QoS Strategy in DiffServ aware MPLS environment

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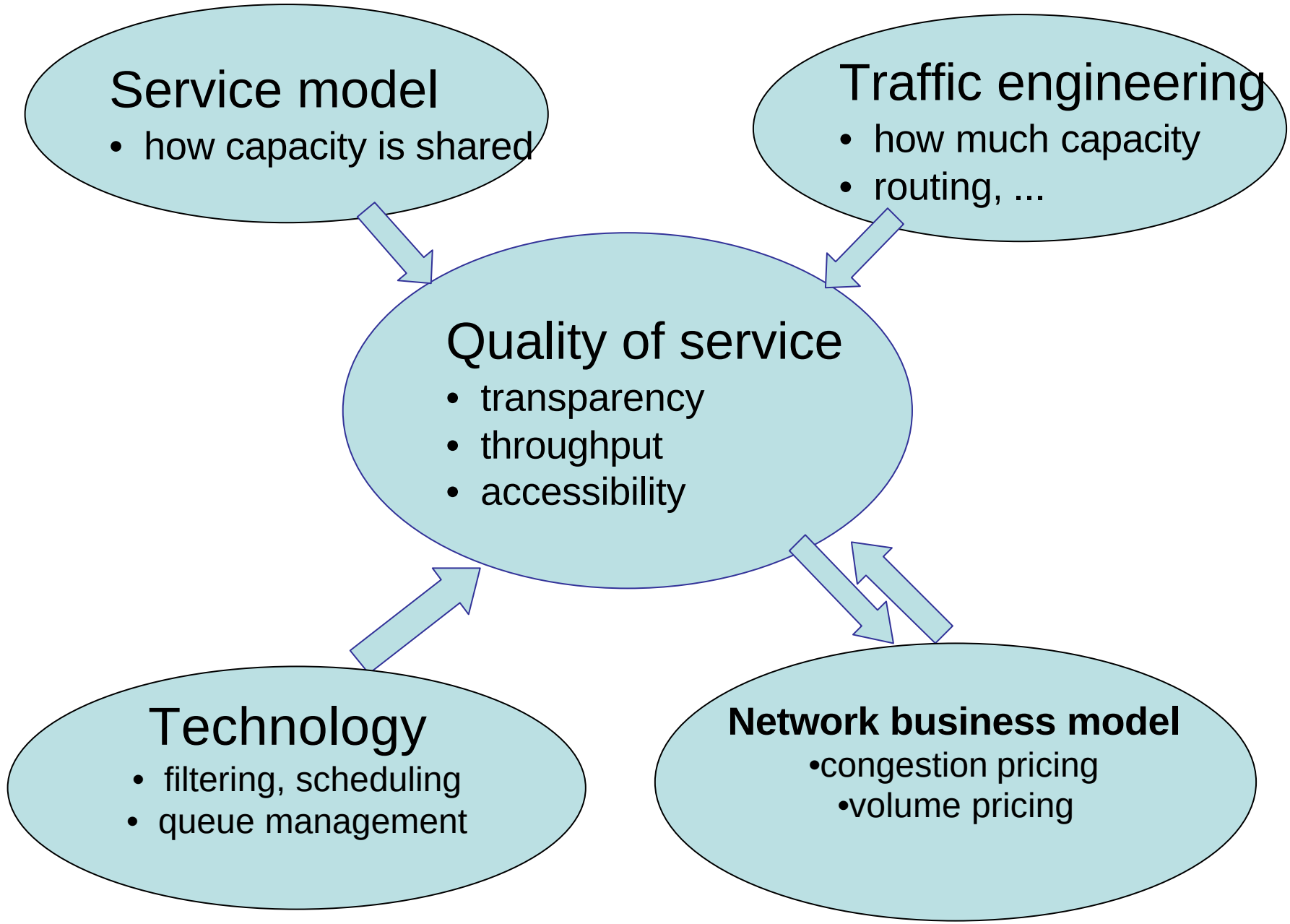

Service model
• how capacity is shared
Traffic engineering
• how much capacity
• routing, ...
Quality of service
• transparency
• throughput
• accessibility
Technology
• filtering, scheduling
• queue management
Network business model
•congestion pricing
•volume pricing

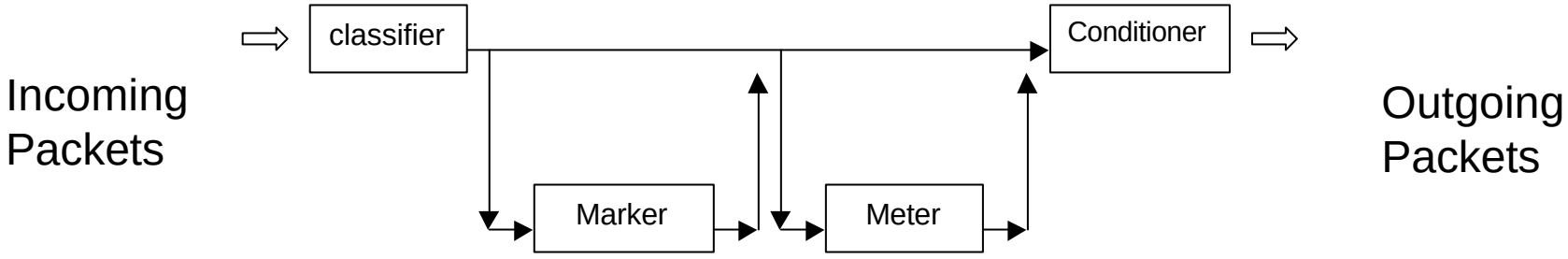
Differentiated Services (DiffServ)

- Required Mechanisms for Service Differentiation

  - Classification: To identify the aggregation (class) to which a packet belongs based on their different QoS requirements.

  – Scheduling: To determine which packet will be transmitted according to its priority specified by DS Code Point.

  – Queue Management: To decide which packets will be dropped, when the buffer overflows in the case of network congestions.



Principle of Service Differentiation

Multi Protocol Label Switching (MPLS)

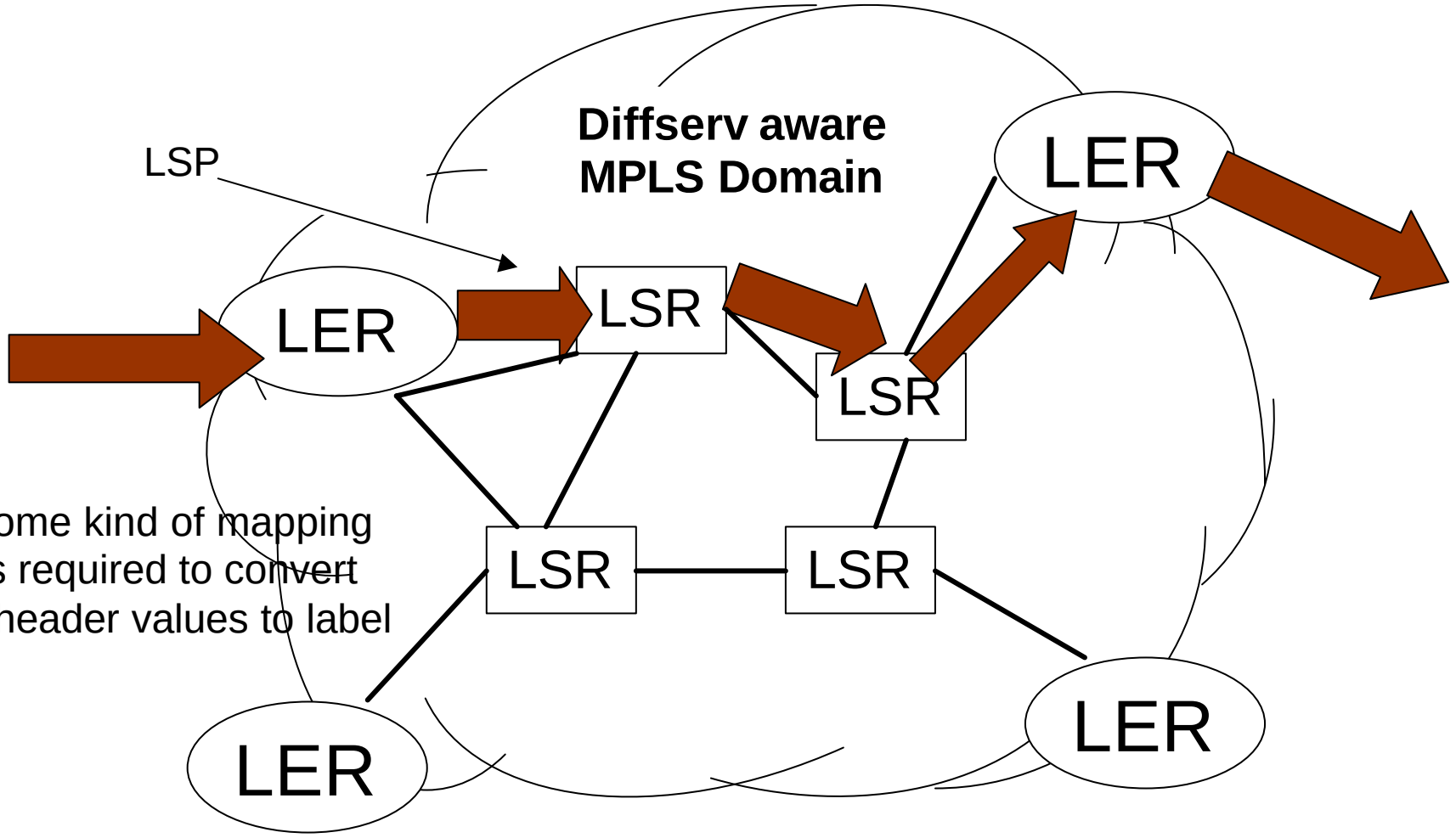
- Fast routing
- Provide bandwidth management
- Less load on core routers
- Use of labels in packet headers (short, fixed length and locally significant)
- Traffic engineering (classification and identification of IP packets with a label and forwarding the packets to a switch or router that is modified to operate with such labels.
- Signaling protocols used in MPLS (Label Distribution Protocol (LDP))
- No end-host protocol component
- Quality of Service (QoS)

DiffServ + MPLS

- A scheme which is mutually beneficial for both…
  - MPLS provides DiffServ with Path protection and restoration.
  - DiffServ acts as CoS architecture for MPLS

SO, MPLS with DiffServ can give network designers the flexibility to provide different treatment to certain QoS classes that need path-protection.

Domain Model



Some kind of mapping
is required to convert
IP header values to label

LER: Label Edge Router
LSR: Label Switch Router
LSP: Label Switch Path

Mapping DiffServ to MPLS

Why:

•Label Switch Routers (LSRs), don't see the IP header and DSCPs in ToS field of IPv4 header.

•LSR only reads the Label contents and decides the next hop

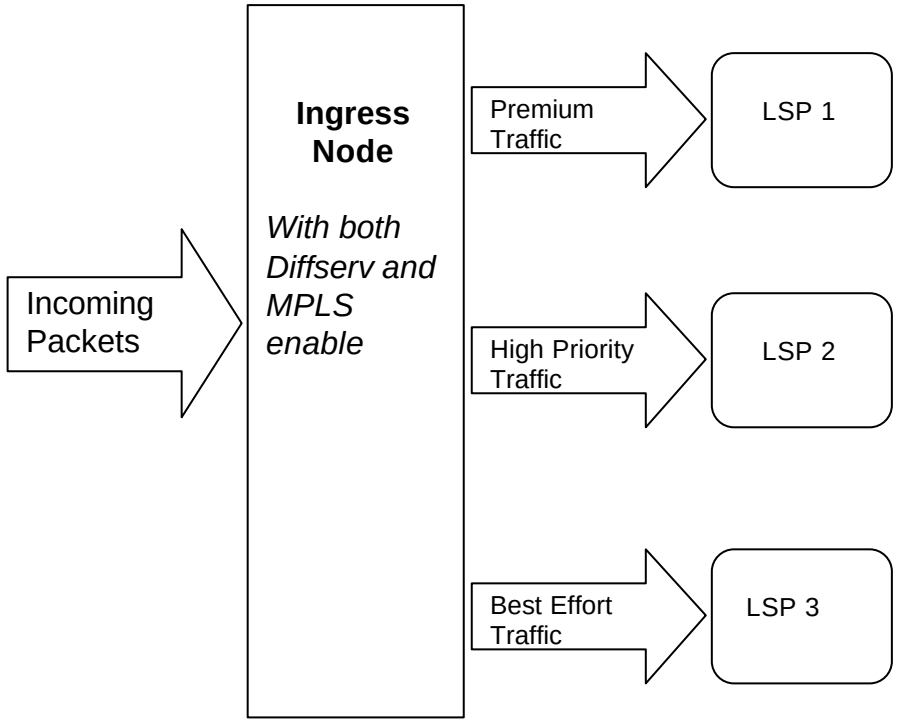
How:

•The contents of 6 bits DSCP is mapped into 3 bits EXP field of Label

There are two options to map DSCP value into the Label…

E-LSP	L-LSP
EXP-inferred-PSC LSP •PHB is determined from EXP bits •No additional signaling is required •EXP-PHB mapping is configured •Shim header is required •Up to 8 PHBs per LSP •With Bandwidth reservations, the bandwidth is shared by set of transported PSCs	Label-only-inferred-PSC •PHB is determined from Label or from label and EXP/CLP bits •PHB or PSC is signaled at LSP setup •Label-PHB mapping is signaled. •EXP/CLP-PHB mapping is well known •Shim or link layer header may be used •One PHB per LSP except for AF and PSC per LSP for AF •With bandwidth reservation, the bandwidth is per-PSC

Mapping Traffic to LSPs



- A network may have multiple classes of traffic.
- For a same destination, there might be different classes.
- Now, we can map different classes to different LSPs.

Problem:

Again the delay and jitter is possible as all the premium traffic is following the same physical path.

- We can solve the above mentioned problem by splitting the traffic into different LSPs, even the destination is the same.
- We can allocate certain Bandwidth for each service class in a single LSP.

Methodology

- **Calculation of**:
  - **Bandwidth Utilization per traffic flow**

$$\frac{N_r ? P_s ? 8bits}{t ? 1000}$$

where;

N_r ? Number of packets received at destination router in bytes

P_s ? Packet size

t ? Time in second

  - **Throughput**

$$\frac{N_r ? P_s ? 8bits}{(T_{stop} ? T_{start}) ? 1000}$$

where;

T_{start} ? Start time of each traffic flow in second

T_{stop} ? Stop time of each traffic flow in second

  - **Dropped packets**

$$\frac{N_g ? N_r}{N_g} ? 100\%$$

where;

N_g ? Number of packets generated at source

N_r ? Number of packets received at source

  - **Mean End-to-End Delay**

$$\frac{\sum_{i?1}^{N} D_i}{N_r}$$

where;

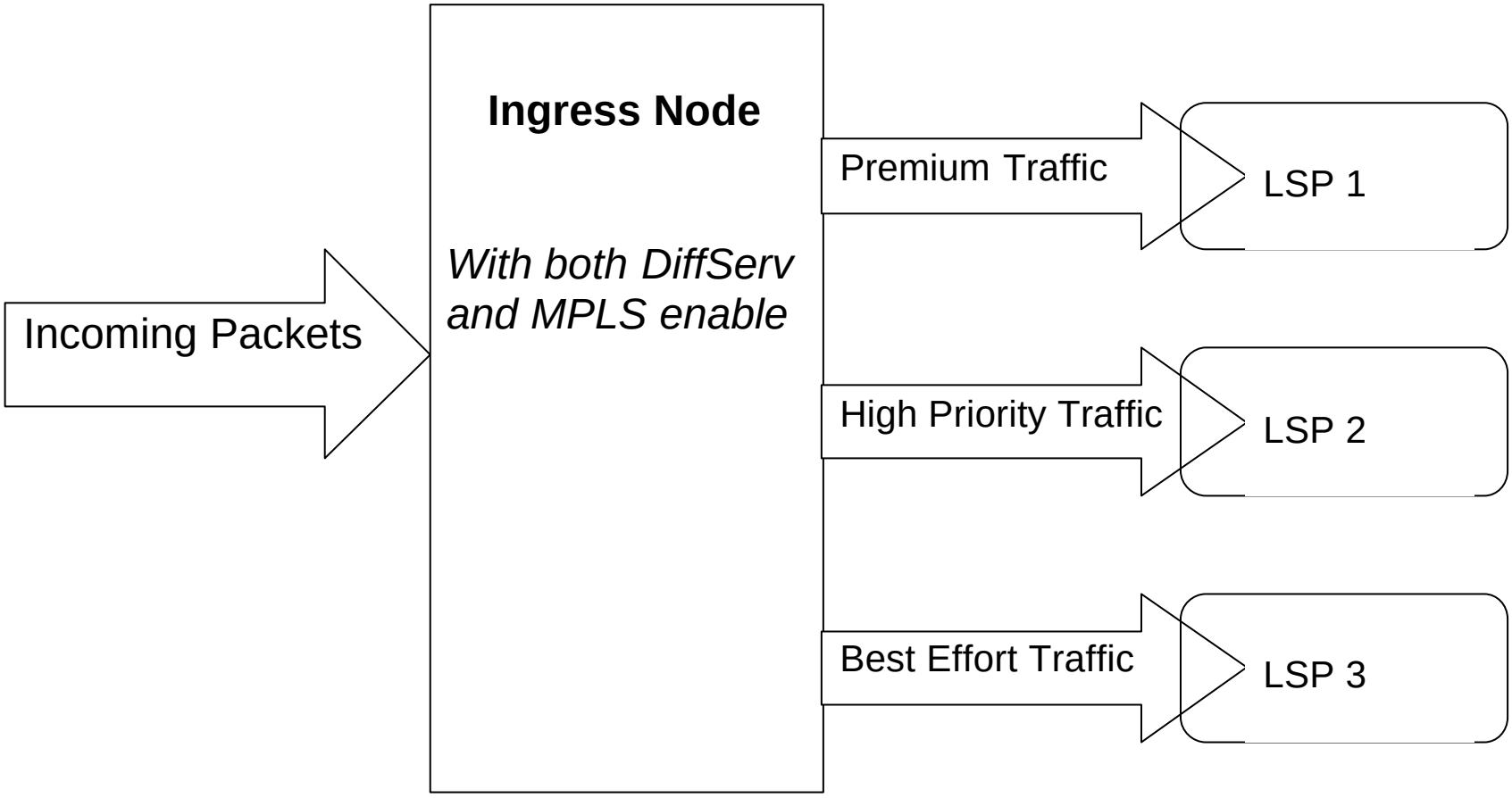
D_i ? End-to-End delay of packet ‘i’= $Ts_i ? Td_i$

Ts_i ? Time of packet ‘i’ en-queue at source router

Td_i? Time of packet ‘i’ receive at destination

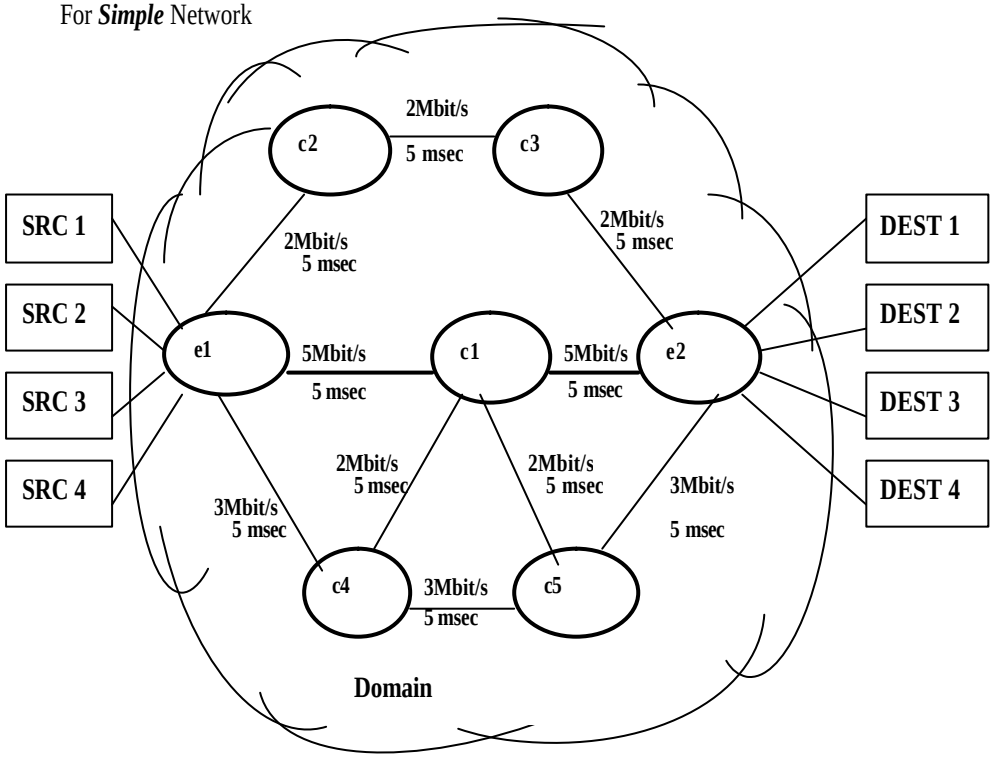
Application Scenario

- DiffServ + MPLS

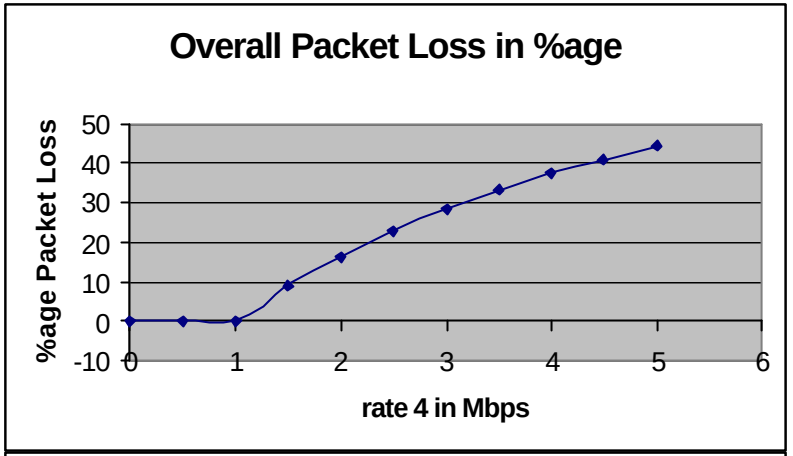


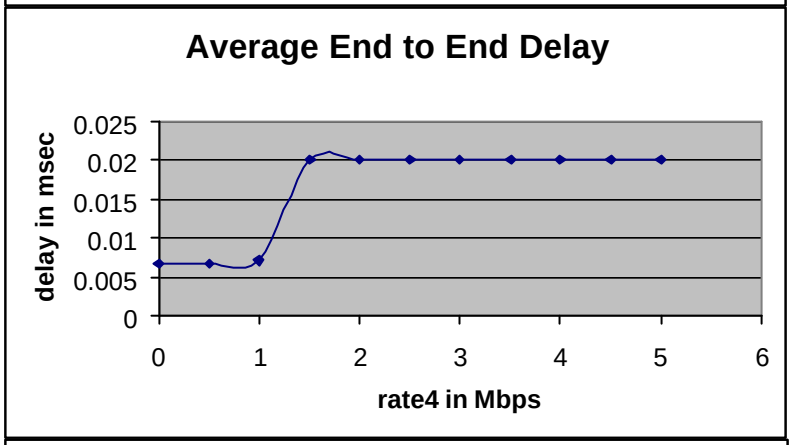
Network Topology: (Simple)

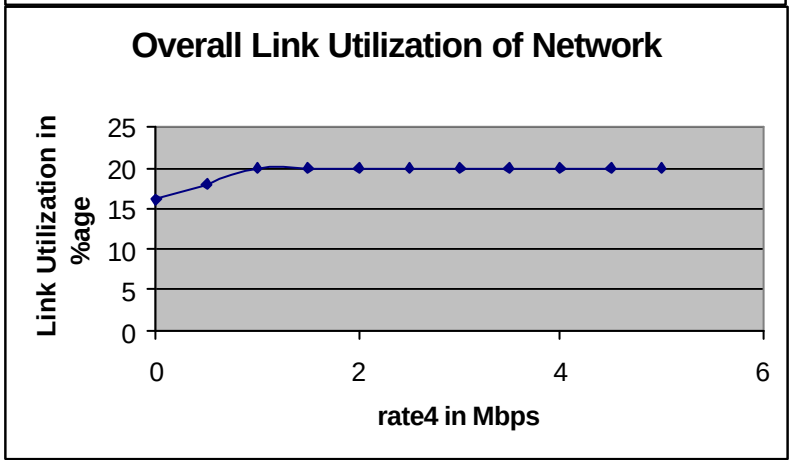
For ***Simple*** Network



- Traffic sources are CBR sources on UDP agents.
- All packets follows the same smallest path e1-c1-e2 for simple case.
- For each case we will keep constant all the above 3 sources and will vary only last source from 500kbps to 5000kbps.
- Other constant rates are:
  - Rate1: 1.9 Mbps (Real Time 1---RT1)
  - Rate2: 1.1 Mbps (Real Time 2---RT2)
  - Rate3: 1.0 Mbps (High Priority Best Effort---HPBE)
  - Rate4: 500kbps✍ 5Mbps (Simple Best Effort—SBE)
- ✍ Simulation time is 30.0 seconds

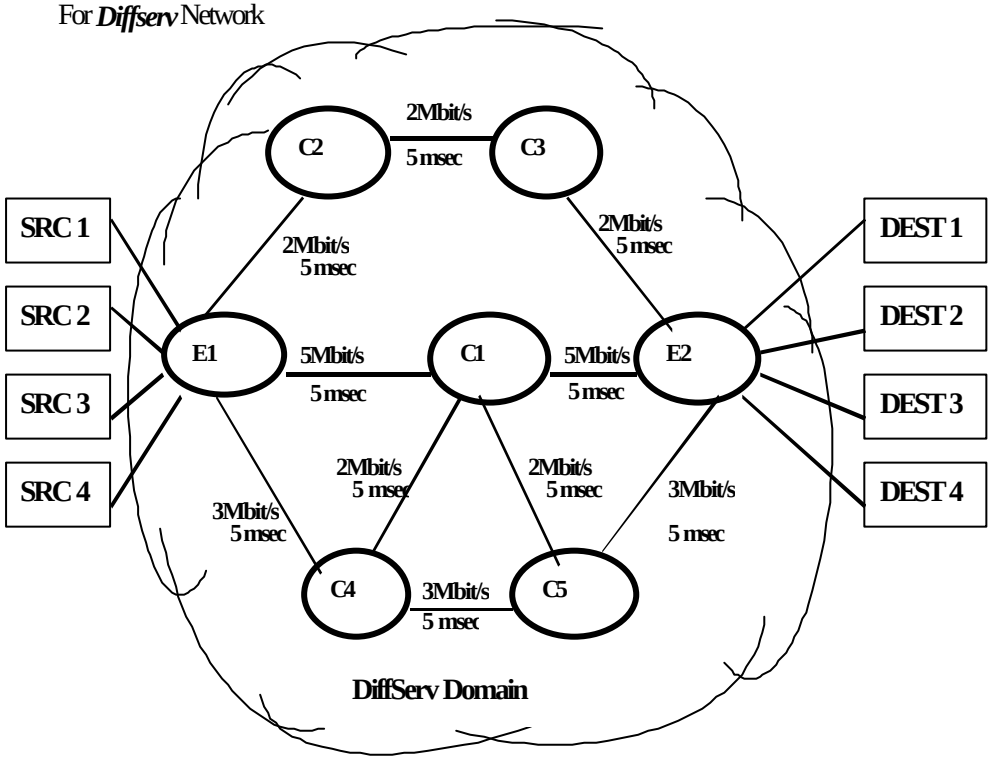






Network Topology: (DiffServ)

For ***Diffserv*** Network



- Traffic sources are CBR sources on UDP agents
- For each case we will keep constant all the above 3 sources and will vary only last source from 500kbps to 5000kbps.
- Other constant rates are:
  - Rate1: 1.9 Mbps (Real Time 1—RT1)
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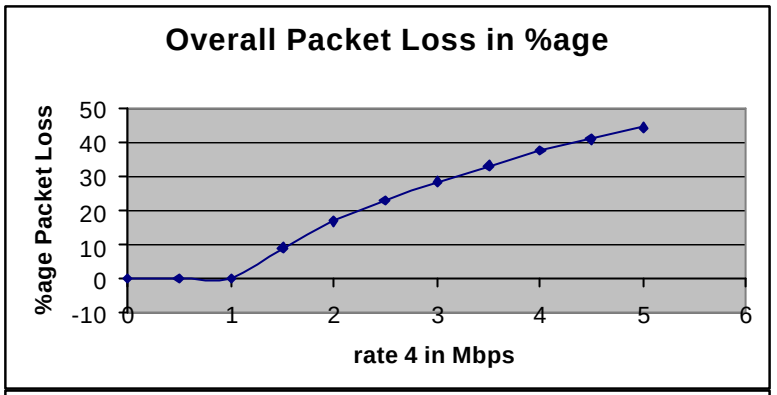
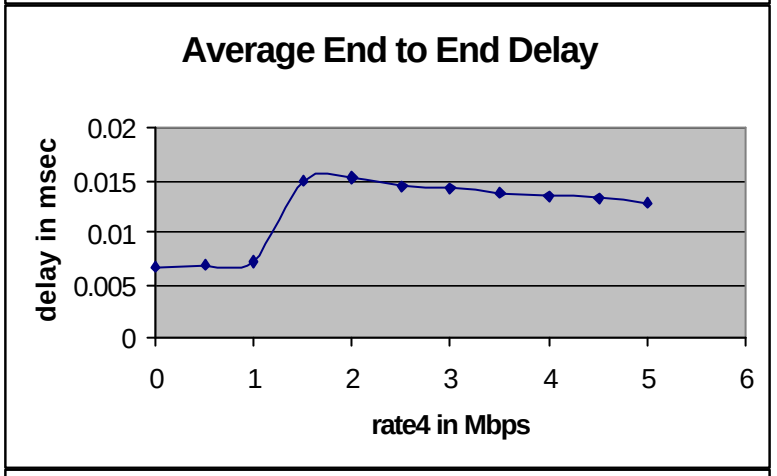
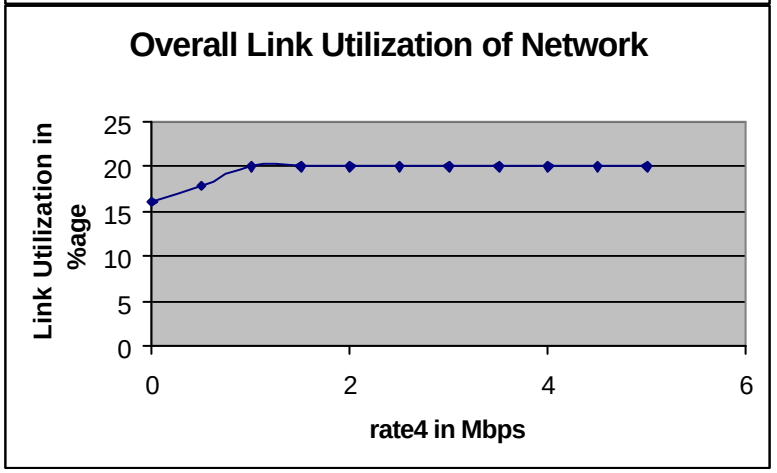
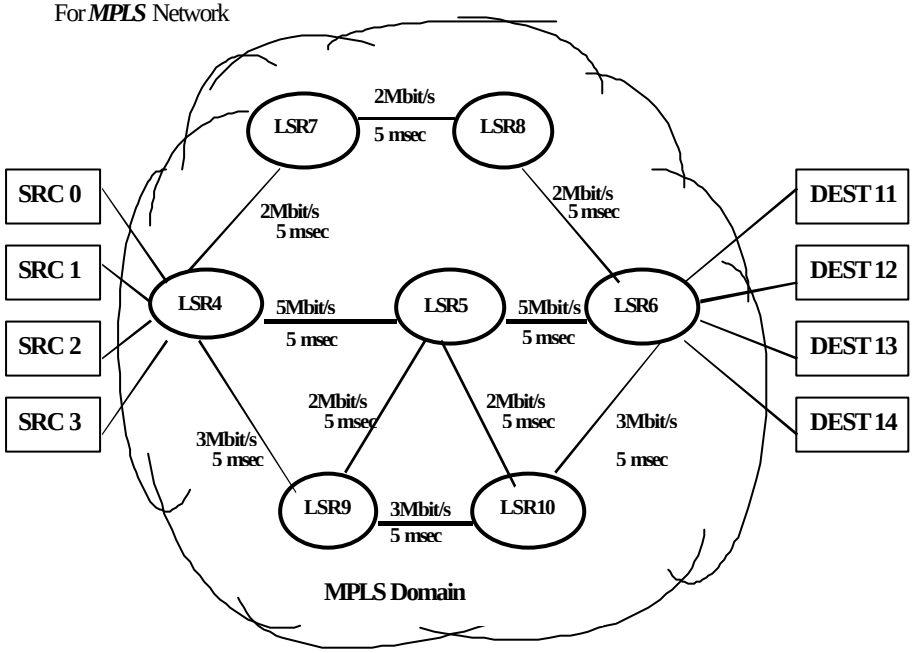






Network Topology: (MPLS)

For ***MPLS*** Network



?? If no ER-LSP is defined, all packets follow the same smallest path LSR4-LSR5-LSR6. In our case, we establish ER-LSP as soon as simulation starts.

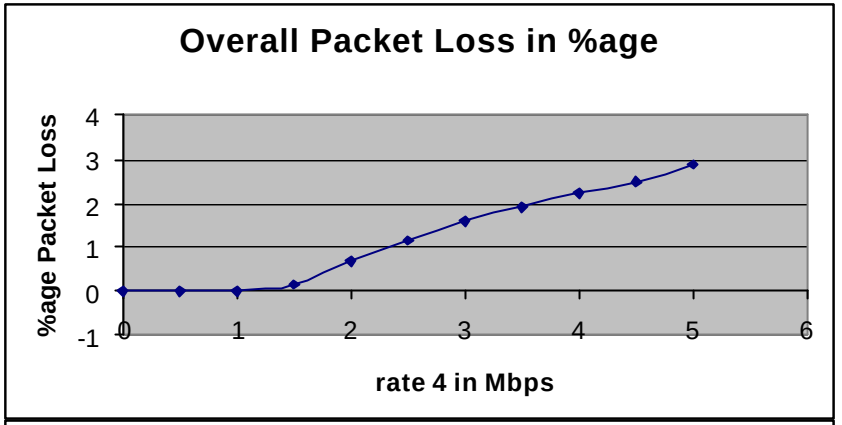
?? Traffic sources are CBR sources on UDP agents

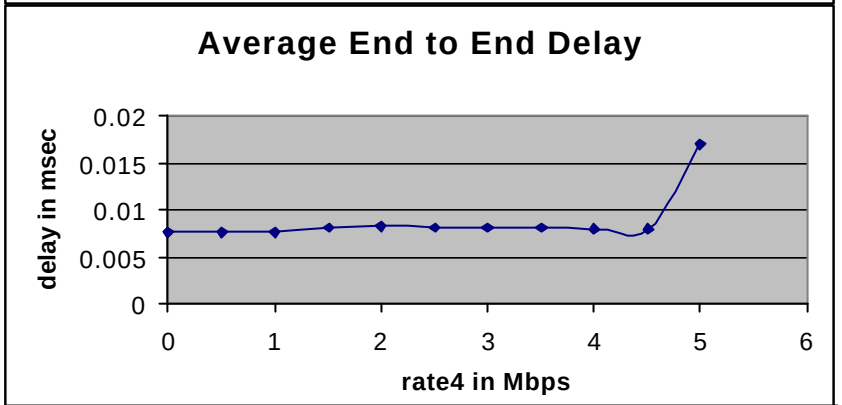
?? For each case we will keep constant all the above 3 sources and will vary only last source from 500kbps to 5000kbps.

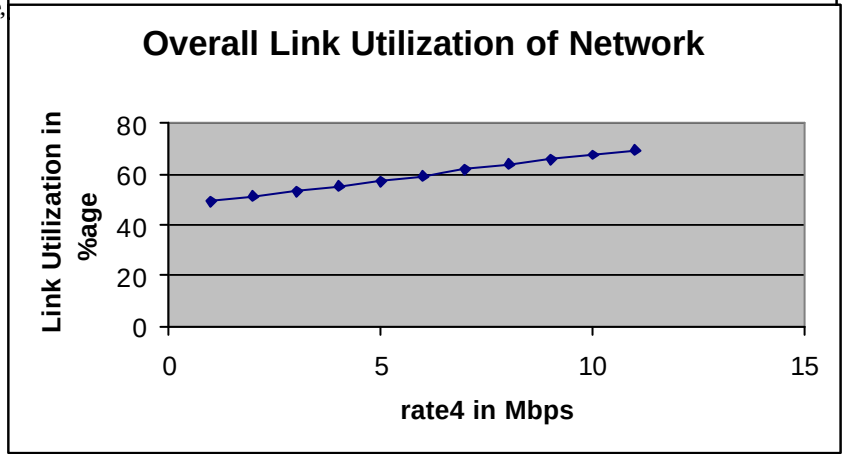
?? Other constant rates are:

- ?? Rate1: 1.9 Mbps (Real Time 1—RT1)
- ?? Rate2: 1.1 Mbps (Real Time 2—RT2)
- ?? Rate3: 1.0 Mbps (High Priority Best Effort—HPBE)
- ?? Rate4: 500kbps 5Mbps (Simple Best Effort—SBE)

Simulation time is 30.0 sec







Conclusions

From our “Dumbbell” network topology,

- The overall performance (packet Loss, End-to-End elay, Link utilization) of *DiffServ* is quite similar to the *Simple* scheme, but *MPLS* is superior than *DiffServ*.
- In *Simple* case, there is no mechanism to classify the packets, so packets are randomly dropped from all 4 sources.
- In *DiffServ*, the low priority packets (Best effort packets) are discarded. Since RED queue has been used, some early dropping of high priority traffic can also be predicted in the network.
- If we simply assign the priority in descending order to RT1,RT2 then HPBE and SBE in case of *MPLS*, Link utilization can be increased by mapping different traffic through different routers.

Thank You!