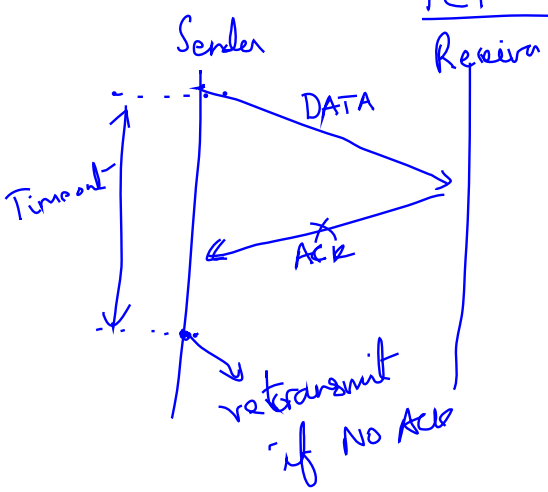
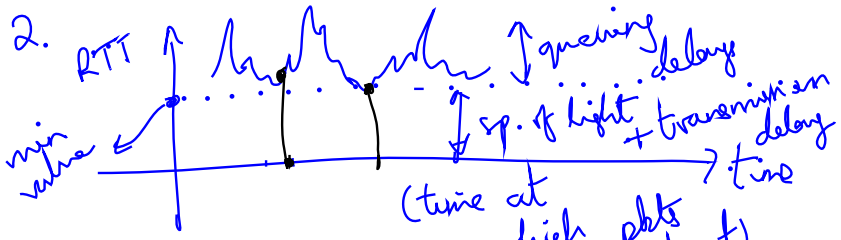
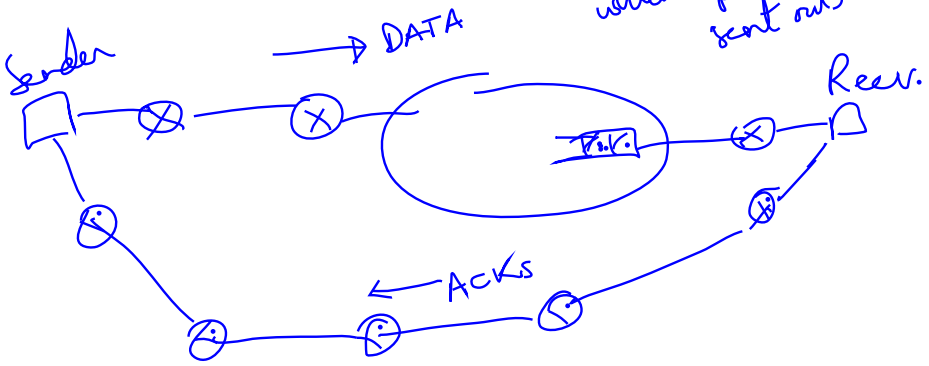
TCP TIMEOUT



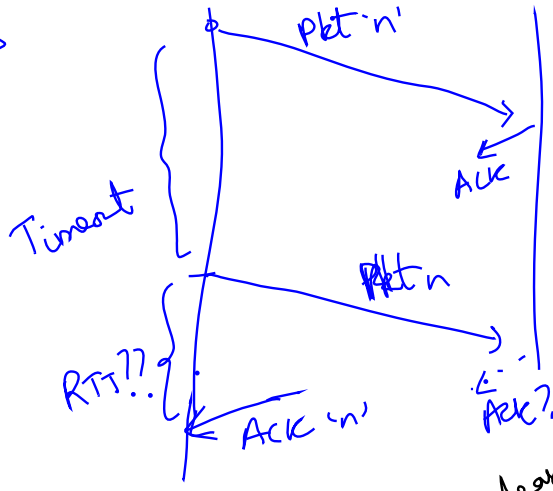
Issue

1. RTT varies by orders of magnitude across different network paths

2. 



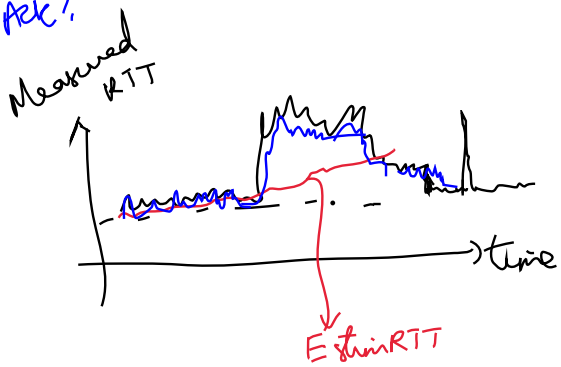
3. Packet loses



Sol: Do not use RTT measurement for retransmitted pkt.

OLD ALGORITHM

SampleRTT: most recent RTT measurement



$$EstimRTT = \alpha \cdot EstimRTT + (1-\alpha)\, SampleRTT$$

if $\alpha \approx 1$

↳ like an avg.

$1/2^m$

$\alpha \in (0,1)$

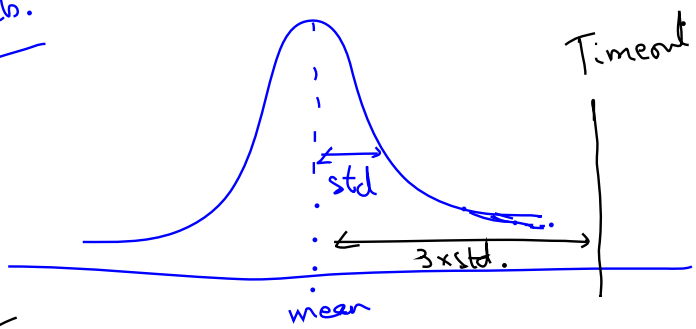
$\alpha \approx 1 \Rightarrow$ less importance to current measurement

$\alpha \approx 0 \Rightarrow$ lot of importance to recent measurements

$$Timeout = 2 \times EstimRTT$$

NEW ALGORITHM

Gaussian Distrib.



Idea: set $Timeout = mean + m \times std$

Measure EstimRTT as before

$$Diff = SampleRTT - EstimRTT \xrightarrow{\text{assume mean}} \approx x_i - \bar{x}$$

Suppose $x_1, x_2, \ldots, x_N$ are some values (i.i.d.) from random variable X

Estim mean $\bar{x} = \frac{1}{N}\sum_{i=1}^{N} x_i$

Meas std $= \sqrt{\frac{1}{N}\sum_{i=1}^{N}(x_i - \bar{x})^2}$

MEAN DEVIATION $= \frac{1}{N}\sum_{i=1}^{N}|x_i - \bar{x}|$

DEV $=$ DEV $(1-\beta) + \beta|Diff|$ ↳ most recent deviation value

↓ Deviation

TIMEOUT $= \mu \times EstimRTT + \phi \times DEV$

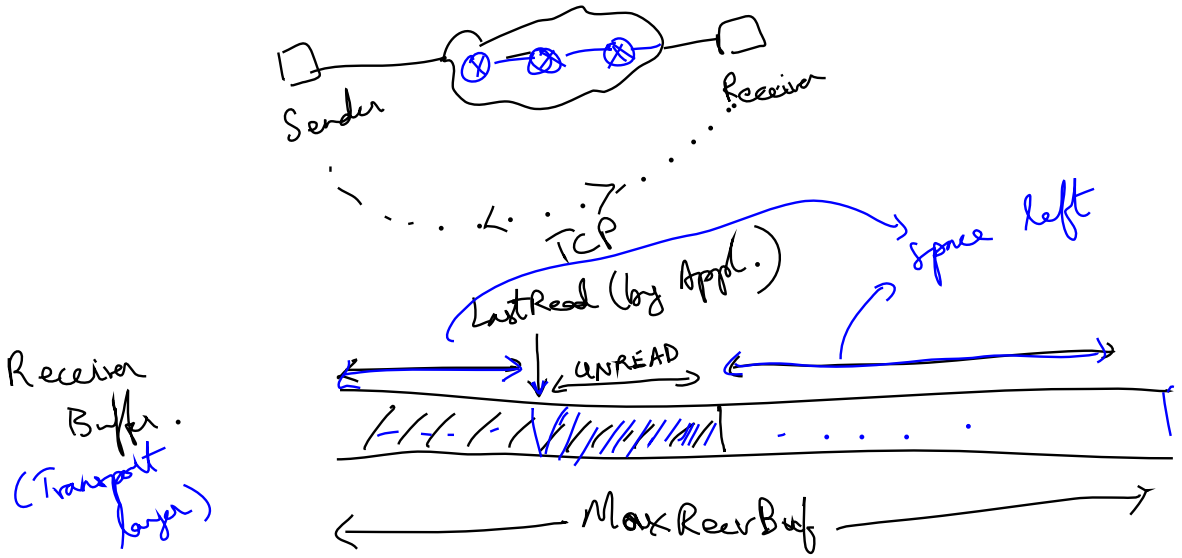
$\mu = 1$ $\quad$ $\phi = 4$ Typical value

$\alpha = 7/8$; $\beta = 1/4$

(Recall $EstimRTT = \alpha\, EstimRTT + (1-\alpha)\, SampleRTT$)

CONGESTION CONTROL

ECN



FLOW CONTROL: Deals with congestion at receiver

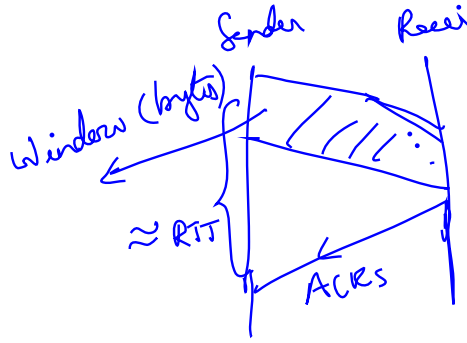
Adv. Window (field in TCP header) = space left in the Rcv. Buffer

Sender has a "Window"

Window = Max. amount of data (in bytes) which is outstanding (sent into network but not Acked)

Suppose RTT is const.

$$\text{DataRate} \approx \frac{\text{Window}}{\text{RTT}}$$



Want Window ≤ Adv. Window → Ensured to take care of Flow control

How to deal with congestion at routers.

Calculate Cong. Window

Window = min (Adv. Window, Cong. Window)

Window ≈ DataRate × RTT

DELAY - BANDWIDTH PRODUCT