CS 414 – Multimedia Systems Design

Lecture 22 - Multimedia Transport Protocols (Layer 3)

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Spring 2009

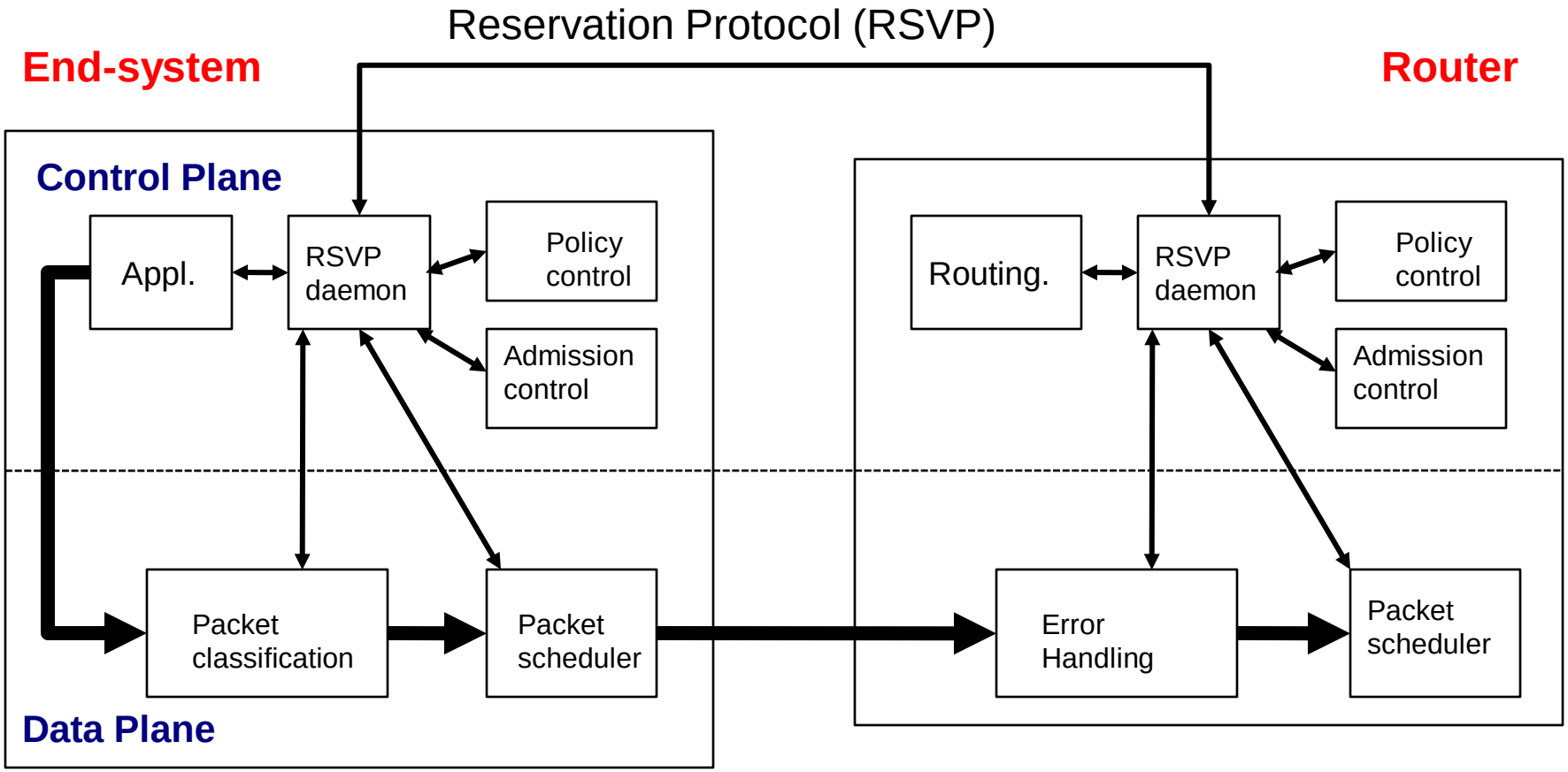
Administrative

- Homework 1
  - average: 58.2, std: 34.86, median: 70.5, max: 100; min: 0
- Midterm
  - average: 67.7, std: 23.68, median: 69.5, max: 95, min: 0
- Ramses Office Hours for midterm and HW1 regrading:
  - Thursday: 2:30pm - 3:30pm
  - Friday: 3:00pm - 4:00pm
  - room: 0207SC
- Klara Office Hours for HW1 regrading:
  - Wednesday 9-11am, room 3104 SC

Administrative

- MP3 will be out today, March 16, 2009
  - Monday, Deadline, April 6

Integrated Services (IntServ) Architecture



Guaranteed Service
(in IntServ)

- Provides guaranteed BW and strict bounds on end-to-end queuing delay for conforming flows
- Controls max. queuing delay
- TSpec – describes traffic sources
  - Bucket rate ('r') (bytes/second)
  - Peak rate (p) (bytes/second)
  - Bucket depth (b) (bytes)
  - Minimum policed unit (m) (bytes) – any packet with size smaller than *m* will be counted as *m* bytes
  - Maximum packet size (M) (bytes) – max, packet size that can be accepted

Guaranteed Service (2)

- Rspec
  - Service rate (R) (bytes/second) – service rate or BW requirement
  - Slack term (S) (µsec) – extra amount of delay that a node may add that still meets the EED (end-to-end delay) requirement.
- This service does policing and shaping
- Resources are reserved at worst case
- For bursty traffic sources – low network utilization

Controlled Load Service

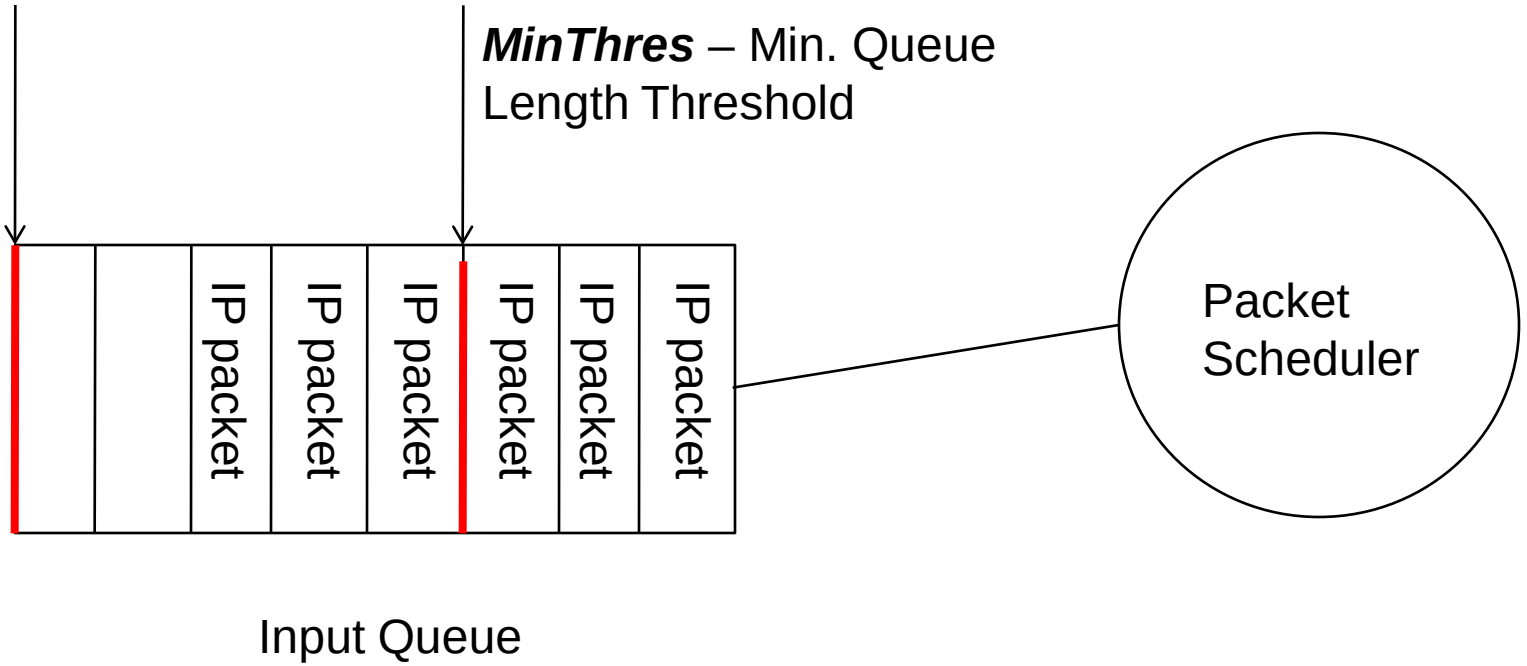
(in IntServ)

- No quantitative guarantees on delay bound or BW
- This service model allows statistical multiplexing – statistical guarantees
  - Very high % of transmitted packets will be successfully delivered
  - Transit queuing delay experienced by a very high % of delivered packets will not greatly exceed min. delay
- Invocation and Policing
  - Specify TSpec (average values) and do admission, reservation, policing based on average TSpec

IntServ (Error Handling - Early Congestion Avoidance)

Avr – Average Queue Length

MaxThres – Max Queue Length Threshold

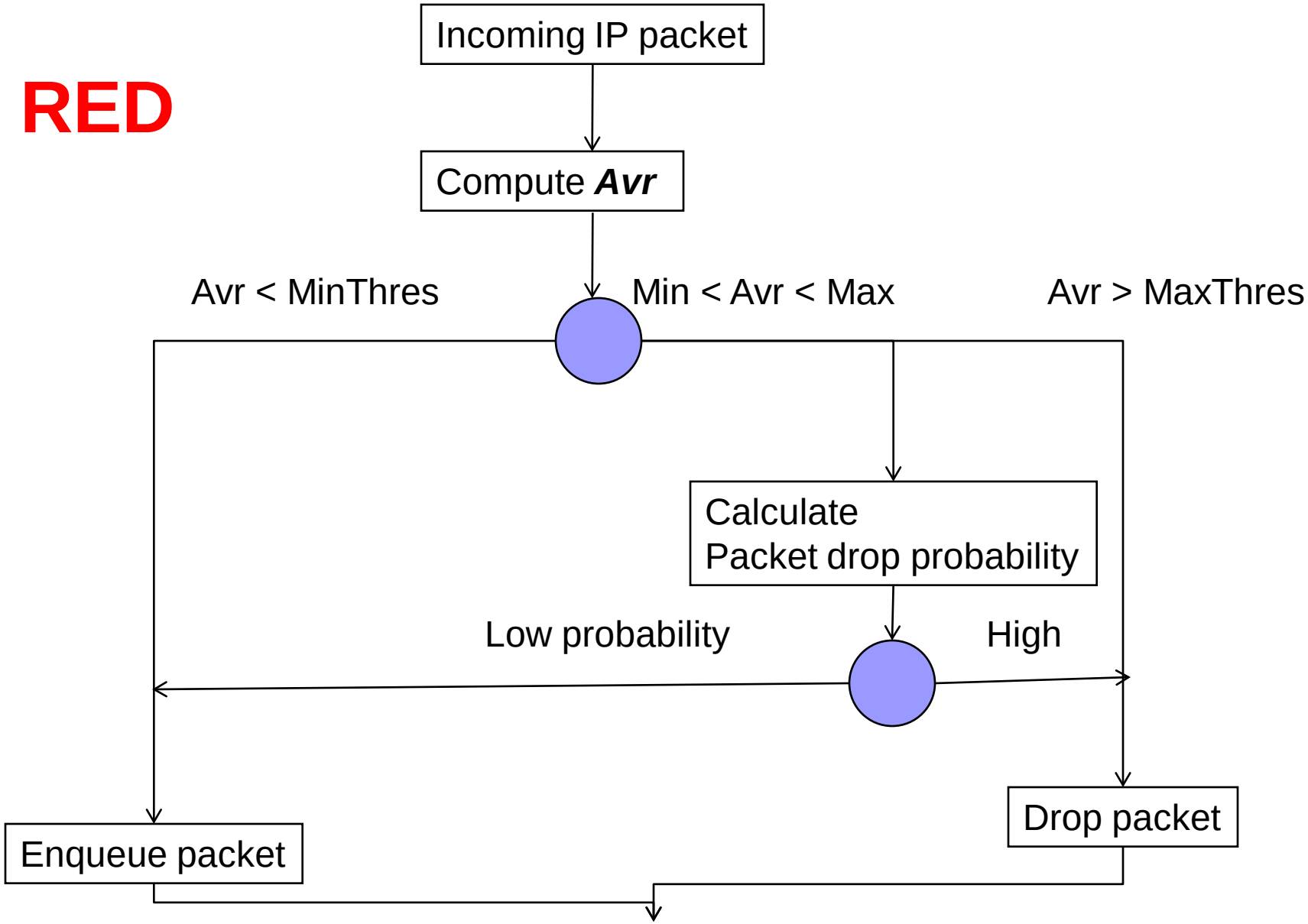


IntServ (Error Handling)

Discard Algorithms

- RED: Random Early Detection;
  - single FIFO queue is maintained for all packets and packets are dropped randomly with a given probability when the average queue length exceeds minimum threshold (MinThresh).If max. threshold (MaxThres) is exceeded, all packets are dropped
- WRED – Weighted RED
  - Drops packets selectively based on IP precedence

RED


Incoming IP packet
Compute *Avr*
Avr < MinThres
Min < Avr < Max
Avr > MaxThres
Calculate
Packet drop probability
Low probability
High
Drop packet
Enqueue packet

Packet Scheduling
(in IntServ)

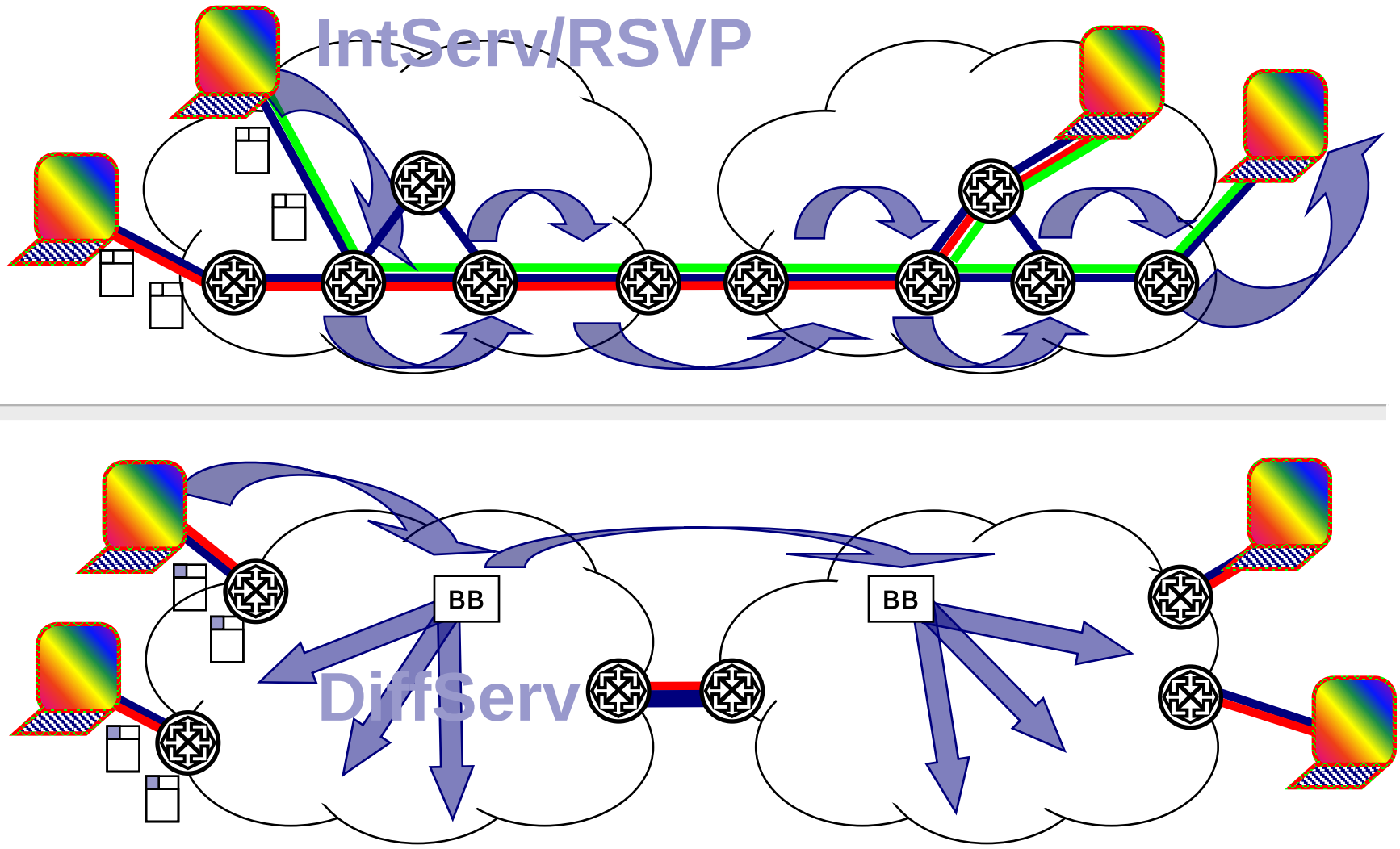
- Isolation versus Sharing
  - Circuit-switched network (e.g., telephone network) – all flows are isolated, i.e., each connection has dedicated resource
  - Datagram-based Internet – all resources are shared on per-packet basis without any form of isolation and protection
- IntServ requires scheduling algorithms to support delay bounds
  - Deterministic or statistical delay bounds
  - Deterministic and statistical bounds reflect trade-offs between isolation and sharing

Packet Scheduling

(in IntServ)

- Simple Priority
  - Be careful – a large volume of higher-priority packets can easily starve lower-priority packets
- Fair queuing approach
  - Allocate BW proportional to active flows based on their weights
- Deadline-based schemes
  - Use EDF on packets
- Rate-based scheduling framework
  - Has two components: regulator and scheduler
  - Example: token bucket with fair queuing

IntServ/RSVP vs DiffServ



Differentiated Services (DiffServ)

- Intended to address the following difficulties with Intserv and RSVP;
- **Scalability**: maintaining states by routers in high speed networks is difficult due to the very large number of flows
- **Flexible Service Models**: Intserv has only two classes, want to provide more qualitative service classes; want to provide ‘relative’ service distinction (Platinum, Gold, Silver, …)
- **Simpler signaling**: (than RSVP) many applications and users may only want to specify a more qualitative notion of service

Diffserv - Motivation

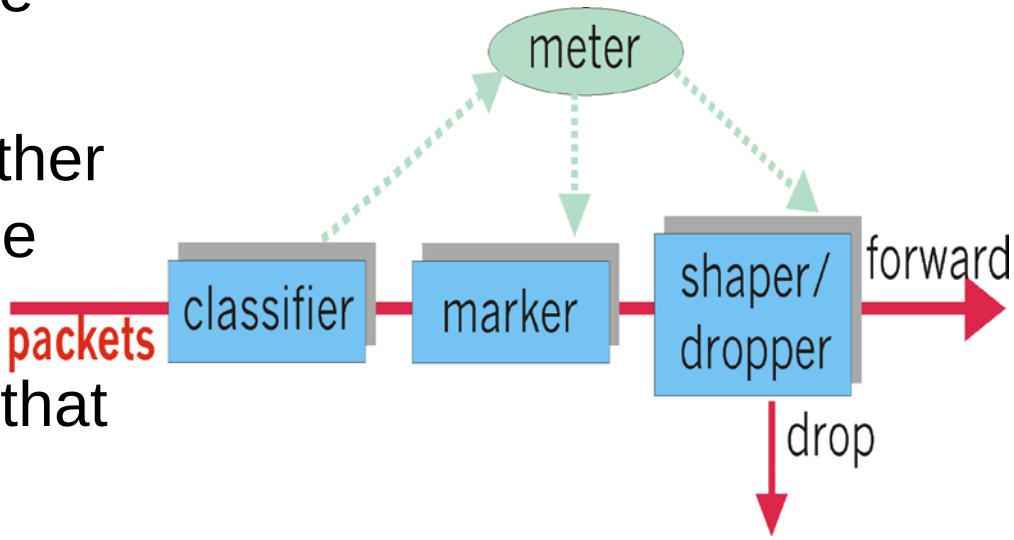
- Do fine-grained enforcement only at the edge of the network.
  - Typically slower links at edges
  - E.g., mail sorting in post office
- Label packets with a field.
  - E.g., a priority stamp
- The core of the network uses only the type field for QoS management.
  - Small number of types with well defined forwarding behavior
  - Can be handled fast
- Example: expedited service versus best effort
- Evolution rather than revolution

Diffserv - Discussion

- Diffserv defines an architecture and a set of forwarding behaviors.
  - It is up to the service providers to define and implement end-to-end services on top of this architecture.
  - Offers a more flexible service model; different providers can offer different service.
- One of the main motivations for Diffserv is scalability.
  - Keep the core of the network simple.
- Focus of Diffserv is on supporting **QoS for flow aggregates**.

Edge Router/Host Functions

- **Classification**: marks packets according to classification rules to be specified.
- **Metering:** checks whether the traffic falls within the negotiated profile.
- **Marking**: marks traffic that falls within profile.
- **Conditioning**: delays and then forwards, discards, or remarks other traffic.



Classification and Conditioning

- Packet is marked in the Type of Service (TOS) in IPv4, and Traffic Class in IPv6.
- 6 bits used for Differentiated Service Code Point (DSCP) and determine PHB that the packet will receive.
- 2 bits are currently unused.

Core Functions

- **Forwarding**: according to “Per-Hop-Behavior” or PHB specified for the particular packet class; such PHB is strictly based on class marking (no other header fields can be used to influence PHB).
- BIG ADVANTAGE:

  No state info to be maintained by routers!

Forwarding (PHB)

- PHB result in a different observable (measurable) forwarding performance behavior.
- PHB does not specify what mechanisms to use to ensure required PHB performance behavior.
- Examples of PHB Behaviors:
  - Class A gets x% of outgoing link bandwidth over time intervals of a specified length.
  - Class A packets leave first before packets from class B.

Forwarding (PHB)

- **Expedited Forwarding (EF):**
  - Guarantees a certain minimum rate for the EF traffic.
  - Implies isolation: guarantee for the EF traffic should not be influenced by the other traffic classes.
  - Admitted based on peak rate.
  - Non-conformant traffic is dropped or shaped.
  - Possible service: providing a virtual wire.

Forwarding (PHB)

- **Assured Forwarding (AF)**:
  - AF defines 4 classes with some bandwidth and buffers allocated to them.
  - The intent is that it will be used to implement services that differ relative to each other (e.g., gold, silver,…).
  - Within each class, there are three drop priorities, which affect which packets will get dropped first if there is congestion.
  - Lots of studies on how these classes and drop priorities interact with TCP flow control.
  - Non-conformant traffic is remarked.

Example of EF: A Virtual Leased Line Service

- Service offers users a dedicated traffic pipe.
  - Guaranteed bandwidth between two points.
  - Very low latency and jitter since there should be no queuing delay (peak rate allocation).
- Admission control makes sure that all links in the network core have sufficient EF bandwidth.
  - Simple case: sum of all virtual link bandwidth is less than the capacity of the slowest link.
- Traffic enforcement for EF traffic limits how much EF traffic enters the network.

Differentiated Services Issues

- The key to making Diffserv work is bandwidth management in the network core.
  - Simple for simple services such as the virtual pipe, but it is much more challenging for complex service level agreements.
  - Notion of a "bandwidth broker" that manages the core network bandwidth.
- Definition of end-to-end services for paths that cross networks with different forwarding behaviors
  - Some packets will be handled differently in different routers.
  - Some routers are not DiffServ capable.

Conclusion

- IntServ and DiffServ are two major competing concepts, architectures and QoS management approaches for the multimedia traffic.
- Qbone Architecture – Interdomain testbed for DiffServ
- Cisco routers implement both, but usually system administrators at the edges do not enable them
- ISP may or may not use some of the concepts for traffic control.