Two-Call Based Cyber Crime Elasticity Analysis of Internet Traffic Sharing In Computer Network

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Abstract

Cyber crime is an area of immense interest where lots of researches are underway, particularly in cases when internet based mischief are of the committed by users. The understanding of cyber crime is like abusive letters, threat to other, unwanted mails, data hacking, phishing attacks etc. While a user is connected through the Internet the cyber crime may appears. This paper presents elasticity examination of Markov Chain model used for the study of probability based evaluation of cyber crime while call is connected. The main focus is to examine the effects of crime probability on traffic sharing between two operators. Simulation study is used as a tool to discriminate the effect among model parameters. It is found that cyber crime probability, after the call connection, if high a bigger proportion of traffic shifts towards specific network operator.

Keywords: *Internet service providers [operators or ISP], Quality of service (QoS), Markov chain model, Initial preference, Blocking probability, Two-call basis, Transition probability matrix.*

1.1 Introduction

The market of computer utilization is growing drastically throughout the world and various new applications are appearing day-by-day in the form of information and communication. In parallel, these developments open scope for software developers regarding user friendly applications. Cyber criminals are, at the same time, got opportunities to perform destructive

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#[2] Corresponding Author : Sharad Gangele, *Research Scholar (Com.Sci.), sharadgangele@gmail.com* activities through networks like, hacking, phishing attacks, unwanted mails, threatening emails, false mails etc. All these appear when the call is connected between source and destination through Internet. Now two possibilities are there, a user may perform cyber crime or not depending upon his mental attitude. This kind of thought provokes to look for a probabilistic study of attitude of crime by users. Naldi (2002) has presented a Markov Chain model based study for the Internet traffic sharing between two operators. This contribution was restricted to the call connectivity level only but the user attitude towards the type of use was not taken into account. The paper considers this aspect of Internet use in two forms (a) Normal user, (b) Cyber criminal. Shukla and Thakur (2007), Shukla *et al.* (2010 d) have some useful contributions on Cyber crime analysis using a Markov Chain Model. The basic idea of Naldi (2002), Shukla and Thakur (2007), Shukla *et al.* (2010 d) has been utilized herein for the cyber crime attitude detection of user with a focus on the elasticity parameter of traffic sharing.

2.1 A Review

The stochastic process has been used by many scientists and researchers for the purpose of statistical modelling 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. Francini and Chiussi (2008) 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 & c) presented different dimensions of Internet traffic sharing in the light of share loss analysis. Shukla *et al*. (2010 a, b. c & d) have given some Markov Chain model applications in view to disconnectivity factor, multi marketing and crime based analysis. Shukla *et al*. (2011 a, b, c, d, e & f) 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.

3.1 Assumptions for System and User Behaviour *[As per Shukla, Tiwari and Thakur (2010 d)]*

(a) The user chooses, operator O_1 with probability p or operator O_2 with probability (1 - p).

(b) When first attempt of connectivity fails he attempts one more to the same operator, and thereafter, switches to the next where two more consecutive attempts may appear. This we say “two-call-basis” attempts for call connectivity.

(c) User has two choices after each failed attempt;
  a. he can either abandon with probability p_A or
  b. switch to the other operator for a new attempt.

(d) The blocking probability that a call attempt fails through the operator O_1 is L_1 and through O_2 is L_2.

(e) If the call for O_1 is blocked at k^{th} attempt ($k > 0$) then in $(k + 2)^{th}$ user shifts to O_2.

(f) Whenever call connects through either of O_1 or O_2 we say system reaches to the state of success after n attempts.

(g) User can terminate the connectivity attempt process which is marked as abandon state A with probability p_A (either O_1 or from O_2).

(h) A successful call connection has a marketing package related to cyber-crime, denoted as C, with attraction probability $(1 - c_1)$ and detention probability $(1 - c_2)$.

(i) After connectivity, user has two choices either to do or cyber-crime or to do usual web surfing through Internet (with probability c_1). This choice is treated as an attempt related to web connectivity.

(j) Attempt means call-connecting attempt or surfing attempt.

(k) User may come-back to usual surfing whenever willing (with probability c_2) or may continue with cyber crime depending on attraction of marketing plan.

(l) From crime, user can neither abandon nor disconnect.

(m) From state of normal surfing, user can not abandon.

(n) State non-crime and abandon are absorbing state.

4.1 Markov Chain Model *[As per Shukla, Tiwari and Thakur (2010 d)]*

Using above hypotheses about user's behavior it can be modeled by a five-state discrete-time Markov chain $\{X^{(n)}, n \geq 0\}$ such that $X^{(n)}$ stands for the state of random variable X at n^{th} attempt (call or surfing) made by a user over the state space $\{O_1, O_2, NC, A, C\}$ where,

State O_1: User attempting to connect a call through the first operator O_1.

State O_2: Corresponding to a call through second operator O_2.

State NC: Success (in connectivity) but no cyber-crime.

State A: User leaving (abandon) the attempt process.

State C: Connectivity gained and cyber-crime.

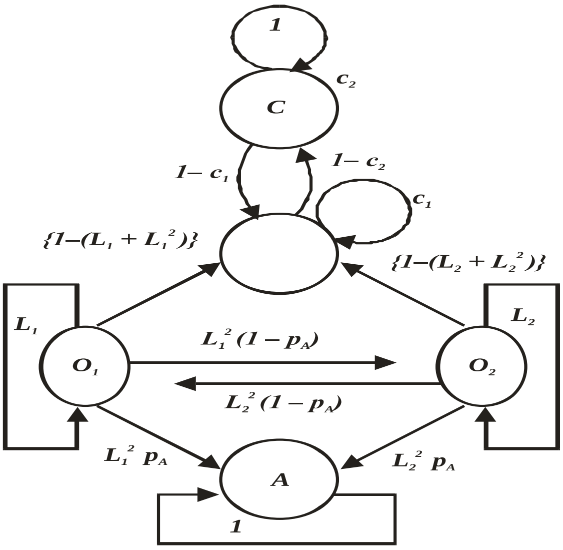

Fig.:- 4.1 Transition Diagram of Model *[As per Shukla, Tiwari and Thakur (2010 d)]*

The connectivity attempts between two operators are on two-call basis, which means if the call for O_1 is blocked in $k^{(th)}$ attempt ($k > 0$), then in $(k + 2)^{th}$ user shifts to O_2. When call connects either through O_1 or O_2 the system reaches to the state of success (NC) and does not perform cyber crime in next attempt with probability c_1. From state C, user cannot move to states O_1, O_2 or A without passing through NC. The A is absorbing state.

5.1 Transition Mechanism in Model and Probabilities *[As per Shukla, Tiwari and Thakur (2010 d)]*

Rule 1: User attempts to O_1 with initial probability p (based on QoS the O_1 provides).

Rule 2: If fails, then reattempts to O_1.

Rule 3: User may succeed to O_1 in either of one attempt or next. Since the blocking probability for O_1 in one attempt is L_1, therefore, blocking probability for O_1 in the next attempt is:

= P [O_1 blocked in an attempt]. P [O_1 blocked in next attempt / previous attempt to O_1 was blocked] = $(L_1.L_1) = L_1^2$

The total blocking probability is $(L_1 + L_1^2)$ inclusive of both attempts. The success probability for O_1 is $[1\text{-}(L_1 + L_1^2)]$ Similar for $O_2 = [1\text{-}(L_2 + L_2^2)]$

Rule 4: User shifts to O_2 if blocks in both attempts to O_1 and does not abandon. The transition probability is:

= P [O_1 blocked in an attempt]. P [O_1 blocked in next attempt/previous attempt to O_1 was blocked]. P [does not abandon attempting process] = L_1^2 (1- p_A) Similar for O_2 = L_2^2 (1- p_A).

Rule 5: User either abandons the system atleast after two attempts to an operator, which is a compulsive with this model. This leads to probability that user abandons process after two attempts over O_1 is:

= P [O_1 blocked in an attempt]. P [O_1 blocked in next attempt/previous attempt to O_1 was blocked]. P[abandon the attempting process] = L_1^2 p_A Similar happens for O_2 = L_2^2 p_A

Rule 6: for, $0 \le c_1 \le 1$ and $0 \le c_2 \le 1$ we have

$$P\left[X^{(n)} = C \big/ X^{(n-1)} = NC\right] = 1 - c_1 \quad ...(5.1)$$

$$P\left[X^{(n)} = NC \big/ X^{(n-1)} = NC\right] = c_1 \quad ...(5.2)$$

$$P\left[X^{(n)} = NC \big/ X^{(n-1)} = C\right] = c_2 \quad ...(5.3)$$

$$P\left[X^{(n)} = C \big/ X^{(n-1)} = C\right] = 1 - c_2 \quad ...(5.4)$$

6.1 Transition Probability between States

Define a Markov chain $\{X^{(n)}, n = 0,1,2,3,.........\,..\}$ where $X^{(n)}$, denotes the state of user at nth attempt to connect (or succeed) a call while transitioning among five states O_1, O_2, NC, C and A, at n = 0, we have

$$\left.\begin{array}{l} P\left[X^{(0)}=O_1\right]=p \\ P\left[X^{(0)}=O_2\right]=(1-p) \\ P\left[X^{(0)}=NC\right]=0 \\ P\left[X^{(0)}=C\right]=0 \\ P\left[X^{(0)}=A\right]=0 \end{array}\right\} \qquad \text{...(6.1)}$$

Now, the transition probability matrix is

$$\xleftarrow{\qquad\qquad} \text{States } X^{(n)} \xrightarrow{\qquad\qquad}$$

$$X^{(n-1)} \left[\begin{array}{c|ccccc} & O_1 & O_2 & NC & C & A \\ \hline O_1 & L_1 & L_1^2(1-p_A) & \left\{1-\left(L_1+L_1^2\right)\right\} & 0 & L_1^2 p_A \\ O_2 & L_2^2(1-p_A) & L_2 & \left\{1-\left(L_2+L_2^2\right)\right\} & 0 & L_2^2 p_A \\ NC & 0 & 0 & c_1 & 1-c_1 & 0 \\ C & 0 & 0 & 1-c_2 & c_2 & 0 \\ A & 0 & 0 & 0 & 0 & 1 \end{array}\right]$$

Table: 6.1 [Transition Probability Matrix] *[As per Shukla, Tiwari and Thakur (2010 d)]*

7.1 Computation of Traffic Share over Large Attempts

Suppose the number of call attempts made by user is very large and then define $\bar{P}_i = \left\lfloor \lim\limits_{n\to\infty} \bar{P}_i^{(n)} \right\rfloor,\ i=1,2$ which provides a measure of traffic share between two operators in terms of cyber crime prospect. The limiting value of expressions of section relates to traffic shares are: Now be again for separator on type A, B, C and D basis.

8.1 Elasticity Analysis over Large Number of Attempt

$$\left[\bar{P}_1\right]_{CC} = \left[\left\{1-\left(L_2+L_2^2\right)\right\}(1-c_1)\left\{\frac{\left[\left(L_1 p+p\right)\right]}{1-\left[L_1^{(3)}L_2^{(3)}(1-p_A)^{(2)}\right]}+\frac{\left(L_1(1-P)+(1-P)\right)\left[L_2^{(3)}(1-p_A)\right]}{1-\left[L_1^{(3)}L_2^{(3)}(1-p_A)^{(2)}\right]}\right\}\right] \qquad \text{...(8.1)}$$

$$\left[\bar{P}_2\right]_{CC} = \left[\left[\left\{1-\left(L_2+L_2^2\right)\right\}(1-c_1)\right]\left\{\frac{\left(L_2(1-p)+(1-p)\right)}{1-\left[L_1^{(3)}L_2^{(3)}(1-p_A)^{(2)}\right]}+\frac{\left[\left(L_2 P+p\right)L_1^{(3)}(1-p_A)\right]}{1-\left[L_1^{(3)}L_2^{(3)}(1-p_A)^{(2)}\right]}\right\}\right] \qquad \text{...(8.2)}$$

$$\bar{P}_{1A\,CC} = \left[\frac{(1-C_1)L_1.p\left\{1-\left(L_1+L_1^2\right)\right\}}{1-L_1^3L_2^3(1-p_A)^2}\right] \qquad \text{...(8.3)}$$

Partially differentiate with respect to L_1 we get

$$e_{21}(.) = \left(\frac{\partial \bar{P}_{1A\,CC}}{\partial L_1}\right)_{L_2,C_1,p,p_A} = \left[\frac{(1-C_1).p\left[\left\{1-L_1^3L_2^3(1-p_A)^2\right\}\left\{1-\left(2L_1+3L_1^2\right)\right\}+\left\{3L_1^3L_2^3(1-p_A)^2\right\}\left\{1-\left(L_1+L_1^2\right)\right\}\right]}{\left\{1-L_1^3L_2^3(1-p_A)^2\right\}^2}\right] \qquad \text{...(8.4)}$$

Partially differentiate with respect to L_2 we get

$$e_{22}(.)=\left(\frac{\partial\bar{P}_{1A\,CC}}{\partial L_2}\right)_{L_1,C_1,p,p_A}=\left[\frac{(1-L_1)p[\{1-L_1{}^3L_2{}^3(1-p_A)^2\}\{1-2L_1\}+\{L_1-(L_1{}^2+L_2{}^3)\}\{(3L_1{}^3L_2{}^3(1-p_A)^2)\}]}{\{1-L_1{}^3L_2{}^3(1-p_A)^2\}^2}\right] \quad ...(8.5)$$

$$\bar{P}_{2A\,CC}=\left[\frac{(1-C_1)L_2(1-p)\left\{1-\left(L_2+L_2^2\right)\right\}}{1-L_1^3L_2^3(1-p_A)^2}\right] \quad ...(8.6)$$

Partially differentiate with respect to L_1 we get

$$f_{21}(.)=\left(\frac{\partial\bar{P}_{2A\,CC}}{\partial L_1}\right)_{L_2,C_1,p,p_A}=\left[\frac{3(1-C_1)(1-p)\left\{1-\left(L_2+L_2^2\right)\right\}.\left\{L_1^3L_2^3(1-p_A)^2\right\}}{\left\{1-L_1^3L_2^3(1-p_A)^2\right\}^2}\right] \quad ...(8.7)$$

Partially differentiate with respect to L_2 we get

$$f_{22}(.)=\left(\frac{\partial\bar{P}_{2A\,CC}}{\partial L_2}\right)_{L_1,C_1,p,p_A}=\left[\frac{(1-C_1)(1-p)\left[\left\{1-L_1^3L_2^3(1-p_A)^2\right\}.\left\{1-\left(2L_2+3L_2^2\right)\right\}+3\left\{L_1^3L_2^3(1-p_A)^2\right\}\left\{1-\left(L_2+L_2^2\right)\right\}\right]}{\left\{1-L_1^3L_2^3(1-p_A)^2\right\}^2}\right] \quad ...(8.8)$$

$$\bar{P}_{1B\,\mathrm{CC}}=\left[\frac{(1-C_1)(1-p)\left\{1-\left(L_1+L_1^2\right)\right\}L_1L_2^3(1-p_A)}{1-L_1^3L_2^3(1-p_A)^2}\right] \quad ...(8.9)$$

Partially differentiate with respect to L_1 we get

$$g_{21}(.)=\left(\frac{\partial\bar{P}_{1B\,CC}}{\partial L_1}\right)_{L_2,C_1,p,p_A}==\left[\frac{(1-C_1)(1-p)(1-p_A)L_2^3\left[\left\{1-L_1^3L_2^3(1-p_A)^2\right\}\left\{1-\left(2L_1+3L_1^2\right)\right\}+\left\{1-\left(L_1+L_1^2\right)\right\}\left\{3L_1^3L_2^3(1-p_A)^2\right\}\right]}{\left\{1-L_1^3L_2^3(1-p_A)^2\right\}^2}\right] \quad ...(8.10)$$

Partially differentiate with respect to L_2 we get

$$g_{22}(.)=\left(\frac{\partial\bar{P}_{1B\,CC}}{\partial L_2}\right)_{L_1,C_1,p,p_A}=\left[\frac{3(1-C_1)(1-p)(1-p_A)L_1L_2^2\left\{1-\left(L_1+L_1^2\right)\right\}.\left[\left\{1-L_1^3L_2^3(1-p_A)^2\right\}+\left\{L_1^3L_2^3(1-p_A)^2\right\}\right]}{\left\{1-L_1^3L_2^3(1-p_A)^2\right\}^2}\right] \quad ...(8.11)$$

$$\bar{P}_{2B\,CC}=\left[\frac{(1-C_1).p\left\{1-\left(L_2+L_2^2\right)\right\}L_1^3L_2(1-p_A)}{1-L_1^3L_2^3(1-p_A)^2}\right] \quad ...(8.12)$$

Partially differentiate with respect to L_1 we get

$$h_{21}(.)=\left(\frac{\partial\bar{P}_{2B\,CC}}{\partial L_1}\right)_{L_2,C_1,p,p_A}=\left[\frac{3(1-C_1).p(1-p_A)L_1^2L_2\left\{1-\left(L_2+L_2^2\right)\right\}.\left[\left\{1-L_1^3L_2^3(1-p_A)^2\right\}+\left\{L_1^3L_2^3(1-p_A)^2\right\}\right]}{\left\{1-L_1^3L_2^3(1-p_A)^2\right\}^2}\right] \quad ...(8.13)$$

Partially differentiate with respect to L_2 we get

$$h_{22}(.)=\left(\frac{\partial\bar{P}_{2B\ CC}}{\partial L_2}\right)_{L_1,C_1,p,p_A}=\left[\frac{(1-C_1).p(1-p_A).L_1^3\left[\left\{1-L_1^3L_2^3(1-p_A)^2\right\}.\left\{1-\left(2L_2+3L_2^2\right)\right\}+\left\{1-\left(L_2+L_2^2\right)\right\}\left\{3L_1^3L_2^3(1-p_A)^2\right\}\right]}{\left\{1-L_1^3L_2^3(1-p_A)^2\right\}^2}\right] \quad ...(8.14)$$

$$\bar{P}_{1C\ CC}=\left[\frac{(1-C_1).p\left\{1-\left(L_1+L_1^2\right)\right\}}{1-L_1^3L_2^3(1-p_A)^2}\right] \quad ...(8.15)$$

Partially differentiate with respect to L$_1$ we get

$$i_{21}(.)=\left(\frac{\partial\bar{P}_{1C\ CC}}{\partial L_1}\right)_{L_2,C_1,p,p_A}=\left[\frac{(1-C_1).p\left[(1-2L_1)\left\{L_1^3L_2^3(1-p_A)^2-1\right\}+\left\{3L_1^2L_2^3(1-p_A)^2\right\}\left\{1-\left(L_1+L_1^2\right)\right\}\right]}{\left\{1-L_1^3L_2^3(1-p_A)^2\right\}^2}\right] \quad ...(8.16)$$

Partially differentiate with respect to L$_2$ we get

$$i_{22}(.)=\left(\frac{\partial\bar{P}_{1C\ CC}}{\partial L_2}\right)_{L_1,C_1,p,p_A}=\left[\frac{3(1-C_1).p\left\{1-\left(L_1+L_1^2\right)\right\}.\left\{L_1^3L_2^3(1-p_A)^2\right\}}{\left\{1-L_1^3L_2^3(1-p_A)^2\right\}^2}\right] \quad ...(8.17)$$

$$\bar{P}_{2C\ CC}=\left[\frac{(1-C_1)(1-p)\left\{1-\left(L_2+L_2^2\right)\right\}}{1-L_1^3L_2^3(1-p_A)^2}\right] \quad ...(8.18)$$

Partially differentiate with respect to L$_1$ we get

$$j_{21}(.)=\left(\frac{\partial\bar{P}_{2C\ CC}}{\partial L_1}\right)_{L_2,C_1,p,p_A}=\left[\frac{(1-C_1)(1-p)\left[\left\{3L_1^2L_2^2(1-p_A)\right\}\left\{1-\left(L_2+L_2^2\right)\right\}\right]}{\left\{1-L_1^3L_2^3(1-p_A)^2\right\}^2}\right] \quad ...(8.19)$$

Partially differentiate with respect to L$_2$ we get

$$j_{22}(.)=\left(\frac{\partial\bar{P}_{2C\ CC}}{\partial L_2}\right)_{L_1,C_1,p,p_A}=\left[\frac{(1-c_1)(1-p)[\{L_1{}^3L_2{}^3(1-p_A)^2-1\}\{1+2L_2\}+\{3L_1{}^3L_2{}^2(1-p_A)^2\}\{1-(L_2+L_2{}^2)\}]}{\{1-L_1{}^3L_2{}^3(1-p_A)^2\}^2}\right] \quad ...(8.20)$$

$$\bar{P}_{1D\ CC}=\left[\frac{(1-C_1)(1-p)(1-p_A)L_2^3\left\{1-\left(L_1+L_1^2\right)\right\}}{1-L_1^3L_2^3(1-p_A)^2}\right] \quad ...(8.21)$$

Partially differentiate with respect to L$_1$ we get

$$k_{21}(.)=\left(\frac{\partial\bar{P}_{1D\ CC}}{\partial L_1}\right)_{L_2,C_1,p,p_A}=\left[\frac{(1-C_1)(1-p)(1-p_A)L_2^3\left[\left\{L_1^3L_2^3(1-p_A)^2-1\right\}.\left\{1+2L_1\right\}+\left\{1-\left(L_1+L_1^2\right)\right\}\left\{3L_1^2(1-p_A)^2\right\}\right]}{\left\{1-L_1^3L_2^3(1-p_A)^2\right\}^2}\right] \quad ...(8.22)$$

Partially differentiate with respect to L$_2$ we get

$$k_{22}(.)=\left(\frac{\partial\bar{P}_{1D\;CC}}{\partial L_2}\right)_{L_1,C_1,p,p_A}=\left[\frac{3(1-c_1)(1-p)(1-p_A)L_2{}^2\{1-(L_1+L_1{}^2)\}[\{1-L_1{}^3L_2{}^3(1-p_A)^2\}+\{L_1{}^3L_2{}^3(1-p_A)^2\}]}{\{1-L_1{}^3L_2{}^3(1-p_A)^2\}^2}\right] \quad ...(8.23)$$

$$\bar{P}_{2D\;CC}=\left[\frac{(1-C_1).p(1-p_A)L_1^3\left\{1-\left(L_2+L_2^2\right)\right\}}{1-L_1^3L_2^3(1-p_A)^2}\right] \quad ...(8.24)$$

Partially differentiate with respect to L$_1$ we get

$$l_{21}(.)=\left(\frac{\partial\bar{P}_{2D\;CC}}{\partial L_1}\right)_{L_2,C_1,p,p_A}=\left[\frac{3(1-C_1).p(1-p_A)L_1^2\left\{1-\left(L_2+L_2^2\right)\right\}.\left[\left\{1-L_1^3L_2^3(1-p_A)^2\right\}+\left\{L_1^3L_2^2(1-p_A)^2\right\}\right]}{\left\{1-L_1^3L_2^3(1-p_A)^2\right\}^2}\right] \quad ...(8.25)$$

Partially differentiate with respect to L$_2$ we get

$$l_{22}(.)=\left(\frac{\partial\bar{P}_{2D\;CC}}{\partial L_2}\right)_{L_1,C_1,p,p_A}=\left[\frac{(1-C_1).p(1-p_A).L_1^3\left[\left\{L_1^3L_2^2(1-p_A)^2-1\right\}.(1+2L_2)+\left\{1-\left(L_2+L_2^2\right)\right\}.\left\{3L_1^3L_2^2(1-p_A)^2\right\}\right]}{\left\{1-L_1^3L_2^3(1-p_A)^2\right\}^2}\right] \quad ...(8.26)$$

9.1 Simulation Study

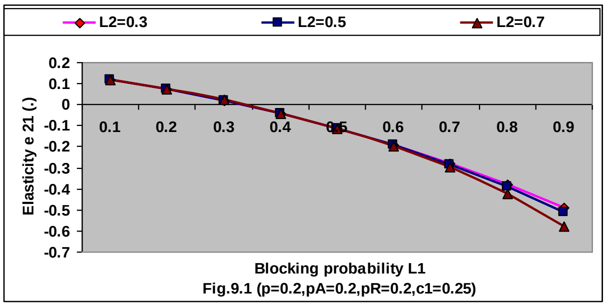

Fig.9.1 (p=0.2,pA=0.2,pR=0.2,c1=0.25)

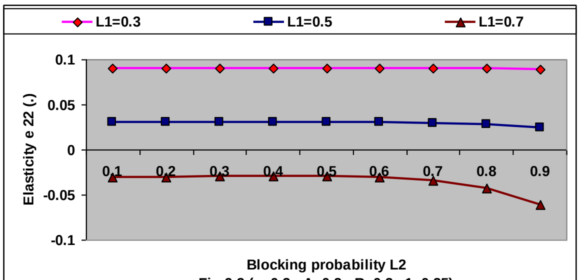

Fig.9.2 (p=0.2,pA=0.2,pR=0.2,c1=0.25)

In light of fig (9.1-9.2) the elasticity of traffic sharing for cyber criminal with respect to operator O$_1$ is becoming negative whereas the same with respect to L$_2$ is positive and stable. We come across the observation that the blocking probability of operator itself is a serious matter and a little fluctuations in L$_1$ are harmful to the operator O$_1$ in terms of traffic sharing.

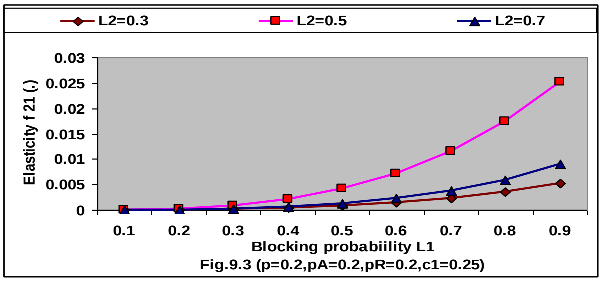

Fig.9.3 (p=0.2,pA=0.2,pR=0.2,c1=0.25)

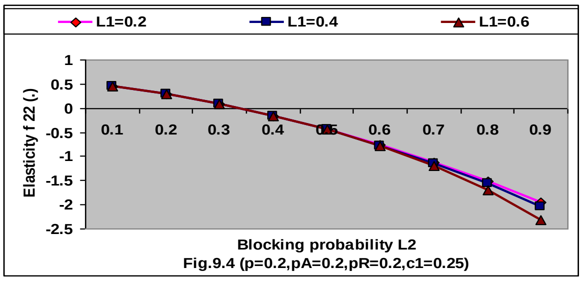

Fig.9.4 (p=0.2,pA=0.2,pR=0.2,c1=0.25)

Fig (9.3-9.4) reveals the variation of elasticities of traffic sharing with respect to second operator. It is found that one of them is negative whereas other is positive. If the L$_2$ is high, the operator O$_2$ has to be worry about his traffic sharing tendency. If opponent blocking is high the O$_1$ has not to worry about the same.

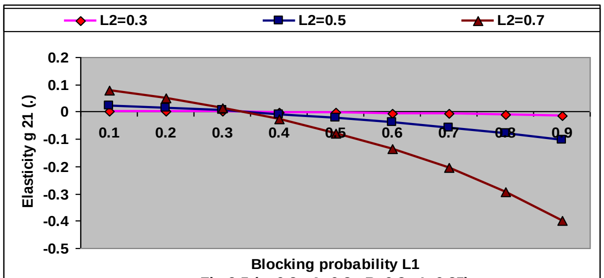

Fig.9.5 (p=0.2,pA=0.2,pR=0.2,c1=0.25)

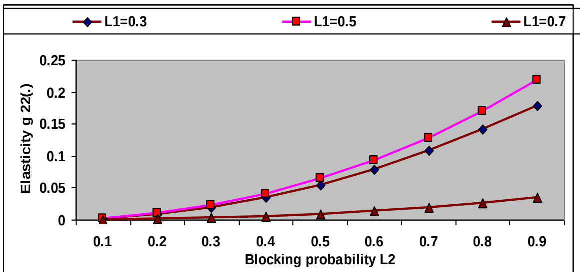

Fig.9.6 (p=0.2,pA=0.2,pR=0.2,c1=0.25)

As clear from fig (9.5-9.6), the elasticity of traffic sharing is varying over L_1 and L_2 parameters. For fix L_1 if L_2 is high the deviation of elasticity is also high.

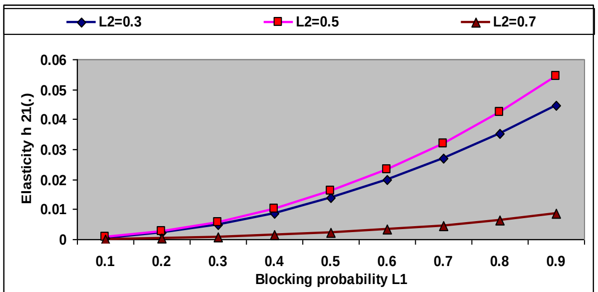

Fig.9.7 (p=0.2,pA=0.2,pR=0.2,c1=0.25)

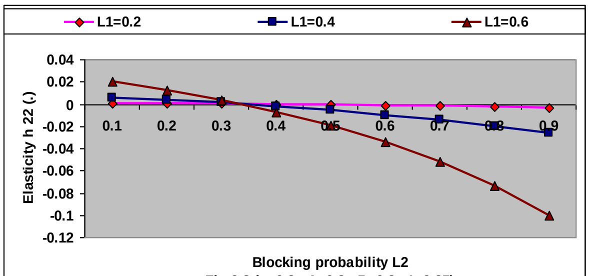

Fig.9.8 (p=0.2,pA=0.2,pR=0.2,c1=0.25)

In view to fig (9.7-9.8) the similar pattern of elasticity is found. Fig (9.9) differs from other because of linear pattern in elasticity. Moreover, it shows the overlapping of elasticity lines which means L_2-variations are not significant for cyber criminals while sharing between two.

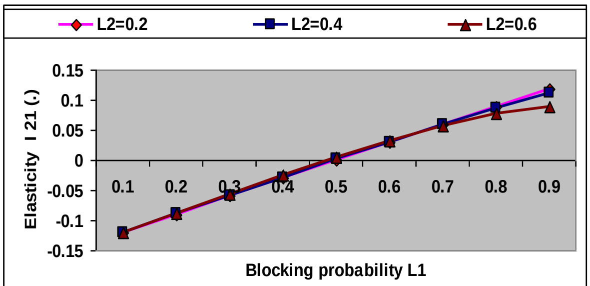

Fig.9.9 (p=0.2,pA=0.2,pR=0.2,c1=0.25)

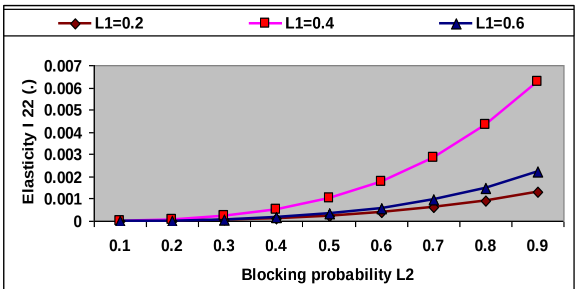

Fig.9.10 (p=0.2,pA=0.2,pR=0.2,c1=0.25)

Fig (9.9) differs from other because of linear pattern found in elasticity parameter. Moreover, it shows the overlapping of elasticity lines which means L_2-variations are not significant for cyber criminal.

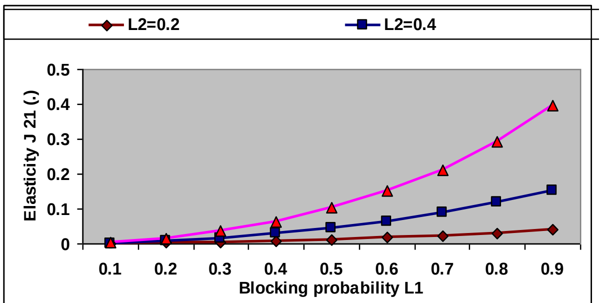

Fig.9.11 (p=0.2,pA=0.2,pR=0.2,c1=0.25)

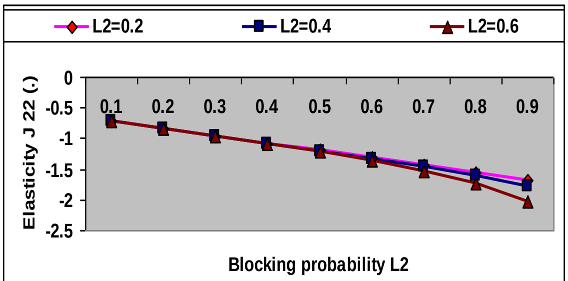

Fig.9.12 (p=0.2,pA=0.2,pR=0.2,c1=0.25)

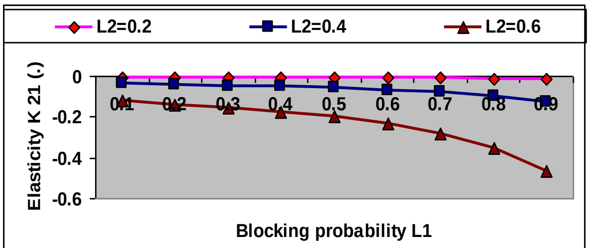

Fig.9.13 (p=0.2,pA=0.2,pR=0.2,c1=0.25)

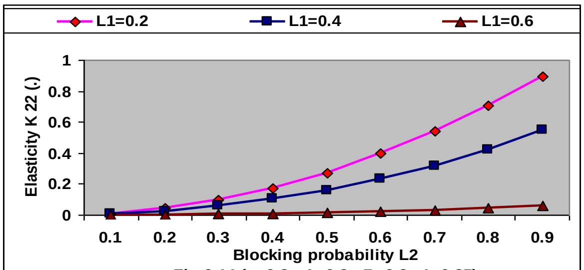

Fig.9.14 (p=0.2,pA=0.2,pR=0.2,c1=0.25)

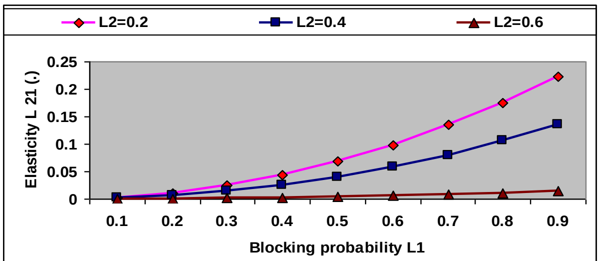

Fig.9.15 (p=0.2,pA=0.2,pR=0.2,c1=0.25)

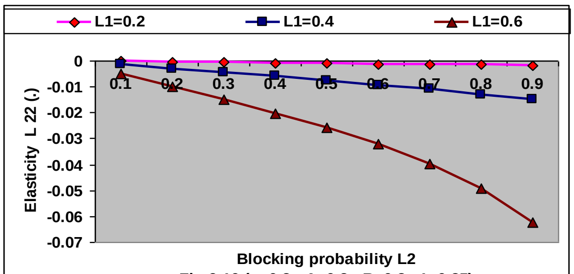

Fig.9.16 (p=0.2,pA=0.2,pR=0.2,c1=0.25)

Figs (9.10-9.16) are similar and in accordance with earlier figures showing the network blocking as a linear function of elasticity parameters in terms of traffic sharing. In every case of categories made for users, the elasticity of traffic sharing is influenced a lot by the network blocking of an operator. If L_1 is high, then cyber criminal group among user is small in favour of O_1 and vice-versa.

10.1 Conclusion

From the simulation study and in view of fig. 9.1 - 9.16, it is clear that elasticities of traffic sharing phenomenon are highly affected by the network blocking probabilities. If blocking level of an operator network is high, he losses a big group of user and corresponding cyber criminal's proportion also reduces. When opponent operator's network blocking is high then earlier operator gains the traffic share and cyber criminals both. Thus, network blocking parameter plays an important role in the varying proportion of cyber criminals dedicated to an operator .If opponent operator has lower network blocking then an amount of proportion of cyber criminal shifts more towards other operator. In order to get more and more users network operator has to keep his blocking lower to the competitive operator even in the presence of cyber criminals.

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