A Better-Than-Best-Effort Service for Continuous Media UDP Flows

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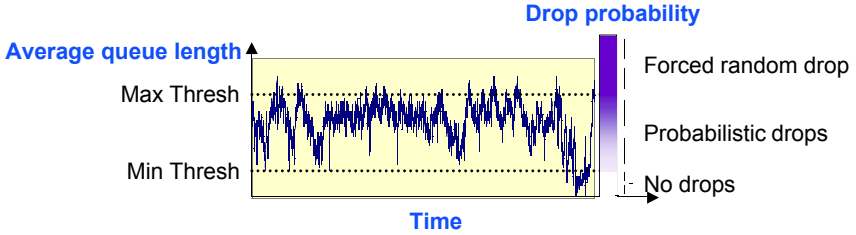
Queue Management and Congestion Avoidance

- Braden, et al. recommend:
  - » Implement some form of active queue management in routers.
    - – Avoid full queues, reduce latency, reduce packet dropping, avoid lock-out phenomena
  - » Continue research into mechanisms to deal with unresponsive or aggressive flows.
- Floyd & Fall:
  - » mechanisms to identify "misbehaving flows"
- To date, focus was on supporting TCP
- How can we do better than best-effort for multimedia in this framework?

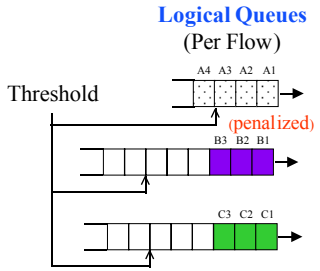
Active Queue Management
RED

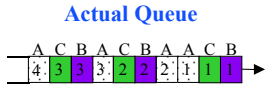
- Random Early Detection (RED) (Floyd, et al.)
  - » Multiple modes based on threshold values
  - » Probabilistic and forced drops
    - – avoid consecutive drops
    - – drops proportional to bandwidth utilization
  - » Weighted average accommodates bursty nature of traffic



Active Queue Management
FRED

- Flow-based RED (Lin & Morris)
  - » Drops are proportional to bandwidth used
  - » Logical queues for each flow
  - » Unresponsive flows are identified and penalized
  - » Each flow has access to an equal share of the queue
    - – dynamically calculated based on current queue size & number of active flows

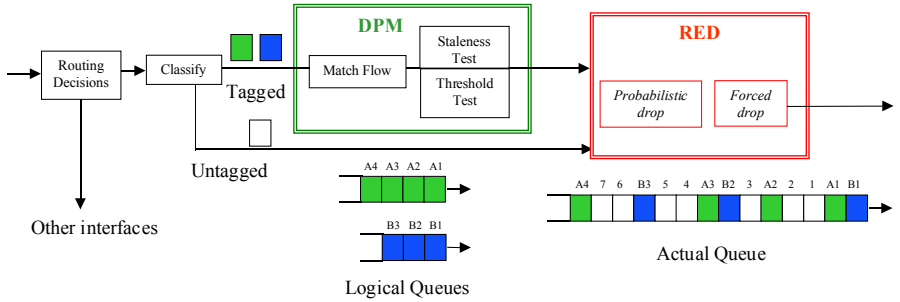




Active Queue Management
Drop Preference Management (DPM)

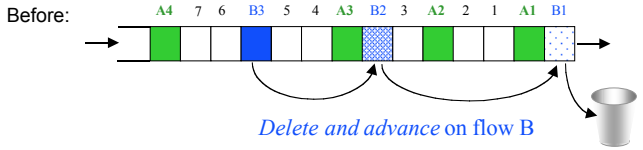
- **Goals:**
  - » maintain most properties of RED
  - » constrain non-responsive flows
  - » given these constraints, improve multimedia performance
    - – lower latency
- **Design:**
  - » Multimedia flows are tracked in logical queues
  - » Fixed portion of the queue shared between these flows
  - » Staleness test
  - » Delete and advance drop policy
  - » Continue to apply RED policies

DPM data flow



- **DPM is an extension to RED for selected flows**
- **All packets remain in a single queue (order is maintained between flows)**

Delete and Advance

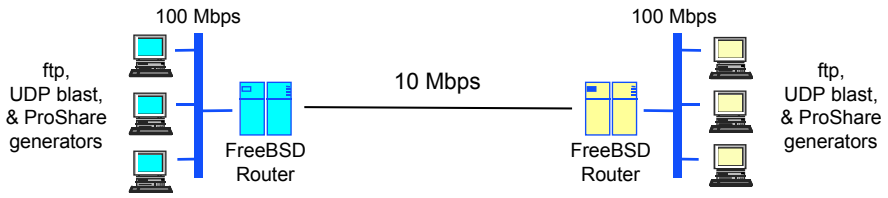


- » Tagged flows use delete and advance instead of standard drops.
- » First packet for the flow is discarded and subsequent packets for that flow are advanced.
- » Depth of packets from all other flows is maintained (or decreased).
- » Freshest packets arrive at receiver

Research Questions

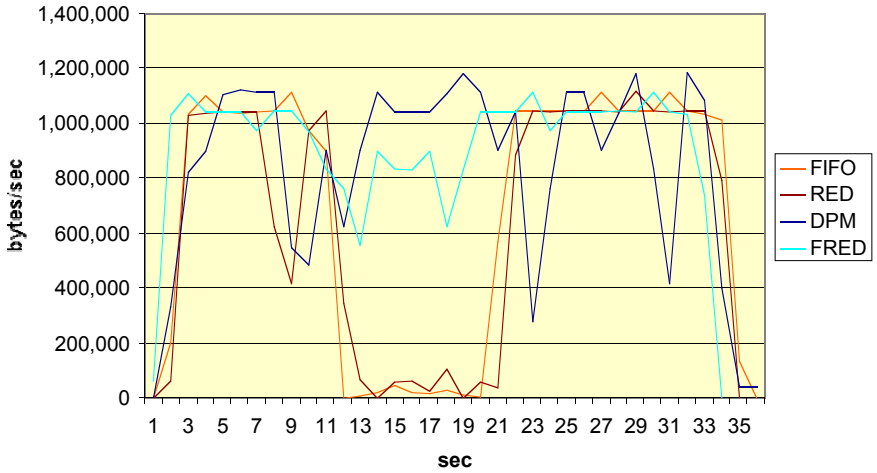
- **Does it work?**
  - » Performance of TCP
  - » Performance of Multimedia
  - » Effect of unresponsive traffic
- **What's the overhead?**
  - » CPU cycles
  - » State
- **What settings offer optimal performance?**
  - » Sensitivity of average calculation
  - » Threshold values
  - » Queue length
  - » Other drop policies?

Empirical Evaluation
Experimental Setup

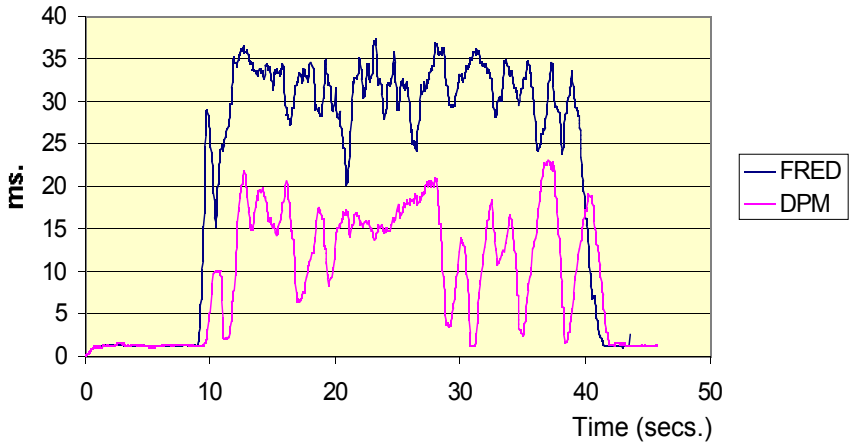


- Senders transmit a mix of TCP, real-time and non-real-time UDP traffic
- Delay introduced at receivers to produce large delay-bandwidth product
- 10 Mbps link bottleneck

Experimental Results
TCP Throughput



Experimental Results
UDP Latency



Conclusions

- DPM offers comparable TCP performance to FRED or RED
- DPM maintains less state than FRED
- DPM offers lower latency to multimedia applications