1. Simulate TCP congestion control options. Use RFC793edu TCP agent with

I additive increase and multiplicative decrease
II exponential increase and multiplicative decrease
III AIMD and slow start
IV AIMD, slow start and fast retransmission (=TCP Tahoe)
V TCP Reno
VI TCP Vegas

For each case, use a 13 s simulation time and use student number (either one) as random number generator seed.

(a) For each simulation,

- plot the congestion window
- explain the events in the congestion window plot. Specifically identify in each picture the different phases:
  - additive increase
  - exponential increase and slow start
  - time out
  - fast retransmit

(b) Calculate the number of packet arrivals, packet drops and throughput,

\[
\text{throughput} = \frac{\#\text{packet arrivals} - \#\text{packet drops}}{\text{simulation time}},
\]

for each option. Discuss the reasons and consequences. Which throughput is the best and why?

Target: The student understands the basic mechanisms of TCP congestion control.

2. Simulate a network that has an bottleneck link with 24 competing TCP connections. There are three sending nodes, each connected with 100 Mbit/s, 100 ms link to the bottleneck link (40 Mbit/s, 50 ms). Each node has eight senders with combinations of congestion control (TCP Tahoe or Forward Ack), segment size (500 or 1500 bytes), and maximum window size (20 or 1000 packets). Run a long simulation (1200 seconds simulated time) and estimate the numbers of packet drops and throughput for all connections. Compare results: did flows with similar settings receive similar throughput, i.e. what was fairness. What was the effect of different parameters to throughput?

Target: The student understands what TCP parameters do have an effect on application throughput and concept of fairness.