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# Least Square Curve Fitting Applications under Rest State Environment in Internet Traffic Sharing in Computer Network

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***Abstract*— While dealing with internet users in the setup of two operators the relationship between traffic sharing and blocking probability is examined by many authors using Markov chain model. Assuming dial-up-setup of connection network and introduction of rest state the mathematical relationship has been modified. This relationship contains many input parameters of the model with special reference to rest state parameter. This paper presents a much simplified form of relationship between blocking probability and traffic sharing under rest state. Because of variation of model parameter there is always an expected change in the equation of straight line. All these changes are average out to get best average linear relationship between traffic sharing and blocking probability. This one is useful for immediate computations of traffic sharing levels when input has variant values.**

***Index Terms*– Transition Probability Matrix (TPM), Markov Chain Model (MCM), Coefficient of Determination (COD) and Confidence Interval**

## I. INTRODUCTION

THE Internet is one of the most widely used tool for accessing the digital information. This service may be implemented through broadband or dial-up-setup. Many developing countries are still having dial-up-setup for market connections. Naldi (2002) has suggested a relationship between traffic sharing and blocking probability in a network using Markov chain model under the assumption of two networks operators. Shukla and Thakur (2010) extended the approach by introducing a rest state in the structural setup. The modified form of relationship contains many parameters therefore the actual simplified form is difficult to understand. In this paper an attempt has been made to express the actual relationship between traffic sharing and blocking probability in linear simplified form.

## II. A REVIEW

The stochastic process has been used by many scientists and researchers for the purpose of statistical modeling whose detailed description is in Medhi (1991, 1992). Chen and Mark (1993) discussed the fast packet switch shared concentration and output queueing for a busy channel. Humbali and Ramani (2002) evaluated multicast switch with a variety of traffic patterns. Newby and Dagg (2002) have a useful contribution on the optical inspection and maintenance for stochastically deteriorating system. Dorea *et al.* (2004) used Markov chain for the modelling of a system and derived some useful approximations. Yeian and Lygeres (2005) presented a work on stabilization of class of stochastic different equations with Markovian switching. Shukla *et al.* (2007 a) advocated for model based study for space division switches in computer network. Shukla *et al.*(2007 b) presented crime based user analysis in internet traffic sharing under cyber crime. Francini and Chiussi (2002) discussed some interesting features for QoS guarantees to the unicast and multicast flow in multistage packet switch.

On the reliability analysis of network a useful contribution is by Agarwal and Lakhwinder (2008) whereas Paxson (2004) introduced some of their critical experiences while measuring the internet traffic. Shukla *et al.* (2009 a, b and c) presented different dimensions of internet traffic sharing in the light of share loss analysis and comparison of method for internet traffic sharing. Shukla *et al.*(2009) studied rest state analysis in internet traffic distribution in multi-operator environment. Shukla and Thakur (2009) discussed a modeling of behavior of cyber criminals when two internet operators in markets. Shukla *et al.* (2009) studied and discussed Markov chain model for the analysis of round robin scheduling and state probability analysis of internet traffic sharing.

Shukla *et al*. (2010 a, b. c, d, e and f) have given some Markov Chain model applications in view to disconnectivity factor, multi marketing and crime based analysis. Shukla *et al*. (2010) presented Index based internet traffic analysis of users by a Markov chain model. Shukla *et al*. (2010 a, b, c and d) discussed cyber crime analysis for multidimensional effect in computer network and internet traffic sharing. Shukla *et al.* (2010) presented ISO-Share analysis of internet traffic sharing in presence of favoured disconnectivity. Shukla *et al*. (2011 a, b, c, d, e, f and g) discussed the elasticity property and its impact on parameters of internet traffic sharing in presence blocking probability of computer network specially when two operators are in business competitions with each other in a market. Shukla, Tiwari and Thakur (2011) presented analysis of internet traffic distribution for user behavior based probability in multi-market environment. Shukla *et al.* (2011) presented analysis of user web browsing using Markov chain model for ISO-browser share probability. Shukla *et al.* (2012) studied least square curve fitting for ISO-Failure in Web Browsing using Markov Chain Model. Shukla, Verma and Gangele (2012) presented Least Square Based Curve Fitting in Internet Access Traffic Sharing in Two Operator Environment.

## III. USERS BEHAVIOUR AS SYSTEM

Consider following hypotheses for the behaviour of user, with rest, blocking, and initial choice parameters, while sharing the traffic between the two operators.

- The competitive market has a café, containing Internet facility of operators $O_1$ and $O_2$.
- A user enters into café with initial choice (first choice) p and (1-p) for $O_1$ and $O_2$ respectively ($0 \le p \le 1$).
- The p is affected by advertising, marketing, quality-of-service and past preference (or attractiveness).
- The premise of café has a place for human energy recharge (like, rest, entertainment, games, refreshment etc.) denoted as R, with probability $p_R$.
- After each failed call attempt, the user has three choices:
  i. he can abandon with probability $p_A$,
  ii. switch over to other operator for a new attempt or moves for a little rest (on R).
- From R, user switches to either of operators [with probability r and (1-r)] but can not abandon.
- Switching among $O_1$, $O_2$ and R is on a call-by-call basis depending just on the latest attempt. The physical movement of user is also an attempt.

During the repeated call, the blocking probability offered by $O_1$ is $L_1$ and of $O_2$ is $L_2$. The blocking implies situation when call attempt process fails to connect an operator.

## IV. MARKOV CHAIN MODEL

These types models are used by Shukla *et. al.* (2007), Shukla and Gadewar (2007) in switch architecture analysis in computer network.

Under hypotheses of user's behaviour and user's attitude can be modelled by a five-state discrete-time Markov chain $\{X^{(n)}, n \ge 0\}$ such that $X^{(n)}$ stands for the state of random variable $X$ at $n^{th}$ attempt (call or movement) made by a user over state space $\{O_1, O_2, R, Z, A\}$, where

**State** $O_1$ : first operator

**State** $O_2$ : second operator

**State** $R$ **:** temporary rest for a short time

**State** $Z$ : success (in connectivity)

**State** $A$ : abandon the call connectivity attempt process.

The Fig. 1 explains the diagrammatic form of transition and Fig. 2 is transition probability matrix of order 6X6 of this model.

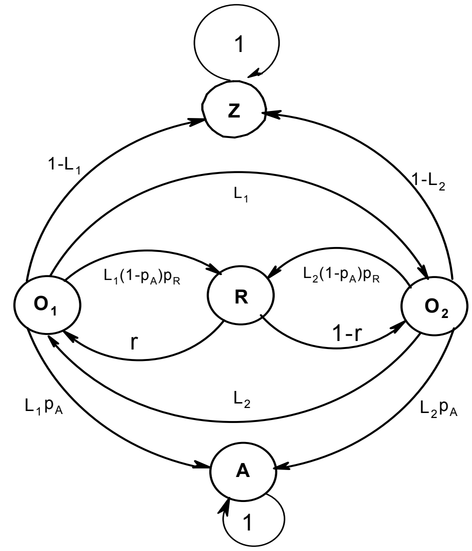


Fig. 1. (Transition model) [Using Shukla and Thakur (2010)]

## V. COMPUTATION OF TRANSITION PROBABILITIES BETWEEN STATES

(i) The initial probabilities (initial choice) for user to start with from any operators

$$P\left[X^{(0)} = O_1\right] = p, P\left[X^{(0)} = O_2\right] = (1-p) \quad ...(5.1),$$

(ii) If in $(n-1)^{th}$ attempt, call for $O_1$ blocked, and user abandons the process.

$$P\left[X^{(n)} = A \big/ X^{(n-1)} = O_1\right] \quad ...(5.2)$$

(iii) P[blocked at $O_1$ ] P[ abandon the process ]

$= L_1 p_A$

Similar for $O_2$,

$$P\left[X^{(n)} = A \big/ X^{(n-1)} = O_2\right] = L_2 p_A \quad ...(5.3)$$

(iv) At $O_1$ in $n^{th}$ attempt, call is successful only when call does not block in $(n-1)^{th}$ and user is at Z in the next.

$$P\left[X^{(n)} = Z \big/ X^{(n-1)} = O_1\right] \quad ....(5.4)$$

= P [not blocked at $O_1$] = $(1-L_1)$

Similar for $O_2$,

$$P\left[X^{(n)} = Z \big/ X^{(n-1)} = O_2\right] = (1-L_2) \quad ......(5.5)$$

(v) At $O_1$, when call blocked in $(n-1)^{th}$ attempt, user does not want to abandon, but wants a little rest then,

$$P\left[X^{(n)} = R \middle/ X^{(n-1)} = O_1\right] \quad ....(5.6)$$

= P [blocked at $O_1$] P[not abandon] P[a little rest]

$$= L_1(1-p_A)p_R$$

Similar to $O_2$,

$$P\left[X^{(n)} = R \middle/ X^{(n-1)} = O_2\right] = L_2(1-p_A)p_R \quad ...(5.7)$$

At $O_1$, if call is blocked in $(n-1)^{th}$ attempt, user does not want both abandon and rest, then he shifts to $O_2$.

$$P\left[X^{(n)} = O_2 \middle/ X^{(n-1)} = O_1\right] \quad ...(5.8)$$

= P [blocked at $O_1$] P [not abandon] P[not rest]

$$= L_1(1-p_A)(1-p_R)$$

Similar to $O_2$,

$$P\left[X^{(n)} = O_1 \middle/ X^{(n-1)} = O_2\right] = L_2(1-p_A)(1-p_R) ...(5.9)$$

(vi) Also, assume for, $0 \le r \le 1$

$$\left.\begin{aligned} P\left[X^{(n)} = O_1 \middle/ X^{(n-1)} = R\right] &= r \\ P\left[X^{(n)} = O_2 \middle/ X^{(n-1)} = R\right] &= 1-r \end{aligned}\right\} ...(5.10)$$

State

s ($X^n$)

States $X^{(n-1)}$

$$\left[\begin{array}{c|ccccc} & O_1 & O_2 & R & Z & A \\ \hline O_1 & 0 & L_1(1-P_A)(1-P_R) & L_1(1-P_A)P_R & 1-L1 & L_1P_A \\ O_2 & L_2(1-P_A)(1-P_R) & 0 & L_2(1-P_A)P_R & 1-L_2 & L_2P_A \\ R & r & 1-r & 0 & 0 & 0 \\ Z & 0 & 0 & 0 & & 0 \\ A & 0 & 0 & 0 & 0 & 1 \end{array}\right]$$

Fig. 2. (Transition Probability Matrix) [*using Shukla and Thakur 2010)*]

## VI. SOME RESULTS FOR $n^{th}$

**Theorem 6.1:** If user restricts to only $O_1$ and R then $n^{th}$ attempt state probabilities are:

$$P\left[X^{(2n)} = O_1\right] = pE^n, P\left[X^{(2n+1)} = O_1\right] = 0 \quad ...(6.1)$$

Where $E = B_1 r$, $B_1 = L_1(1-p_A)p_R$

**Theorem 6.2:** If user restricts to only $O_2$ and $R$ then $n^{th}$ attempt state probabilities are:

$$P[X^{(2n)} = O_2] = (1-p)D, P[X^{(2n+1)} = O_2] = 0 ...(6.2)$$

Where, $D = B_2(1-r)$, $B_2 = L_2(1-p_A)p_R$

**Theorem 6.3:** If user restricts to only between $O_1$ and $O_2$, not interested for $R$ then,

$$\left.\begin{aligned} P\left[X^{(2n)} = O_1\right] &= pC^n \\ P\left[X^{(2n+1)} = O_1\right] &= (1-p)A_2C^n \\ P\left[X^{(2n)} = O_2\right] &= (1-p)C^n \\ P\left[X^{(2n+1)} = O_2\right] &= pA_1C^n \end{aligned}\right\} ...(6.3)$$

Where $C = A_1A_2$, $A_1 = L_1(1-p_A)(1-p_R)$, $A_2 = L_2(1-p_A)(1-p_R)$

**Theorem 6.4:** If call attempt is among $O_1$, $O_2$ and $R$ only then for $n^{th}$ state probability the approximate expressions of probabilities are,

$$\left.\begin{aligned} P\left[X^{(2n)} = O_1\right] &= p(C+E)^n \\ P\left[X^{(2n+1)} = O_1\right] &= (1-p)A_2(C+D+E)^n \\ P\left[X^{(2n)} = O_2\right] &= (1-p)(C+D)^n \\ P\left[X^{(2n+1)} = O_2\right] &= pA_1(C+D+E)^n \end{aligned}\right\} ...(6.4)$$

## VII. TRAFFIC SHARE OVER LARGE NUMBER OF ATTEMPTS

Suppose n is large, then $\overline{P_i} = \left[\lim_{n\to\infty} \overline{P_i}^{(n)}\right]$, i = 1, 2 and

$$\left.\begin{aligned}
\left[\overline{P_1}\right]_{FU} &= \frac{(1-L_1)p}{1-E}\\
\left[\overline{P_2}\right]_{FU} &= \frac{(1-L_2)(1-p)}{1-D}\\
\left[\overline{P_1}\right]_{PIU} &= (1-L_1)\left[\frac{p+(1-p)A_2}{1-C}\right]\\
\left[\overline{P_2}\right]_{PIU} &= (1-L_2)\left[\frac{(1-p)+pA_1}{1-C}\right]\\
\left[\overline{P_1}\right]_{CIU} &= (1-L_1)\left[\frac{p}{1-(C+E)}+\frac{(1-p)A_2}{1-(C+D+E)}\right]\\
\left[\overline{P_2}\right]_{CIU} &= (1-L_2)\left[\frac{1-p}{1-(C+D)}+\frac{pA_1}{1-(C+D+E)}\right]
\end{aligned}\right\} \quad ...(7.1)$$

## VIII. LEAST SQUARE CURVE FITTING

We suggest a linear relationship where a, b are constants

$$\overline{P_1} = \hat{a} + \hat{b}.L_1 \quad ....(8.1)$$

Let $((\overline{P}_{1i,}L_{1i})\ i = 1,2,3....n$ be n observations generated from $\left[\overline{P_1}\right]_{FU}$ and $\left[\overline{P_1}\right]_{PIU}$ of equation (7.1) keeping values fixed for p, $p_A$ and $L_2$. Suppose n=9 and blocking probabilities for $L_1$ are (0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9) then using (8.1), the generated data of $\left[\overline{P_1}\right]_{FU}$ and $\left[\overline{P_1}\right]_{PIU}$ are is in table (9.1, 9.2, 9.3, 9.4, 9.5 and 9.6). The estimated $\hat{P}_1$ is obtained using line equation (9.1) with values of $\hat{a},\hat{b}$.

## XI. FITTING THE STRAIGHT LINE

We suggest an approximate the relationship between parameter $\left[\overline{P_1}\right]_{FU}$ and $\left[\overline{P_1}\right]_{PIU}$ and $L_1$ through a straight line $\left[\overline{P_1}\right]_{FU}$ =a+b.$L_1$ and $\left[\overline{P_1}\right]_{PIU}$ = a+b.$L_1$. The normal equations are

$$\left.\begin{aligned}
\sum_{i=1}^{n} P_{1i} &= n.a + b\sum_{i=1}^{n} L_1\\
\sum P_{1i}.L_{1i} &= a\sum_{i=1}^{n} L_1 + b\sum_{i=1}^{n} L_1^{\,2}
\end{aligned}\right\} \quad ...(9.1)$$

Where $P_{1i}$ = $\left[\overline{P_1}\right]_{FU}$ or $\left[\overline{P_1}\right]_{PIU}$

Solving the above equation the least square estimate are a and b are (denoted as $\hat{a},\hat{b}$ ):

$$\hat{a} = \left\{\frac{1}{n}\sum_{i=1}^{n} P_{1i} - \hat{b}\sum_{i=1}^{n} L_1\right\} \quad ...(9.2)$$

$$\hat{b} = \left\{\frac{n\sum_{i=1}^{n} P_{1i}L_1 - (\sum_{i=1}^{n} P_1)(\sum L_1)}{n\sum_{i=1}^{n} L_1^{\,2} - (\sum_{i=1}^{n} L_1)^2}\right\} \quad ....(9.3)$$

Where n is the number of observations in sample (n) and the coefficient of determination (COD) is defined as

$$\text{COD} = \left\{\frac{\sum(\hat{P}_{1i} - \overline{P_1})^2}{\sum(P_{1i} - \overline{P_1})^2}\right\} \quad ...(9.4)$$

where $\overline{P_1} = \frac{1}{n}\sum P_{1i}$ is mean of original data of $P_1$ obtained through Markov chain model. The term $\hat{P}_1 = \hat{a} + \hat{b}.L_1$ is the estimated value given observation $L_1$. The COD lies between 0 to 1. If the straight line is good fit then it is near to 1. We generate pair of value ($\overline{P_1}$, $L_1$) from express tables (9.1, 9.2, 9.3, 9.4, 9.5 and 9.6) by providing values of fixed input parameters.

Table 9.1, 9.2, 9.3 are based on $\left[\overline{P_1}\right]_{FU}$ and 9.4, 9.5, 9.6 are for $\left[\overline{P_1}\right]_{PIU}$ where

$$\left[\overline{P_1}\right]_{FU} = \frac{(1-L_1)p}{1-E} \quad ...(9.5)$$

$$\left[\overline{P_1}\right]_{PIU} = (1-L_1)\left[\frac{p+(1-p)A_2}{1-C}\right] \quad ...(9.6)$$

Table 9.1: [Values of $L_1$, $[P_1]_{FU}$ and $[\hat{P}_1]_{FU}$] when p=0.4, $L_2$=0.3, $p_A$=0.2

| **Fixed parameter** | $L_1$ | 0.1 | 0.2 | 0.3 | 0.4 | 0.5 | 0.6 | 0.7 | 0.8 | 0.9 | **COD** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| p=0.4<br>$L_2$=0.3<br>$p_A$=02 | $P_1$ | 0.3719 | 0.3418 | 0.3097 | 0.2752 | 0.2380 | 0.1980 | 0.1546 | 0.1075 | 0.0561 | **0.9925** |
| | $\hat{P}_1$ | 0.3850 | 0.3458 | 0.3065 | 0.2673 | 0.2281 | 0.1889 | 0.1496 | 0.1104 | 0.0712 | |

$$\hat{a} = 0.4242; \quad \hat{b} = -0.3922; \quad \hat{P}_1 = 0.4242 - 0.3922.(L_1) \qquad ...(9.6.1)$$

Table 9.2: [Values of $L_1$, $[P_1]_{FU}$ and $[\hat{P}_1]_{FU}$] when p=0.4, $L_2$=0.5, $p_A$=0.5

| **Fixed parameter** | $L_1$ | 0.1 | 0.2 | 0.3 | 0.4 | 0.5 | 0.6 | 0.7 | 0.8 | 0.9 | **COD** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| p=0.4<br>$L_2$=0.5<br>$p_A$=0.5 | $P_1$ | 0.3673 | 0.3333 | 0.2978 | 0.2608 | 0.2222 | 0.1818 | 0.1395 | 0.0952 | 0.0487 | **0.9975** |
| | $\hat{P}_1$ | 0.3752 | 0.3355 | 0.2958 | 0.2560 | 0.2163 | 0.1765 | 0.1368 | 0.9712 | 0.0573 | |

$$\hat{a} = 0.4150; \quad \hat{b} = -0.3973; \quad \hat{P}_1 = 0.4150 - 0.3973.(L_1) \qquad ...(9.6.2)$$

Table 9.3: [Values of $L_1$, $[P_1]_{FU}$ and $[\hat{P}_1]_{FU}$] when p=0.4, $L_2$=0.7, $p_A$=0.7

| **Fixed parameter** | $L_1$ | 0.1 | 0.2 | 0.3 | 0.4 | 0.5 | 0.6 | 0.7 | 0.8 | 0.9 | **COD** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| p=0.4<br>$L_2$=0.7<br>$p_A$=0.7 | $P_1$ | 0.3643 | 0.3278 | 0.2904 | 0.2521 | 0.2127 | 0.1724 | 0.1310 | 0.0884 | 0.0448 | **0.9992** |
| | $\hat{P}_1$ | 0.3690 | 0.3291 | 0.2891 | 0.2492 | 0.2093 | 0.1694 | 0.1295 | 0.0896 | 0.0497 | |

$$\hat{a} = 0.4089; \quad \hat{b} = -0.3991; \quad \hat{P}_1 = 0.4089 - 0.3991.(L_1) \qquad ...(9.6.3)$$

**Where $P_1 = [P_1]_{PIU}$ and** $\hat{P}_1 = [\hat{\bar{P}}_1]_{PIU}$

Table 9.4: [Values of $L_1$, $[P_1]_{PIU}$ and $[\hat{P}_1]_{PIU}$] when p=0.4, $L_2$=0.3, $p_A$=0.2

| Fixed parameter | $L_1$ | 0.1 | 0.2 | 0.3 | 0.4 | 0.5 | 0.6 | 0.7 | 0.8 | 0.9 | COD |
|---|---|---|---|---|---|---|---|---|---|---|---|
| p=0.4 $L_2$=0.3 $p_A$=0.2 | $P_1$ | 0.4408 | 0.3945 | 0.3476 | 0.3001 | 0.2519 | 0.2029 | 0.1533 | 0.1029 | 0.0518 | 0.9997 |
| | $\hat{P}_1$ | 0.4440 | 0.3954 | 0.3468 | 0.2981 | 0.2495 | 0.2009 | 0.1523 | 0.1037 | 0.0551 | |

$$\hat{a} = 0.4926; \quad \hat{b} = -0.4860; \quad \hat{P}_1 = 0.4926 - 0.4860.(L_1) \qquad ...(9.6.4)$$

Table 9. 5: 4 [Values of $L_1$, $[P_1]_{PIU}$ and $[\hat{P}_1]_{PIU}$] when p=0.4, $L_2$=0.5, $p_A$=0.5

| Fixed parameter | $L_1$ | 0.1 | 0.2 | 0.3 | 0.4 | 0.5 | 0.6 | 0.7 | 0.8 | 0.9 | COD |
|---|---|---|---|---|---|---|---|---|---|---|---|
| p=0.4 $L_2$=0.5 $p_A$=0.5 | $P_1$ | 0.4429 | 0.3955 | 0.3476 | 0.2993 | 0.2506 | 0.2014 | 0.1517 | 0.1016 | 0.0510 | 0.9999 |
| | $\hat{P}_1$ | 0.4450 | 0.3960 | 0.3471 | 0.2981 | 0.2491 | 0.2001 | 0.1511 | 0.1021 | 0.0531 | |

$$\hat{a} = 0.4940; \quad \hat{b} = -0.4898; \quad \hat{P}_1 = 0.4940 - 0.4898.(L_1) \qquad ...(9.6.5)$$

Table 9.6: 4 [Values of $L_1$, $[P_1]_{PIU}$ and $[\hat{P}_1]_{PIU}$] when p=0.4, $L_2$=0.7, $p_A$=0.7

| Fixed parameter | $L_1$ | 0.1 | 0.2 | 0.3 | 0.4 | 0.5 | 0.6 | 0.7 | 0.8 | 0.9 | COD |
|---|---|---|---|---|---|---|---|---|---|---|---|
| p=0.4 $L_2$=0.7 $p_A$=0.7 | $P_1$ | 0.4525 | 0.4038 | 0.3548 | 0.3054 | 0.2555 | 0.2052 | 0.1546 | 0.1034 | 0.0519 | 0.9999 |
| | $\hat{P}_1$ | 0.4544 | 0.4043 | 0.3543 | 0.3042 | 0.2541 | 0.2041 | 0.1540 | 0.1039 | 0.0539 | |

$$\hat{a} = 0.5045; \quad \hat{b} = -0.5006; \quad \hat{P}_1 = 0.5045 - 0.5006.(L_1) \qquad ...(9.6.6)$$

## X. CONFIDENCE OF INTERVALS (COI)

The 100(1- $\alpha$) percent confidence interval for a and b are:

$$\hat{a} \pm \left\{ t_{(n-2)} \frac{\alpha}{2} \right\} . s \left[ \sqrt{\frac{1}{n} + \frac{\overline{L}_1}{\sum_{i=1}^{n} (L_{1i} - \overline{L}_1)^2}} \right] ...(10.1)$$

Where $\overline{L_1} = \frac{1}{n}\sum_{i=0}^{n} L_{1i}$. The $\overline{L_1}$ = 4.5 for all table (9.1, 9.2, 9.3, 9.4, 9.5 and 9.6 )

$$\hat{b} \pm \left\{t_{(n-2)}, \frac{\alpha}{2}\right\}.s\left[\sqrt{\sum_{i=1}^{n}(L_{1i}-\overline{L_1})^2}\right] \quad ...(10.2)$$

Where s= $\sqrt{\frac{\sum (P_i - \hat{P}_i)^2}{n-2}}$ and $t_{(n-2)} \frac{\alpha}{2}$ is obtained from standard table. Take $\alpha$ =0.05, n=9 then $t_7$, 0.025=2.365

Table 10.1: Confidence interval for a and b using (9.5)

| **Fixed parameter** | Constant (a) | Constant (b) | Confidence Interval |
|---|---|---|---|
| p=0.4,$L_2$=0.3,$p_A$=0.2 | $\hat{a}$ =0.4242 | $\hat{b}$ =-0.3922 | For a: (a=0.4012, a=0.4472)<br>For b: ( b=-0.3739,b=-0.4105) |
| p=0.4,$L_2$=0.5,$p_A$=0.5 | $\hat{a}$ =0.4150 | $\hat{b}$ =-0.3973 | For a: (a=0.4015, a=0.4285 )<br>For b: ( b=-0.3866, b=-0.4081) |
| p=0.4,$L_2$=0.7,$p_A$=0.7 | $\hat{a}$ =0.4089 | $\hat{b}$ =-0.3991 | For a: (a=0.4011, a=0.4167)<br>For b: (b=-0.3929, b=-0.4053) |
| Average Estimates | $\bar{a} = 0.4160$ | $\bar{b} = -0.3962$ | $\hat{P}_1 = \bar{a} + \bar{b}(L_1)$<br>$\hat{P}_1 = (0.4160 - 0.3962)(L_1)$ |

Table 10.2: Confidence interval for a and b (9.6)

| **Fixed parameter** | Constant (a) | Constant (b) | Confidence Interval |
|---|---|---|---|
| p=0.4,$L_2$=0.3,$p_A$=0.2 | $\hat{a}$ =0.4926 | $\hat{b}$ =-0.4860 | For a: (a=0.4873, a=0.4979)<br>For b: ( b=-0.4818,b=-0.4903) |
| p=0.4,$L_2$=0.5,$p_A$=0.5 | $\hat{a}$ =0.4940 | $\hat{b}$ =-0.4898 | For a: (a=0.4906, a=0.4975 )<br>For b: ( b=-0.4871, b=-0.4926) |
| p=0.4,$L_2$=0.7,$p_A$=0.7 | $\hat{a}$ =0.5045 | $\hat{b}$ =-0.5006 | For a: (a=0.5013, a=0.5076)<br>For b: (b=-0.4981, b=-0.5031) |
| Average Estimates | $\bar{a} = 0.4970$ | $\bar{b} = -0.4922$ | $\hat{P}_1 = \bar{a} + \bar{b}(L_1)$<br>$\hat{P}_1 = (0.4970 - 0.4922)(L_1)$ |

## XI. AVERAGE RELATIONSHIP

We define $\hat{P}_1 = \bar{a} + \bar{b}\,(L_1)$ in table 10.1 and 10.2 where $\bar{a}, \bar{b}$ are average estimate obtain through all tables. We found that $\hat{P}_1 = 0.4160 - 0.3962.(L_1)$ and $\hat{P}_1 = 0.4970 - 0.4922.(L_1)$

## XII. DISCUSSION AND CONCLUSION

A linear relationship has been established between blocking probability and traffic sharing in the rest state setup. The equation on line depends on input parameters. The confidence intervals are very small length showing the strength of estimation procedure. The coefficient of variations is near to unity showing the high efficiency of line fitting procedure. The average linear relationship is $\hat{P}_1 = 0.4160 - 0.3962(L_1)$ and $\hat{P}_1 = (0.4970 - 0.4922(L_1)$ . This can be used for quick calculation of traffic sharing when blocking level of network varies for an operator.

## REFERENCES


[1]. **Medhi, J. (1991):** Stochastic models in queuing theory, Academic Press Professional, Inc., San Diego, CA.

**References**

[2]. **Medhi, J. (1992):** Stochastic Processes, Ed.4, Wiley Eastern Limited (Fourth reprint), New Delhi.

[3]. Chen, D.X. and Mark, J.W. (1993): A fast packet switch shared concentration and output queuing, IEEE Transactions on Networking, vol. 1, no. 1, pp. 142-151.

[4]. **Hambali, H. and Ramani, A. K., (2002):** A performance study of at multicast switch with different traffics, Malaysian Journal of Computer Science. Vol. 15, Issue No. 02, Pp. 34-42.

[5]. **Naldi, M. (2002):** Internet access traffic sharing in a multi-user environment, Computer Networks. Vol. 38, pp. 809-824.

[6]. **Newby, M. and Dagg, R. (2002):** Optical inspection and maintenance for stochastically deteriorating systems: average cost criteria, Jour. Ind. Statistical Associations. Vol. 40, Issue No. 02, pp. 169-198.

[7]. **Francini, A. and Chiussi, F.M. (2002):** Providing QoS guarantees to unicast and multicast flows in multistage packet switches, IEEE Selected Areas in Communications, vol. 20, no. 8, pp. 1589-1601.

[8]. **Dorea, C.C.Y., Cruz and Rojas, J. A. (2004):** Approximation results for non-homogeneous Markov chains and some applications, Sankhya. Vol. 66, Issue No. 02, pp. 243-252.

[9]. **Paxson, Vern, (2004):** Experiences with internet traffic measurement and analysis, ICSI Center for Internet Research International Computer Science Institute and Lawrence Berkeley **National Laboratory.**

[10]. **Yeian, C. and Lygeres, J. (2005):** Stabilization of class of stochastic differential equations with Markovian switching, System and Control Letters. Issue 09, pp. 819-833.

[11]. **Shukla, D., Gadewar, S. and Pathak, R.K. (2007 a):** A stochastic model for space division switches in computer networks, International Journal of Applied Mathematics and Computation, Elsevier Journals, Vol. 184, Issue No. 02, pp235-269.

[12]. **Shukla, D. and Thakur, Sanjay, (2007 b**) Crime based user analysis in internet traffic sharing under cyber crime, Proceedings of National Conference on Network Security and Management (NCSM-07), pp. 155-165, 2007.

[13]. **Shukla, D., Virendra Tiwari, M. Tiwari and Sanjay Thakur [2007 c]**: Rest State analysis of Internet traffic distribution in multi-operator environment published in the Journal of management Information Technology (JMIT-09), Vol. 1, pp. 72-82

[14]. **Agarwal, Rinkle and Kaur, Lakhwinder (2008):** On reliability analysis of fault-tolerant multistage interconnection networks, International Journal of Computer Science and Security (IJCSS) Vol. 02, Issue No. 04, pp. 1-8.

[15].**Shukla, D., Tiwari, Virendra, Thakur, S. and Deshmukh, A. (2009 a):**Share loss analysis of internet traffic distribution in computer networks, International Journal of Computer Science and Security (IJCSS), Malaysia, Vol. 03, issue No. 05, pp. 414-426.

[16]. **Shukla, D., Tiwari, Virendra, Thakur, S. and Tiwari, M. (2009 b) :**A comparison of methods for internet traffic sharing in computer network, International Journal of Advanced Networking and Applications (IJANA).Vol. 01, Issue No.03, pp.164-169.

[17]. **Shukla, D., Tiwari, V. and Kareem, Abdul, (2009 c)** All comparison analysis in internet traffic sharing using markov chain model in computer networks, Georgian Electronic Scientific Journal: Computer Science and Telecommunications. Vol. 06, Issue No. 23, pp. 108-115.

[18]. **Shukla, D, Tiwari, M., Thakur, Sanjay and Tiwari, Virendra [2009 d]:** Rest State Analysis in Internet Traffic Distribution in Multi-operator Environment, (GNIM's) Research Journal of Management and Information Technology, Vol. 1, No. 1, pp. 72-82.

[19]. **Shukla, D., Jain Saurabh, Singhai Rahul and Agarwal R.K. [2009 f]:** A Markov chain model for the analysis of round robin scheduling scheme, International Journal of Advanced Networking and Applications (IJANA), vol. 01, no. 01, pp. 01-07.

[20]. **Shukla, D., Thakur S. and Deshmukh Arvind [2009 g]:** State probability analysis of Internet traffic sharing in computer network, International Journal of Advanced Networking and Applications (IJANA), vol. 1, issue 1, pp. 90-95.

[21]. **Shukla, D., Tiwari, Virendra, and Thakur, S. (2010 a):** Effects of disconnectivity analysis for congestion control in internet traffic sharing, National Conference on Research and Development Trends in ICT (RDTICT-2010), Lucknow University, Lucknow.

[22].**Shukla, D., Gangele, Sharad and Verma, Kapil, (2010 b):** Internet traffic sharing under multi-market situations, Published in Proceedings of 2nd National conference on Software Engineering and Information Security, Acropolis Institute of Technology and Research, Indore, MP, (Dec. 23-24,2010), pp 49-55.

[23].**Shukla, D., and Thakur, S. (2010 c):** Stochastic Analysis of Marketing Strategies in internet Traffic, INTERSTAT (June 2010).

[24].**Shukla, D., Tiwari, V., and Thakur, S., (2010 d):** Cyber Crime Analysis for Multi-dimensional Effect in Computer Network, Journal of Global Research in Computer Science(JGRCS), Vol. 01, Issue 04, pp.31-36.

[25].**Shukla, D., Tiwari V. and Thakur S. [2010 e]:** User behavior Based Probability Analysis of Internet Traffic Distribution in Two market in Computer Networks, Kalpagam Journal of Cambridge Studies (KJCS)

[26].**Shukla, D., Tiwari V. and Thakur S. [2010 f]:** Performance Analysis for Two Call Attempt of rest State Based Traffic Network, International Journal of Advanced Networking and Application (IJANA)

[27].**Shukla, D. and Thakur, Sanjay [2010]:** Index based Internet traffic sharing analysis of users by a Markov chain probability model. , Karpagam Journal of Computer Science, vol. 4, no. 3, pp. 1539-1545.

[30]. **Shukla, D., Tiwari, V., Thakur, S. and Deshmukh, A.K. [2010 a]:** Two call based analysis of internet traffic sharing, International Journal of Computer and Engineering (IJCE), Vol. 1, No. 1, pp. 14-24.

[31].**Shukla, D. and Singhai, Rahul [2010 b]:** Traffic analysis of message flow in three cross-bar architecture in space division switches, Karpagam Journal of Computer Science, vol. 4, no. 3, pp. 1560-1569.

[32]. **Shukla, D., Thakur, Sanjay and Tiwari, Virendra [2010 c]:** Stochastic modeling of Internet traffic management, International Journal of the Computer the Internet and Management, Vol. 18, no. 2 pp. 48-54.

[33]. **Shukla, D., Tiwari, Virendra and Thakur, Sanjay [2010 d]:** Cyber crime analysis for multi-dimensional effect in computer network, Journal of Global Research in Computer Science, Vol.1, no. 4. pp. 14-21.

[34]. **Shukla, D. and Thakur, Sanjay [2010 e ]:** Iso-share Analysis of Internet Traffic Sharing in Presence of Favoured Disconnectivity, GESJ: Computer Science and Telecommunications, 4(27), pp. 16-22.

[35]**. Shukla, D., Gangele, Sharad, Verma, Kapil and Singh, Pankaja (2011 a):** Elasticity of Internet Traffic Distribution Computer Network in two Market Environment, Journal of Global research in Computer Science (JGRCS) Vol.2, No. 6, pp.6-12.

[36]. **Shukla, D., Gangele, Sharad, Verma, Kapil and Singh, Pankaja (2011 b):** Elasticities and Index Analysis of Usual Internet Browser share Problem, International Journal of Advanced Research in Computer Science (IJARCS),Vol. 02, No. 04, pp.473-478.

[37].**Shukla, D., Gangele, Sharad, Verma, Kapil and Thakur, Sanjay, (2011 c):** A Study on Index Based Analysis of Users of Internet Traffic Sharing in Computer Networking, World Applied Programming (WAP), Vol. 01, No. 04, pp. 278-287.

[38]. **Shukla, D., Tiwari, Virendra and Thakur, Sanjay [2011]** Analysis of Internet Traffic Distribution for User Behavior Based Probability in Two Market Environment, International Journal of Computer Application (IJCA), Vol. 30, Issue No. 08. pp. 44-51.

[39]**. Shukla, D., Gangele, Sharad, Singhai, Rahul and Verma, Kapil, (2011 d):** Elasticity Analysis of Web Browsing Behavior of Users, International Journal of Advanced Networking and Applications (IJANA), Vol. 03, No. 03, pp.1162-1168.

[40]. **Shukla, D., Verma, Kapil and Gangele, Sharad, (2011 e):** Re-Attempt Connectivity to Internet Analysis of User by Markov Chain Model, International Journal of Research in Computer Application and Management (IJRCM) Vol. 01, Issue No. 09, pp. 94-99.

[41]. **Shukla, D., Gangele, Sharad, Verma, Kapil and Trivedi, Manish, (2011 f):** Elasticity variation under Rest State Environment In case of Internet Traffic Sharing in Computer Network, International Journal of Computer Technology and Application (IJCTA) Vol. 02, Issue No. 06, pp. 2052-2060.

[42]. **Shukla, D., Gangele, Sharad, Verma, Kapil and Trivedi, Manish, [2011]:** Two-Call Based Cyber Crime Elasticity Analysis of Internet Traffic Sharing In Computer Network, International Journal of Computer Application (IJCA) Vol.02, Issue 01, pp.27-38.

[43]. **Shukla, D., Singhai, Rahul [2011]:** Analysis of User Web Browsing Using Markov chain Model, International Journal of Advanced Networking and Application (IJANA), Vol. 02, Issue No. 05, pp. 824-830.

[44]. **Shukla, D., Verma, Kapil and Gangele, Sharad, [2012]:** Iso-Failure in Web Browsing using Markov Chain Model and Curve Fitting Analysis, International Journal of Modern Engineering Research(IJMER) , Vol. 02, Issue 02, pp. 512-517.

[45]. **Shukla, D., Verma, Kapil and Gangele, Sharad, [2012]:** Least Square Curve Fitting in Internet Access Traffic Sharing in Two Operator Environment, International Journal of Computer Application (IJCA), Vol.43(12), pp. 26-32.