Dynamic-CBT and ChIPS -
Router Support for Improved
Multimedia Performance on the
Internet

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The Internet and Multimedia

- Internet routers are best effort
  - No timing constraints
  - Packet loss, which indicates congestion
- TCP
  - Completely reliable delivery through retransmission
  - Respond to loss as congestion
- But … TCP often unsuitable for interactive multimedia
  - Full reliability not needed
  - Window-based rate fluctuations

Multimedia Using TCP

Multimedia Using UDP

Multimedia on the Internet

- Multimedia often uses UDP
  - Avoid delay and jitter from retransmission
  - Rate-based
  - Unresponsive!
- Router queue management goals
  - Congestion Control
  - Fairness
  - Reduce Jitter

Current Router Queue
Management

Drop Tail (FIFO)

Resource Reservation

Active Queue Mgmt

CBQ

RED

FRED
Class-Based Threshold (CBT)
AQM Support for Multimedia - Jeffay, 99

Outline
- Introduction
- CBT and D-CBT
  - Design
  - Evaluation
- ChIPS
  - Design
  - Evaluation
- Conclusion

CBT Concepts
- CBQ + RED: Class-based isolation on RED
- Use Class Thresholds and Avg. # of enqueued packets on a single FIFO Queue
- Three classes: TCP, MM UDP (flow controlled) and Unresponsive UDP

CBT Design

CBT - Pros and Cons
- **Pros**: RED + Class-Based Isolation
  - Early Congestion Notification
  - Protect TCP, and protect (distinguish) MM UDP
  - Different flows coexist with predefined fairness.
  - Dividing bandwidth assigned is up to the class.
- **Cons**: CBQ function w/o admission control
  - Might not work well for certain traffic mixes
  - Arguable that it’s not fair (as in the case of CBQ)

Dynamic-CBT
**Dynamic-CBT and ChIPS**

- **Drop Tail (FIFO)**
- **ChIPS**
- **Resource Reservation**
- **Active Queue Mgmt**
  - CBQ
  - RED
  - FRED
- **Class-Based Threshold (CBT)**
- **Dynamic-CBT**

**D-CBT Design**

**Flow Counting in D-CBT**

- For every incoming packet, insert or update `<dest-addr, flow-id, local-time>` info and update count
  - Sorted Linked List - \(O(n)\)
  - Hash Table - \(O(1)\)
- Every \(\Delta ns\), delete old info and update count
  - Sorted Linked List - \(O(n)\)
  - Hash Table - \(O(n)\)
- (How are flows counted in FRED?)

**Evaluation in NS**

- Developed responsive multimedia application (for tagged UDP class)
  - AIMD Media Scaling (5 discrete rates)
  - “MPEG-1 like” transmission rates
  - [CC00a], MM-Flow
- Implemented and validated CBT
- Implemented D-CBT and measured congestion time fairness
  - RED vs. CBT vs. D-CBT

**Validation of CBT on NS**

**Aggregate TCP Throughput under RED**

- X axis: Seconds, Y axis: Kbyte/Sec

- RED Settings:
  - \(qsize = 60\) pkts
  - \(max-th = 30\) pkts
  - \(min-th = 15\) pkts
  - \(qweight = 0.002\)
  - \(max-pro = 0.1\)

- CBT Settings:
  - \(mm-th = 10\) pkts
  - \(udp-th = 2\) pkts

(Our setup is ok, so now can check our CBT test)
Aggregate TCP Throughput under CBT
X axis: Seconds, Y axis: Kbyte/Sec

PJS99 Experimental Results
NS Simulated Results

Jain’s Fairness Index (f) - Jain, 91

\[ f(x_0, x_1, x_2, \ldots, x_n) = \frac{(\sum_{i=0}^{n} x_i)^2}{n \sum_{i=0}^{n} x_i^2} \]

• Examples:
  - 1 flow
  - 2 flows, 5 Kbps each
  - 2 flows, 9 Kbps and 1Kbps

Simulation (RED, CBT, D-CBT)

Fairness: RED

Fairness: CBT

Fairness: D-CBT
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• ChIPS
  – Design
  – Evaluation

• Conclusion

Cut-In Packet Scheduling (ChIPS) Design

ChIPS Evaluation - Jitter

ChIPS Evaluation - Fairness

Conclusion

Future Work

• Active Flow Counting (Overhead)
  – For every incoming packet, update flow info
    + Hash Table - O(1)
  – Every Δms, delete old flows
    + Hash Table - O(n)

• Measure Overhead
  – Processing Time and Memory Usage
Future Work

• How many different classes are needed?
  – Example
    + 1 class is RED
    + 1 class per flow is FRED
  – Overhead per class

• Effects of D-CBT and ChIPS on Perceptual Quality

Evaluation of Science?

• Category of Paper
• Science Evaluation (1-10)?
• Space devoted to Experiments?