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COMPARISON OF UDPdownT TRAFFIC FOR SINGLE AND MULTIPLE USERS

Joy N. Ayidu, Itua O. Akhideno*

Abstract*:* The number of Internet-connected devices is growing exponentially yearly. One of the most common modes of accessing the internet for most devices is through the use of Wireless Local Area Network (WLAN) technology. In this scenario two types of flows are to be distinguished; User Datagram Protocol downstream throughput (UDPdownT) single user and User Datagram Protocol downstream throughput (UDPdownT) multiple users, based on respective signal to noise ratio (SNR) under different activities or traffic scenarios in the download stream. The WLAN technology investigated is the IEE802.11 b/g specifically. Dataset obtained from the experiment was used to develop a models base on the scenarios previously described (single and multiple user) and were used to provide insight into the scenarios. The result shows that the UDPdownT flow for single-user scenario in throughput ranked higher than the multiple-user scenario with an overall average difference of 6.07 Mbps.

Keywords: IEEE802.11b/g; UDPdownT, WLAN, User Datagram Protocol; Throughput, Signal to Noise Ratio

Introduction*:* Good flow of communication in a WLAN is essential for Internet applications to function optimally. Under these scenarios, two types of traffic can be distinguished; elastic and inelastic traffic. Elastic traffic refers to "low-priority, delay-to-lerant, and throughput-greedy applications" [1]. Inelastic traffic does not easily adapt to changes in delay and throughput since it is often used to characterize the traffic in real-time multimedia traffic such as audio streaming, video surveillance, Voice over IP (VoIP), and Internet protocol television (IPTV) while elastic traffic offers controllable rates for the injection of packets into the network[2].

*Corresponding author

*** Benson Idahosa University, Department of Electrical/Electronic Engineering, P.M.B. 1100, Benin City, Nigeria. +234-8067940716**

E-mail: iakhideno@biu.edu.ng,

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Oftentimes, packets are generated by applications where real-time is not a priority. Transmission Control Protocol (TCP) is the fundamental technology implemented in this scenario. Inelastic traffic in its operation refers to fixed size packets injected into the network in a stipulated amount of time and can also be described by the user datagram protocol (UDP) [3].

Most existing literature does not fully explore inelastic traffic as it relates to network user such upstream and downstream channels. Studies have been carried out on the integration of elastic and inelastic flows in WLANs with both single and multiple hop networks. In order to carry out such integration, the characteristic behaviour of both elastic and inelastic flows has to be studied and models developed.

This paper attempts to carry out modeling of specific inelastic traffic under two traffic scenarios such as throughput and signal-to-noise ratio (SNR). This would be done in a WLAN environment with the devices configured for IEEE 802.11 b/g protocol. This protocol makes it possible for people who are thousands of kilometers apart to share

information with one another in the form of papers, photographs, and movies across the globe.

All the services and applications can be carried out using a WLAN as the transmission channel. This investigation is done in order to predict a quality of measure (QoS) metric such as throughput; given a specific range of values for SNR. The throughput as it relates to this study is defined as the rate at which data packets are sent from one point to another during a specific amount of time, which is measured in bits per second[4]; it is also defined as data delivery rate in real time[5]. Throughput is a measure of network speed compared to bandwidth. It is also easier to measure as several measuring tools abound [6].

This work is done under high-demanding traffic scenarios such as real-time and non-real time applications. The real time applications include voice and video streaming and non-real time include activities such as file transfers. The purpose of this study therefore is to compare UDPdownT Traffic for Single and Multiple Users that will provide the best overall performance for a certain smart environment scenario and for a set of applications.

Materials and Methods: The WLAN test bed considered different traffic scenarios. Three (3) environments within the main campus of the University of Benin, Nigeria were used: Open spaces, Hallway and the administrative office building. The two software tools used are: Tamosoft Throughput Test and inSSIDer version 2.1 and the hardware tools used are: Access point, laptop computers with a wireless LAN card corresponding to the vendor of the access point (AP) in real-time measurements. This system was built in a server and client connections. Received signal strength level (RSSL) at the client terminal was taken into consideration as a parameter to measure. The throughput is measured in Mbps while the RSSL is measured in dBm. The experimental setup consisted of Access Points (AP) mounted on a pole. The network configuration consisted of two scenarios of Single user on a workstation and multiple users connected to the network with various devices. The list of activities under the following types of quality of service (QoS): Best effort, Background, Excellent effort, Audio, Video and Voice Control. The specifications of Hardware and Access Points (AP) used in the research are presented in Table 1.

Table 1: Research Hardware Specifications

Hardware	Specification(s)
Band (GHz)	2.4
Cabling	Category 5e Unshielded Twisted Pair (UTP)
Data Speed (MHz)	100
IP Address Range	192.168.1.xx
Output Power (V dc)	12

Results and Discussion: Table 2 presents the data for UDP downstream Throughput (UDPdownT) for a single and multiple users' client in the three environments combined based on the signal to noise ratio (SNR) which was computed from the primary field data obtained from this work as a function of signal and noise.

Table 2. UDPdownT data for single and multiple users' environments

UDPdownT Single user (Mbps)	SNR(dB)	UDPdownT Multiple users (Mbps)	SNR (dB)
26	68	14	64
27	66	14	63
19	63	14	62
23	62	14	61
19	61	14	60
20	60	13	59
18	44	13	58
20	59	14	57
19	58	15	56
22	43	14	55
23	57	15	54
21	42	15	53
25	56	15	52
22	41	14	51
26	55	14	50
21	40	14	49

25	54	16	48
24	39	13	47
23	53	15	46
21	38	16	45
24	52	13	44
23	37	14	43
23	51	15	42
19	36	15	41
21	50	15	40
21	35	15	39
24	49	15	38
22	34	14	37
21	48	12	36
21	33	8	35
22	47	10	34
17	32	9	33
22	46	12	32
20	31	8	31
20	45	12	30
20	30	8	29
22	29	8	27
16	28	5	18
15	27	10	17
14	26	12	16
12	25	12	15
11	24	15	14
14	23	11	13
15	22	10	12
18	21	8	11
11	20	12	10

Combined Model Parameters: Modeling the optimum characteristics of the UDP throughput performance based on the various parameters (R squared value, Std. error of the Estimate, and the level of significance) for single and multiple users is created showing the statistical characteristic of the best fit as shown in Tables 2 and 3. The equation of the model as obtained is in Equations 1 and 2. Each of the models gives an accurate representation of the characteristic model and statistically tested for validity with respect to the environment and usage scenario(s).

Table 2: UDPdownT model Parameters of Single User

Model Summary: Power				
R Square			Std. Error of the Estimate	
0.965			0.558	
The independent variable is SNR.				
ANOVA				
	Sum of Squares	Df	F	Sig.
Regression	8101.864	1	26016.233	0.000
Residual	295.845	950		
Total	8397.709	951		
The independent variable is SNR.				
Ln(SNR)	Coefficien		T	Sig.
	b1			
	0.771		161.295	0.000

Equation 1 shows the developed model equation for UDPupT

$$\text{SU UDP}_{\text{UP}}\text{T Model} = f(SNR) = \begin{cases} SNR^{b} & SNR \geq 45dB \\ SNR^{b} + 3Mbps & 18db \geq SNR < 45dB \end{cases} \quad ---(1)$$

Single User UDP$_{\text{down}}$T

The Table 2 shows that the power model best described the behavior of the network experimentally of throughput versus SNR obtained as can be seen by having an R square value of 0.965, standard error of the estimate of 0.558, which is also zero significance in nature. F test and T-test were significant and acceptable at 1% and 0.5% level of Coefficient. For F test, the null hypothesis is rejected while the alternative is accepted, this means that the dependent and independent variable used in the model development is accepted to have a coherent variance at a stated level of significance and degree of freedom and the model can be depended on within some stated boundaries.

Table 3: UDPdownT model Parameters for Multiple Users

Model Summary: Cubic				
R Square		Std. Error of the Estimate		
0.947		3.051		
The independent variable is SNR.				
ANOVA				
	Sum of Squares	Df	F	Sig.
	156488.482	3	5603.423	0.000
Residual	8694.699	934		
Total	165183.181	937		
The independent variable is SNR.				
Coefficients			T	Sig.
SNR	b1	0.778	20.397	0.000
SNR²	b2	-0.016	-9.737	0.000
SNR³	b3	0.00022	6.843	0.000

Equation 2 shows the developed model equation for UDPdownT

$$\text{MU UDP}_{\text{down}}\text{T Model} = f(SNR) = \begin{cases} b_1 SNR - b_2 SNR^2 + b_3 SNR^3 - 2\,Mbps \\ b_1 SNR - b_2 SNR^2 + b_3 SNR^3 + 3\,Mbps \quad 46dB \le SNR \le 57dB \\ b_1 SNR - b_2 SNR^2 + b_3 SNR^3 + 4\,Mbps \quad 10 \le SNR \le 45dB \end{cases} \text{---(2}$$

Multiple Users UDP$_{down}$T: Table 3 shows that a cubic model is best to validate the data of throughput versus SNR obtained experimentally by having an R square value of 0.947, standard error of the estimate of 3.051, which is also zero significance in nature. F test and T-test were significant and acceptable at 1% and 0.5% level of Coefficient. For F test, the null hypothesis is rejected while the alternative is accepted, this means that the dependent and independent variable used in the model development is accepted to have a coherent variance at a stated level of significance and degree of freedom and the model can be depended on within some stated boundaries.

The Comparison of UDPdownT for Single and Multiple Users Combined Environment: The graph shown in Figure 1 presents the comparison of the Average UDPdownT for Single and multiple users combined in the environment shown in Table. It was plotted against the computed SNR. The graph shows an average throughput difference of approximately 10.2 Mbps between the two environments. It is observed that UDPdownT for Single user environment has a higher throughput performance compared to the observed Average UDPdownT Multiple user environment on the WLAN network.

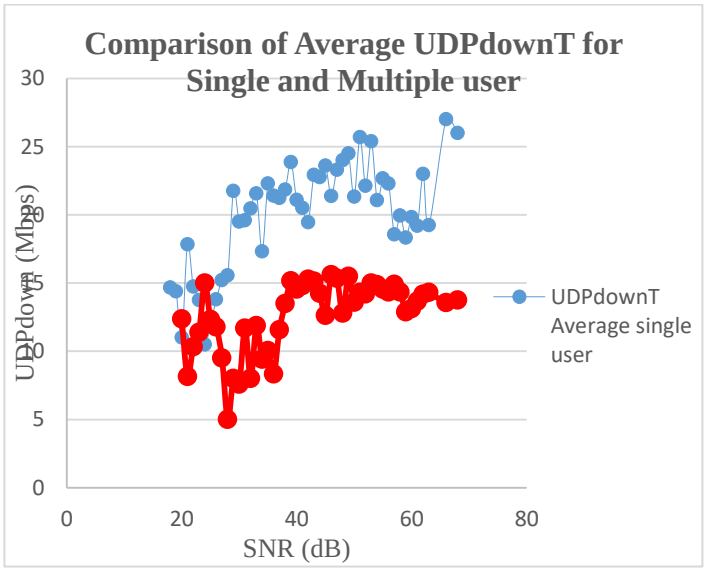

Fig 1: Comparison of Average UDPdownT for Single and Multiple Users

The graph (Fig 1) presents the UDPdownT of the single User scenario (data1) and multiple User scenario (data2) plotted against the computed SNR. The graph (fig 1) shows an average throughput difference of approximately 10.2 Mbps between the two scenarios. The models, however, shows that UDPdownT single user has a higher throughput performance compare to multiple users scenario.

What can be deduced is that throughput decreases as the number of users increase on the channel. This suggests that multiple users must be optimum in order not to downgrade network throughput below a threshold value.

Conclusion: This paper presented an analysis of UDPdownT traffic flow under a single-user scenario versus a multiple user in terms of key performance indicators: throughput and signal-to-noise ratio. Results showed a higher throughput performance for single users scenario compare to multiple users scenario for a UDP downstream throughput data. Investigating the relationship between single and multiple access showed better network throughput for a single entity (user) compared to a multiple access (user) scenario for a UDPdownT connection. However, the models obtained show a strong dependence of $UDP_{down}T$ single user on SNR and a little lesser dependence of $UDP_{down}T$ multiple users on a SNR. The models developed would help network engineers and researchers estimate $UDP_{down}T$ for both single and multiple users on a network for a given value of SNR.

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