

HyStart++: Modified Slow Start for TCP

TCPM, IETF 105

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HyStart Recap

- Slow Start can overshoot ideal send rate and cause massive packet loss
- HyStart: Exit slow start early based on Delay Increase algorithm
 - Inter-Packet Arrival algorithm does not perform well due to ACK compression
- Delay Increase algorithm works well but has false positives
 - Latency fluctuations on wireless links
 - Transient queue buildup

HyStart “Delay Increase” algorithm

- Keep track of minimum observed RTT in each round in slow start
- For rounds where cwnd is at or higher than MIN_SSTHRESH and N_RTT_SAMPLE RTT samples have been obtained
 - Eta = clamp(MIN_ETA, lastRoundMinRTT / 8, MAX_ETA)
 - if (currentRoundMinRTT >= (lastRoundMinRTT + Eta))
 - ssthresh = cwnd
 - exit slow start
- MIN_SSTHRESH = 16, MIN_ETA = 4 msec, MAX_ETA = 16 msec, N_RTT_SAMPLE = 8

HyStart++

- HyStart “Delay Increase” for only the initial slow start
- Compensate for premature slow start exit
 - Congestion Avoidance algorithm can take time to ramp up
- Use Limited Slow Start (RFC3742) until next congestion signal
- For each arriving ACK in LSS, where N is the number of previously unacknowledged bytes acknowledged in the arriving ACK:
 - $$K = \text{cwnd} / (\text{LSS_DIVISOR} * \text{ssthresh})$$
 - $$\text{cwnd} = \max(\text{cwnd} + N / K, \text{CA_cwnd}())$$
- $\text{LSS_DIVISOR} = 0.25$

Fix for high BDP links

- Use maximum of cwnd computed by LSS and Congestion Avoidance
 - Thanks to Neal Cardwell!
 - We forced early exit and measured an improvement in the lab
- For each arriving ACK in LSS, where N is the number of previously unacknowledged bytes acknowledged in the arriving ACK:
$$K = \text{cwnd} / (\text{LSS_DIVISOR} * \text{ssthresh})$$
$$\text{cwnd} = \max(\text{cwnd} + N / K, \text{CA_cwnd}())$$

Status & Next Steps

- HyStart++ is deployed on by default for all connections
 - Windows 10 May 2019 Update onwards
 - Windows Server 2019 1903 version onwards
 - Fix for high BDP links in Preview for next update
- Draft Status
 - draft-balasubramanian-tcpm-hystartplusplus-01 posted
 - Please review and provide feedback
- Future: compare HyStart++, BBR STARTUP phase, and Paced Chirping
- Adopt document in tcpm?