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TRANSPORT PROTOCOLS

"METHODS" :

* "COMMON SENSE" + "KNOWING DEFINITIONS"
* "PROBABILISTIC" CALCULATIONS
  - EXPECTED # OF TRIALS UNTIL SUCCESS
  - AVERAGE NUMBER OF TRIALS
* "LTI SYSTEMS" AND EWMA
* LITTLE'S LAW

Ex. 1 (COMMON SENSE + DEF)

BOTTLENECK RATE = B
PACKET SIZE = P
ACK SIZE = A
PROCESSING TIME + DELAY = T
NO LOSS ASSUMPTION, NO QUEUES, ETC.

"STOP & WAIT" THROUGHPUT

$$= \frac{P}{\frac{P}{B} + T + \frac{A}{B}}$$

Ex. 2 (C.S. + DEF) + LITTLE'S LAW

BOTTLENECK RATE = B
PACK. SIZE = P
WINDOW SIZE = W
RTT = T
NO LOSS

PACK. TRANSM. RATE $= \frac{W}{T}$ (L.L)

TRANSM. RATE $= \frac{PW}{T}$

UTILIZATION $= \frac{PW}{BT}$

Ex. 3 (C.S)

# CLIENTS = N
RTT = T
ACK SIZE = A

SERVER'S OUTGOING BANDWIDTH

$$\geq \frac{N \cdot A}{T}$$

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Ex. 4

RTT $= \tau$

TIMEOUT $= T$

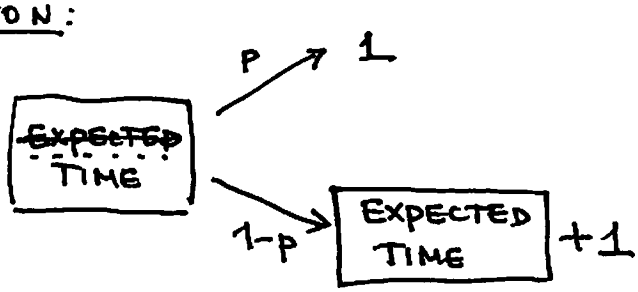
SINGLE PACKET SUCCESS PROB. $= p$

EXPECTED TIME TO ACK: $\tau - T + \frac{T}{p}$

VERY USEFUL, FROM 6.041

> IN A SEQUENCE OF INDEPENDENT "TRIALS", EACH WITH $\mathbb{P}$(SUCCESS) $= p$, EXPECTED ~~TIME~~ # OF TRIALS UNTIL SUCCESS IS $1/p$

DERIVATON:



$$X = p \cdot 1 + (1-p) \cdot (X+1)$$
$$\Downarrow$$
$$X = 1/p$$

Ex. 5 (C.S. + DEF + L.L)

BANDWIDTH $= B$

RTT $= T$

PACK. SIZE $= P$

MIN. WINDOW SIZE

$$\underbrace{W}_{\text{"queue SIZE"}} = \underbrace{(B/P)}_{\text{"rate" ("PACKET" rate)}} \cdot \underbrace{T}_{\text{"DWELLING TIME"}}$$

Ex. 6 (C.S. + DEF)

BANDWIDTH $= B$ (BOTTLENECK)

RTT WITH QUEUE $= T_q$

RTT (NO QUEUE) $= T_0$

QUEUE SIZE

$$Q = B \cdot (T_q - T_0)$$

Ex. 7 (LTI FOR EWMA)

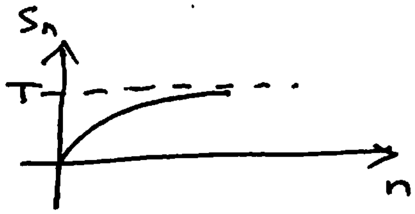
$s_n = a r_n + (1-a) s_{n-1}$ ($a \in (0,1)$: EWMA)

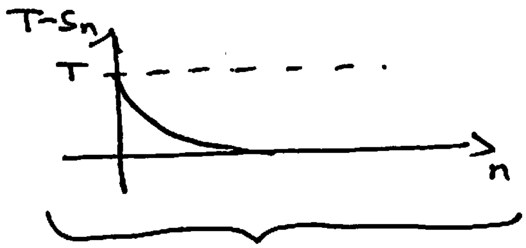
TIMEOUT $= 3 s_n$

RTT's ($= r_n$) jump from $r_n \ll T$ to $r_n = T$

HOW SOON "NO SPURIOUS RETRANSMISSIONS" ?

i.e. $\left.\begin{array}{l} s_0 = 0 \\ s_n = a + (T-a) s_{n-1} \end{array}\right\}$ HOW SOON $s_n \geq T/3$?





$$T - s_{n+1} = \underbrace{(1-a)}_{\text{CONVERGENCE RATE}} (T - s_n)$$

$\Rightarrow$ SOLVE FOR $(1-a)^n \leq 2/3$!

Ex. 8

$\mathbb{E}$(SINGLE ACK) $= T_0$

$\mathbb{E}$(n ACK) $= n T_0 \Rightarrow \dfrac{\mathbb{E}(n \text{ ACK})}{n} = T_0$

$\dfrac{\mathbb{E}(\# \text{ OF ACK IN } T)}{T} = ?$

WHEN T SMALL, SOMETHING $\leq \dfrac{1}{T_0}$

AS $T \rightarrow \infty$: APPROACHES $\dfrac{1}{T_0}$.