Project 4 TFO Analysis by Neeraj Sharma

11.a. Experimental Data

Page	RTT(ms)	PLT: no TFO (s)	PLT: TFO (s)	Improv.
httpcanvas.gatech.edu				
	200	21767.503	7189.723	66.970382409
	100	6521.361	6060.282	7.07028793529
	20	5666.495	5570.373	1.69632197681
httpmedia.mit.edu				
	200	7876.896	6923.645	12.1018609361
	100	4136.435	3875.448	6.30946696854
	20	2102.926	1945.137	7.5033072966
httpwww.sjsu.edu				
	200	3707.772	2393.448	35.4478107068
	100	2392.856	1624.249	32.1209048936
	20	1475.634	1377.327	6.66201781743

The above table shows the average Page Load Time (PLT) in seconds for three pages. PLT's are calculated based on emulated Round Trip Time (RTT) in milliseconds of 20, 100, 200 ms for each page and samples are collected for **TFO Enabled** and **TFO Not Enabled** interactions. Finally, percentage of PLT improvement is calculated indicating how TFO helps reduce PLT for different servers.

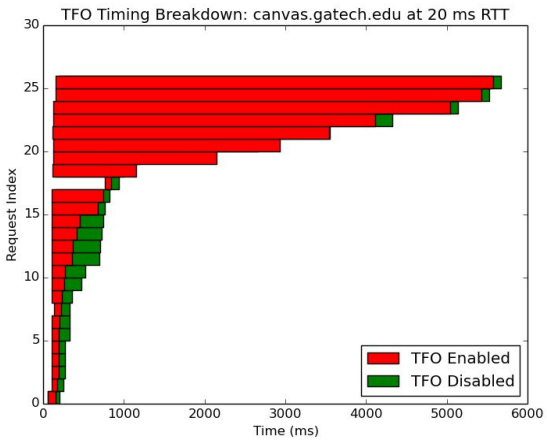
11.b.i. It is evident from the table above that TFO improves the PLT for all pages, i.e. TFO helps reduce the page load time.

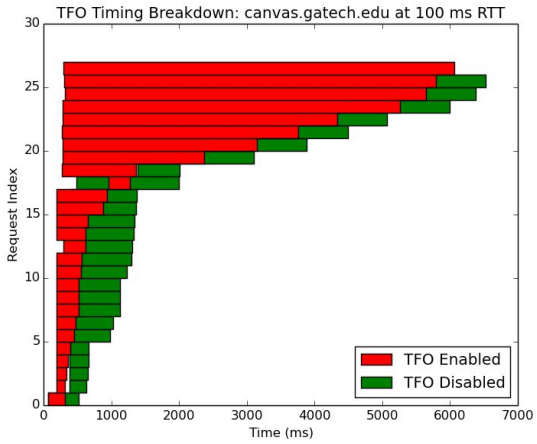
11.b.ii. Higher RTT values observe higher improvements in TFO Enabled page loads. This is because TFO saves one RTT delay and most of these websites, being content heavy, have multiple resources to be loaded. Thus, saving one RTT in case RTT is 20ms is a minor improvement, but saving one RTT in case RTT is 200 ms is a major improvement in overall PLT. It should also be noted that different resources of a page are spread across different subdomains, which means TFO might save one RTT in every resource loaded, which improves overall PLT which needs multiple resources to be loaded.

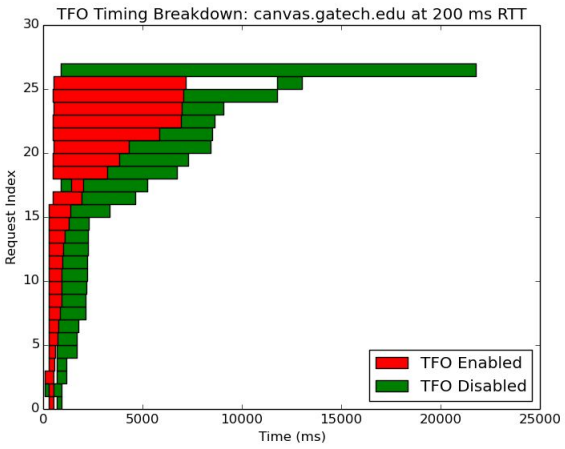
11.b.iii. Content on the pages certainly affect the amount of improvement seen with TFO. A page comprises of multiple resources and these resources are also spread across different subdomains. This means that TFO saves one RTT for every resource loaded, which improves the overall PLT when multiple resources are loaded for a page. Light content websites might see more improvements because page load for such websites mostly comprises of waiting on network transmissions and saving one RTT could significantly reduce this wait and hence the PLT.

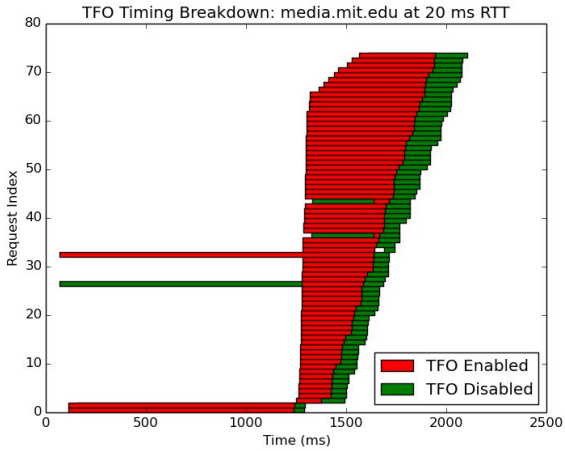
11.b.iv. One unordinary observation is that for mit.edu, 100ms dropped the improvement in PLT. This could be attributed to SSL errors observed in the logs, and in general, PLT did improve the page load time but because this site is content heavy, a small RTT did not see a big increase. Another unordinary observation is that for gatech.edu PLT time, we see a surprisingly huge improvement in PLT of 66% for 200ms RTT, compared to lower RTT's. This is most likely because the page is loading multiple resources and saving a large RTT for every resource load adds up to significantly larger improvement.

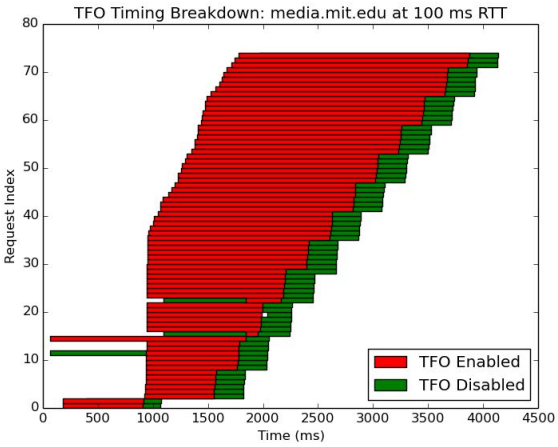
11.b.v. Images

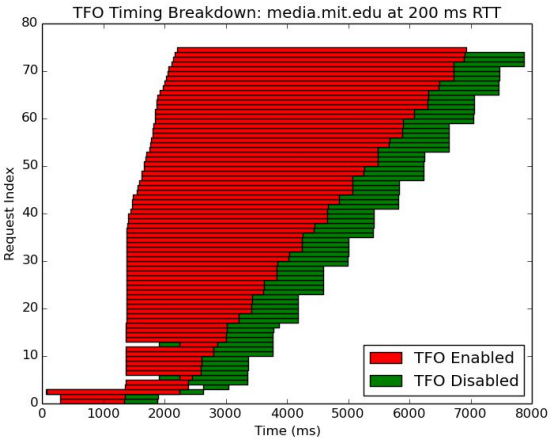


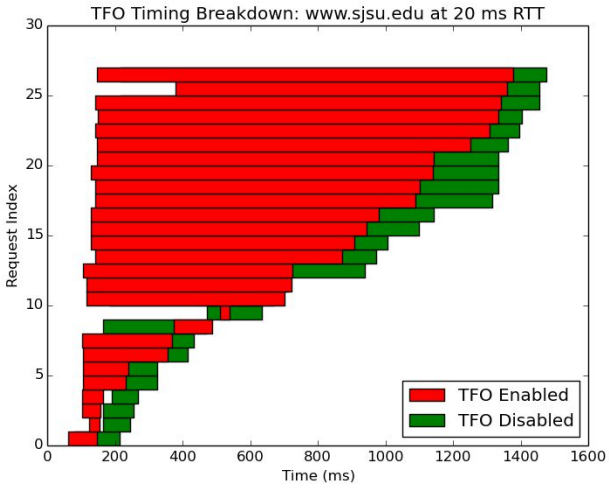


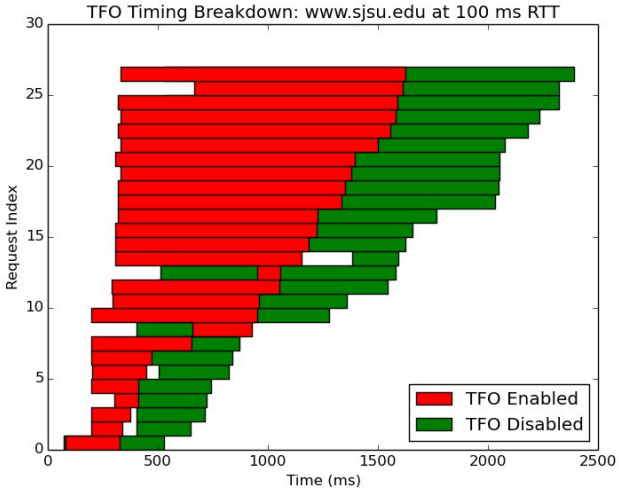

TFO Timing Breakdown: canvas.gatech.edu at 200 ms RTT
Request Index
Time (ms)
TFO Enabled
TFO Disabled

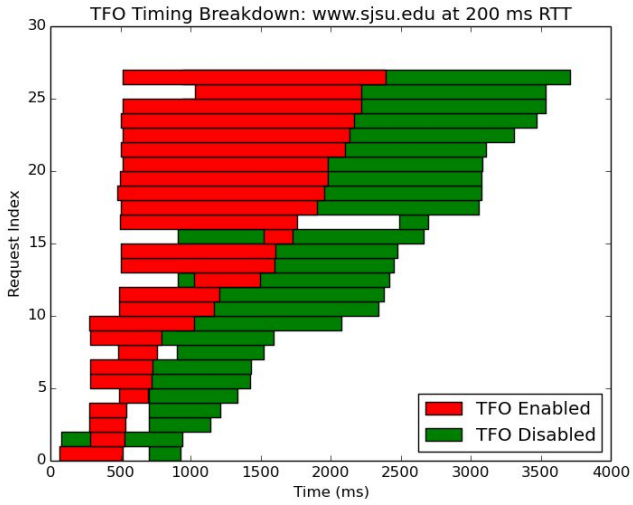

TFO Timing Breakdown: media.mit.edu at 20 ms RTT
Request Index
Time (ms)
TFO Enabled
TFO Disabled


TFO Timing Breakdown: media.mit.edu at 100 ms RTT
Request Index
Time (ms)
TFO Enabled
TFO Disabled


TFO Timing Breakdown: media.mit.edu at 200 ms RTT
Request Index
Time (ms)
TFO Enabled
TFO Disabled







11.c. Observations from the experiments reveal that for gatech.edu domain, emulated RTT of 200ms saw a significant improvement of 66%, while the improvement with lower emulated RTT was significantly small. The improvement for mit.edu domain was on average less than ten percent. Compared to canvas.gatech.edu domain, which made 63 requests and downloaded 63.1 KB of data, media.mit.edu was more content heavy, which made 82 requests and downloaded 189 KB of data. More requests made mean slightly lower improvement, because TFO saves one RTT initially but if the connection is reused for multiple http requests, TFO does not have any effect and the connection continues as normal TCP connection. Out of all three pages, sjsu.edu is the most light content, which made only 32 requests and downloaded only 11.4 KB of data. Given the data loaded, sjsu.edu domain observed a significant improvement in page load time, 35% of improvement. It is pretty evident from results of the experiments that TFO does improve overall performance for applications which include short-transfers, tend to use more cold

requests, have multiple resources to be loaded at the same time from different subdomains. From the observations, gatech.edu and sjsu.edu saw larger improvements in comparison. It can also be seen from the size of improvements that pages warranting for long-transfers or for large downloads (multiple requests on same subdomain) might see a smaller improvement in PLT. From the observations, media.mit.edu saw a small improvement in comparison.

11.d. Based on the observations, I see TFO having best potential for improvement for websites having short-transfers, loading resources from multiple subdomains, using more cold requests and downloading light content. I see TFO having potentially less impact for websites having long-transfers, downloading heavy content (multiple requests on same domain) and using lot of warm requests.