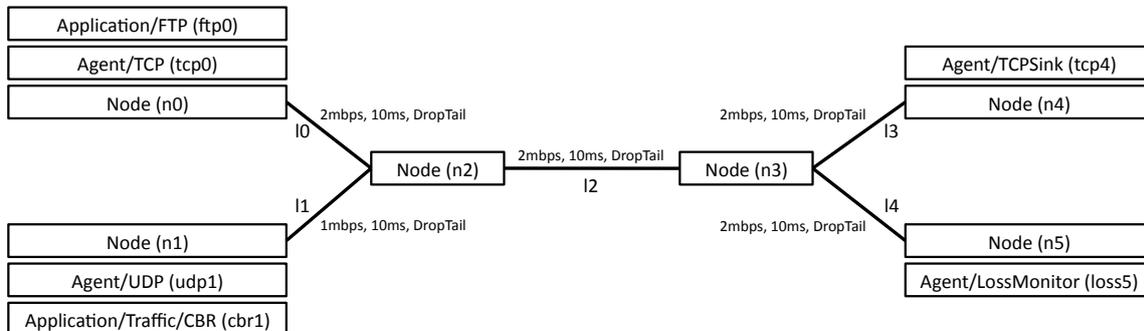


### Problem Sheet #5

#### Problem 5.1: ns2 simulations and result analysis

(2+3+3+2 = 10 points)



- a) Write a NS2 simulation script that generates the topology shown above, attaches agents, connects the agents and configures the traffic sources. The CBR traffic source should generate  $1kB$  packets with a rate of  $1.5mbps$ . The FTP traffic source should start transmitting at  $t = 1s$  and terminate at  $t = 29s$ , while the CBR traffic source should start at  $t = 0.5s$  and terminate at  $t = 29.5s$ . The entire simulation should stop at  $t = 30.5s$ . The TCP endpoints should use the New Reno congestion control algorithm (see RFC 6582).

Color the two traffic flows (TCP red, UDP blue). Orient the links so that `nam` generates the topology layout as shown above. Observe the queues attached to link `l2` and `l4` and set the capacities of the queues to 10 packets. Look at the result in the `nam` network animator.

- b) Modify the script written for the previous step to generate a trace file that contains the rate at which data is arriving at the `Agent/TCPSink (tcp4)` and the congestion window of `Agent/TCP (tcp0)` at an interval of every  $0.2s$ . Plot the data (e.g., using `gnuplot`). How does the data rate relate to the size of the congestion window? (The current congestion window is stored in the property `cwnd_` of a TCP agent while the number of received bytes is stored in the property `bytes_` of a TCP agent.)
- c) Add two more nodes (`n6` and `n7`). Attach them similar to nodes `n0` and `n4` and run another FTP traffic source over TCP from `n6` to `n7`. This second FTP flow starts at  $t = 10s$  and ends at  $t = 20s$ . Plot the two congestion window for both TCP flows. How long does it (roughly) take from the start of the second TCP flow until both flows share the capacity available to TCP flows? After the second flow stops, how long does it (roughly) take until the first flow again runs at the capacity available to TCP flows?
- d) Summarize the differences between the Tahoe congestion control algorithm and the New Reno congestion control algorithm. Using the simulation model from the previous step, change the TCP congestion control algorithm of the second TCP flow to Tahoe. Do the two TCP flows still share the capacity available to them fairly?

**Solution:**