

## **A Review of Menace of Call Drops in India and Possible Ways to Minimize It**

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### **Abstract**

In this age of wireless telecommunications, it is expected from the telecom service providers that the quality of services is the best; but unfortunately, it is not so and in India the telecom sector is struggling with a menace called Call Drops. Most of the operators in India do not meet the benchmark set by the TRAI for call drops. So, keeping in mind the Indian context of the problem, in this paper, the overall condition of call drops has been reviewed and possible ways to minimize the phenomena of call drops- Cell Splitting and Sectoring, Dynamic channel allocation, Hybrid channel allocation. Also, mathematical proof of relevance of these methods has been provided through Erlang B Formula and various other methods of proving used in other scientific pieces of work have been discussed such as Poisson Probability Function with a discrete variable. The data collected from various resources shows the gravity of the problem. Cell splitting and sectoring methods result in improvised soft handover mechanisms which in turn decrease the rate of call drops. This paper provides a brief but sufficed introduction to the term of call drops and also proposes some simple but efficient ways to cope this menace.

**Keywords**-Call drops, call drop rate, cell splitting, sectoring, hand-offs/hand-over.

### **1. Introduction**

India is the fastest growing economy in the world. And in this fastest growing economy, communication is a very important parameter. As we are living in the age of wireless communication, it is the right of the taxpayers to enjoy good Quality of Service (QoS) in the field of cellular networks. India is a proud country of 869 million active subscribers (www.forbes.com, 2016) of telecom services and these subscribers are paying a handsome amount for this service. But unfortunately, now-a-days it is very common to hear from customers that they are not satisfied with the services provided and suffer from sudden and frequent termination of their call. This sudden and undesirable termination of successfully established calls from the Telecom Service Providers' (TSPs) side is known as call drops. This unfortunate menace of call drops is now-a-days terrifying both Indian TSP's and the government as well. If we talk in the context of India, the Telecom Regulatory Authority of India (TRAI) monitors the following network related QoS parameters in a cellular mobile telephones service network:

- (a) Network Availability
- (b) Connection Establishment
- (c) Connection Maintenance
- (d) Points of Interconnection

For customer satisfaction, as soon as a call channel is established, the maintenance of the connection becomes crucial to keep the call continued and prevent the occurrence of call drop. Sudden and undesirable call drops affecting the QoS provided, can take place due to many reasons such as inadequate coverage, rough handoff mechanisms, problems with intensity of

signals, interference with other RF signals, network congestion and network failure. Though in this paper, handoff mechanisms as well as the issue of inadequate coverage is emphasized to analyse the problem of call drops and propose a reasonable solution to the problem. Call Drop Rate (CDR), the rate of calls ended unsuccessfully and the Call Handover Success Rate (CHSR) are two of the worst performing metrics of Telecom Services. As per TRAI report, in metropolitan cities, some of the operators operating in dual-hand network usually set up a call in a GSM1800 cell and handover the same to a GSM900 cell in the same site. If, by bad luck, network clocks of GSM1800 and GSM900 cells are not properly synchronized, it could lead to call drop, especially in cases of circuit embedded networks (TRAI et al., 2015).

## 2. Handoffs

Handoff may be defined as the phenomena of changing of the channel associated with the ongoing established connection while a call is in progress. Handoff is very often started either by crossing a cell boundary or by deterioration in the quality of signal in the current traffic channel. Handoffs may also be defined as the transfer of the call from one base station to a new base station when a mobile user travels from one cell to another cell within a call's duration. There are two types of hand-offs which take place- Soft Handoffs and hard handoffs (Fig. 1).

When the traffic channel/communication channel is first released before a new channel is acquired by the mobile station the ongoing call is lost, and hard handoff is said to occur. The primary reason behind this hard handoff is that the base stations are located very far away or are pre-occupied i.e., there is no available channel in the Base station so that the call can be sustained/ maintained.

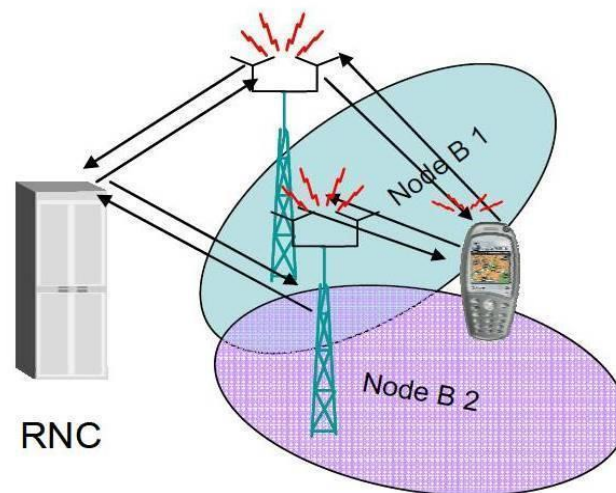


Fig. 1. Mechanism of soft handover [Soft and Softer handover technology, [www.3glteinfo.com](http://www.3glteinfo.com)]

## 3. Survey Analysis

The recent data shared by the Department of Telecom, Govt. of India was shared conducted by TERM cell ([www.indianexpress.com](http://www.indianexpress.com), 2015).

The Dept. stated that though the situation has improved but still the call drop rate is above the set benchmark.

Here is the data in Fig. 2 obtained by TERM cell in Delhi:

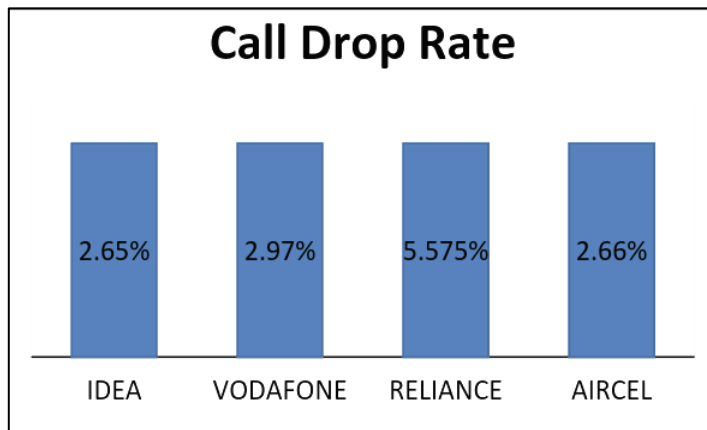


Fig. 2. Call drop rates of prominent telecom service providers

The TRAI report on operators' performance released on 25th November, 2015 was very alarming and threw back dangerous data stating that mobile operators had a call drop rate of as high as 24.59% for 2G services and a 16.13% for 3G services in the April-June Quarter of 2015.

As per the drive tests conducted by TRAI in Delhi showed that approximately 18-20% of calls dropped were dropped due to radio failure during handover and this percentage shoots up to 35-40% in Mumbai.

The following Table 1 shows the data obtained by TRAI in Quarter Ending of June, 2015 regarding performance of various TSPs (names not disclosed in the report) in the field of call drops throughout the country and it projects a very grim picture:

Quarter	Benchmark	Service Provider	Performance
Quarter Ending June, 2015	<=2%	TSP-1	10.73%
		TSP-2	8.24%
		TSP-3	5.4%
		TSP-4	4.08%
		TSP-5	4.6%

Table 1. Average performance of telecom service providers on call drop rate in quarter ending June, 2015

From, the above table, it can be easily concluded that none of the TSPs is achieving the set benchmark as also inferred by the following results of Drive Tests conducted by TRAI in June-July 2015.

Results of Drive Tests by TRAI in Delhi in July, 2015 as per Table 2.

KPI	Aircel	Idea	Vodafone	Airtel	Reliance	Tata (CDMA)
CALL ATTEMPT	441	782	490	587	603	723
DROPPED CALL RATE (in %)	5.18	2.84	4.28	8.04	17.29	0.84

Table 2. Results of drive tests conducted by TRAI in Delhi in July, 2015

Results of Drive Tests at Mumbai by TRAI in June, 2015 as per Table 3.

KPI	Idea	Airtel	Vodafone	Reliance (GSM)	Aircel	TATA (GSM)
CALL ATTEMPT	570	529	535	575	550	546
DROPPED CALL RATE (in %)	5.56	0.97	4.83	2.29	3.19	5.51

Table 3. Results of drive tests conducted by TRAI at Mumbai in June, 2015

As clearly visible from the results obtained from the above data that most of the TSPs fail to achieve the call drop rate of less than or equal to 2%, which is alarming for us.

The primary factors responsible for this alarming situation are unsuccessful handoff/handovers, inadequate signal strength, co-channel and adjacent channel frequency interference, less number of cell sites, faulty machines in the base stations.

#### 4. Possible ways for Minimizing Call Drops due to Hand-offs

One of the best possible ways to minimize call drops due to hand-off is Cell Splitting. There are many other methods such as cell sectoring, dynamic channel allocation etc.

##### 4.1 Cell Splitting

Cell splitting is the technique of redesigning the congested and over-occupied cells into many smaller cells which have their own base stations and a corresponding reduction in antenna height and transmitter power (Fig. 3). If the coverage area of each cell is redesigned (split) to accommodate micro and picocells in it. But after applying this method, the count of handovers/handoffs may increase. But here the handover would be very smooth as now the coverage areas of the cells would overlap with each other and hence the rate of call drops would decrease satisfactorily. The cell splitting technique though increases the handoffs, it preserves the architecture of the cell and simply scales up the geometry of the architecture of the cell, thereby increasing the number of cells which, in turn, would increase the number of clusters which implies an increase in number of reusable channels which will decrease the probability of call drops and increases the capacity of the cells.

Also, one of the major advantages of applying Cell Splitting technique is that power transmitted in the smaller cells formed after redesigning of the existing cells is very much reduced compared to the power transmitted in the larger cells reason being that it would now very much less power to cover the whole cell compared to the power wasted in the case of older and larger cells. It is worth mentioning that the power transmitted will be reduced by a factor of:

$$\frac{P_{\text{transmitted in small cell}}}{P_{\text{transmitted in large cell}}} = \left( \frac{R_{\text{small cell}}}{R_{\text{large cell}}} \right)^n \quad (1)$$

Where ‘ $n$ ’ is the path loss exponent.

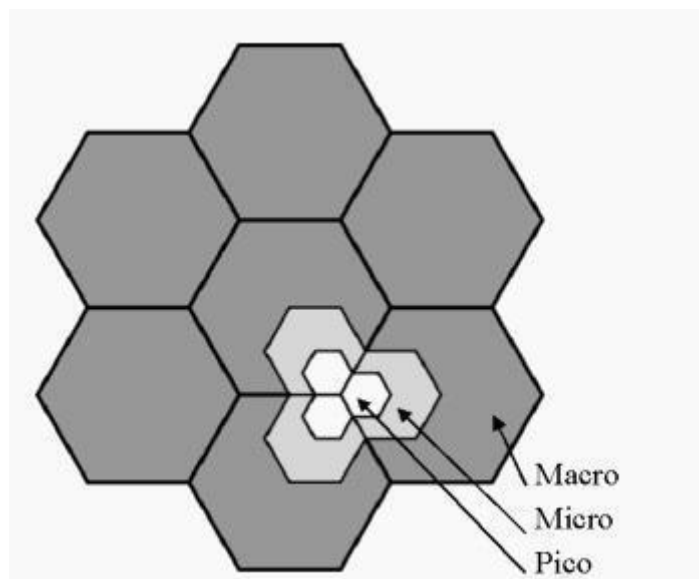


Fig. 3. Structure of cells after proposed cell splitting [Cell splitting- Mobile computing, [www.iportal.in](http://www.iportal.in)]

#### 4.2 Cell Sectoring

Most of the operators have installed Omni-directional antennas which very often provide signals of feeble intensities. Sectoring involves replacing of these Omni-directional antennas with the Sector antennas which produce beams of higher/ stronger intensities, Sectoring uses directional antennas which check interference and frequency reuse of channels. Cell sectoring can generally be done in two ways- using 6 single-directional antennas each covering 60 degrees of the cell or the second way that is using 3 single-directional antennas each covering 120 degrees of the cell. Dividing the cell into sectors would theoretically result in the network’s capacity of holding calls because the channel allocated to the cell earlier are now divided among different sectors, thereby increasing the rate of handoffs. The gain in the network’s capacity is achieved by reducing the number of interfering co-channel cells. Now the channels only interfere with one or two or three channels having the same transmission angle as theirs in spite of interfering with channels in all the directions as is happening now-a-days (Fig. 4). The most important advantage of using this technique is that it results in a significant decrease in Signal to Interference Ratio (SIR). SIR is a factor which tells us about the interference of alien signals in the signal transmitted from the

tower. Lesser the SIR is, greater is the quality of the services provided and lesser will the rate of the call drops. SIR can be calculated as follows:

$$\frac{S}{I} = \frac{R^{-n}}{\sum_{i=1}^{i_0} D_i^{-n}} \quad (2)$$

Where, ‘ $S$ ’ is Signals’ Intensity or strength, ‘ $I$ ’ is the measure of interference occurred, ‘ $D$ ’ is the distance between the nearest co-channel cells center, ‘ $R$ ’ is the radius of the cell,  $i_0$  is the number of co-channel interfering cells. As can be seen from the above formula that if the distance between the cell centers increases, the  $S$  to  $I$  ratio decreases and hence the call drop also decreases.

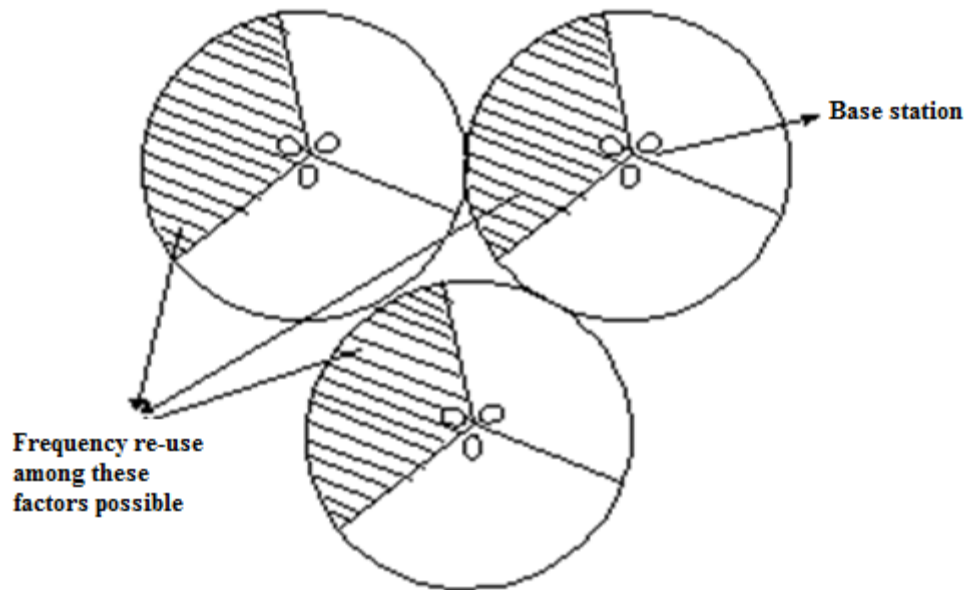


Fig. 4. Cell sectoring [Wireless in local loop, [www.tenet.res.in](http://www.tenet.res.in)]

Also, it can be proposed that a definite number of traffic channels should be reserved for the management of handovers which has been proposed in (Agustina et al., 2003). A very detailed analysis of how cell splitting, sectoring and efficient handoff management increases radio resources was presented.

As far as the proof of the above methods is concerned, it can simply be derived using the probability analysis with the help of Erlang B Formula.

### 4.3 Probability Analysis

Suppose if we have to estimate a relationship between the call losses and the number of available traffic channels. Then it can very easily be estimated by Erlang B Formula (Boggia et al., 2007; Tarkaa et al., 2011).

Let 'B' be the Loss Probability, 'A' be the offered traffic intensity in Erlang and 'N' be the number of available channels.

Then Erlang B Formula is:

$$B = \frac{A^N}{N!} \frac{1}{\sum_{k=0}^N \frac{A^k}{k!}} \quad (3)$$

From Equation (3) it is very clear that if 'N' increases the drop call probability decreases. There are many other formulae through which probability analysis has been carried out in various literature (Boggia et al., 2005; Boggia et al., 2007; Tarkaa et al., 2011) which show that drop call probability decreases with an increasing number of channels, thus vindicating the fact that efficiency of handoff mechanism in GSM will greatly improve through cell splitting and sectoring.

Also, the call drop rate can be calculated using the formula:

$$\text{Drop call rate} = \frac{\text{Number of dropped calls}}{\text{Number of call attempts}} \quad (4)$$

Suppose if we have to calculate the Drop call probability with respect to the duration of the call it can be calculated using the Poisson Probability Function with a discrete variable as follows:

$$P(Y = n) = \frac{(tv_d)^n}{n!} e^{-tv_d}, n \geq 0 \quad (5)$$

Where  $v_d$  is the call drop rate and 't' is the time duration, 'Y' is a random variable that is used for counting the number of drops and 'n' is the confirmed call dropped (Boggia et al., 2005; Boggia et al., 2007).

### 4.4 Dynamic Channel Allocation

In cellular networks, Time Division Multiple Access (TDMA) based dynamic channel allocation in high traffic conditions is a very efficient method adopted by a very few service providers across the world to reduce the call drop probability in their networks. The performance is evaluated for probability of call drops due to handover in busy traffic conditions. Under dynamic channel allocation, a bandwidth window is used which changes its size as per the prevalent traffic conditions. In this phenomena, the highly prioritized and real time handover calls, generally voice and multimedia calls, are allotted the requested bandwidth while the lower priority calls (data

calls) get minimum bandwidth and hence the probability of dropping of handover calls is reduced to minimum.

One of the major concerns with this approach is the occurrence of co-channel interference. This phenomena which could result in two neighbouring cells using the same channel simultaneously, it can be provisioned that any channel which is in use by one cell can only be reallocated simultaneously to the another cell if and only if the relative distance between the two cells is ‘ $d$ ’, where ‘ $d$ ’ is defined as:

$$d=D/R \tag{6}$$

Where ‘ $R$ ’ is the radius of the cell and ‘ $D$ ’ is the physical distance between the two cell centres.

#### 4.5 Hybrid Channel Allocation

One of the rarely but quite effective technique of minimizing the occurrence of call drops is Hybrid Channel Allocation. As the name of this technique suggests very well that this technique is the combination of more than one different techniques. In this case, it can be defined as a well-planned strategy to allocate traffic channels through two different methods that are Fixed Channel Allocation (FCA) and Dynamic Channel Allocation (DCA). Hybrid channel allocation strategy considers FCA method to allocate channels to new calls whereas on the other hand it considers DCA method to manage handoff calls and hence successfully manages to reduce both call dropping and call blocking.

#### 5. Conclusion

Through this study, it is very clear that the menace of call drops is very critical and needs to be resolved very soon. Cell splitting and sectoring are very efficient methods to minimize this phenomena. Also, in this study, it was found that despite the repeated efforts of both the government of India and TSPs the benchmark of call drops in India is still left unachieved. The Govt. of India stands committed over this issue but the infrastructure required for tackling with this menace is not at par with the requirements and the infrastructural issues need to be resolved very soon. The methods like Cell splitting and cell sectoring can prove to be very successful in minimizing the call drop rate and will also increase energy efficiency of the cellular networks as shown by Equation (1). Other methods like HCA, FCA and DCA also prove to be very beneficial in achieving this target. As of now, these methods have only been simply suggested by Telecom Regulatory Authority of India to the Department of Telecom, Govt. of India. So, this issue stands unresolved and lots of scientific research work is going on by scholars and researchers. The future scope of this work may involve mathematical modelling of these methods like cell splitting and cell sectoring. These techniques enhance the Quality of Services provided by the telecom service providers by enhancing the signal strength. Cell Sectoring prevents the inference of alien signals with the established call signals and prevents call droppings. Methods like FCA, HCA etc. prevent congestion of the cellular network by strategically allocating channels to new calls and ongoing handover calls differently. Overall, the future of call drop rates depends upon how seriously TSPs work over it.

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