Quality of Service In Data Networks: Problems, Solutions, and Issues

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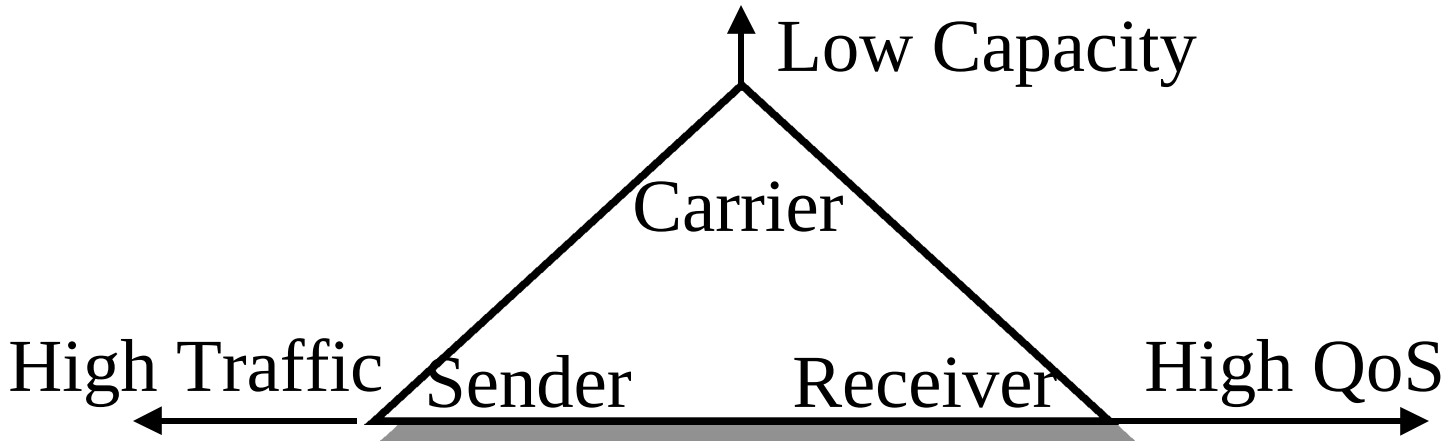
http://www.cis.ohio-state.edu/~jain/talks/qos9905.htm

Overview

- ATM QoS and Issues
- Integrated services/RSVP and Issues
- Differentiated Services and Issues
- QoS using MPLS
- End-to-end QoS
- This is an update to the May'98 talk
  http://www.cis.ohio-state.edu/~jain/talks/ipqos.htm

QoS Triangle



- Senders want to send traffic any time with high load, high burstiness
- Receivers expect low delay and high throughput
- Since links are expensive, providers want to minimize the infrastructure
- If one of the three gives in ⇒ no problem

What is QoS?

- "Unequal" allocation of resources
- Predictable Quality: Throughput, Delay, Loss, Delay jitter, Error rate
- Mechanisms: Routing, Classifiers, Scheduling, Queueing, Buffer Management, Admission Control, Shaping, Policing, capacity planning

ATM Service Categories

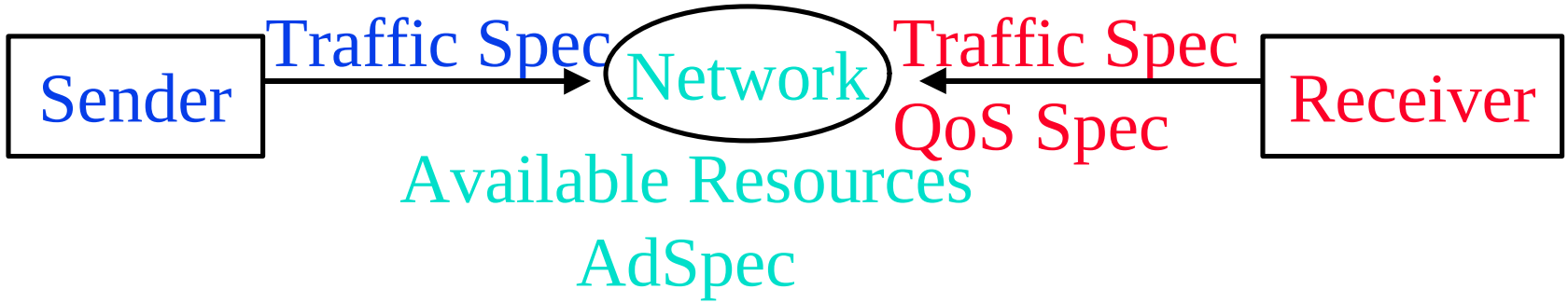
- **CBR**: Throughput, delay, delay variation
- **rt-VBR**: Throughput, delay, delay variation
- **nrt-VBR**: Throughput
- **UBR**: No Guarantees
- **GFR**: Minimum Throughput
- **ABR**: Minimum Throughput. Very low loss. Feedback.
- ATM also has QoS-based routing (PNNI)

Integrated Services

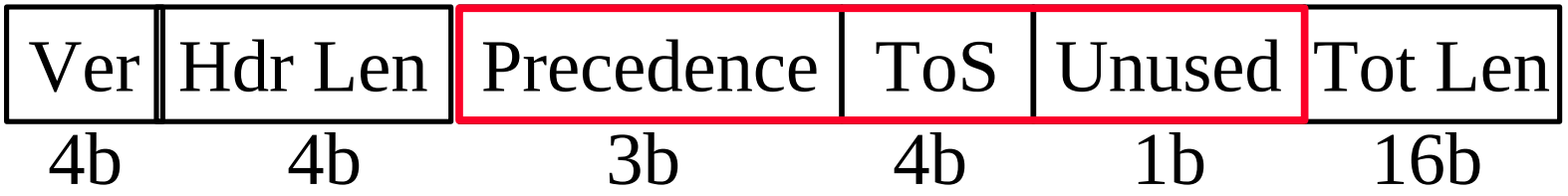
- Best Effort Service: Like UBR.
- Controlled-Load Service: Performance as good as in an unloaded datagram network. No quantitative assurances. Like nrt-VBR or UBR w MCR
- Guaranteed Service: rt-VBR
  - Firm bound on data throughput and delay.
  - Delay jitter or average delay not guaranteed or minimized.
  - Every element along the path must provide delay bound.
  - Is not always implementable, e.g., Shared Ethernet.
  - Like CBR or rt-VBR

RSVP

- Resource ReSerVation Protocol
- Internet signaling protocol
- Carries resource reservation requests through the network including traffic specs, QoS specs, network resource availability
- Sets up reservations at each hop

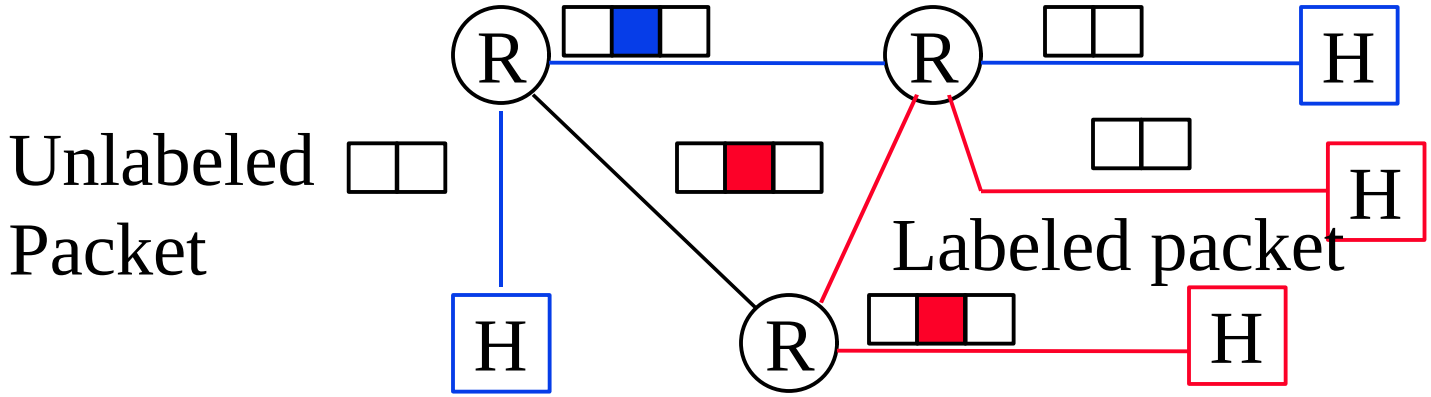


Differentiated Services



- IPv4: 3-bit precedence + 4-bit ToS
- OSPF and integrated IS-IS can compute paths for each ToS
- Many vendors use IP precedence bits but the service varies ⇒ Need a standard ⇒ Differentiated Services
- DS working group formed February 1998
- Charter: Define ds byte (IPv4 ToS field)
- Mail Archive: http://www-nrg.ee.lbl.gov/diff-serv-arch/

Multiprotocol Label Switching



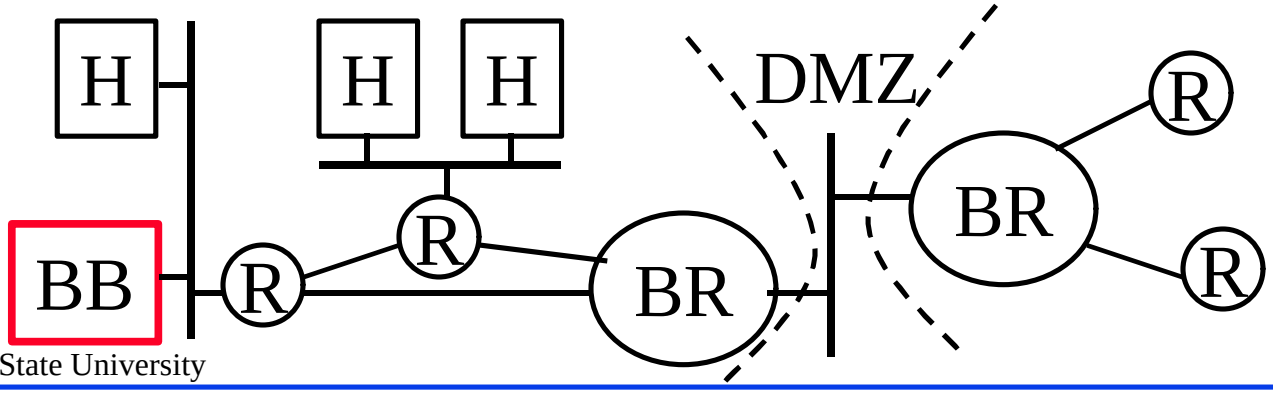
- Entry "label switch router (LSR)" attaches a label to the packet based on the route
- Other LSRs switch packets based on labels.
  Do not need to look inside ⇒ Fast.
- Labels have local significance
  ⇒ Different label at each hop (similar to VC #)
- Exit LSR strips off the label

Traffic Engineering Using MPLS

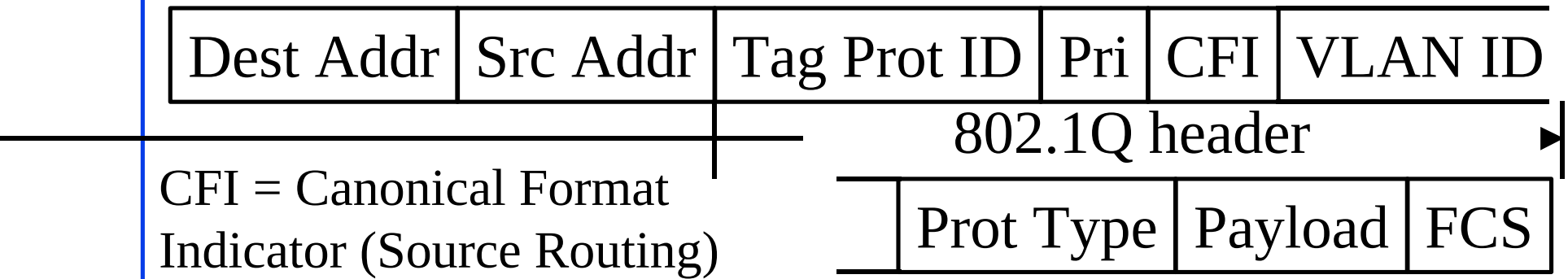
- Traffic Engineering = Performance Optimization
  = Efficient resource allocation, Path splitting
  ⇒ Maximum throughput, Min delay, min loss
  ⇒ Quality of service
- In MPLS networks: "Traffic Trunks" = SVCs
  Traffic trunks are routable entities like VCs
- Multiple trunks can be used in parallel to the same egress.
- Each traffic trunk can have a set of associated characteristics, e.g., priority, preemption, policing, overbooking

Bandwidth Broker

- Repository of policy database. Includes authentication
- Users request bandwidth from BB
- BB sends authorizations to leaf/border routers
  Tells what to mark.
- Ideally, need to account for bandwidth usage along the path
- BB allocates only boundary or bottleneck



IEEE 802.1D Model

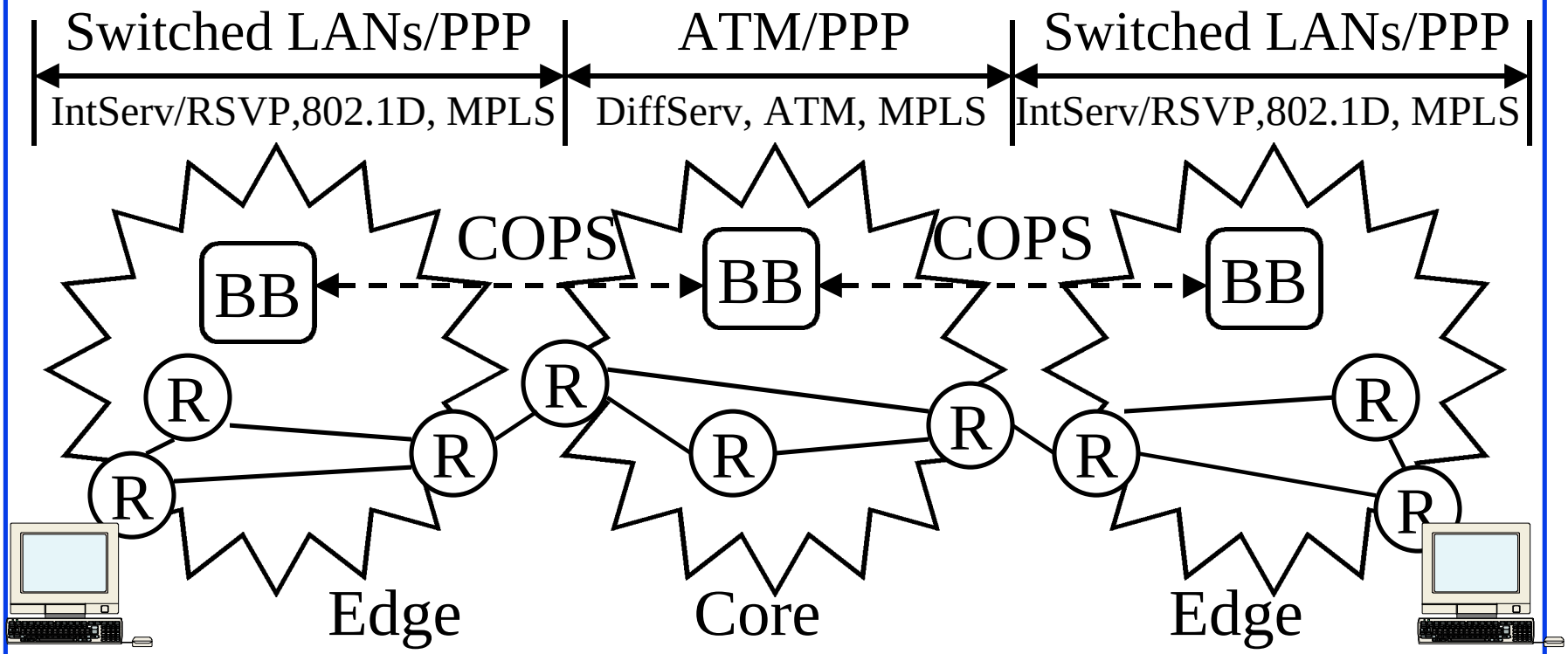


CFI = Canonical Format Indicator (Source Routing)

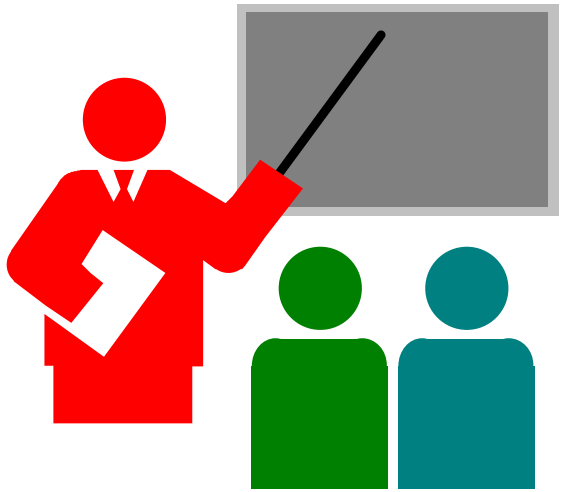
- **Up to eight priorities:** Strict.
  1. Background
  2. Spare
  0. Best Effort
  3. Excellent Effort
  4. Control load
  5. Video (Less than 100 ms latency and jitter)
  6. Voice (Less than 10 ms latency and jitter)
  7. Network Control

End-to-end View

- ATM/PPP backbone, Switched LANs/PPP in Stub
- IntServ/RSVP, 802.1D, MPLS in Stub networks
- DiffServ, ATM, MPLS in the core



Summary



- ATM: CBR, VBR, ABR, UBR, GFR
- Integrated Services: GS = rtVBR, CLS = nrt-VBR
- Signaling protocol: RSVP
- Differentiated Services will use the DS byte
- MPLS allows traffic engineering
- 802.1D allows priority

References

- For a detailed list of references see: refs/ipqs_ref.htm
- Additional papers and presentations on QoS are at: http://www.cis.ohio-state.edu/~jain/

Our Panelists

- Sameh Rabie, Nortel Networks
- Sudhir Dixit, Nokia Research
- David Drury, FORE Systems
- Raj Yavatkar, Intel Corp

Thank You!