

# Network Simulation with ns/2: report

Maarten Tegelaers      Thomas Vochten

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## Abstract

This report describes the use of the ns/2 network event simulator to simulate the behaviour of simple network topologies. Two topology situations are considered. For the first situation, the focus lies on an FTP application competing for bandwidth with a CBR application. In the second situation, we investigate the evolution of the congestion window size during the execution of the TCP algorithm in detail; an FTP application is running continuously while a web user on the same LAN as the FTP application generates short intense bursts of traffic. We also compare congestion window size behaviour between the Tahoe implementation of TCP and the Reno implementation of TCP.

## 1 Exercise 1: Bandwidth restrictions on KotNet

## 2 Exercise 2: Tahoe and Reno versus bursty web traffic

1. Investigate the throughput of the main FTP application. Can you indicate the effects the individual bursts of web traffic have on its total throughput? Why do these effects not immediately become visible when each burst starts (i.e. at 5, 10 , or resp. 15 seconds)?

Figure 1 shows the throughput of the main FTP application. We can see that the throughput rises rapidly at the start before hitting the bandwidth limit within the first 700 milliseconds. Thereafter, it remains at 1.25 megabytes/s. When the first burst begins at 5 seconds, we see a drop to 800 kilobytes/s as the first TCP connection for the web user starts, but the throughput can still climb to one megabytes/s. It is only after 700 milliseconds that the throughput decreases dramatically. When the burst starts, new connections between the web user and the web server are opened within about 0.05 milliseconds. These connections first go through the slow start phase of TCP, which means it takes some time before each connection attains a throughput that could affect existing connections. Soon, the 10 megabytes/s bandwidth limit cannot support high throughputs for each active connection, which means the main FTP connection experiences packet loss. This triggers congestion avoidance for the main

FTP application and it sets its congestion window to 1 kilobyte, after which it must go through slow start again.

After about 8 seconds, the main FTP application has to contend with increasingly fewer connections from the web user, which allows the throughput to climb steadily. A new burst starts at 10 seconds, and this time the effects manifest themselves after 300 milliseconds. This is again explained by connections being opened one after another and each connection gradually increasing its throughput.

Right before the third burst, the FTP application cuts its throughput because of congestion. The throughput is allowed to climb until 15.7 seconds, when the new burst first has an impact. From 17 seconds on, more and more web connections finish their work, allowing the FTP application to steadily increase its throughput to the highest allowed bandwidth across the network.

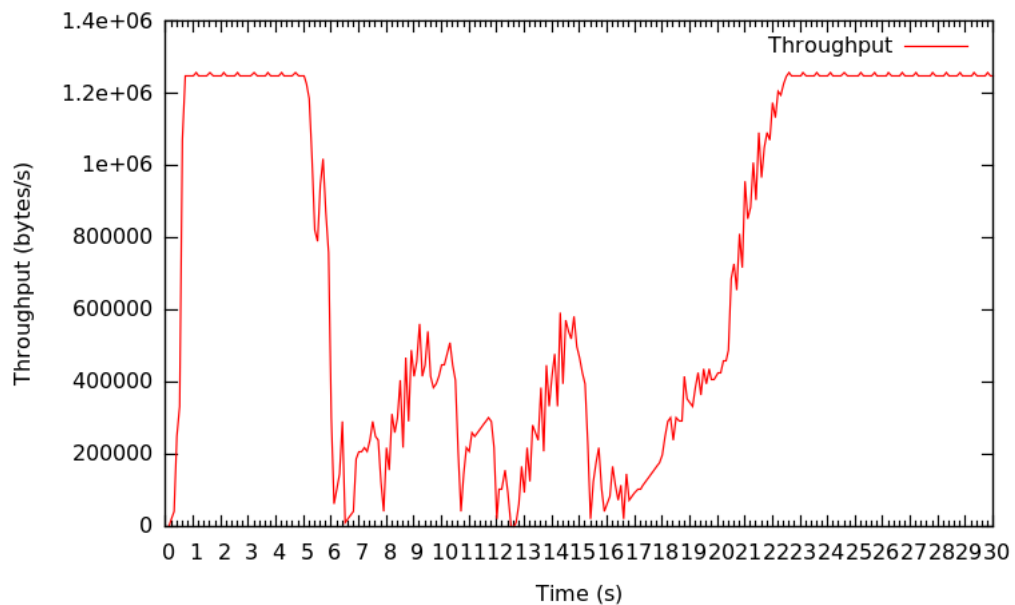


Figure 1: The throughput of the continuously running FTP application. Ticks are drawn every 200 milliseconds.

2. Plot the congestion window size and slow start thresholds in another graph. Can you identify the different phases of the TCP algorithm? When is the slow start threshold recalculated and how?

Figure 2 shows the congestion window sizes and the slow start thresholds for the main FTP application. To start off, the threshold is set to 80 packets and the congestion window to 1 packet. Each time the sender

receives an acknowledgement, the congestion window is set to  $\min(2 \cdot \text{window size}, \text{threshold})$ . This is the slow start phase. Once the threshold has been reached, the window size increases linearly. This is the additive increase phase. At about 5.76 seconds, the FTP application experiences a packet loss, which causes the window size to drop to one packet. The slow start threshold is set to  $\max(2, \frac{\text{threshold}}{2})$

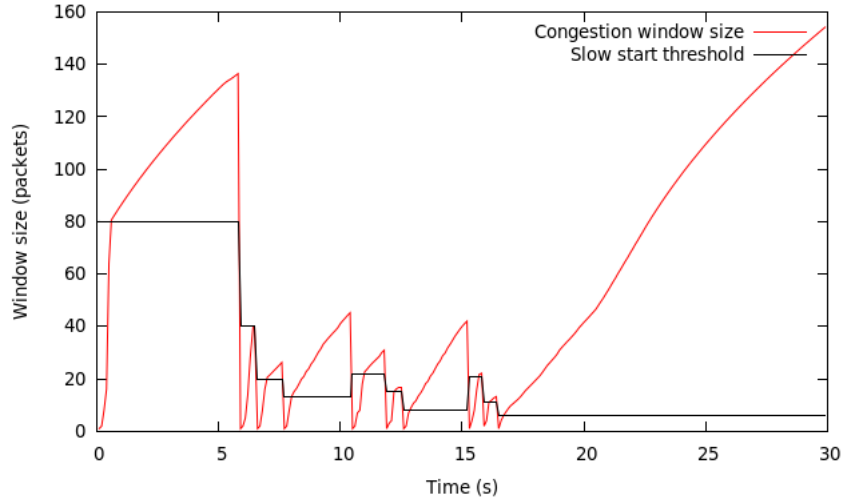


Figure 2: The congestion window sizes and slow start thresholds for the main FTP application running TCP Tahoe.