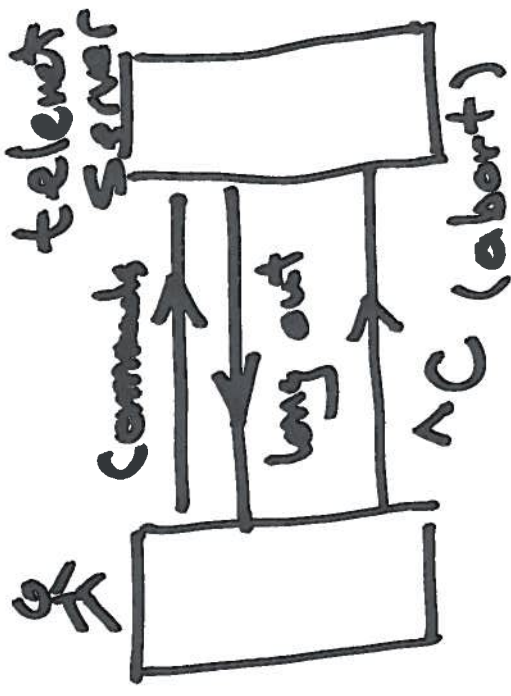
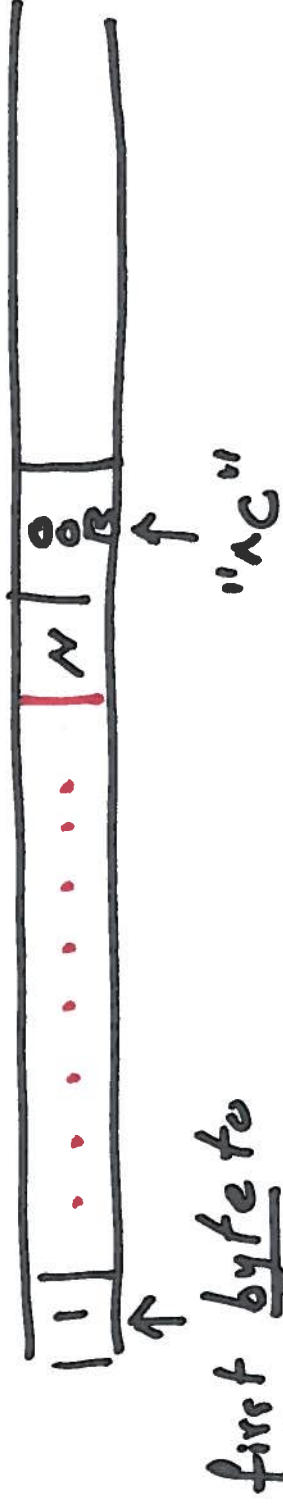


TCP URG Flag



- Expedited data \equiv would like to send ACK as "out-of-band" data
- TCP has no true "out-of-band" data
it has "out-of-band" mode

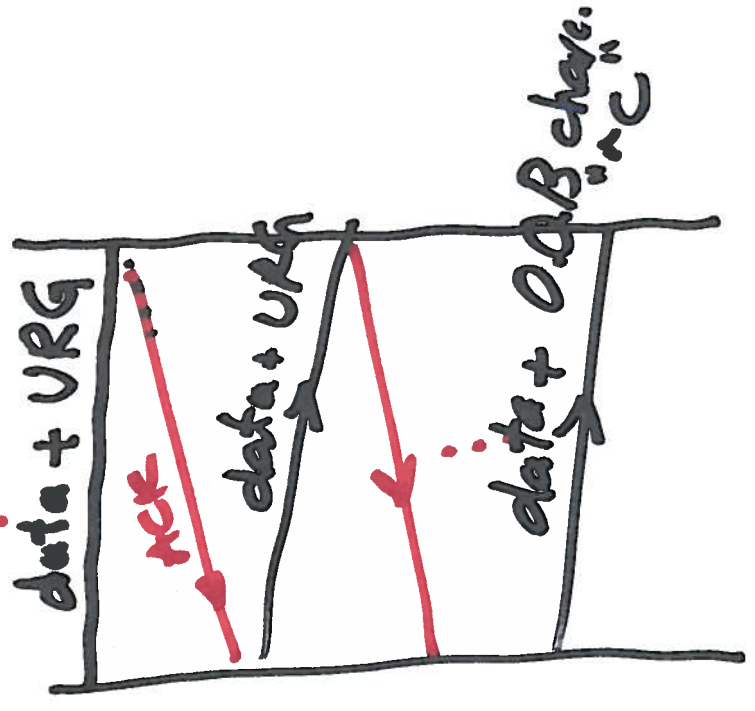
Sender: buffer may look like:



TCP 16-bit URG data pointer

Receiver

- Notified when the OOB character arrives:
 - using SIGURG
- Can pull the OOB character when it arrives quickly.



The PSH bit:

Not useful in sending

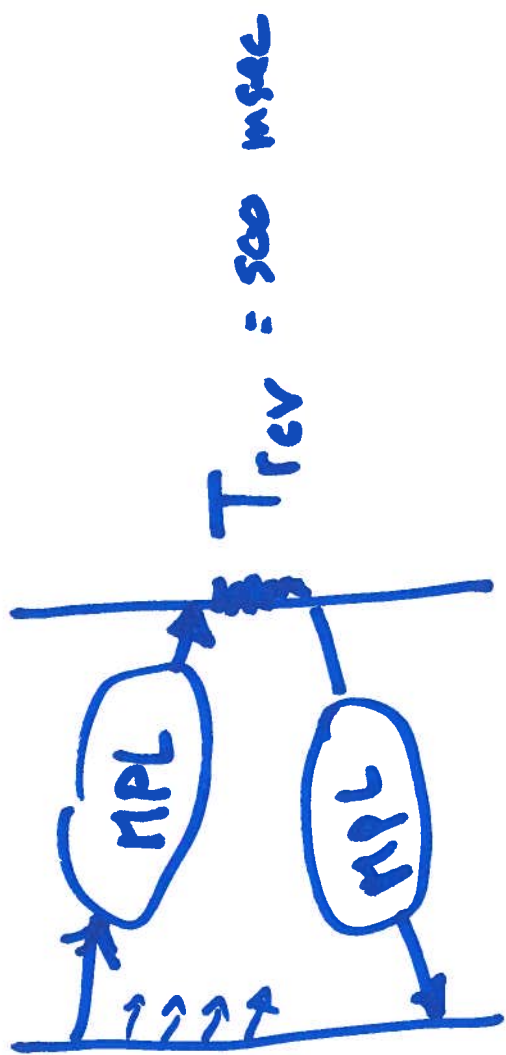
records

write: "Hello: world \n"



Record may be sent in 2 segments

PSH does not enforce use of 1 segment.

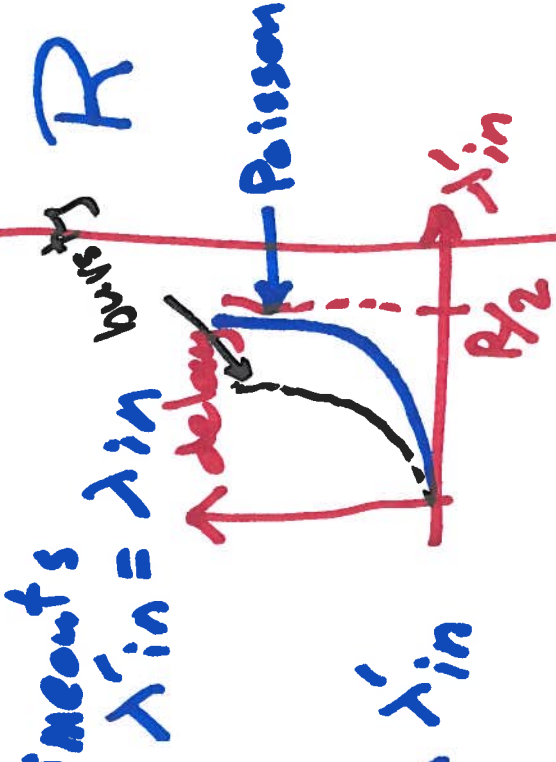
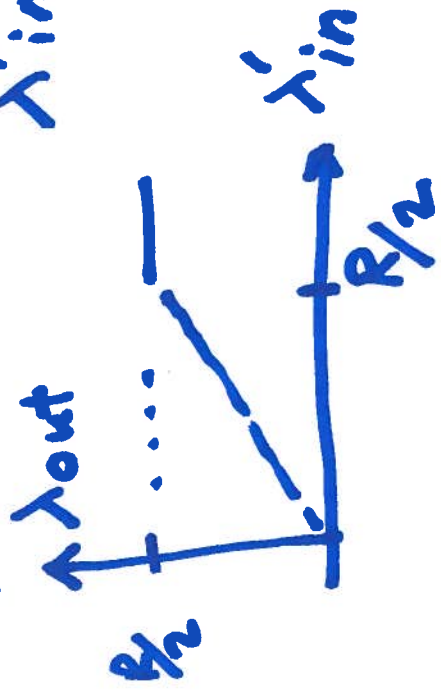


Congestion Control

λ_{in} : offered load to the network
 λ_{out} : useful throughput

Case

- 2 hosts
- ∞ buffer
- Assume: no timeouts



Acquired Bandwidth

\$

As λ_{in} increases
 Productivity!
 Fairness!

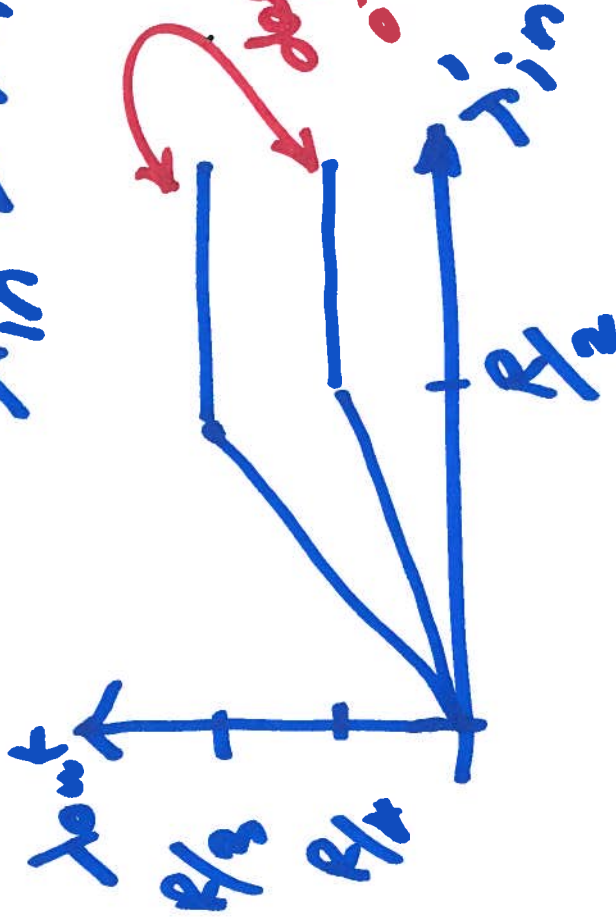
Almost zero
 (delay)



Case

- 2 hosts
- finite buffer
 \Rightarrow timeouts & retransmissions

$$\gamma_{in} > \gamma_{in} R$$



\$

Almost
Zero
(delay,
rate)



Acquired
Bandwidth

Productivity

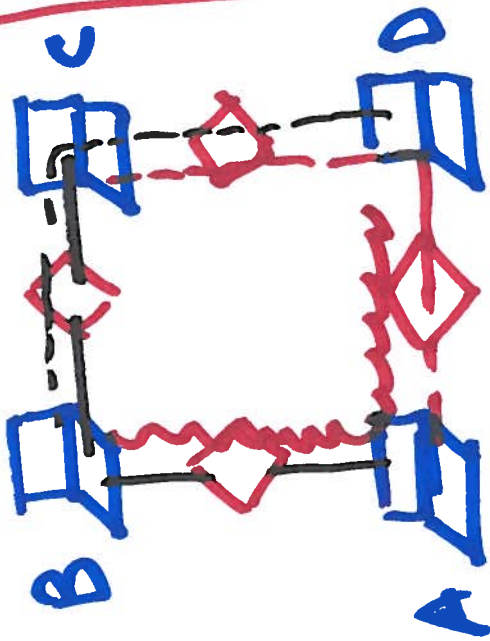
Firm

Case

Acquired
bandwidth

Productivity,

fairness



A-C

B-D

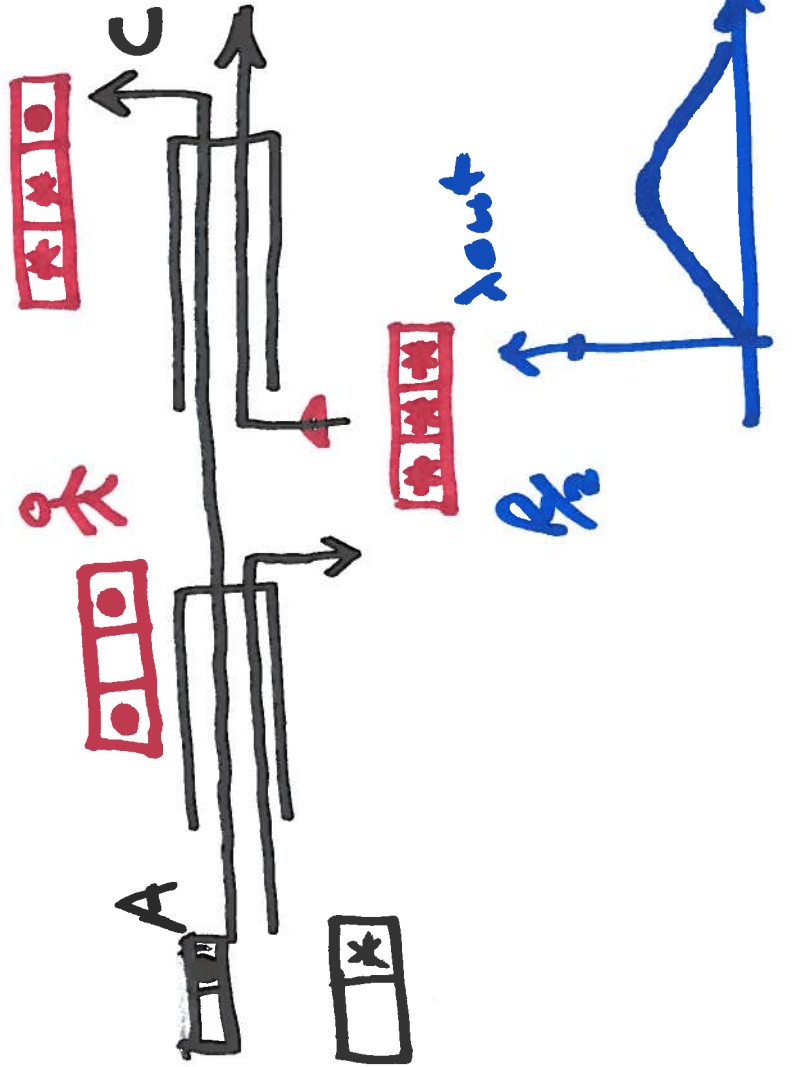
C-A

D-B

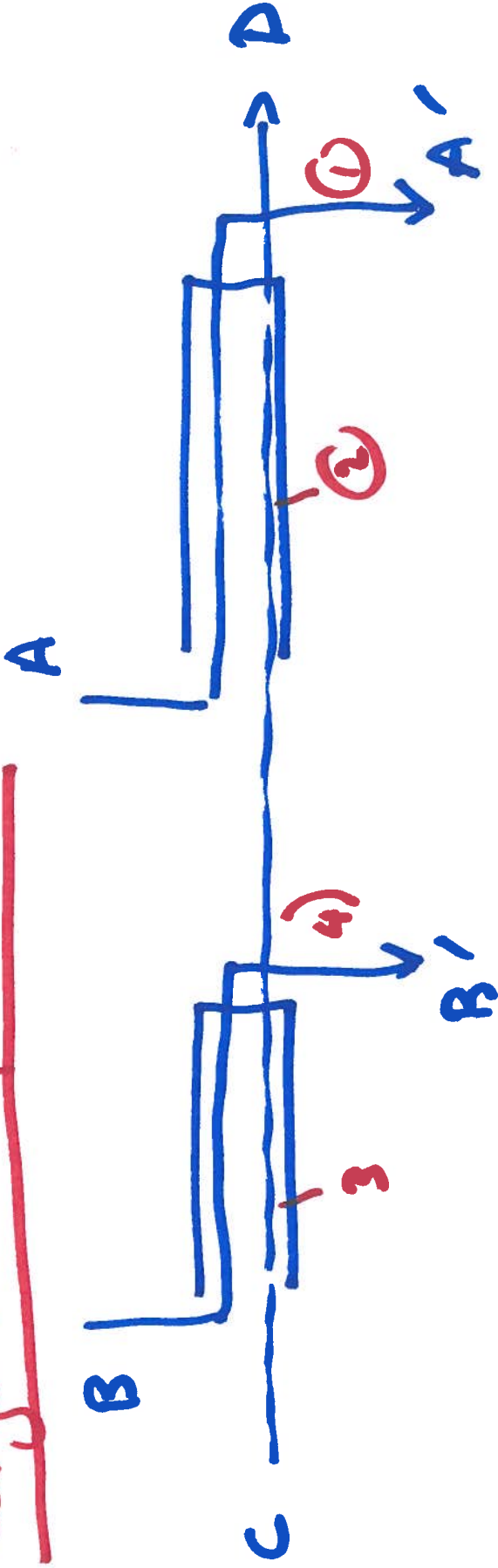
R

Almost
Zero
(delay,
rate)

Not
on
every
link



Congestion Spreading



- 1) Traffic is misbehaving
- 2) Congestion builds up
- 3) Congestion builds up
- 4) B to B' will be affected

Congestion Control

ATM

TCP/IP

- Cells (fixed length packets)
32 bytes

Variable length packets

- Core network devices:
Switches

routers

- Uses virtual circuits
- Switches keep complete state about each traffic flow.

ATM

- Traffic Management:

- regulating traffic in the network
- Guarantee quality of Service (QoS)

measures.

ATM traffic classes

- CBR
- rt-VBR
- nrt-VBR
- ABR
- UBR

Resource Management (RM) cells

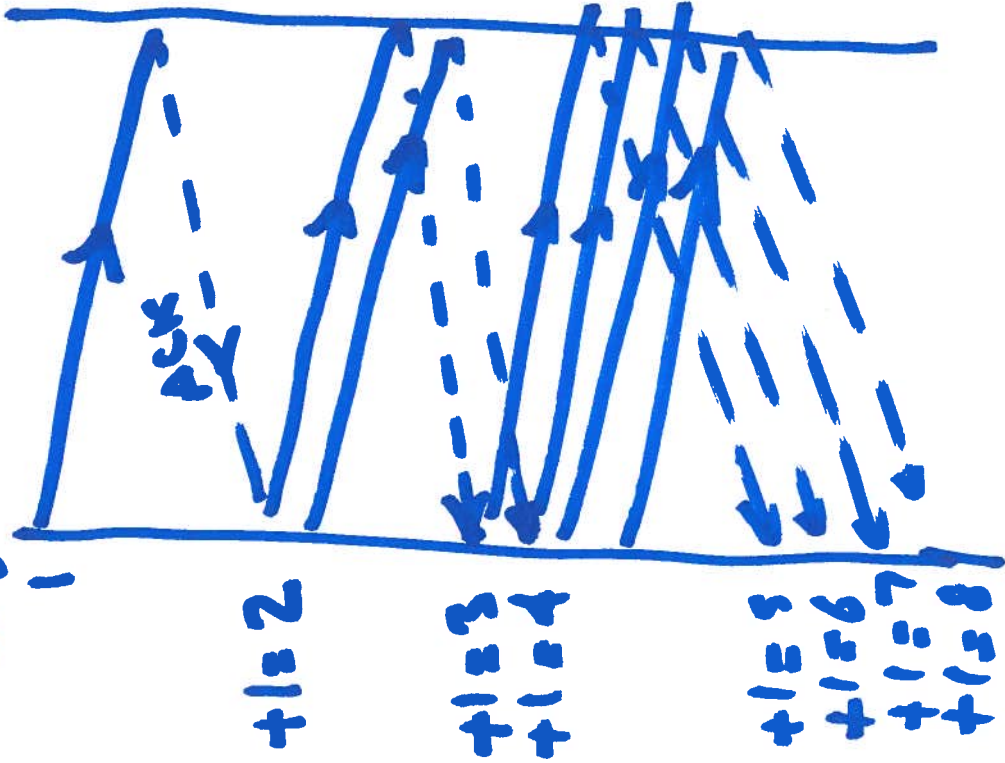
No increase (NI) Congestion Indicator (CI)
Explicit Rate (2 byte)

Data Cell

Explicit forward congestion Indicator (EFCI) ... one bit

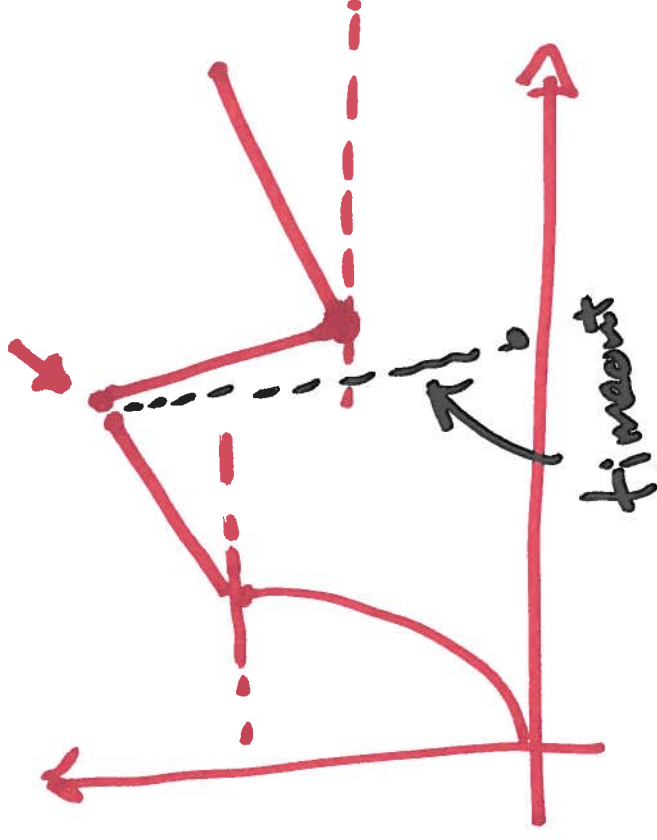
TCP: Slow Start

CongWin



TCP Reno

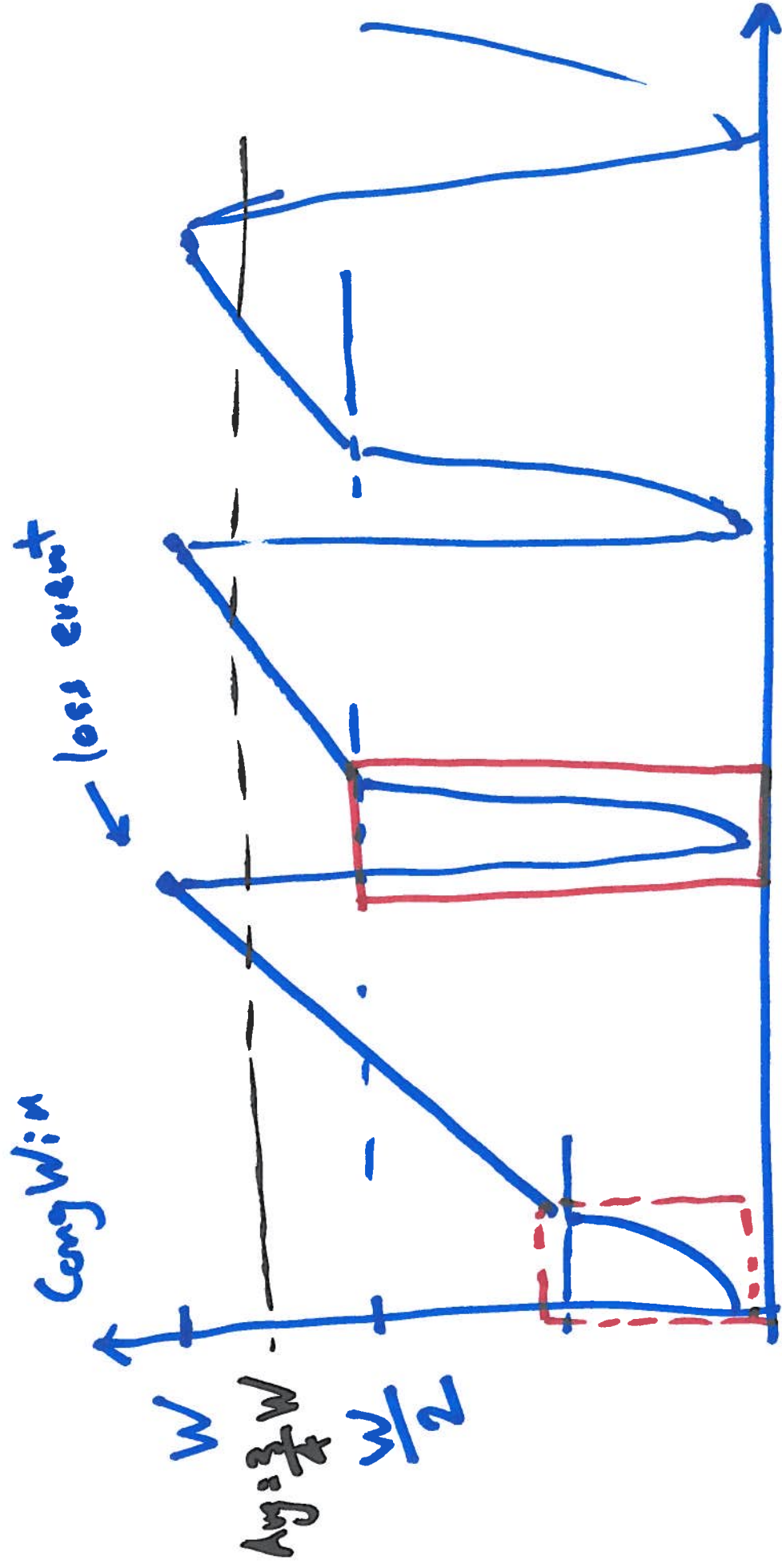
CongWin



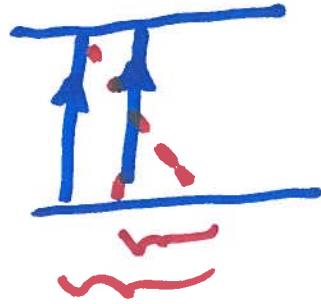
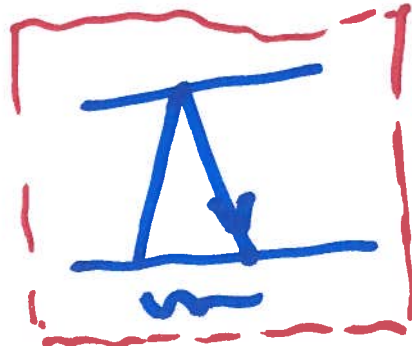
Timeout

3-dup. ACKs

Simplified TCP Throughput Analysis



Expo. Moving Averages



$$S_{n+1} =$$

$$=$$

$$=$$

$$=$$

Smoothed
avg

$$(1-\alpha) S_n + \alpha X_n$$

$$(1-\alpha)^2 S_{n-1} + \alpha(1-\alpha) X_{n-1} + \alpha X_n$$

$$(1-\alpha)^3 S_{n-2} + \alpha(1-\alpha)^2 X_{n-2} + \alpha(1-\alpha) X_{n-1} + \alpha X_n$$

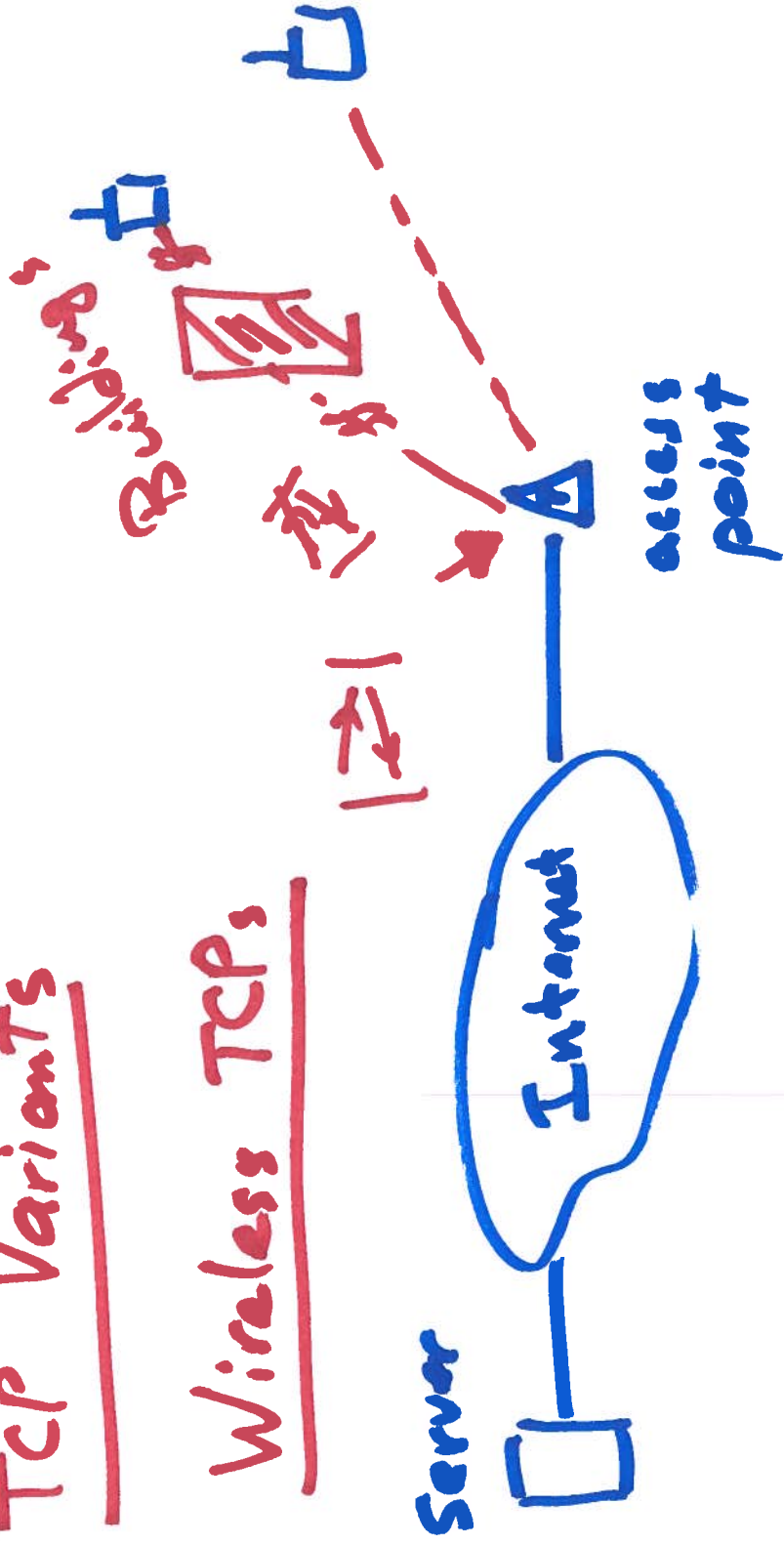
$$\vdots$$

$$.00195 \quad .0136 \quad .109 \quad .875$$

if $\alpha = .075$

Tcp Variants

Wireless TCPs



- Timeouts may be due to wireless channel conditions
- Why invoke congestion control mechanism?
⇒ split-Tcp