ECEN 5032

WIRELESS LANs

HOMEWORK 3

SUBMITTED BY:

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In this exercise, the distribution of WLAN traffic according to data rate and type was obtained and analyzed.

Methodology

The data packet capture and analysis was done on a Macbook. Wireshark was used to capture WiFi packets. The WiFi interface was selected (802.11b/g/n at 2.4 GHz) and data packet capture was started. A total of 13986 packets were captured at 12:30 PM in Pearl Street (Macy's).

After the data packets were captured, two columns were added.

1. Data Rate (Using the "Apply as Column" option)
2. Frame Type (By creating new column and giving "wlan.fc.type_subtype" as field)

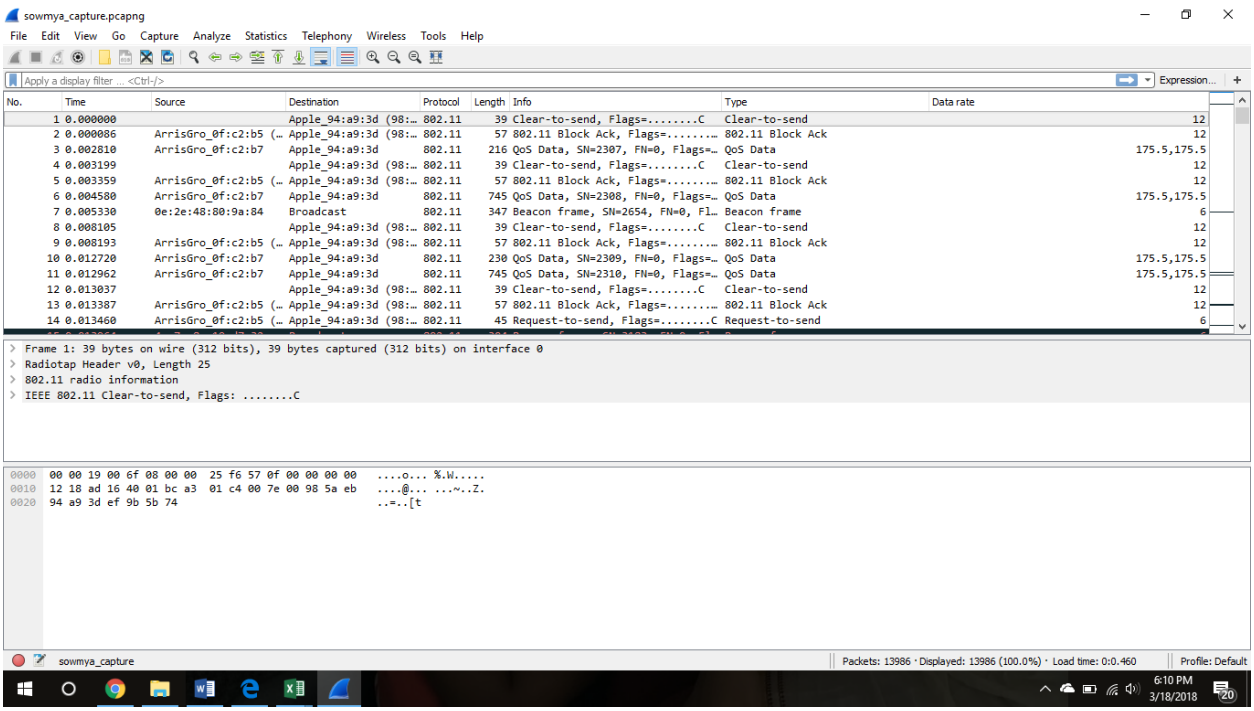


Figure 1 First few packets captured - Wireshark

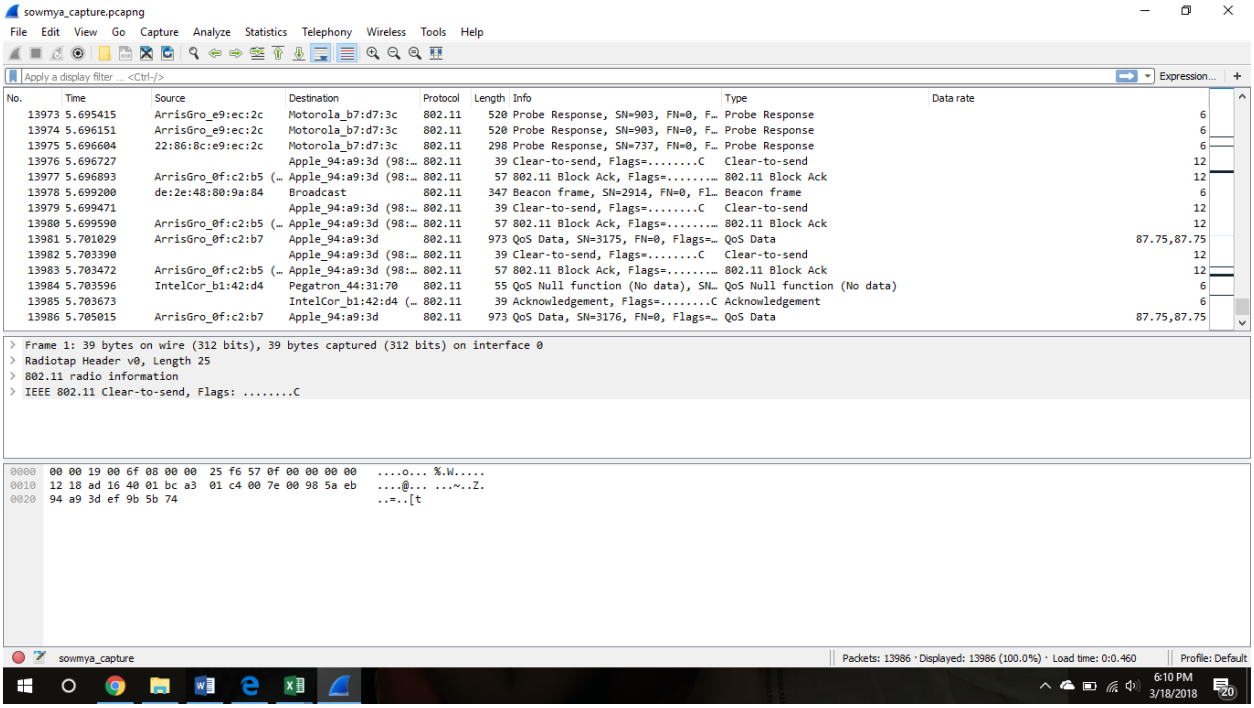
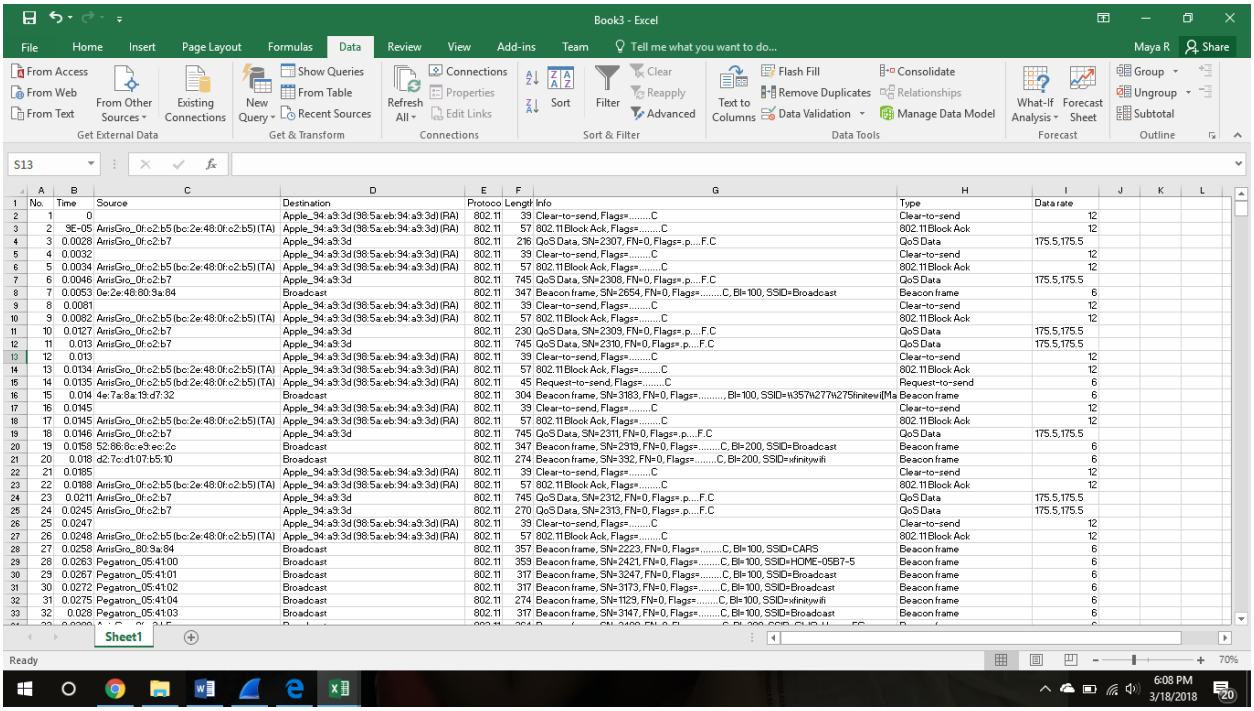


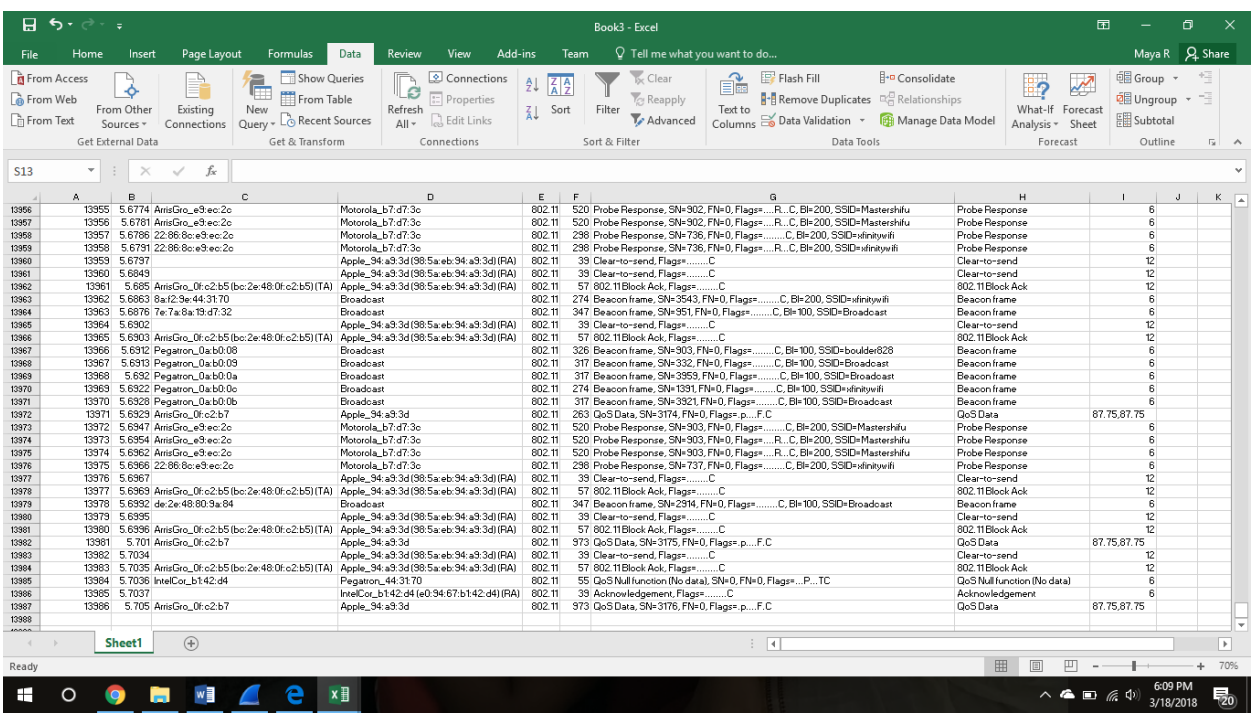
Figure 2 Last few packets captured – Wireshark

The entire data obtained (.cap file) is then exported as a .csv file from Wireshark, and opened in Micosoft Excel as a table. The problem of data rate being twice the original was not observed.



No.	Time	Source	Destination	Protoco	Length	Info	Type	Data rate
1	0		Apple_94:a9:3d (98:5a:eb:94:a9:3d) (RA)	802.11	39	Clear-to-send, Flags=.....C	Clear-to-send	12
2	9E-05	ArrisGro_0f:c2:b5 (bc:2e:48:0f:c2:b5) (TA)	Apple_94:a9:3d (98:5a:eb:94:a9:3d) (RA)	802.11	57	802.11Block Ack, Flags=.....C	802.11Block Ack	12
3	0.0028	ArrisGro_0f:c2:b7	Apple_94:a9:3d	802.11	216	QoS Data, SN=2307, FN=0, Flags=.p....F.C	QoS Data	175.5,175.5
4	0.0032		Apple_94:a9:3d (98:5a:eb:94:a9:3d) (RA)	802.11	39	Clear-to-send, Flags=.....C	Clear-to-send	12
5	0.0034	ArrisGro_0f:c2:b5 (bc:2e:48:0f:c2:b5) (TA)	Apple_94:a9:3d (98:5a:eb:94:a9:3d) (RA)	802.11	57	802.11Block Ack, Flags=.....C	802.11Block Ack	12
6	0.0046	ArrisGro_0f:c2:b7	Apple_94:a9:3d	802.11	745	QoS Data, SN=2308, FN=0, Flags=.p....F.C	QoS Data	175.5,175.5
7	0.0053	0e:2e:48:80:9a:84	Broadcast	802.11	347	Beacon frame, SN=2654, FN=0, Flags=.....C, BI=100, SSID=Broadcast	Beacon frame	6
8	0.0081		Apple_94:a9:3d (98:5a:eb:94:a9:3d) (RA)	802.11	39	Clear-to-send, Flags=.....C	Clear-to-send	12
9	0.0082	ArrisGro_0f:c2:b5 (bc:2e:48:0f:c2:b5) (TA)	Apple_94:a9:3d (98:5a:eb:94:a9:3d) (RA)	802.11	57	802.11Block Ack, Flags=.....C	802.11Block Ack	12
10	0.0127	ArrisGro_0f:c2:b7	Apple_94:a9:3d	802.11	230	QoS Data, SN=2309, FN=0, Flags=.p....F.C	QoS Data	175.5,175.5
11	0.013	ArrisGro_0f:c2:b7	Apple_94:a9:3d	802.11	745	QoS Data, SN=2310, FN=0, Flags=.p....F.C	QoS Data	175.5,175.5
12	0.013		Apple_94:a9:3d (98:5a:eb:94:a9:3d) (RA)	802.11	39	Clear-to-send, Flags=.....C	Clear-to-send	12
13	0.0134	ArrisGro_0f:c2:b5 (bc:2e:48:0f:c2:b5) (TA)	Apple_94:a9:3d (98:5a:eb:94:a9:3d) (RA)	802.11	57	802.11Block Ack, Flags=.....C	802.11Block Ack	12
14	0.0135	ArrisGro_0f:c2:b5 (bd:2e:48:0f:c2:b5) (TA)	Apple_94:a9:3d (98:5a:eb:94:a9:3d) (RA)	802.11	45	Request-to-send, Flags=.....C	Request-to-send	6
15	0.014	4e:7a:8a:19:d7:32	Broadcast	802.11	304	Beacon frame, SN=3183, FN=0, Flags=....., BI=100, SSID=\\357\\277\\275finitewi[Ma	Beacon frame	6
16	0.0145		Apple_94:a9:3d (98:5a:eb:94:a9:3d) (RA)	802.11	39	Clear-to-send, Flags=.....C	Clear-to-send	12
17	0.0145	ArrisGro_0f:c2:b5 (bc:2e:48:0f:c2:b5) (TA)	Apple_94:a9:3d (98:5a:eb:94:a9:3d) (RA)	802.11	57	802.11Block Ack, Flags=.....C	802.11Block Ack	12
18	0.0146	ArrisGro_0f:c2:b7	Apple_94:a9:3d	802.11	745	QoS Data, SN=2311, FN=0, Flags=.p....F.C	QoS Data	175.5,175.5
19	0.0158	52:86:8c:e9:ec:2c	Broadcast	802.11	347	Beacon frame, SN=2919, FN=0, Flags=.....C, BI=200, SSID=Broadcast	Beacon frame	6
20	0.018	d2:7c:d1:07:b5:10	Broadcast	802.11	274	Beacon frame, SN=332, FN=0, Flags=.....C, BI=200, SSID=xfinitywifi	Beacon frame	6
21	0.0185		Apple_94:a9:3d (98:5a:eb:94:a9:3d) (RA)	802.11	39	Clear-to-send, Flags=.....C	Clear-to-send	12
22	0.0188	ArrisGro_0f:c2:b5 (bc:2e:48:0f:c2:b5) (TA)	Apple_94:a9:3d (98:5a:eb:94:a9:3d) (RA)	802.11	57	802.11Block Ack, Flags=.....C	802.11Block Ack	12
23	0.0211	ArrisGro_0f:c2:b7	Apple_94:a9:3d	802.11	745	QoS Data, SN=2312, FN=0, Flags=.p....F.C	QoS Data	175.5,175.5
24	0.0245	ArrisGro_0f:c2:b7	Apple_94:a9:3d	802.11	270	QoS Data, SN=2313, FN=0, Flags=.p....F.C	QoS Data	175.5,175.5
25	0.0247		Apple_94:a9:3d (98:5a:eb:94:a9:3d) (RA)	802.11	39	Clear-to-send, Flags=.....C	Clear-to-send	12
26	0.0248	ArrisGro_0f:c2:b5 (bc:2e:48:0f:c2:b5) (TA)	Apple_94:a9:3d (98:5a:eb:94:a9:3d) (RA)	802.11	57	802.11Block Ack, Flags=.....C	802.11Block Ack	12
27	0.0258	ArrisGro_80:9a:84	Broadcast	802.11	357	Beacon frame, SN=2223, FN=0, Flags=.....C, BI=100, SSID=CARS	Beacon frame	6
28	0.0263	Pegatron_05:41:00	Broadcast	802.11	359	Beacon frame, SN=2421, FN=0, Flags=.....C, BI=100, SSID=HOME-05B7-5	Beacon frame	6
29	0.0267	Pegatron_05:41:01	Broadcast	802.11	317	Beacon frame, SN=3247, FN=0, Flags=.....C, BI=100, SSID=Broadcast	Beacon frame	6
30	0.0272	Pegatron_05:41:02	Broadcast	802.11	317	Beacon frame, SN=3173, FN=0, Flags=.....C, BI=100, SSID=Broadcast	Beacon frame	6
31	0.0275	Pegatron_05:41:04	Broadcast	802.11	274	Beacon frame, SN=1129, FN=0, Flags=.....C, BI=100, SSID=xfinitywifi	Beacon frame	6
32	0.028	Pegatron_05:41:03	Broadcast	802.11	317	Beacon frame, SN=3147, FN=0, Flags=.....C, BI=100, SSID=Broadcast	Beacon frame	6

Figure 3 First few packet details after exporting to Excel



13955	5.6774	ArrisGro_e9:ec:2c	Motorola_b7:d7:3c	802.11	520	Probe Response, SN=902, FN=0, Flags=....R...C, BI=200, SSID=Mastershifu	Probe Response	6
13956	5.6781	ArrisGro_e9:ec:2c	Motorola_b7:d7:3c	802.11	520	Probe Response, SN=902, FN=0, Flags=....R...C, BI=200, SSID=Mastershifu	Probe Response	6
13957	5.6786	22:86:8c:e9:ec:2c	Motorola_b7:d7:3c	802.11	298	Probe Response, SN=736, FN=0, Flags=.....C, BI=200, SSID=xfinitywifi	Probe Response	6
13958	5.6791	22:86:8c:e9:ec:2c	Motorola_b7:d7:3c	802.11	298	Probe Response, SN=736, FN=0, Flags=....R...C, BI=200, SSID=xfinitywifi	Probe Response	6
13959	5.6797		Apple_94:a9:3d (98:5a:eb:94:a9:3d) (RA)	802.11	39	Clear-to-send, Flags=.....C	Clear-to-send	12
13960	5.6849		Apple_94:a9:3d (98:5a:eb:94:a9:3d) (RA)	802.11	39	Clear-to-send, Flags=.....C	Clear-to-send	12
13961	5.685	ArrisGro_0f:c2:b5 (bc:2e:48:0f:c2:b5) (TA)	Apple_94:a9:3d (98:5a:eb:94:a9:3d) (RA)	802.11	57	802.11Block Ack, Flags=.....C	802.11Block Ack	12
13962	5.6863	8a:f2:9e:44:31:70	Broadcast	802.11	274	Beacon frame, SN=3543, FN=0, Flags=.....C, BI=200, SSID=xfinitywifi	Beacon frame	6
13963	5.6876	7e:7a:8a:19:d7:32	Broadcast	802.11	347	Beacon frame, SN=951, FN=0, Flags=.....C, BI=100, SSID=Broadcast	Beacon frame	6
13964	5.6902		Apple_94:a9:3d (98:5a:eb:94:a9:3d) (RA)	802.11	39	Clear-to-send, Flags=.....C	Clear-to-send	12
13965	5.6903	ArrisGro_0f:c2:b5 (bc:2e:48:0f:c2:b5) (TA)	Apple_94:a9:3d (98:5a:eb:94:a9:3d) (RA)	802.11	57	802.11Block Ack, Flags=.....C	802.11Block Ack	12
13966	5.6912	Pegatron_0a:b0:08	Broadcast	802.11	326	Beacon frame, SN=903, FN=0, Flags=.....C, BI=100, SSID=boulder828	Beacon frame	6
13967	5.6913	Pegatron_0a:b0:09	Broadcast	802.11	317	Beacon frame, SN=332, FN=0, Flags=.....C, BI=100, SSID=Broadcast	Beacon frame	6
13968	5.692	Pegatron_0a:b0:0a	Broadcast	802.11	317	Beacon frame, SN=3959, FN=0, Flags=.....C, BI=100, SSID=Broadcast	Beacon frame	6
13969	5.6922	Pegatron_0a:b0:0c	Broadcast	802.11	274	Beacon frame, SN=1391, FN=0, Flags=.....C, BI=100, SSID=xfinitywifi	Beacon frame	6
13970	5.6928	Pegatron_0a:b0:0b	Broadcast	802.11	317	Beacon frame, SN=3921, FN=0, Flags=.....C, BI=100, SSID=Broadcast	Beacon frame	6
13971	5.6929	ArrisGro_0f:c2:b7	Apple_94:a9:3d	802.11	263	QoS Data, SN=3174, FN=0, Flags=.p....F.C	QoS Data	87.75,87.75
13972	5.6947	ArrisGro_e9:ec:2c	Motorola_b7:d7:3c	802.11	520	Probe Response, SN=903, FN=0, Flags=.....C, BI=200, SSID=Mastershifu	Probe Response	6
13973	5.6954	ArrisGro_e9:ec:2c	Motorola_b7:d7:3c	802.11	520	Probe Response, SN=903, FN=0, Flags=....R...C, BI=200, SSID=Mastershifu	Probe Response	6
13974	5.6962	ArrisGro_e9:ec:2c	Motorola_b7:d7:3c	802.11	520	Probe Response, SN=903, FN=0, Flags=....R...C, BI=200, SSID=Mastershifu	Probe Response	6
13975	5.6966	22:86:8c:e9:ec:2c	Motorola_b7:d7:3c	802.11	298	Probe Response, SN=737, FN=0, Flags=.....C, BI=200, SSID=xfinitywifi	Probe Response	6
13976	5.6967		Apple_94:a9:3d (98:5a:eb:94:a9:3d) (RA)	802.11	39	Clear-to-send, Flags=.....C	Clear-to-send	12
13977	5.6969	ArrisGro_0f:c2:b5 (bc:2e:48:0f:c2:b5) (TA)	Apple_94:a9:3d (98:5a:eb:94:a9:3d) (RA)	802.11	57	802.11Block Ack, Flags=.....C	802.11Block Ack	12
13978	5.6992	de:2e:48:80:9a:84	Broadcast	802.11	347	Beacon frame, SN=2914, FN=0, Flags=.....C, BI=100, SSID=Broadcast	Beacon frame	6
13979	5.6995		Apple_94:a9:3d (98:5a:eb:94:a9:3d) (RA)	802.11	39	Clear-to-send, Flags=.....C	Clear-to-send	12
13980	5.6996	ArrisGro_0f:c2:b5 (bc:2e:48:0f:c2:b5) (TA)	Apple_94:a9:3d (98:5a:eb:94:a9:3d) (RA)	802.11	57	802.11Block Ack, Flags=.....C	802.11Block Ack	12
13981	5.701	ArrisGro_0f:c2:b7	Apple_94:a9:3d	802.11	973	QoS Data, SN=3175, FN=0, Flags=.p....F.C	QoS Data	87.75,87.75
13982	5.7034		Apple_94:a9:3d (98:5a:eb:94:a9:3d) (RA)	802.11	39	Clear-to-send, Flags=.....C	Clear-to-send	12
13983	5.7035	ArrisGro_0f:c2:b5 (bc:2e:48:0f:c2:b5) (TA)	Apple_94:a9:3d (98:5a:eb:94:a9:3d) (RA)	802.11	57	802.11Block Ack, Flags=.....C	802.11Block Ack	12
13984	5.7036	IntelCor_b1:42:d4	Pegatron_44:31:70	802.11	55	QoS Null function (No data), SN=0, FN=0, Flags=...P...TC	QoS Null function (No data)	6
13985	5.7037		IntelCor_b1:42:d4 (e0:94:67:b1:42:d4) (RA)	802.11	39	Acknowledgement, Flags=.....C	Acknowledgement	6
13986	5.705	ArrisGro_0f:c2:b7	Apple_94:a9:3d	802.11	973	QoS Data, SN=3176, FN=0, Flags=.p....F.C	QoS Data	87.75,87.75

Figure 4 Last few packet details after exporting to Excel

The number of packets (Frequency) was then found for each Data Rate and Frame Type using the =COUNTIF function in Excel.

These (Data Rate vs Frequency and Frame Type vs Frequency) were obtained as two separate tables.

Data Rate	Number of Packets (Frequency)
6	5044
12	1665
24	3152
29.25	303
36	2
58.5	185
87.75	440
117	49
150	128
173.333	1
175.5	58
180	2
200	239
216	2
234	110
243	15
263.25	50
292.5	3
300	1
324	1
325	1357
351	14
390	124
433.333	1028
468	9
526.5	2
877.5	1
11,701,170	1
Total Number of Packets =	13986

Figure 5 Data Rate vs Frequency Table

Frame Type	Number of Frames (Frequency)
ACK	706
Block ACK	2698
CTS	2368
RTS	1781
Probe Response	83
Probe Request	3
Authentication	12
Deauthentication	3
Disassociation	0
Action	7
Beacon	2041
Data	33
QoS Data	3958
NULL	17

Figure 6 Frame Type vs Frequency Table

The corresponding Histogram plots (Data Rate vs Frequency and Data Type vs Frequency) were then plotted.

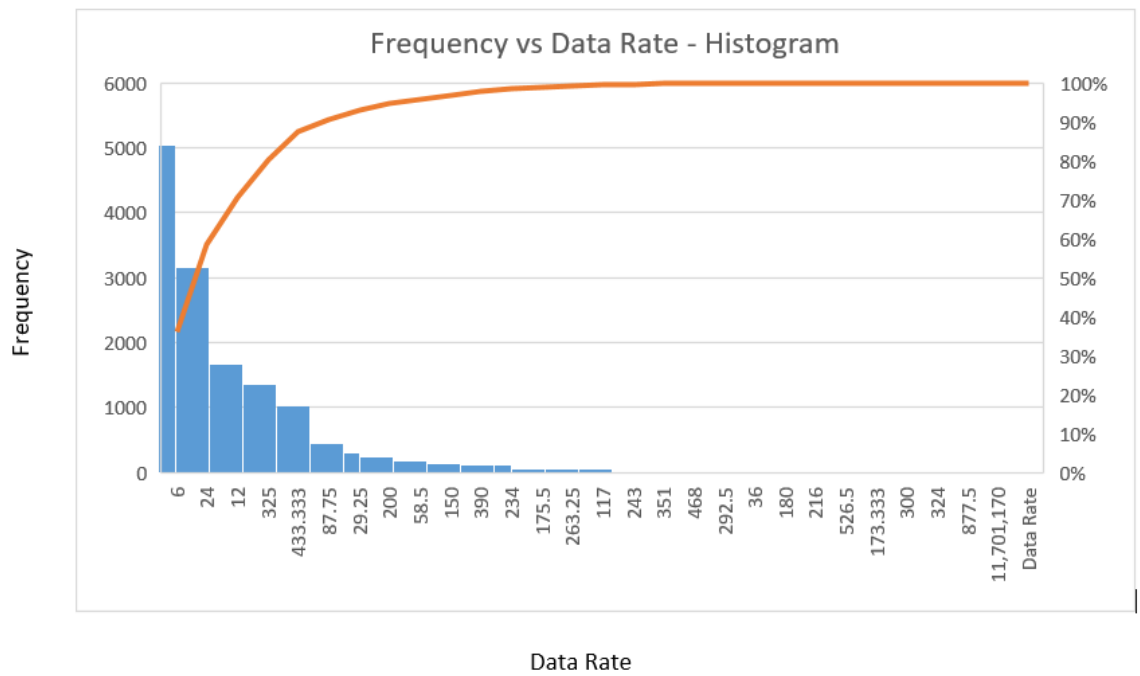


Figure 7 Data Rate vs Frequency - Histogram Graph

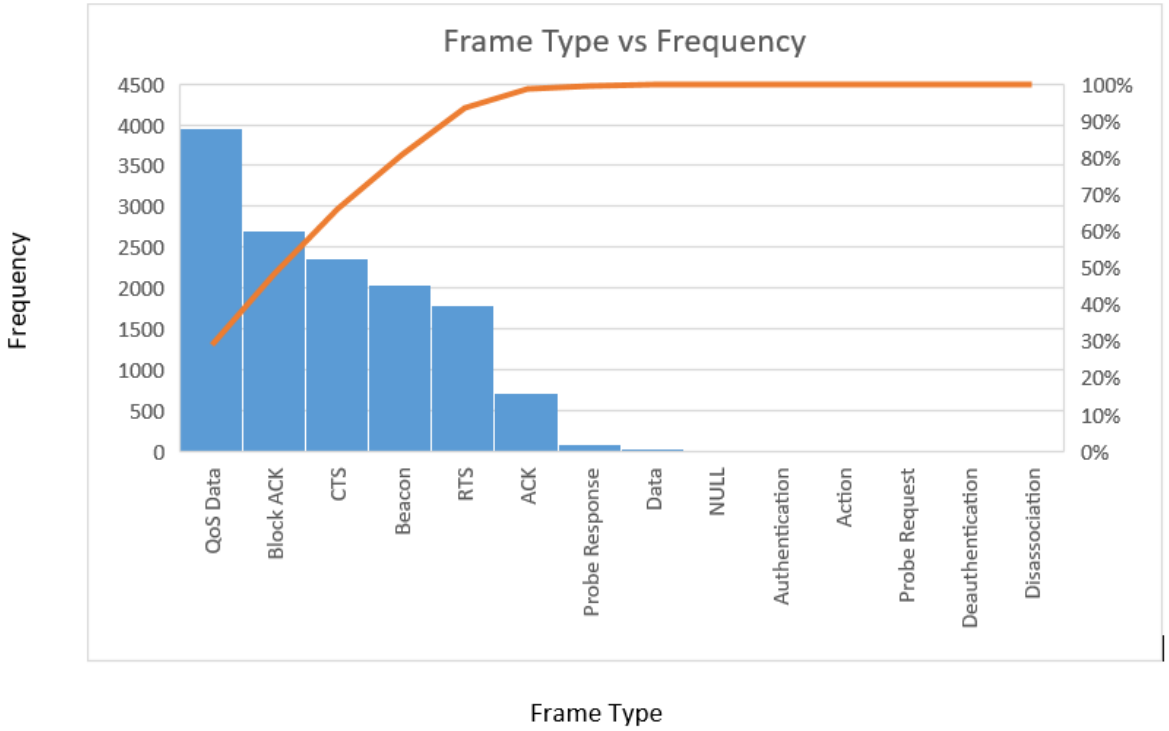


Figure 8 Frame Type vs Frequency - Histogram Graph

Thus, the distribution of packets at different data rates and data types was observed.

Results and Conclusions

- The maximum and minimum data rates of the channel spectrum were found.
- The data rate with the most frequency (number of data packets) was found to be 6 Mbps.
- Other packets (a large number) were captured between 6 and 24 Mbps, which indicates that the WiFi access points were working at data rates of around that range. Hence, packets close to that range of data rates were picked up by the network analyzer (Wireshark).
- Out of almost 14000 packets, at-least 20 frame types were captured. The frame type that was captured most was QoS data. 3958 out of 13986 packets were of this type. This is followed by Block Ack (Block Acknowledgement) and CTS (Clear-to-send) frame types.
- Most packets captured were data packets. Channel seems congested due to the large volume of data packets obtained in a small duration/period (It took approximately 20 seconds to capture all 13986 packets).
- The RTS (Request-to-send) and CTS (Clear-to-send) of the packets were found out and analyzed. The effective network utilization of the channel could be found using data rate and signal strengths.

- There are 14 frequency channels in WLAN, and we can find out which packet comes under which channel.
- Different applications which run in each IP address can be found and analyzed.
- The various IP Address protocols can be found. Address count comparisons can be made between IP and physical addresses.

Congestion

- Since there are a number of packets transmitted (13986) in a small period of time (20 seconds), there is bound to be some congestion in the channel.
- Congestion can be found by analyzing the number of times packets have been re-transmitted. If there is a large number of re-tries of a packet, there is congestion present in the channel. Analyzing over 10000 packets in a retail environment means that the role of congestion is big.

Efficiency

- The key factors in WLAN Efficiency are data rate and signal strength.
- There is a large number of channels which were overlapping in terms of channel frequencies, which indicates presence of co-channel interference.
- The data rate was obtained to be pretty high, which means that the co-channel interference is significantly less and hence the WLAN is effective in its function, in spite of the congestion.