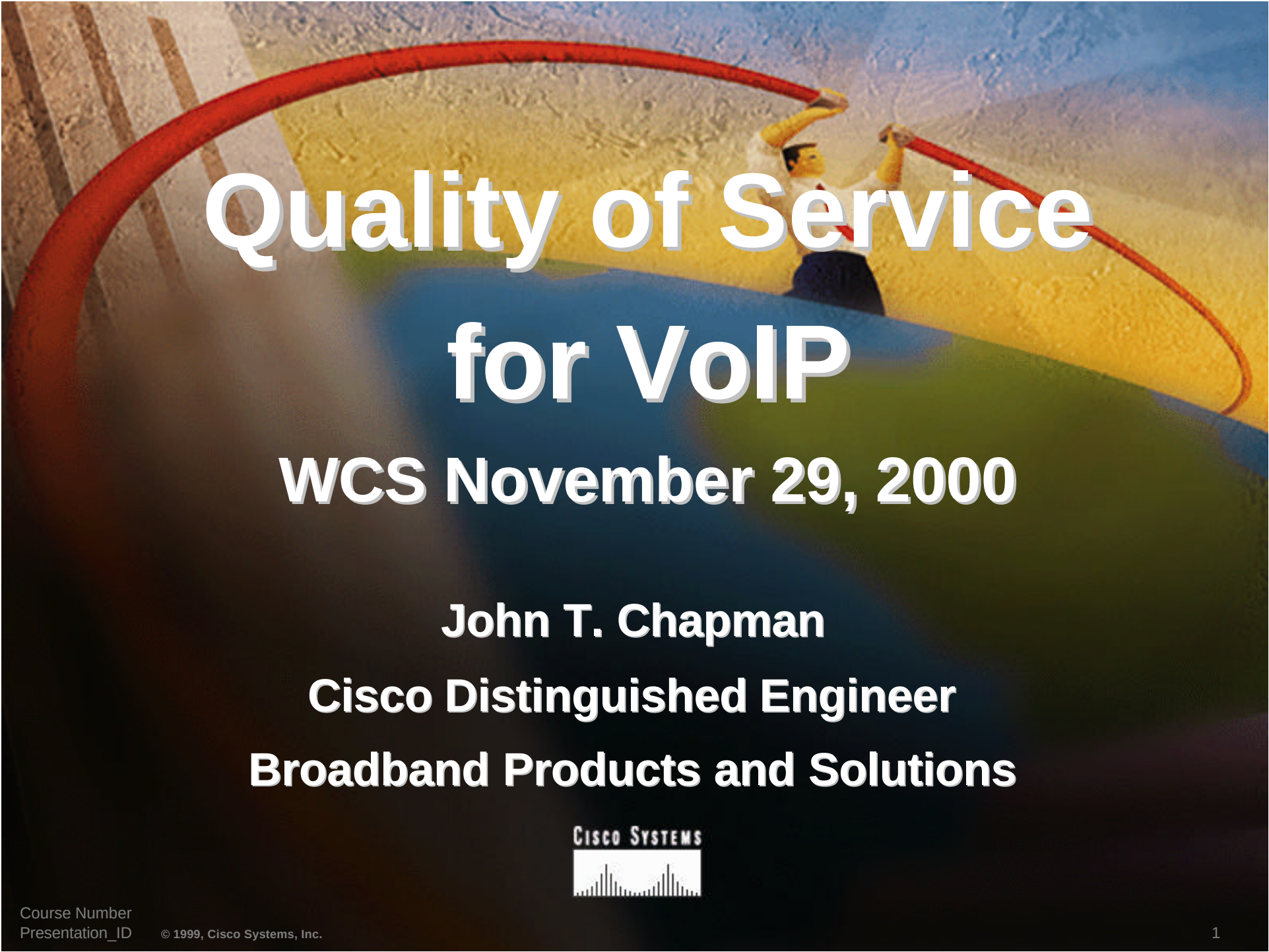




Quality of Service for VoIP

WCS November 29, 2000

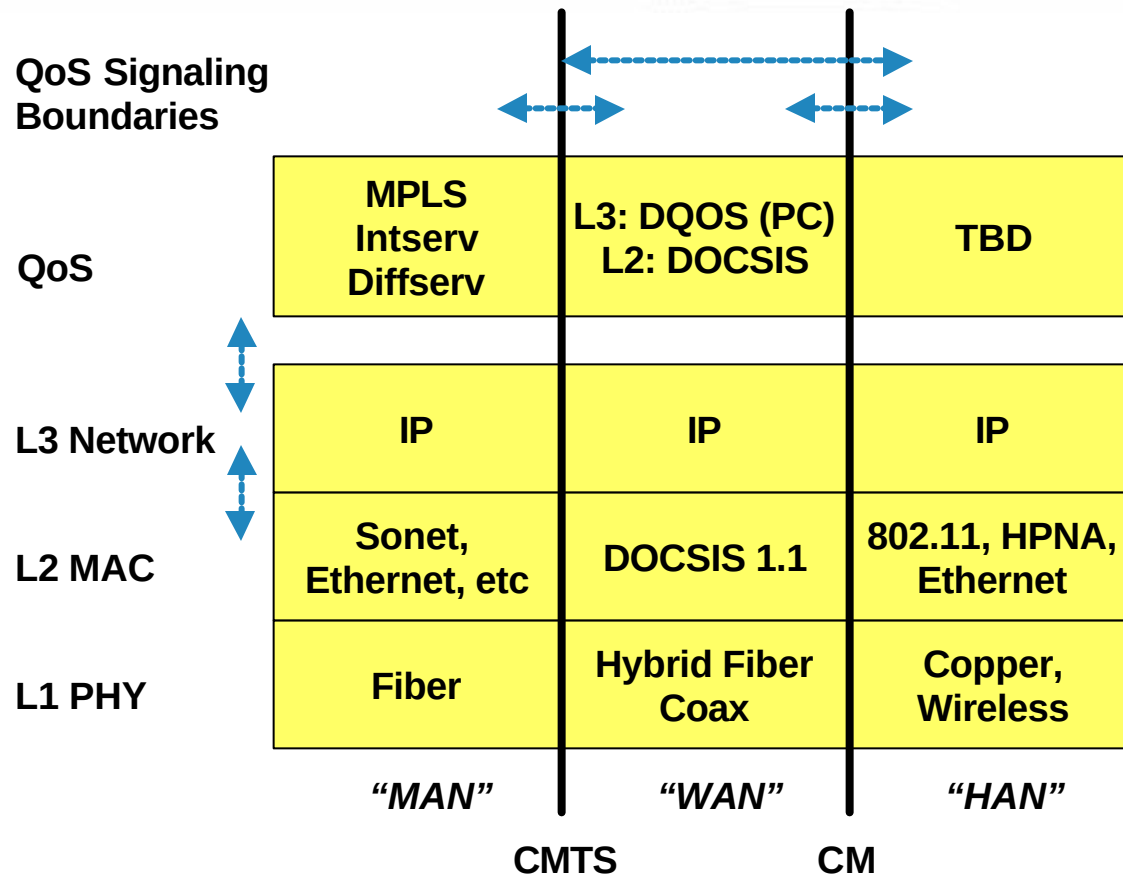
John T. Chapman

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

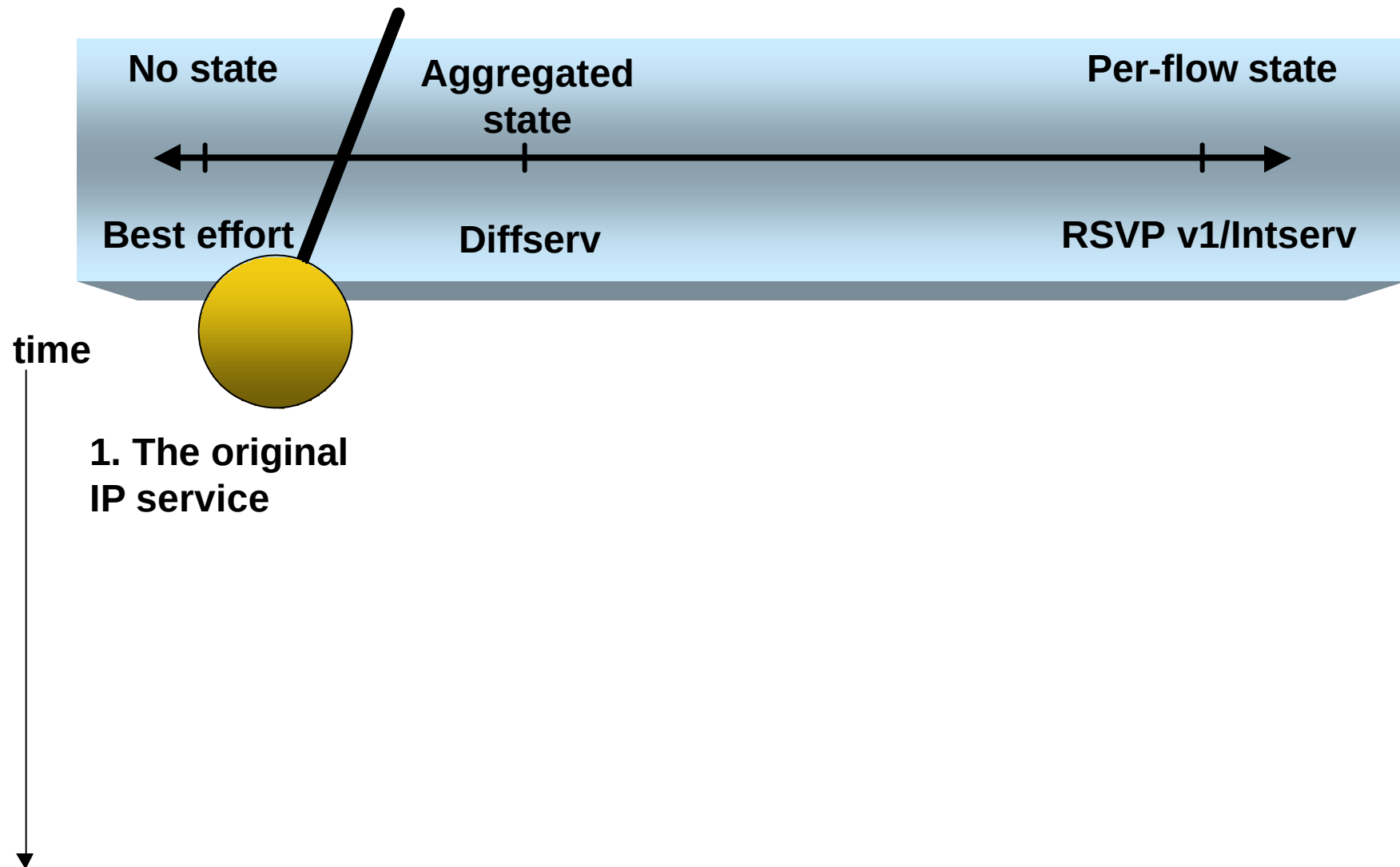
- Now that we can place a VoIP telephone call across the HFC Plant with DOCSIS 1.1 and PacketCable, how does it get across an IP backbone without getting trashed?
- How is bandwidth guaranteed in order to support an SLA?
- What is Intserv, Diffserv, RSVP, and MPLS, and how do they all relate to each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

The way things were ...

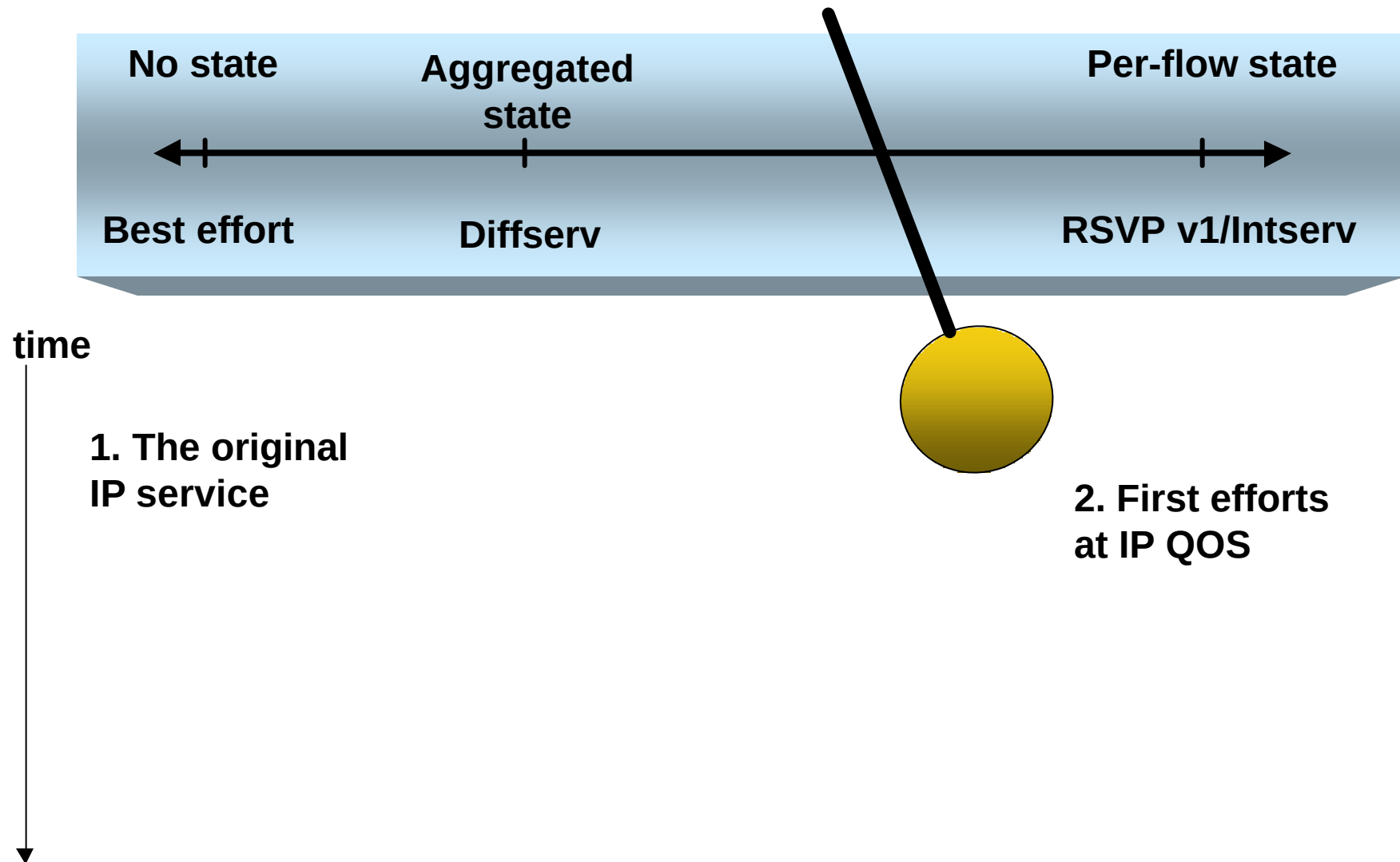
The way things are ...

The shape of things to come ...

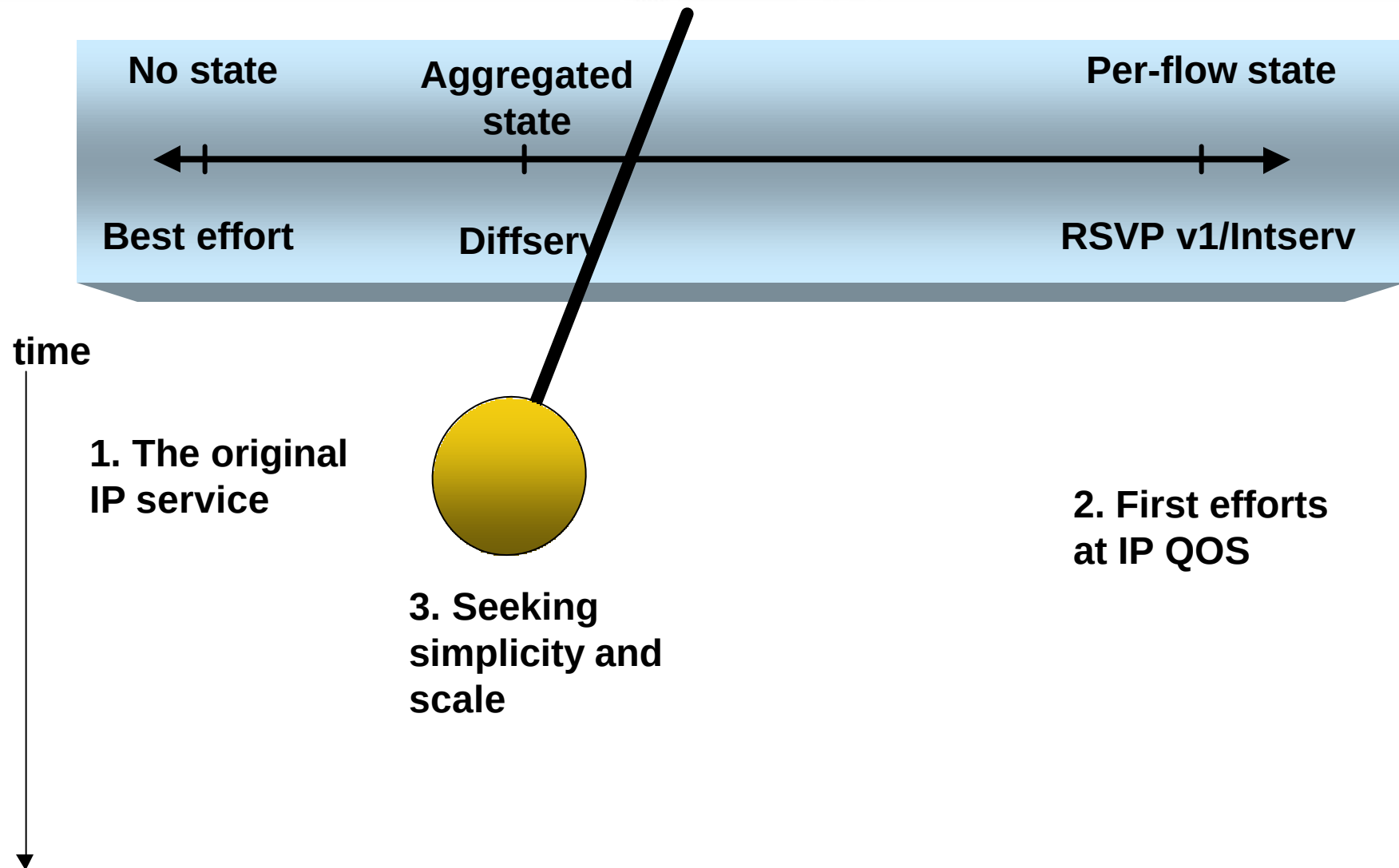
The IP QOS Spectrum



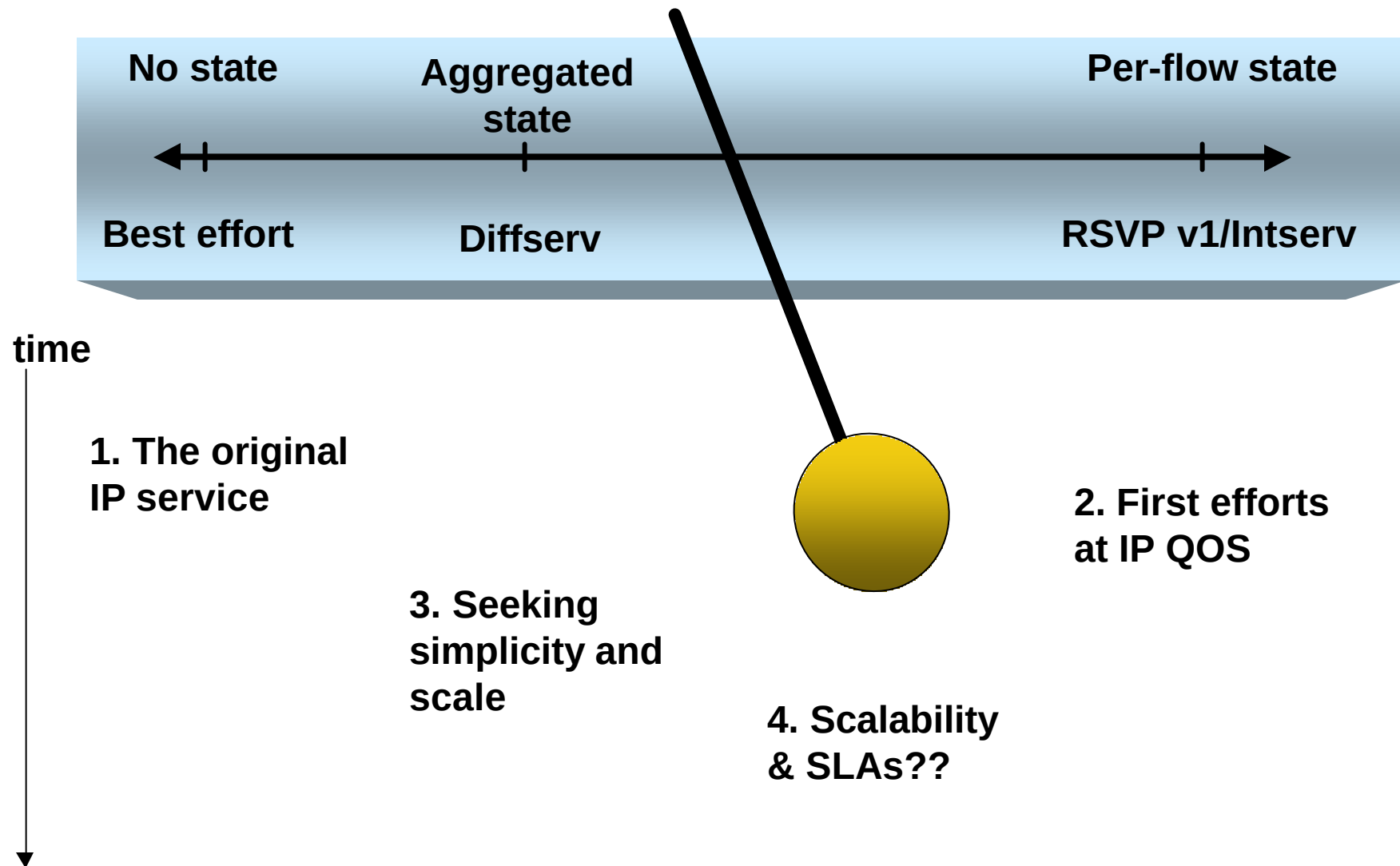
The IP QOS Spectrum



The IP QOS Spectrum



The IP QOS Spectrum



DiffServ

- **Routers at the edge classify and mark packets with a 6 bit Diffserv Code Point (DSCP)**

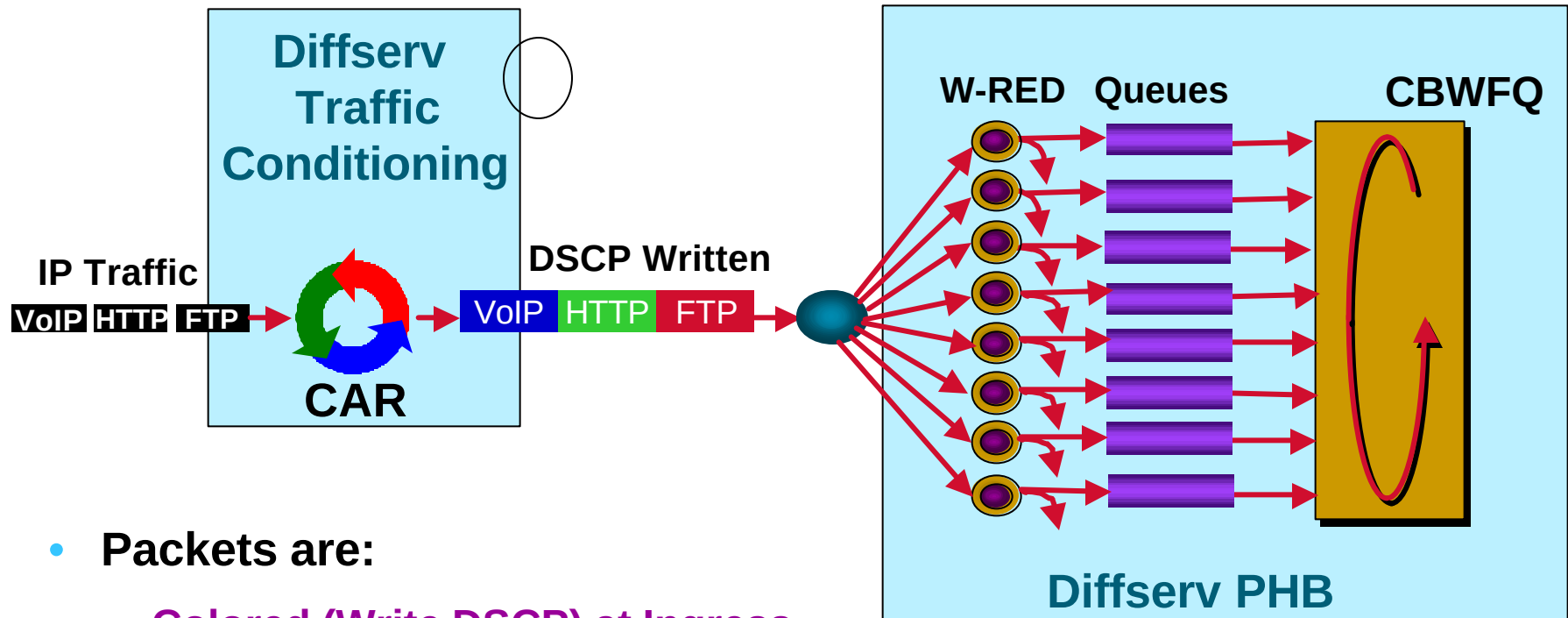
Previously, only the 3 bit IP Precedence field was used

- **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:**

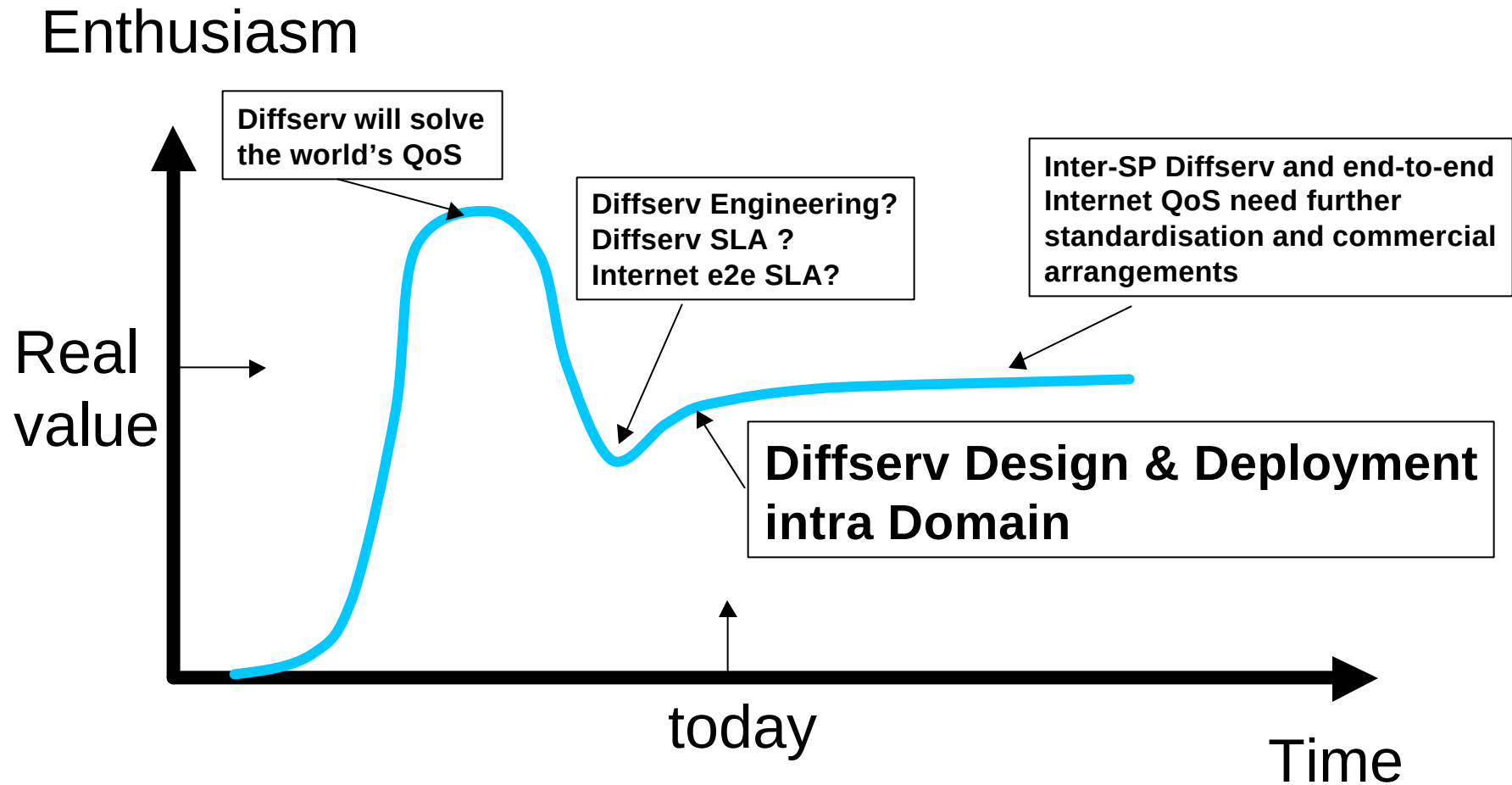
Colored (Write DSCP) at Ingress

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

Assigned to the Appropriate Outgoing Queue

Scheduled for Transmission by CBWFQ

Diffserv Acceptance



IntServ

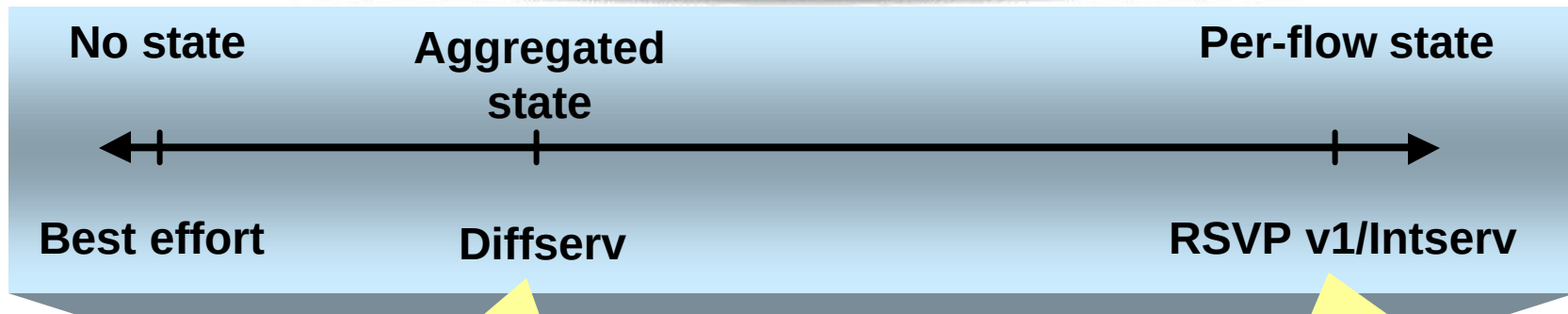
- **Goal: introduce QOS 'guarantees' into IP without damaging best effort**
- **Support multicast, remain connectionless, and achieve scalability.**
- **From several candidates, two services - guaranteed and controlled load - became standards**
- **RSVP**

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

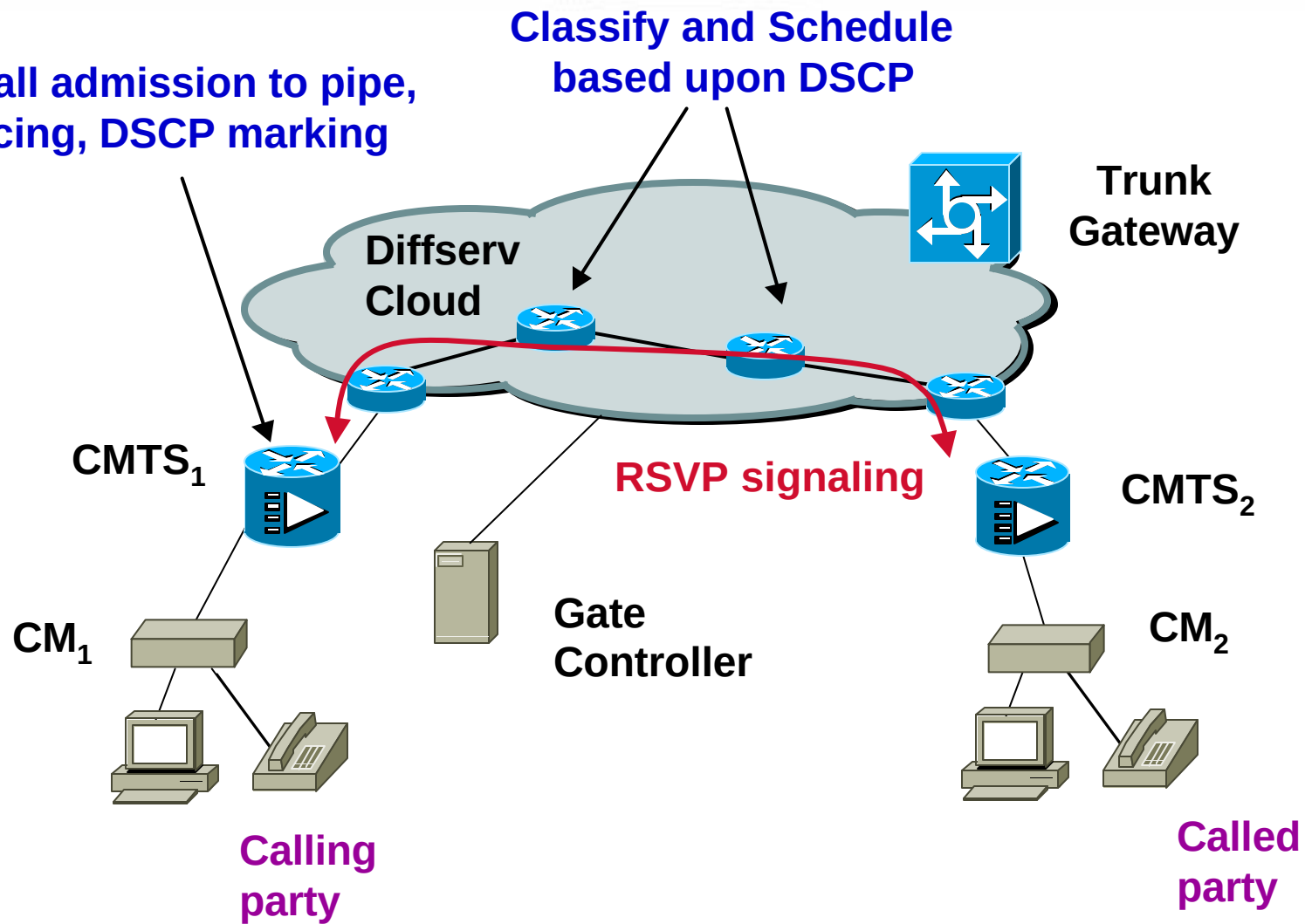
- Scaling issues due to storing too much state in backbone routers for both **control plane** and **forwarding plane**

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

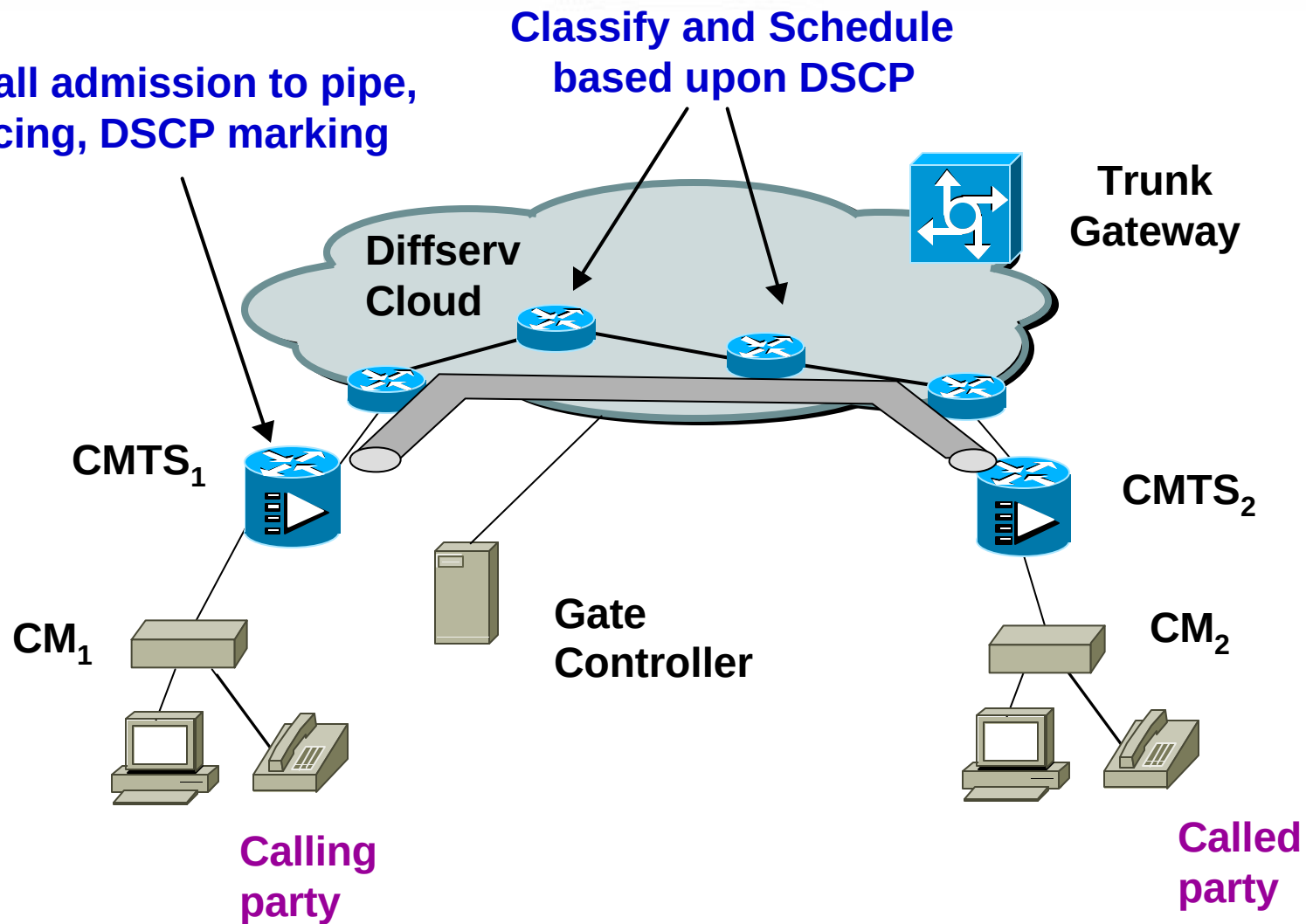


RSVP/Diffserv Integration + Aggregation

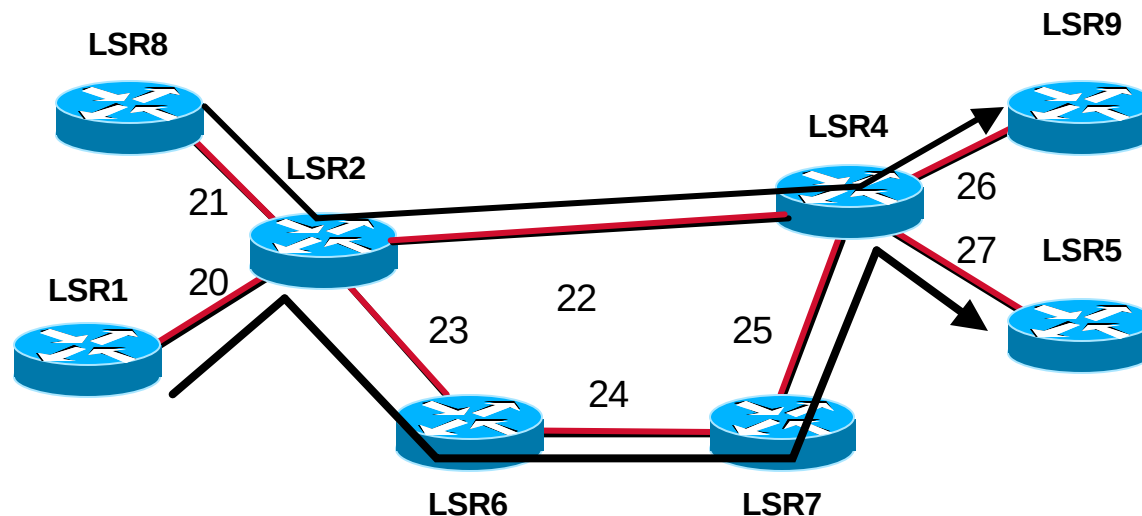


- Same forwarding plane is before
- We now make aggregated reservations (“fat pipes”) from ingress to egress
 - Microflow RSVP messages are “hyperspaced” across cloud
 - Control plane is simplified.
- Size of aggregate reservation may be dynamically adjusted to cover all microflows
 - Heuristics are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

- 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

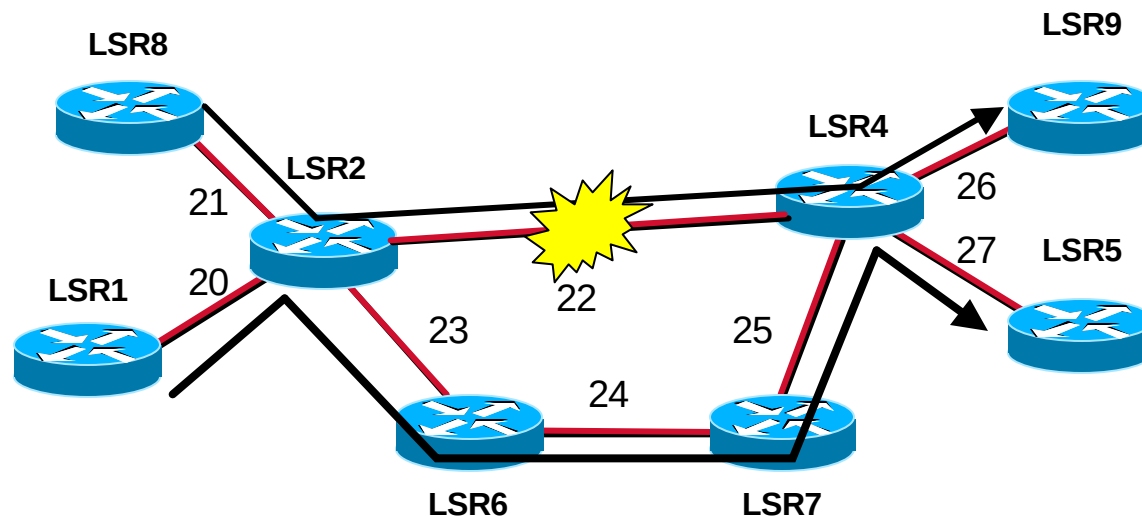
Very fast response to link or node failure without waiting for routing reconvergence

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

The Back-up Path can be a different media type

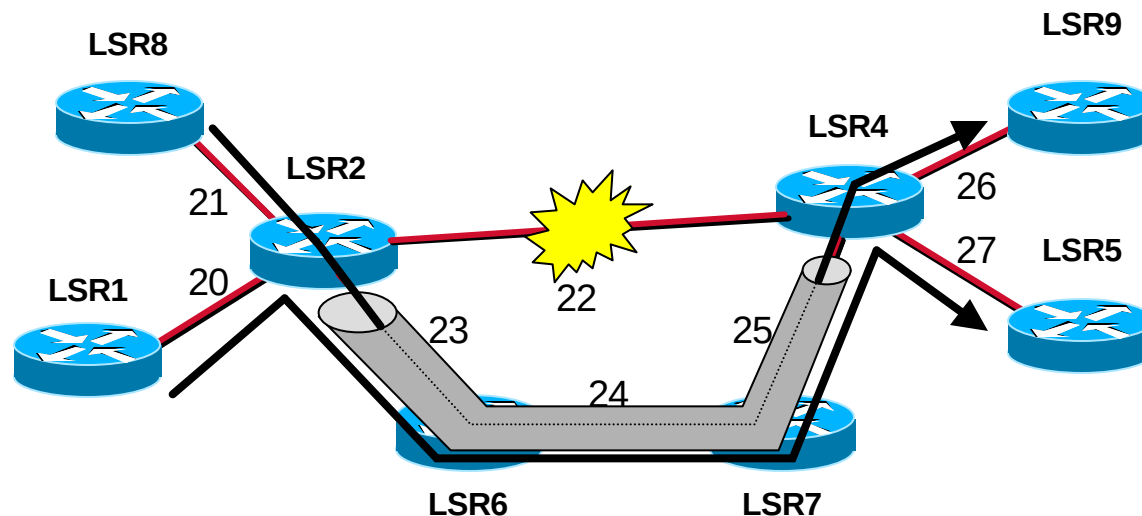
An Gigabit Ethernet link could back up a POS link.

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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