Analyzing the Influence of Resource Prioritization on HTTP/3 HOL Blocking and Performance

Constantin Sander, Ike Kunze, Klaus Wehrle

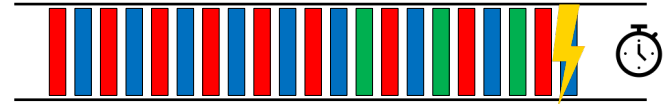{sander, kunze, wehrle}@comsys.rwth-aachen.de

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- **HTTP/2: multiplexing via TCP connection**
  - ▶ TCP unaware of streams, transport HOL blocking

- **HTTP/3: multiple QUIC streams**
  - ▶ Independent, no inter-stream HOL blocking

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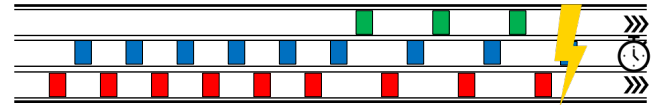
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- **Resource Prioritization: Browser signals server preferred scheduling**
  - ▶ E.g., send HTML first, then images
  - ▶ Different prioritization strategies per browser

Prioritization Strategies

Round Robin

Weighted Round Robin

Chrome (sequential)

Firefox (WRR+sequential)

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Prioritization Strategies	Wijnants et al. HTTP/2 Performance	Marx et al. HTTP/3 Performance
Round Robin	worst	worst
Weighted Round Robin	worst	worst
Chrome (sequential)	best	better
Firefox (WRR+sequential)	best	better

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Website specific

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Worst for HOL?

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Worst for HOL?

HTTP/2 ≠ HTTP/3

Premature QUIC stack constant rate / no loss

- **Evaluate impact of prioritization on HTTP/3 performance under loss**

  ▶ Change Loss, Loss Burstsize, RTT, Bandwidth

  ▶ Test (W)RR, Chrome, Firefox, Firefox (EPS adapted)

  ■ Identify HOL blocking + performance

Loss	RTT	BW	Loss Burstsize
0%	10ms	1Mbps	1
1%	50ms	2Mbps	5
2%	100ms	5Mbps	10
5%		10Mbps	15

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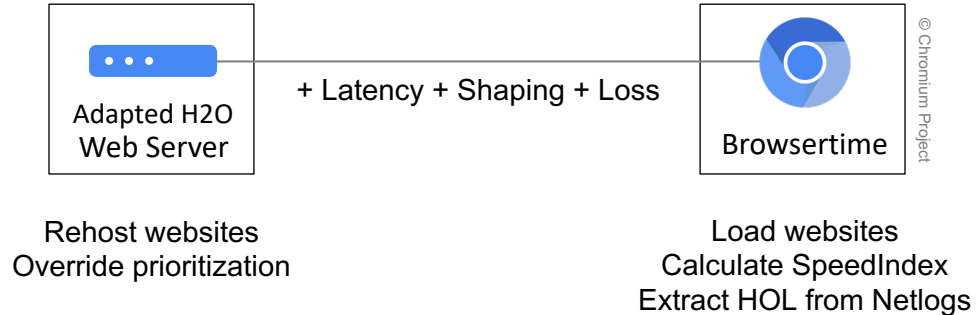
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⬇ Download 35 websites (from 1 & 2)

🔄 Replay websites (30 times per setting)

📈 Measure SpeedIndex & HOL bytes

Adapted H2O Web Server

+ Latency + Shaping + Loss

Browsertime

© Chromium Project

Rehost websites
Override prioritization

Load websites
Calculate SpeedIndex
Extract HOL from Netlogs

- **Δ: Relative median difference to Chrome / sequential baseline**
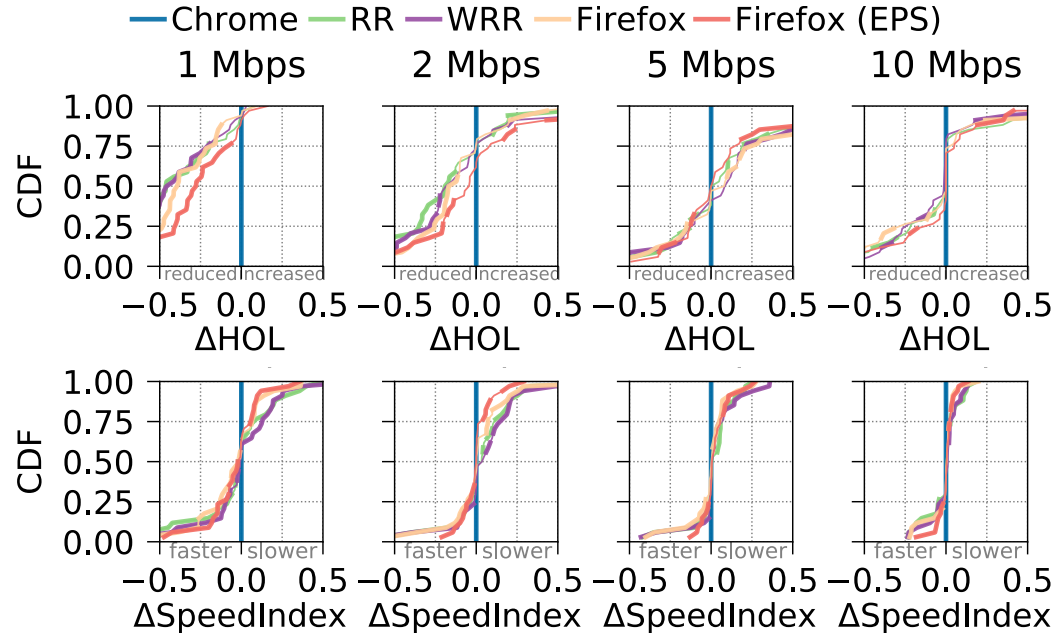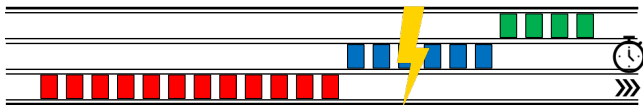
- **HOL:** (lower=better)
  - ▶ Reduced with parallelism
  - ▶ Vanishing differences for higher bandwidths

- **SpeedIndex:** (lower=faster/better)
  - ▶ Fewer benefits of parallelism for higher bandwidth / cwnd

No art. loss
100ms RTT
BDP Queue

—Chrome —RR —WRR —Firefox —Firefox (EPS)
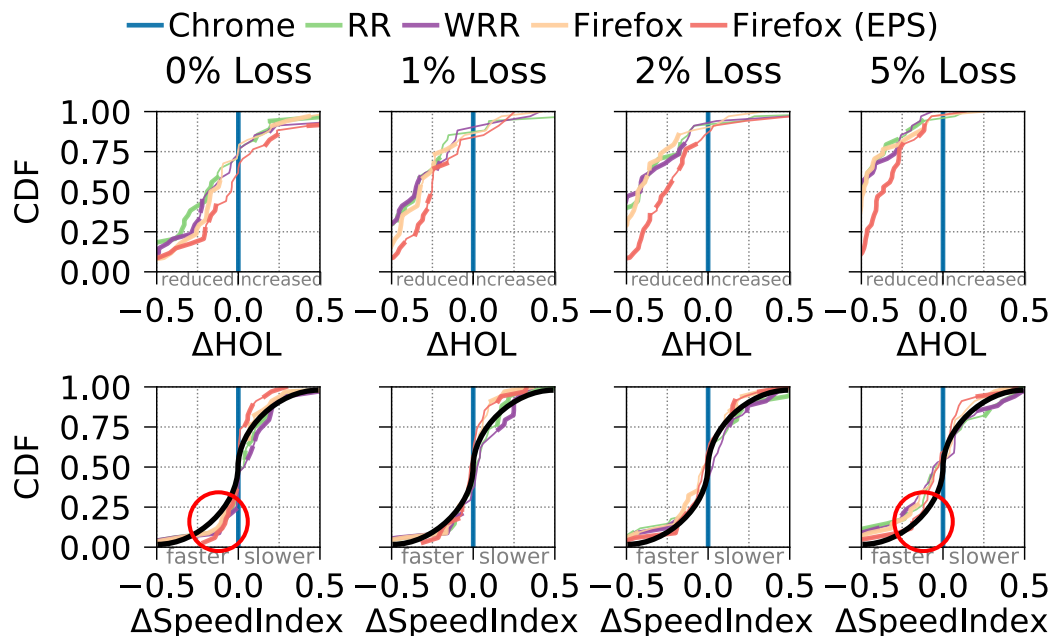
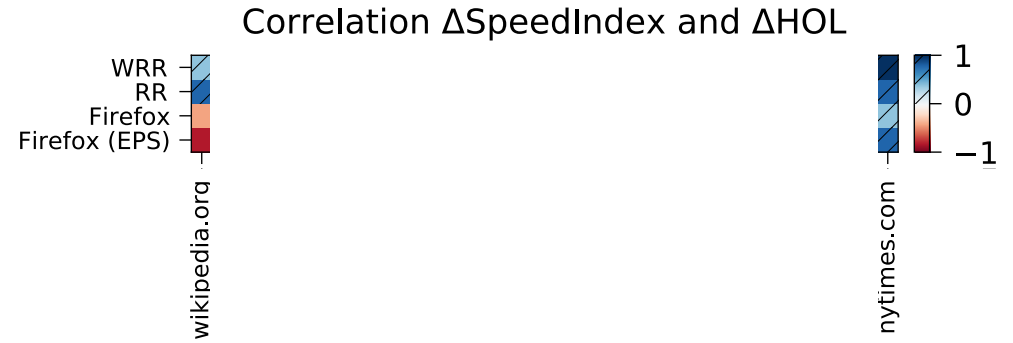Constantin Sander, Ike Kunze, Klaus Wehrle

- **HOL:**
  - ▶ Less HOL blocking for higher loss (as expected)
  - ▶ Loss stopping many streams for sequential scheduling

- **SpeedIndex:**
  - ▶ Growing benefits for higher loss
 - ▶ Not as strongly as for HOL

2Mbps BW
100ms RTT
1BDP Queue

— Chrome — RR — WRR — Firefox — Firefox (EPS)

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Correlation ΔSpeedIndex and ΔHOL

2Mbps BW
100ms RTT
1BDP Queue

WRR
RR
Firefox
Firefox (EPS)

wikipedia.org

nytimes.com

1
0
−1

- **Correlation SpeedIndex and HOL:**

  ▶ Negative for smaller websites

    ■ HOL reduced, but only slightly

    ■ Negative effect of parallel prioritization

  ▶ Positive for larger websites

    ■ HOL reduced more strongly

   ■ Negative effect outweighed

Correlation ΔSpeedIndex and ΔHOL
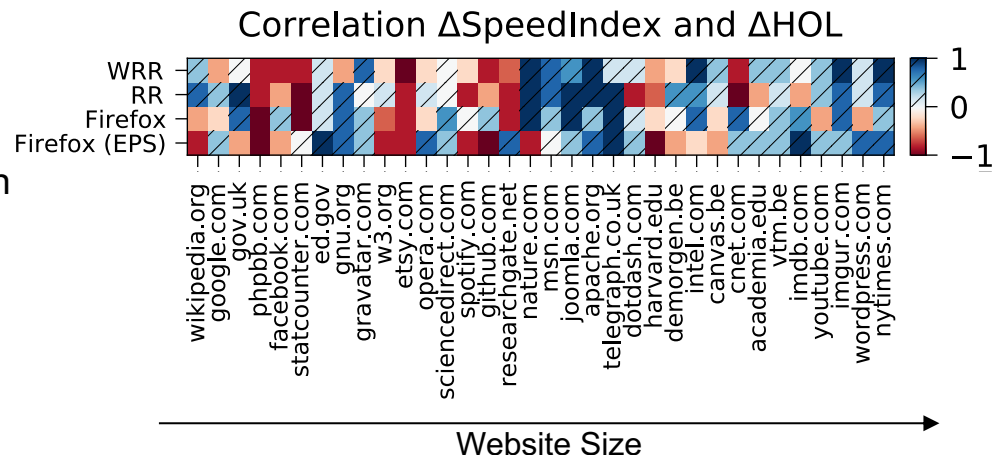
- **Reduced HOL Blocking via QUIC**

  ▶ Multiple streams need to be active in parallel

  ▶ HTTP Prioritization influences active streams: use Round Robin

  ▶ Related Work: Round Robin detrimental for performance
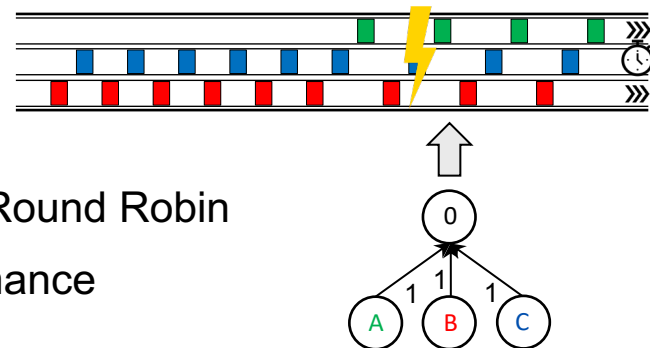
- **New performance interplay between prioritization and network**

  ▶ Round Robin can improve HOL and thus performance

  ▶ Mainly for large websites / small BW / high RTT / random loss

  ▶ No strong difference when using EPS
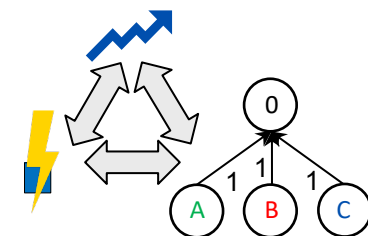
- **Overall: HTTP/3 prioritization still website + now also network dependent**