Journal of the Nigerian Association of Mathematical Physics
Volume26, (March, 2014), **pp 375 – 378**
© J. of NAMP

Comparative Study of Blocking Probability used in Mobile Communication Networks

Osahenvemwen, O. A.[1] *and Odiase, O. F.*[2]

[1]**Department of Electrical and Electronic, Faculty of Engineering and Technology. Ambrose Alli University. Ekpoma, Edo State, Nigeria**
[2]**Department of Electrical and Electronic, Faculty of Engineering, University of Benin, Edo State, Nigeria.**

Abstract

This paper presents the comparative study of blocking probability used in mobile communication networks. It is focused at determine the relationship between the conventional Erlang B blocking probability traffic model and developed blocking probability traffic model, called the Austin J traffic model. Data were obtained from Globacom limited (mobile communication network) in Nigeria, for two years, 1st March 2010 to 29th February 2012 duration. The obtained set of traffic data, were used to validate the investigated blocking probability traffic models and also, it was simulated using MATLAB (version 7.6.3. 325) program. Statistical tools were deployed, such as correlation coefficient and coefficient of determination used to compared the developed blocking probability traffic model with conventional Erlang B blocking probability traffic model. The Erlang B blocking probability is assumed to be the observed values denoted as x; While Austin J (developed) blocking probability is denoted as y, also called the predicted values. The obtained mean value from the conventional Erlang B is 0.018 and while, Austin J traffic model is 0.019 respectively. The correlation coefficient value obtained is 0.999954, this value imply that there is a strong relationship between Erlang B blocking probability traffic model and developed (Austin J) blocking probability traffic model. Also, the coefficient of determination value obtained is 0.999908. This coefficient of determination value had shown the degree of variation between the blocking probability traffic models respectively.

Keywords: Traffic model, correlation coefficient, coefficient of determination, relationship and variation

1.0 Introduction

Models can be a mathematical equations, diagram or algorithm that represents unique characteristics of certain saturations. These models are developed to reduce cumbersome tactic in our environment. The blocking probability traffic models considered here are aimed to provide easy function in the management of transmission channels, offered traffic load (in erlang) and the expected blocking probability value. The famous Erlang B blocking probability traffic model was developed by A.K Erlang for fixed telephone network and also used in mobile communication networks [1]. Recently, a similar blocking probability traffic model was developed by Osahenvemwen et al, with unique feature and performing the same function as Erlang B traffic model. This developed traffic model by Osahenvemwen et al is referred to as Austin J traffic model. These blocking probability traffic models, for both Erlang B and Austin J are compared mathematical by deploying statistics tools known as correlation coefficient and coefficient of determination used to determine the relationship and variation between these two blocking probability traffic models [2].

Correlation coefficient is a single summary number that gives you a good idea about how closely one variable is related to another variable. Also, the coefficient of determination is a measure of the variation of the dependent variable that is explained by the regression line and the independent variable. The symbol for the coefficient of determination is r^2 [3-6].

The term "correlation" refers to a process for establishing whether or not relationships exist between two variables. Usually, the way to get a general idea about whether or not two variables are related is to plot them on a "scatter plot". If the

Corresponding author: **Osahenvemwen, O. A.,** E-mail: osahenvemwenaustin@ymail.com, Tel.: +2348037273256

dots on the scatter plot tend to go from the lower left to the upper right it means that it has one variable [3,5]. When both lines go the same direction or posses a positive numbers it is called a "*positive relationship*". On the other hand, if the dots on the scatter plot tend to go from the upper left corner to the lower right corner of the scatter plot, it means that as values on one variable go up, values on the other variable go down it is called a "*negative relationship*" [3]. Also, correlation coefficients are always between - 1 and +1. If a correlation coefficient value is larger than +1 or –1 then it is made up of a calculated error [5]. Most correlation coefficients (assuming that there are really relationships between the two variables you are examining) tend to be plus or minus 1.00, meaning that there are perfect relationships. Remember that a correlation coefficient of 0.00 means that there is no relationship between two variables investigated based on the data collected [7,8]. The closer a correlation coefficient value is to zero, the weaker the relationship is and its difficult to predict what exactly happens to one variable based on the knowledge of the other variable. The closer a correlation coefficient approaches plus or minus one, mean a stronger relationship and the more accurately you are able to predict what happens to one variable based on the knowledge you have on the other variable[5,9,10]. This correlation coefficient is used in most research work, in this study the statistical tool (correlation coefficient) is used to determine the relationship between the existing Erlang B blocking probability traffic model and the developed blocking probability (called Austin J) traffic model. The blocking probability traffic models are used in mobile telecommunication networks to determine the blocking probability in relationship with estimated number of transmission channels required, with a target offered traffic load in erlang on a geographical location [2].

2.0 Research Method

Comparative study, between the conventional Erlang B blocking probability traffic model and developed or know as Austin J) blocking probability traffic model. The developed blocking probability traffic model was based on queue theory with mobile futures. Both blocking probability traffic models were validated based on the two years, 1st March 2010 to 29th February 2012 traffic data obtained from Globacom network in Nigeria and were simulated using MATLAB (version 7.6.3. 325) program in line with obtained traffic data. In addition, statistical tools were deployed, such as correlation coefficient and coefficient of determination used to compared the developed blocking probability traffic model with conventional Erlang B blocking probability traffic model. However, the correlation coefficient is used to determine the relationship between both blocking probability traffic models and while, coefficient of determination is used to determine the degree of variation between both blocking probability traffic models in this study. In Table 1, the conventional Erlang B blocking probability values are assumed to be the observed values denoted as x, While the developed traffic model, known as Austin J blocking probability values are denoted as y, known as the predicted values.

Comparison between conventional Erlang B blocking probability traffic model and developed blocking probability traffic model using statistical tools.

The developed blocking probability traffic model obtained, called Austin J traffic model is compared with conventional Erlang B blocking probability traffic model using the same set of traffic data obtained from the field. The statistical tools deployed are correlation coefficient and coefficient of determination used to determine the relationship and the variation between the conventional Erlang B traffic model and the developed traffic model. The main idea behind the correlation coefficient is to compute an index which reflects how much two series of measurement from different traffic models are related to each other. Also correlation coefficient is always between

-1 and +1, any values less or greater than – 1 or +1 constitute of an error, while zero indicates that the two measurements from traffic models have nothing in common.

3.0 Data Analysis and Results

Correlation Coefficient parameters deployed two basic variables x and y, presented in Table 1.

$x\ represents\ observed\ values\ obtained\ from\ Erlang\ B\ blocking\ probability.$

$\bar{x}\ represents\ the\ mean\ value\ obtained\ from\ Erlang\ B\ blocking\ probability\ .$

$y\ represents\ predicted\ values\ obtained\ from\ developed\ blocking\ probability$

$\bar{y}\ represents\ the\ mean\ Predicted\ values\ obtained\ from\ developed\ blocking\ probability$

$$correlation\ coefficient\ (r) = \frac{\sum(x-\bar{x}).(y-\bar{y})}{\sqrt{\sum(x-\bar{x})^2\ .(y-\bar{y})^2}} \quad (1)$$

From Table 1, the following parameters are highlighted;

$$\sum(x-\bar{x}).(y-\bar{y}) = 0.0005082029$$

$$\sum(x-\bar{x})^2 = 0.00004995$$

$$\sum(y-\bar{y})^2 = 0.00005171$$

$\sum(x-\bar{x})^2.(y-\bar{y})^2 = 0.00004995x0.00005171 = 0.00000000258294$

$\sqrt{\sum(x-\bar{x})^2.(y-\bar{y})^2} = \sqrt{0.00000000258294}$= 0.0000508226327

Recall the correlation coefficient (r) in Equation (1) and substitute the equivalent values into the Equation.

$correlation\ \ coefficient\ (r) = \frac{\sum(x-\bar{x}).(y-\bar{y})}{\sqrt{(x-\bar{x})^2\ .(y-\ \bar{y})^2}}\ = \frac{0.00005082029}{0.00005082263}$

$correlation\ \ coefficient\ (r) = 0.999953903$

While, coefficient of determination is given as r^2

Therefore, r^2 =0.999907808

The correlation coefficient value obtained is 0.999954, which reflect strong relationship between conventional Erlang B blocking probability traffic model and developed blocking probability traffic model. This value obtained, implies that both blocking probability traffic models are affected by the same factors and also, the positive value involved, shown that the both blocking probability traffic models under goes change in the same right directions. The coefficient of determination value obtained is 0.999907808 from the value, it shown slight variation between the two blocking probability traffic models under investigation. Also, the positive value obtained, shown that the variations are on the same right directions. Based on the statistical tools deployed, it is ascertain that, the two blocking probability traffic models compared have great similarities, when used in network performance in mobile communication networks. The strong relationship obtained from both correlation coefficient and coefficient of determination help to predict the output of what happens to another traffic model (variable) based on the knowledge obtained from one of the blocking probability traffic model. Therefore, based on these statistics analysis obtained, the developed blocking probability traffic model known as Austin J traffic model can be adapted also in telecommunication networks to archive similar result in traffic network performance in term of blocking probability, in relationship with number of transmission channels and offered traffic load in erlang.

4.0 Conclusion

The study is focused on comparative study of blocking probability traffic models used in mobile communication networks. It is aimed at determine the relationship and variation between blocking probability traffic models under investigation. The conventional Erlang B blocking probability traffic model and developed blocking probability traffic model know as Austin J traffic model by deploying statistics tools known as correlation coefficient and coefficient of determination. The corresponding values obtained from correlation coefficient and coefficients of determination are 0.9999 and 0.99990 respectively. These set of values imply that there are stronger relationship between the conventional Erlang B blocking probability traffic model and Austin J blocking probability traffic model and also, shown the slight variation between conventional Erlang B and Austin J traffic model due to 1 digit closeness. The value obtained possess a positive value, which imply that as conventional Erlang B blocking probability traffic model increases also, Austin J blocking probability traffic model increases, both in the right directions. Therefore, this developed blocking probability traffic model known as Austin J blocking probability traffic model can be adapted in mobile communication networks to determined traffic network performance.

Table 1 Comparison of traffic models using correlation coefficient parameters

S/N	ROUTES ID	(x)	(y)	$(x-\bar{x})$	$(y-\bar{y})$	$(x-\bar{x})^2$	$.(y-\bar{y})^2$	Y-Y^2
1	BSC 8 (12)	0.01970	0.02002	0.0009855	0.001004	0.000000989442	0.0000009712	0.0000010080
2	BSC10_1(13)	0.01990	0.02022	0.001855	0.001204	0.000001427342	0.0000014054	0.0000014496
3	BSC 10_2(8)	0.01971	0.02003	0.0009955	0.001014	0.000001009437	0.0000009910	0.0000010282
4	BEN 13_1(15)	0.01601	0.01627	-0.0027045	-0.002746	0.000007426557	0.0000073143	0.0000075405
5	MSC11(0)	0.01978	0.02010	0.0010655	0.001084	0.000001155002	0.0000011353	0.0000011751
6	MSC16(1)	0.01972	0.02004	0.0010055	0.001024	0.000001029632	0.0000010110	0.0000010486
7	MSC17(11)	0.01989	0.02021	0.0011755	0.001194	0.000001403547	0.0000013818	0.0000014256
8	MSC2O(12)	0.01903	0.01934	0.0003155	0.000324	0.000000102222	0.0000000995	0.0000001049
9	MSC35(6)	0.01523	0.01547	-0.0034845	-0.003546	0.00001235604	0.0000121417	0.0000125741
10	MSC51(4)	0.01516	0.01539	-0.0035545	-0.003626	0.0000128886	0.0000126345	0.0000131478
11	MSC52(13)	0.01661	0.01689	-0.0021045	-0.002126	0.000004474	0.0000044289	0.0000045198
12	MSC 53(8)	0.01913	0.01940	0.0004155	0.000384	0.000000159552	0.0000001726	0.0000001474
13	MSC 54(5)	0.01956	0.01988	0.0008455	0.000864	0.0000007305	0.0000007149	0.0000007465
14	M20G2(10)	0.01914	0.01945	0.0004255	0.000434	0.000000184667	0.0000001811	0.0000001884
15	M17G2(9)	0.01943	0.01975	0.0007155	0.000734	0.000000525177	0.0000005119	0.0000005387
16	WARRIR(10)	0.01762	0.01790	-0.0010945	-0.001116	0.00000122146	0.000001198	0.0000012455
17	BSC8(14)	0.01960	0.01992	0.0008855	0.000904	0.000000800492	0.0000007841	0.0000008172
18	BSC 10_1(15)	0.01963	0.01995	0.0009155	0.000934	0.000000855077	0.000000838	0.0000008724
19	BSC10_2(2)	0.01980	0.02013	0.0010855	0.001114	0.000001209247	0.0000011783	0.0000012409
20	M37LN(14)	0.01964	0.01996	0.0009255	0.000944	0.00000087367	0.0000008565	0.0000008911

References

[1] Oliver, M. M., Mohammad, S. S., Oodit, B. and Vinaye, A., (2011). ‘A Study of voice traffic Blocking in a model cellular network,’ International Journal of wireless and mobile Networks (IJWMN), Vol.3, No. 6, Pp 101 -110.

[2] Osahenvemwen, O.A., Edeko, F.O. And Emagbetere, J. (2012),Traffic modeling in mobile communication networks, International Journal of Computer Applications (0975 – 8887), Volume 51– No.9, Pp 45-48.

[3] Harry, F., and Steven, C. A., (1995). ‘Statistics concepts and Applications’,Cambridge University Press, Pp 664-667.

[4] Rewati, R. C., and Balk, J., (2005), “Correlation and Path Coefficient Analyses in Sugarcane,’ Nepal Agric. Res..J., Vol.6, Page 24-27.

[5] http//en. Wikipedia.org/wiki/rank_ correlation, Rank correlation-Wikipedia, accessed 24, Sept; 2012.

[6] Khoshnevisan, F. M., Marvo, H.P., Singh, R.S., Smarandache, F.,(2004). Empirical Study in finite Correlation Coefficient in two Phase Estimation, International Journal of social Economics, Vol.31, Iss: 10, Pp 890-902.

[7] Sheldon, M. R., (2009), “Introduction to probability and statistics for Engineers and scientists, ”Published by Elsevier, a division of Reed Elsevier India private limited, third Edition, Pp 312-346.

[8] Georgy, S., and Pavel, S., (2011). Robust Estimation of the Correlation Coefficient an attempt of Survey, Austrian Journal of Statistics, Volume 40, Number 1&2, pp 147-156.

[9] Soong, T.T., (2004). Fundamentals of probability and Statistics for Engineers, John Wiley & Sons Ltd, page 354-358.

[10] http// arxiv.org/ftp/ arxi., The relation between Pearson correlation coefficient r and salton’s cosine measure, accessed 4, Nov; 2012.