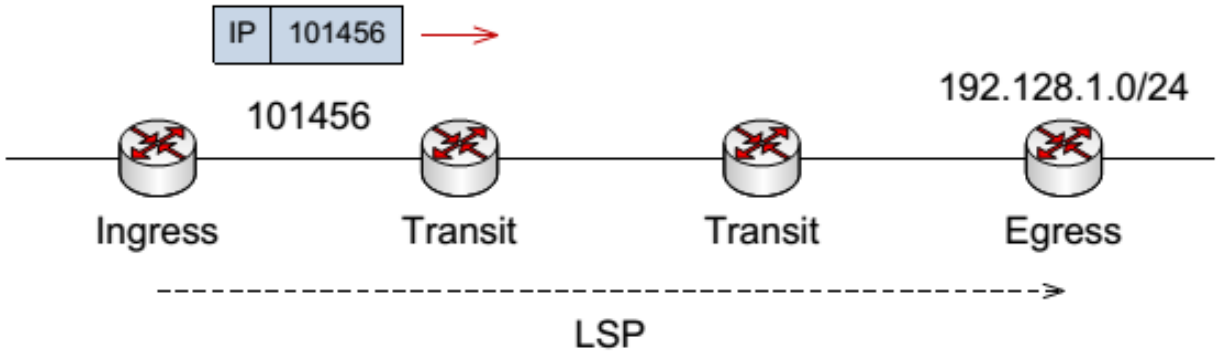
- Multiprotocol Support
- MPLS
- Label
- IP vs MPLS
- Acronyms
- FEC

Labels

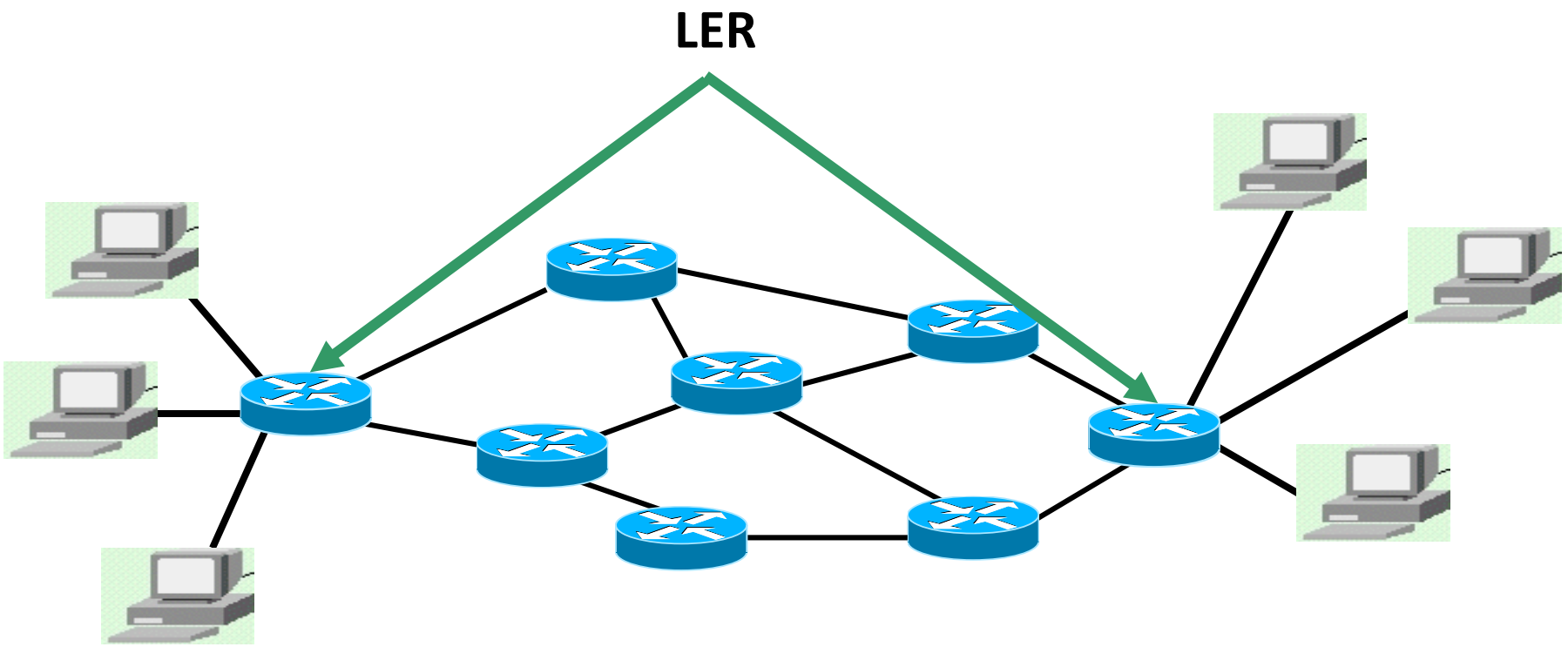
- Scope and Uniqueness.
  - Labels are local between two LSRs.
  - Rd might give label L1 for FEC F and distribute it to Ru1.
  - At the same time, it might give a label L2 to FEC F and distribute it to Ru2.
  - L1 might not necessarily be equal to L2.
  - Can there be a same label for different FECs?
    - Generally, NO.
    - BUT no such specification.
    - LSR must have different label spaces to accommodate both.
    - SHIM header specifies that different label spaces used for unicast packets and multicast packets.
- Invalid Labels:
  - MUST be discarded!
  - Forwarding it can cause a loop. Same treatment if there is no valid outgoing label.

Label Edge Router (LER)

- Ingress LER receives an IP packet with 192.128.1.100 destination address.
- Determines that there is a path to 192.128.1.0/24 through MPLS domain.
- Using PUSH, adds label 101456.
  - **PUSH for IP packets**: Add a new label. Copy TTL from the IP packet to TTL of the label. CoS from the queue (DiffServ/MPLS)
  - **PUSH for MPLS packets**: Add 1 more label. S must be set to 1. CoS from the penultimate label. Set TTL to 255 (does not depend on the previous labels).
- Egress LER removes label and sends the packet to the next hop in the LSP.

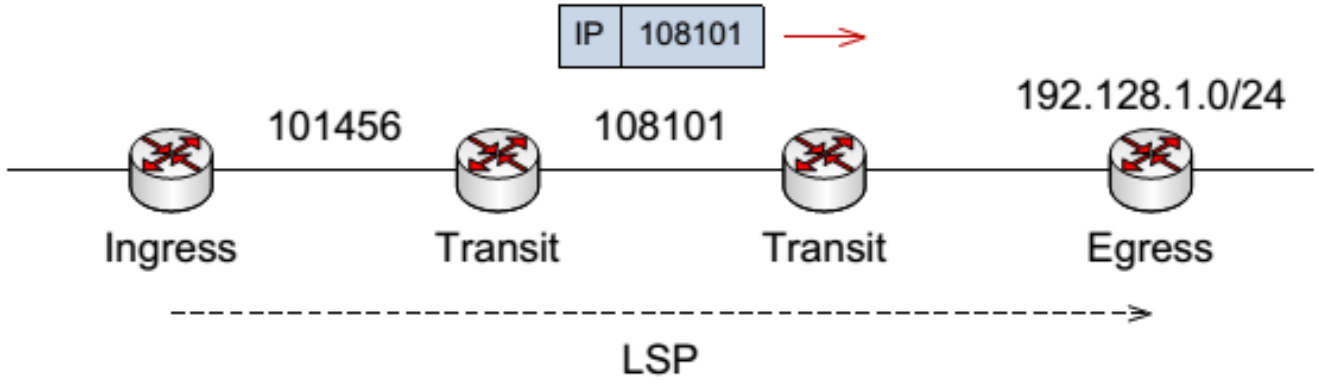


LER



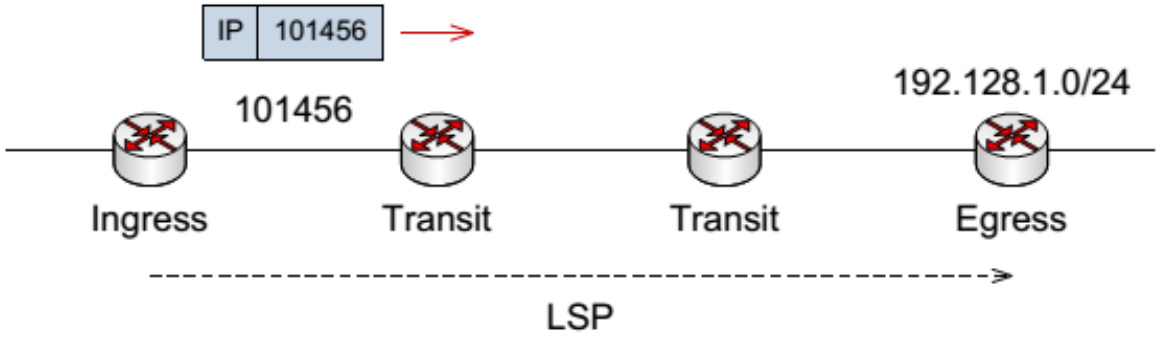
Label Switch Router (LSR)

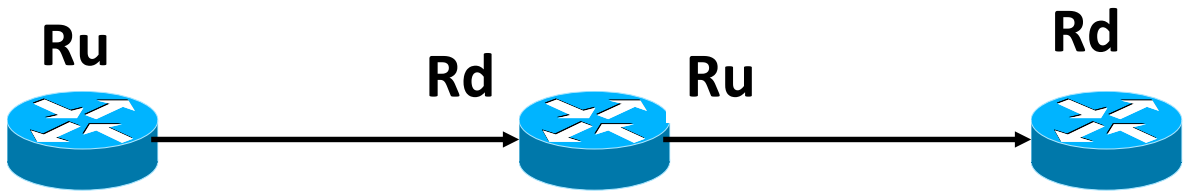
- A.k.a Transit node. Receives the labeled packet.
- Checks its switching table. Can also be a router.
- Using SWAP, changes the label from 101456 to 108101.
  - Swaps the latest label with a new one.
  - S and CoS should be copied into a new one.
  - Decrease TTL by 1.
- Similar process is repeated on all transit nodes.



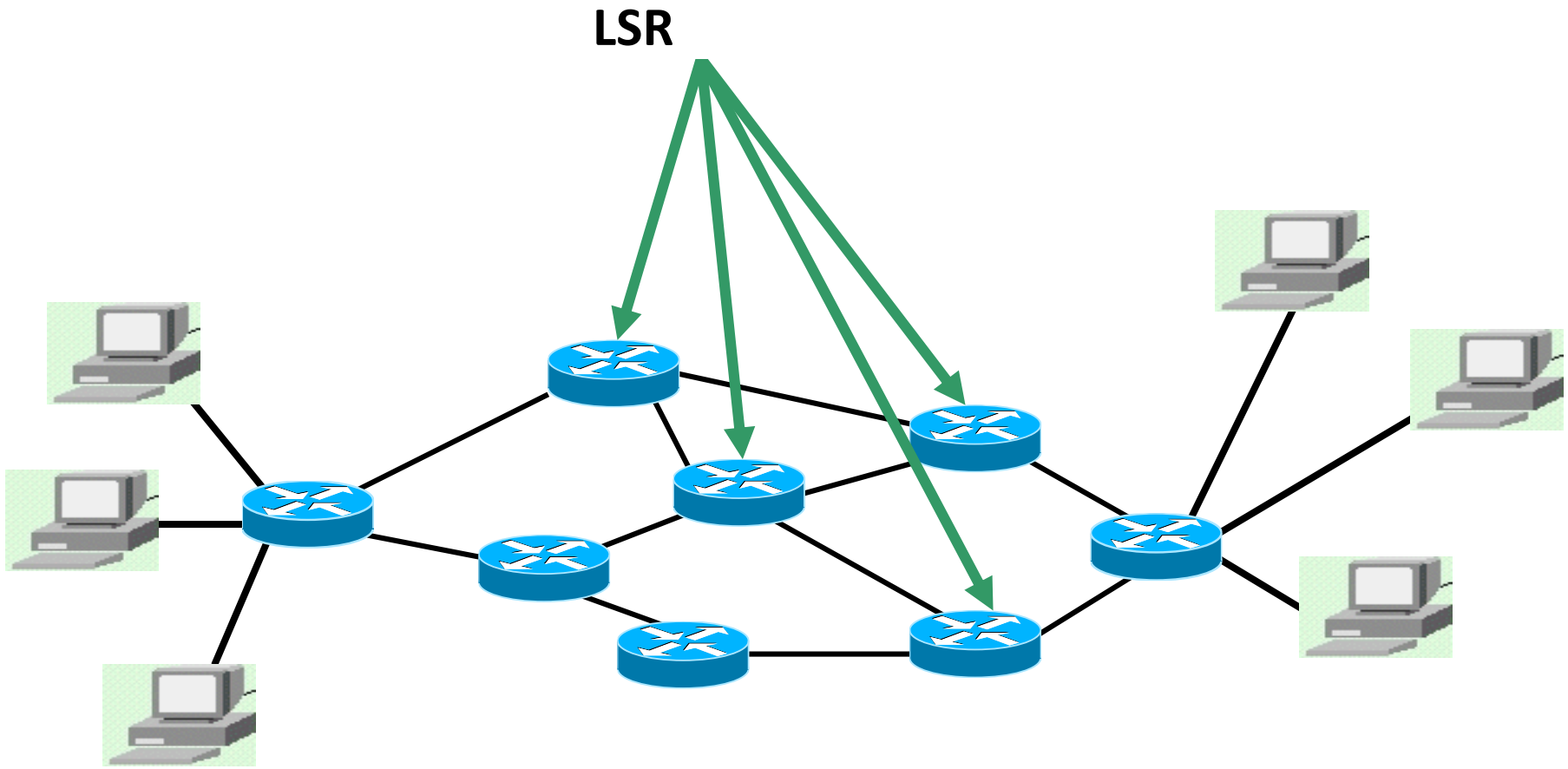
LSR

- Label swapping
  - Each LSR examines the label on top of the stack
  - Uses the Label Information Base (LIB) to decide the outgoing path and the outgoing label
  - Removes the old label and attaches the new label
  - Forwards the packet on the predetermined path
- Upstream Router (Ru) – router that sends packets
- Downstream Router(Rd) – router that receives packets
  - Need not be an end router
  - Rd for one link can be the Ru for the other



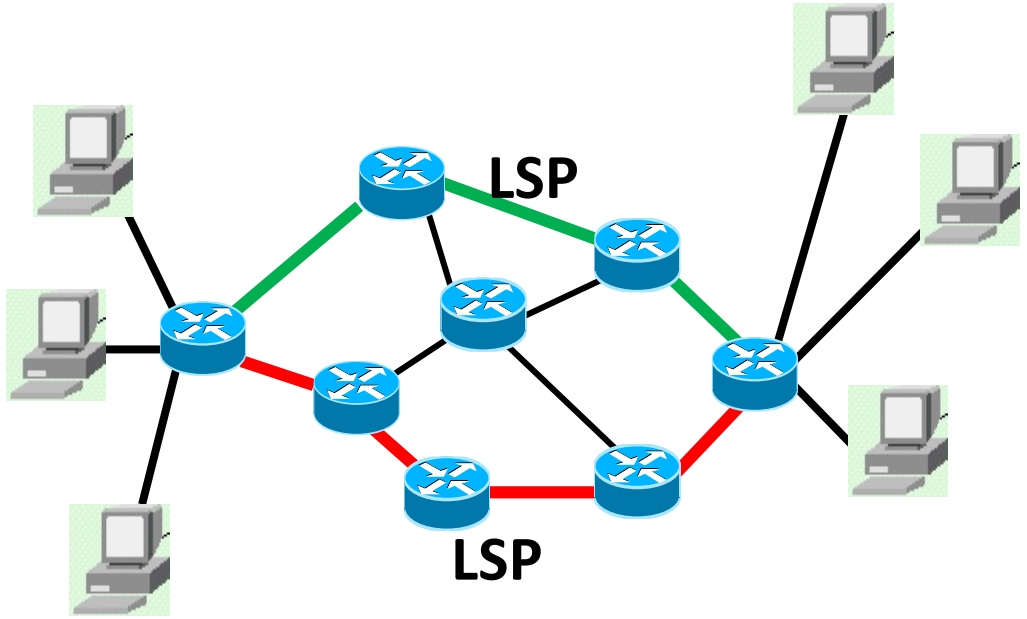


LSR



Label Switched Path(LSP)

- LSP defines the path through LSRs from ingress to egress router.
- FEC is determined at the LER-ingress.
- LSPs are unidirectional.
- 3 types of LSP :
  - Static LSP
  - Dynamic LSP using LDP (LDP-signaled LSP)
  - Dynamic LSP using RSVP (RSVP-signaled LSP)
- 2 types of dynamic LSPs :
  - Explicit LSP
  - Constrained LSP



LSP

- **Static LSPs** are a lot like static routes.
  - Network admin has to explicitly configure every LSR in an LSP manually as no protocols dynamically signal the LSP for you, the load on the LSRs is reduced.
  - However, if you have changes in the topology, the paths can't adapt to the new network. As a result, topology changes create routing black holes.
- **Dynamic LSPs** use signaling protocols to establish themselves and propagate LSP information to other LSRs in the network.
  - Because the LSRs must exchange and process signaling packets and instructions, dynamic LSPs consume more resources than static LSPs.
  - However, dynamic LSPs can avoid the network black holes of static LSPs by detecting topology changes and outages and dynamically establishing new LSPs to move around the failure.
- **Explicit LSP** – determined manually at the ingress node
- **Constrained LSP** – similar to explicit LSP but takes into account:
  - Topology information distributed by IGP. An IGP (Interior Gateway Protocol) is a protocol for exchanging routing information between gateways (hosts with routers) within an autonomous network.
  - Resource information distributed by IGP.
  - Traffic requirements and restrictions.

Label Distribution Protocol (LDP)

- Defined in RFC 5036.
- Does not support traffic engineering (priorities).
- Labels are distributed automatically.
- Properties of LDP:
  - Used by routers to exchange label mapping information (just maps routing information into labels).
  - A router can be either any node of a MPLS domain or an edge router.
  - Recommended by ITU-T (traffic engineering is enabled by extension Constrained-Routing LDP (CR-LDP)).
- MPLS was developed to achieve:
  - Fast switching and Traffic engineering.
- What LDP does? Just maps a routing topology to a switching one that achieves fast switching.
  - Traffic engineering: no, just simply maps the IGP view.
- With LDP, we still have to rely on IGP.

Label Information Base (LIB)

- Table maintained by the LSRs
- Contents of the table
  - Incoming label
  - Outgoing label
  - Outgoing path
  - Address prefix

Incoming label	Address Prefix	Outgoing Path	Outgoing label

MPLS

- Originally, the point of label switching was facilitating high-speed switching in routers
  - But nowadays routers can perform line speed routing on most interfaces
  - Thus, this is no longer the main benefit of MPLS
- Today, the major benefits of MPLS are:
  - Simplifying packet forwarding (cheaper hardware, better power efficiency)
  - Traffic engineering support (guaranteed channel speeds)
  - Delivering QoS and differentiated services
  - Supporting Virtual Private Networks (VPNs)