Title: An Adaptive Queue Management Method for Congestion Avoidance in TCP/IP Networks

Presented By:
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Outline

- Background
  - Network Power
  - Simulation Topology
  - Weakness of RED - Motivation
  - Algorithm
  - Simulations & Comparisons RED Vs READ
  - READ Tuning
- Conclusions and Future Work
Goals:

- Show drawbacks of RED with ECN
- Propose new AQM: Random Early Adaptive Detection
TCP congestion control
Congestion Control vs. Avoidance
RED
ECN
ECN:

- Binary feedback scheme
- Router sets a bit in packet to “mark” instead of drop
- ACK mirrors the marking back to receiver
What’s Power??

Throughput optimized N/W
- Great throughput - Takes 15 minutes to view a web page.

Delay optimized N/W
- Low Delays – But the web page is missing a lot of information…..

\[
\text{Power} = \frac{\text{Throughput} \times \text{Response Time}}{\text{Throughput}}
\]
Simulation Topology

Bottleneck
Queue Size = 60 pkts
Pkt Size = 512 bytes
MIN$_{th}$ = 15
MAX$_{th}$ = 45
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3/15/02
Weakness of RED - Motivation
Weakness of RED - Motivation
Weakness of RED - Motivation

10 flows
Weakness of RED - Motivation

60 flows
Weakness of RED - Motivation

20 flows
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3/15/02
Random Early Adaptive Detection

Exponentially Weighted Moving Averages

\[ \text{Avg}_{t+1} = (1-w_q) \text{avg}_t + w_q q_t \]

Old weighted average  Instantaneous queue

\[ \text{Sl}_{t+1} = (1-w_{sl}) \text{sl}_t + w_{sl} (\text{avg}_{t+1} - \text{avg}_t) \]

Old weighted slope  Instantaneous slope
Random Early Adaptive Detection

At each change of MIN

\[ \text{level} = \frac{(\text{MAX} + \text{MIN})}{2} \]

if(level > buffer * 0.52)

\[ p = p + \text{INC} \quad \text{INC} = 0.02 \]

if(level < buffer * 0.48)

\[ p = p - \text{DEC} \quad \text{DEC} = 0.002 \]
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Fig 5: Throughput Vs. Delay

![Graph showing throughput vs. delay with multiple curves indicating different conditions.](image)
RED:
- Lower Drop probability = Higher Throughput & Higher Delay
- Higher Drop probability = Lower Delay & Lower Throughput

READ:
- Always Lower Delay and Higher Throughput
Fig 6: Power (alpha=1)
RED:
- Performance varies with maxp and number of flows
- Performs worse than Drop Tail under certain conditions

READ:
- Always performs better than RED and Drop Tail
Table 1: Throughput For Mixed Traffic

<table>
<thead>
<tr>
<th>Number of FTP Connections</th>
<th>Number of Telnet Connections</th>
<th>RED total throughput</th>
<th>RED Telnet roundtrip delay</th>
<th>READ total throughput</th>
<th>READ Telnet roundtrip delay</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>10</td>
<td>9824938</td>
<td>0.0481</td>
<td>9951914</td>
<td>0.0539</td>
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<tr>
<td>30</td>
<td>10</td>
<td>9999701</td>
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<td>50</td>
<td>10</td>
<td>9983044</td>
<td>0.0997</td>
<td>9995878</td>
<td>0.0499</td>
</tr>
</tbody>
</table>
Fig 8 & 9: Adaptation to Changes in Network Conditions
READ Vs. RED (3)

**RED:**
- Large variation in instantaneous and average queue size
- Large variation in marking probability
- Marking probability varies with queue size

**READ:**
- Less variation in marking probability and queue size
- Large, periodic fluctuations
Fig 10: READ Tuning
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Conclusions and Future Work

Conclusions:
- RED can fail & too aggressive
- READ – reliable CA; higher power levels

Current & Future Work:
- Examine different increase/decrease algorithms
- READ with different Network Topologies