Matt Wong
CN

Project 3 Analysis

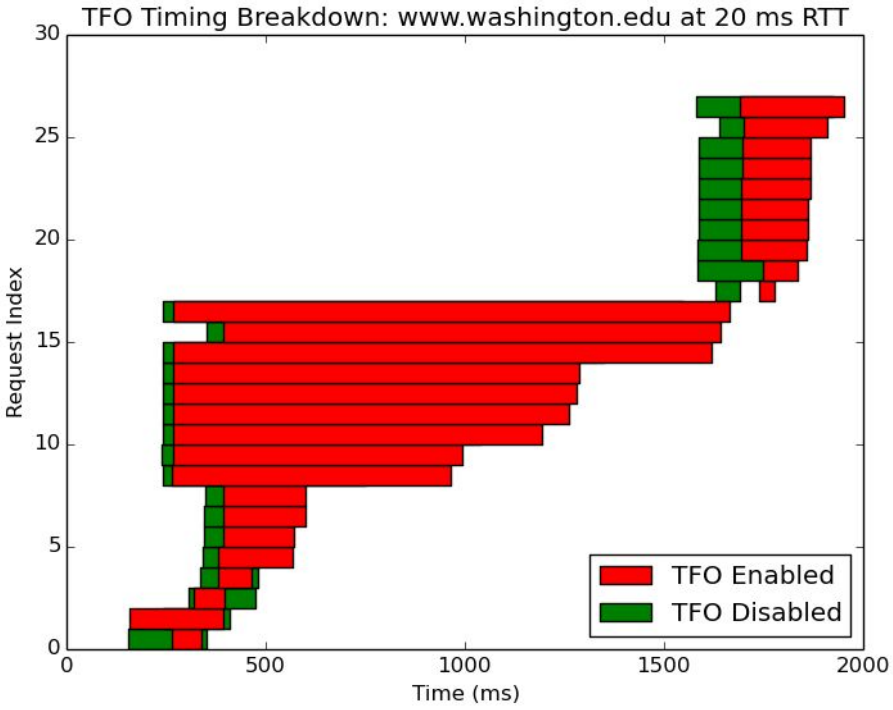
For this project, I tested the performance gains achieved by TCP Fast-Open (TFO), versus standard TCP (without TFO), measured in terms of page load time (PLT). Each site, http://www.washington.edu, http://www.gnu.org, and http://www.baidu.com have page load times, for 3 unique round trip times, or RTTs. The percentage improvement in terms of PLT was also calculated in the last column. This test mimics the test done in the TCP Fast Open experiment done at Google, and acts as an extension of their work implemented in Mininet with Mininet hosts used as web servers hosting mirrored content.

Page	RTT(ms)	PLT: no TFO (s)	PLT: TFO (s)	Improv.
httpwww.washington.edu				
	200	33111.504	5463.237	83.5004867191
	100	13161.234	3470.019	73.6345467302
	20	1926.913	1950.203	1.20866899543
httpwww.gnu.org				
	200	3230.009	2093.729	35.1788493469
	100	1968.679	1660.592	15.6494278651
	20	1323.354	1201.537	9.20517110312
httpwww.baidu.com				
	200	8135.723	5871.38	27.8321053949
	100	4976.641	4112.119	17.3715966251
	20	2967.532	2689.707	9.36215683605

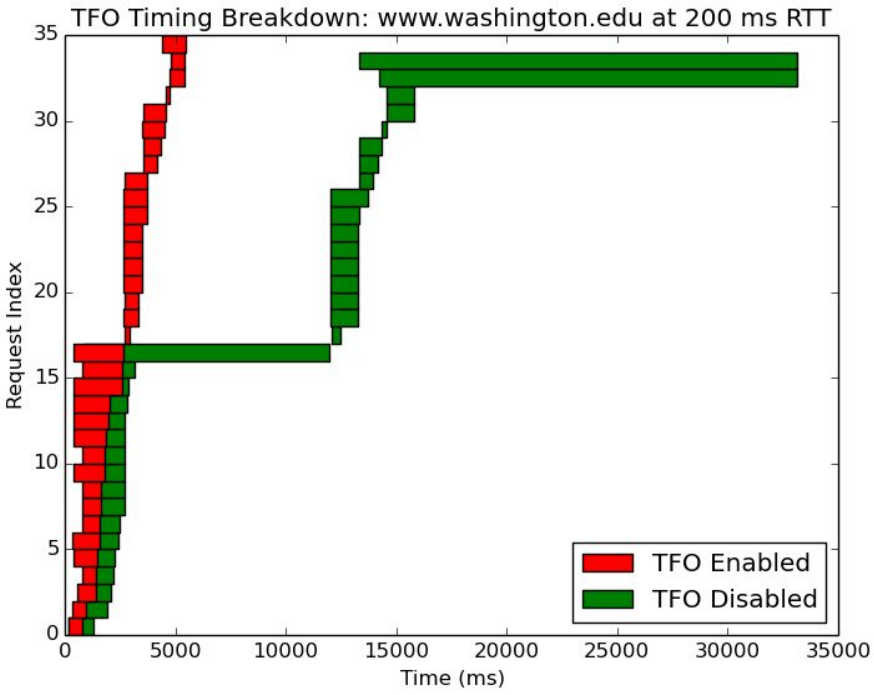
Figure 1. PLTs and percentage improvement with TFO vs no TFO in seconds for 3 web pages.

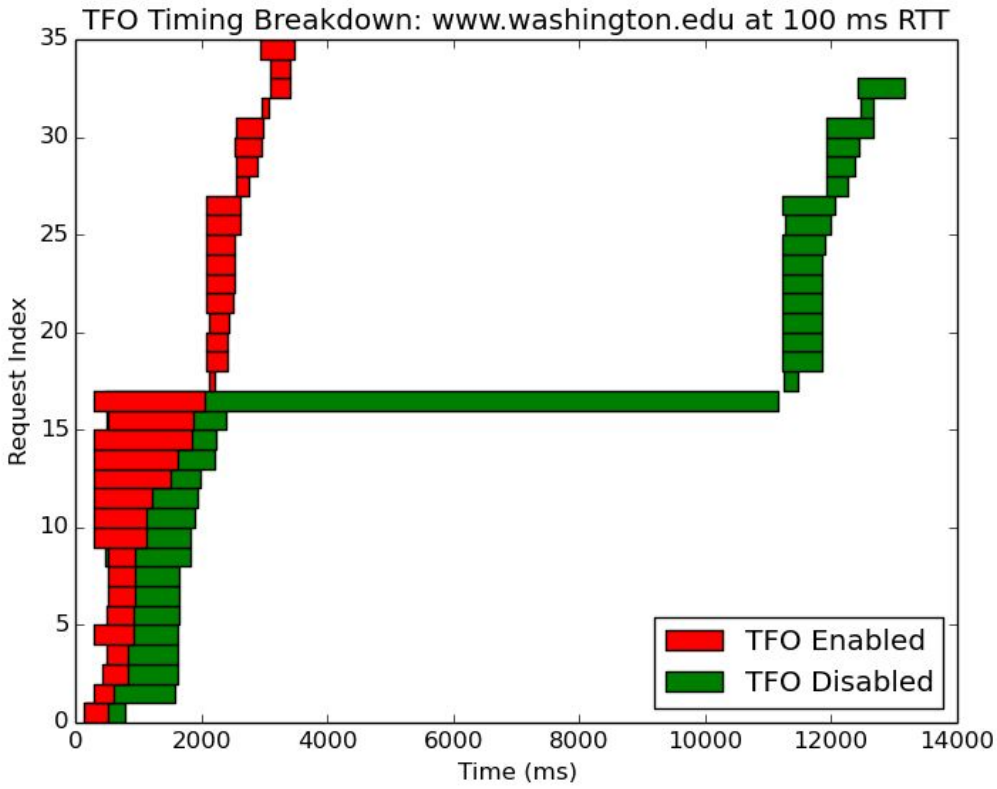
Analysis of http://www.washington.edu

1. TFO significantly improves the PLT for the site.
2. PLT improves greatly with larger RTT delays, and less so with smaller RTT delays.
3. The content is very simple, so the site will spend most of its time waiting for network transfers rather than actually processing content, so this lends itself greatly to PLT improvements, particularly when there are larger RTT delays.
4. I am surprised that the performance improvements are so significant, but not surprised that this site benefits the most.


TFO Timing Breakdown: www.washington.edu at 20 ms RTT
Request Index
Time (ms)
TFO Enabled
TFO Disabled
0
5
10
15
20
25
30
0
500
1000
1500
2000

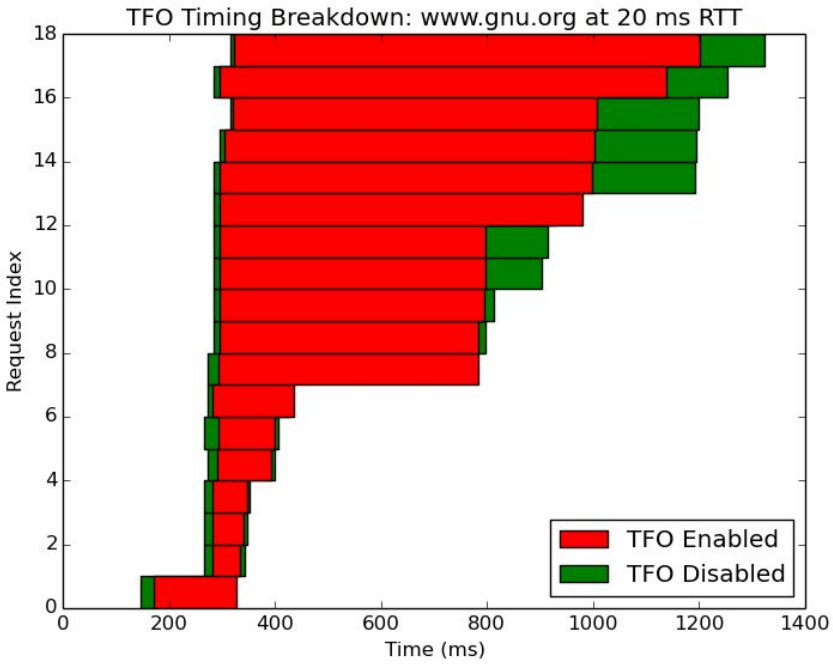
5.

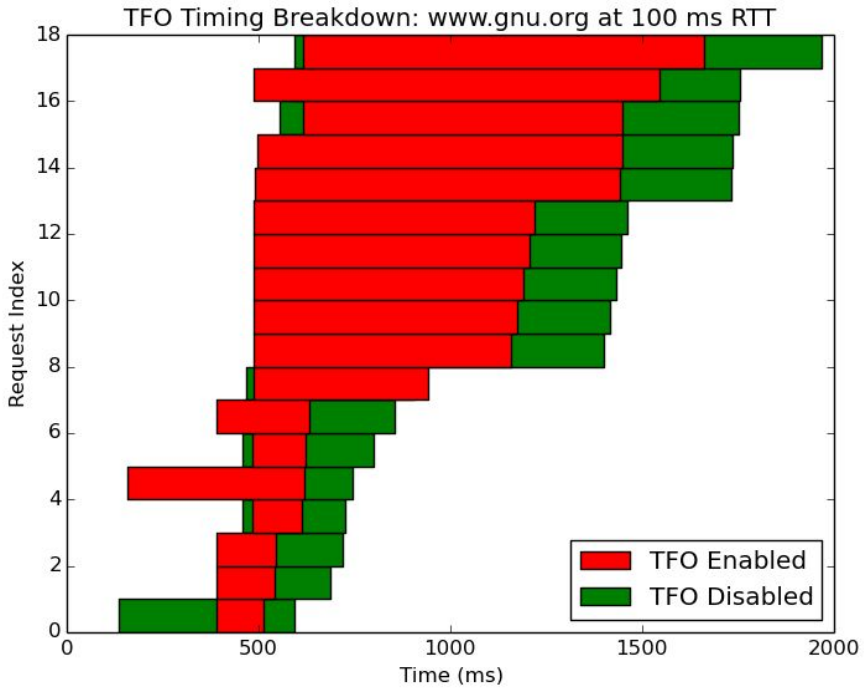

TFO Timing Breakdown: www.washington.edu at 200 ms RTT
Request Index
Time (ms)
TFO Enabled
TFO Disabled
0
5
10
15
20
25
30
35
0
5000
10000
15000
20000
25000
30000
35000

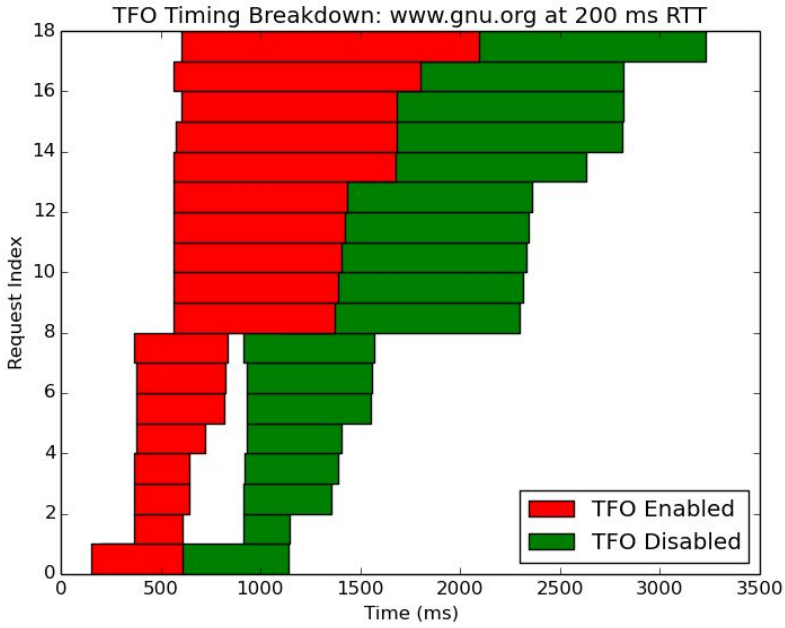


Analysis of http://www.gnu.org

1. TFO also improves the PLT for the site when compared with standard TCP.
2. PLT improves greatly across all RTTs, including low RTTs.
3. The content on the GNU site is even more simple than that of the Washington university website, and thus lends itself to larger latencies due to network transfers.
4. I am not surprised by these results in any way.
5.

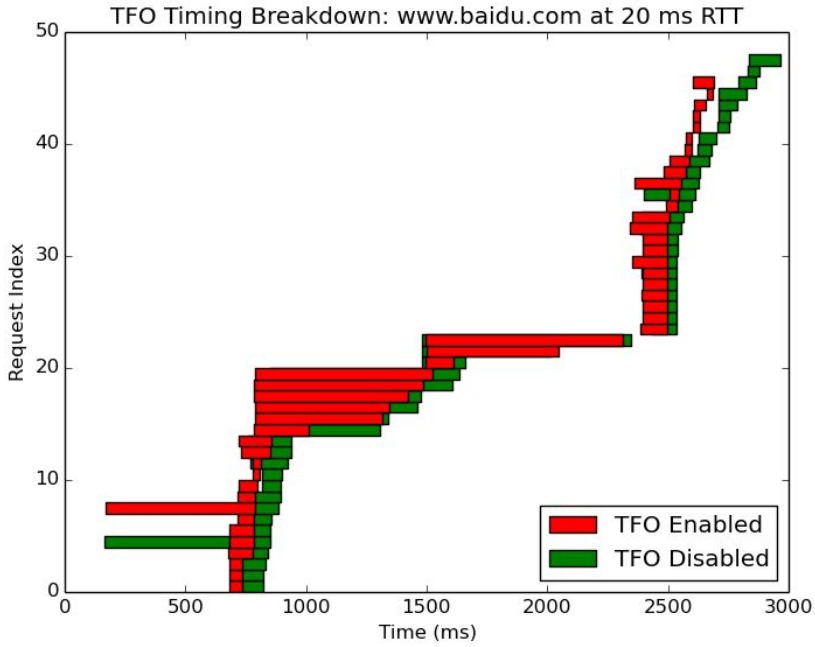

TFO Timing Breakdown: www.gnu.org at 20 ms RTT
Request Index
Time (ms)
TFO Enabled
TFO Disabled
0
2
4
6
8
10
12
14
16
18
0
200
400
600
800
1000
1200
1400

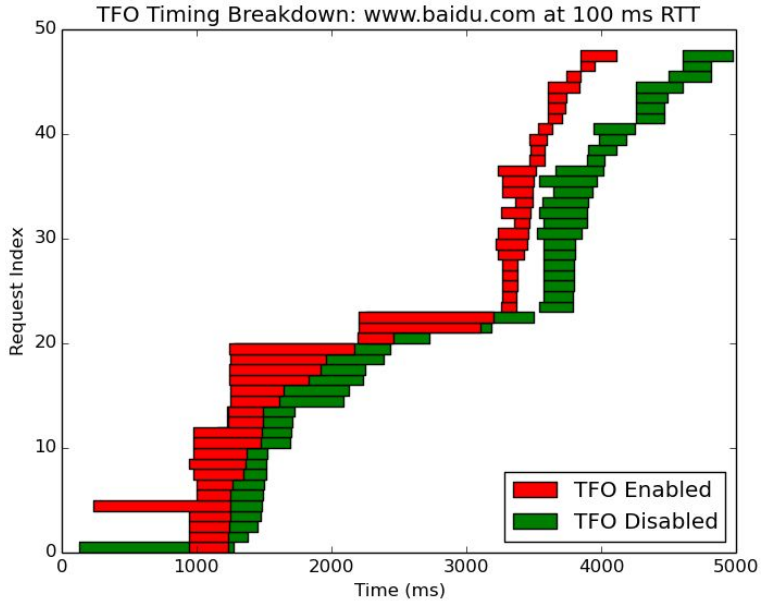

TFO Timing Breakdown: www.gnu.org at 100 ms RTT
Request Index
Time (ms)
TFO Enabled
TFO Disabled
0
2
4
6
8
10
12
14
16
18
0
500
1000
1500
2000

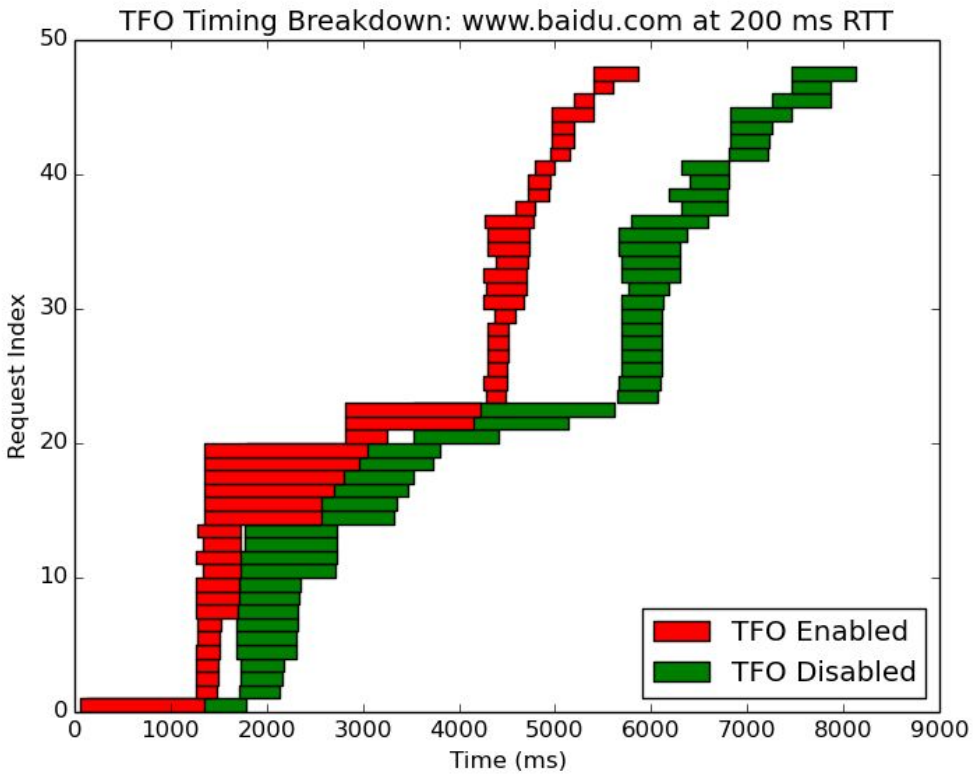


Analysis of http://www.baidu.com

1. TFO improves overall PLT for all RTTs.
2. PLT improves greatly across all RTTs, including low RTTs, but especially for higher RTTs.
3. The content on the Baidu site contains a lot of Javascript, and functions as a search engine in China, among many other things. Because of this, the performance gains realized by TFO are less than the other sites, since the resource processing time is higher relative to the network transferring time. Nonetheless, this PLT for the site is improved across all RTTs.
4. I am not surprised by these results in any way.
5.


TFO Timing Breakdown: www.baidu.com at 20 ms RTT
Request Index
Time (ms)
TFO Enabled
TFO Disabled
0
10
20
30
40
50
0
500
1000
1500
2000
2500
3000


TFO Timing Breakdown: www.baidu.com at 100 ms RTT
Request Index
Time (ms)
TFO Enabled
TFO Disabled
0
10
20
30
40
50
0
1000
2000
3000
4000
5000



Conclusions

As a result of both reading the research done on TFO, as well as performing this experiment, it is clear that TFO has had large benefits in the field of computer networking, and has ultimately improved the usability of the internet as a whole. Despite the mentioned threats regarding DDos and reflection attacks, the creators of TFO had made significant improvements which ultimately lead to its adoption in the Linux kernel.

Based on my results, it is clear that TFO has a significant impact on PLT for all sites, with higher performance impacts on sites that are network transfer intensive. Out of the three sites tested in this experiment, the Washington website was without question the site that enjoyed the largest benefit in PLT, especially under larger RTTs. Sites like this which have latencies due to network transfer times as opposed to time spent on processing content benefit the most. Contrastingly, there exists less of a benefit for sites that spend more time on processing content from various sources, such as Baidu. Baidu has a significantly larger number of request indexes relative to the other two, and this processing of content is the limiting factor in PLT, making it the site that benefits the least from TFO.