



Computer Networks: Quality of Service

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QoS Architectures for the

Internet

Integrated Services (IntServ)

- **Flow Based** QoS Model (Resources are available prior to establishing the session)
- Uses **RSVP** (signaling protocol) to create a flow over a connectionless IP

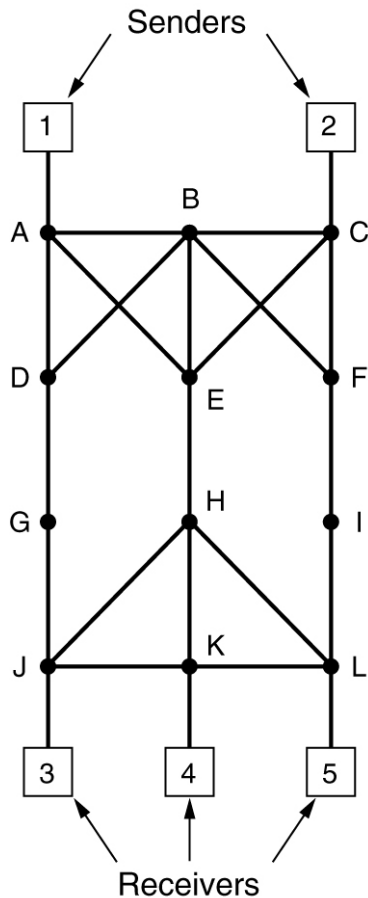
Differentiated Services (DiffServ)

- Categorize traffic into different **classes** or priorities with high priority value assigned to real time traffic
- **Hop by hop** (no assurance of end-to-end QoS)

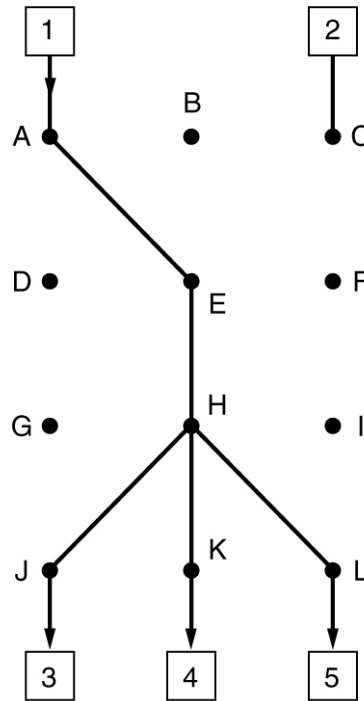
Multiprotocol Label Switching (MPLS)

- Not primarily a QoS model, rather a **Switching** architecture
- Ingress to the network decides a **label** according to FEC

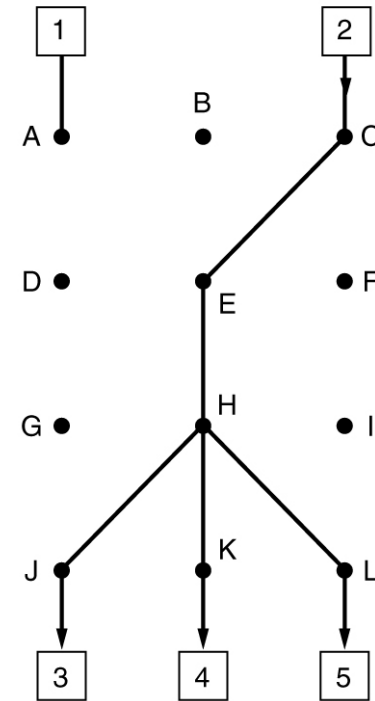
RSVP Example



(a)
(A network)

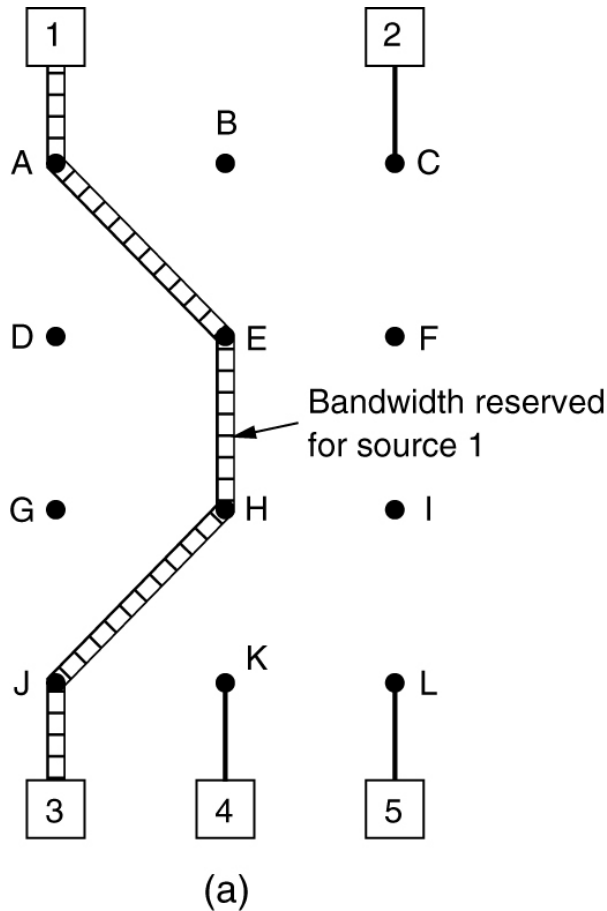


(b)
**(The multicast spanning tree
for host 1)**

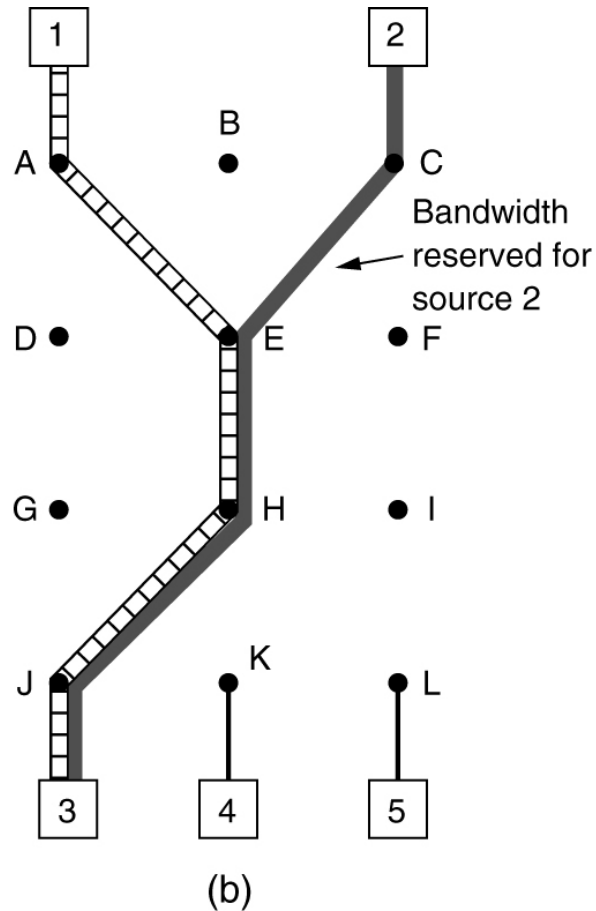


(c)
**(The multicast spanning tree
for host 2)**

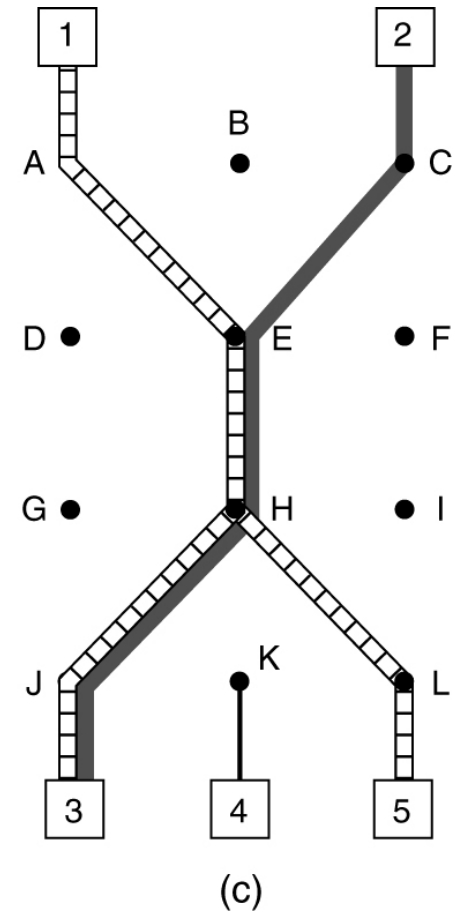
RSVP Example continued...



(Host 3 requests a channel to host 1)



(Additionally, it requests a second channel, to host 2)



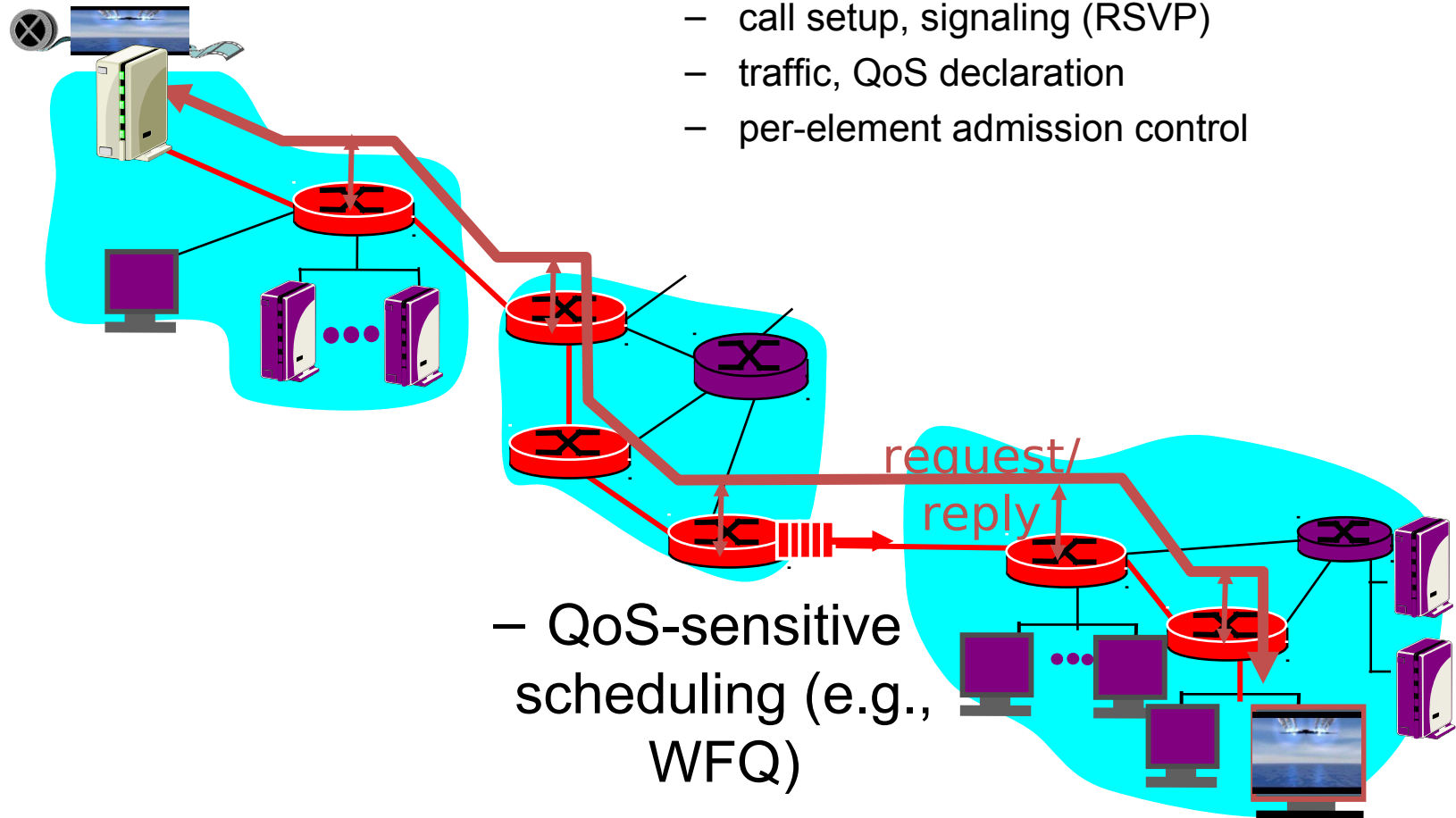
(Host 5 requests a channel to host 1)

Integrated Services (IntServ)



Resource reservation

- call setup, signaling (RSVP)
- traffic, QoS declaration
- per-element admission control



- QoS-sensitive scheduling (e.g., WFQ)

DiffServ Architecture

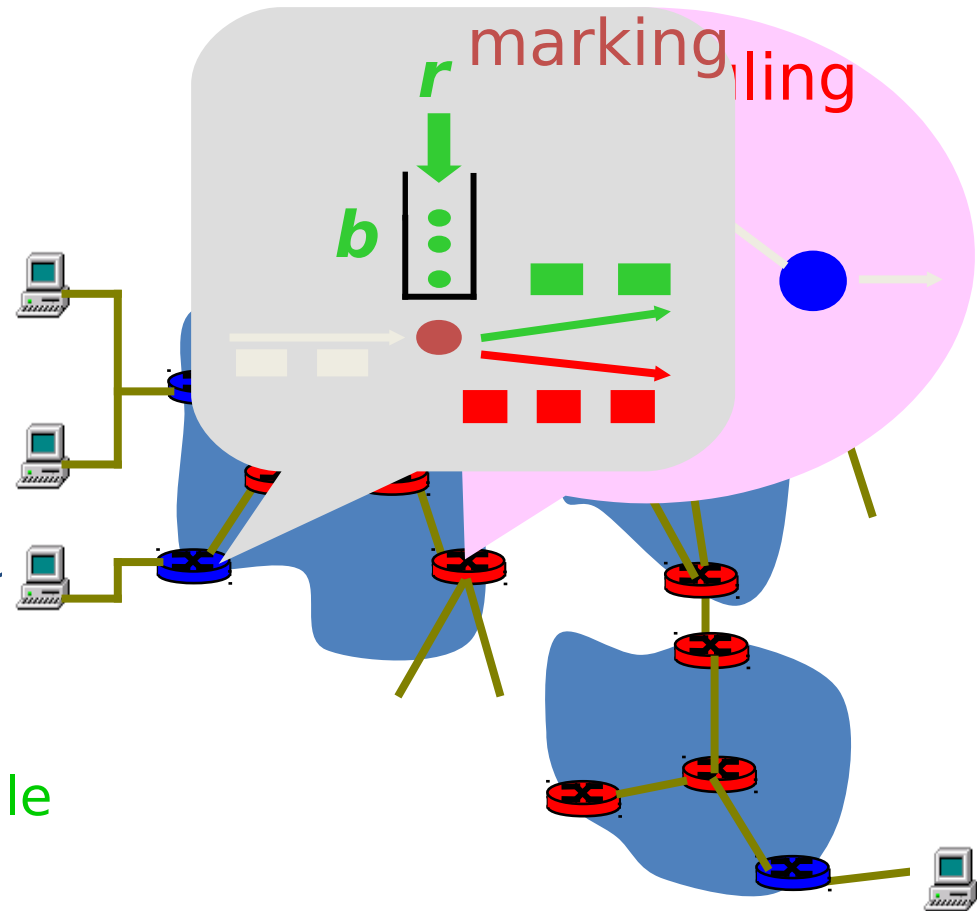


Edge router:

- ❑ per-flow traffic management
- ❑ marks packets as in-profile and out-profile

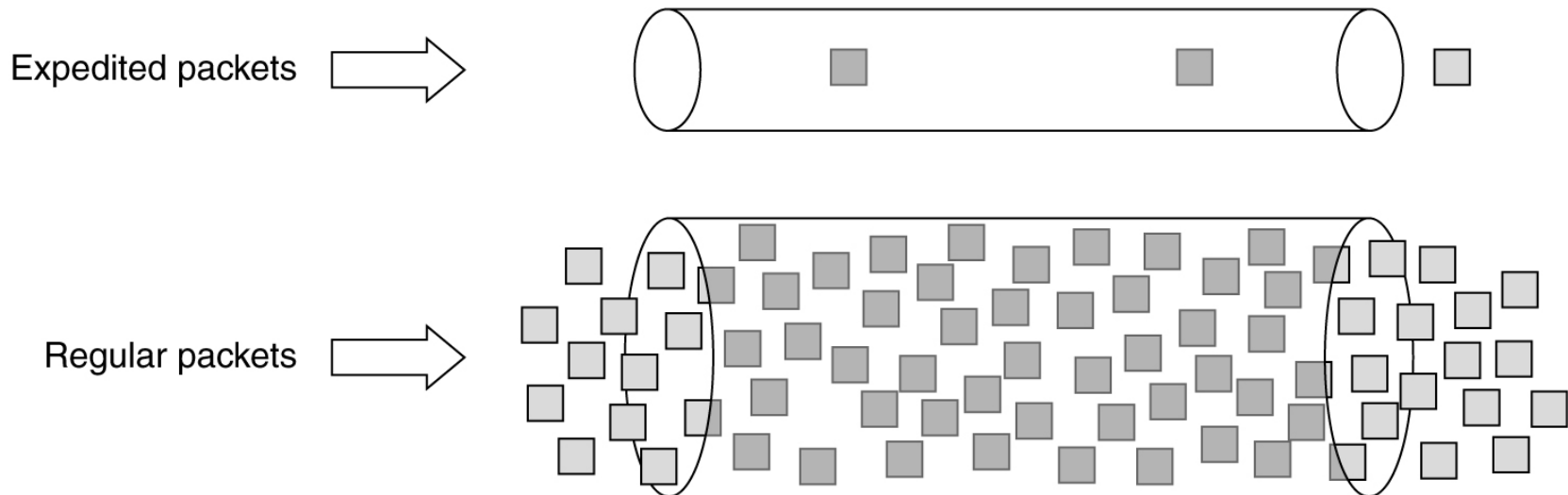
Core router:

- ❑ per class traffic manager
- ❑ buffering and scheduling based on marking at edge
- ❑ preference given to in-profile packets



Expedited Forwarding

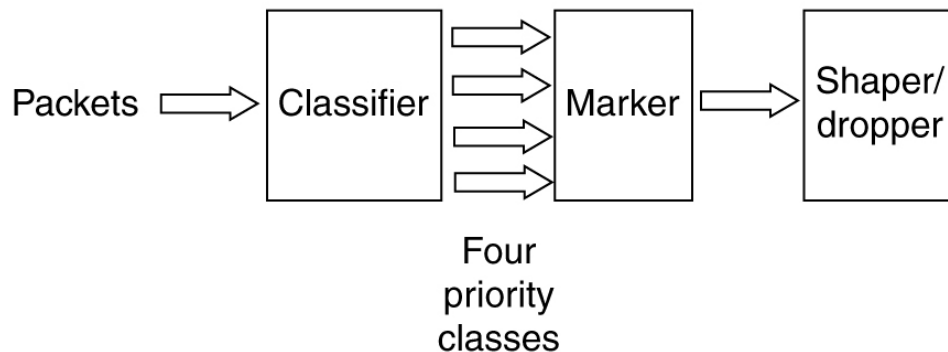
- Expedited packets experience a traffic-free network (low loss, low latency, low jitter, and assured bandwidth (**premium service**))



Assured Forwarding



- A possible implementation of the data flow for assured forwarding is shown below.
- AF delivers the packet with high assurance as long as its' class does not exceed the traffic profile of the node.

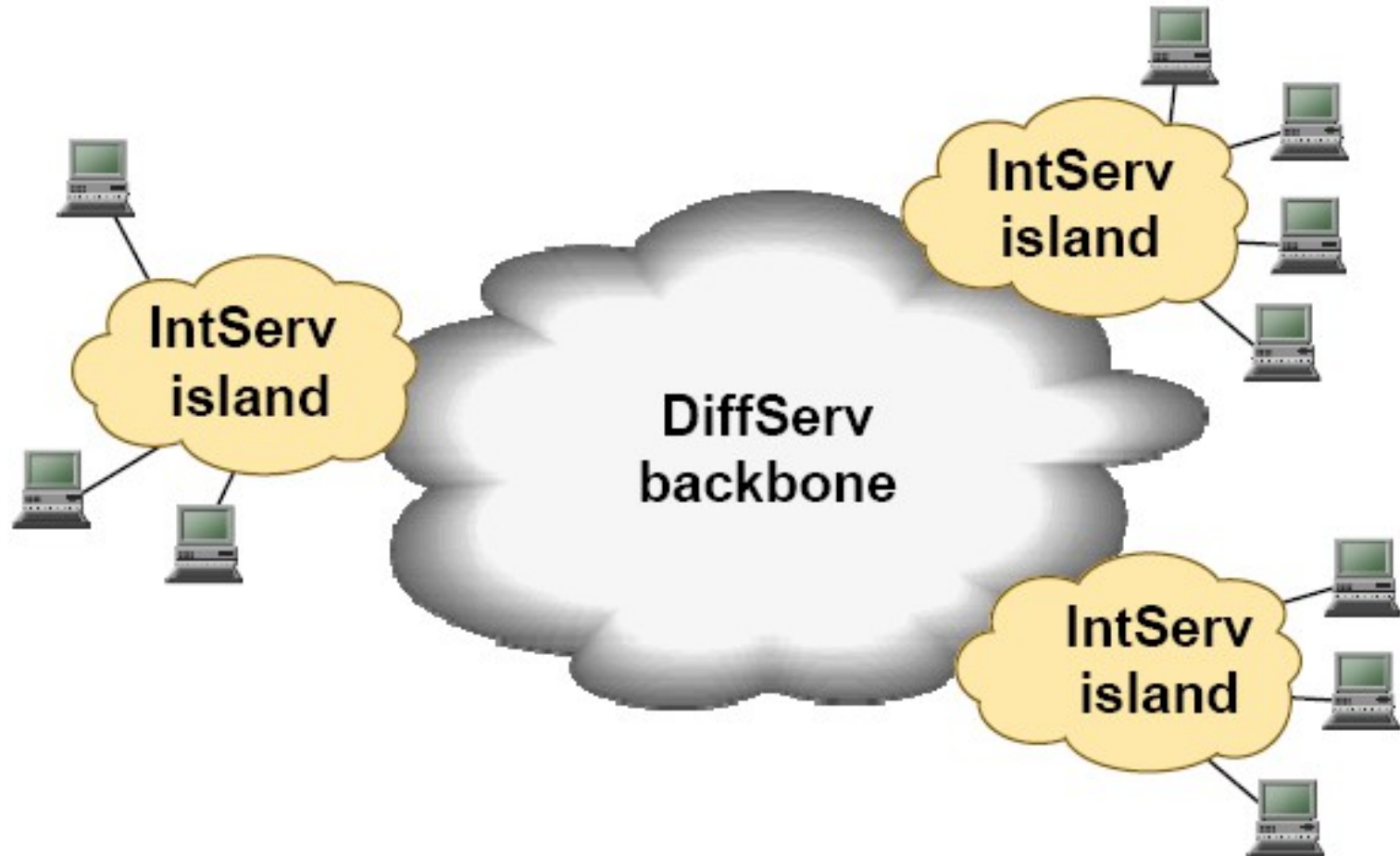


Example packet classifier

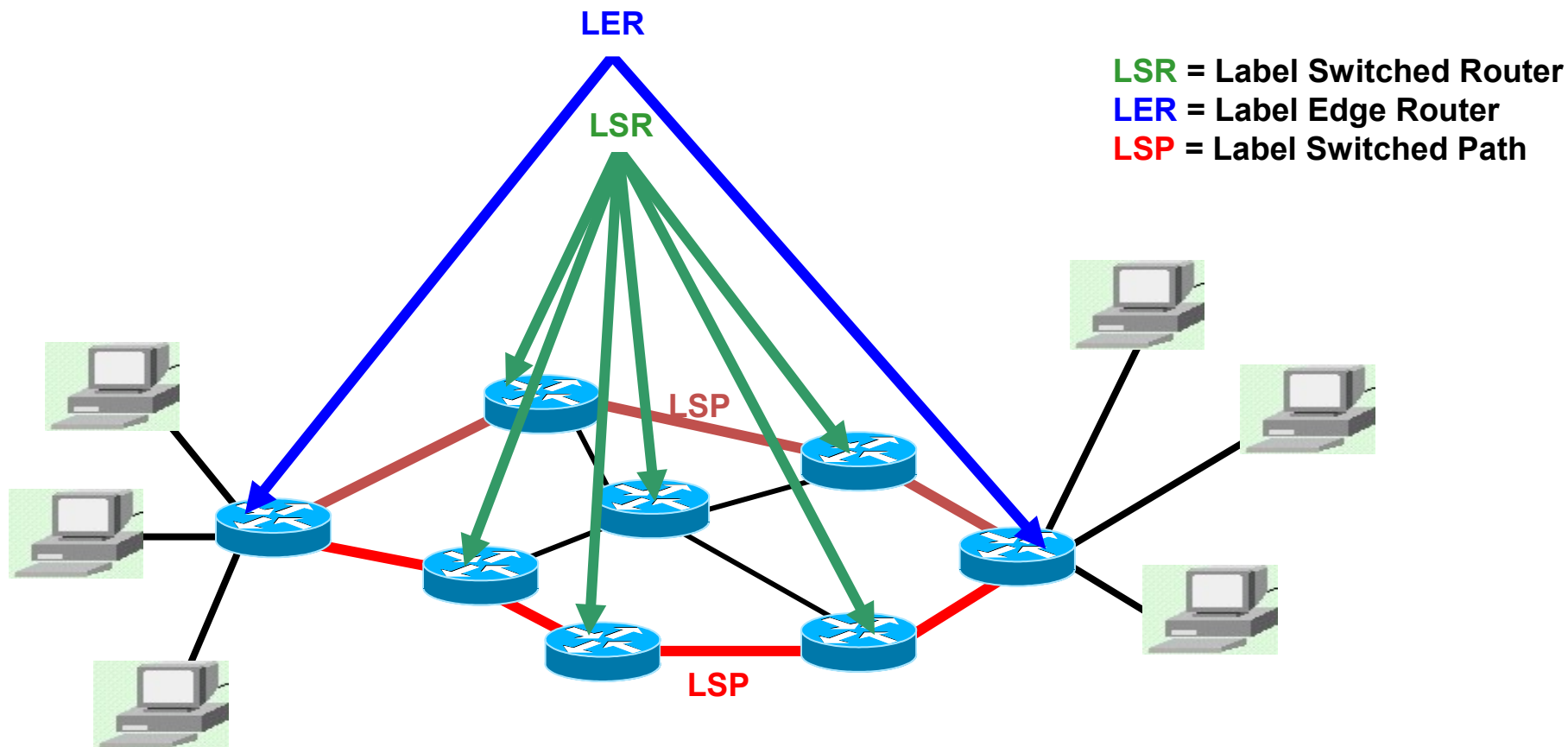


- **Gold traffic**
 - All traffic to/from Director office (IP address)
 - All traffic to/from the port number for DNS
- **Silver traffic**
 - All traffic to/from academic and administrative buildings
- **Bronze traffic**
 - All traffic on the public wireless network
- Then, schedule resources accordingly
 - E.g., 50% for **gold**, 30% for **silver**, and 20% for **bronze**

Integrated solution



Model for MPLS Network



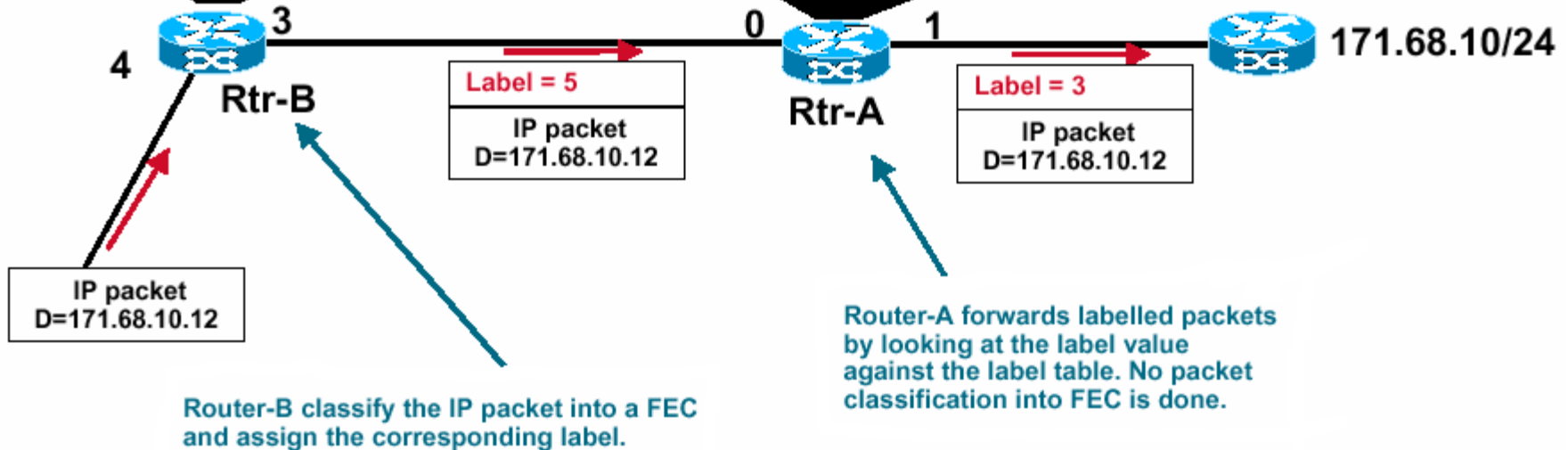
Route at edge and Switch at core

MPLS Forwarding



In I/F	In Lab	Address Prefix	Out I/F	Out Lab
4	x	171.68.10	3	5
...

In I/F	In Lab	Address Prefix	Out I/F	Out Lab
0	5	171.68.10	1	3
...



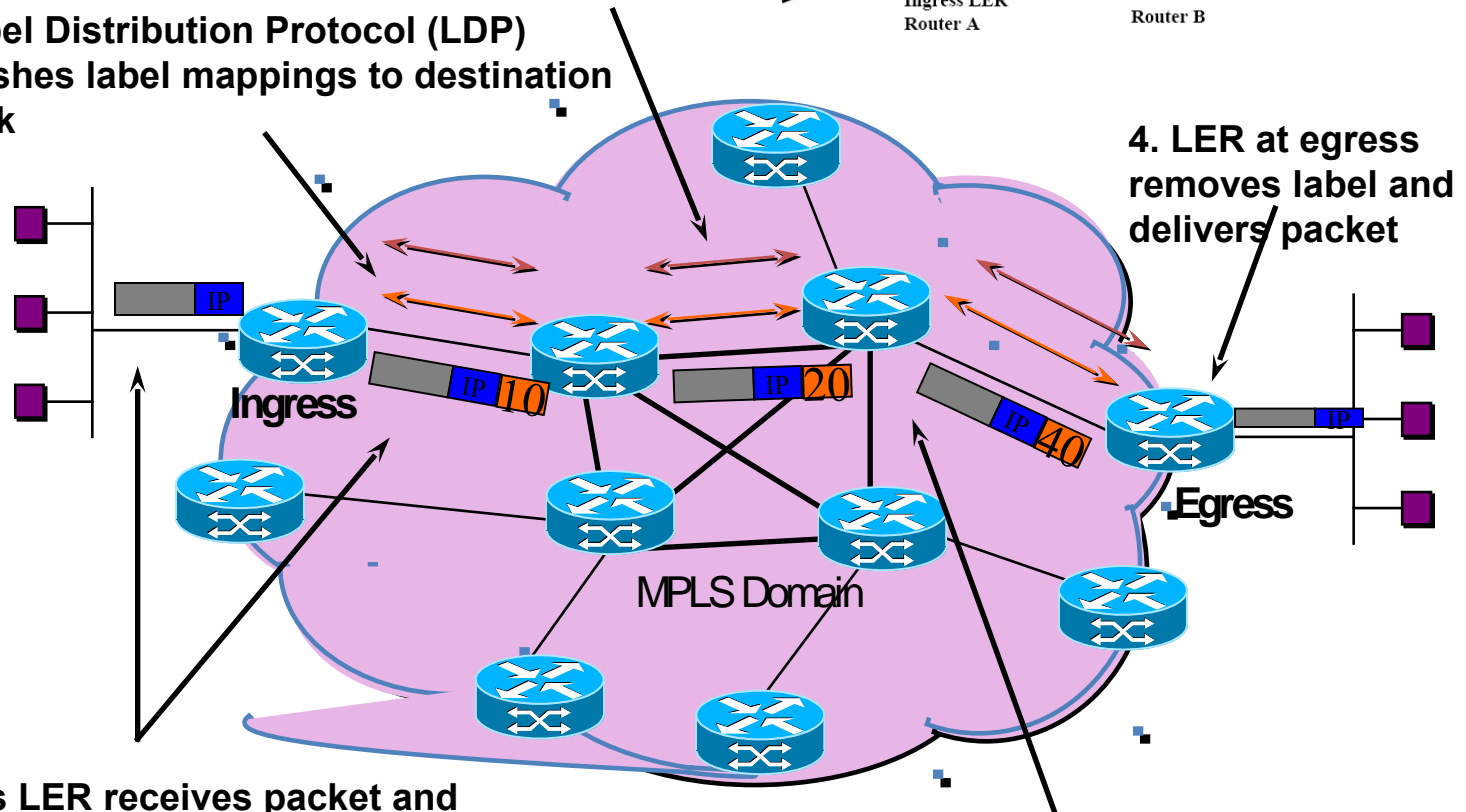
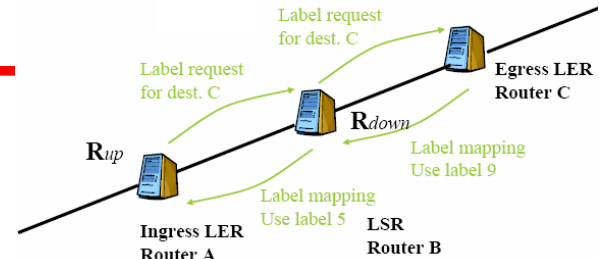
MPLS Operation



1a. Routing protocols (e.g. OSPF-TE) exchange reachability to destination networks

1b. Label Distribution Protocol (LDP) establishes label mappings to destination network

LDP:



2. Ingress LER receives packet and “label”s packets

3. LSR forwards packets using label swapping

4. LER at egress removes label and delivers packet