

Reducing Call Drops Due to Cell Failure

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Abstract : The **dropped-call rate (DCR)** is the fraction of the telephone calls which, due to technical reasons, were cut off before the speaking parties had finished their conversational tone and before one of them had hung up (dropped calls). This fraction is usually measured as a percentage of all .CDR is defined as the ratio of abnormal disconnect of calls to total calls established. The performance of a TSP relating to call drop is assessed through this parameter. The benchmark set by TRAI for CDR is <2%. Since the CDR for the service area as a whole does not reveal the extent of number of areas or localities where the CDR is poor, the Authority is monitoring another parameter called “Worst affected cells” in which the call drop rate exceeds 3% during cell busy hour, averaged over a month for a service area ” provides a much more localised view of the network. In this paper we have suggested a forced handoff method (Directed Retry) for cells going down due to weak transmission plan or other reason to reduce call drops .

Key words : Call drop . GSM ,Directed Retry , Handoff.

Introduction: In telecommunications, the **dropped-call rate (DCR)** is the fraction of the telephone calls which, due to technical reasons, were cut off before the speaking parties had finished their conversational tone and before one of them had hung up (dropped calls). This fraction is usually measured as a percentage of all calls . A call attempt invokes a call setup procedure, which, if successful, results in a connected call. A connected call may be terminated (disconnected) due to a technical reason before the parties making the call would wish to do so (in ordinary phone calls this would mean before either of the parties has hung up). Such calls are classified as dropped calls. In many practical cases this definition needs to be further expanded with a number of detailed specifications describing which calls exactly are counted as dropped, at what stage of the call setup procedure a call is counted as connected, etc. In modern telecommunication systems, such as cellular (mobile) networks, the call setup procedure may be very complex and the point at which a call is considered successfully connected may be defined in a number of ways, thus influencing the way the dropped-call rate is calculated.[10]

What Causes Call Drops?

The blame tilts more towards the operators here though they rebut the claims. The prime reasons for dropped calls are:

Inadequate coverage which can be due to multiple reasons [3]

- Lack of tower infrastructure
- Improper network planning
- Non-optimization of network

1. Overloaded cell towers – number of subscribers are growing day by day and most of them are on smartphones. The network capacity is simply not being ramped up at the same pace resulting in overloaded networks

2. Cityscape changes - there have been instances where a new multistoried building comes up & the adjacent building’s subscribers lose cell reception. Such instances are very common with rapidly changing cityscapes and call for routine network data analysis from service providers

3. Switching between towers – this situation occurs when a person is traveling or moving around while talking. If a call handover takes place from one BTS to another, especially in case of overloaded networks, there are chances of dropped calls.

4. Technical Failures – this is beyond anyone’s control and operators generally monitor downtimes through well-equipped network operation centres , can be due to transmission path or power outages .

Cellular Network

A Mobile *network* [4] can be defined as the group of multiple nodes like MS, BTS/Node B, BSC/RNC, MSS, HLR, etc. These nodes architecture are vendor dependent but in general it consist Specific hardware & software. Software is application specific & vendor proprietary. Nokia Siemens Network, Ericsson, Huawei are major manufacturer of telecom equipment & they implement the Mobile network architecture for Mobile Network Operator World wide.

A mobile network can be classified in to mainly three parts of RAN, SCN, and OSS domain. BSS is responsible for providing the mobile connection at air interface while SCN is responsible for providing the control over BSS along with mobility management, Charging etc. OSS is responsible for providing the maintenance of the entire node connected in Mobile Network.

Cell Site or BTS (BS)

The power of the radio signals transmitted by the BS decay as the signals travel away from it. A minimum amount of signal strength (let us say, x dB) is needed in order to be detected by

the MS or mobile sets which may be the hand-held personal units or those installed in the vehicles. The region over which the signal strength lies above this threshold value x dB is known as the coverage area of a BS, which gives this actual radio coverage, is called the foot print of a cell (in reality, it is amorphous).

Networking technology that breaks geographic area into cells shaped like honey comb.

Handover

Handover basically means changing the point of connection while communicating. Whenever Mobile Station is connected to 1 Base Station and there is a need to change to another Base Station, it is known as HANDOVER

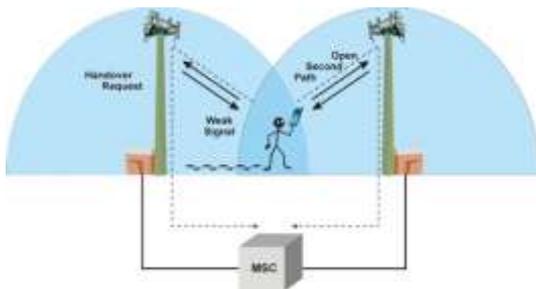


Figure 1. Handover request

There are numerous methods for performing handoff. From the decision process point of view, one can find at least three different kinds of handoff decisions.

- **Network-Controlled Handoff**
- **Mobile-Assisted Handoff**
- **Mobile-Controlled Handoff**

Network-Controlled Handoff

- In a network-controlled handoff protocol, the network makes a handoff decision based on the measurements of the MSs at a number of BSs.
- In general, the handoff process takes 100–200 ms.
- Network-controlled handoff is used in first-generation analog systems such as AMPS (Advanced Mobile Phone System), TACS (Total Access Communication System), and NMT (Nordic Mobile Telephone).

Mobile-Assisted Handoff

- In a mobile-assisted handoff process, the MS makes measurements and the network makes the decision.
- In the circuit-switched GSM (global system mobile), the BS controller (BSC) is in charge of the radio interface management. This mainly means allocation and release of radio channels and handoff management.
- The handoff time between handoff decision and execution in a circuit-switched GSM is approximately 1 second.

Mobile-Controlled Handoff

- In mobile-controlled handoff, each MS is completely in control of the handoff process.
- This type of handoff has a short reaction time (in the order of 0.1 second).
- MS measures the signal strengths from surrounding BSs and interference levels on all channels.
- A handoff can be initiated if the signal strength of the

serving BS is lower than that of another BS by a certain threshold.

TYPES OF HANDOVER

- Hard Handover
- Soft Handover
- Horizontal Handover
- Vertical Handover

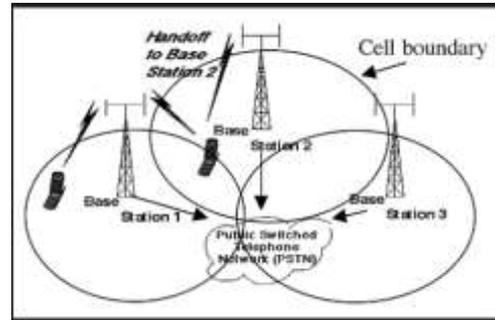


Figure 2. Handover scenario

INTER-CELL AND INTRA-CELL HANDOVER

The inter-cell handover switches a call in progress from one cell to another cell, and the intra-cell handover switches a call in progress from one physical channel of a cell to another physical channel of the same cell.

Hard Handover

- Old connection is broken before a new connection is activated.

Soft Handover

- The call is first connected to the new base station BS₂ and then it is dropped by the previous base station BS₁.

HANDOFF FAILURES

- Because frequencies cannot be reused in adjacent cells, when a user moves from one cell to another, a new frequency must be allocated for the call.
- If a user moves into a cell when all available channels are in use, the user's call must be terminated.
- Problem of signal interference where adjacent cells overpower each other resulting in receiver desensitization is also there.

Directed Retry

Directed Retry [9] is the process of assigning a Mobile Station to a Traffic Channel in a cell different from the serving cell. Call or traffic in a cell may be offloaded to nearby cell. If a call is chosen for Directed Retry to GSM, the request for the speech channel will be rejected with cause "Directed retry" and then a request is made to the core network to relocate the UE to a specific GSM cell, using the Inter-RAT handover procedure. This handover is

a blind one since the target cell is chosen not based on UE measurements. Therefore, the target cell must be co-located with the cell. Co-located GSM cells are assumed to have similar coverage and accessibility as their respective cells. Criteria can be set based on cell loading where threshold say 95% has reached so that nearby adjacent cell having less utilization may be used to mature a call and improve Network KPI .

Statistics on call drop

Call Drop Rate (CDR) is defined as the ratio of abnormal disconnect of calls to total calls established. The performance of a TSP relating to call drop is assessed through this parameter. The benchmark set by TRAI for CDR is <2%. [10] According, to the PMRs submitted by various TSPs it is seen that the TSPs are mostly complying with the benchmark for the entire service area as a whole.

Since the CDR for the service area as a whole does not reveal the extent of number of areas or localities where the CDR is poor, the Authority is monitoring another parameter called “Worst affected cells having more than 3% Traffic Channel (TCH) drops”. It is defined as, “cells in which the call drop rate exceeds 3% during cell busy hour, averaged over a month for a service area.”

The parameter “Worst affected cells having more than 3% TCH drops” provides a much more localised view of the network. Complying with this benchmark shall ensure that on an average not more than 3% of the base transceiver stations (BTS) on a day are having call drops of more than 3% during the busy hour, thus improving overall call drop rate.

The formula for calculating the percentage of dropped calls is:

$$= A / B * 100$$

where: A = the total number of interrupted calls (dropped calls)

B = the total number of calls successfully established (where traffic channel is allotted)

The formula includes the interrupted calls which consist of failures which cause the dropping of the call once the TCH has been successfully established, and the successful seizure of TCH for an originated or terminated call.

It has been seen that sudden loss of signal one of the prominent causes of dropped calls ,various factors contributing can be

- (a) Transmission link failure
- (b) BTS failure due to power , other reasons like electronics , etc

Referring (a) above leads to analysis of Transmission topology planning of a network , is directly contributing to cell site availability.

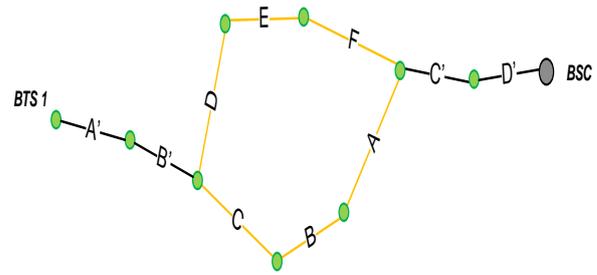


Figure 3. Transmission topology for cell connectivity

The overall end to end availability of BTS 1 is calculated using the formula below,;

$$100 - \left[\left(\sum_{i=A'}^{D'} U_i \right) + \left(\sum_{i=A}^C U_i \right) \left(\sum_{i=D}^F U_i \right) \right]$$

In table 1 we have given each of the chain links that enter and exit the top topology an availability number. We have then applied the above formula to come up with a final improvement factor.

Table 1: Link availability in reference to Figure 3

Link	Annual Planned		
	Unavailability (seconds)	Unavailability %	Availability
A'	243	0.00071%	99.99929%
B'	154	0.00045%	99.99955%
C'	67	0.00020%	99.99980%
D'	23	0.00007%	99.99993%
End to End,	487	0.00143%	99.99857%

Various network topology are available [7] like ,Ring ,Star ,Bus for connectivity between nodes . Linear sites are having less availability and having high probability of getting down.

Methodology

As per NW topology connecting Cell sites in a GSM Network , sites which are linear or not in a ring are prone to more outages . Any break in Transmission media may be microwave or fibre or power outage impacting cell site will result in DROP of calls running at that moment .

To avoid this situation and improve NW KPI parameters following is suggested

1. Identify cells which are linear connected thus having more potential for outage can be termed as WEAK CELLS , other cells in ring topology can be termed as NORMAL CELLS.

- Monitor utilization of WEAK CELL and whenever utilization crosses 50% D-Retry feature is to be enabled for channel assignment of new calls so that TCH of adjacent NORMAL cell can be allotted.

This will require identification of all NORMAL cell as COLD (less utilized) or HOT (high utilized)

- BSC will run the algorithm to identify WEAK CELL loading and enabling D-Retry feature as soon as threshold is crossed . TCH will be allotted based on COLD or HOT cell and cell with less loading will be preferred.

Result: Data analysis shows that with DR enabled in weak cell leads to forced handoff of call to nearby cell & helps to reduce call drop % incase of cell failure .This will result in improving KPI by reducing number of calls dropped by number of calls which got latched to other cells when utilization exceed 50% and cell went down

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Table 2: Sample data (assumption) for calls

Network Scenario	Number of cells	Normal Cell (Protected)	Weak Cell (Linear)	Number of calls (@10) in an hour	Calls completed without drop	Remark
Normal Working	10	8	2	100	100	Normal working
Weak Cell down	10	8	2	100	80	Incase weak cell goes down
D-Retry enabled	10	8	2	100	90	D-Retry enabled after 50% utilization of WEAK CELL

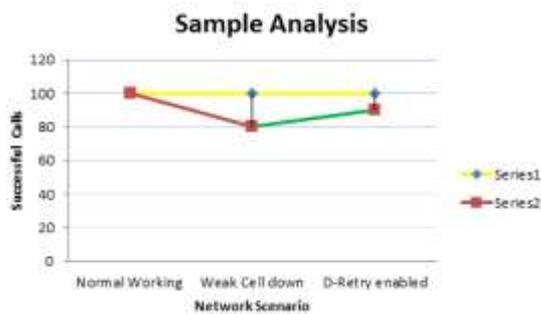


Figure 4. Graphical form in reference to Table 2

Conclusion : Generally a GSM operator has 80% NW protected and on an average 5000 cell sites in a telecom circle .Cumulative impact of 1000 sites having weak transmission connectivity is high on call drops however same gets averaged out . After implementing this method significant increase in KPI, Capex saving can be done as sites will not to be converted into RING closures which require costly electronics.

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