Oct 13: Finish Up TCP

Topics:

- Timeout (RTO) Estimation
  - RTT, Variation
  - Smoothing EWMA.
- TCP: Packets to Bytes.
- AIMD
- Rough Throughput
- Flow control
- TCP Fairness
- TCP over wireless.

\[
\frac{w}{RTT} + \frac{w/2}{RTT} = 0.75 \cdot \frac{w}{RTT}
\]
RTO Estimation

RTO = \( f(\text{historical RTT}) \)

RTO = \( \max \left\{ \text{last } k \text{ RTTs} \right\} \)

mean \( \{ \text{last } k \text{ RTTs} \} \)

RTO = \( \text{weighted arg- of historical RTTs} + \text{Safety factor} \)

Estimated RTT \( (\hat{R}) \)

Deviation of RTT \( (\hat{\Delta}) \)

RTO(t) = \( \hat{R}(t) + \hat{\Delta}(t) \)

\( \hat{R}(t) = 0.8 \hat{R}(t-1) + 0.2 R(t) \)

RTT measured at time t

periodic outliers will affect max
\[ \hat{R}(t-1) = \alpha \hat{R}(t-2) + (1-\alpha) R(t-1) \]  
\[ \hat{R}(t) = \alpha (\kappa \hat{R}(t-2) + (1-\kappa) R(t-1)) + (1-\kappa) R(t) \]
\[ = \alpha^2 \hat{R}(t-2) + \alpha (1-\alpha) R(t-1) + (1-\alpha) R(t) \]

\[ (0.8)^2 = 0.64 \]

\[ \hat{R}(t) = \alpha \hat{R}(t-1) + (1-\alpha) R(t) \]

\[ \hat{\Delta}(t) = \alpha \hat{\Delta}(t-1) + (1-\alpha) |R(t) - \hat{R}(t)| \]

\[ \text{RTO}(t) = \hat{R}(t) + 4 \hat{\Delta}(t) \]

\( \text{Est. RTT} \) \( \text{Est. dev (RTT)} \)
TCP Packets $\rightarrow$ Bytes

$C W \rightarrow$ Expressed in # of bytes.

Segment

MSS bytes

Maximum Segment size.

AIMD $\rightarrow$ Additive Increase but Multiplicative Decrease.

Saw tooth behavior of $C W$

Avg Throughput

$$\text{Avg Throughput} = \frac{N}{\text{RTT}} + \frac{N/2}{\text{RTT}} \times \frac{2}{N}$$

Time $= 0.75N/\text{RTT}$
Flow Control

ACK \{ B = \text{No. of bytes still available} \}

Tx transmits \min \{ CW, B \}
TCP Fairness

How is capacity divided between Alice & Bob?

Bob's CW

link capacity

Bob's

Capacity = 100

Alice

CW = 60

Bob

CW = 0

at capacity

CW = 80

40

65

32.5

60

40

16

35

17.5

CWA + CWB = Constant = Capacity
TCP HW#2 will be released tomorrow