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Stochastic Model for Internet Mobile Data Traffic Sharing Analysis in Dual SIM Environment

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ABSTRACT

Today's lots of remarkable features are existing over mobile phones and their users seek connectivity ubiquitously round the clock everywhere to fulfill their requirements. Normally mobile phone users identify the quality of their mobile telephone network in terms of drops in internet connectivity and speed of web-page loading. At the same time trend of using more than one SIM has become common and users have started use of dual SIM mobile handset. Mobile user's behaviour is depending on the quality of services provided by mobile telephone operator and his marketing strategy. At the same time congestion of network is a major factor in selection of SIM of a particular operator in the setup of dual SIM environment. In this paper a stochastic model of user behaviour is proposed under dual SIM environment and a correlation concerning, mobile data traffic Sharing and congestion probability has been derived with the usage of markov chain model. Moreover, for the clarification of derived results, Simulation study has also been implemented.

Keywords: Dual SIM, Stochastic Model, Mobile Data Traffic, Congestion Probability, Dial-by-Dial, User's behaviour

I. INTRODUCTION

The ground breaking contribution of Neilson (2012) and his group need special mention in determining the utilisation of dual SIM and their behaviour over network congestion on traffic share. Neilson (2012)survey reveals that 71 million subscribers use multiple sim cards in India, which show the rising trend and enlighten the potential for multiple sim mobile handsets. The subscribers who contributed in the survey were classified by age group, profession, different key reasons they gave for opting the multi sim. An obvious approach of average multiple sim users emerged as 31% subscribers showed their interest in multiple sim card to avail the better deals and offers out of which 30% were between (5-10 L), 27 % were between (10-40 L)and 40% were above 40 L. Moreover 17 % subscribers opted for multiple sim cards to get the best tariff selections available out of which 9% were between (5-10 L),18% were involving (10-40 L) and 18 % flanked by 40 L above. Further 10 % preferred multiple sim for continuous network connectivity, While 8% showed their interest for closed user group scheme. Additionally 8% subscribers used multiple sim cards for assurance of network coverage all the time. 8% subscriber used dual sim for privacy reasons also .In addition 6% subscribers preferred to keep multiple sim for free add given by service provider.Interestingly,5% chosen because the secondary sim was offered with their handset. This work proposes a prediction model of user behaviour using specific condition of dual sim environment. However, for comparative studies, the utilisation of Markov Model by simulation study has also been determined.

II. LITERATURE REVIEW

A survey was conducted by Nielsen (2012) in which dual-multi-sim users are studies age's byes and some facts of mobile users are suggested.

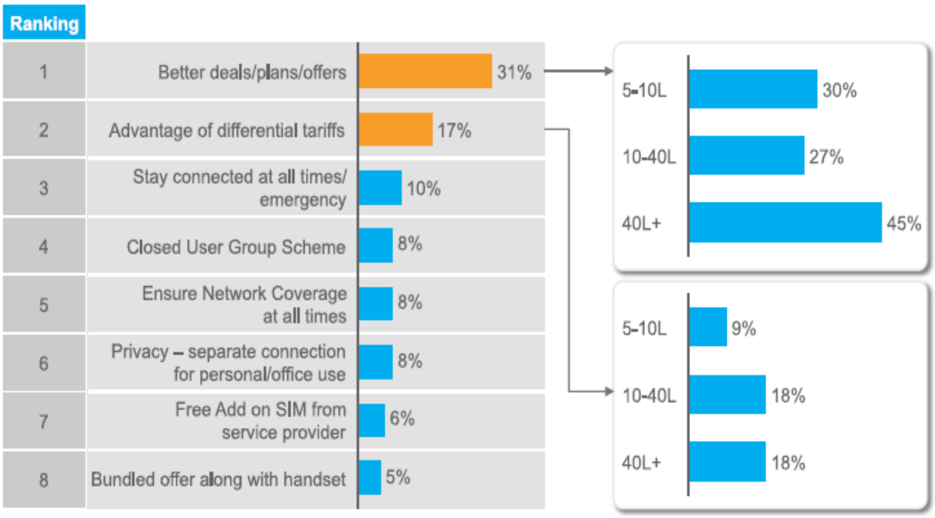

Fig.1 -A Survey According to Nielson (2012) for Multi Sim Users

Yassine and Abid(2010) develop a design and performance of delta networks for mpsoc on programmable circuits. A detail discussing was given by Tanenbaum (1996) in which facts of computer networks was suggested. Neelamkavil(1990) elaboratea fundamental discussion of simulation and modeling in various field.Shukla,Gadewar and Pathak (2007) given a view point approach on stochastic modeling for Space-Division Switches in computer networking field. Shukla and Gadewar (2007) used a markov chain model for cell movement in a knockout switch in the field of networking.Francini and Chiussi(2002) have given a study on QoS guarantees to unicast and multicast flows in multistage packet switches system. Färber, Bodamer and Charzinski (1998) have recently introduced evaluation of dial-up behaviour for Internet users. Gordon *et al.* (1997) worked over for the overview of Internet traffic issues on the public switch telephone network.Iverson (1999) has conducted an extensive analysis for the introduction to traffic engineering while Kassim*et al.* (2015) have discussed on statistical analysis and modeling of internet traffic ip-based network for tele-traffic engineering. Moustafa*et al.*(1999) attempts for designing a structure and performance evaluation of a replicated banyan network based atm switch in the networking field. Naldi (2002) explored a Markov chain model based study for Internet access traffic sharing in a multi-user environment where as one more similar study was given by Naldi (1998) for the Internet growth problems. Gordon *et al.* (2003) have given a thought and detail discussion on System Simulation. Medhi (1992) focused on for the basic fundamental concept of stochastic process in various field. Newby and Dagg (2002) conducted a study on optical inspection and maintenance for stochastically deteriorating systems for average cost criteria. Thakur and Jain (2013) have another interesting contribution on user's share analysis through a prediction model in case of dual-sim environment. Thakur, Jain and Dashore(2013) have explored a Markov chain model based study by using prediction model for delta interconnection network and find the new result for it. Thakur,Jain and Shukal(2014) presented ainternet traffic distribution management in case when two service provider are in competitive mode under cyber crime marketing plans. Shukla and Singhai (2011) presented a view point approach on for users web browsing behaviour using markov chain model in which browser share analysis was examined in the condition when two browser are installed in a computer system. A fundamental concept of data communication was given by Singh (2006) in which various technology of networking discussed.

III. MOBILE STATION

The mobile station (MS) comprise of the equipment of the user, software desired for the communication and subscriber identity module (SIM), which provides all the user specific data according to their requirements.

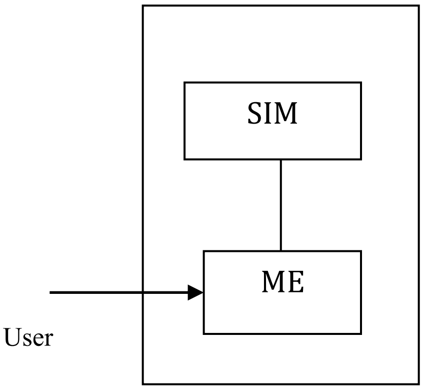

Fig. 2 -Mobile Station

When network congestion take place in dual SIM, Users find disconnectivity in making calls and go for repeated call attempt to get connectivity. Due to congestion, dial-by-dial process commence between both the SIM for a successful call connection. In this paper we have focused on model based analysis of dual SIM environment to examine the User behaviour. Related contribution are reinforced by [5],[9],[11],[16],[17] and [19] for scheming such a prediction model based study.

IV. USER'S BEHAVIOUR MODEL

We initialize the simulation with dual SIM. We consider following hypotheses for the behavior of user, while sharing the call between the two SIM.

- The user has a dual SIM mobile phone, containing Sims, S_1 and S_2 of two different mobile service provider or operators.
- A user initially chooses one of the two SIM with probability p and (1-p) for S_1 and S_2 respectively $(0 \leq p \leq 1)$.
- The p is affected by advertising, marketing, quality-of-service and past preference (or attractiveness).
- After each failed call attempt, the user has two choices:
  He can abandon with probability p_E, switch over to other SIM for a new call.
- Switching among S_1 and S_2 is on dail-by-dail basis depending just on the latest attempt.
- During the repeated calls, the congestion probability offered by S_1 is C_1 and of S_2 is C_2.
  The congestion implies situation when call attempt process fails to connect a SIM.

Under above hypotheses the user's behavior and attitude could be modeled by a four-state discrete-time markov chain $\{D^{(n)}, n \geq 0\}$ such that $D^{(n)}$ stands for the state of random variable D at nth attempt made by a user over state space $\{S_1, S_1, Z, E\}$,

Where

State S_1: Sim corresponding to first service provider

StateS_2: Simcorresponding to second service provider

State Z: Success (in connectivity)

State E: Exit from call connectivity attempt process.

The transition probabilities are indicated on the arcs connection the circles representing the chain states. The time is represented by the number of attempts. $P[\ D^{(n)} = S_i]$ $(i = 1,2)$ is the probability that the $(n + 1)^{th}$ call attempt is placed through the Sim S_i. The Fig. 1 explains the transition in model and Fig. 2 is a transition probability matrix of the model.

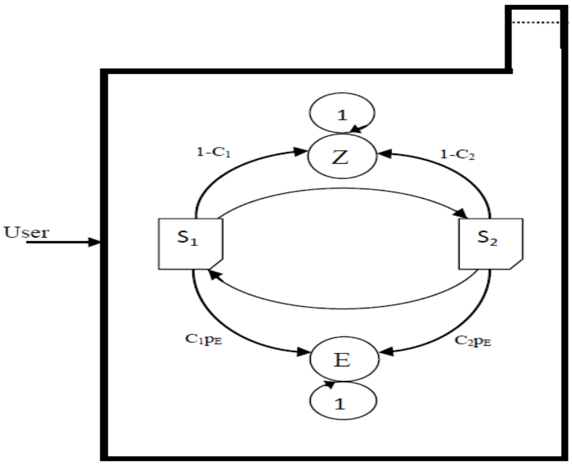

Fig. 3- Model of User's Behaviour in Dual Sim Case

State y^n

State y^{n-1}

	S_1	S_2	Z	E
S_1	0	$C_1(1\text{-}p_E)$	$(1\text{-}C_1)$	C_1p_E
S_2	$C_1(1\text{-}p_E)$	0	$(1\text{-}C_2)$	C_2p_E
Z	0	0	1	0
E	0	0	0	1

Fig.4- Transition Probability Matrix

V. THE QUALITY OF SERVICE EXPERIENCE BY USER

The prominent purpose of user is to complete the call. User experiences congestion possibility that is a primary quality of service parameter. In our model a User classified as:

(a) DEDICATED USER (DU):

Who abide with the SIM[Si (i=1,2)only],and opt for its first attempt otherwise, prefers to abandon, but doesn't go for other competitive.

(b) UNDEDICATED USER (UDU):

Who toggles between two SIM (Si and Sj, i ≠ j = 1, 2) till he either completes his call or exits.

VI. STATE PROBABILITIES IN N^TH^ STEP

$$P[D^{(n)}=S_1]=p(1-p_E)^n(C_1C_2)^{\frac{n}{2}}$$

$$P[D^{(n)}=S_1]=(1-p)C_2(1-p_E)^n(C_1C_2)^{\frac{n-1}{2}}$$

$$P[D^{(n)}=S_2]=(1-p)(1-p_E)^n(C_1C_2)^{\frac{n}{2}}$$

$$P[D^{(n)}=S_2]=pC_1(1-p_E)^n(C_1C_2)^{\frac{n-1}{2}}$$

VII. TRAFFIC SHARE ANALYSIS OF MOBILE SERVICE PROVIDER (OR OPERATORS)

In this work we analyse user's traffic share between two mobile service providers. A dial is completed through sim S_1 if a dial is placed with it and the dial is not congestion (same for S_2), the probability that a call is completed through sim S_1 at n^th^ dial is

$$\overline{M}_{T_1}^{(n)}=P\left[D^{(n-1)}=S_1\right].P\left[D^{(n)}=Z/D^{(n-1)}=S_1\right]$$ Here we have again rewriting the n^th^ state probabilities *i.e*

$$\overline{M}_{T_1}^{(n)}=p(1-C_1)(1-p_E)^{n-1}\sqrt{(C_1C_2)^{n-1}}$$

For n is odd

$$\overline{M}_{T_1}^{(n)}=p(1-C_1)(1-p_E)^{n-1}\sqrt{(C_1C_2)^{n-1}}$$

For n is even

$$\overline{M}_{T_1}^{(n)}=(1-p)C_2(1-C_1)(1-p_E)^{n-1}\sqrt{(C_1C_2)^{n-2}}$$

A dial is completed through SIM-1 within the first n^th^ dials we have to sum over the number of dials:

$$\overline{M}_{T_1}^{(n)}=\sum_{i=1}^{n}\overline{M}_{T_1}^{(i)}=(1-C_1)\sum_{i=1}^{n}P\left\{D^{(i-1)}=S_1\right\}$$

$$=(1-C_1)\sum_{i=0}^{n-1}P\left\{D^{(i)}=S_1\right\}$$

$$=(1-C_1)\left[p\sum_{\substack{i=0\\ i=Even}}^{n-1}\begin{matrix}\sqrt{\left(C_1C_2\right)^i}(1-p_E)^i+\\ (1-p)C_2\displaystyle\sum_{\substack{i=0\\ i=Odd}}^{n-1}\sqrt{\left(C_1C_2\right)^{i-1}}(1-p_E)^i\end{matrix}\right]$$

When n is even

$$=(1-C_1)\begin{bmatrix}p+(1-p)\\(1-p_E)C_2\end{bmatrix}\left\{\left.1-\sqrt{\begin{bmatrix}C_1C_2\\(1-p_E)^2\end{bmatrix}}^{\,n}\right/\begin{matrix}1-C_1C_2\\(1-p_E)^2\end{matrix}\right\}$$

When n is odd we obtain the expression

$$\overline{M}_{T_1}^{(n)}=\frac{\begin{matrix}(1-C_1)p\left\{1-\sqrt{\left[C_1C_2(1-p_E)^2\right]}^{\,n+1}\right\}+\\ C_2(1-p_E)(1-p)\left\{1-\sqrt{\left[C_1C_2(1-p_E)^2\right]}^{\,n-1}\right\}\end{matrix}}{1-C_1C_2(1-p_E)^2}$$

In the same way we can obtain the probability that a dial is completed through the mobile service provider (operator) S_2

$$\overline{M}_{T_2}^{(n)}=(1-C_2)\left[(1-p)\sum_{\substack{i=0\\ i=Even}}^{n-1}\begin{matrix}\sqrt{\left(C_1C_2\right)^i}(1-p_E)^i+\\ pC_1\displaystyle\sum_{\substack{i=0\\ i=Odd}}^{n-1}\sqrt{\left(C_1C_2\right)^{i-1}}(1-p_E)^i\end{matrix}\right]$$

These probabilities indicates that the proportions by which the overall mobile data traffic offered by a user is distributed between two mobile service provider(operators) through SIM-1 or SIM-2.

If we suppose that the number of dials goes to infinite then, the limiting expressions are

$$\overline{M}_{T_1}=\lim\underset{\substack{\lim\\ n\to\infty}}{\overline{M}^{(n)}}_{T_1}=(1-C_1)\frac{\left[(1-p)C_2(1-p_E)+p\right]}{1-C_1C_2(1-p_E)^2}$$

$$\overline{M}_{T_2}=\lim\underset{\substack{\lim\\ n\to\infty}}{\overline{M}^{(n)}}_{T_2}=(1-C_2)\frac{\left[1-p+C_1(1-p_E)p\right]}{1-C_1C_2(1-p_E)^2}$$

VIII. SIMULATION STUDY

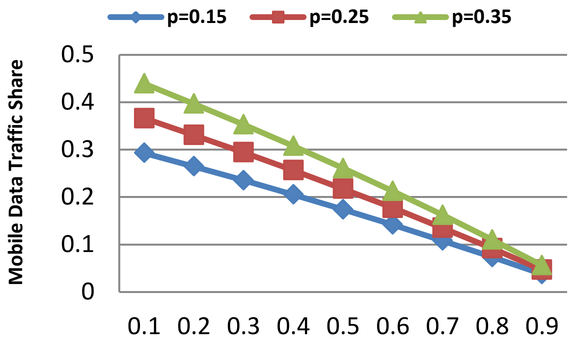

Fig. 1 Congestion Probability C_1
(Where PE=0.2, c_2=0.25)

Figure 1 reflects that the mobile data traffic share pattern is in downward trend for some constant increment in initial share p by 10% subject to the condition when opponent congestion probability of mobile service provider c_2= 25% &p_E=20%.

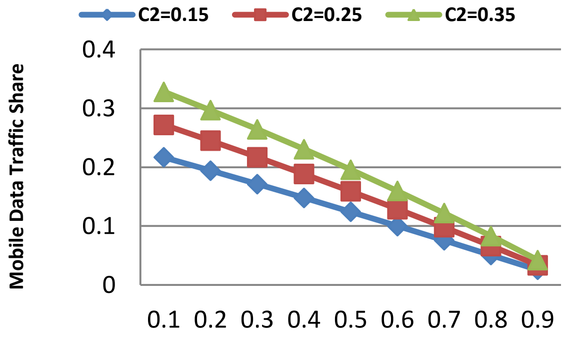

Fig. 2 Congestion Probability C_1
(Where p=0.15, pE=0.35)

Figure 2 reveals that the mobile data traffic share decreases with respect to congestion probability C_1 when p=15% &p_E=35% and for the little increment of C_2 by 10%.

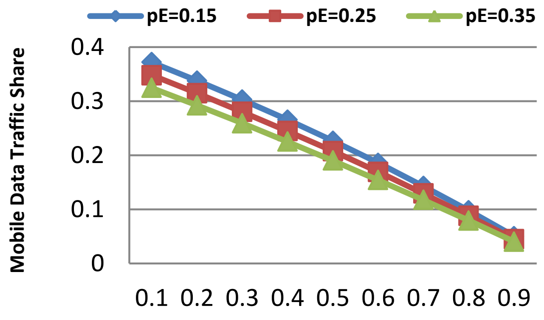

Fig. 3 Congestion Probability C_1
(Where p=0.2, p_E=0.25)

In the light of figure 3 it seems to be that for some constant network parameter traffic pattern decreases when abandon probability p_E increased by 10%.

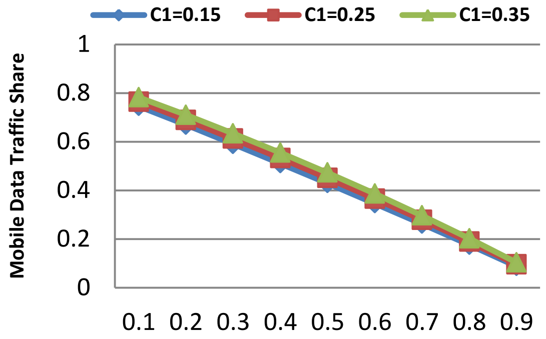

Fig. 4 Congestion Probability C_2
(Where p=0.2, p_E=0.25)

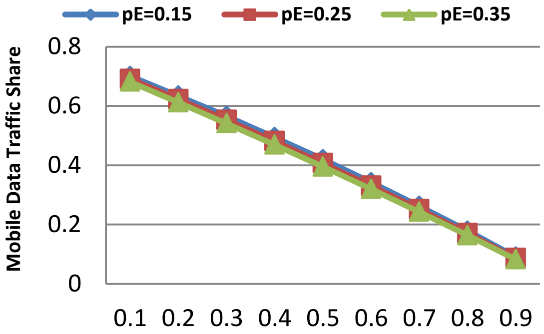

Fig. 5 Congestion Probability C_2
(Where p=0.3, C_1=0.25)

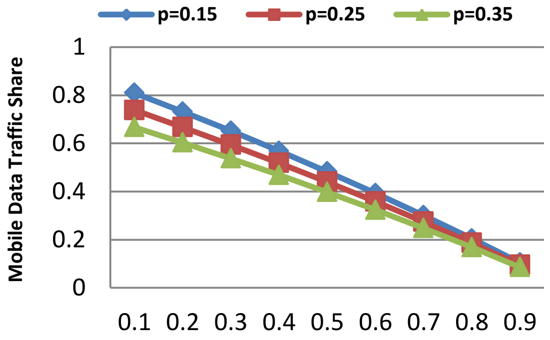

Fig. 6 Congection Probability C_2
(Where c_1=0.3, p_E=0.25)

On the other hand when figures 4-5 are underway the mobile data traffic share patterns are overlapped for some constant parameter. While figure 6 is taking into consideration that mobile data traffic share pattern for sim-2 decrease subject to the condition when C_1=30% & p_E=25%.

IX.CONCLUSION

This paper has given an account of a correlation between congestion probability and mobile data traffic share which has been determined for each mobile telephone operator. Moreover, Mobile data traffic sharing is analysed through markov chain model under dual sim environment. In our findings, we observed that the pattern is overlapped where initial share of mobile users is p=30% and congestion probability 25% along with the case when p=20 % and p_E=25%.Additionally, in the case when p=20% and p_E=25%, a downward pattern is found for constant network parameter. Furthermore, the findings also reflect that in the system of dual sim environment, a negative correlation existed between congestion probability and mobile data traffic.

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