Oct 15: TCP Complete

- TCP over wireless
- TCP RED
- End to end bottleneck bandwidth estimation (pkt pair)

\[ I = v \]

Network Layer
TCP over wireless

BER (Bit error rate)

= prob. of bit error much higher in wireless than wired.

Wireless \sim 1 \text{ bit in error every } 10^{4-6} \text{ bits}

\quad 10^{-5}

Wired \sim 10^{-12}

Packet Drop

- Congestion (Router buffer filled up)
- Wireless Link failure

Cut back CW

Just retransmit.
Problem is → TCP doesn’t know the reason for packet drop.

Cross layer approaches → TCP asking Link layer for hints.

all N retransmission failing is very low prob.
Split TCP. Link layer is "SNOOPING" into TCP ACKs flowing through it.

TCP RED (Random Early Drop).

Random Drop packet when \( Q \) is beginning to fill up, say > 60%.

\( Q \) → increasing.

RED is a nice way for the network layer in the router to tell TCP Transmitter.
that Q is filling up, so cut back on CW (via Fast Recovery).

Note: Does not violate layering.

Packet Pair

TCP

\[ \text{Bottleneck bandwidth} \]

\[ 100 \text{ Mbps} \]

\[ 20 \text{ Mbps} \]

\[ 30 \text{ Mbps} \]

\[ 40 \text{ Mbps} \]

\[ \text{TCP Rx} \]
\[ T = \frac{\text{Packet Size}}{\text{Bottleneck B/W}} \]

Transport layer done.