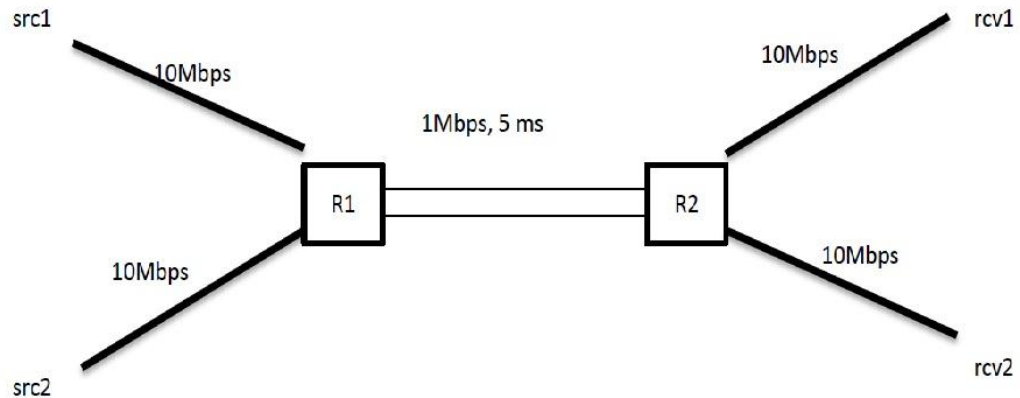


Network Simulator Assignment No 1

1)

Set up: There are two routers , 2 source and 2 receivers sending ftp packets over TCP SACK and TCP Vegas :



We created links between these nodes as per the different cases

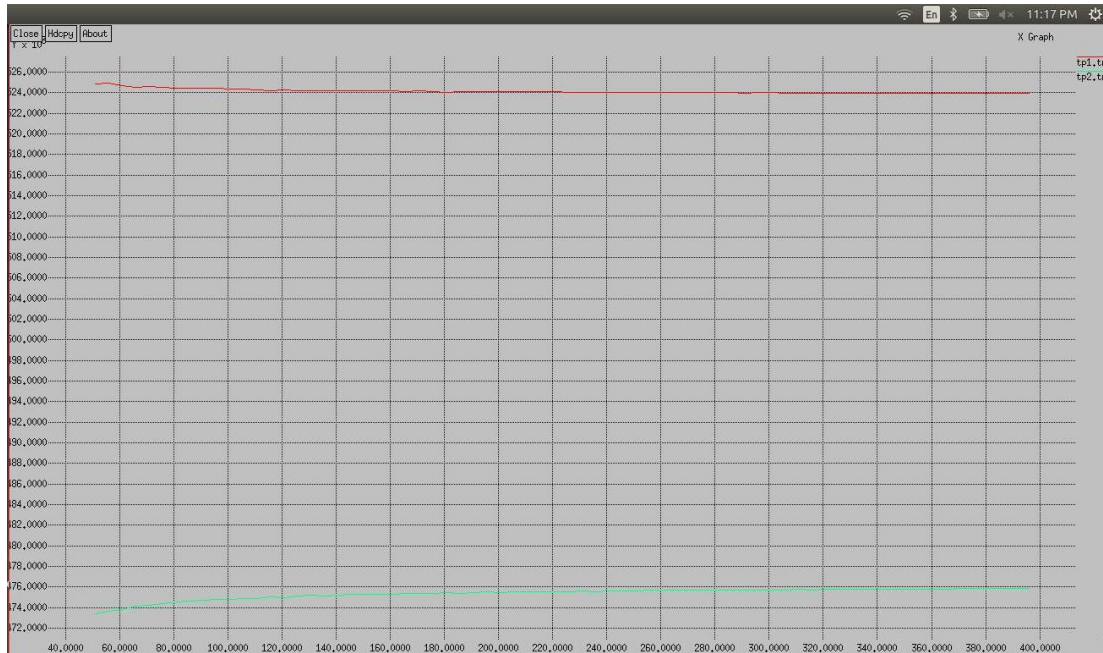
- Case 1:
 - src1-R1 and R2-rcv1 end-2-end delay = 5 ms
 - src2-R1 and R2-rcv2 end-2-end delay = 12.5 ms
- Case 2:
 - src1-R1 and R2-rcv1 end-2-end delay = 5 ms
 - src2-R1 and R2-rcv2 end-2-end delay = 20 ms
- Case 3:
 - src1-R1 and R2-rcv1 end-2-end delay = 5 ms
 - src2-R1 and R2-rcv2 end-2-end delay = 27.5 ms

Created 2 TCP agent over the Source 1 and Source 2 and attached to the sources using “attach-agent”. Created a FTP application for each sources and attached the application to the TCP agents of each sources respectively. Then using the input from the command prompt executed two different flavours of TCP-TCP Vegas and Sack (selectively acknowledgement) to calculate the throughputs of ftp packets transmission from source to receiver.

Simulation result of TCP SACK for 3 cases:

Case 1:

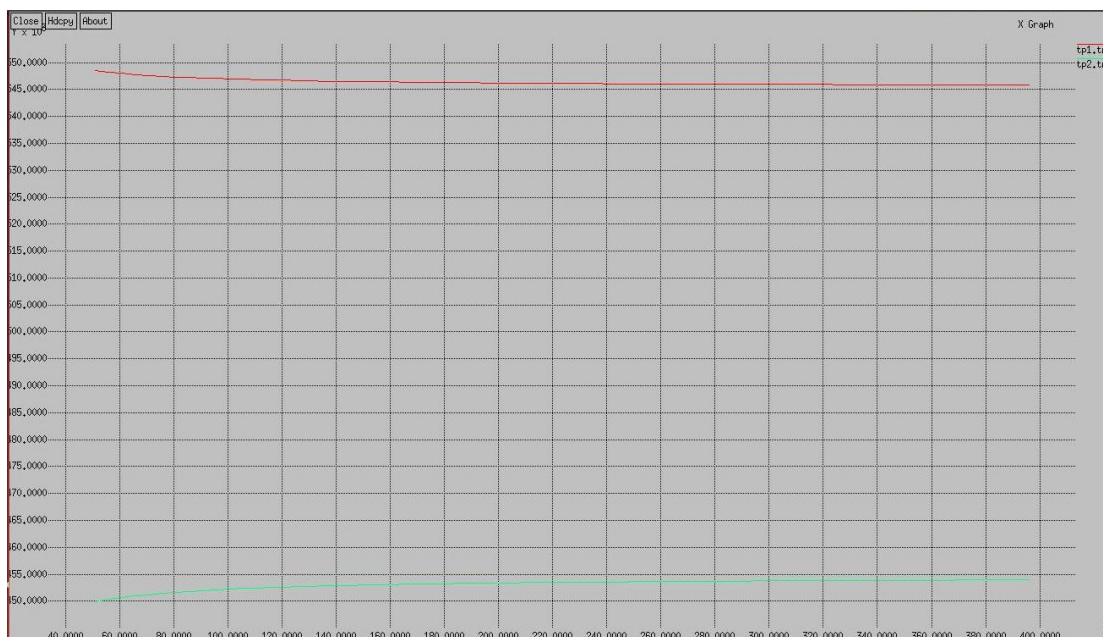
The Xgraph plot for throughput vs time



Throughput of the TCP SACK for case 1 and the source 1 comes out to be around : 523971 bps Throughput of the TCP SACK for case 1 and the source 2 comes out to be around : 475837 bps Throughput = (Total bytes received)* 8 / (total time)this graph shows the cumulative average of the throughput at every time...so the average throughput will be the result of the last timestamp.

Ratio of the throughputs for source 1 to source 2 is 1.1

Case 2:



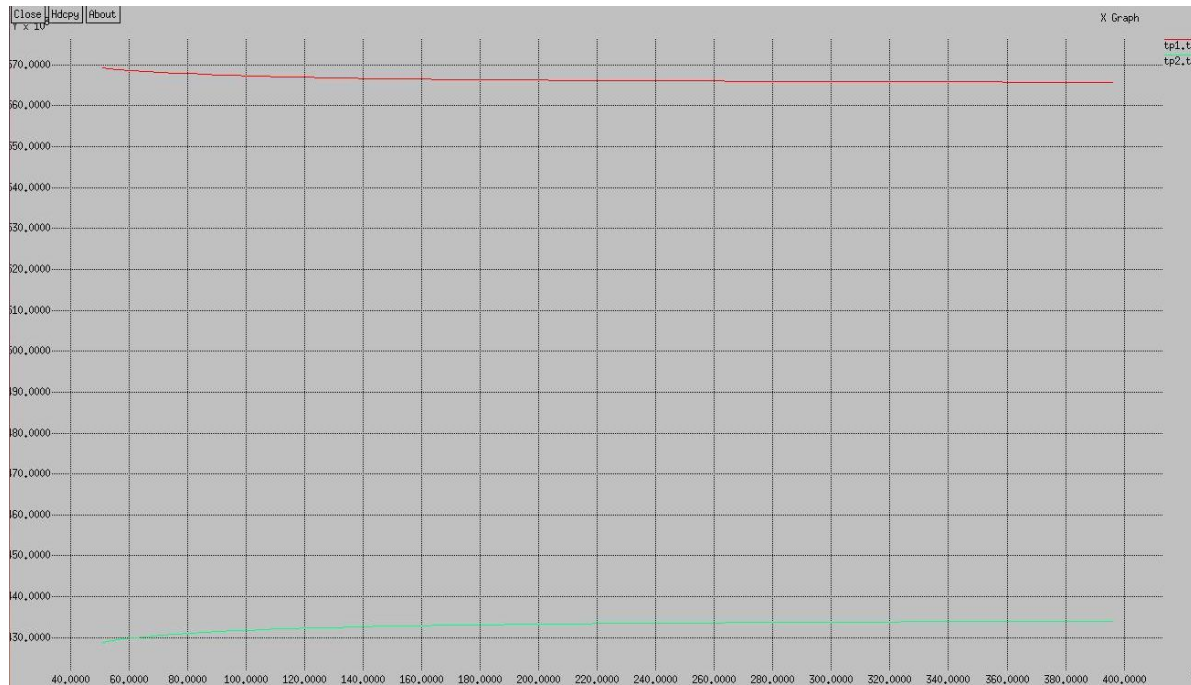
Throughput of the TCP SACK for case 2 and the source 1 comes out to be around : 545843 bps

Throughput of the TCP SACK for case 2 and the source 2 comes out to be around : 453945 bps

Throughput = (Total bytes received)* 8 / (total time)this graph shows the cumulative average of the throughput at every time...so the average throughput will be the result of the last timestamp.

Ratio of the throughputs for source 1 to source 2 is 1.2

Case3



Throughput of the TCP SACK for case 3 and the source 1 comes out to be around : 565739 bps

Throughput of the TCP SACK for case 3 and the source 2 comes out to be around : 434027 bps

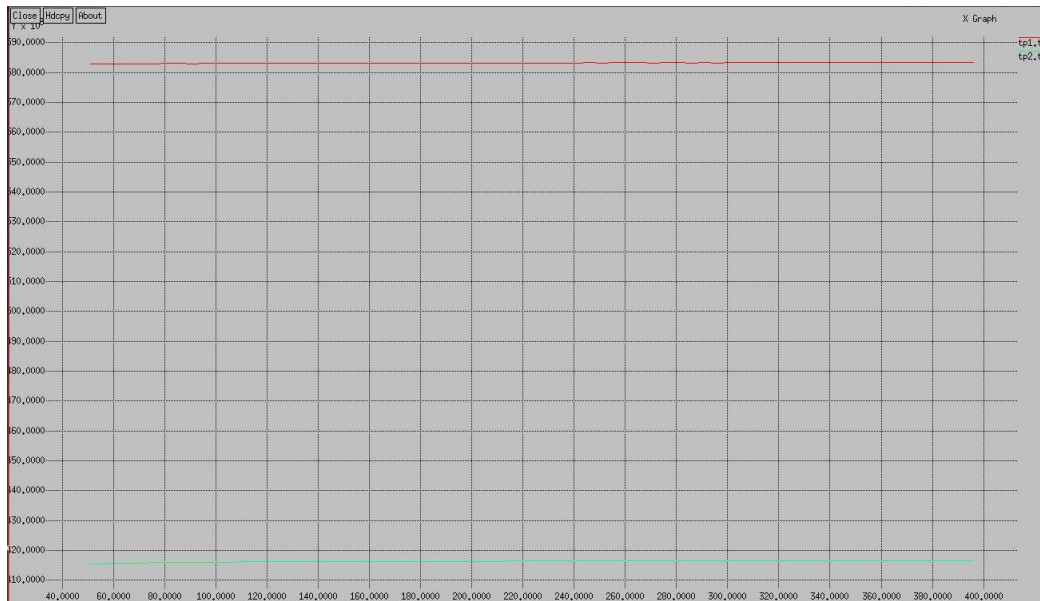
Throughput = (Total bytes received)* 8 / (total time)this graph shows the cumulative average of the throughput at every time...so the average throughput will be the result of the last timestamp.

Ratio of the throughputs for source 1 to source 2 is 1.3

Serial No.	Src1->Rec1	Src2->Rec1	Ratio of throughput
Case 1	523971	475837	1.1
Case 2	545843	453945	1.2
Case 3	565739	434027	1.3

2) Simulation result of TCP VEGAS for 3 cases:

Case 1:



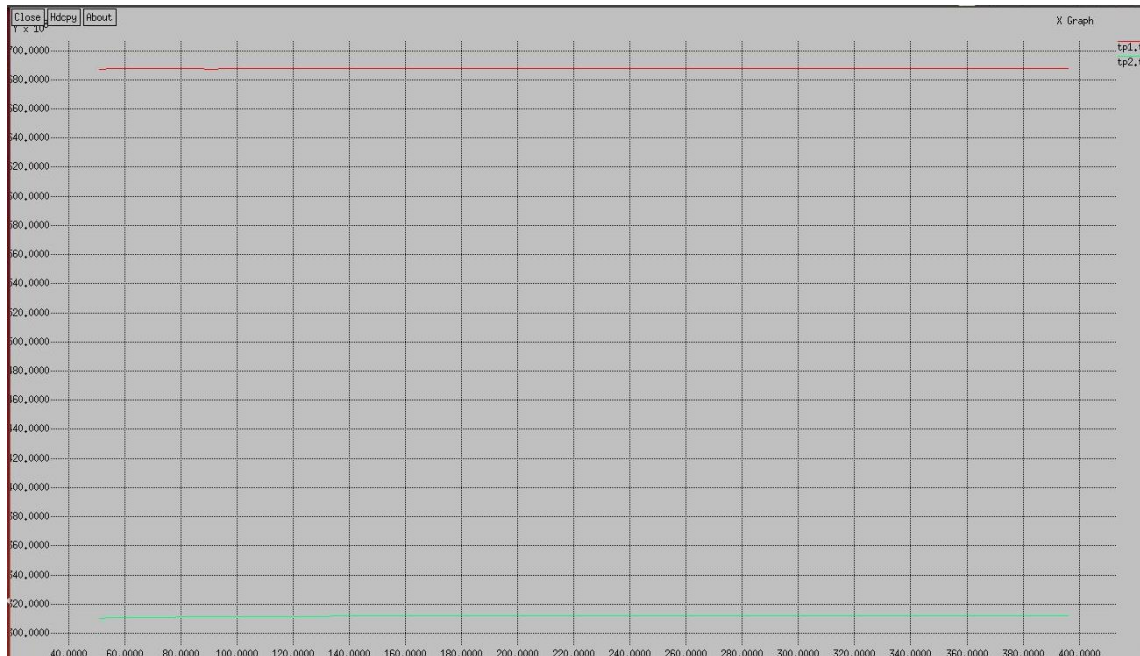
Throughput of the TCP VEGAS for case 1 and the source 1 comes out to be around : 583252 bps

Throughput of the TCP VEGAS for case 1 and the source 2 comes out to be around : 416525 bps

Throughput = (Total bytes received)* 8 / (total time)this graph shows the cumulative average of the throughput at every time...so the average throughput will be the result of the last timestamp.

Ratio of the throughputs for source 1 to source 2 is 1.4

Case 2:



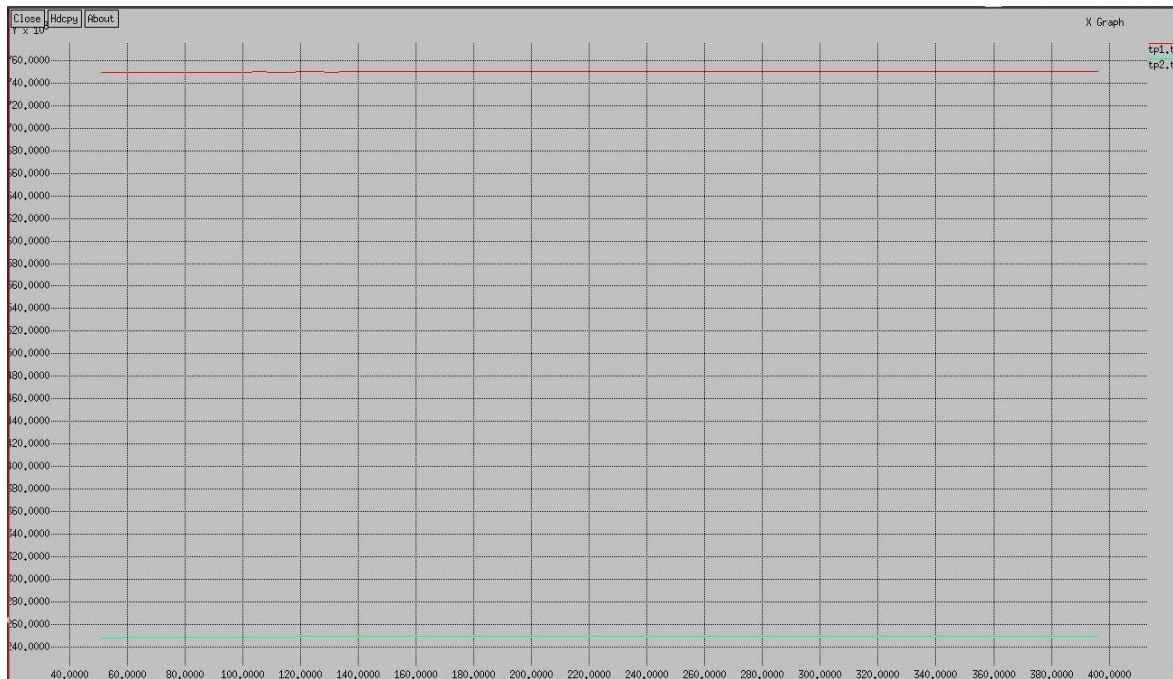
Throughput of the TCP VEGAS for case 2 and the source 1 comes out to be around : 687494 bps

Throughput of the TCP VEGAS for case 2 and the source 2 comes out to be around : 312222 bps

Throughput = (Total bytes received)* 8 / (total time)this graph shows the cumulative average of the throughput at every time...so the average throughput will be the result of the last timestamp.

Ratio of the throughputs for source 1 to source 2 is 2.2

Case3:



Throughput of the TCP VEGAS for case 3 and the source 1 comes out to be around : 749939bps

Throughput of the TCP VEGAS for case 3 and the source 2 comes out to be around : 249777 bps

Throughput = (Total bytes received)* 8 / (total time)this graph shows the cumulative average of the throughput at every time...so the average throughput will be the result of the last timestamp.

Ratio of the throughputs for source 1 to source 2 is 3.0

Serial No.	Src1->Rec1	Src2->Rec1	Ratio of throughput
Case 1	583252	416525	1.1
Case 2	687494	312222	2.2
Case 3	749939	249777	3.0

Conclusion deduced from the results:

As the delay between the Routers and the source 2 and destination 2 increased for cases 2 and cases 3, the TCP VEGAS throughput reduces from 416125bps to 312222 bps and 249777 bps. But in case of TCP SACK throughput reduces from 475837 bps to 453945 bps and 434027 bps. So we can conclude that the delay has more negative impact for TCP Vegas rather than TCP SACK. Though the overall throughput of TCP Vegas is higher than TCP SACK, SACK outperforms VEGAS in a heavily delay prone channel. But the throughput response of TCP VEGAS is more stable with time compared to TCP SACK.

SACK follows the slow start and fast retransmits like the TCP RENO. The acknowledgement in SACK is done selectively rather than cumulatively. Its detection of multiple lost packets, and re-transmission of more than one lost packet per RTT makes it a better option than TCP Tahoe or RENO.

TCP VEGAS outperforms TCP SACK :

1. In its estimation of impending congestion, and its efficient estimation of congestion by measuring change in throughput rather than only the packet loss. This results in a better utilization of bandwidth and lesser congestion.
2. It is more stable than SACK. The reason for this being that SACK uses packet losses to denote congestion. Sender continually increase sending rate until there is congestion and reduce speed as congestion reduces. This cycle continues and the system keeps on oscillating speed. Vegas flattens out its sending rate at the optimal bandwidth utilization point thus inducing stability.

Modified Slow-start of TCP VEGAS : It differs from SACK during it's slow-start phase. The reason for this modification is that when a connection first starts it has no idea of the available bandwidth and it is possible that during exponential increase it over shoots the bandwidth by a big amount and thus induces congestion. To this end Vegas increases exponentially only every other RTT, between that it calculates the actual sending through put to the expected and when the difference goes above a certain threshold it exits slow start and enters the congestion avoidance phase.

If we analyse the trace files for both the TCP VEGAS and TCP SACK:

TCP VEGAS:	TCP SACK:
+ 0 0 4 tcp 1000 ----- 0 0.0 2.0 0 0	+ 0 0 4 tcp 40 ----- 0 0.0 2.0 0 0
- 0 0 4 tcp 1000 ----- 0 0.0 2.0 0 0	- 0 0 4 tcp 40 ----- 0 0.0 2.0 0 0
+ 0 1 4 tcp 1000 ----- 0 1.0 3.0 0 1	+ 0 1 4 tcp 40 ----- 0 1.0 3.0 0 1
- 0 1 4 tcp 1000 ----- 0 1.0 3.0 0 1	- 0 1 4 tcp 40 ----- 0 1.0 3.0 0 1
r 0.0058 0 4 tcp 1000 ----- 0 0.0 2.0 0 0	r 0.005032 0 4 tcp 40 ----- 0 0.0 2.0 0 0
+ 0.0058 4 5 tcp 1000 ----- 0 0.0 2.0 0 0	+ 0.005032 4 5 tcp 40 ----- 0 0.0 2.0 0 0
- 0.0058 4 5 tcp 1000 ----- 0 0.0 2.0 0 0	- 0.005032 4 5 tcp 40 ----- 0 0.0 2.0 0 0
r 0.0133 1 4 tcp 1000 ----- 0 1.0 3.0 0 1	r 0.010352 4 5 tcp 40 ----- 0 0.0 2.0 0 0
+ 0.0133 4 5 tcp 1000 ----- 0 1.0 3.0 0 1	+ 0.010352 5 2 tcp 40 ----- 0 0.0 2.0 0 0
- 0.0133 4 5 tcp 1000 ----- 0 1.0 3.0 0 1	- 0.010352 5 2 tcp 40 ----- 0 0.0 2.0 0 0
r 0.0188 4 5 tcp 1000 ----- 0 0.0 2.0 0 0	r 0.012532 1 4 tcp 40 ----- 0 1.0 3.0 0 1
+ 0.0188 5 2 tcp 1000 ----- 0 0.0 2.0 0 0	+ 0.012532 4 5 tcp 40 ----- 0 1.0 3.0 0 1
- 0.0188 5 2 tcp 1000 ----- 0 0.0 2.0 0 0	- 0.012532 4 5 tcp 40 ----- 0 1.0 3.0 0 1
r 0.0246 5 2 tcp 1000 ----- 0 0.0 2.0 0 0	r 0.015384 5 2 tcp 40 ----- 0 0.0 2.0 0 0
+ 0.0246 2 5 ack 40 ----- 0 2.0 0.0 0 2	+ 0.015384 2 5 ack 40 ----- 0 2.0 0.0 0 2
- 0.0246 2 5 ack 40 ----- 0 2.0 0.0 0 2	- 0.015384 2 5 ack 40 ----- 0 2.0 0.0 0 2
r 0.0268 4 5 tcp 1000 ----- 0 1.0 3.0 0 1	r 0.017852 4 5 tcp 40 ----- 0 1.0 3.0 0 1
+ 0.0268 5 3 tcp 1000 ----- 0 1.0 3.0 0 1	+ 0.017852 5 3 tcp 40 ----- 0 1.0 3.0 0 1
- 0.0268 5 3 tcp 1000 ----- 0 1.0 3.0 0 1	- 0.017852 5 3 tcp 40 ----- 0 1.0 3.0 0 1
r 0.029632 2 5 ack 40 ----- 0 2.0 0.0 0 2	r 0.020416 2 5 ack 40 ----- 0 2.0 0.0 0 2
+ 0.029632 5 4 ack 40 ----- 0 2.0 0.0 0 2	+ 0.020416 5 4 ack 40 ----- 0 2.0 0.0 0 2
- 0.029632 5 4 ack 40 ----- 0 2.0 0.0 0 2	- 0.020416 5 4 ack 40 ----- 0 2.0 0.0 0 2
r 0.034952 5 4 ack 40 ----- 0 2.0 0.0 0 2	r 0.025736 5 4 ack 40 ----- 0 2.0 0.0 0 2
+ 0.034952 4 0 ack 40 ----- 0 2.0 0.0 0 2	+ 0.025736 4 0 ack 40 ----- 0 2.0 0.0 0 2
- 0.034952 4 0 ack 40 ----- 0 2.0 0.0 0 2	- 0.025736 4 0 ack 40 ----- 0 2.0 0.0 0 2
r 0.039984 4 0 ack 40 ----- 0 2.0 0.0 0 2	r 0.030384 5 3 tcp 40 ----- 0 1.0 3.0 0 1
+ 0.039984 0 4 tcp 1000 ----- 0 0.0 2.0 1 3	+ 0.030384 3 5 ack 40 ----- 0 3.0 1.0 0 3
- 0.039984 0 4 tcp 1000 ----- 0 0.0 2.0 1 3	- 0.030384 3 5 ack 40 ----- 0 3.0 1.0 0 3
r 0.0401 5 3 tcp 1000 ----- 0 1.0 3.0 0 1	r 0.030768 4 0 ack 40 ----- 0 2.0 0.0 0 2

+ 0.0401 3 5 ack 40 ----- 0 3.0 1.0 0 4	+ 0.030768 0 4 tcp 1040 ----- 0 0.0 2.0 1 4
- 0.0401 3 5 ack 40 ----- 0 3.0 1.0 0 4	- 0.030768 0 4 tcp 1040 ----- 0 0.0 2.0 1 4
r 0.045784 0 4 tcp 1000 ----- 0 0.0 2.0 1 3	+ 0.030768 0 4 tcp 1040 ----- 0 0.0 2.0 2 5
+ 0.045784 4 5 tcp 1000 ----- 0 0.0 2.0 1 3	- 0.0316 0 4 tcp 1040 ----- 0 0.0 2.0 2 5
- 0.045784 4 5 tcp 1000 ----- 0 0.0 2.0 1 3	r 0.0366 0 4 tcp 1040 ----- 0 0.0 2.0 1 4
r 0.052632 3 5 ack 40 ----- 0 3.0 1.0 0 4	+ 0.0366 4 5 tcp 1040 ----- 0 0.0 2.0 1 4
+ 0.052632 5 4 ack 40 ----- 0 3.0 1.0 0 4	- 0.0366 4 5 tcp 1040 ----- 0 0.0 2.0 1 4

By looking into the trace files of both the outputs we can see that the modified slow start and slow start of TCP VEGAS and TCP SACK. TCP SACK starts the tcp packets with 40 size but TCP VEGAS started with 1000 packets size.

Trace file report(for TCP SACK):

Case1		Case 2		Case 3	
Src1-Rec1	Src2-Rec2	Src1-Rec1	Src2-Rec2	Src1-Rec1	Src2-Rec2
Time(S) Tput(bps)	Time(S) Tput(bps)	Time(S) Tput(bps)	Time(S) Tput(bps)	Time(S) Tput(bps)	Time(S) Tput(bps)
51 524818	51 415529	51 687372	51 310431	51 749490	51 248313
56 524908	56 415571	56 687428	56 310714	56 749571	56 248428
61 524710	61 415737	61 687475	61 310819	61 749639	61 248655
66 524543	66 415757	66 687515	66 310909	66 749696	66 248727
71 524633	71 415774	71 687436	71 310985	71 749633	71 248788
76 524492	76 415894	76 687473	76 311052	76 749684	76 248842
81 524472	81 415901	81 687407	81 311209	81 749728	81 248987
86 524453	86 415906	86 687441	86 311255	86 749767	86 249023
91 524437	91 416000	91 687384	91 311384	91 749714	91 249054
96 524423	96 416083	96 687416	96 311416	96 749750	96 249083
101 524327	101 416079	101 687445	101 311524	101 749782	101 249188
106 524398	106 416075	106 687471	106 311547	106 749811	106 249207
111 524312	111 416144	111 687495	111 311567	111 749765	111 249225
116 524234	116 416137	116 687448	116 311586	116 749793	116 249241
121 524300	121 416198	121 687471	121 311603	121 749818	121 249322
126 524228	126 416190	126 687428	126 311682	126 749841	126 249333
131 524225	131 416183	131 687450	131 311694	131 749801	131 249343
136 524223	136 416235	136 687470	136 311764	136 749823	136 249352
141 524221	141 416226	141 687489	141 311773	141 749843	141 249418
146 524219	146 416219	146 687506	146 311780	146 749863	146 249424
151 524162	151 416264	151 687470	151 311788	151 749827	151 249430
156 524162	156 416307	156 687487	156 311794	156 749846	156 249435
161 524161	161 416298	161 687453	161 311850	161 749863	161 249490
166 524111	166 416289	166 687469	166 311855	166 749879	166 249493
171 524161	171 416327	171 687438	171 311906	171 749847	171 249497
176 524114	176 416318	176 687454	176 311909	176 749863	176 249500
181 524069	181 416353	181 687469	181 311955	181 749878	181 249546
186 524116	186 416344	186 687483	186 311956	186 749892	186 249548
191 524074	191 416335	191 687497	191 311958	191 749863	191 249549
196 524076	196 416367	196 687469	196 311959	196 749877	196 249551
201 524078	201 416358	201 687482	201 311960	201 749890	201 249592
206 524080	206 416349	206 687456	206 312000	206 749902	206 249592
211 524082	211 416379	211 687469	211 312000	211 749876	211 249592
216 524084	216 416407	216 687481	216 312037	216 749888	216 249592

221 524086	221 416398	221 687493	221 312036	221 749900	221 249628
226 524050	226 416389	226 687504	226 312035	226 749911	226 249628
231 524053	231 416415	231 687480	231 312034	231 749887	231 249627
236 524055	236 416406	236 687491	236 312033	236 749898	236 249627
241 524023	241 416431	241 687468	241 312066	241 749908	241 249659
246 524026	246 416422	246 687479	246 312065	246 749918	246 249658
251 524028	251 416414	251 687458	251 312095	251 749896	251 249657
256 524031	256 416437	256 687468	256 312093	256 749906	256 249656
261 524033	261 416429	261 687478	261 312122	261 749915	261 249685
266 524036	266 416421	266 687488	266 312120	266 749924	266 249684
271 524038	271 416442	271 687498	271 312118	271 749904	271 249682
276 524010	276 416463	276 687478	276 312115	276 749913	276 249681
281 524013	281 416455	281 687487	281 312113	281 749921	281 249708
286 524015	286 416447	286 687468	286 312139	286 749930	286 249706
291 523989	291 416467	291 687477	291 312137	291 749910	291 249704
296 523992	296 416459	296 687486	296 312162	296 749918	296 249702
301 523995	301 416478	301 687495	301 312159	301 749926	301 249727
306 523970	306 416470	306 687503	306 312156	306 749934	306 249725
311 523973	311 416463	311 687485	311 312154	311 749916	311 249723
316 523976	316 416481	316 687493	316 312151	316 749924	316 249721
321 523979	321 416473	321 687476	321 312174	321 749931	321 249744
326 523982	326 416466	326 687484	326 312171	326 749938	326 249742
331 523985	331 416483	331 687468	331 312193	331 749921	331 249740
336 523987	336 416500	336 687476	336 312190	336 749928	336 249738
341 523965	341 416492	341 687483	341 312211	341 749935	341 249759
346 523968	346 416485	346 687491	346 312208	346 749942	346 249757
351 523971	351 416501	351 687498	351 312205	351 749925	351 249754
356 523950	356 416494	356 687483	356 312202	356 749932	356 249752
361 523953	361 416509	361 687490	361 312199	361 749939	361 249772
366 523956	366 416502	366 687475	366 312218	366 749945	366 249770
371 523959	371 416495	371 687482	371 312215	371 749929	371 249768
376 523961	376 416510	376 687489	376 312234	376 749936	376 249765
381 523964	381 416503	381 687496	381 312230	381 749942	381 249784
386 523966	386 416497	386 687502	386 312227	386 749948	386 249782
391 523948	391 416511	391 687488	391 312225	391 749933	391 249780
396 523971	396 416525	396 687494	396 312222	396 749939	396 249777

Trace file report (for TCP Vegas):

Case 1		Case 2		Case 3	
Src1-Rec1	Src2-Rec2	Src1-Rec1	Src2-Rec2	Src1-Rec1	Src2-Rec2
Time(S) Tput(bps)	Time(S) Tput(bps)	Time(S) Tput(bps)	Time(S) Tput(bps)	Time(S) Tput(bps)	Time(S) Tput(bps)
51 582745	51 473430	51 548473	51 449938	51 569192	51 428894
56 582714	56 473651	56 548234	56 450325	56 568885	56 429525
61 582819	61 473836	61 548034	61 450649	61 568629	61 429917
66 582909	66 474118	66 547738	66 451049	66 568286	66 430249
71 582873	71 474244	71 547601	71 451159	71 568108	71 430652
76 582947	76 474353	76 547482	76 451473	76 567953	76 430892
81 583012	81 474552	81 547275	81 451646	81 567818	81 431103
86 582976	86 474630	86 547285	86 451799	86 567601	86 431289
91 582945	91 474700	91 547112	91 451934	91 567500	91 431546

96 583000	96 474763	96 547043	96 452143	96 567410	96 431690
101 583049	101 474819	101 546981	101 452248	101 567328	101 431819
106 583018	106 474870	106 546925	106 452344	106 567175	106 431936
111 583063	111 474917	111 546799	111 452430	111 567037	111 432118
116 583034	116 475031	116 546755	116 452510	116 566982	116 432212
121 583074	121 474999	121 546716	121 452583	121 566931	121 432298
126 583111	126 475100	126 546613	126 452716	126 566819	126 432444
131 583083	131 475195	131 546581	131 452712	131 566778	131 432515
136 583117	136 475160	136 546552	136 452830	136 566741	136 432581
141 583148	141 475245	141 546525	141 452881	141 566647	141 432701
146 583123	146 475267	146 546500	146 452929	146 566616	146 432756
151 583099	151 475289	151 546477	151 452973	151 566588	151 432807
156 583128	156 475308	156 546402	156 453015	156 566508	156 432855
161 583155	161 475327	161 546434	161 453054	161 566485	161 432952
166 583132	166 475344	166 546365	166 453141	166 566463	166 432992
171 583157	171 475360	171 546348	171 453174	171 566394	171 433031
176 583136	176 475376	176 546332	176 453205	176 566423	176 433114
181 583160	181 475436	181 546317	181 453234	181 566359	181 433101
186 583182	186 475404	186 546303	186 453307	186 566343	186 433178
191 583162	191 475461	191 546290	191 453289	191 566327	191 433207
196 583183	196 475515	196 546235	196 453356	196 566271	196 433235
201 583203	201 475483	201 546182	201 453420	201 566258	201 433303
206 583184	206 475533	206 546213	206 453401	206 566205	206 433328
211 583165	211 475542	211 546164	211 453461	211 566195	211 433390
216 583185	216 475551	216 546117	216 453480	216 566185	216 433411
221 583203	221 475559	221 546147	221 453460	221 566137	221 433432
226 583185	226 475566	226 546102	226 453515	226 566129	226 433488
231 583203	231 475610	231 546095	231 453531	231 566121	231 433505
236 583186	236 475581	236 546089	236 453547	236 566078	236 433522
241 583203	241 475622	241 546083	241 453562	241 566072	241 433538
246 583219	246 475661	246 546077	246 453576	246 566031	246 433588
251 583203	251 475633	251 546071	251 453590	251 566026	251 433602
256 583218	256 475671	256 546033	256 453636	256 566021	256 433616
261 583233	261 475675	261 546029	261 453616	261 566016	261 433629
266 583218	266 475680	266 546024	266 453660	266 565980	266 433673
271 583202	271 475684	271 546020	271 453671	271 565976	271 433685
276 583217	276 475688	276 546016	276 453682	276 565972	276 433696
281 583231	281 475691	281 546012	281 453692	281 565938	281 433707
286 583216	286 475695	286 545979	286 453732	286 565935	286 433746
291 583230	291 475699	291 546004	291 453741	291 565932	291 433756
296 583216	296 475730	296 545972	296 453750	296 565901	296 433765
301 583229	301 475706	301 545969	301 453786	301 565899	301 433801
306 583241	306 475736	306 545967	306 453794	306 565896	306 433810
311 583228	311 475765	311 545964	311 453802	311 565868	311 433818
316 583240	316 475741	316 545935	316 453809	316 565866	316 433852
321 583252	321 475770	321 545932	321 453816	321 565864	321 433859
326 583239	326 475772	326 545905	326 453823	326 565837	326 433866
331 583226	331 475774	331 545903	331 453855	331 565861	331 433897
336 583238	336 475776	336 545901	336 453837	336 565835	336 433879
341 583249	341 475778	341 545900	341 453867	341 565834	341 433909
346 583236	346 475779	346 545874	346 453873	346 565833	346 433915
351 583247	351 475781	351 545897	351 453855	351 565808	351 433920

356 583235	356 475806	356 545872	356 453884	356 565807	356 433949
361 583246	361 475808	361 545871	361 453890	361 565783	361 433954
366 583256	366 475809	366 545870	366 453895	366 565783	366 433982
371 583245	371 475833	371 545869	371 453900	371 565760	371 433986
376 583255	376 475834	376 545868	376 453927	376 565760	376 433990
381 583265	381 475834	381 545867	381 453910	381 565739	381 434016
386 583253	386 475835	386 545844	386 453936	386 565739	386 434020
391 583242	391 475836	391 545843	391 453962	391 565739	391 434023
396 583252	396 475837	396 545843	396 453945	396 565739	396 434027