HyStart++: Modified Slow Start for TCP

draft-ietf-tcpm-hystartplusplus-03

TCPM, IETF 111

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HyStart++ Recap

- Slow Start can overshoot ideal send rate & cause massive packet loss
  - Increased retransmissions
  - Time spent in recovery
  - Sometimes results in RTO (retransmission timeout)

- HyStart++ until draft-01
  - Simple modification to Slow Start
  - Only use Delay Increase algorithm from original HyStart
  - Compensate for premature slow start exit
  - Use max of Limited Slow Start (RFC3742) and Congestion Avoidance
  - Define tuning constants based on measurements and deployment experience

Jitter Problems

- Intra DC WAN transfers suffered latency spikes

HYSTART	HTTP	RUN COUNT	PAYLOAD SIZE (BYTES)	AVERAGE THROUGHPUT (MB/S)	MAX THROUGHPUT (MB/S)	MIN THROUGHPUT (MB/S)
ENABLED	2	30	262144000	100.435	120.9	54.4
DISABLED	2	30	262144000	118.538	108.3	128.02

  - Latency spike lasted 1-2 rounds but triggered HyStart exit
  - Source of spike not root caused, but later disappeared during testing

- Performance problems due to jitter
  - Reported as an issue in https://datatracker.ietf.org/meeting/interim-2020-maprg-01/materials/slides-interim-2020-maprg-01-sessa-behavior-of-tcp-cubic-in-low-latency-mobile-radio-networks-00.pdf
  - Raised as an issue in tcpm mailing list by Christian and others
  - Reported as an issue in TCP HyStart Performance over a Satellite Network (wpi.edu)

Jitter Resiliency and Simplification

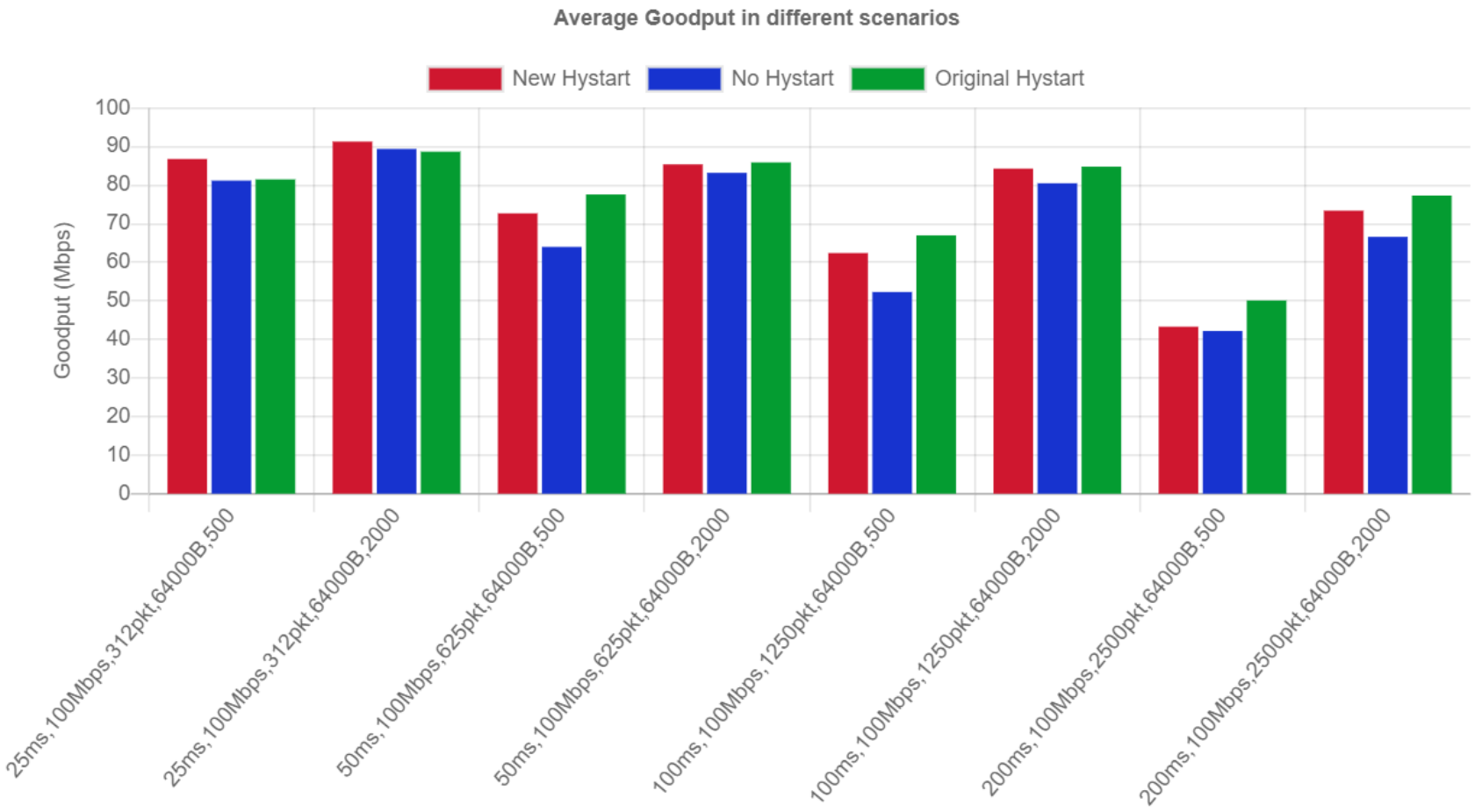
- Standard slow start (RFC 5681)
- Only use Delay Increase algorithm from original HyStart
- Upon exit from slow start, enter Conservative Slow Start (CSS)
- Under CSS increase cwnd as a fraction of standard slow start
- If measured RTT shrinks during CSS, exit was spurious, resume HyStart++
- Else enter congestion avoidance

- Rationale: Instead of trying to compensate for early exit, add detection for spurious exits to be able to resume slow start

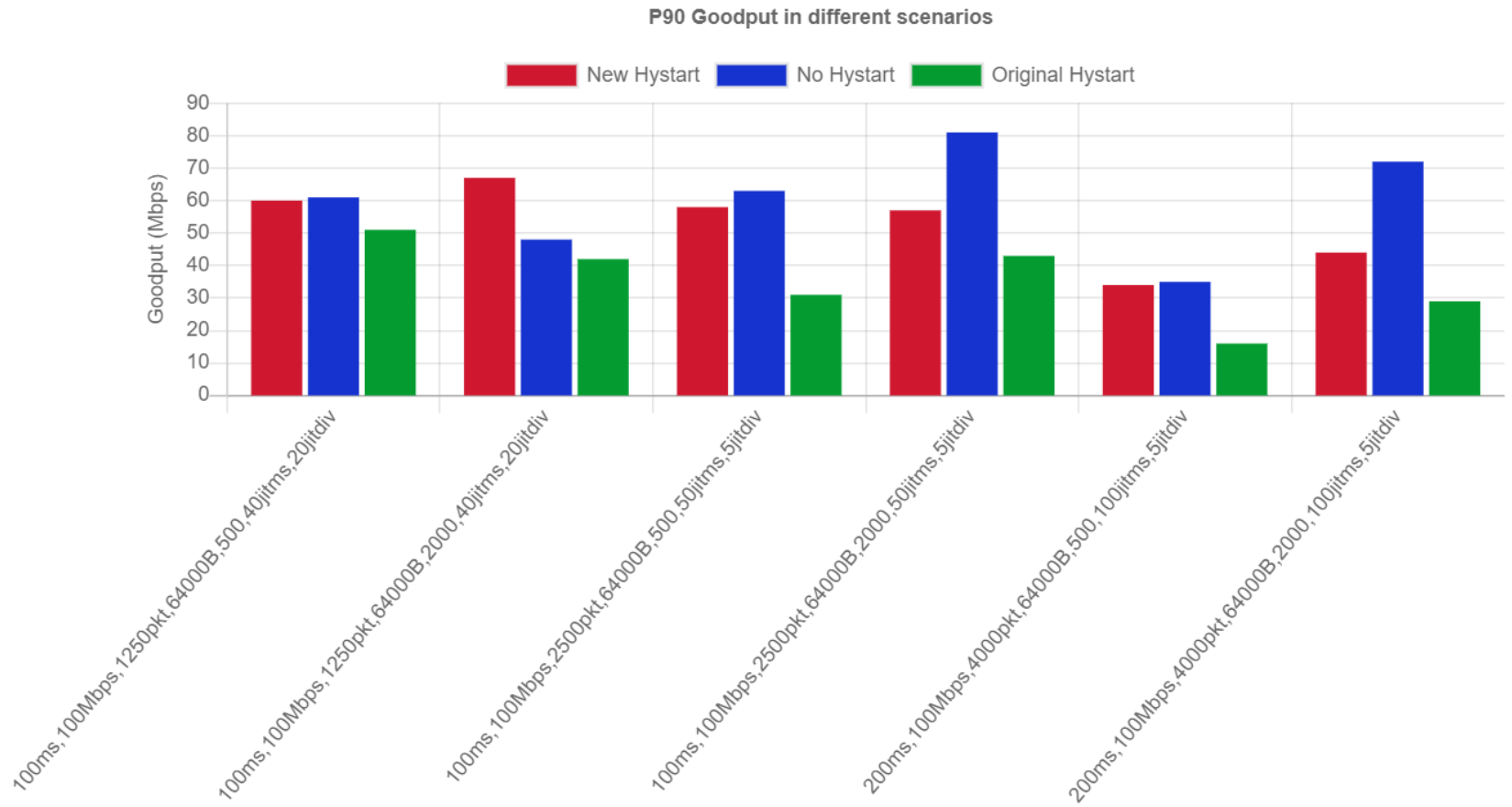
Algorithm Details

- On each ACK in slow start
  - Update the cwnd per standard slow start
  - If taking an RTT sample, measure current round's minRTT
- For each round in slow start (round approximates an RTT)
  - Remember last round's minRTT
  - If cwnd >= (LOW_CWND * SMSS) and at least N_RTT_SAMPLE RTT samples taken
  - Check if currentRoundMinRTT is greater than lastRoundMinRTT + Threshold
  - If yes, set ssthresh = cwnd, cssBaselineRtt = currentRoundMinRTT, exit slow start and enter CSS
- CSS lasts at most CSS_ROUNDS rounds. On each ACK in CSS
  - Update the cwnd as "standard slow start cwnd" / CSS_GROWTH_DIVISOR
- For each round in CSS
  - If at least N_RTT_SAMPLE RTT samples taken
  - Check if currentRoundMinRTT is less than cssBaseLineRtt
  - If yes, declare exit as spurious and resume HyStart++
  - Else enter congestion avoidance
- Exit HyStart++ on first congestion signal
- SHOULD use on first slow start and MAY use after idle

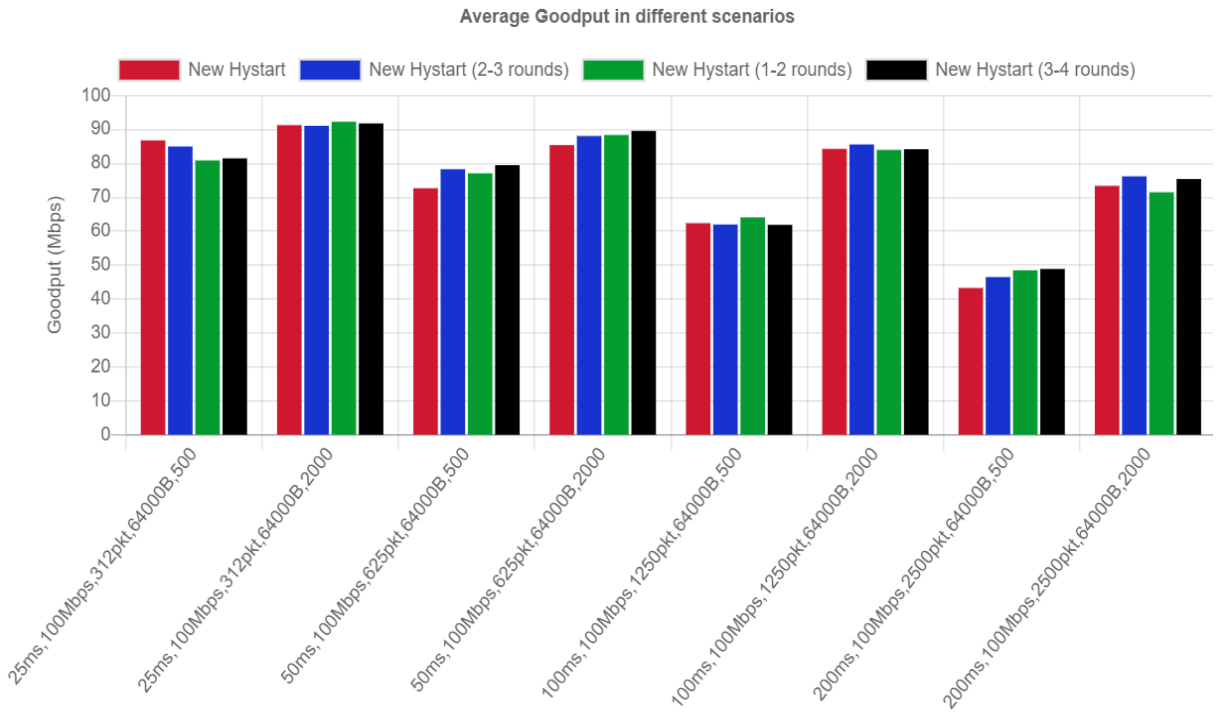
Lab Measurements – no jitter

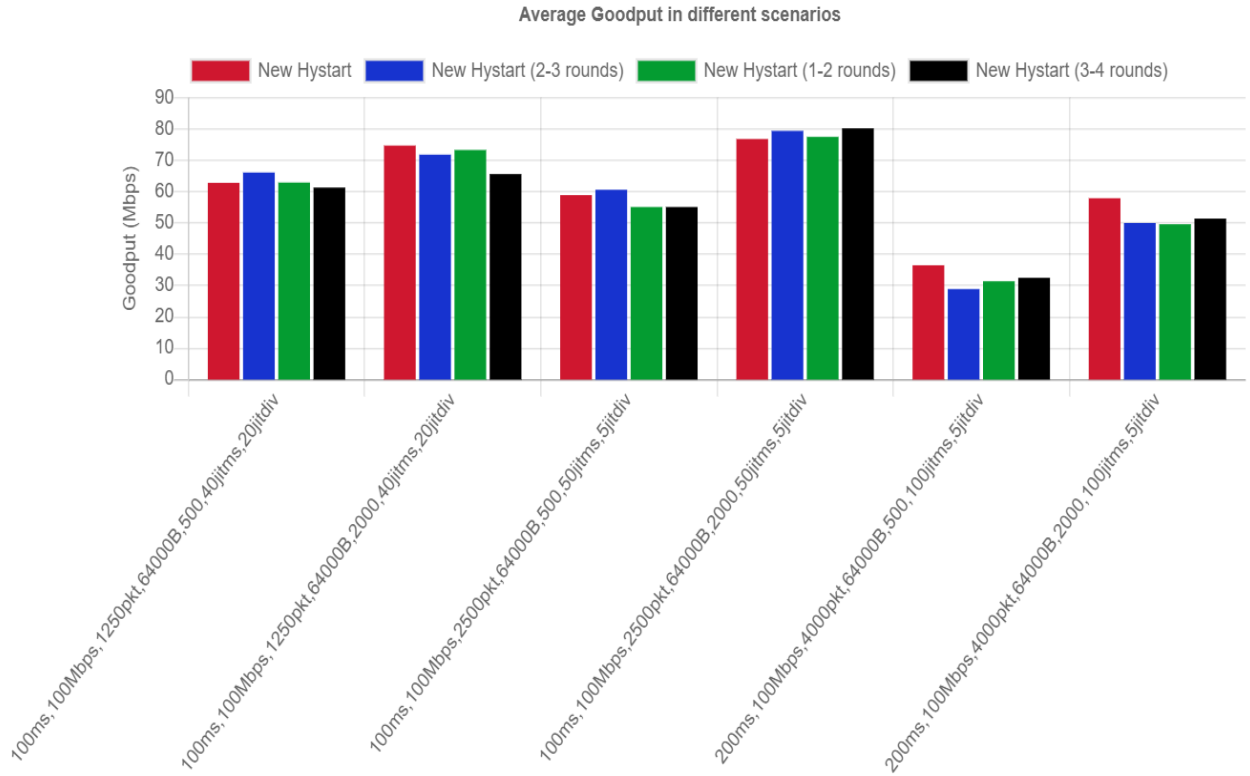


Lab Measurements – jitter



Lab Measurements – Varying CSS_ROUNDS





Status & Next Steps

- We made a rather significant change to the algorithm
- Currently flighting and doing A/B measurements
- Revaluate fixed threshold clamps

- Should we change the Intended Status to Experimental?