Quantifying the Effects of Recent Protocol Improvements to TCP: Web Performance

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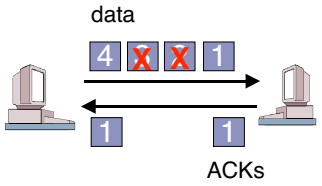
Conventional Wisdom vs. Our Findings

Why Different?
- complex traffic model
- focus on web performance
- large range of RTTs
- two-way congestion

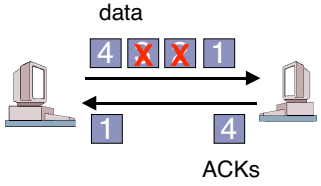
- TCP SACK is not better than TCP Reno
- RED is not clearly better than Drop Tail
- ECN is clearly better than dropping

Evaluation
TCP

- **TCP Reno**
  - cumulative ACKs

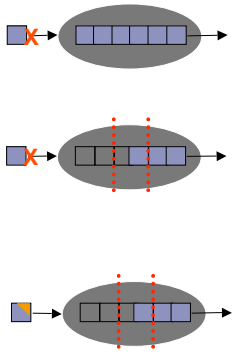


- **TCP SACK**
  - selective ACKs
  - lets sender infer which packets were lost
  - helps avoid timeouts

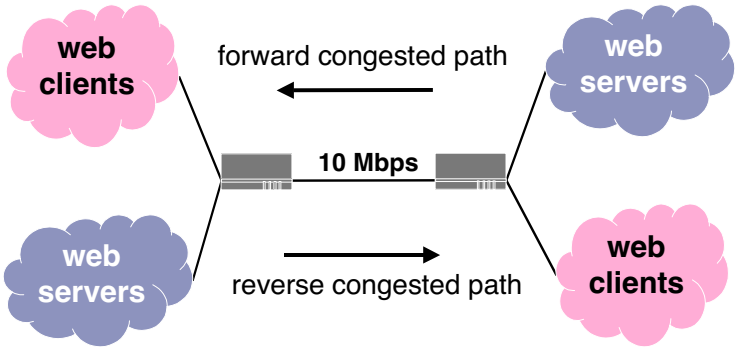


Evaluation
Queuing

- **Drop Tail**
  - high loss with bursts of packets
- **Adaptive RED**
  - Random Early Detection
  - lowers queue size
- **Adaptive RED with ECN**
  - Explicit Congestion Notification
  - marks instead of drops

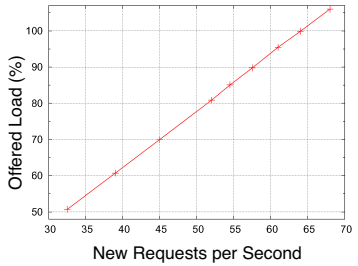


Network Setup



RTTs vary from 1 ms to 3.5 seconds

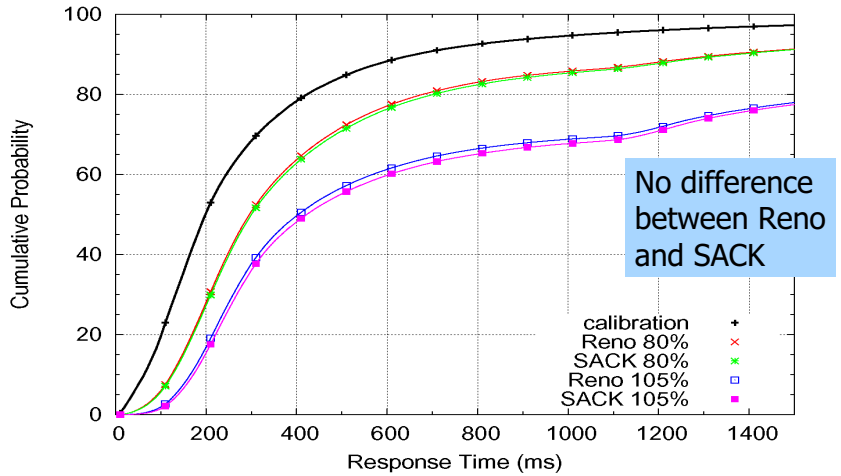
Simulation Setup



- **ns-2**
  - **two-way web traffic**
    - **Bell Labs HTTP model**
  - **250,000 request-response pairs**
  - **offered loads of 50-105% of 10 Mbps link**
  - **each TCP paired with each queuing mechanism**
- **Main Performance Metric**
  - **HTTP response time - time between sending HTTP request and receiving HTTP response**
    - **no major differences below 80% load**

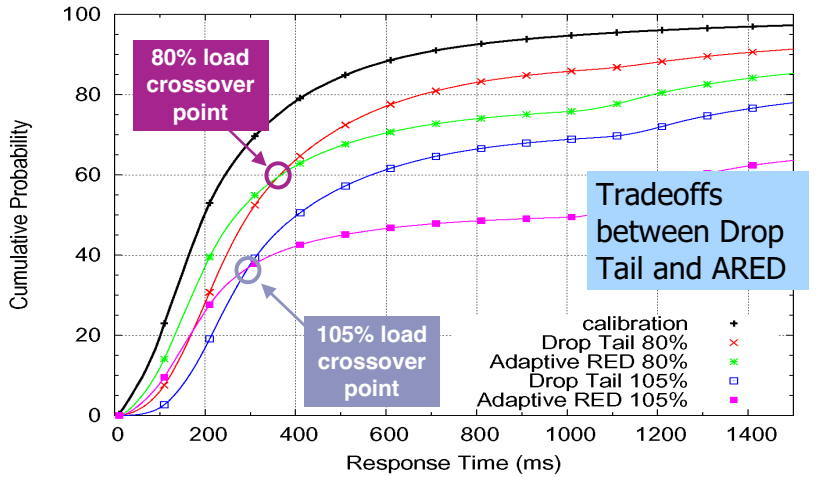
Drop Tail: Reno vs. SACK

80% and 105% load



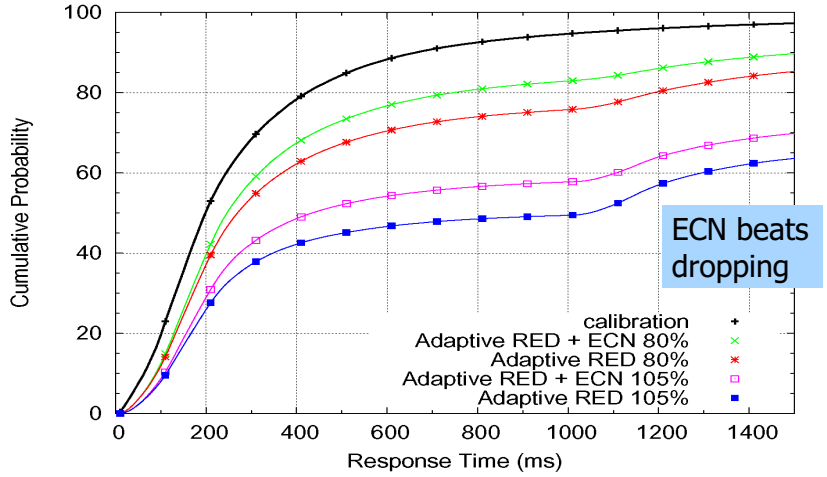
Drop Tail vs. Adaptive RED

80% and 105% load



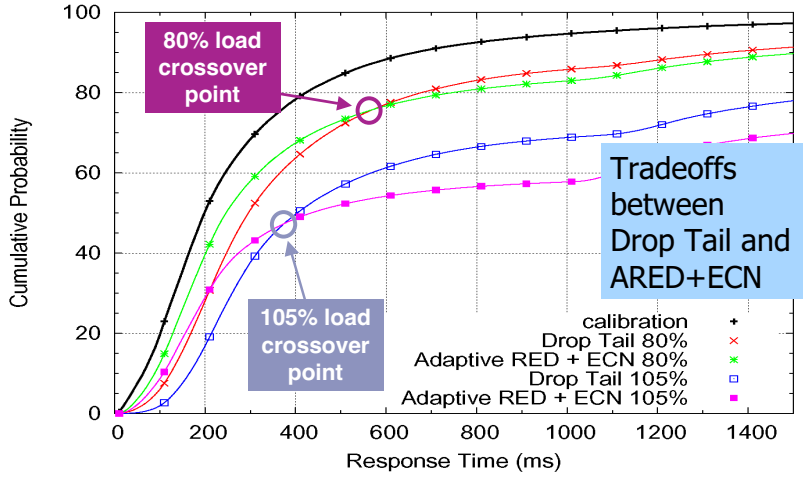
ARED vs. ARED+ECN

80% and 105% load



Drop Tail vs. ARED+ECN

80% and 105% load



Our Findings

For HTTP Traffic

- **No benefit to using SACK over Reno**
  - **not enough flows can take advantage of SACK**
- **Complex tradeoffs exist when comparing Drop Tail and ARED (even with ECN)**
- **ARED with ECN performs better than ARED with dropping**
  - **drops cause retransmissions, which only increases response times**

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