SENG3500 Laboratory 4 Report – Simulation Experiment IV

Introduction

The purpose of the simulations in this report is to facilitate understanding of random access Medium Access Control (MAC) protocols. This will be accomplished by comparing and analysing the performance of two protocols – ALOHA and S-ALOHA. Comprehension of the random access techniques and ALOHA/S-ALOHA protocols will create understanding of their role in communication networks.

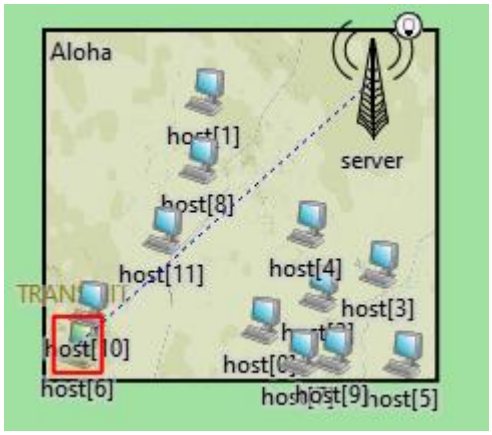
Simulation Model

The simulation model used is a local area network (LAN) consisting of 12 hosts connected to a server. The hosts send packets of size 1728b along a connection with transmission rate 19.2 kbps. There is no simulated radio delay.

The pure ALOHA model is used for simulations 1 & 2. It can be updated to make packet size variable – this is used for simulation 2. The slotted ALOHA model is used for simulation 3. It has a slot time of 100 seconds. For both models, interarrival time is changed to calculate simulated normalised traffic load. The interarrival time ***t*** for each normalised load ***p*** are:

p	***t***
0.1	10.799
0.25	4.320
0.4	2.700
0.55	1.964
0.7	1.543
0.85	1.271
1	1.080
1.25	0.864
1.5	0.720
1.75	0.617
2	0.540

All simulations execute for 900 seconds.



Simulation model – local network w/ server connected to 12 hosts.

Results

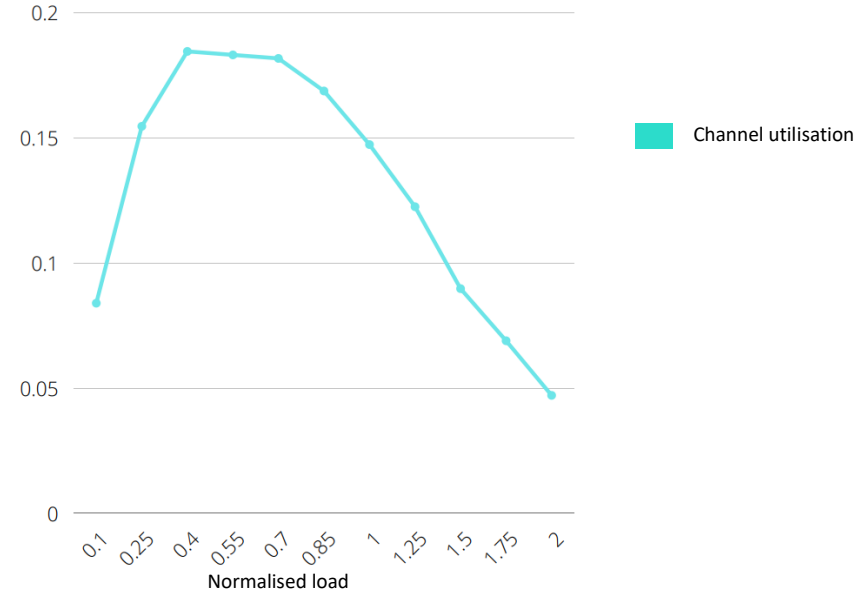


Figure 1: Normalised traffic load vs channel utilisation for sim. 1 – ALOHA fixed packet size

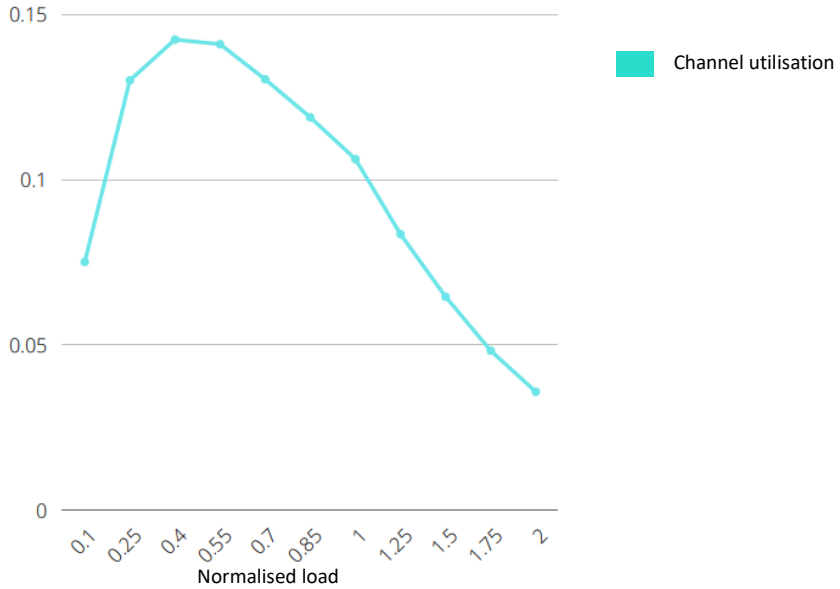


Figure 2. Normalised traffic load vs average utilisation for sim. 2 – ALOHA variable packet size

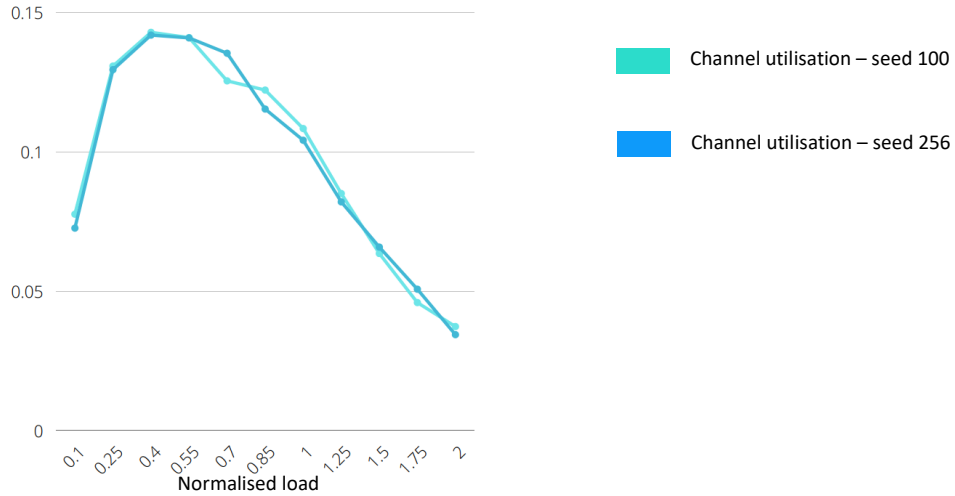


Figure 3. Normalised traffic load vs channel utilisation for sim. 2 – ALOHA variable packet size

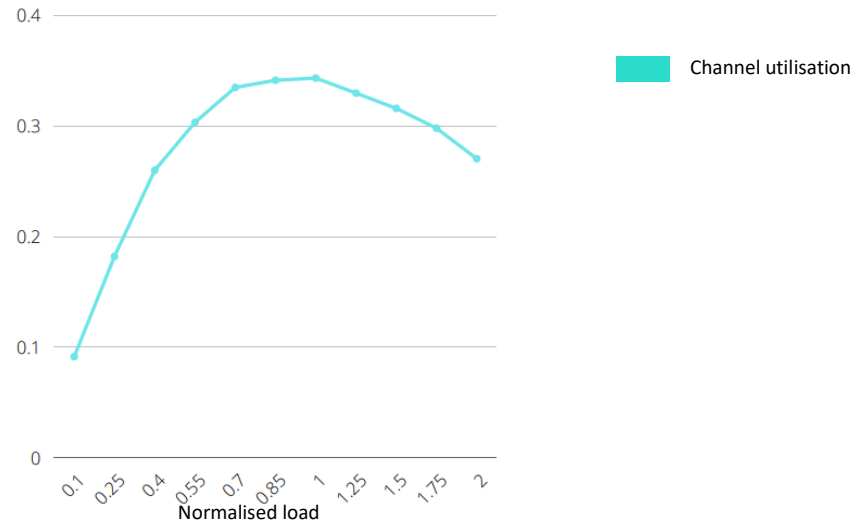


Figure 4. Normalised traffic load vs channel utilisation for sim. 3 – S-ALOHA

	Received Frames		
Load	**Sim. 1 – ALOHA fixed packet**	**Sim. 2 – ALOHA variable packet**	**Sim. 3 – S-ALOHA**
0.1	836	842	914
0.25	1544	1661	1821
0.4	1844	1985	2598
0.55	1830	2177	3031
0.7	1814	2134	3346
0.85	1686	2199	3411
1	1472	2074	3431
1.25	1223	1787	3294
1.5	897	1524	3157
1.75	689	1225	2978
2	471	1085	2702

Table 1. No. of received frames for sim. 1, 2 & 3. The Sim. 2 column is an average of the seed 100 & seed 256 values.

	Collided Frames		
Load	**Sim. 1 – ALOHA fixed packet**	**Sim. 2 – ALOHA variable packet**	**Sim. 3 – S-ALOHA**
0.1	173	141	93
0.25	901	850	591
0.4	2125	1960	1301
0.55	3577	3143	2253
0.7	4927	4573	3206
0.85	6367	5844	4365
1	7869	7201	5513
1.25	10293	9608	7584
1.5	12584	11785	9533
1.75	14743	14157	11437
2	16886	16147	13339

Table 2. No. of received frames for sim. 1, 2 & 3. The Sim. 2 column only uses seed 100 values.

Analysis

A comparison of the utilisation graphs from simulations 1 & 2 show that the "fixed-length packet" simulation (1) performs consistently better than the "variable-length packet" simulation (2). This holds true for both the channel utilisation and average utilisation graphs for simulation 2 – both perform significantly weaker than simulation 1.

By contrast, the utilisation rate of simulation 3 (S-ALOHA) is much higher than simulation 1 or 2, peaking at around 0.35 compared to 0.18 for simulation 1 and 0.14 for simulation 2. Simulation 3 also performs more consistently, lacking the significant drop in utilisation from $\boldsymbol{p}$ = 0.85.

To aid analysis of the collided frames, see *Table 2.* We can see that the simulation 1 produced a significantly increased rate of collisions compared to simulation 2, which can be attributed to the overall higher utilisation time – more time active means more opportunities for collisions.

We can also see that the rate of collisions in simulation 3 is significantly lower than both pure ALOHA simulations. The improved synchronicity of S-ALOHA is on display here, the use of designated timeslots resulting in fewer collisions.

Knowledge

1. *Calculate the theoretical value of normalised throughput, S, when normalised arrival rate, G = 0.25, 0.55, 0.85, 1 and 1.25 for ALOHA and S-ALOHA protocols. Use the fixed packet size value and service rate used in the simulation model.*

Arrival load G	**ALOHA Throughput *S***	**S-ALOHA Throughput *S***
0.25	0.1516	0.1947
0.55	0.1831	0.3173
0.85	0.1553	0.3633
1	0.1353	0.3679
1.25	0.1026	0.3581

2. *Compare the theoretical and simulation normalised throughput values for the fixed packet size. Explain why the simulation and theoretical values differ.*

For the ALOHA (fixed) throughput values, the simulated values were consistently **higher** than the theoretical values, whereas for the S-ALOHA values, the simulated values were consistently **lower**. The discrepancy in the S-ALOHA model could perhaps be explained by the theoretical calculation not considering processing time – the ability of the protocol to handle synchronicity causing simulated processing delays.

3. *Explain why the S-ALOHA protocol offers higher throughput than the ALOHA protocol?*

Since S-ALOHA uses discrete, segmented timeslots, it is able to better manage synchronisation. These timeslots correspond to frame length. This reduces the number of frame collisions, meaning more packets are able to pass through.

4. *Aside from the higher throughput, what is the other advantage of the S-ALOHA protocol that can be observed from the load vs channel utilisation plots?*

From the plots in can be observed that the S-ALOHA protocol offers more consistently channel utilisation over a wider range of normalised traffic load. The results taken from the experiments parameters show that the pure ALOHA protocol peaks in utilisation where load *p* is 0.4-0.7, before dropping sharply. S-ALOHA peaks in normalised load from 0.55-1.25 before dropping, suggesting that S-ALOHA can handle higher traffic loads.