Wifi Simulation

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1 Questions

First Study)

Q1: Carry out simulations for different distances between the STA and the AP.For each distance measure the average throughput obtained by the flow Use both flowmon and wireshark to characterize throughputs Flowmon will enable you to obtain relevant statistics, including histograms Wireshark enables you to observe packets along the time, including the TCP congestion control mechanism in action Represent results as a function of distance

R) After analyzing the captures, we can determine a couple of things. Firstly, only from about 100m, does the throughput start decreasing. By analyzing the packet data available, we can see that the percentage of larger packets only decreases slightly, whilst the burst rate drops more significantly (meaning there are less packets per ”normalized” burst). But this is mainly a consequence, not a cause for the low throughput.

Topic / Item	Count	Average	Min val	Max val	Rate (ms)	Percent	Burst rate	Burst start
Packet Lengths	415479	445.09	36	1512	6.9195	100%	7.3200	22.440
0-19	0	-	-	-	0.0000	0.00%	-	-
20-39	204256	36.67	36	38	3.4017	49.16%	3.6300	22.405
40-79	0	-	-	-	0.0000	0.00%	-	-
80-159	75058	110.00	86	116	1.2500	18.07%	1.3700	57.246
160-319	12875	248.00	248	248	0.2144	3.10%	0.2300	0.410
320-639	23	390.96	384	544	0.0004	0.01%	0.2300	0.213
640-1279	55035	1141.33	760	1272	0.9166	13.25%	0.9900	22.385
1280-2559	68232	1512.00	1512	1512	1.1363	16.42%	2.1200	0.110
2560-5119	0	-	-	-	0.0000	0.00%	-	-
5120 and greater	0	-	-	-	0.0000	0.00%	-	-

Topic / Item	Count	Average	Min val	Max val	Rate (ms)	Percent	Burst rate	Burst start
Packet Lengths	149240	436.25	36	1512	2.4816	100%	2.8400	50.466
0-19	0	-	-	-	0.0000	0.00%	-	-
20-39	71366	36.67	36	38	1.1867	47.82%	1.3700	50.466
40-79	0	-	-	-	0.0000	0.00%	-	-
80-159	30302	110.00	86	116	0.5039	20.30%	0.7700	49.136
160-319	4474	248.00	248	248	0.0744	3.00%	0.0900	0.671
320-639	23	390.96	384	544	0.0004	0.02%	0.1500	0.464
640-1279	19139	1141.45	760	1272	0.3183	12.82%	0.3600	25.410
1280-2559	23936	1512.00	1512	1512	0.3980	16.04%	0.7000	0.231
2560-5119	0	-	-	-	0.0000	0.00%	-	-
5120 and greater	0	-	-	-	0.0000	0.00%	-	-

Figure 1: Comparison between packet length at 100m and 900m respectively.

From analyzing the Wireshark IO Graphs we can infer that the TCP congestion mechanism is engaging and causing the TCP connection to stall and reset the window size. For the first captures, after an initial period, the congestion mechanism isn’t activated most of the time, and the connection is more stable. But as can be seen in the following graphs, as the distance increases, the congestion control mechanism becomes more and more active and the throughput more unstable, until right about 1600m where the throughput drops to almost 0.

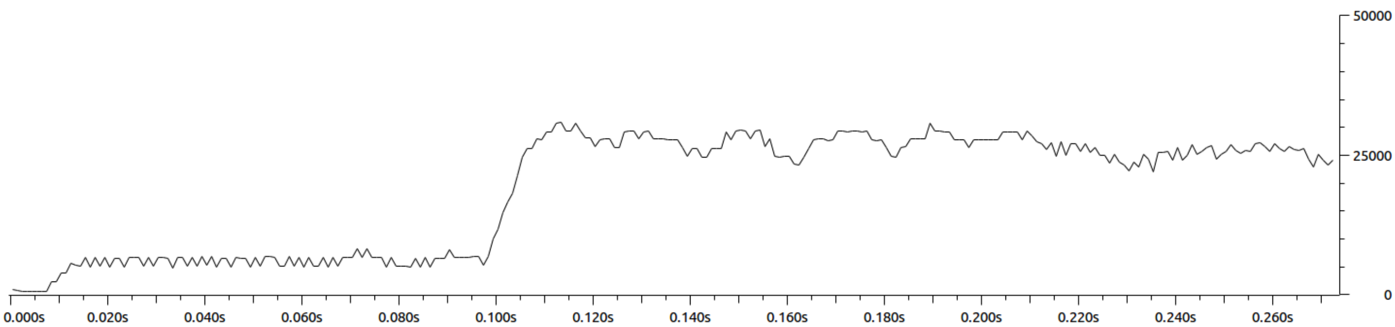

Figure 2: Exp1 100m initial congestion.

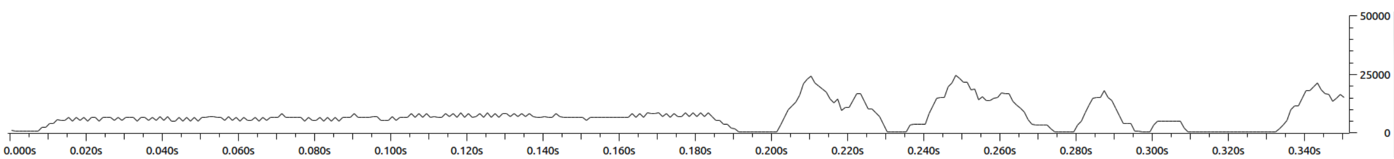

Figure 3: Exp1 200m initial congestion (after a couple of seconds, it becomes more stable, the chosen resolution was chosen to compare with the other graphs).

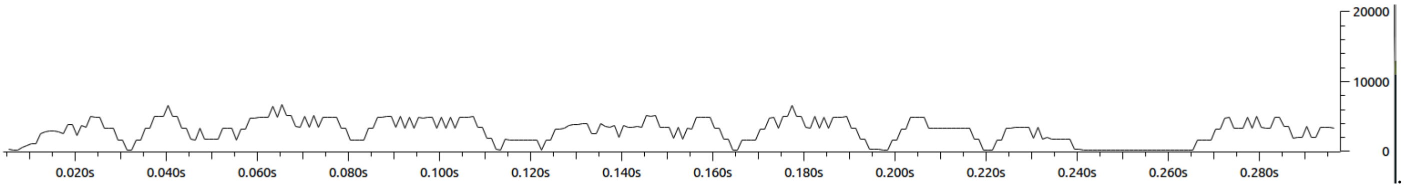

Figure 4: Exp1 1500m initial congestion.

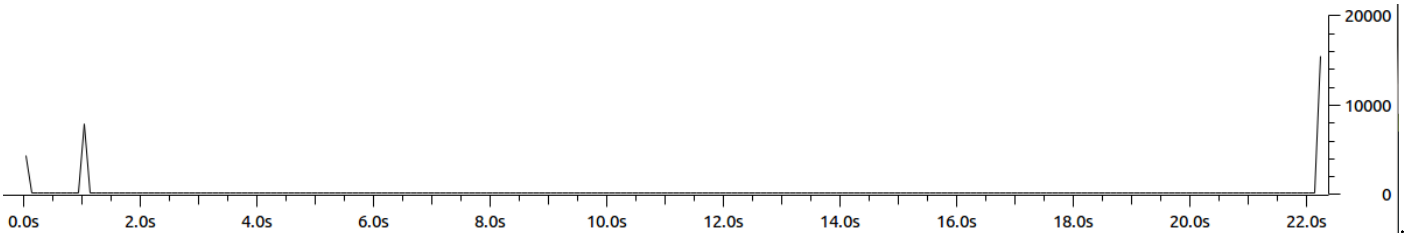

Figure 5: Exp1 1600m initial congestion (different scale from the previous graphs, due to very low throughput).

For all the previous graphs, and average of 8 smoothing filter was used, except for the 1600m one.

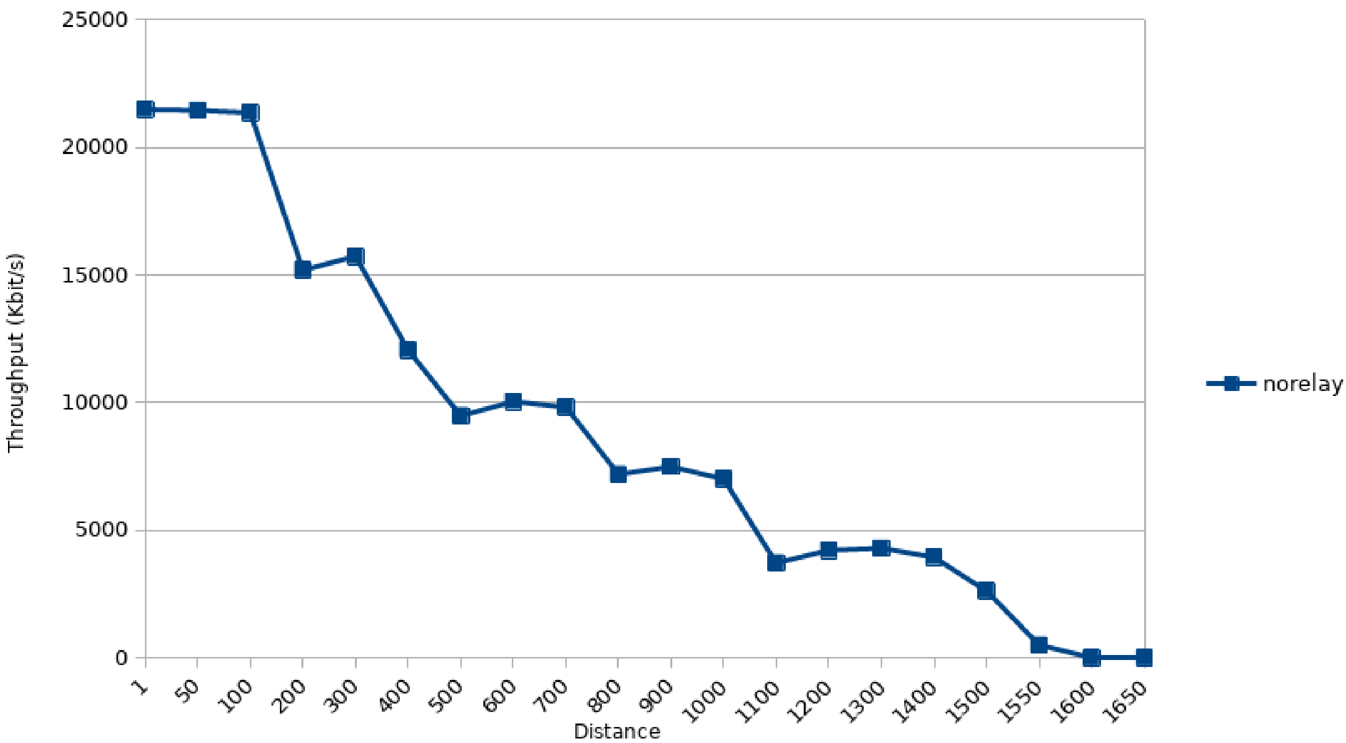

Figure 6: Exp1 throughput (kbit/s) per distance graph.

Second Study)

Q2) Carry out simulations for variable numbers of STA located around the AP. For each number of STAs measure the throughput obtained by stations – aggregated (sum of all stations) and average Represent results as a function of number of STAs

R)As the question states in this scenario we simulate from 1 to 10 STAs and from each one of them we measured the throughput ,the latency and the Packet Lost probability. The following graphs represents the aggregate throughput , the STAs are represented with different colors and with name SX.

We concluded that the aggregate capacity of the senders tends to not vary a lot, having a mean of 20833kbits/s and a Standart deviation of 573 kbits/s. This value should represent the maximum capacity that we can have in a TCP connection in this link (note: this is not the link capacity per say , it is inferior because it takes into account TCP Overheads ,retransmissions and other aspects).

We also see that the bandwith is fairly distributed beetween the STAs in all scenarios.

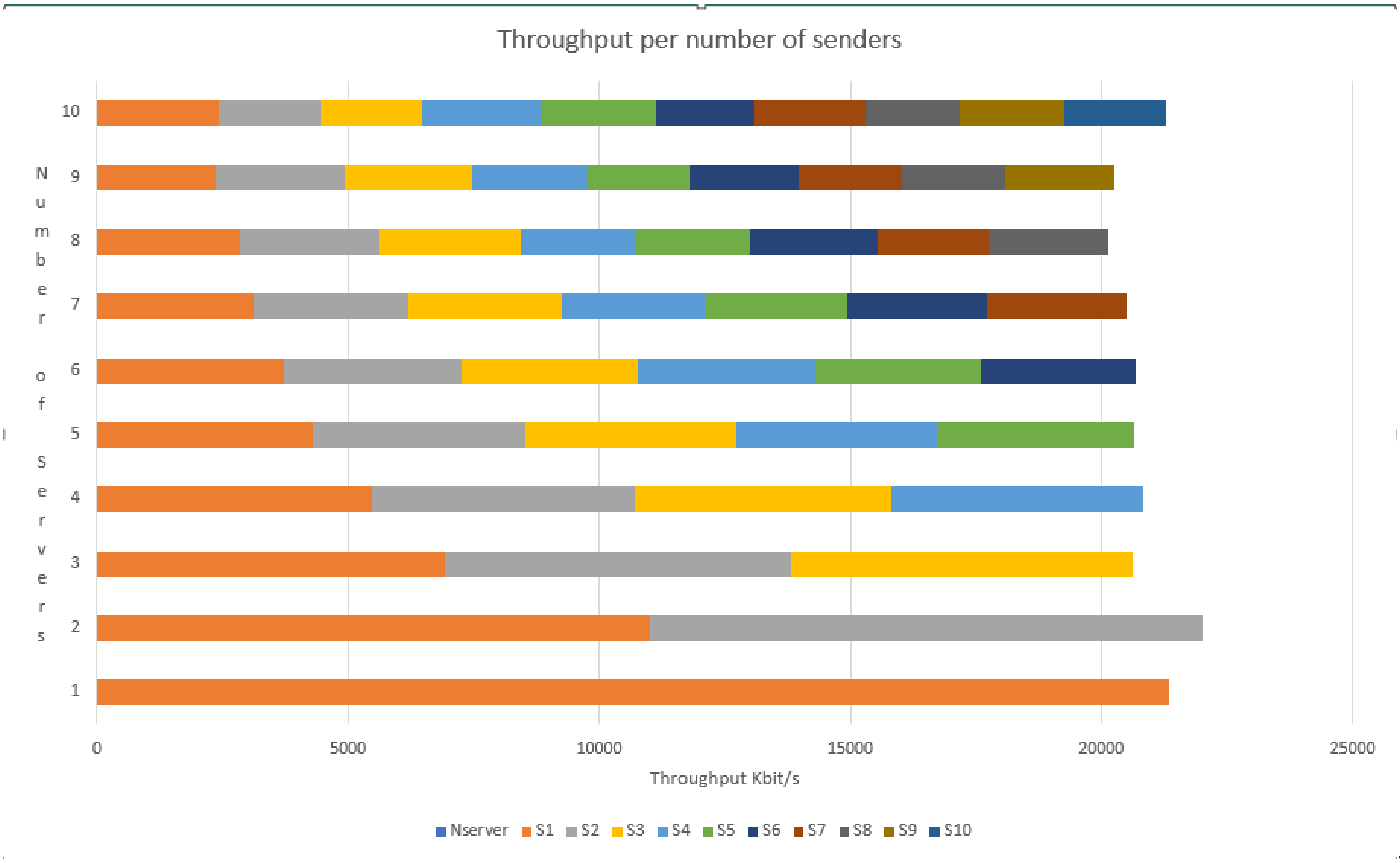

Figure 7: Agreggate throughput from 1-10 STAs in kbit/s.

In terms of packet lost we see that there were no packet lost until 7 senders and after that the packet lost rate scales quickly. But note that this packet lost are from the lower debit connections (Ack of packet well received etc).

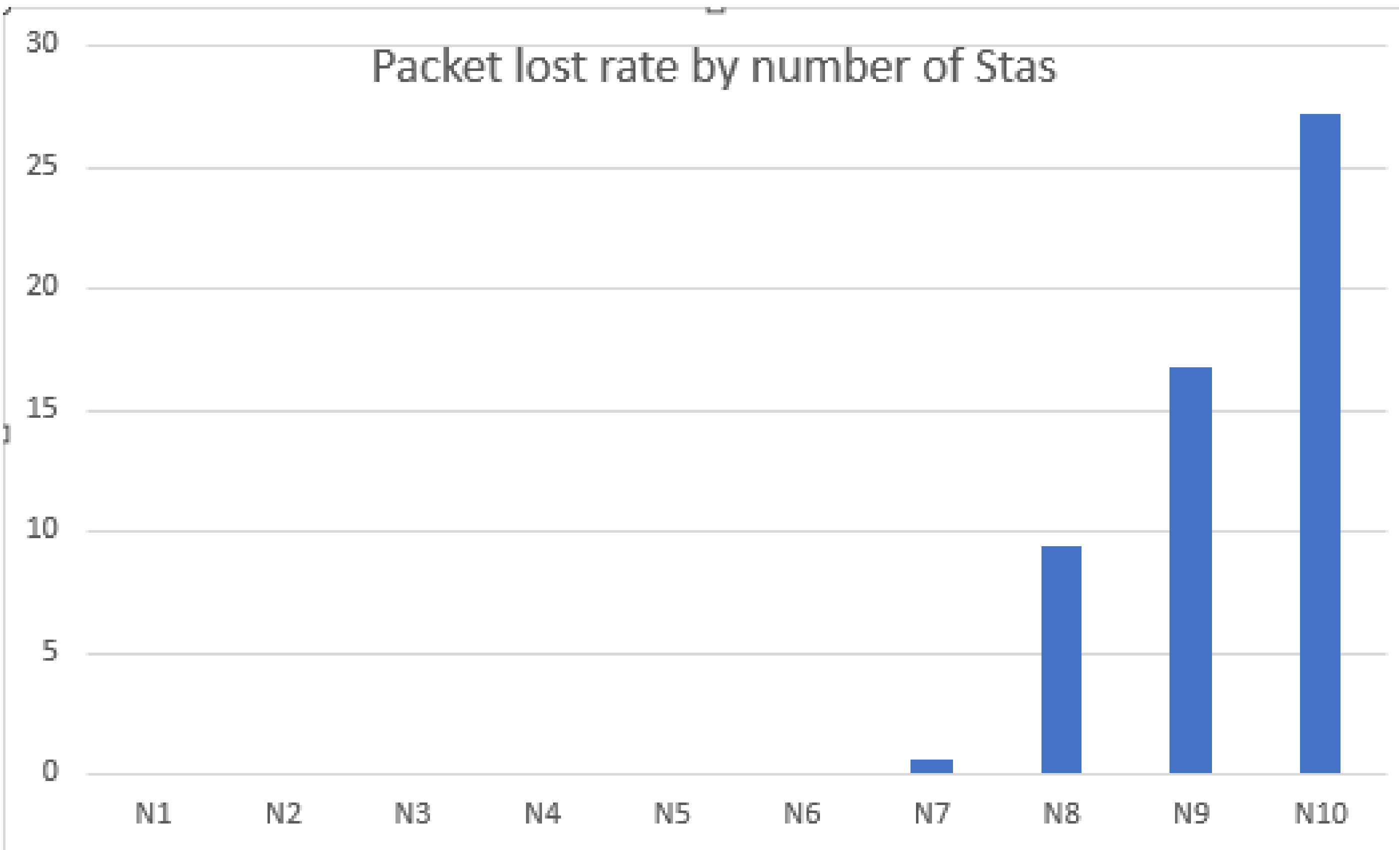

Figure 8: Agreggate throughput from 1-10 STAs in kbit/s.

The last point that we saw was latency comparison , note that the low debit connection (on the left) had bigger latency that the other.We also concluded that the Latency from the AP to the STA tend to increase linearly with the number of servers in our examples, and that the latency in the direction STA AP first reduces (for 1-5 STAS excluding N=2) and them increases (when it has 7 servers).

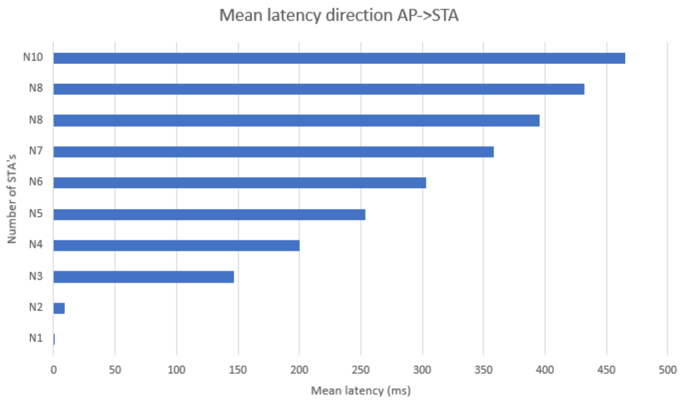

Figure 9: Mean latency, direction AP-Sta's (low debit)

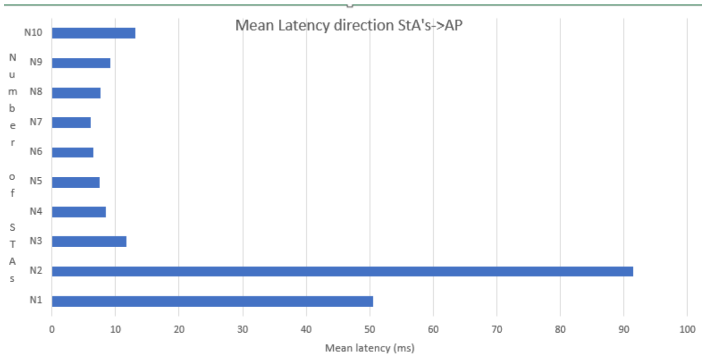

Figure 10: Mean latency, direction Sta's-Ap (High debit)

Third Study)

Q3) AP wit hame distance for both STAs; the nodes listen to each other

- Carry out simulations for different bitrates generated by the UDP STA
- Measure throughputs, delays and packet losses
- Represent results as functions of the bitrate generated by the UDP STA

Answer:

To perform this simulation, 25 different cases were used, in which each corresponds to simulate a UDP flow of comulative bitrate, starting at 1Mbps and ending at 25 Mbps.

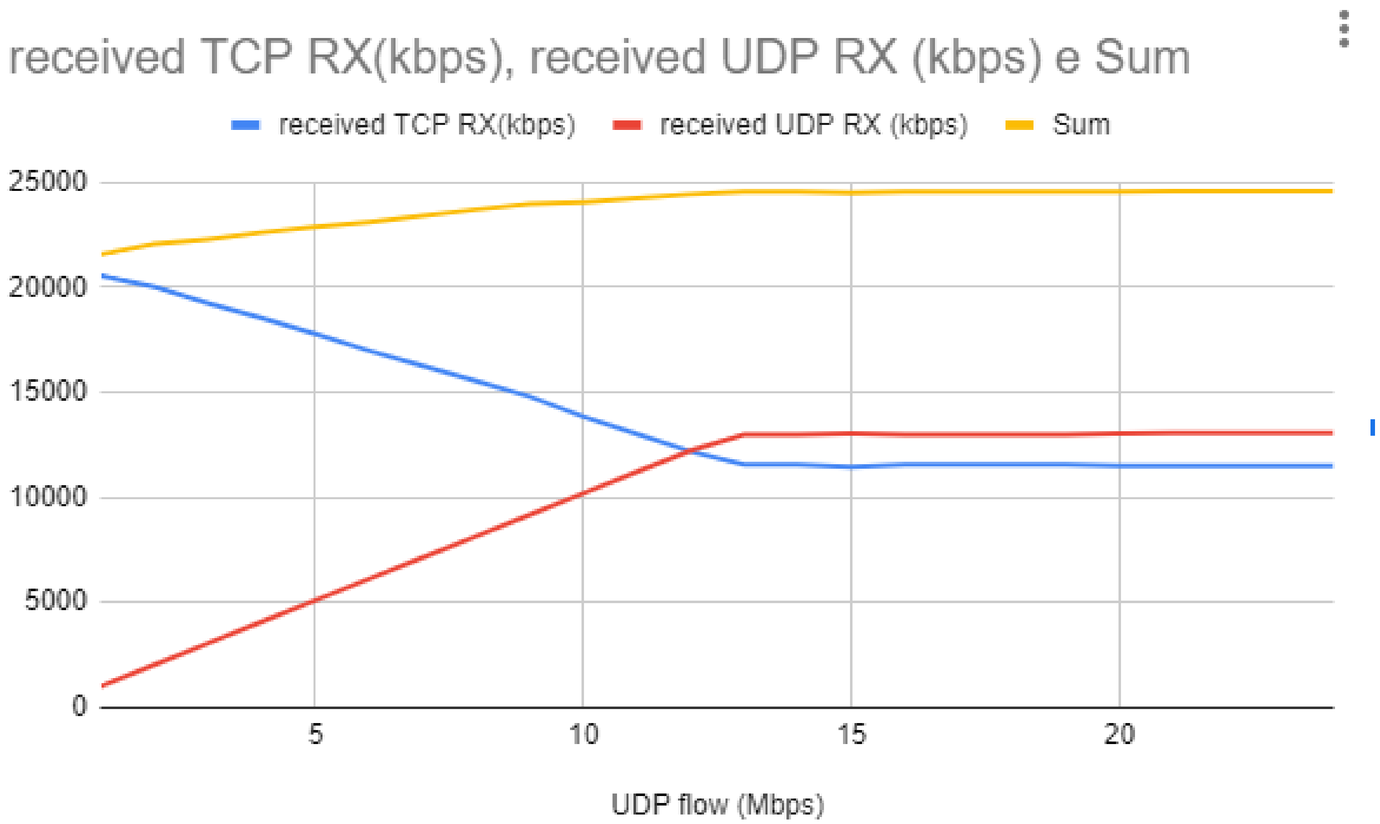

Figure 11: TCP vs UDP flow and total RX in Sink node.

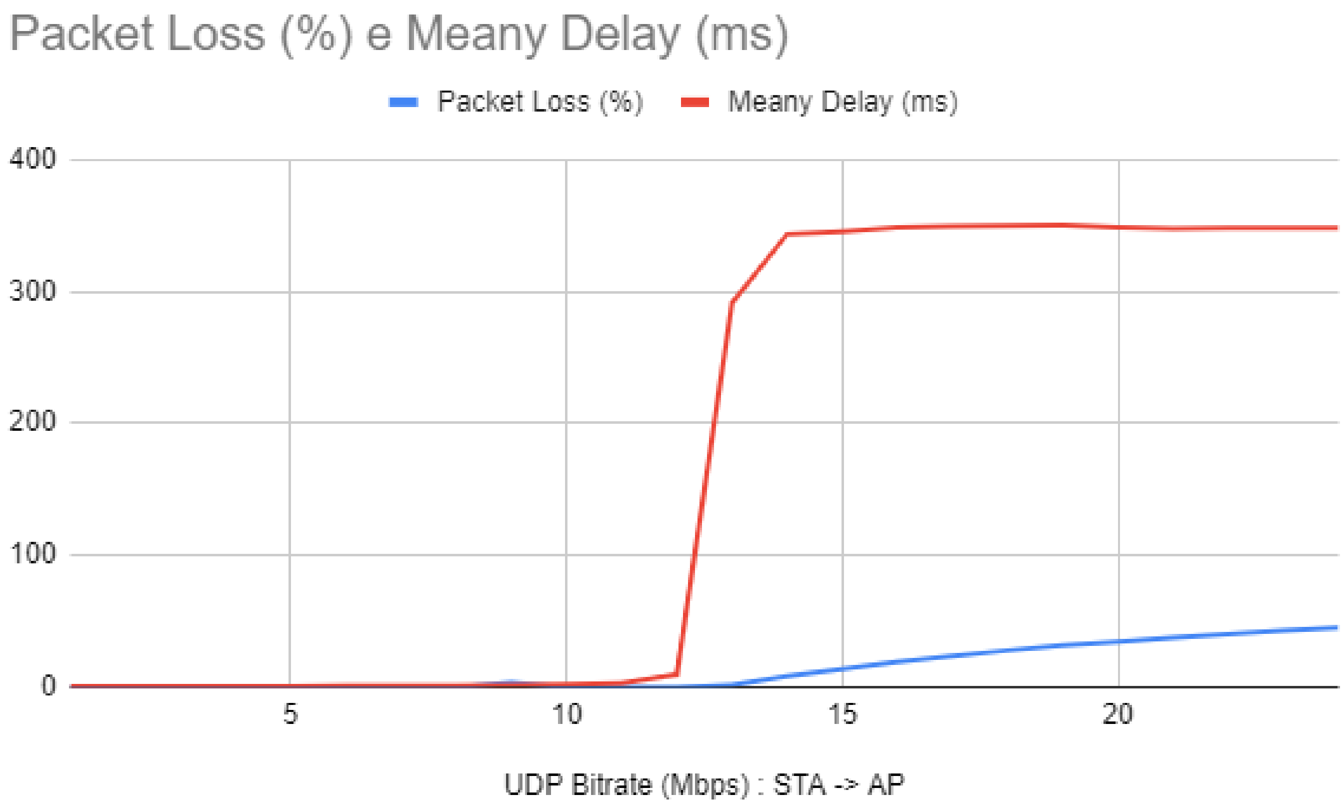

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Figure 12: TCP vs UDP flow and total RX in Sink node. (Packet Loss and Mean Delay).

The figures presented above demonstrate the behavior of the simulation, for different inputs of UDP flows. It is evident that the increase of the incoming flow in the AP, of the UDP type, makes the channel congestion, diluting the TCP flow with the same destination. With approximately 13Mbps of UDP flow, there is a balance between the two flows, as well as a significant increase in delay and packet loss. In this value the biggest congestion occurs, the channel is substantially clogged.

Fourth Study)

Carry out simulations for different distances d, considering – Distance AP-STA= d — Distance AP-RELAY = Distance RELAY-STA = d/2 For each distance measure the average throughput obtained by the flow – Throughput (in bit/s) measured at the AP Represent results as a function of distance Compare the results with the results obtained in the First Study In which situations should a relay node be used? Why?

R) From the comparison graph, it is obvious that having a relay at low distances is counter-productive, and only when the throughput dips bellow the relatively stable throughput that the relay provides, is it worth using it (at around 1050m).

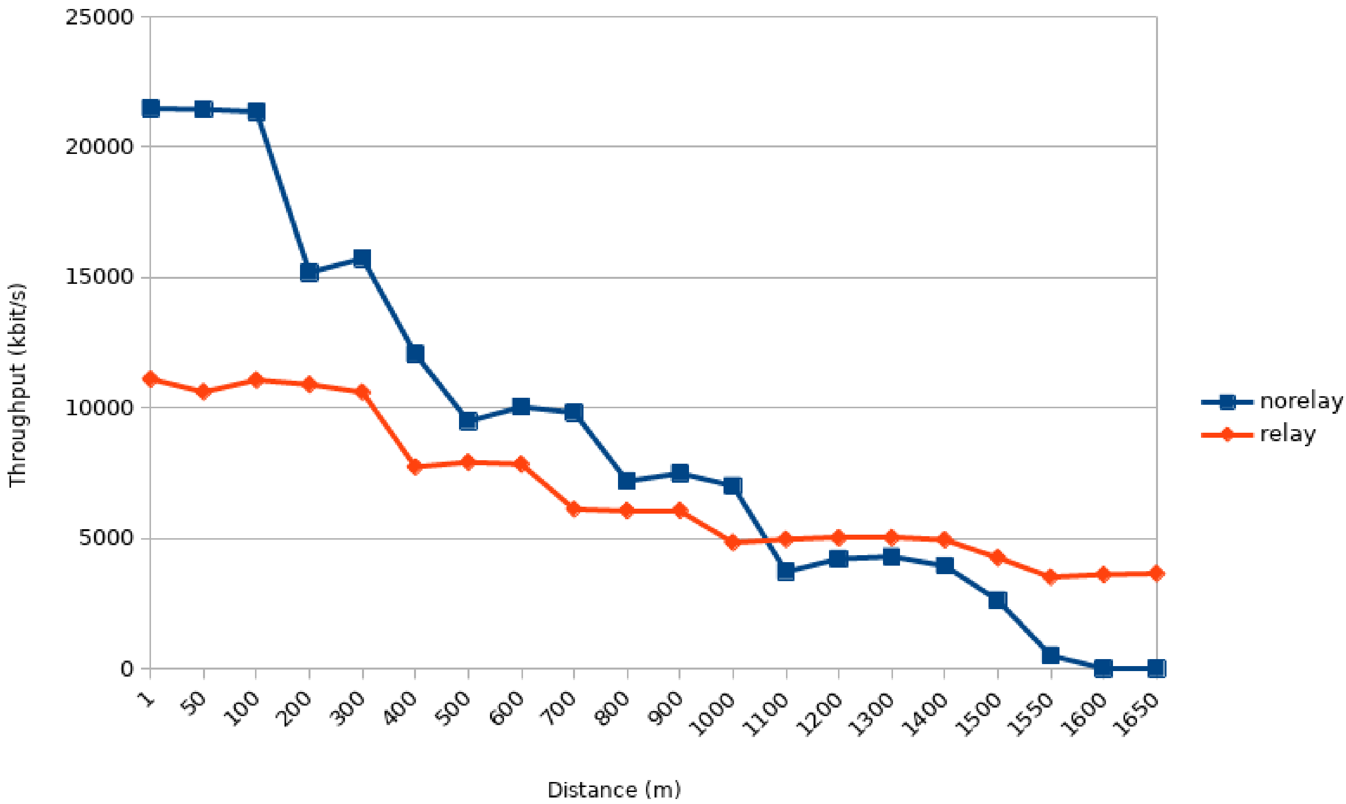

Figure 13: Exp4 Throughput/distance comparison.

The reason for this is that since the relay is halfway in-between, the distance increases by half of what it does with no relay. By looking at the wireshark captures, we can assert that the flow with a relay is indeed similar to the one, at half the distance, without a relay.

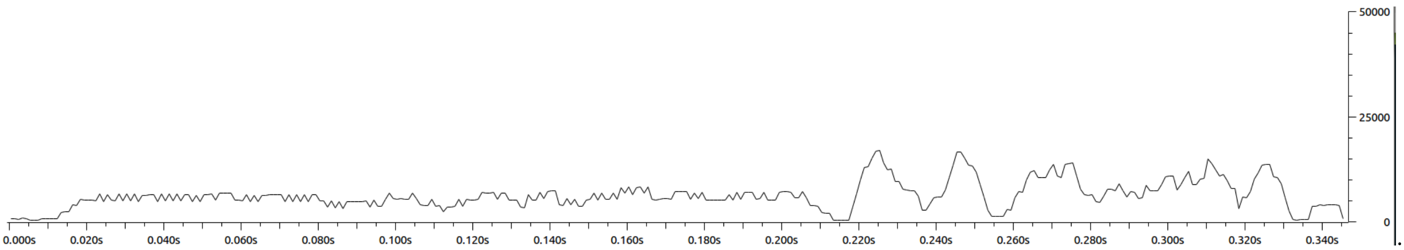

Figure 14: Exp4 400m initial congestion.

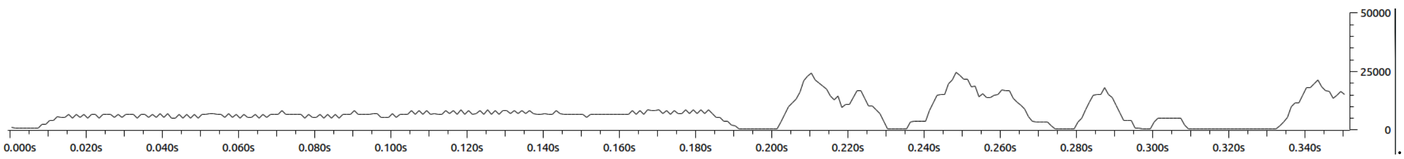

Figure 15: Exp1 200m initial congestion.