HyStart++: Modified Slow Start for TCP

TCPM, IETF 105

Praveen Balasubramanian, Yi Huang, Matt Olson
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
  
  \[ \text{Eta} = \text{clamp} \left( \text{MIN\_ETA}, \frac{\text{lastRoundMinRTT}}{8}, \text{MAX\_ETA} \right) \]
  
  \[
  \text{if} \ (\text{currentRoundMinRTT} \geq (\text{lastRoundMinRTT} + \text{Eta}))
  \]
  
  \[
  \text{ssthresh} = \text{cwnd}
  \]
  
  \[
  \text{exit slow start}
  \]

- \( \text{MIN\_SSTHRESH} = 16, \text{MIN\_ETA} = 4 \text{ msec}, \text{MAX\_ETA} = 16 \text{ msec}, \)
  \( \text{N\_RTT\_SAMPLE} = 8 \)
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:
  \[ K = \frac{cwnd}{(\text{LSS\_DIVISOR} \times \text{ssthresh})} \]
  \[ cwnd = \max(cwnd + \frac{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:
  \[ K = \frac{cwnd}{(LSS\_DIVISOR \times \text{ssthresh})} \]
  \[ cwnd = \max(cwnd + \frac{N}{K}, \text{CA}_\text{cwnd}()) \]
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?