Revised CUBIC

IETF 110

Lisong Xu, Sangtae Ha, Injong Rhee, Vidhi Goel, Lars Eggert

K's definition

Time it takes to increase the *cwnd* size at the beginning of the congestion avoidance to W_{max}

- $cwnd_{start}$ is the congestion window at the start of congestion avoidance.
- RFC 7661 for rate-limited applications.
  - $cwnd_{start}$ may be smaller than $(W_{max} * \beta_{cubic})$
- If fast convergence is used, W_{max} is further reduced
- Updated K's definition

$$K = \sqrt[3]{\frac{W_{max} * (1 - \beta_{cubic})}{C}}$$

$$K = \sqrt[3]{\frac{W_{max} - cwnd_{start}}{C}}$$

- Implementations MAY employ Fast Recovery mechanisms.

W_{max} size of *cwnd* just before *cwnd* was reduced in the last congestion event.
β_{cubic} CUBIC multiplicative decrease factor
C constant that determines the aggressiveness of CUBIC

CUBIC target window

$$\mathrm{W}_{\mathrm{cubic}}(t) = C * (t - K)^3 + W_{max}$$

- Lower bound for non-decreasing window.
- Upper bound for lower than slow-start increase.

$$target = \begin{cases} cwnd & \text{if } \mathrm{W}_{\mathrm{cubic}}(t + RTT) < cwnd \\ 1.5 * cwnd & \text{if } \mathrm{W}_{\mathrm{cubic}}(t + RTT) > 1.5 * cwnd \\ \mathrm{W}_{\mathrm{cubic}}(t + RTT) & \text{otherwise} \end{cases}$$

$W_{cubic}(t)$ congestion window at time *t* based on the cubic increase function
RTT smoothed round-trip time
target target value of congestion window after the next RTT, i.e., $W_{cubic}(t + RTT)$

AIMD-Friendly region

- TCP-friendly -> AIMD-friendly
- Initialize W_{est} to the cwnd at the start of congestion avoidance. Same after a timeout.
- Instead of linear increase based on time, do it similar to AIMD.

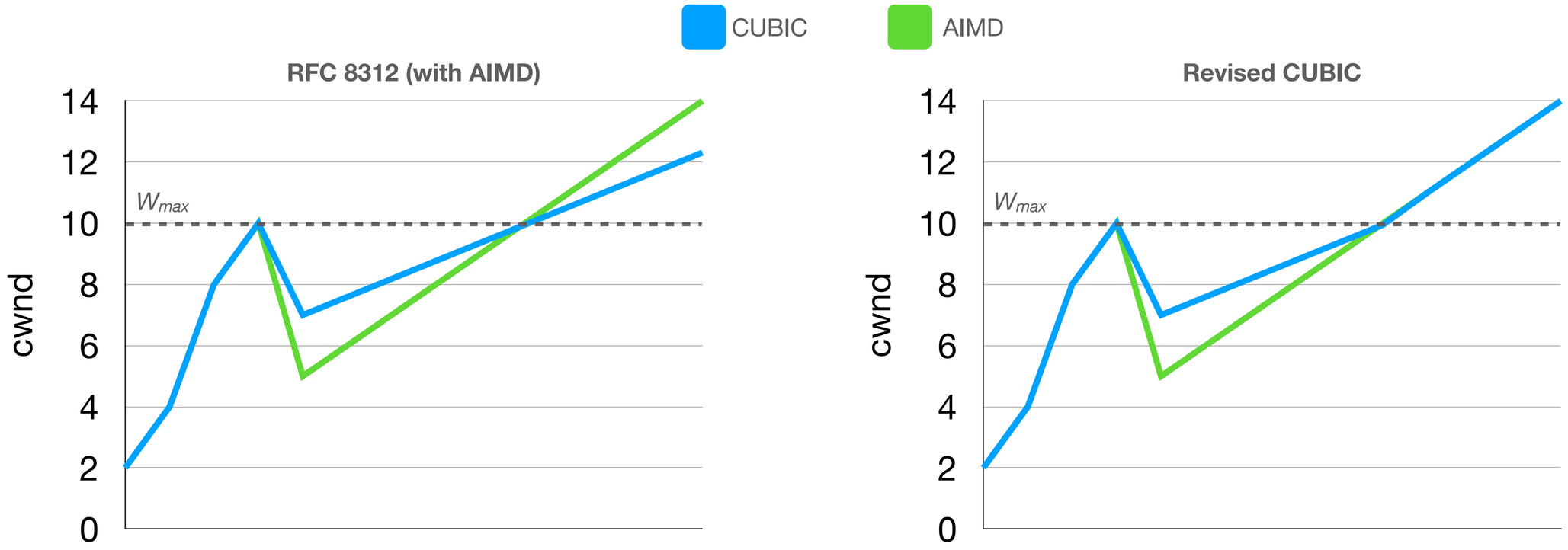
$$W_{est} = W_{max} + 3 * \frac{(1 - \beta_{cubic})}{(1 + \beta_{cubic})} * \frac{t}{RTT}$$

$$W_{est} = W_{est} + \alpha_{aimd} * \frac{segments\_acked}{cwnd}$$

$$\alpha_{aimd} = 3 * \frac{1 - \beta_{cubic}}{1 + \beta_{cubic}}$$

W_{est} an estimate for the congestion window in the AIMD-friendly region
α_{aimd} CUBIC additive increase factor used in AIMD-friendly region

AIMD-Friendly region



- When $W_{est} >= W_{max}$,
  - Set $\alpha_{aimd} = 1$ to have same increase as AIMD.

W_{est} an estimate for the congestion window in the AIMD-friendly region
α_{aimd} CUBIC additive increase factor used in AIMD-friendly region

More updates

- Lower bound of 2 packets for cwnd.
- Definition of variables and constants with units.
- New section for spurious losses.
- Rename TCP-Friendly to AIMD-Friendly and Standard TCP to AIMD TCP.
- Reflect the significant broader deployment of CUBIC in the Internet.
- Highlight the differences from the original CUBIC research paper.
- Pretty Latex Math and more…