



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

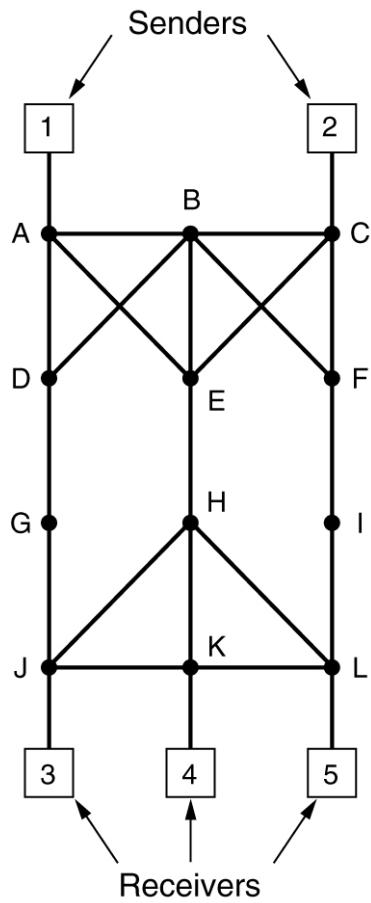
Differentiated Services (DiffServ)

- 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)

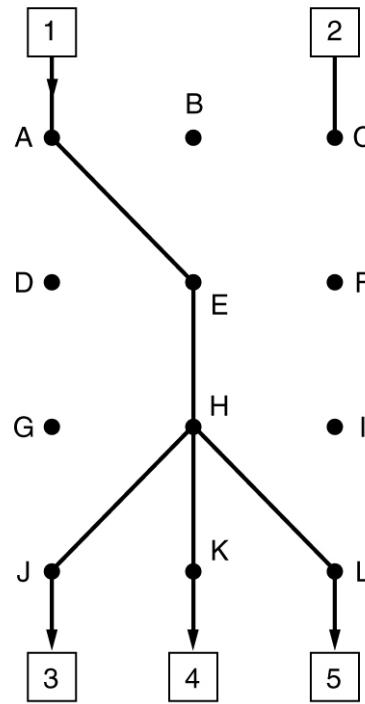
- Not primarily a QoS model, rather a Switching architecture
- Ingress to the network decides a label according to FEC

RSVP Example



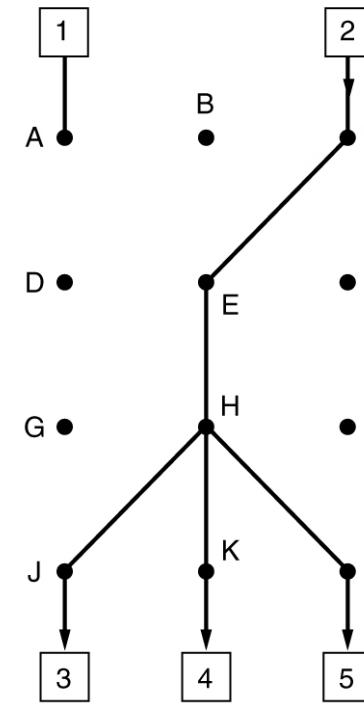
(a)

(A network)



(b)

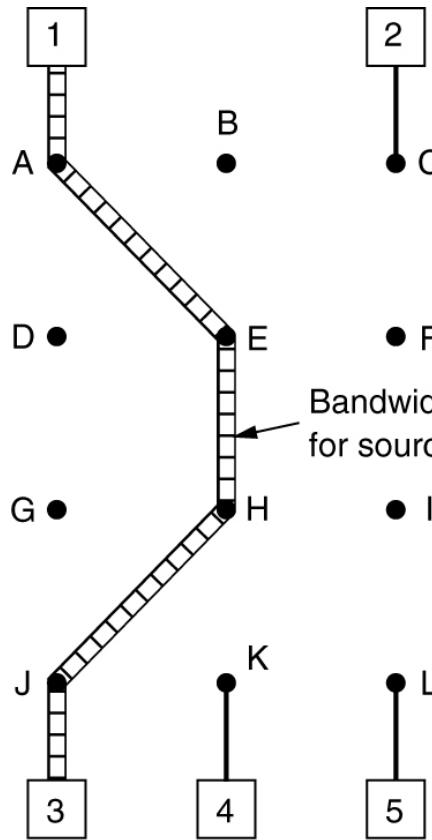
(The multicast spanning tree for host 1)



(c)

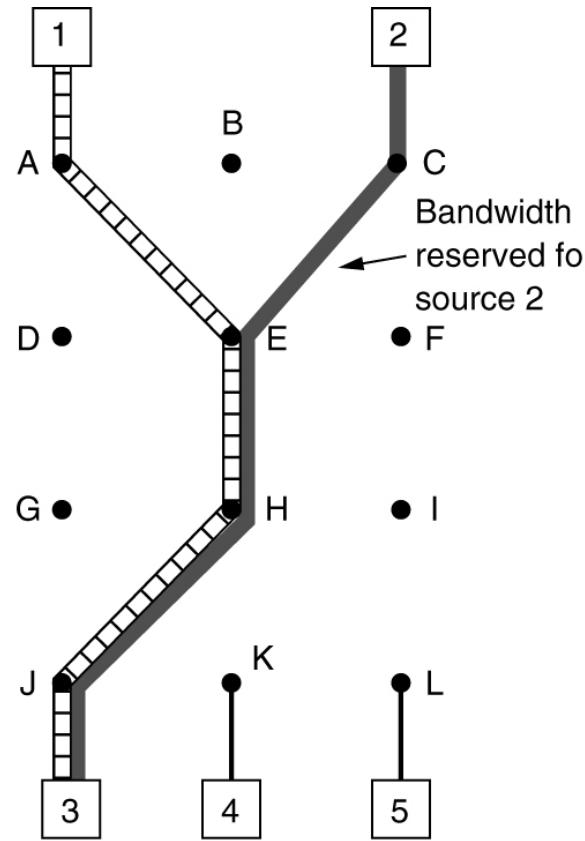
(The multicast spanning tree for host 2)

RSVP Example continued...



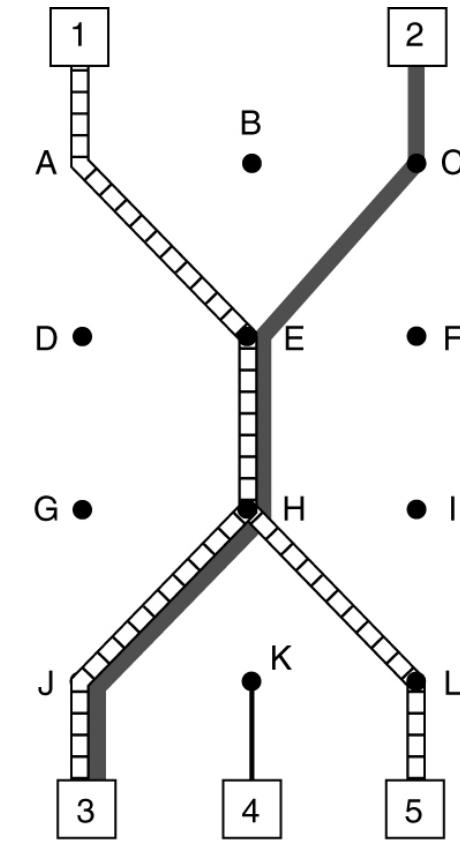
(a)

(Host 3 requests a channel to host 1)



(b)

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

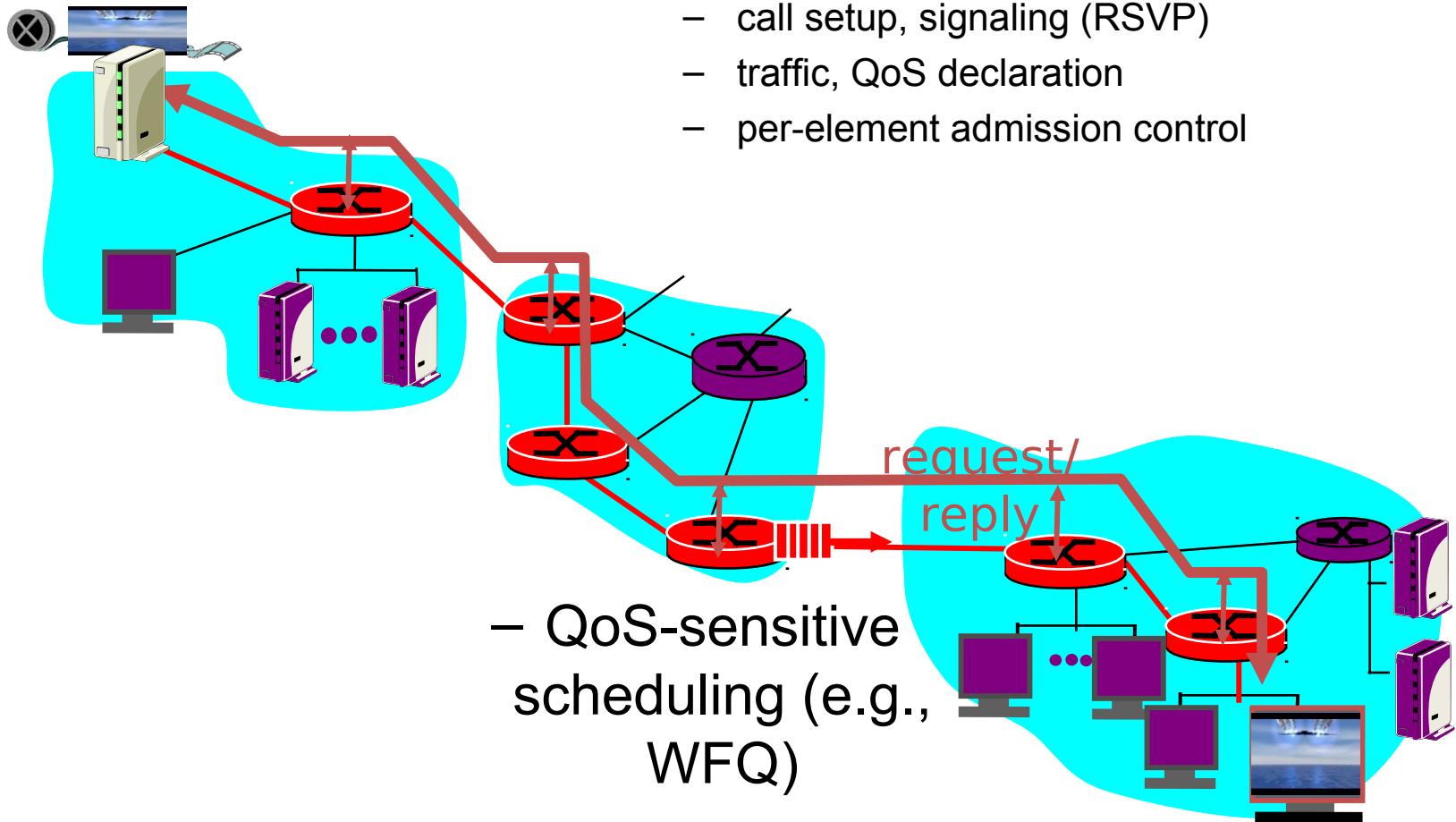


(c)

(Host 5 requests a channel to host 1)

Integrated Services (IntServ)

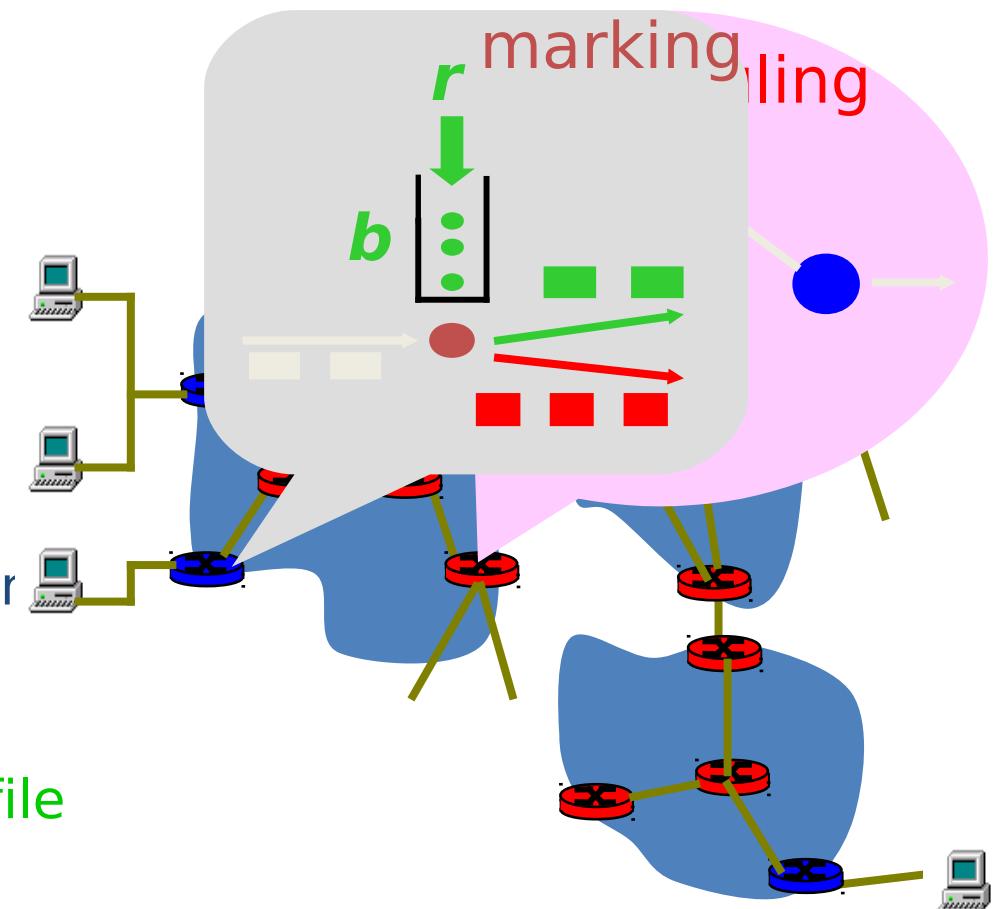
Resource reservation



DiffServ Architecture

Edge router:

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

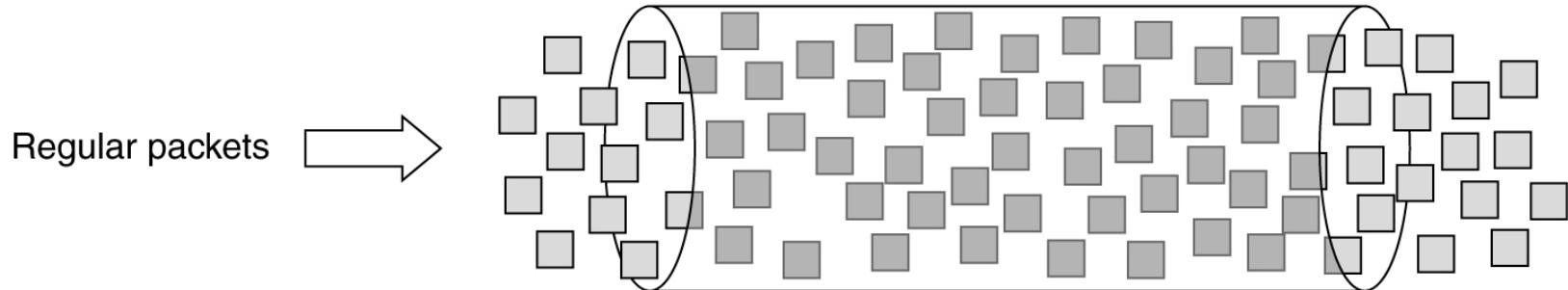


Core router:

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

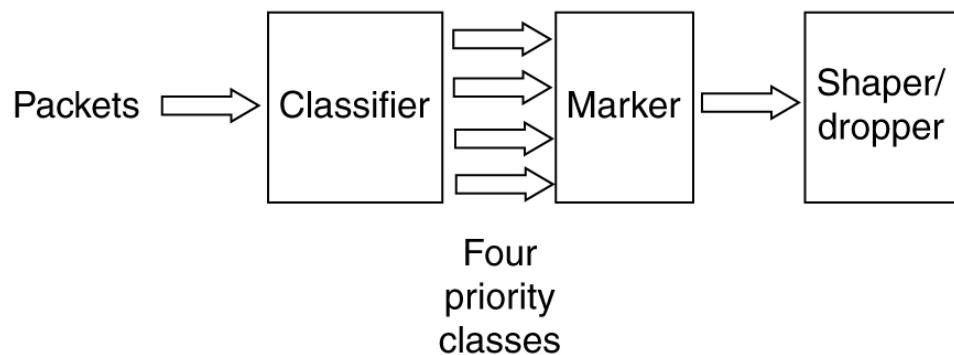
Expedited Forwarding

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



Assured Forwarding

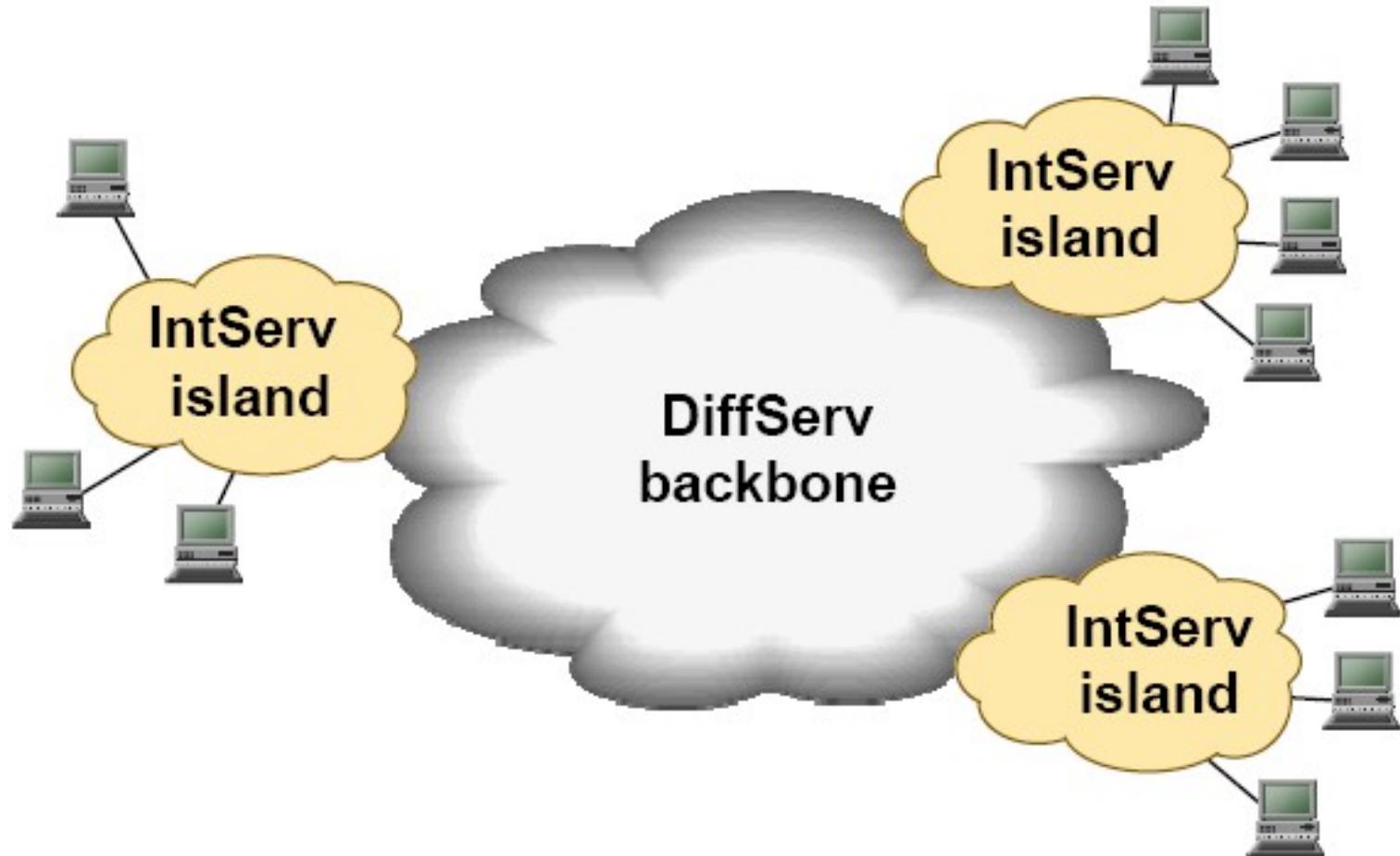
- A possible implementation of the data flow for assured forwarding is shown below.
- AF delivers the packet with high assurance as long as its' class does not exceed the traffic profile of the node.



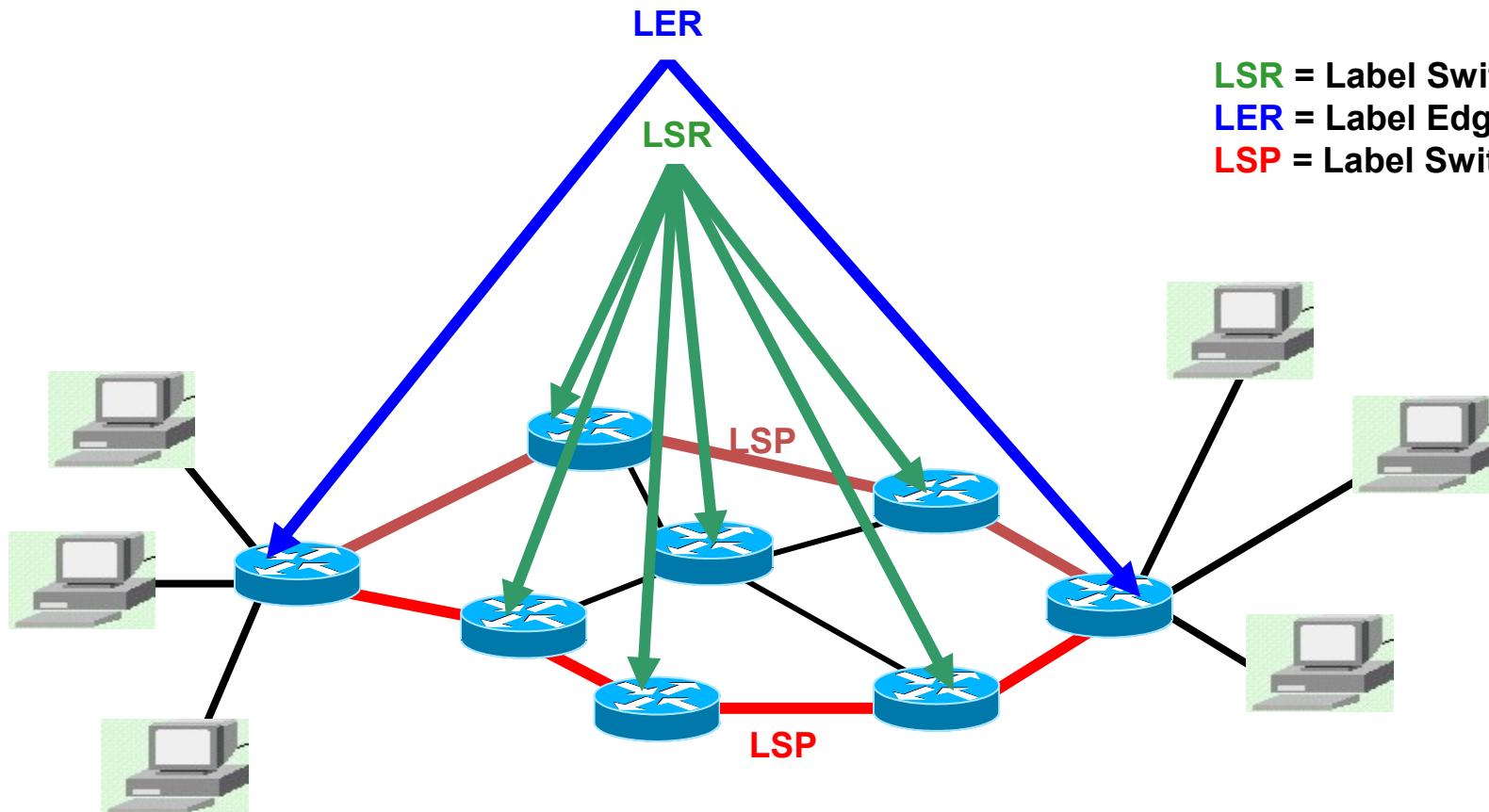
Example packet classifier

- 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



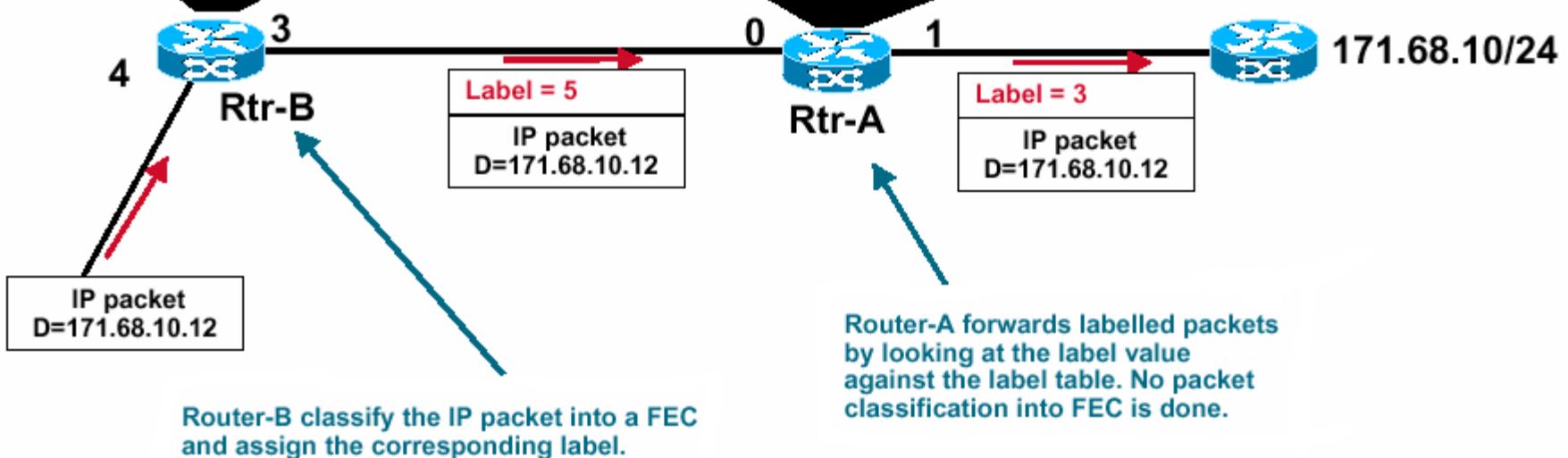
LER = Label Edge Router
LSR = Label Switched Router
LSP = Label Switched Path

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

