



# Quality of Service for VoIP

**WCS November 29, 2000**

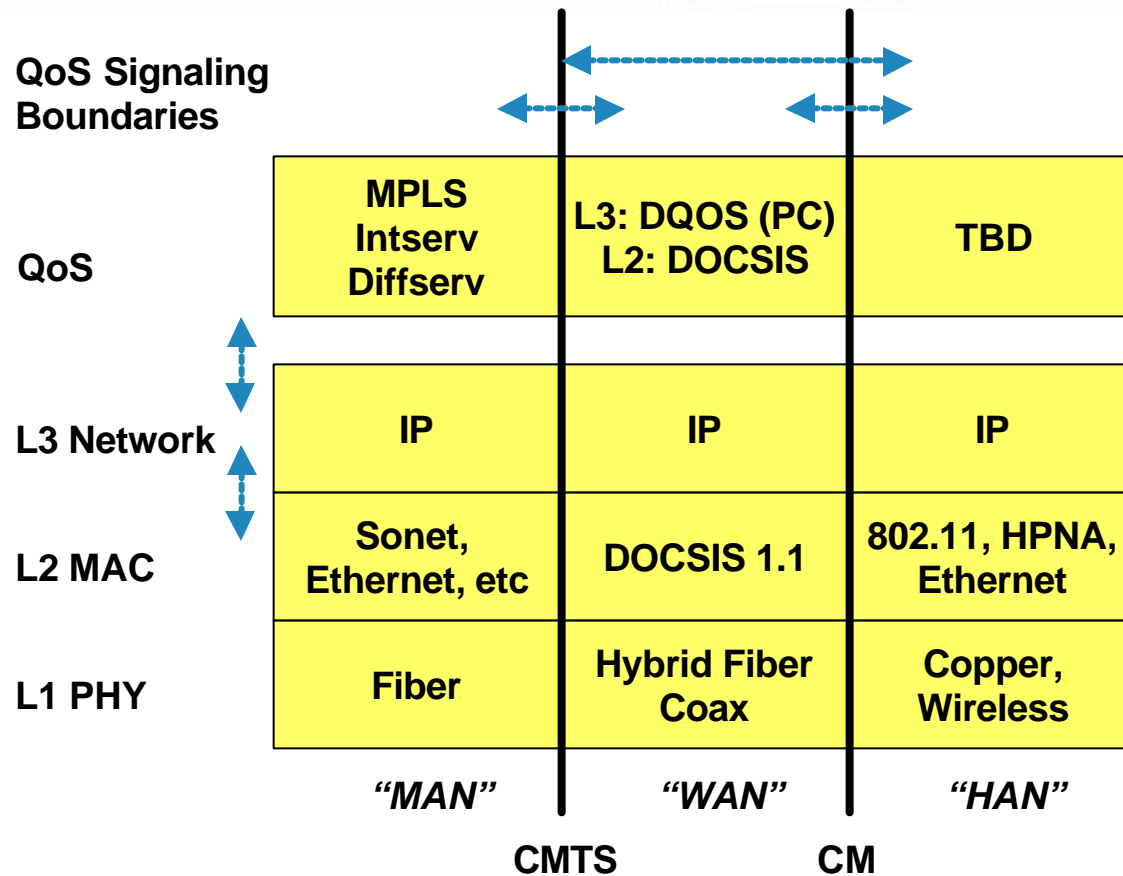
**John T. Chapman**

**Cisco Distinguished Engineer**

**Broadband Products and Solutions**



# The QoS Matrix



- Each QoS Element must be defined and present for a successful end to end VoIP call

# IP QoS

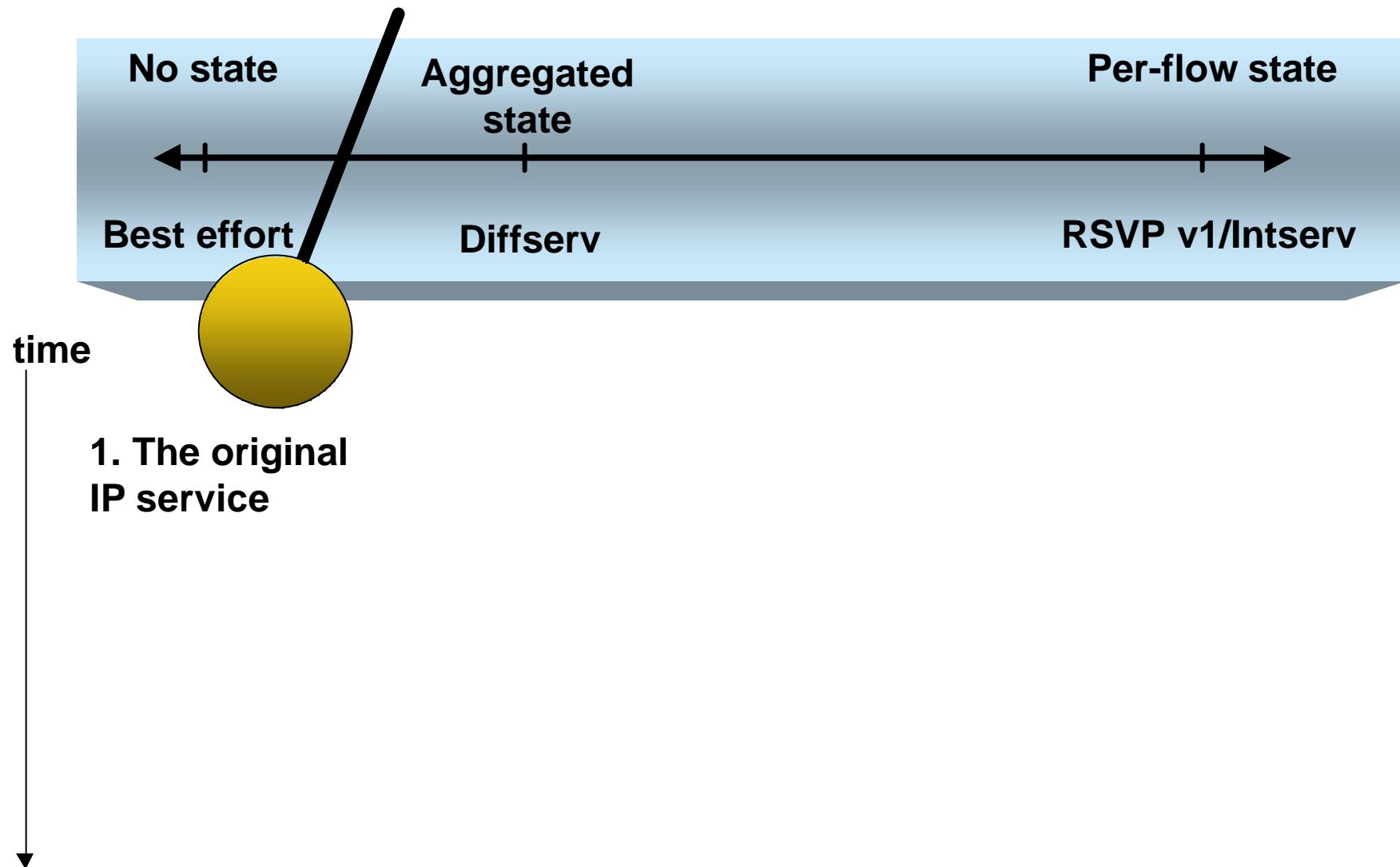
- **Now that we can place a VoIP telephone call across the HFC Plant with DOCSIS 1.1 and PacketCable, how does it get across an IP backbone without getting trashed?**
- **How is bandwidth guaranteed in order to support an SLA?**
- **What is Intserv, Diffserv, RSVP, and MPLS, and how do they all relate to each other?**
- **Lets look at the world of IP QoS**

**The way things were ...**

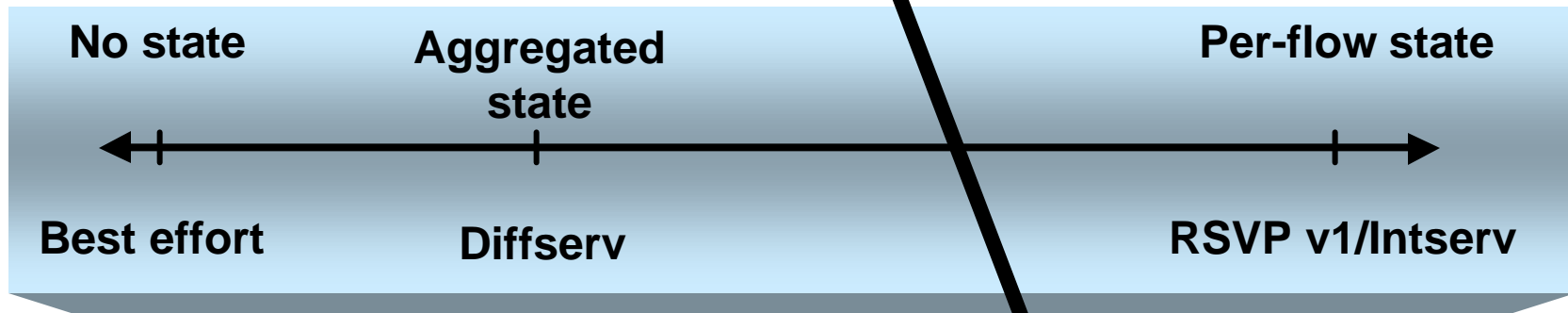
**The way things are ...**

**The shape of things to come ...**

# The IP QOS Spectrum



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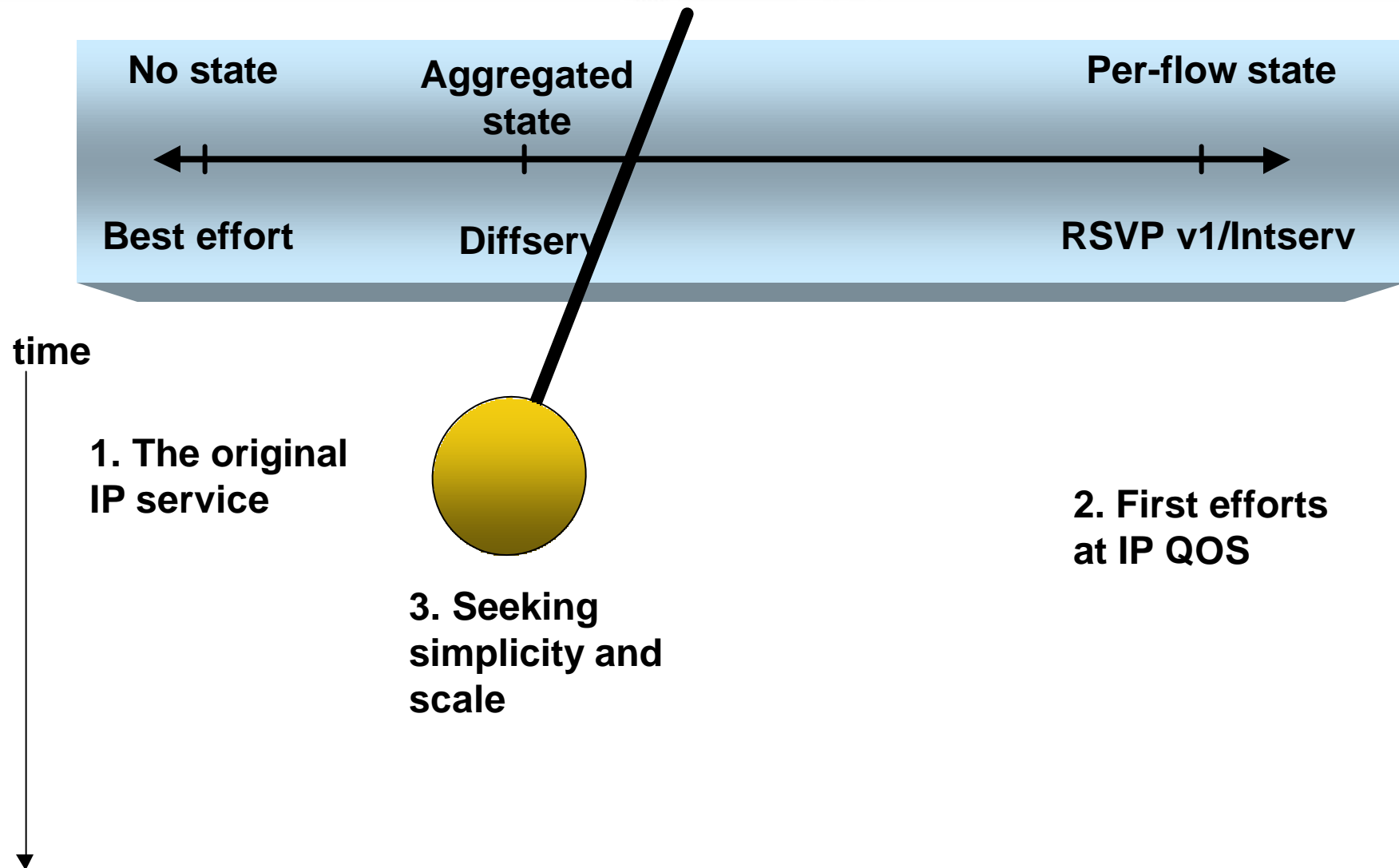


time

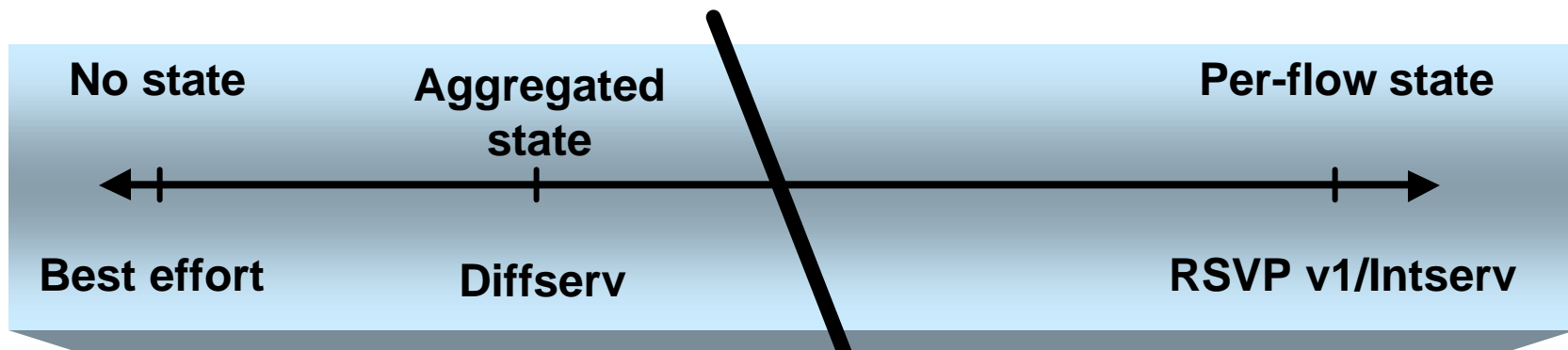
1. The original IP service

2. First efforts at IP QOS

# The IP QOS Spectrum



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time

1. The original IP service

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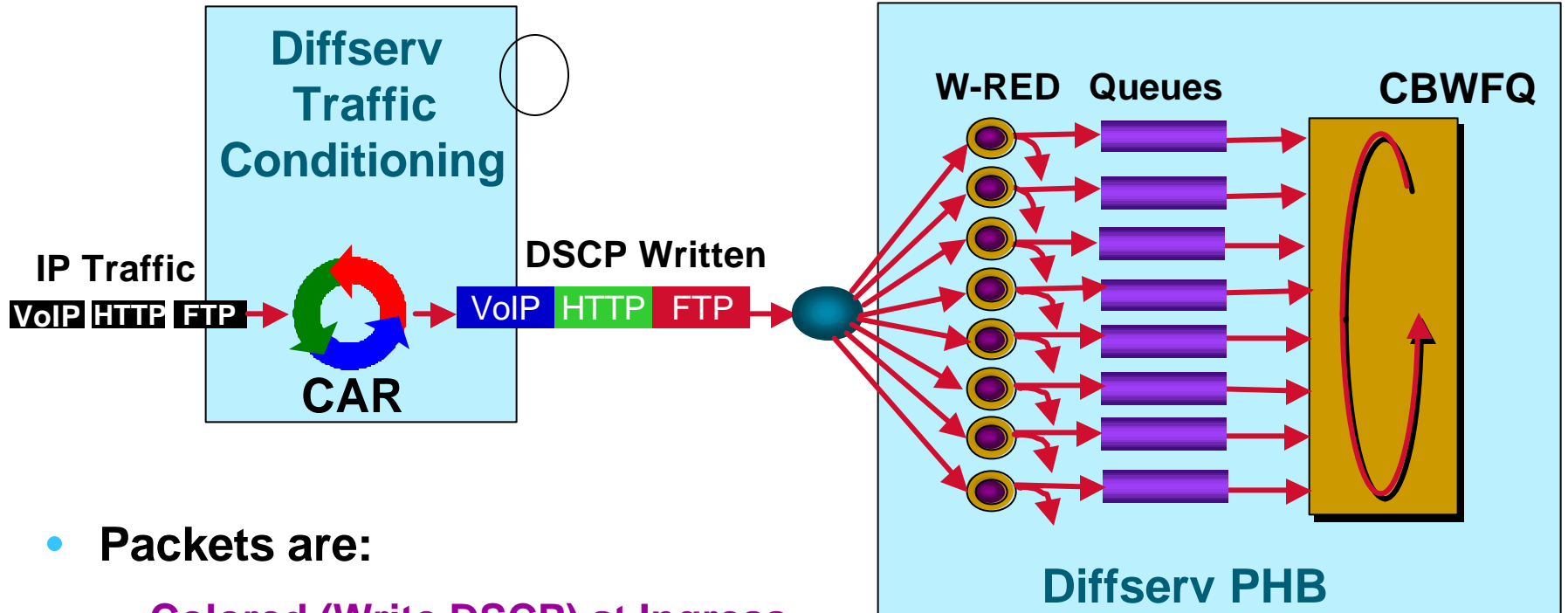
3. Seeking simplicity and scale

4. Scalability & SLAs??

# DiffServ

- **Routers at the edge classify and mark packets with a 6 bit Diffserv Code Point (DSCP)**
  - **Previously, only the 3 bit IP Precedence field was used**
- **Routers at the core apply different queuing disciplines to each DSCP. Now called Per Hop Behavior (PHB)**
  - **Expedited Forwarding (EF), Assured Forwarding (AF), Default, Class selector (CS)**
- **Preferred approach for today's ISPs. Near-minimum complexity.**

# Putting it all together



- **Packets are:**

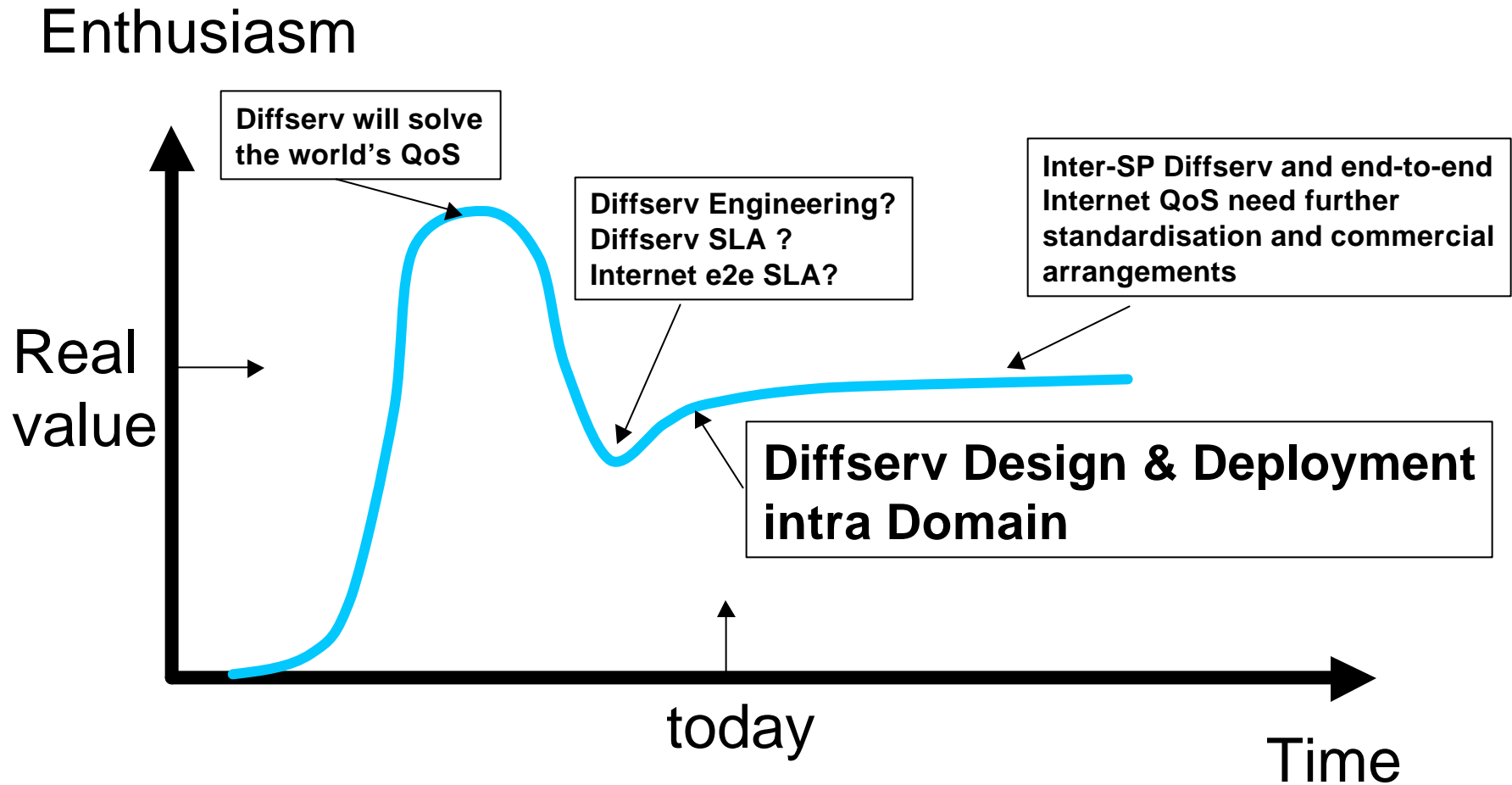
Colored (Write DSCP) at Ingress

Classified and Potentially Discarded by W-RED (Congestion Mgmt)

Assigned to the Appropriate Outgoing Queue

Scheduled for Transmission by CBWFQ

# Diffserv Acceptance



# IntServ

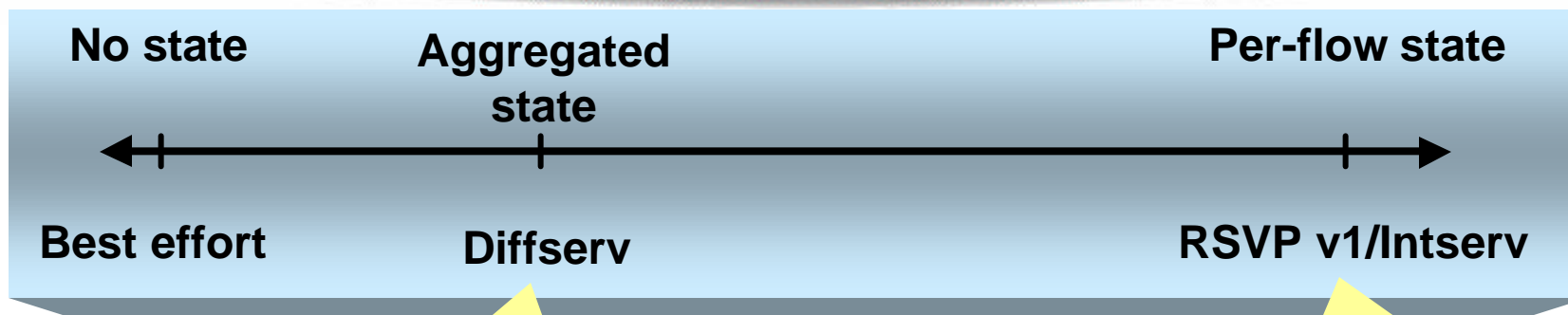
- **Goal: introduce QOS 'guarantees' into IP without damaging best effort**
- **Support multicast, remain connectionless, and achieve scalability.**
- **From several candidates, two services - guaranteed and controlled load - became standards**
- **RSVP**

**General IP signaling protocol. RSVP != Intserv**

**Describes characteristics of IP microflows, a 5-tuple of Protocol ID and from <host A,port X> to <host B,port Y>**

**Receiver driven, soft state protocol, PATH, RESV messages**

# The Imperfect World



## Pro

- Strong on simplicity

## Con

- Weak on guarantees
- Can't reject the "last straw" VoIP call.

## Pro

- Topology aware admission control is ideal for voice

## Con

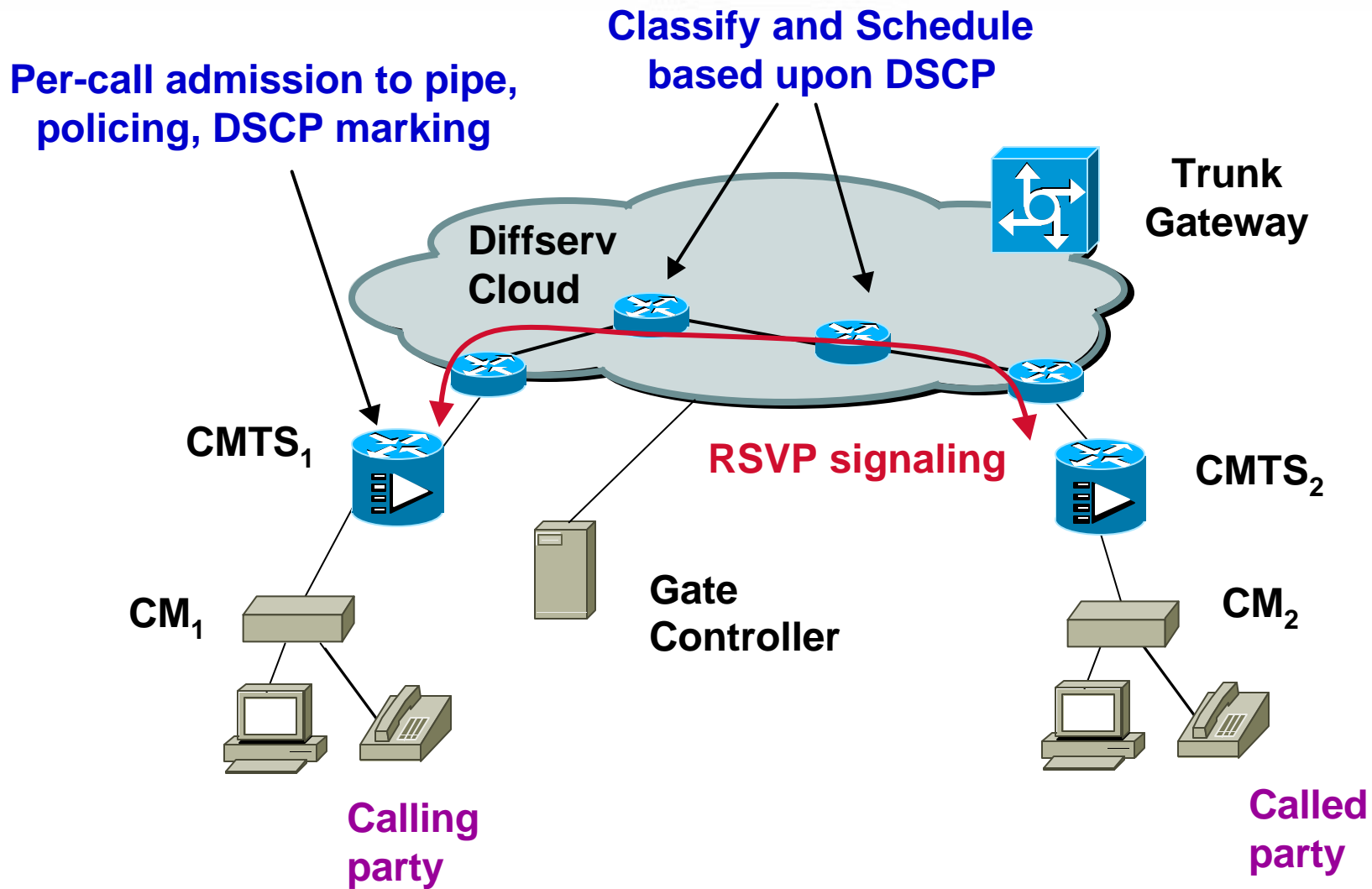
- Scaling issues due to storing too much state in backbone routers for both **control plane** and **forwarding plane**

# RSVP/Diffserv Integration



- Routers at edge of Diffserv cloud perform microflow classification, policing, admission control, and set DSCP
  - May use 2 values for “in” and “out” of contract
- Diffserv packet marking provides the key to increasing RSVP scalability -- Best of both worlds
  - RSVP is used at every hop for admission control
  - DSCP classification and scheduling in the core
- Scaling limit is now just the per-flow reservation state (control plane only)
  - > 10k reservations per node already demonstrated

# RSVP/Diffserv Integration

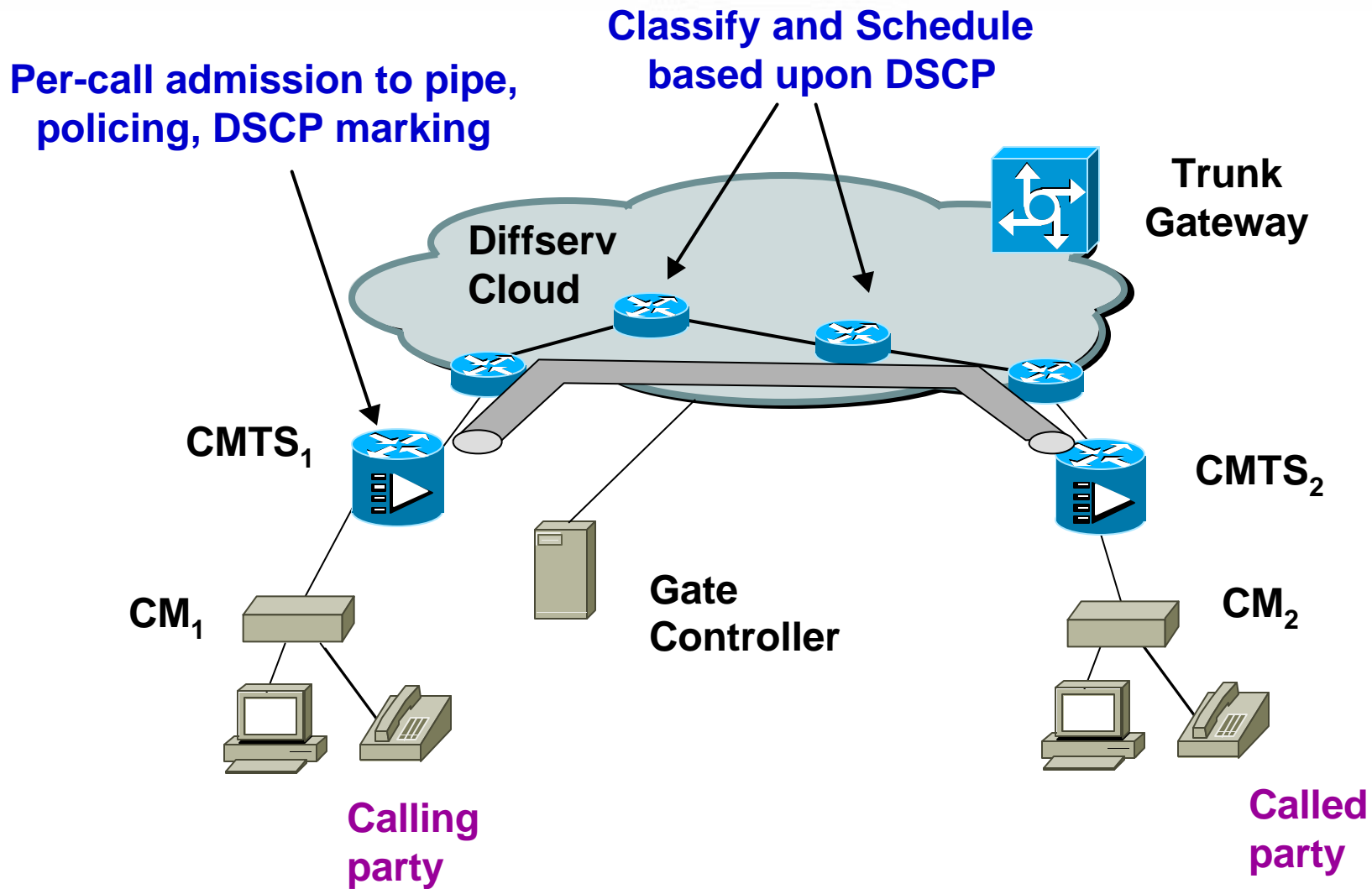


# RSVP/Diffserv Integration + Aggregation

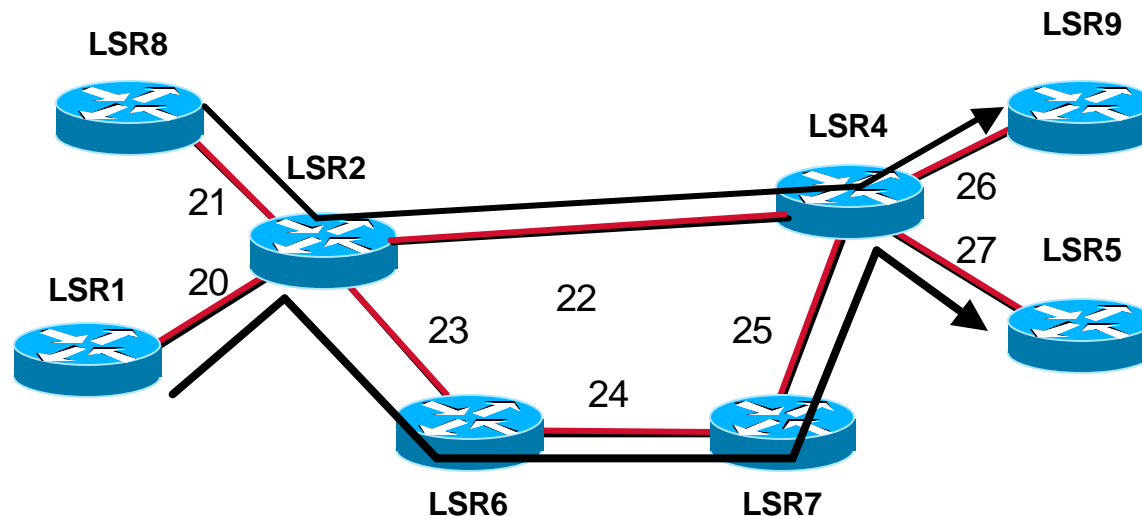


- Same forwarding plane is before
- We now make aggregated reservations (“fat pipes”) from ingress to egress
  - Microflow RSVP messages are “hyperspaced” across cloud
  - Control plane is simplified.
- Size of aggregate reservation may be dynamically adjusted to cover all microflows
  - Heuristics are possible

# RSVP/Diffserv Integration + Aggregation



# Multiprotocol Label Switching MPLS



- Adds “Labels” to the front of packets based upon LSR (Label Switched Paths). More than one label can exist per physical path.
  - **LSR (Label Switch Router) switches based upon labels, not IP addr**
- Using the same Label on different packets creates a tunnel.
- Labels may be pushed and popped to create nested tunnels

# MPLS

- **Enables constraint-based routing**

Higher BW routes may be chosen over lower BW routes

- **Ensures aggregated data follows aggregate reservation**

Routes become deterministic and repeatable

- **Enables fast reroute**

Route Fail-over and restore can be < 50 ms

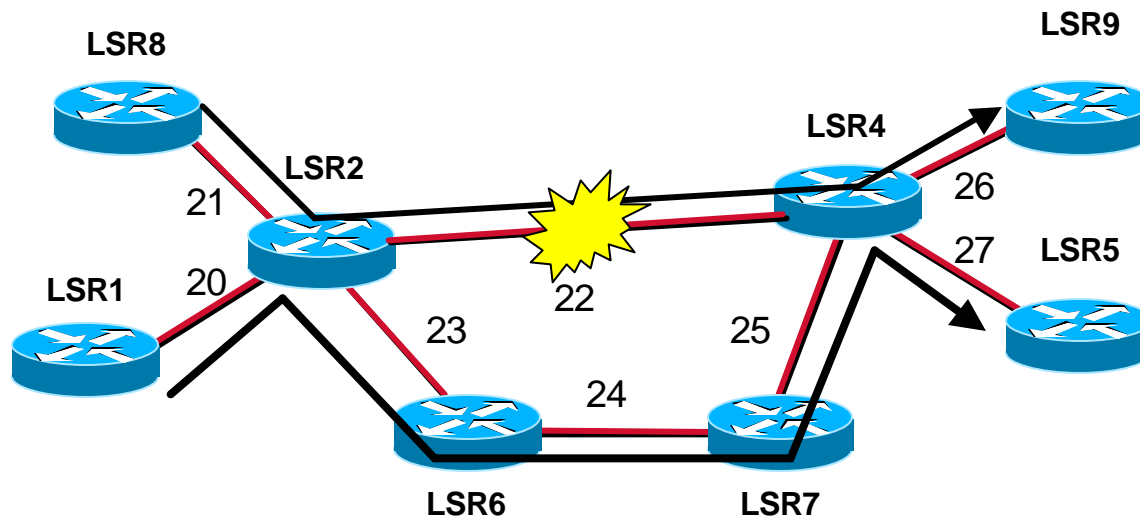
Very fast response to link or node failure without waiting for routing reconvergence

Response time governed by speed of failure detection, e.g. SONET alarm

The Back-up Path can be a different media type

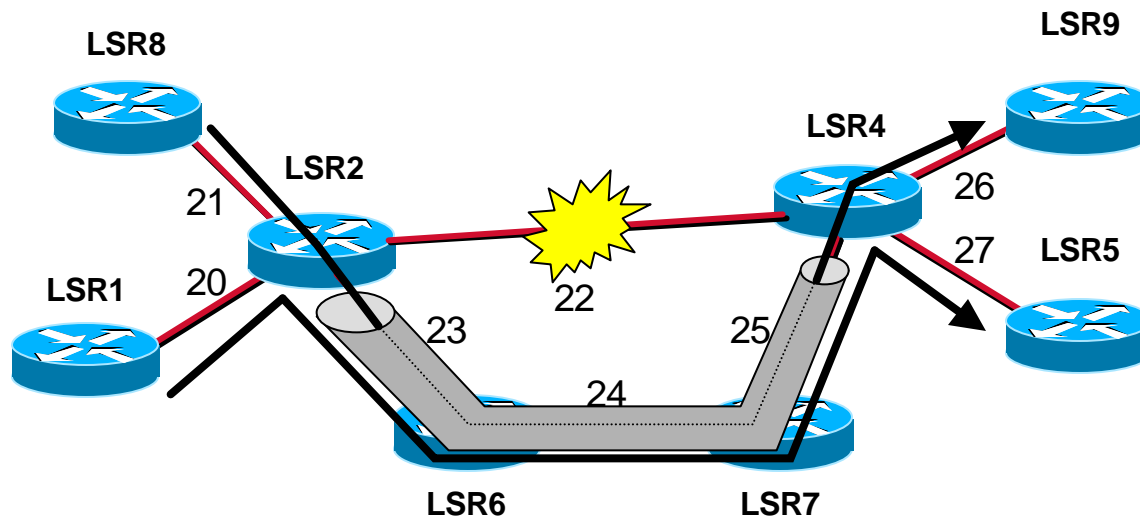
An Gigabit Ethernet link could back up a POS link.

# Fast Reroute



- Protection LSP 23-24-25 has been established from LSR2 to LSR4 to protect direct link 22
  - Longer LSPs can be used to protect nodes or other LSPs
- LSR2 detects link failure (e.g SONET Alarm)

# Fast Reroute



- LSR2 changes outgoing i/f from failed link to backup LSP  
tunnel 21-22-26 is nested inside of 23-24-25
- LSRs 6 & 7 forward packets obliviously
- LSR 4 receives correctly labeled packets and sends them to LSR9

# MPLS Guaranteed Bandwidth

- **MPLS Guaranteed Bandwidth combines:**
  - 1) Diffserv classification & queuing
  - 2) RSVP-based admission control & LSP establishment
  - 3) MPLS forwarding and constraint-based routing
- **MPLS Guaranteed Bandwidth adds capabilities for strict Point-to-Point QoS guarantees**

“Strict” in terms of committed targets (delay, jitter, loss) and commitment level (e.g. 99.99%)
- **Doesn't replace Diffserv “Soft Point-to-Cloud QoS”**

complements it for more demanding services

# MPLS Guaranteed Bandwidth: QoS Recipe

- Each service is delivered using 3 ingredients:
  - per-service input policing at edge**
  - per-LSP admission control at every hop**
    - Ⓜ Aggregated admission control: one LSP may carry many individual “Guaranteed Bandwidth” services
  - per-class scheduling (one queue for all traffic of a given PHB)**
    - Ⓜ Aggregated scheduling: a class queue carries many LSPs.
- Admission control + policing at edge + dedicated queue Ⓜ  
guaranteed BW
  - combines topology-aware admission control w/ Diffserv scheduling & classification for scalability

# Conclusions

- **Int-serv/RSVP versus Diffserv is the wrong question**  
**Diffserv alone is an excellent first-step for scalability**  
-> ready for ISP deployment  
**RSVP v.1 is a fine solution in moderate sized nets**  
-> increasing number of RSVP-aware endpoints, such as Win2K
- **RSVP + Intserv + Diffserv promise a combination of scalability, solid guarantees and admission control**
- **MPLS Guaranteed Bandwidth applies RSVP to MPLS networks**  
**adds point-to-point guarantees to the QoS portfolio**
- **For a multi-service IP network, multiple QoS strategies will co-exist on the same network.**  
**Which is the right strategy? “All of the above”**

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