A PREDICTION MODEL FOR USER'S SHARE ANALYSIS IN DUAL-SIM ENVIRONMENT

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Abstract

As soon as the dual-Sim handsets are getting popularity in the country a call-by-call competition occurs among the operators or mobile service providers. Due to call congestion, users must often make repeated call attempt at Sim until getting the connectivity. During the repeated calling process the user will be able to change his choice of Sim on call-by-call basis. In this paper a Markov chain proposed as a prediction model for analysis the user's behaviour in the set up of dual Sim mobile environment. This model use to predict the effect of congestion on initial traffic share between the Sims.

Keywords: *Markov Chain Model, Transition Probability Matrix, Mobile Service Providers (Operators), User's Behaviour*

I. Introduction

A survey conducted by Nielsen reveals that 71 million or approximately 8 per cent of more than 900 million mobile users in India use multiple Sim cards. The survey says cities with population between 5-10 lakh have the highest density of multiple Sim users, which is about 21 percent. About 11 percent of multiple Sim users are based out of towns with 40-lakh population.

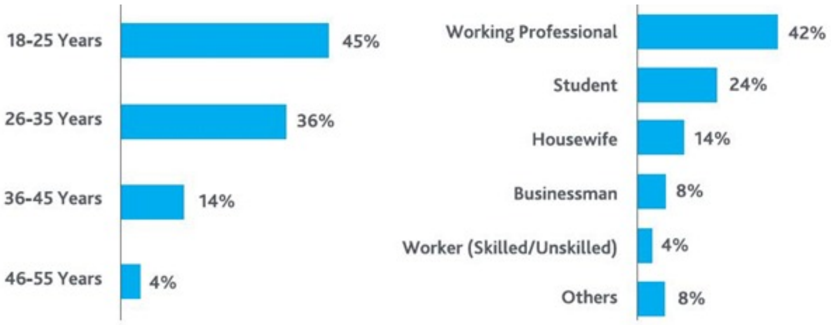

Fig. 1. Multi-Sim users according Nielsen Survey

Only 9 percent of users belong to rural areas, says the survey. In Nielsen survey the youth are the highest multi-Sim users, as much as 45 percent between the age group of 18-25 years old. Most of them are students, working professionals and newly employed. A multi-Sim user prefers different operators and prepaid connection. Interestingly, 61 percent of multi-Sim users are owners of dual-SIM phones.

A. Key reasons for choosing Multi-Sim:

The 31% or 6,200 respondents said that they use more than one Sim card to get access to better deals and offers. Additional 17% or 3,400 respondents said that they carried multiple Sims to avail the best tariff options available. Other reasons why the respondents used multiple Sim cards varied from continuous network connectivity, UGs and segregation of work and private calls. While these reasons were on a personal level, it is interesting to note that 6% used multiple Sim cards just because it was given as an add-on by their service provider. Additionally 5% said that their secondary Sim card was bundled along with the purchase of their handset. The two categories together reveal that 2,200 respondents use multiple Sim cards just because they've been given one.

B. Mobile Station

Mobile station (MS) communicates the information with user. The MS has two elements. The first element is mobile equipment (ME), which is a piece of hardware that the customer purchases from the equipment manufacture or their dealers. The second element of MS in the GSM is the subscriber identity module (Sim) that is a smart card issued at the subscription time identifying the specifications of a user such as address and type of service. Implementing a Sim is a fairly simple concept, it has a significant impact on the way that user transacts with the service provider.

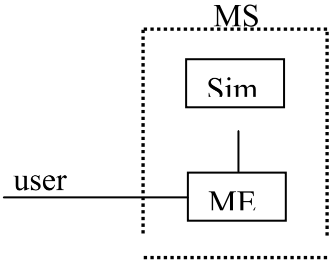

Fig.2. Mobile Station

Due to congestion in packet flow in network, users have to make repeated call attempts before getting their call connected by a Sim. Due to other technical problems, the network of a mobile service provider fails to provide connectivity even after a large number of efforts and users think of to change the Sim of service provider to get an early connectivity for communication.

Cybernetic traffic model in the IXPs/SP environment with e-services is presented by [3], which simulate IXPs/SPs market competition behaviour. In this paper, we make a simple traffic prediction model for analyze the user's behaviour in dual- Sim environment. Contributions of [1], [2], [4], [5] are used as helping tools to design and perform the model based study.

II. User's Behavior Model

We start 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). $X^{(n-}$
- 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 $\{X^{(n)}, n \geq 0\}$ such that $X^{(n)}$ stands for the state of random variable X 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
State S_2 :Sim corresponding to second service provider

State Z: Success (in connectivity)
State E: Exit from call connectivity attempt process.

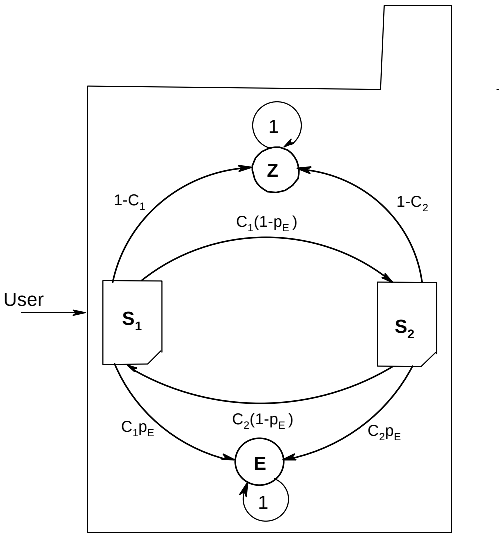

Fig.3. Model of user's behavior in the dual Sim case

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[$X^{(n)}$ = S_i] (i = 1,2) is the probability that the (n + 1)th call attempt is placed through the Sim S_i. The Fig. 3 explains the transition in model and Fig. 4 is a transition probability matrix of the model.

$$\begin{array}{cc} & \longleftarrow X^{(n)} \longrightarrow \\ X^{(n-} & \left(\begin{array}{c|cccc} & S_1 & S_2 & Z & E \\ \hline S_1 & 0 & C_1(1-p_E) & 1-C_1 & C_1p_E \\ S_2 & C_1(1-p_E) & 0 & 1-C_2 & C_2p_E \\ Z & 0 & 0 & 1 & 0 \\ E & 0 & 0 & 0 & 1 \end{array}\right) \end{array}$$

Fig.4. One step Transition Probabilities Matrix

III. n^{th} Step State Probabilities

$$P\left[X^{(n)} = S_1\right] = p\sqrt{(C_1C_2)^n}(1-p_E)^n \text{ ,} \qquad \text{n even} \qquad (2)$$

$$P\left[X^{(n)} = S_1\right] = (1-p)C_2\sqrt{(C_1C_2)^{n-1}}(1-p_E)^n \text{ ,} \qquad \text{n odd} \qquad (3)$$

$$P\left[X^{(n)} = S_2\right] = (1-p)\sqrt{(C_1C_2)^n}(1-p_E)^n \text{ ,} \qquad \text{n even} \qquad (4)$$

$$P\left[X^{(n)} = S_2\right] = pC_1\sqrt{(C_1C_2)^{n-1}}(1-p_E)^n \text{ ,} \qquad \text{n odd} \qquad (5)$$

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IV. The Quality of Service Experience by User

The principal goal of user is to complete the call. User experiences congestion probability that is a first quality of service parameter. In our model a user categorized as:

a) Dedicated User (DU)

Who sticks with the Sim [S_i (i = 1, 2) only)], it has chosen for its first attempt otherwise, prefers to abandon, but does not attempt for other competitive.

b) Undedicated User (UDU)

Who toggles between two Sim (S_i and S_j, $i \neq j = 1, 2$) till he either completes his call or exits.

A. Average Congestion Probability for Users

If dedicated user chosen the Sim S_1 then he always experiences the same congestion probability C_1 otherwise C_2. Averaging over these two choices gives us the average congestion probability B_d for the dedicated user:

$$B_d = pC_1 + (1-p)C_2 . \tag{6}$$

Instead, at the nth attempt undedicated user experiences a varying congestion probability it is

$$B_{ud}^{(n)} = \frac{P[X^{(n-1)} = S_1]C_1 + P[X^{(n-1)} = S_2]C_2}{P[X^{(n-1)} = S_1] + P[X^{(n-1)} = S_2]} \quad . \tag{7}$$

Since the state probabilities for the two states S_1 and S_2 at the nth attempt depend on whether n is even or odd .We obtain two expression for congestion probability of the undedicated user by using expression (2)-(5) in exp. (7):

$$B_{ud}^{(n)} = \frac{C_1C_2}{pC_1 + (1-p)C_2} \quad , \qquad \textit{when n even} \tag{8}$$

$$B_{ud}^{(n)} = pC_1 + (1-p)C_2 \quad , \qquad \textit{when n odd} \tag{9}$$

So, $B_d = B_{ud}$, *when n even,* $B_{du} < B_d$ or $B_{du} > B_d$, *when n odd.*

$$p < \frac{\sqrt{C_1C_2} - C_2}{C_1 - C_2}, C_1 < C_2 \tag{10}$$

$$p > \frac{\sqrt{C_1C_2} - C_2}{C_1 - C_2}, C_1 > C_2 \ . \tag{11}$$

Fig.4 and Fig.5 reveals that the undedicated user increases the initial share of S_1 when the S_2 congestion probability is 0.02 and 0.1 respectively.

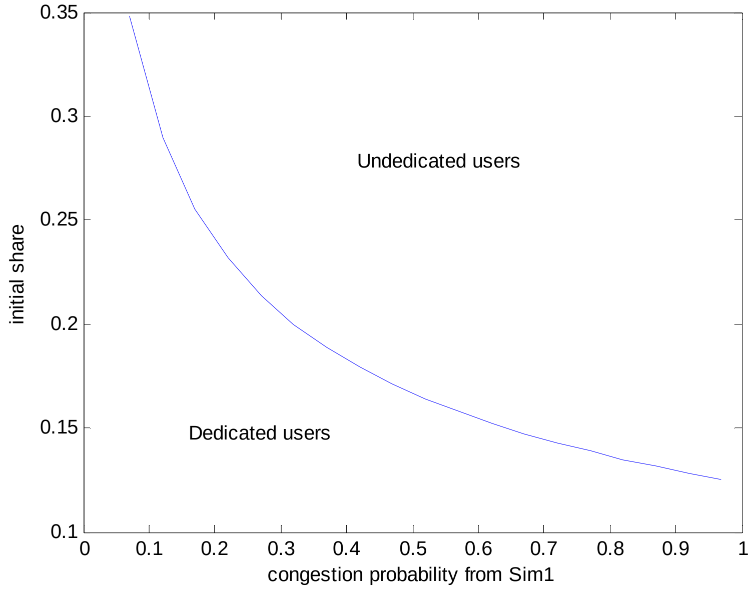

Fig.4 initial share when $C_2 = 0.02$

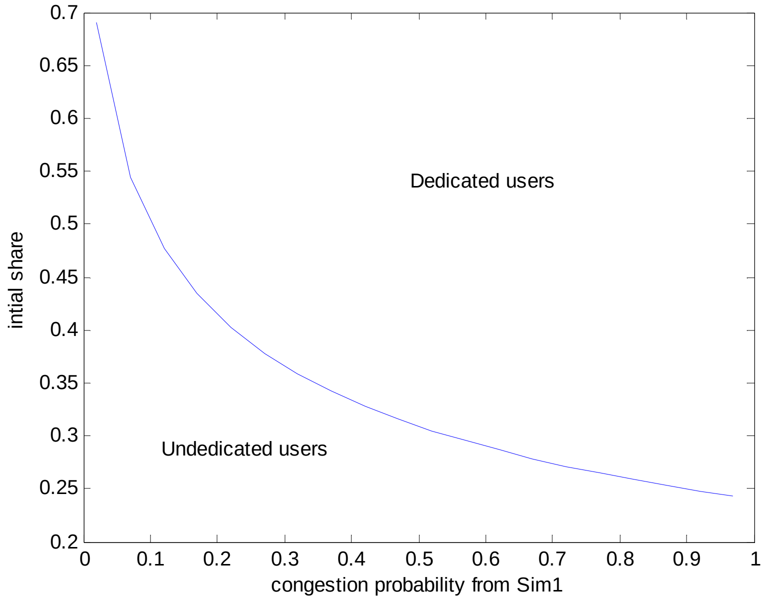

Fig.5 initial share when C2 = 0.1.

The initial market group p of a Sim highly depends on network congestion probabilities C_1 and C_2. The undedicated user always have to keep larger initial traffic share than dedicated user irrespective of whatever may the values of C_2.The proportion of undedicated user is lesser than the dedicated user when opponent's congestion probability is small, but increases gradually as the C_2 increases.

V. Conclusion

The proposed Prediction model for user's behavior explains the initial traffic sharing pattern in dual-Sim mobile. The competitor's congestion probability has a strong impact over improving proportion of dedicated users of S_1.The smaller service provider are more popular among the multi-Sim users.

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