



Modeling and Evaluation of Soft Handoff in Wireless Communication Networks for Effective Performance Based on Traffic Indicators

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Abstract

The ever growing provision of highly developed services in Mobile networks required operators to offer severe Quality of Service (QoS) assurance. This goal can be accomplished by applying several optimization measures. One of the most significant indexes for QoS evaluation is the call admission and drop-call probability. Consequently, these core indexes in networks service performance have not deeply been studied in well-established mobile network environments. Indeed, these requirements, judging from an accurate statistical analysis on realistic data call for a proposed model for optimizing soft handoff of the call admission and subsequent drop call occurrences in Code Division Multiple Access (CDMA) Networks.

Performance analysis on statistical field data validates the efficiency of the model already available theoretically, considering handoff failure as the main reason of drop calls, which offer a minor contribution for service optimization in an established cellular network. Basically, many other incidents indicate more relevant factor in influencing the call admission and call dropping. Nonetheless, the proposed model relates the drop-call probability with call admission parameters. The level of its effectiveness has been demonstrated and authenticated by experimental procedures. Essentially, results reveal how each traffic parameter affects cellular network performance and QoS provisioning. Consequently, network performance considered response time indicating how fast a packet can be sent or how quickly a document can be retrieved. The outcome of this work demonstrates how the network performance can be affected by traffic metrics; types of network traffic, the number of devices connected on the network, network latency, number of transmission errors and the bandwidth of the transmission medium.

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1.0 Introduction

In a cellular network, it is the network operator's responsibility to provide sufficient Quality of Service (QoS) to all subscribers. The key QoS performance metrics are *block Call Probability (BCP)* and *Call Drop Probability (CDP)*, with the corresponding clarification. Since cell capacity is limited, some call attempts may be blocked. The probability that a new call is not admitted into the system is called the block call probability. Even after a call is admitted, the network may terminate the call prematurely when a handoff is attempted into a cell that has no network capacity available. The probability that a call that has been admitted will be terminated some time before call completion is called the call Drop probability. These two QoS performance metrics are strongly influenced by the *call admission control* process, which determines whether a new call should be admitted or blocked. Blocking more calls generally advances the recovery of call drops probability of those calls that are admitted. Though, there is a trade-off in networks communication. Hence, the questions on *which* calls should be blocked to minimize forced-termination probability? This paper presents novel model for call admission control, and it shows the extent to which both existing and new procedures can improve these QoS performance metrics. However, a mobile user during an ongoing call may move from a cell area to an adjacent one, thus invoking the handover procedure. During this procedure, radio resources of the originating cell are released while radio resources of the target cell are assigned to the call. From the traffic viewpoints, user mobility results in:

- Reduction of the resource occupation time compared to the total call duration (regarding a single cell),
- The radio resources of a cell catering for both new call and incoming handoff requests and
- Abnormal call termination due to lack of resources in the target cell (call dropping).

2.0 Problem Statement

There are a number of dropped calls in cellular networks. Majority of these occur mainly due to lack of radio resources created by electromagnetic causes and user mobility. Another important contribution to dropped calls is the traffic load, where the call arrival rate and holding time play significant roles. In many network environments, the network carrying capacity varies with time and high priority call such as video conferences or emergency service, which may take precedence over ordinary traffic. In wireless networks, capacity variation may arise from user's mobility (example handover) and time-varying characteristics of the wireless propagation environment (Samrat et al. 2013). Also, the pattern of wireless interference (attenuation) for active connections may dynamically affect the link quality performance of wireless cellular networks.

At the infrastructural level, several factors (both hardware and software) could affect the performances of a network. These factors include transmitter problem, version upgrade, improper parameter/configuration settings, signal power control problem (uplink and downlink imbalance) and coverage problem.

To keep these problems on check, effective monitoring of the networks should be made and frequent check of the coverage plots, output power, power balance and link budget, antenna configuration and type, antenna

installation, and performance of site server are important.

Provision of solution to these problems could be achieved through the following means:

- (i) Addition of new base station to block large coverage holes
- (ii) Addition of repeater(s) to increase coverage
- (iii) Replacement of poor performance antenna (with low gain) at the base station

3.0 Motivations and Related Literature

Cellular networks are inherently scalable as stated by Kriens (1997). To manage this growth is a tremendous task. The rapid change in technology creates a demand for better and faster cellular communication service delivery. The main characteristics of cellular communication system offer user maximum freedom of movement while using cell phones (mobiles). A cellular network is made up of numbers of cells (or radio cells). Each cell is allocated a band of frequencies and served by base station consisting of transmitter, receiver and control unit. Adjacent cells are assigned different frequencies to avoid interference or cross (Ekici, 1997). As more customers use the cellular network with single base station, traffic may be built up, so there are not enough frequency bands assigned to a cell to handle its calls. Handoff is created for reason of seamless connectivity though its performance is influenced by admission, congestion, dropping and blocking of signals. Research works on call drop have progressed steadily over the years. Nasser et al., (2006) have proposed a dynamic adaptation framework, which provide an acceptable trade-off between new call blocking and handoff call dropping probability in cellular based multimedia wireless networks. The framework takes advantage of the adaptive bandwidth access to enhance

system utilization and blocking probability of new calls. Umoren et al., (2013) have shown that even if handoff dropping probabilities are controlled below a certain maximum value in every cell of the network, the call dropping probabilities experienced by the user cannot be controlled independently from the admission control scheme implanting the handoff dropping probabilities (HDP). They also observed that the networks have cells of different sizes and shapes, which further complicate the control of the call dropping probability (CDP) at the cell level. Therefore, resource management decisions should not be based on cell information if call drop is to be minimized. The knowledge of call dropping behaviour is a function of network parameters (example traffic load and call duration) can support operators to optimize performance and improve the QoS, as well as revenues. Boggia and De Biasi (2005), have carried out a statistical analysis of monitored calls chosen as a representation (or sample) to obtain numerically significant data, by studying the call duration and formulated distribution of the calls. They formulated an analytical model and validated the model using network data. The test was performed using a significance level of 0.01.

Boggia and De Biasi (2005) have also demonstrated that in a well-established cellular network, heterogeneous independent mix causes not just handover failure, but also forced termination of calls. According to Shigeki and Michihiro (2002), an effective admission control scheme is required to solve handoff probability. Their scheme is based on the estimation of call dropping probability and estimates of the call dropping probability of the cell. Here, a new channel exists and accepts call only when the estimated probability does not exceed a certain threshold value set in advance. Unfortunately, they do

not consider multiple access and handoff control. In a realistic mobile communication environment, the request of call and its response are performed with control packets, which contend with one communication element and another and compromises with effective bandwidth allocation. A prediction technique is proposed in Shigeki and Michihiro (2002), which uses simple moving average and simple mobility pattern matching. The impact of incorporating handover prediction information into the call admission is studied in Tarkaa *et al.* (2011). Although these models were helpful at showing that soft handover has some trade margin gain over hard handover and that there is a possible uplink capacity increase in power-controlled systems with hard handover, they are however limited comparisons which do not adequately balance the main advantages and disadvantages of soft handover.

The effect of soft handoff techniques on cell coverage on reverse link capacity was investigated in Viterbi *et al.* (1994). The authors show that soft handoff significantly increases both parameters relatively to conventional handoffs. To the best of our knowledge, existing literature on the soft handoff problem constitutes a body of analytical evidence, which does not adapt proposed models to practical environments. The importance of this paper is not only to make data publicly available for future research, but to present a concise and working methodology that can be built on and enhance effective academic and industrial collaborations.

Umoren *et al.* (2016), carried out performance modeling on mobile communication networks using Bit Error Rate (BER) performance metric to obtain an efficient networks service delivery as well as proffer direction to networks operators on superlative practices. The model

was simulated based on a realistic field data using a robust Programming tool (MATLAB) for evaluation of BER and *Signal-to-Noise Ratio (SNR)* respectively for mobile networks optimization. The simulation results confirmed that BER thresholds should be carefully chosen in order to minimize networks defect and to deliver the optimal and efficient rating to the digital signal quality.

4.0 Methodology

4.1 System Model

The handover procedure between two Base Station/Mobile Station Controllers (BS/MSCs), shown in Figure1, includes the following basic components:

- i. The mobile station (MS) moves across the cell border and the Base Station controller (BSC) of the active network decides to initiate handover to another cell (neighboring set). The decision is based on the measurement information sent by the mobile station and by the base transceiver (BTS). The measurement information includes, in addition to traffic channel measurement results, identifications of neighboring cells and the measurement results. The mobile station continuously measures the common channel of each neighbour cell in addition to the traffic channel in use for the call.
- ii. The BSC (active) notices that the best cell candidate is not under its control and requests the MSC (active) to begin handover preparation to the neighboring cell. The MSC (active) recognizes that the proposed cell (neighbouring set) is connected to another MSC.
- iii. The BS/MSC (active) requests a handover number from MSC (neighbour). The handover number is a temporary telephone number that is used to establish a connection via Public Land Mobile Network Integrated Services Digital Network (PLMN, ISDN) or

- Public Switched Telephone Network and (PSTN) for the handover.
- iv. The new MSC requests allocation of a traffic channel from the BSC (neighbouring set).
 - v. The BSC (neighbour) allocates the channel and informs the MSC (neighboring).
 - vi. The MSC (neighbour) allocates a handover number and sends it to the MSC (active).
 - vii. The MSC (active) routes a call toward the MSC (neighbour) using the handover number as call digits.
 - viii. When the routing is complete and channel is established from the attached MSC to the new neighbouring cell, the new MSC/Visitor Location Register(VLR)commands the mobile station, via the MSC (active), to switch to the new traffic channel (frequency and time slot of the new cell) and MSC (active) to perform switching.
 - ix. The active MSC switches to the neighbouring channel and the neighbouring MSC and BSC connect the speech path through the reserved channels in the neighbouring cell. It is observed that, the call is still controlled by the active BS/MSC, which has the role of secure MSC.
 - x. At last, the channel of the active cell is released.

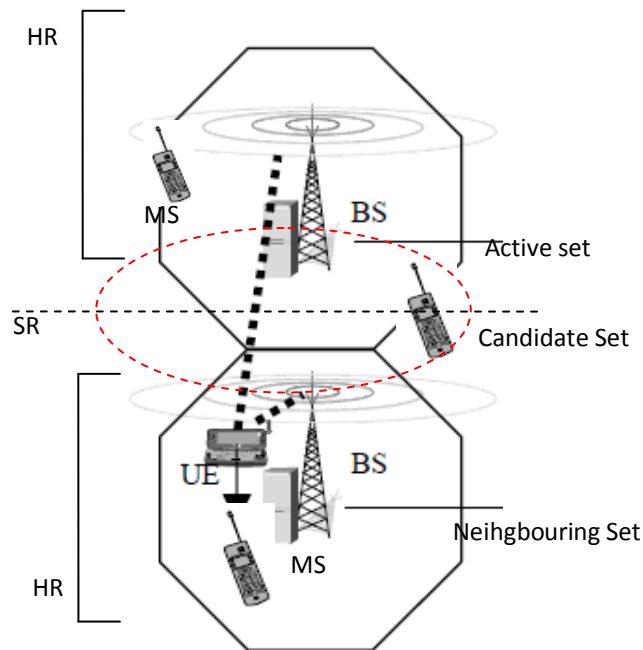


Fig. 1: CDMA Soft Handover Model Architecture (adapted from Umoren et al., 2013)

4.2 Model Description

A simplified Cellular System Model is shown in Figure 2. We considered two overlapping cells, *cell-X* and *cell-Y*, where the shape of each cell is circular, for simplicity. Also, both cells may be of the same size or different sizes. The overlap region represents the soft handoff

region (a transition area where soft handoff occurs), and calls within this region are connected to at least two base stations. Calls in the non-overlapping region (also called the hard region) are connected to only one base station. An efficient handoff scheme should ensure that calls are allocated a free channel in

the hard region (HR) and two channels in the soft region (SR), where one of the channels would service the mobile on transit and the other assigned at the point of successful handshake. On successful handshake, the

handoff scheme should disengage one of the channels, after an acknowledgment is received and the mobile enters the neighbouring cell and the call is finally dropped.

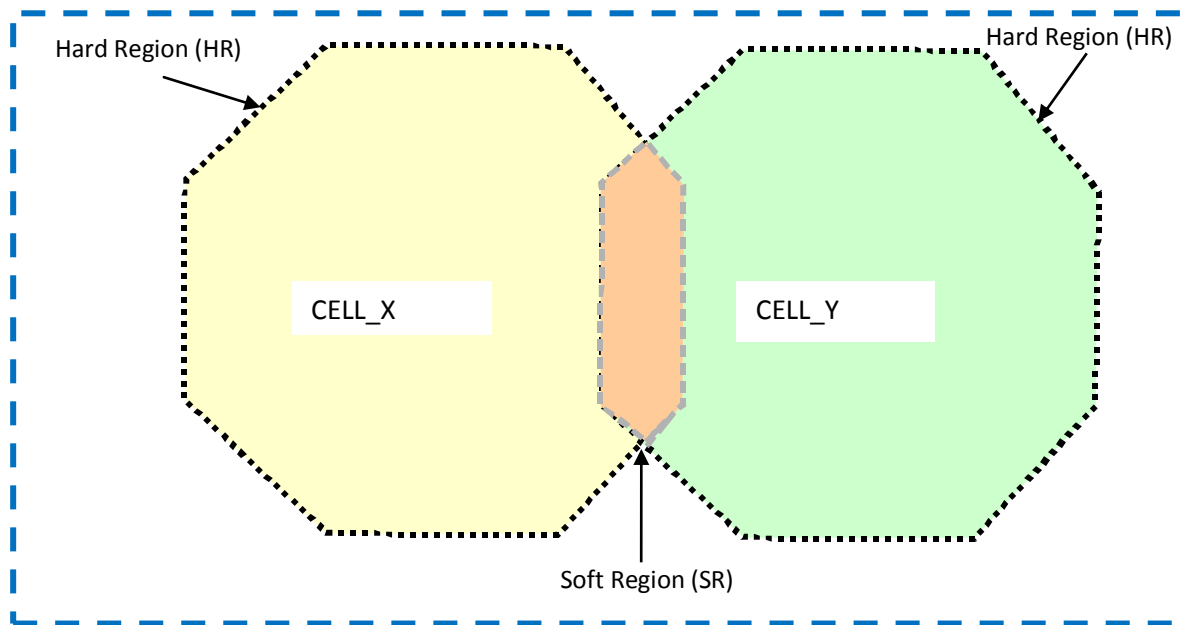


Fig. 2: A Simplified Cellular System Model (adapted from Umoren, *et al.* 2013)

5.0 Model Formulation

Fundamentally, by induction, we assert that the successful admittance of a call on handoff is mutually exclusive of call dropping, that is:

$$A = D^c \dots\dots\dots(1)$$

where A is admission, D is dropping, and C is congestion. Congestion would lead to blocking, so, a call can be finally dropped on the

condition that it has existed in the blocked state for a specified latency time, or due to technical reasons, or any other factors. Now, the ultimate state ‘dropping’ is only imminent when the system is not finally admitted after blocking. Thus, we establish using statistical evidence through set theory notations, that event A can also be defined as the union of three other events as shown in equation (2):

$$A = (B \cap A) \cup (C \cap A) \cup (B^c \cap A) \dots\dots\dots (2)$$

Applying probabilities, we obtain:

$$P(A) = P(B \cap A) + P(C \cap A) + P(B^c \cap A) \\ = P(B).P(A|B) + P(C).P(A|C) + P(B^c).P(A|B^c) \dots\dots\dots (3)$$

where $P(A|B)$ is the conditional probability that a call is finally admitted, given that there was blocking.

$P(A \setminus C^c)$ is the conditional probability that a call is finally admitted, given that there was no congestion. $P(A \setminus B^c)$ is the conditional probability that a call is finally admitted, given that there was no blocking. Realistically, if h is the rate of successful handoff, then,

$$\begin{aligned}
 P(A) &= P(B).h[P(B)]+[1 - P(C)].h[1 - P(C)] + [1 - P(B)].h[1 - P(B)] \\
 &= h\{[P(B)]^2 + [1 - P(C)]^2 + [1 - P(B)]^2\} \\
 &= h\{[P(B)]^2 + \{1 - 2P(C) + [P(C)]^2\} + \{[1 - 2P(B) + [P(B)]^2\}\} \\
 &= h\{[P(B)] + 2 - 2P(C) + [P(C)]^2 - 2P(B) + [P(B)]^2\} \\
 &= h\{2 + 2[P(B)]^2 - P(B) - 2P(C) + [P(C)]^2\} \\
 &= 2h\left\{1 + P(B)[P(B) - 1] - P(C)\left[1 - \frac{P(C)}{2}\right]\right\} \dots\dots\dots (4)
 \end{aligned}$$

We derived our call Admission Control (CAC) from Equation (4). Generally, it has been observed that call admission probability in broadband networks is almost halved by call dropping (Tong and Brown, 2002). Apparently, equation (4) is reduced to:

$$P(A) = h\left\{1 + P(B)[P(B) - 1] - P(C)\left[1 - \frac{P(C)}{2}\right]\right\} \dots\dots\dots (5)$$

We can also relate the call admission probability with traffic by transforming $P(B)$ and $P(C)$. According to Garg and Goyal (2012) it is stated that, congestion is directly proportional to traffic

$$P(C) = k.p \dots\dots\dots (6)$$

Where k is a constant and p is the traffic intensity. Correspondingly, the Erlang-B capacity formula (Angus, 2001) is used to depict blocked traffic and is given as,

$$P(B) = \frac{\frac{P^{ch}}{ch!}}{\sum_{i=0}^{ch} \frac{P^i}{i!}} \dots\dots\dots (7)$$

where ch is the number of channels. Relating blocked traffic, congestion and call dropping, by substituting equations (6) and (7) into equation (5), we have:

$$P(A) = h\left\{1 + \frac{\frac{P^{ch}}{ch!}}{\sum_{i=0}^{ch} \frac{P^i}{i!}} \left[\frac{\frac{P^{ch}}{ch!}}{\sum_{i=0}^{ch} \frac{P^i}{i!}} - 1\right] - kp\left[1 - \frac{1}{2}kp\right]\right\}$$

$$= h \left\{ 1 + \frac{P^{ch}}{ch!} \left[\frac{P^{ch}}{ch!} - \sum_{i=0}^{ch} \frac{P^i}{i!} \right] - kp + \frac{1}{2} (kp)^2 \right\} \dots\dots\dots (8)$$

6.0 Evaluation of Existing CDMA Cellular Networks

In the analysis of the existing cellular networks, we study the effect of call handoff dropped calls on the system. Recall that in equation (1), handoff call admission is mutually exclusive of call dropping; therefore, it can be ascertained that:

$$P(A) = 1 - P(D) \dots\dots\dots(9)$$

In addition, we have asserted in equation (3), that call admission probability is a union of three other conditional probabilities relating blocking and congestion. Establishing a relationship between dropping, blocking and congestion will be helpful to determine the optimum performance of the existing system.

6.1 Realistic Mobile Communication Field Data and Evaluation

In this paper, several mobile data have been collected for two weeks from Airtel Nigeria network: for the month of June 2013. These data sets were related to several GSM traffic

cells, for a total of about 300,000 monitored calls, chosen as a representative sample to obtain numerically considerable data. The relative sample significance is defined in terms of cell extension, number of served subscribers in the region, and traffic load; for this basis, macro-GSM cells in an urban metropolitan environment were selected. The software tool (I-manager) utilizes the Clear Codes reported in the databases of the cellular networks operator. Calls are classified in dropped, blocked and congested, for purpose of distinguishing for the former, the causes of handoff success rate. By observing the Dropped, blocked and congested Calls, and the difference between their derivatives, it is possible to evaluate the distribution of the Handoff process, which we refer to as Handoff performance. Statistical analysis of the measured data was carried out, allowing us the estimation of network Quality of Service (GoS). Nevertheless, from the table, the average performance value for two weeks significantly shows value: 0.53 for drop calls. 0.10 on congestion 16.29 block calls respectively.

Table 1: Empirical Soft Handoff Field Data Analysis

Days	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8	Day 9	Day 10	Day 11	Day 12	Day 13	Day 14	Ave.
Dropped Calls	0.504	1.169	0.714	0.18	0.502	0.443	0.187	0.561	0	0.254	0.68	1.46	0.208	0.5	0.53
Congested	0	0	0	0.06	0.397	0.564	0.124	0	0	0.137	0	0.06	0	0.05	0.10
Blocked Calls	14	0	2	1	10	17	3	1	3	25	25	74	38	15	16.29
Days	1	2	3	4	5	6	7	8	9	10	11	12	13	14	

6.2 Simulation results and Discussions on Table 1

A feasible representation of the analysis is shown in Figure 4. Here the average call blocking rate is viewed as a function of base stations (bs) and number of days. Figure 3 reveals that call blocking increased more than acceptable state and this is adverse to a network whose aim is to satisfy her clients with Good

Quality of Service (QoS). Nevertheless, we further observed that call blocking is not significantly influenced by the number of base stations (i.e., $R^2=0.0427$). Therefore, network operators should explore more vibrant alternatives to solve network inconvenience since appropriate options are essentially available to optimize any vulnerable network system.

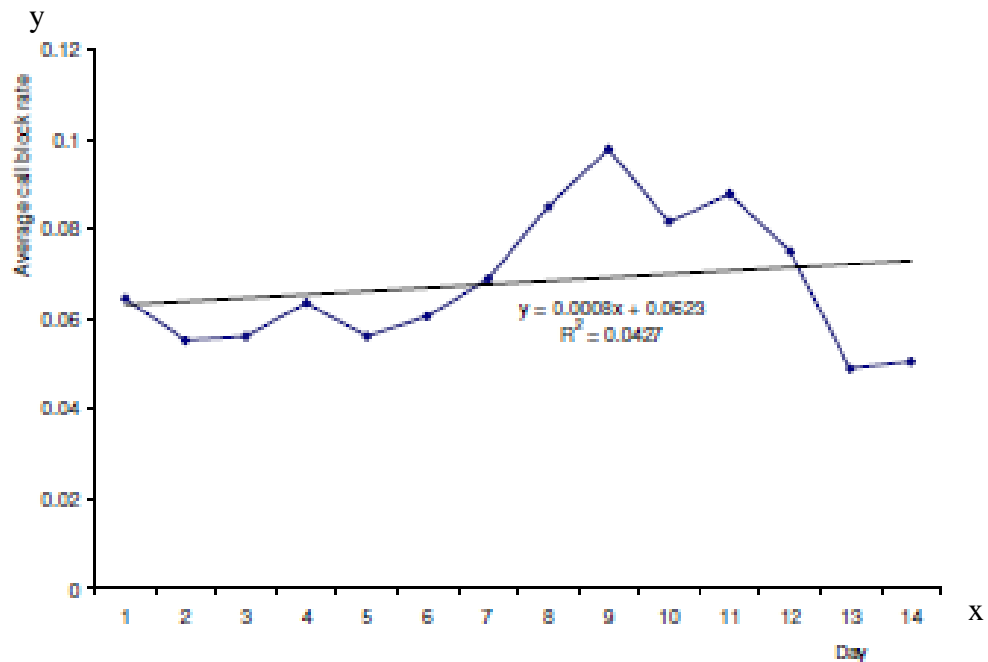


Fig. 3: A graph of average call block rate (%) with simulated data sets at different BSCs for a period of 2 weeks in (3) three months

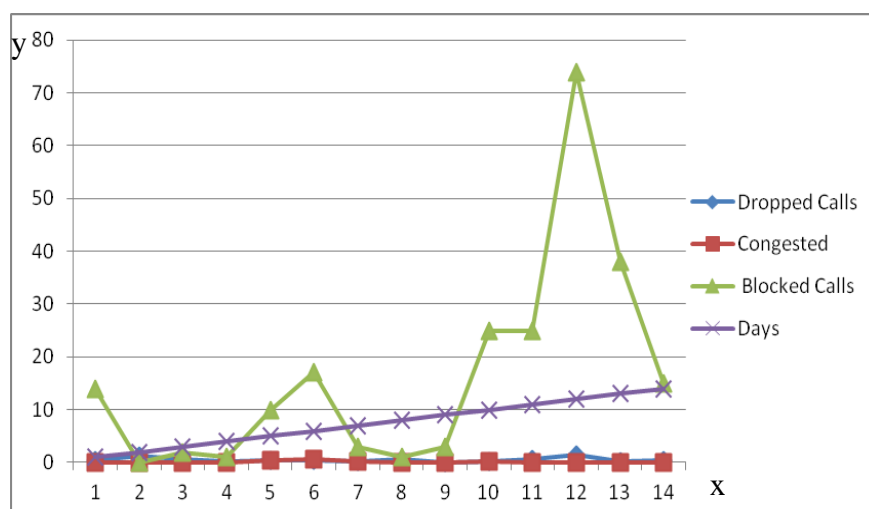


Fig. 4: A graph of call block rate (y) (not in %) at different BSCs with realistic mobile data sets for a period of 2 weeks (x) in three (3) months

Table 2: Empirical Network Performance Datasets

Date	IP Address	Download Speed	Upload Speed	latency (packet delay)	Jitter
6/14/2020 21:55:0	102.89.2.166	2.40 Mbps	0.15Mbps	255 ms	28ms
6/14/2020 22:13:42	102.89.2.166	2.14 Mbps	0.23Mbps	227 ms	238ms
6/14/2020 22:17:47	102.89.2.166	0.75 Mbps	0.28Mbps	228 ms	5ms
6/14/2020 22:24:37	102.89.2.166	4.07 Mbps	0.41Mbps	226 ms	6ms
6/14/2020 22:31:11	102.89.2.166	2.44 Mbps	0.44Mbps	220 ms	9 ms
6/14/2020 22:44:40	102.89.2.166	4.70 Mbps	0.52Mbps	224 ms	6 ms
6/14/2020 22:50:38	102.89.2.166	2.11 Mbps	0.85Mbps	232 ms	67ms
6/14/2020 22:51:48	102.89.2.166	5.20 Mbps	0.56Mbps	234 ms	6 ms
6/14/2020 22:53:48	102.89.2.166	3.55 Mbps	0.83Mbps	221 ms	10 ms
6/13/2020 22:59:33	102.89.2.166	4.68 Mbps	1.23Mbps	230 ms	5 ms
6/13/2020 9:44:40	102.89.2.166	4.70 Mbps	0.52Mbps	224 ms	6 ms
6/13/2020 8:50:38	102.89.2.166	2.11 Mbps	0.85Mbps	232 ms	7 ms
6/13/2020 9:53:48	102.89.2.166	3.55 Mbps	0.83Mbps	221 ms	10 ms
6/13/2020 22:51:33	102.89.2.166	4.68 Mbps	1.23Mbps	230 ms	5 ms
6/13/2020 12:44:40	102.89.2.166	4.70 Mbps	0.52Mbps	224 ms	6 ms
6/13/2020 1:50:38	102.89.2.166	2.11 Mbps	0.85Mbps	232 ms	67 ms
6/13/2020 22:51:48	102.89.2.166	5.20 Mbps	0.34Mbps	234 ms	6 ms
"6/13/2020 2:23:48"	102.89.2.166	3.55 Mbps	0.83Mbps	221 ms	10 ms
6/13/2020 2:12:33	102.89.2.166	4.68 Mbps	1.23Mbps	230 ms	5 ms
6/12/2020 5:20:40	102.89.2.166	4.70 Mbps	0.52Mbps	224 ms	6 ms
6/12/2020 5:50:38	102.89.2.166	2.11 Mbps	0.85Mbps	232 ms	67 ms
6/12/2020 5:51:48	102.89.2.166	6.20 Mbps	0.21Mbps	234 ms	6 ms
6/12/2020 5:53:48	102.89.2.166	3.55 Mbps	0.83Mbps	221 ms	10 ms
6/12/2020 22:59:33	102.89.2.166	4.68 Mbps	1.23Mbps	230 ms	5 ms
6/12/2020 22:44:40	102.89.2.166	4.70 Mbps	0.52Mbps	224 ms	6 ms
6/12/2020 22:50:38	102.89.2.166	2.11 Mbps	0.85Mbps	232 ms	67ms
6/12/2020 22:51:48	102.89.2.166	5.20 Mbps	0.67Mbps	234 ms	6 ms

6/12/2020 22:53:06	102.89.2.166	3.55 Mbps	0.83Mbps	221 ms	10ms
6/12/2020 22:59:33	102.89.2.166	4.68 Mbps	1.23Mbps	230 ms	5ms
6/11/2020 22:44:40	102.89.2.166	4.70 Mbps	0.52Mbps	224 ms	6ms
6/11/2020 22:50:38	102.89.2.166	2.11 Mbps	0.85Mbps	232 ms	67ms
6/11/2020 22:51:48	102.89.2.166	5.20 Mbps	0.41Mbps	234 ms	6ms
6/11/2020 22:53:48	102.89.2.166	3.55 Mbps	0.83Mbps	221 ms	10ms
6/11/2020 22:59:33	102.89.2.166	4.68 Mbps	1.23Mbps	230 ms	5ms
6/11/2020 22:44:40	102.89.2.166	4.70 Mbps	0.52Mbps	224 ms	6ms
6/11/2020 22:50:38	102.89.2.166	2.11 Mbps	0.85Mbps	232 ms	67ms
6/11/2020 22:51:48	102.89.2.166	5.20 Mbps	0.59Mbps	234 ms	6ms
6/11/2020 22:53:48	102.89.2.166	3.55 Mbps	0.83Mbps	211 ms	10ms
6/11/2020 22:59:73	102.89.2.166	4.68 Mbps	1.23Mbps	230 ms	5ms
6/10/2020 4:44:40	102.89.2.166	4.70 Mbps	0.52Mbps	224 ms	6ms
6/10/2020 22:50:38	102.89.2.166	2.11 Mbps	0.25Mbps	232 ms	67ms
6/10/2020 22:51:42	102.89.2.166	2.20 Mbps	0.40Mbps	234 ms	6ms
6/10/2020 5:53:08	102.89.2.166	3.55 Mbps	0.83Mbps	125 ms	10ms
6/10/2020 7:59:33	102.89.2.166	4.68 Mbps	1.23Mbps	230 ms	5ms
6/10/2020 9:44:04	102.89.2.166	4.70 Mbps	0.52Mbps	314 ms	6 ms
6/10/2020 22:50:38	102.89.2.166	2.11 Mbps	0.85Mbps	232 ms	67ms
6/10/2020 22:51:48	102.89.2.166	5.20 Mbps	0.32Mbps	234 ms	6ms
6/10/2020 8:38:48	102.89.2.166	3.55 Mbps	0.83Mbps	221 ms	10ms
6/10/2020 7:59:33	102.89.2.166	4.68 Mbps	1.23Mbps	230 ms	5ms
6/10/2020 7:30:40	102.89.2.166	4.70 Mbps	0.42Mbps	224 ms	6ms

6.3 Analytical Findings and Discussions on Table 2

We used a scientific analysis tool to pre-process our entire network performance variable from our filed data to get the summary and relationships between different indicators of our, which is depicted in figure 5. Again, figure 6, depicts the download speed and the upload speed, with the download speed greater

than the upload speed resulting from many network subscribers (users) focusing more on download, uploading files is quite a bit slower than downloading files. This is usually common, because most high-speed Internet connections, including cable modems and DSL, are asymmetric such that, they are designed to provide much better speed for downloading than uploading. Since most users spend much

more time downloading (which includes viewing web pages or multimedia files) than they ordinarily do for uploading, high speed Internet providers have designed their systems to give priority to downloading. Again, it must be notice that a trade-off has to be established by network operators to satisfy download speed, this is probably designed to serve the expected network performance as indicated in figure 6. Furthermore, figure 7 depicts how latency and jitter contribute to the network's overall performance; packet delay and jitter are naturally linked, although they are not the

same. Processing delay, queuing delay, transmission delay, and propagation delay are four main components of packet delay, which is a significant statistic in network performance management. It has an impact on the user experience and can change depending on a variety of things. Jitter is caused by delays, notably discrepancies in the delay. Jitter is the difference in delay between two packets; it frequently leads to packet loss and network congestion. Latency and jitter from our dataset as shown in Figure 7.

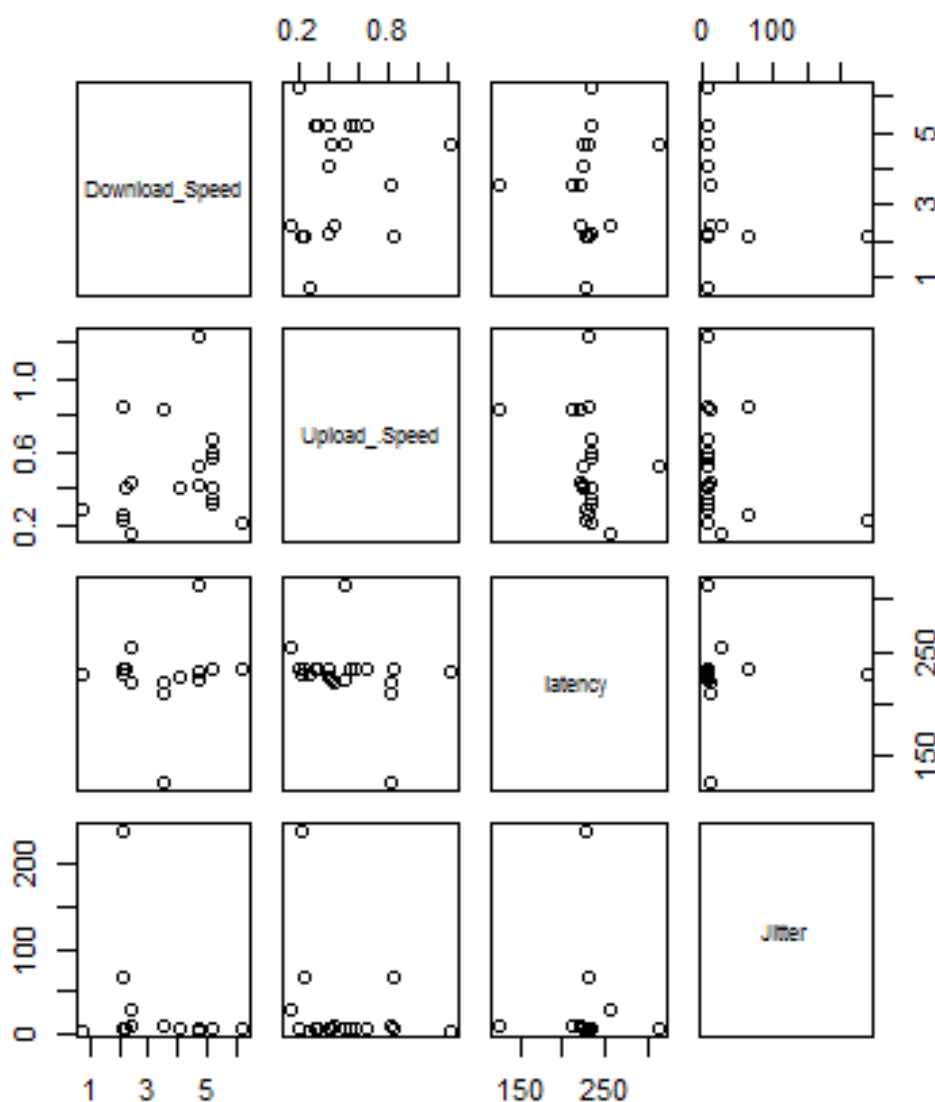


Fig. 5: Wireless Network Metrics Relationship

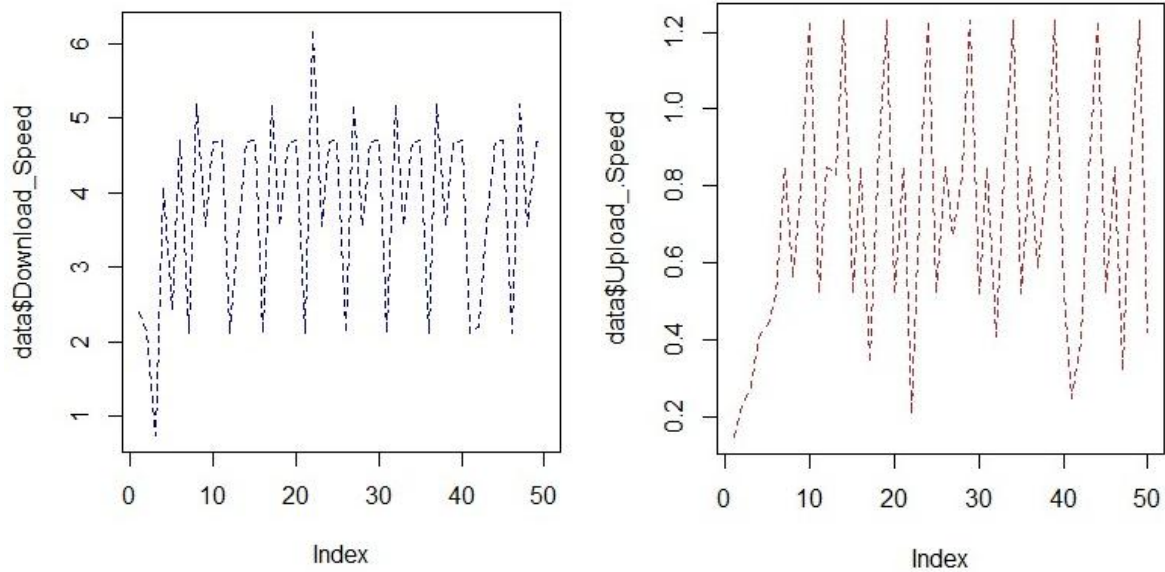


Fig. 6: Plot for Download versus. Upload speed

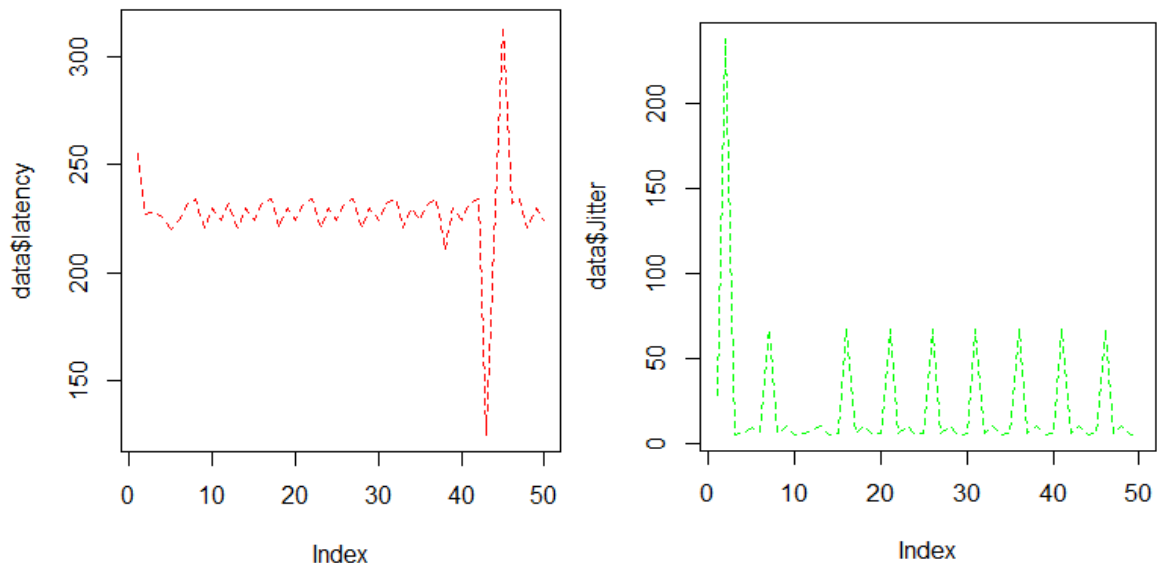


Fig.7: Plot for Latency vs. Jitter

7.0 Conclusion

Optimizing soft handoff for maximizing wireless networks' efficiency model has been proposed for related wireless networks. The model was derived and evaluated to allow for the investigation of the impact of call blocking probability (CBP) and Call dropping probability (CDP) on varying parameters such as coverage and capacity, average arriving traffic intensity and number of users. We

observed that, apart from the fact that there exists a constant standard deviation; the effect of drop calls was investigated on call admission which influences the performance of soft handoffs in CDMA networks and eventually affects the network performance. The proposed model relates the drop-call probability with other traffic parameters. Its effectiveness has been validated by experimental measures. The results show how each traffic parameter affects system performance. Furthermore, this paper evaluates how latency and jitter contribute to

the network's overall performance. Basically, packet delay and jitter are naturally linked, although they are not the same. Processing delay, queueing delay, transmission delay and propagation delay are the four (4) main components of packet delay, which is a significant statistic in network performance management. Moreover, research findings demonstrated that a trade-off has to be established by network operators to satisfy download speed against upload speed in wireless network performance. Generally, there are other fundamental physics behind wireless transmission network performance.

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