Volume 1, No. 4, November 2010
Journal of Global Research in Computer Science
ISSN-2229-371X
RESEARCH PAPER
Available Online at www.jgrcs.info

CYBER CRIME ANALYSIS FOR MULTI-DIMENSIONAL EFFECTS IN COMPUTER NETWORKS

Virendra Kumar Tiwari [*1], Sanjay Thakur [2] and Diwakar Shukla [3]

[*1]Department of Computer Science & Applications, Sagar University, Sagar M.P. 470003, India
virugama@gmail.com
[2]Department of Computer Science & Applications, Sagar University, Sagar M.P. 470003, India
sanjaymca2002@yahoo.com
[3]Department of Mathematics and Statistics, Sagar University, Sagar M.P. 470003, India
diwakarshukla@rediffmail.com

Abstract: The stuff of internet users increasing with the every moment of time, due to this huge lead of traffic grows on the wide area networks. Some users have crime category behavior and have attitudes of criminals like hacking the site, blocking the mail, chatting unauthorized users etc. Every service provider wants to increase his traffic share and way, which creates the competition among the providers. Simulation study is performing to analysis the better proportion of traffic by the users.
Keywords: Markov chain model, Transition probability, Initial preference, Blocking probability, Two-call basis, Call-by-call basis, Internet service providers [operators or ISP], Quality of service (QoS), Transition probability matrix

INTRODUCTION

In the markets many types of users are situated. Based on task and liking a suggested categorization of users is:
Crime Users [CU]- Who after getting success in call connection performs cyber-crime.
Non-Crime Users [NCU]- Who never opt to cyber-crimes on Internet the moment call gets connected.
Naldi (1999, 2000) has performed a study of measurement based modeling of Internet dial-ups. Naldi (2002) has made an attempt to describe the traffic sharing under the multi-operator environment with the help of a Markov chain model. An operator means either Internet service providers (ISP) or network owners. The blocking in a network may be due to congestion (traffic overflow), insufficient number of modems, inefficient hardware for transmission or due to inadequate care and services. Some other important contributions on the use of Markov chain models to the study of physical phenomenon are due to Medhi (1992), Horvath et al. (2005), Moore and Zuev (2005), Babiker Mohd and Mohd Nor (2009), Shukla and Gadewar (2007), Shukla et. al. (2007, 2009), Shukla and Thakur (2008). Georgios et al. (2003) have presented Internet traffic modeling using the index of variability. Shukla, Tiwari et al. (2009 a, b, c) used share loss analysis of Internet traffic distribution in computer networks. Park and Willinger (2000) discussed self-similar network traffic and performance evaluation. Muscariello, et al. (2003) have presented a simple Markovian approach to model internet traffic at edge routers. Clegg (2007) has discussed simulating internet traffic with Markov-modulated processes.

SYSTEM AND USER BEHAVIOR

(a) The user initially chooses one of the two operators, operator O_1 with probability p and operator O_2 with probability (1-p). This we say is the initial preference to an operator.
(b) When first attempt of connectivity fails user attempts one more to the same operator, and thereafter, switches over to the next one where two more consecutive attempts are likely to occur. This we say "two-call-basis" attempts for the effort of call connectivity.
(c) User has two choices after each failed attempt
    a. He can either abandon with probability p_A or
    b. Switch over to the other operator for a new attempt.
(d) The blocking probability that the call attempt fails through the operator O_1 is L_1 and through O_2 is L_2.
(e) The connectivity attempts of user between 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 shift over to O_2.
(f) Whenever call connects through either of O_1 or O_2 we say system reaches to the state of success in n attempts.
(g) User can terminate the attempt process marked as the system to the abandon state A at n^{th} attempts with probability p_A (either O_1 or from O_2).
(h) A successful call connection provides to user a marketing package related to cyber-crime, denoted as C, with attraction probability $(1\text{-}c_1)$ and detention probability $(1\text{-}c_2)$.
(i) After a successful attempt, user has two choices: he performs cyber-crime or can opt the usual web surfing through Internet (with probability c_1). This choice is treated as an attempt related to web connectivity.
(j) Attempt has two definitions like call connecting attempt and Surfing attempt (occurs when call attempt is successful).
(k) User may come-back to usual net-surfing whenever willing (with probability c_2), or may continue with cyber crime surfing state depending on attraction of marketing plan.
(l) From C, user can neither abandon nor disconnect.
(m) From state NC, user can not move to the abandon state A.
(n) State NC and A are absorbing state.

MARKOV CHAIN MODEL

Under above hypotheses of user's behavior 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 nth attempt (call or surfing) made by a user over the state space {O_1, O_2, NC, A, C} where,

State O_1: Corresponding to the user attempting to connect a call through the first operator O_1.
State O_2: Corresponding to the user attempting to place a call through second operator O_2.
State NC: Success (in connectivity) but no cyber-crime.
State A: To the user leaving (abandon) the attempt process.
State C: Connectivity and cyber-crime conduct through surfing.

The connectivity attempts of user 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. Whenever call connects either through O_1 or O_2, the user 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 *NC.* The *A* is absorbing state.
The diagrammatic form of transition between two operators is given in fig.1.

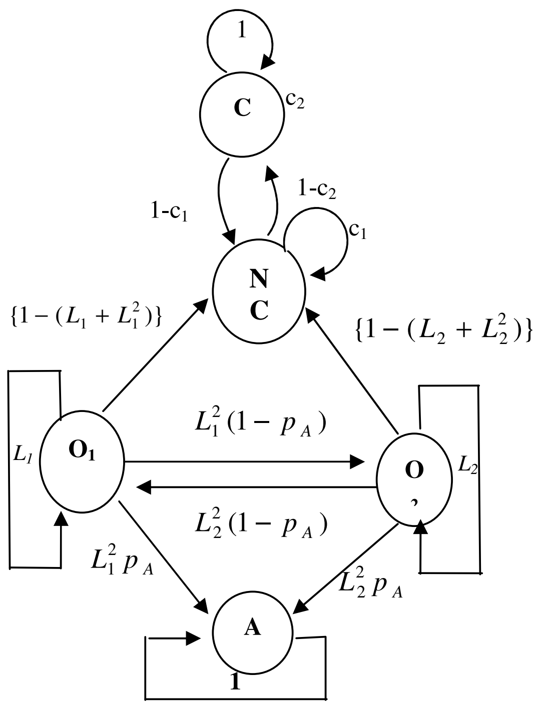


Figure- 1 Transition Diagram of Model

TRANSITION MECHANISM IN MODEL AND PROBABILITIES

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 one attempt or in the 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. Hence, success probability for O_1 is $[1-(L_1+L_1^2)]$

Similar happens for O_2
$=[1-(L_2+L_2^2)]$

Rule 4: User shifts to O_2 if call blocks in both attempts to O_1 and does not abandon the attempting process. 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 happens for O_2
$= L_2^2(1-p_A)$

Rule 5: User earliest abandons the system only 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 $0 \le c_2 \le 1$

$$P\left[X^{(n)} = C \big/ X^{(n-1)} = NC\right] = 1 - c_1 \;;$$
$$P\left[X^{(n)} = NC \big/ X^{(n-1)} = NC\right] = c_1 \;;$$
$$P\left[X^{(n)} = NC \big/ X^{(n-1)} = C\right] = c_2 \;;$$
$$P\left[X^{(n)} = C \big/ X^{(n-1)} = C\right] = 1 - c_2 \;;$$

TRANSITION PROBABILITY BETWEEN STATES

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

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

Now, the transition probability matrix is

States $X^{(n)}$

$X^{(n-1)}$

$$\begin{array}{c|ccccc} & O_1 & O_2 & NC & C & A \\ \hline O_1 & L_1 & L_1^2(1-P_A) & \{1-(L_1+L_1^2)\} & 0 & L_1^2P_A \\ O_2 & L_2^2(1-P_A) & L_2 & \{1-(L_2+L_2^2)\} & 0 & L_2^2P_A \\ NC & 0 & 0 & c_1 & 1-c_1 & 0 \\ C & 0 & 0 & 1-c_2 & c_2 & 0 \\ A & 0 & 0 & 0 & 0 & 1 \end{array}$$

SOME RESULTS FOR n^{th} ATTEMPTS

In n^{th} attempt the probability of resulting state is derived in the following theorems for all n=0,1,2,3,4,5… If the user make attempt between O_1 and O_2, then the n^{th} step transitions probability is:

$$P[X^{(0)}=O_1]=p; \qquad P[X^{(0)}=O_2]=(1-p);$$

The details of transition probabilities, for n>0, are given in the above for the attempts n=0,1,2,3,4,5,............classified into four different categories A, B, C and D. The general expressions of probability of n^{th} attempts for O_1 and O_2 are:

Type A : when t=(4n+1), (e.g. t= 1,5,9,13,17,21,......); (n>0)

$$P\left[X^{(4n+1)}=O_1\right]_A = L_1\left[pL_1^{(3n)}L_2^{(3n)}(1-p_A)^{(2n)}\right]$$

$$P\left[X^{(4n+1)}=O_2\right]_A = L_2\left[(1-p)L_1^{(3n)}L_2^{(3n)}(1-p_A)^{(2n)}\right]$$

Type B : when t=(4n-1), (e.g. t= 3.7.11.,15,19,23.....); (n>0)

$$P\left[X^{(4n-1)}=O_1\right]_B = \left[(1-p)L_1^{(3n-2)}L_2^{(3n)}(1-p_A)^{(2n-1)}\right]$$

$$P\left[X^{(4n-1)}=O_2\right]_B = \left[pL_1^{(3n)}L_2^{(3n-2)}(1-p_A)^{(2n-1)}\right]$$

Type C : when t=(4n), (e.g. t= 0,4,8,12,16,20,........); (n>0)

$$P\left[X^{(4n)}=O_1\right]_C = \left[pL_1^{(3n)}L_2^{(3n)}(1-p_A)^{(2n)}\right]$$

$$P\left[X^{(4n)}=O_2\right]_C = \left[(1-p)L_1^{(3n)}L_2^{(3n)}(1-p_A)^{(2n)}\right]$$

Type D : when t=(4n-2), (e.g. t= 2,6,10,14,18,22....); (n>0)

$$P\left[X^{(4n-2)}=O_1\right]_D = \left[(1-p)L_1^{(3n-3)}L_2^{(3n)}(1-p_A)^{(2n-1)}\right]$$

$$P\left[X^{(4n-2)}=O_2\right]_D = \left[pL_1^{(3n)}L_2^{(3n-3)}(1-p_A)^{(2n-1)}\right]$$

TRAFFIC SHARING AND CALL CONNECTION

We have assumed that the traffic is shared between two operators. Let us calculate the probability of the completion of a call with the assumption that this achieved in n^{th} attempt with operator O_i (i = 1,2).

$$\left[\overline{P}_1^{(n)}\right]_{NCU} = P\left[\begin{array}{l} Call\,complete\,with\,O_1\,and\,user\,is\,at \\ Non-crime\,state(NC)\,at\,n^{th}\,attempt\end{array}\right]$$

$$= P\left[At\,(n-2)^{th}\,attempt\,on\,O_1\right]$$

$$P\left[(n-1)^{th}\,on\,NC \big/ (n-2)^{th}\,on\,O_1\right]$$

$$P\left[n^{th}\,on\,NC \big/ (n-1)^{th}\,on\,NC\right]$$

$$\left[\overline{P}_1^{(n)}\right]_{NCU} = P\left[X^{(n-2)}=O_1\right]P\left[X^{(n-1)}=NC \big/ X^{(n-2)}=O_1\right]$$

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

$$\left[\overline{P}_1^{(n)}\right]_{NCU} = \left\{1-(L_1+L_1^2\right\}c_1\left[\sum_{i=0}^{n-2}P\left\{X^{(i)}=O_1\right\}\right], \quad n\geq 2$$

$$\left[\overline{P}_1^{(n)}\right]_{NCU} = \left\{1-(L_1+L_1^2\right\}c_1 \left[\begin{array}{l} \sum\limits_{\substack{i=0\\ t=Type\,A}}^{n-2}P\left[X^{(i)}=O_1\right]+\sum\limits_{\substack{i=0\\ t=Type\,B}}^{n-2}P\left[X^{(i)}=O_1\right] \\ +\sum\limits_{\substack{i=0\\ t=Type\,C}}^{n-2}P\left[X^{(i)}=O_1\right]+\sum\limits_{\substack{i=0\\ t=Type\,D}}^{n-2}P\left[X^{(i)}=O_1\right]\end{array}\right], n\geq 2$$

COMPUTATION OF TRAFFIC SHARE OVER LARGE ATTEMPTS

Suppose the number of call attempts made by user is very large and then define $\overline{P_i}=\left[\lim_{n\to\infty}\overline{P}_i^{(n)}\right]$, $i=1,2$ 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:

$$\left[\overline{P_1}\right]_{NC} = \left[\left\{1-(L_1+L_1^2\right\}c_1\right] \left\{\begin{array}{l}\left\{\dfrac{(L_1p+p)}{1-\left[L_1^{(3)}L_2^{(3)}(1-p_A)^{(2)}\right]}\right\} \\ +\dfrac{(L_1(1-P)+(1-P))\left[L_2^{(3)}(1-p_A)^{(1)}\right]}{1-\left[L_1^{(3)}L_2^{(3)}(1-p_A)^{(2)}\right]}\end{array}\right\}$$

$$\left[\overline{P_2}\right]_{NC} = \left[\left\{1-(L_2+L_2^2\right\}c_1\right] \left\{\begin{array}{l}\left\{\dfrac{(L_2(1-p)+(1-p))}{1-\left[L_1^{(3)}L_2^{(3)}(1-p_A)^{(2)}\right]}\right\} \\ +\dfrac{(L_2P+p)\left[L_1^{(3)}(1-p_A)^{(1)}\right]}{1-\left[L_1^{(3)}L_2^{(3)}(1-p_A)^{(2)}\right]}\end{array}\right\}$$

Again for separator on type A, B, C and D basis

$$\left[\overline{P_1}\right]_{\substack{Type=A(NC)\\t=4n+1}} = \frac{\left[\left\{1-(L_1+L_1^2\right\}c_1 L_1 p\right]}{1-\left[L_1^{(3)}L_2^{(3)}(1-p_A)^{(2)}\right]}$$

$$\left[\overline{P_2}\right]_{\substack{Type=A(NC)\\t=4n+1}} = \frac{\left[\left\{1-(L_2+L_2^2\right\}c_1 L_2 (1-p)\right]}{1-\left[L_1^{(3)}L_2^{(3)}(1-p_A)^{(2)}\right]}$$

$$\left[\overline{P_1}\right]_{\substack{Type=B(NC)\\t=4n-1}} = \frac{\left\{1-(L_1+L_1^2\right\}c_1(1-p)\left[L_1L_2^{(3)}(1-p_A)\right]}{1-\left[L_1^{(3)}L_2^{(3)}(1-p_A)^{(2)}\right]}$$

$$\left[\overline{P_2}\right]_{\substack{Type=B(NC)\\t=4n-1}} = \frac{\left[\left\{1-(L_2+L_2^2\right\}c_1 p\left[L_1^{(3)}L_2(1-p_A)\right]\right]}{1-\left[L_1^{(3)}L_2^{(3)}(1-p_A)^{(2)}\right]}$$

$$\left[\overline{P_1}\right]_{\substack{Type=C(NC)\\t=4n}} = \frac{\left[\left\{1-(L_1+L_1^2\right\}c_1 p\right]}{1-\left[L_1^{(3)}L_2^{(3)}(1-p_A)^{(2)}\right]}$$

$$\left[\overline{P_2}\right]_{\substack{Type=C(NC)\\t=4n}} = \frac{\left[\left\{1-(L_2+L_2^2\right\}c_1 (1-p)\right]}{1-\left[L_1^{(3)}L_2^{(3)}(1-p_A)^{(2)}\right]}$$

$$\left[\overline{P_1}\right]_{\substack{Type=D(NC)\\t=4n-2}} = \frac{\left[\left\{1-(L_1+L_1^2\right\}c_1(1-p)L_2^{(3)}(1-p_A)\right]}{1-\left[L_1^{(3)}L_2^{(3)}(1-p_A)^{(2)}\right]}$$

$$\left[\overline{P_2}\right]_{\substack{Type=D(NC)\\t=4n-2}} = \frac{\left[\left\{1-(L_2+L_2^2\right\}c_1 pL_1^{(3)}(1-p_A)\right]}{1-\left[L_1^{(3)}L_2^{(3)}(1-p_A)^{(2)}\right]}$$

$$\left[\overline{P_1}\right]_{CC} = \left\{1-(L_2+L_2^2\right\}(1-c_1)\left\{\begin{array}{l}\dfrac{\left[(L_1p+p)\right]}{1-\left[L_1^{(3)}L_2^{(3)}(1-p_A)^{(2)}\right]}\\ +\dfrac{(L_1(1-P)+(1-P))\left[L_2^{(3)}(1-p_A)\right]}{1-\left[L_1^{(3)}L_2^{(3)}(1-p_A)^{(2)}\right]}\end{array}\right\}$$

$$\left[\overline{P_2}\right]_{CC} = \left[\left\{1-(L_2+L_2^2\right\}(1-c_1)\right]\left\{\begin{array}{l}\dfrac{(L_2(1-p)+(1-p))}{1-\left[L_1^{(3)}L_2^{(3)}(1-p_A)^{(2)}\right]}\\ +\dfrac{\left[(L_2P+p)L_1^{(3)}(1-p_A)\right]}{1-\left[L_1^{(3)}L_2^{(3)}(1-p_A)^{(2)}\right]}\end{array}\right\}$$

$$\left[\overline{P_1}\right]_{\substack{Type=A(CC)\\t=4n+1}} = \frac{\left[\left\{1-(L_1+L_1^2\right\}(1-c_1)L_1 p\right]}{1-\left[L_1^{(3)}L_2^{(3)}(1-p_A)^{(2)}\right]}$$

$$\left[\overline{P_2}\right]_{\substack{Type=A(CC)\\t=4n+1}} = \frac{\left[\left\{1-(L_2+L_2^2\right\}(1-c_1)L_2(1-p)\right]}{1-\left[L_1^{(3)}L_2^{(3)}(1-p_A)^{(2)}\right]}$$

$$\left[\overline{P_1}\right]_{\substack{Type=B(CC)\\t=4n-1}} = \frac{\left[\left\{1-(L_1+L_1^2\right\}(1-c_1)(1-p)\left[L_1^{(1)}L_2^{(3)}(1-p_A)\right]\right]}{1-\left[L_1^{(3)}L_2^{(3)}(1-p_A)^{(2)}\right]}$$

$$\left[\overline{P_2}\right]_{\substack{Type=B(CC)\\t=4n-1}} = \frac{\left[\left\{1-(L_2+L_2^2\right\}(1-c_1)p\left[L_1^{(3)}L_2^{(1)}(1-p_A)\right]\right]}{1-\left[L_1^{(3)}L_2^{(3)}(1-p_A)^{(2)}\right]}$$

$$\left[\overline{P_1}\right]_{\substack{Type=C(CC)\\t=4n}} = \frac{\left[\left\{1-(L_1+L_1^2\right\}(1-c_1)p\right]}{1-\left[L_1^{(3)}L_2^{(3)}(1-p_A)^{(2)}\right]}$$

$$\left[\overline{P_2}\right]_{t=4n}^{Type=C(CC)} = \frac{\left[\left\{1-(L_2+L_2^2\right\}(1-c_1)(1-p)\right]}{1-\left[L_1^{(3)}L_2^{(3)}(1-p_A)^{(2)}\right]}$$

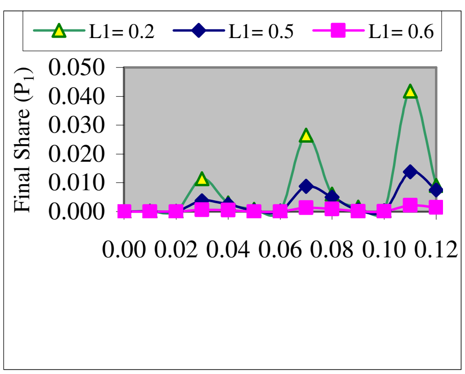
$$\left[\overline{P_1}\right]_{t=4n-2}^{Type=D(CC)} = \frac{\left[\left\{1-(L_1+L_1^2\right\}(1-c_1)(1-p)L_2^{(3)}(1-p_A)\right]}{1-\left[L_1^{(3)}L_2^{(3)}(1-p_A)^{(2)}\right]}$$

$$\left[\overline{P_2}\right]_{t=4n-2}^{Type=D(CC)} = \frac{\left[\left\{1-(L_2+L_2^2\right\}(1-c_1)pL_1^{(3)}(1-p_A)\right]}{1-\left[L_1^{(3)}L_2^{(3)}(1-p_A)^{(2)}\right]}$$

SIMULATION OVER LARGE ATTEMPTS

By Non-Crime User [NCU]

In view of fig. 1 to fig. 3, the increase in blocking probability of network reduces the final traffic share of non-crime user (NCU) group. If opponent blocking L_2 is high, then operator O_1 gains the traffic over the two-call-basis setup. With the joint variation of both the blocking, probabilities it is observed that lower blocking level is only preferential.



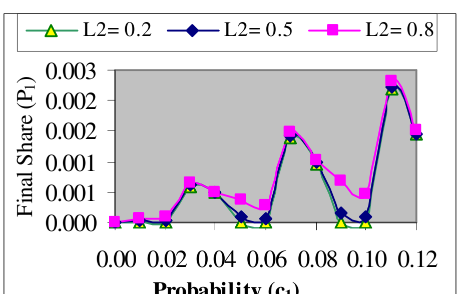
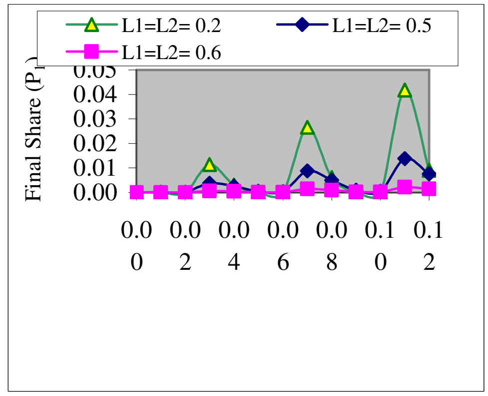


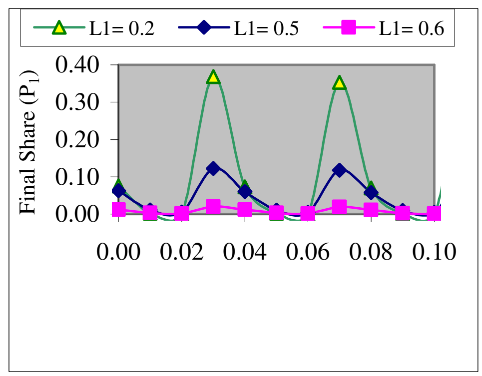
Fig. 2 (L_1=0.6, p=0.5, p_A=0.3)

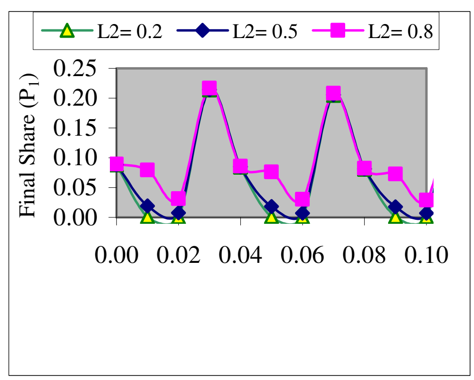
Non Crime User [NCU] for O_1

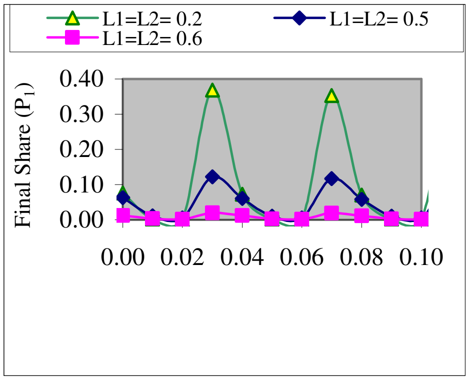


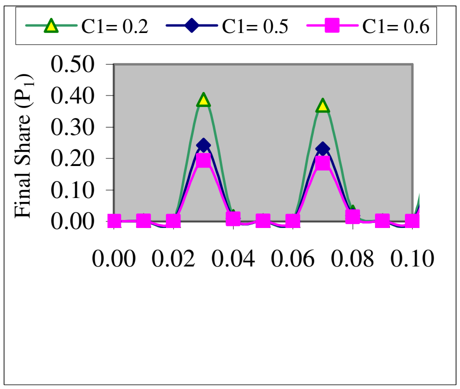
BY CRIME USER [CU]

With reference to fig. 4 to 7, the final share probability has fluctuating trend. The lower blocking probability L_1 of operator O_1 generates high CU proportion. The small c_1 probability also produces high level of cyber criminals; therefore it is suggested to set high probability for c_1 and low probability for L_1.









CONCLUSION

In the two-call setup, with the increase of a c_1 and L_1 probability together, there is loss due to proportion of no-cyber criminals. But, with increase of c1 alone the proportion of non cyber criminals is high. In contrary, if c1 is low (10%). One can get high proportion of final traffic of CU group. It seems marketing plans related to promotion of cyber crimes help to uplift the Internet traffic for an operator. The proportion of non-cyber criminals shift over to other side. With this, self-blocking of network is low, the operator gains better of traffic.

REFERENCES

[1] Horvath, M. Telek, “A Markovian Point Process Exhibiting Multifractal Behaviour and its Application to Traffic Modeling”, Fourth International Conference Matrix Analytic Methods in Stochastic Models, Adelaide, Australia, pp. 14-18 July, 2005.

[2] A. W. Moore and D. Zuev, “Internet traffic classification using bayesian analysis techniques”, SIGMETRICS Perform. Eval. Rev., vol. 33(1), 2005.

[3] Abuagla Babiker Mohd and Dr. Sulaiman bin Mohd Nor “Towards a Flow-based Internet Traffic Classification for Bandwidth Optimization”, International Journal of Computer Science and Security (IJCSS), 3(2):146-153, 2009.

[4] B. Wydrowski and M. Zukerman, “QoS in Best -Effort Networks,” IEEE Communications Magazine 40, 44-49, 2002.

[5] C. Fraleigh, S. Moon, C. Diot, B. Lyles, and F. Tobagi, “Packet-level traffic measurements from a tier-1 IP backbone”. In Under submission, November 2001.

[6] D. Shukla and S. Gadewar, Stochastic model for cell movement in a Knockout Switch in computer networks, Journal of High Speed Network, 16(3), 310-332, 2007.

[7] D. Shukla and Sanjay Thakur, “Crime based user analysis in Internet traffic sharing under cyber crime”, Proceedings of National Conference on Network Security and Management (NCSM-07), 155-165, 2007.

[8] D. Shukla, V. Tiwari and S. Thakur, “Effects of Disconnectivity Analysis for Congestion Control in Internet Traffic Sharing”, published in the proceedings of the National Conference on Research and Development Trends in ICT (RDTICT-2010), Lucknow University, Lucknow, pp 161-169, 2010.

[9] D. Shukla, V. Tiwari, S. Thakur and A. Deshmukh, “Share Loss Analysis of Internet Traffic Distribution in Computer Networks”, published in International Journal of Computer Science and Security (IJCSS) Malaysia, vol 3, Issue 5, pp. 414-427, 2009.

[10] D. Shukla, V. Tiwari, S. Thakur and M. Tiwari, ”A Comparison of Methods for Internet Traffic Sharing in Computer Network”, published in International Journal of Advanced Networking and Applications (IJANA), vol. 1, issue 3, pp. 164-169, 2009.

[11] D. Shukla, Virendra Tiwari and Abdul Kareem P, “All Comparison analysis in Internet Traffic Sharing using markov chain model in Computer Networks”, published in International Journal of Georgian Electronic Scientific Journal: Computer Science and Telecommunications No. 6(23), 2009.

[12] Emanual Perzen “Stochastic Processes”, Holden-Day, Inc., San Francisco, and California, 1992.

[13] Georgios Y. Lazarou, Xiangdong Xia, Victor S. Frost, “Internet traffic modeling using the index of variability”, pp 01-06, (2003)

[14] J. Medhi, “Stochastic Processes”, Ed. 4, Wiley Eastern Limited (Fourth reprint), New Delhi ,1992.

[15] Joshua Thomas (Ohio University) and Thomas Conley (Ohio University), “Internet Traffic Analysis for Threat Detection”, Midwest Regional Conferences (03/22/2005).

[16] K. Park, W. Willinger, “Self-Similar Network Traffic And Performance Evaluation”, New York: John Wiley & Sons Inc., 2000.

[17] M. Naldi, “Internet Access Traffic Sharing in A Multi-user Environment”, Computer Networks, 38:809-824, 2002.

AUTHORS

Dr. Diwakar Shukla is working as an Associate Professor in the Department of Mathematics and Statistics, Sagar University, Sagar, M.P. and having over 23 years experience of teaching to U.G. and P.G. classes. He obtained M.Sc.(Stat.), Ph.D.(Stat.), degree from Banaras Hindu University, Varanasi and served the Devi Ahilya University, Indore, M.P. as a Lecturer over nine years and obtained the degree of M. Tech. (Computer Science) from there. During Ph.D., he was junior and senior research fellow of CSIR, New Delhi qualifying through Fellowship Examination (NET) of 1983. Till now, he has published more than 75 research papers in national and international journals and participated in more than 35 seminars / conferences at national level. He is the recipient of MPCOST Young Scientist Award, ISAS Young Scientist Medal, UGC Career Award and UGC visiting fellow to Amerawati University, Maharashtra. He also worked as a selected Professor to the Lucknow University, Lucknow, U.P., for one year and visited abroad to Sydney (Australia) and Shanghai (China) for conference participation. He has supervised ten Ph.D. theses in Statistics and Computer Science both; and eight students are presently enrolled for their doctoral degree under his supervision. He is member of 10 learned bodies of Statistics and Computer Science both at national level. The area of research he works for are Sampling Theory, Graph Theory, Stochastic Modelling, Computer Network and Operating Systems.

Mr Virendra Tiwari has completed M.C.A. degree from Dr. H. S. Gour University, Sagar in 2005. He is presently working as Lecturer in the Department of Computer Science & Applications in the same University since 2005. He did his research in the field of Stochastic Modelling and Computer Networking. In this field, he has authored and co-authored 6 research papers in National/International journals. His current research interest is to analyze the internet traffic sharing under various traffic analyses.

Dr. Sanjay Thakur has completed M.C.A. and Ph.D. (CS) degree from H.S. Gour University, Sagar in 2002 and 2009 respectively. He is presently working as a Lecturer in the Department of Computer Science & Applications in the same University since 2007. He did his doctoral work in the field of Computer Networking and Internet traffic sharing. He has authored and co-authored 10 research papers in National/International journals and conference proceedings. His current research interest is Stochastic Modeling of Switching System of Computer Network and Internet Traffic Sharing Analysis.