Bounded Area Estimation of Internet Traffic Share Curve

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ABSTRACT

The problem of internet traffic sharing between two operators was discussed by Naldi (2002) and he has developed mathematical relationship between traffic share and network blocking probability. This relationship generates probability based quadratic function which has a definite bounded area. This area is a function of many parameters and needs to be estimated. But, by direct integration methods, it is difficult solve. This paper presents an approximate methodology to estimate the bounded area using Trapezoidal rule of numerical quadrature. It is found that bounded area is directly proportional to customer choice and network blocking .It helps to explain relationship among traffic share and computer network parameters.

Keywords

Probability, Area estimation, Trapezoidal rule, Network blocking, Operator.

1. INTRODUCTION

The business of Internet is going fast and many countries are still using dial-up-setup as provided by Internet operators. When network is blocked, it is called cognition and is a parameter of this satisfaction among users. Naldi (2002) has suggested Markov chain model where internet traffic sharing was involved between two network operators. He has developed expressions for traffic share and network blocking probability. These expressions are functions of many other input parameters like initial choice of user, blocking of competitor operator and probability of abandoning use. The graphical relationship between traffic share and owners blocking probability is a complex relationship and generates a curve where both axes contain probability values ranging between 0-1. Now it is need to estimate the area bounded by these curves at x-axis. If the area is high, operator can have more traffic share. The estimation of bounded area provides first hand knowledge about the traffic share status. This paper presents approximate computation of the bounded area using Trapezoidal method of numerical quadrature.

2. BACKGROUND STUDY

The stochastic modeling was initiated by Naldi (2002) and consequently utilized by Shukla, Gadewar and Pathak (2007). Shukla, Tiwari and Tiwari (2009) extend a Markov chain model approach for internet traffic sharing by introducing concept of two call basis. Shukla, Tiwari and Deshmukh (2010) suggested a new expression for traffic sharing between two operators. Shukla and Thakur (2010) examined the disconnectivity factor effect in traffic sharing and modified the traffic sharing expressions. Shukla, Verma and Gangele (2011) focused on the problem of re-attempt connectivity over the same area. Shukla, Gangele, Verma and Trivedi (2011) derived the internet traffic sharing expressions for cyber crime through elasticity analysis. Shukla and Singh (2011) utilize the knowledge of Markov chain model for the scenario of web-browsing. Some other useful contributions on traffic sharing are due to Shukla, Gangele and Verma (2012), Shukla, Verma, Dubey and Gangele (2012) where the Markov chain model utilized as a tool for expression development and curve fitting technique.

Shukla, Jain, and Ojha (2009) presented an analysis of thread scheduling with multiple processors under a Markov chain model whereas Shukla, Jain, Singhai, and Agrawal (2009) discussed Markov chain model based analysis for round robin scheduling scheme. Shukla and Jain (2009) have a discussion on deadlock analysis of a class of multi-level queue scheduling in operating system using Markov chain model. Shukla, Thakur, and Deshmukh (2009) performed a state probability analysis of Internet traffic sharing. Shukla, Tiwari, Thakur and Deshmukh (2009) contributed on the share loss analysis of Internet traffic distribution. Shukla, Tiwari, and Kareem (2009) presented a comparative analysis of Internet traffic sharing problem using Markov chain model.

Shukla, et al. (2010) discussed stochastic model approach for reaching probabilities of message flow in space division switches. Shukla, et al. (2010) examined the effect of dis-connectivity analysis in computer networks for congestion control. Shukla , Ojha and Jain (2010) suggested performance evaluation of general class of multilevel queue scheduling scheme whereas Shukla, Ojha, and Jain (2010) discussed the data model approach and Markov chain based analysis of multilevel queue scheduling.

Shukla, Jain, and Choudhary (2010) attempted for the estimation of Ready queue processing time under SL- scheduling scheme in multiprocessors environment and in similar approach Shukla , Jain, and Ojha (2010) explored the effect of data model on the analysis of multi-level queue scheduling. One more similar study is due to Shukla, Jain, and Ojha (2010) on deadlock index analysis in operating system using data model approach. Shukla, Jain, and Ojha (2010) conducted a study of scheduling for deadlock state in operating system and in parallel Shukla & Thakur (2010) presented an Index based internet traffic sharing analysis of users by a Markov chain probability model.

Shukla and Singhai (2010) performed traffic analysis of message flow in three cross-bar architecture in space division switches and accordingly Shukla , Jain, and Choudhary (2010) has a contribution on estimation of ready queue processing time under usual group lottery scheduling(GLS) in multiprocessor environment. Shukla, Thakur, and Tiwari (2010) performed stochastic modeling of Internet traffic management whereas Tiwari, Thakur, and Shukla (2010) discussed the cyber -crime analysis for multi-dimensional effect.

Shukla, Singhai, and Thakur (2011) discussed a new imputation method for missing attribute values in data mining setup whereas Shukla, Gangele , Singhai, Verma (2011) have a new viewpoint approach on elasticity analysis of web-browsing behavior of users. In a useful contribution, Shukla, Gangele, Verma, and Singh (2011) discussed elasticity and index analysis of the usual Internet traffic share problem. Moreover, Shukla, Jain and Choudhary (2011) presented an analytical approach on prediction of Ready Queue processing time in multiprocessor environment using Lottery scheduling (ULS) .Likewise, Shukla, Gangele, Verma, and Thakur (2011) performed an study on index based analysis of user of Internet traffic sharing in computer network.

Shukla, Verma, and Gangele (2012) has a contribution on least square based curve fitting approach in internet access traffic sharing in two operator environment and later Shukla, Verma, and Gangele (2012) have extended the curve fitting approximation in Internet traffic distribution in two market environment. A similar contribution is due to Shukla, Verma, Bhagwat, and Gangele (2012). Some other useful are due to Shukla and Jain (2012), Shukla and Jain (2012), Jain and Shukla (2013).

3. EXPRESSION OF TRAFFIC SHARING:

Naldi (2002) suggested the following expression for traffic sharing.

$$\bar{P}_1 = (1-L_1)\frac{p+(1-p)(1-p_A)L_2}{1-L_1L_2(1-p_A)^2} ....(3.1)$$

The graph of above expression is based on blocking probability (L_1 or L_2) and traffic sharing (P_1) of operator O_1. It provides a bounded area A within curve between X and Y axes. If the bounded area A is high then different conclusions could be drawn. Now the problem is how to estimate this bounded area. In this paper, we have tried to estimate the bounded area A using trapezoidal method of numerical analysis.

4. TRAPEZOIDAL METHOD:

Let **y = f(x)** be a function to be integrated in the range a to b (a < b). Using functional relationship, we can write n different discrete values of x in range a - b, and can write different y using y=f (x) as below:

x: x_0, x_2------ x_n

y: y_0, y_2------ y_n, ; (i=1,2,3,4,…..n) ;

where $a = x_0$, $x_1 < x_2 < x_3$, ---- $< x_n = b$ and differencing $h = (x_{i+1} - x_i)$ is like equal interval.

$$I = \int_a^b f(x)dx = \int_a^b ydx = \frac{h}{2}[y_0 + 2(y_1 + y_2 + y_3 + - - - - + y_{n-1}) + y_n] \quad .....(4.1)$$

which is known as Trapezoidal rule of Integration used in numerical analysis.

4.1 USE OF TRAPEZOIDAL METHOD:

We take the followings for (3.1), and consider $\overline{P}_1 = f(L_j)$, j=1,2, and assume

X = Blocking probability of network (L_1) or (L_2)

Y = Traffic sharing is equal to $\overline{P}_1$

And want to evaluate the following integral (suggested due to Naldi (2002)) in the limit d to l where d=0 and l=1 are the constraints:

$$I = \int_d^l f(L)dL_1 = \int_d^l (1-L_2)\left\{\frac{(1-p)+pL_1(1-p_A)}{1-L_1L_2(1-p_A)}\right\}dL_1 \quad ...(4.1.1)$$

Table 1. [for fig. (1) {Where fixed $p_A = 0.3, L_2 = 0.4, h=0.1$}]

p	**0.1**	**0.2**	**0.3**	**0.4**	**0.5**	**0.6**	**0.7**	**0.8**	**0.9**
L_1	$\overline{P}_1$	$\overline{P}_1$	$\overline{P}_1$	$\overline{P}_1$	$\overline{P}_1$	$\overline{P}_1$	$\overline{P}_1$	$\overline{P}_1$	$\overline{P}_1$
0	0.352	0.424	0.496	0.568	0.64	0.712	0.784	0.856	0.928
0.1	0.348	0.412	0.475	0.538	0.601	0.665	0.728	0.791	0.854
0.2	0.345	0.399	0.453	0.507	0.562	0.616	0.670	0.724	0.778
0.3	0.342	0.386	0.431	0.475	0.520	0.565	0.609	0.654	0.699

0.4	0.338	0.373	0.407	0.442	0.477	0.512	0.546	0.581	0.616
0.5	0.334	0.359	0.383	0.407	0.432	0.456	0.481	0.505	0.529
0.6	0.330	0.344	0.358	0.371	0.385	0.398	0.412	0.426	0.439
0.7	0.326	0.329	0.331	0.333	0.336	0.338	0.340	0.343	0.345
0.8	0.322	0.313	0.303	0.294	0.284	0.275	0.265	0.256	0.246
0.9	0.318	0.296	0.274	0.252	0.230	0.208	0.186	0.165	0.143
Area(A)	**0.302**	**0.327**	**0.353**	**0.378**	**0.403**	**0.428**	**0.454**	**0.479**	**0.504**

The data in following tables for equal intervals of L_1 (where bounded area is A): The table 1 shows that for increasing p , the area A increases subject to condition other parameters p_A and L_2 are fixed. The lowest value of area is A=0.3 at p=0.1 whereas highest value is A = 0.504 on p= 0.9.

Table 2. [for fig. (2) { Where fixed p=0.2, p_A = 0.3, , h=0.1}]

L_2	**0.1**	**0.2**	**0.3**	**0.4**	**0.5**	**0.6**	**0.7**	**0.8**	**0.9**
L_1	$\overline{P}_1$	$\overline{P}_1$	$\overline{P}_1$	$\overline{P}_1$	$\overline{P}_1$	$\overline{P}_1$	$\overline{P}_1$	$\overline{P}_1$	$\overline{P}_1$
0	0.256	0.312	0.368	0.424	0.48	0.536	0.592	0.648	0.704
0.1	0.237	0.294	0.353	0.412	0.471	0.531	0.592	0.653	0.715
0.2	0.218	0.277	0.337	0.399	0.462	0.526	0.592	0.659	0.728
0.3	0.198	0.259	0.322	0.386	0.453	0.522	0.593	0.666	0.742
0.4	0.179	0.241	0.305	0.373	0.443	0.516	0.593	0.673	0.757
0.5	0.159	0.222	0.289	0.359	0.433	0.511	0.593	0.681	0.774
0.6	0.140	0.203	0.271	0.344	0.422	0.505	0.594	0.690	0.794
0.7	0.120	0.184	0.254	0.329	0.410	0.498	0.594	0.700	0.815
0.8	0.099	0.164	0.235	0.313	0.398	0.491	0.595	0.710	0.840
0.9	0.079	0.144	0.216	0.296	0.384	0.484	0.595	0.723	0.868
Area(A)	**0.152**	**0.207**	**0.266**	**0.327**	**0.392**	**0.461**	**0.534**	**0.612**	**0.695**

The table 2 shows that for increasing L_2, the area A increases subject to condition other parameters p_A and p are fixed. The lowest value of area is A = 0.152 at L_2=0.1 whereas highest value is A=0.695 on L_2=0.9.

Table 3. [for fig. (3){ where p = 0.5, L_2 = 0.4, h=0.1}]

p_A	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
L_1	$\overline{P}_1$	$\overline{P}_1$	$\overline{P}_1$	$\overline{P}_1$	$\overline{P}_1$	$\overline{P}_1$	$\overline{P}_1$	$\overline{P}_1$	$\overline{P}_1$
0	0.680	0.660	0.640	0.620	0.600	0.580	0.560	0.540	0.520
0.1	0.651	0.626	0.601	0.578	0.555	0.533	0.511	0.490	0.470
0.2	0.620	0.590	0.562	0.535	0.510	0.486	0.463	0.441	0.420
0.3	0.587	0.552	0.520	0.491	0.463	0.438	0.414	0.391	0.370
0.4	0.551	0.512	0.477	0.445	0.416	0.389	0.365	0.342	0.320
0.5	0.513	0.470	0.432	0.398	0.368	0.340	0.315	0.292	0.270
0.6	0.471	0.425	0.385	0.350	0.319	0.291	0.265	0.242	0.220
0.7	0.426	0.377	0.336	0.300	0.268	0.240	0.215	0.192	0.170
0.8	0.377	0.326	0.284	0.248	0.217	0.189	0.164	0.141	0.120
0.9	0.324	0.272	0.230	0.195	0.164	0.137	0.113	0.091	0.070253
Area(A)	**0.470**	**0.434**	**0.403**	**0.375**	**0.350**	**0.326**	**0.305**	**0.285**	**0.265**

The table 3 shows that for increasing p_A, the area A decreases subject to condition other parameters p and L_2 are fixed. The highest value of area is A=0.470 at p_A = 0.1 whereas lowest value is A = 0.265 on p_A =0.9 .

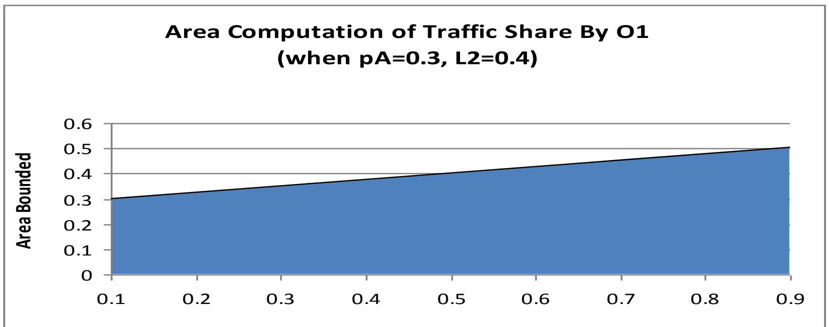

Fig 1. (Variation over p)

Fig 1 supports the facts observed in table 1 over variation of estimated bounded area A.

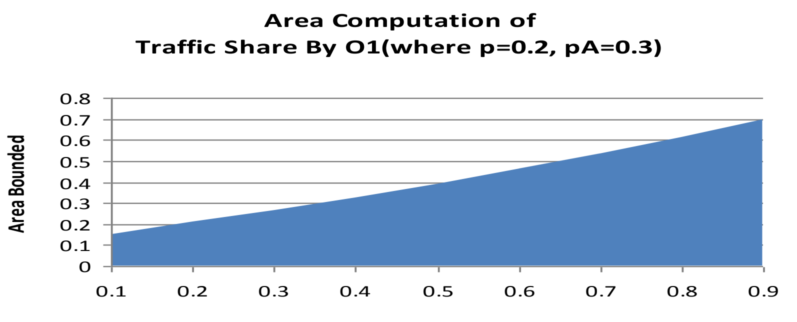

Fig. 2 (Variation over L2)

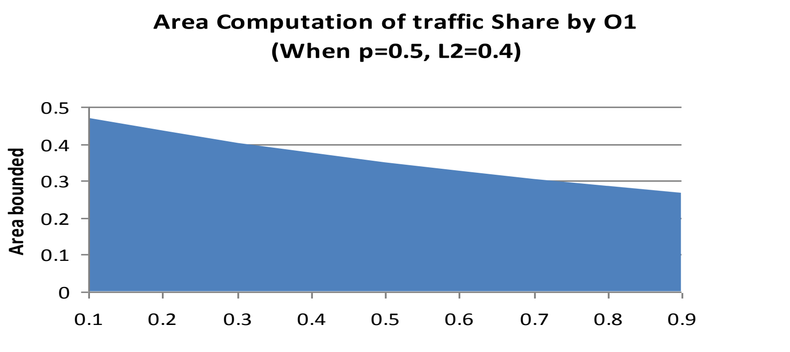

Fig. 3 (Variation over pA)

The fig 2 and 3 support the observations in table 2 & 3 over variation of estimated bounded area A. Consider another form of integration as below:

$$I = \int_d^l f(L)dL_2 = \int_d^l (1-L_1)\left\{\frac{p+(1-p)(1-p_A)L_2}{1-L_1L_2(1-p_A)}\right\}dL_2 \quad ....(4.1.2)$$

We have data in following tables for equal intervals of L_2 (taking A as bounded area):

Table 4. [for fig. (4) { where $p_A = 0.3, L_1 = 0.4, h=0.1$}]

p	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
L_2	$\overline{P}_1$	$\overline{P}_1$	$\overline{P}_1$	$\overline{P}_1$	$\overline{P}_1$	$\overline{P}_1$	$\overline{P}_1$	$\overline{P}_1$	$\overline{P}_1$
0	0.928	0.856	0.784	0.712	0.64	0.568	0.496	0.424	0.352
0.1	0.851	0.785	0.719	0.653	0.587	0.521	0.455	0.389	0.323
0.2	0.772	0.712	0.652	0.59	0.532	0.472	0.412	0.353	0.293
0.3	0.690	0.636	0.583	0.529	0.475	0.422	0.368	0.311	0.261

0.4	0.604	0.557	0.510	0.463	0.416	0.369	0.322	0.276	0.229
0.5	0.514	0.474	0.434	0.394	0.354	0.314	0.274	0.235	0.195
0.6	0.420	0.388	0.355	0.322	0.290	0.257	0.224	0.192	0.159
0.7	0.322	0.297	0.272	0.247	0.222	0.197	0.172	0.147	0.122
0.8	0.220	0.203	0.185	0.168	0.151	0.134	0.117	0.100	0.083
0.9	0.112	0.103	0.095	0.086	0.077	0.068	0.060	0.051	0.042
Area(A)	**0.491**	**0.454**	**0.415**	**0.377**	**0.339**	**0.301**	**0.262**	**0.225**	**0.186**

The table 4, 5, 6 are made on varying values of L_2 when many parameters are constant. Table 4 shows that for increasing p, the area A decreases subject to condition other parameters p_A and L_1 are fixed. The highest value of area is A=0.491 at p=0.1 whereas lowest value is A=0.186 on p=0.9.

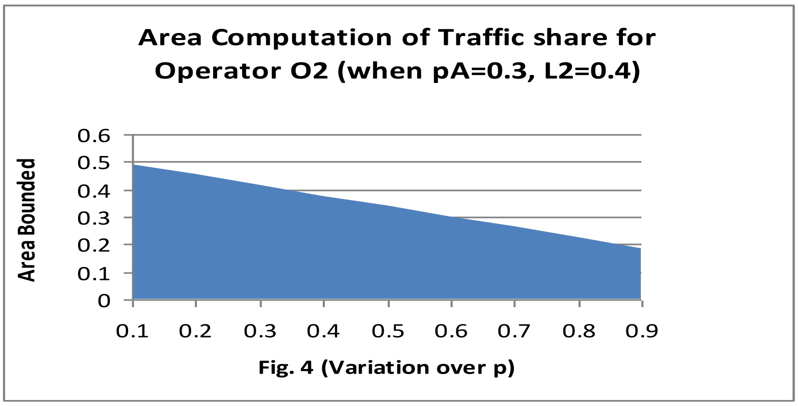

Fig 4 supports the facts observed in table 4 over variation of estimated bounded area A.

Table 5. [for fig. (5) { where p = 0.2, p_A = 0.3, h=0.1}]

L_1	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
L_2	$\bar{P}_1$	$\bar{P}_1$	$\bar{P}_1$	$\bar{P}_1$	$\bar{P}_1$	$\bar{P}_1$	$\bar{P}_1$	$\bar{P}_1$	$\bar{P}_1$
0	0.814	0.828	0.842	0.856	0.87	0.884	0.898	0.912	0.926
0.1	0.736	0.752	0.769	0.785	0.802	0.819	0.836	0.854	0.871
0.2	0.657	0.675	0.694	0.712	0.731	0.751	0.771	0.791	0.812

0.3	0.578	0.597	0.616	0.636	0.657	0.678	0.700	0.723	0.747
0.4	0.498	0.517	0.536	0.557	0.578	0.601	0.624	0.648	0.674
0.5	0.417	0.435	0.454	0.474	0.495	0.518	0.541	0.567	0.593
0.6	0.335	0.351	0.369	0.388	0.407	0.429	0.452	0.476	0.503
0.7	0.252	0.266	0.281	0.297	0.315	0.333	0.354	0.377	0.401
0.8	0.169	0.179	0.190	0.203	0.216	0.231	0.247	0.265	0.286
0.9	0.08	0.090	0.097	0.103	0.111	0.120	0.129	0.140	0.153
Area(A)	**0.409**	**0.423**	**0.438**	**0.453**	**0.469**	**0.486**	**0.504**	**0.523**	**0.543**

Table 5 shows that for increasing L_1, the area A increases subject to condition other parameters p_A and p are fixed. The lowest value of area is A=0.049 at L_1=0.1 whereas highest value is A=0.543 on L_1=0.9.

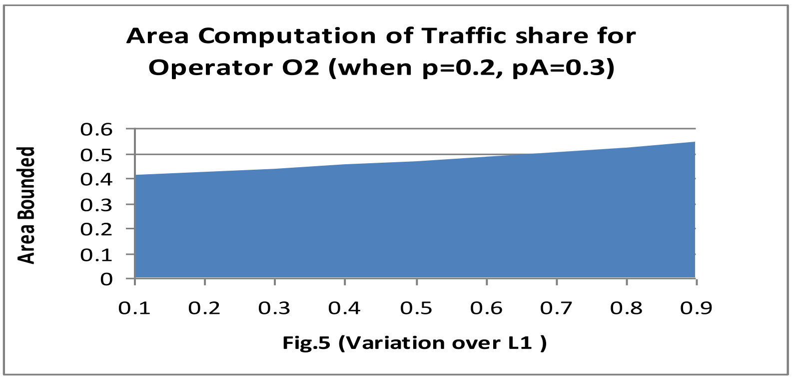

Fig.5 (Variation over L1)

Fig 5 supports the facts observed in table 5 over variation of estimated bounded area A.

Table 6. [for fig. (6) {where p = 0.5, L_1 = 0.4, h=0.1}]

p_A	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
L_2	$\bar{P}_1$	$\bar{P}_1$	$\bar{P}_1$	$\bar{P}_1$	$\bar{P}_1$	$\bar{P}_1$	$\bar{P}_1$	$\bar{P}_1$	$\bar{P}_1$
0	0.680	0.660	0.640	0.620	0.600	0.580	0.560	0.540	0.520
0.1	0.632	0.609	0.587	0.566	0.545	0.525	0.505	0.486	0.468
0.2	0.581	0.556	0.532	0.510	0.489	0.470	0.451	0.433	0.416

0.3	0.527	0.500	0.475	0.453	0.432	0.413	0.396	0.379	0.364
0.4	0.468	0.441	0.416	0.394	0.375	0.357	0.340	0.326	0.312
0.5	0.405	0.378	0.354	0.334	0.315	0.299	0.285	0.272	0.260
0.6	0.337	0.311	0.290	0.271	0.255	0.241	0.228	0.218	0.208
0.7	0.263	0.241	0.222	0.206	0.193	0.182	0.172	0.163	0.156
0.8	0.183	0.165	0.151	0.140	0.130	0.122	0.115	0.109	0.104
0.9	0.095	0.085	0.077	0.071	0.065	0.061	0.057	0.054	0.052
Area(A)	**0.378**	**0.357**	**0.339**	**0.322**	**0.307**	**0.293**	**0.280**	**0.268**	**0.257**

The table 6 shows that for increasing p_A, the area A decreases subject to condition other parameters p and L_1 are fixed. The highest value of area is as A=0.378 at p_A =0.1 whereas lowest value is A= 0.257 on p_A = 0.9.

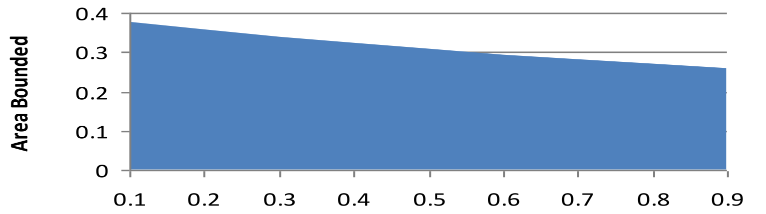

Fig. 6 (Variation over pA)

Fig 6 supports the facts observed in table 6 over variation of estimated bounded area A.

5. DISCUSSION

The bounded area A is propositional to initial choice p. We can express A as directly proportional variable to p when p_A, L_2 are kept constants (see table 1). Although rate of increment is slow as if p is doubled then area A has only 5 to 10 percent increment. When p is at highest level (p=0.9) the bounded area A is nearly approaching to level 50 percent.

The bounded area A is also proportional to opponent blocking probability L_2 of the network competitor. The rate of increment in area A is higher than as observed in earlier table. At the highest level equal to 0.9, the maximum area is 0.69. When we look into the relation between bounded area A and p_A

parameter, it is of inversely proportional nature. The larger p_A reduces fast to the bounded area A.

As per Table 4, where the variation of blocking probability L_2 relates opposite to A, it is observed that bounded area A is inversely propositional to the L_2. The decrement rate is nearly 5 percent for unit increase in initial probability p. Table 5 depicts the bounded area variation with two different blocking probabilities. Increment in L_1 provides higher levels of bounded area for operator O_2. Similarly, as per table 6, the p_A and bounded area are inversely proportional with the 2 to 3 percent decrement rate.

6. CONCLUSION

This is observed that estimated bounded area A contains lots of information about the traffic sharing phenomenon. The A is directly proportional to the initial preference p of consumer. It is also to state that bounded area is directly proportional to the blocking probability of the owner's network. When blocking probability of network competitor increases, bounded area reduces. It provides the knowledge of relationship between initial preference p and network blocking probabilities L_1 and L_2.

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