Analysis of Abnormal Call Drops in LTE Network with Unsupervised Techniques

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ABSTRACT

Irregular call drop investigation concentrates on fault investigating. In a 4G network, when a call is dropped due to some RF issues, we are unable to determine the exact cause of such dropped call which may impact the network operator's revenue. Generally Service provider send his technicians to physical site to collect bits of knowledge and data , however as the framework measure and multifaceted nature grows this operation and upkeep task ends up being more problematic. This article gives a methodology to decide underlying driver of an issue without additional cost to make the network more exact about determining cause of dropped call.

Keyword: *Fault diagnosis, Received signal strength indicator, SONET, 4G mobile communication*

INTRODUCTION

Giving a respectable and hearty organization to customer is the most outrageous need of a versatile administrator, on which their pay is liable to. Remote frameworks today have created in broad size which makes organization endeavors troublesome. Self healing (SH) structures [1] have been utilized, to explore and recovery exercises. Such SH utilizes information gathered by , OAM assignment [2]. The essential limit of this technique is that such data don't propose client level analysis and along these lines keep the expert from having the capacity to perceive real reason of call detachments, which is the solid reason clients are ordinarily unhappy with service provider. Such customer level examinations have been performed with the help of manual drive tests. Be that as it may, this is a tedious obligation. Regardless, this is a repetitive commitment. Consequently, experts need to go physically in a predefined way in order to make the customer level estimations. Along these lines, the hit or miss examination focuses on the area which is sampled neglecting the rest of area. Moreover, manual drive test does not reinforce expert to break down the call drop disengagement of every customer separately. Fig. 1 demonstrates an examination between system operation with Self Organizing Networks (SON) capacities and a customary instrument, which depends on human contribution [3]. For such conditions, the Third Generation Partnership Project (3GPP) has trained minimization of drive test (MDT) [4]. On the other hand, MDT especially fixated on researching and separating the LTE radio access network (RAN) execution of a particular cell [5]. However, MDT is still a manual process, As a result, exploring specialist need to put an impressive measure of time in breaking down the problems.. Consequently, this article proposes a technique to analyze abnormal call drops in a LTE network along with faulty area of user without gathering such information physically.

RELATED WORK

Majority of frameworks rely upon MDT. In [6] authors recognized the issue and make an activity in perspective of key performance indicators (KPI). In [2], authors uses Bayesian approach in (1) to find the probability of certain symptoms out of total symptoms.

$$P(Ci|E) = \frac{P(Ci)P(E|Ci)}{P(E)} \qquad (1)$$

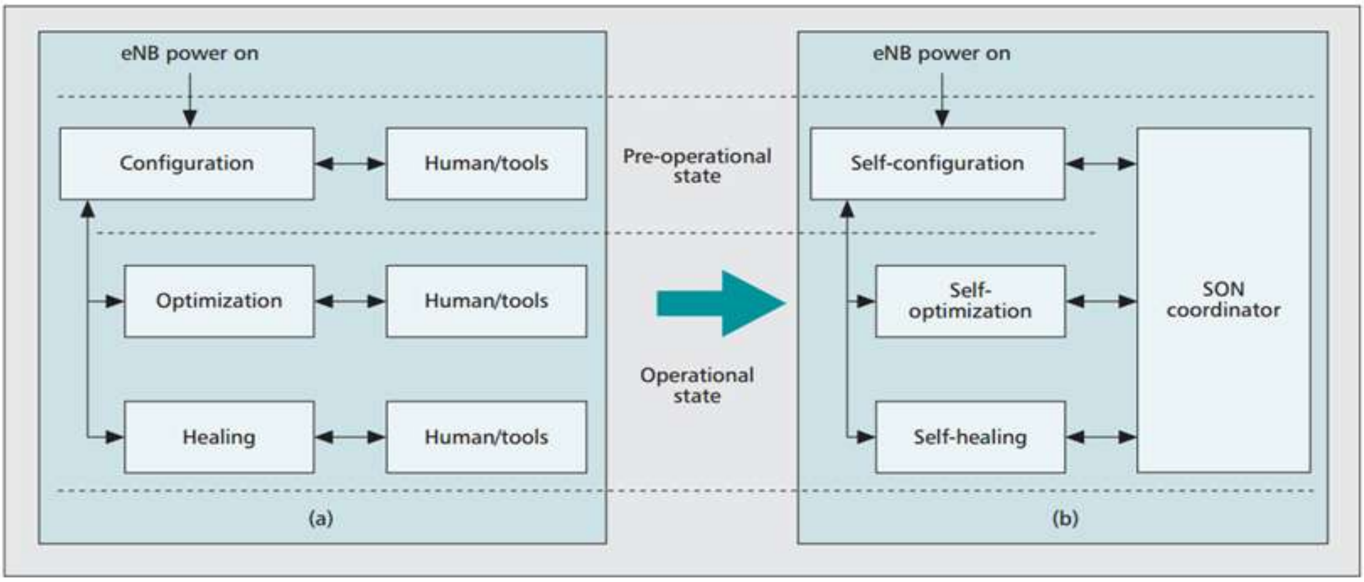

Fig.1 Network operation a) without ; b) with SON functions

Here, Ci means reason of issue in the system. E is the arrangement of total N symptoms. P(E|Ci) is likelihood function. In [7], auhors proposed a technique to recapture the whole cell area. At whatever point an area deformity is recognized, the bordering Base Station (BS) power and radio tilt is adjusted to give service in imperfect division. This arrangement relies upon compensate work [fig.2] where the customer having better channel quality gets a reward and along these lines more likely to be served by adjacent BS.

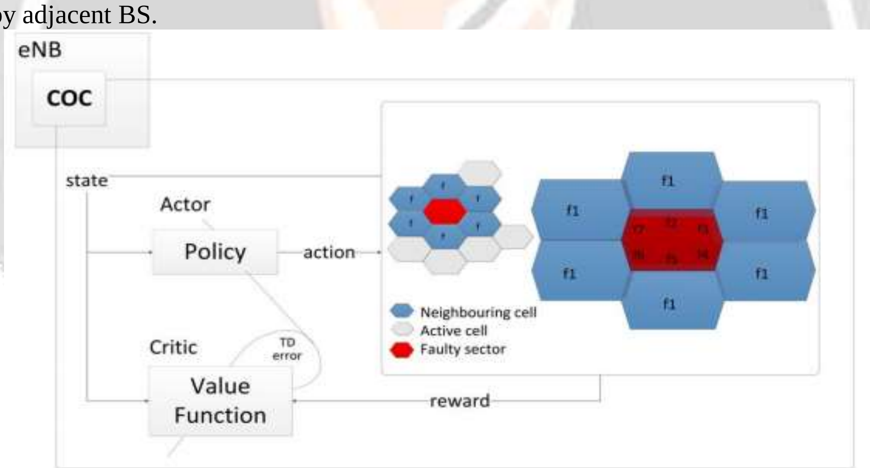

Fig.2 Sector Recovery

DRAWBACKS IN EXISTING SYSTEMS

These self repairing schemes rely upon supervisory action. We acknowledge that the experts accumulate the customer level data and depending upon this tried data, we inspect the issues. In any case, we simply consider certain cases and neglect rest of the region which lessens exactness of structure. In particular cases, it is imperative to expect probability of a reason. Further, such approaches can't give the defective area where the service fault has happened. So in this paper we give an unsupervised technique to explore the issue with expanded precision in lesser amount of time

Note that this article covers the call drops because of abnormal reasons. These dropped calls should be recognized from other different reasons such as ordinary release and access failure release [8]. Ordinary release suggests advantage of administration offered to the customer has been done while Access failure implies customer cannot infer requested service because of over-burden, resource unavailability, unsuccessful authentication and so forth.Since the mobile network contains large amount of users, processing time to analyze call drops will be larger. The network operator has to decide whether he wants to analyze the entire network or just few selected customers. If the network operator wants to analyze specific user, then he can use International Mobile Subscriber Identity (IMSI) or International Mobile Equipment Identity (IMEI) number of user equipment (UE) which is unique in nature.

Table 1. Relation between radio cause and various measured parameters

Radio Cause	**Current Serving RSRP**	**Current Serving RSRQ**	**Strongest (non Serving / Neigh-boring) RSRP**	**Number of Detected Cells**	**Relative TA (Delay)**
CH	$< TrRSRP_{BAD}$	$< TrRSRQ$	$< TrRSRP_{BAD}$	$< TrNC$	$< TrTA$
CE	$< TrRSRP_{BAD}$	$< TrRSRQ$	-	-	$\geq TrTA$
LD	$< TrRSRP_{BAD}$	$< TrRSRQ$	$< TrRSRP_{BAD}$	$\geq TrNC$	$< TrTA$
MP	$< TrRSRP_{GOOD}$	$< TrRSRQ$	Better than serving	-	$< TrTA$
I	$\geq TrRSRP_{GOOD}$	$< TrRSRQ$	-	-	$< TrTA$

REQUIRED PARAMETERS

When call setup request arrives at BS by the customer, we need to measure certain such as TA (Timing Advance) from which we can identify the transmission delay in the downlink and uplink path between the client and its current base station. [9], reference signal received power (RSRP) [10] which represents the air interface quality, Strongest non-serving RSRP other cells detected by UE [8] along with total number of detected cells by UE which is additionally helpful while performing handover.

IDENTIFICATION OF RADIO CAUSES

On disconnecting a call, various measured parameters are stored in a database to find connection release reason. The particular components of those radio issues such as CH, CE, MP, I, LD alongside the normal conduct of the parameters are itemized beneath and abridged in Table 1 [8].

Coverage Hole (CH): It is the zone where there is no coverage by both serving BS and non-serving adjacent BS and quality of air interface is poor, thus they are beneath limit of threshold.

Cell Edge (CE): The call is dropped because user is at the boundary of cell which can be identified by values of serving and non serving RSRP to be below threshold, however since the distance between UE and BS is large, the value of TA will be larger than threshold.

Mobility Problems (MP): This release is brought when client does not have adequate signal strength & quality to keep up the session however there is another BS whose RSRP is above threshold, which could avoid abnormal release but UE does not complete handover to other strongest nearby cell causing call to be dropped.

Interference (I): RSRP is above threshold but due to large interface near the user, quality of air interface is poor causing quality of air interface (RSRQ) to be below threshold.

Lack of Dominant Cells (LD): Here the detected cells are more than threshold but none of them is sufficient to provide service to the client

CALL DROP DIAGNOSIS

Once the theoretical commence of the framework has been considered, around there, the procedure is evaluated using simulation. In specific, the point of this article is to delineate how the proposed structure functions and can be used in automating the call drop diagnosis. There are several methods in literature to diagnosis a system. Rule based system is the simplest technique to identify the cause of call drops according to Table 1 which is simple and does not require computational complexity. The frameworks require the outline of edges/thresholds to examine the input data. There are distinctive methods of doing that, e.g. the percentile-based discretization (PBD) technique proposed in [2]. However the false positive rate increments as any of the thresholds turn out to be less strict [8]. Since the system scope zone may have diverse reach-ability at various cells and considering nearby local working conditions we propose distinctive thresholds rather than a single threshold. Thus, threshold values of various parameters such as RSRP, RSRQ, number of detected cells and timing advance have been set by various experiments conducted by network operator’s technicians and may not be same for all the cells. Threshold values of three cells which are obtained individually are shown in Table 2. We have chosen rule-based system due to its simplistic nature.

Table 2. Thresholds for various parameters

Parameters	Cell 1	Cell 2	Cell 3
Max Transmit Power	47 dBm	42 dBm	43 dBm
Thr $RSRP_G$	-82 dBm	-80 dBm	-86 dBm
Thr $RSRP_B$	-107 dBm	-115 dBm	-101 dBm
Thr RSRQ	-7.8 dB	-8.1 dB	-7.2 dB
Thr NC (Number of cells detected by UE)	4	4	3
Thr TA (Timing advance)	1	2	1
System Bandwidth	1.4 MHz	5 MHz	10 MHz

The criterion for rule-bases system is based on IF…..THEN rule [8]. Each rule is designed to show relation between radio cause and measured parameters shown in Table 1. For instance, the rule of LD would be as shown in the flowchart [Fig.3]

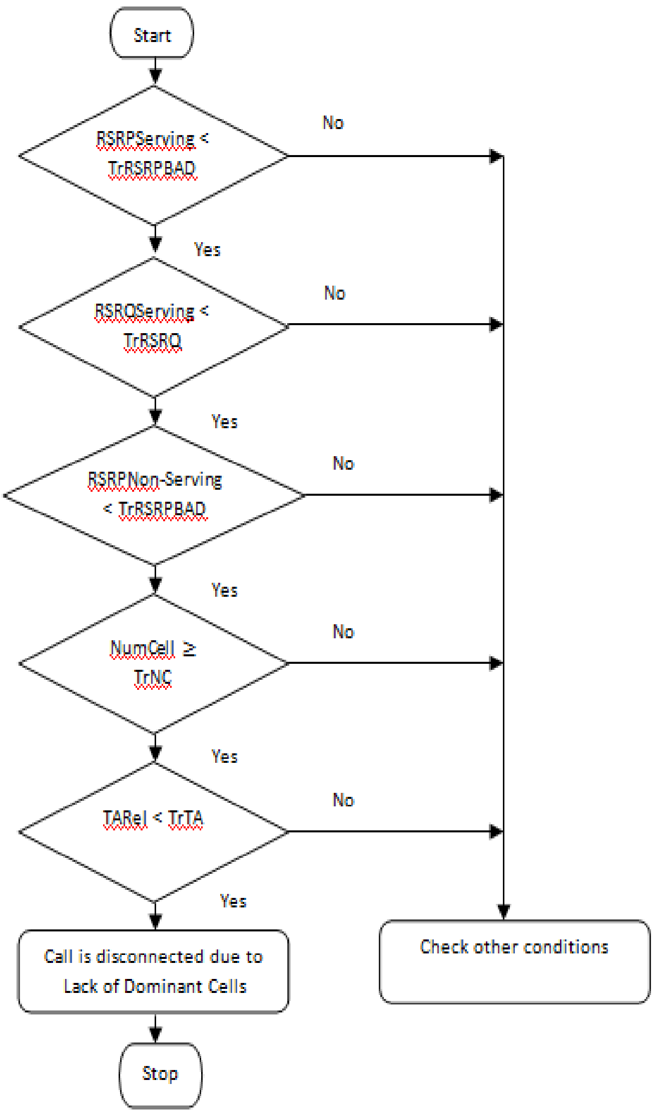

Fig.3 Flowchart of LD cause

DETERMINING FAULT LOCATION

The fault area of customer can be obtained using GPS co-ordinates which is considered as mostly known localization technique [11]. However when GPS is not accessible, other procedure like received signal strength indicator (RSSI) based location determination system [12] can be used by service provider. Since the location of client at beginning of call may be not same as location towards end of the call thus we propose to maintain a database acquiring the client location towards the end of call instead of obtaining location at call connection request to get a correct area at which fault has occurred.

SIMULATIONS

In MATLAB, LTE network with three cells are considered to analyze call drop reason. Fig.4 shows the disconnections that happened over these three cells. Radio causes have been assigned with different colours. Using IMSI/IMEI, the call drop reason of individual user can be obtained [fig.5] after which network operator can obtain the specific client's location from the database [fig.6].

Cell 1: In cell 1, majority of calls are dropped because of cell edge and mobility problems followed by interference. Coverage hole and lack of dominant cell is not of much concern here.

Cell 2: There might be a interfering source near the client which causes dropped calls thus the major cause of call drops in this cell is interference followed by mobility problems.

Cell 3: Here, the majority users are suffering from cell edge problem followed by mobility problems

In this way,, by looking at results a service provider can get an idea about call drops in a network and their specific reason along with fault location using which a network operator can improve the service provided to the customers.

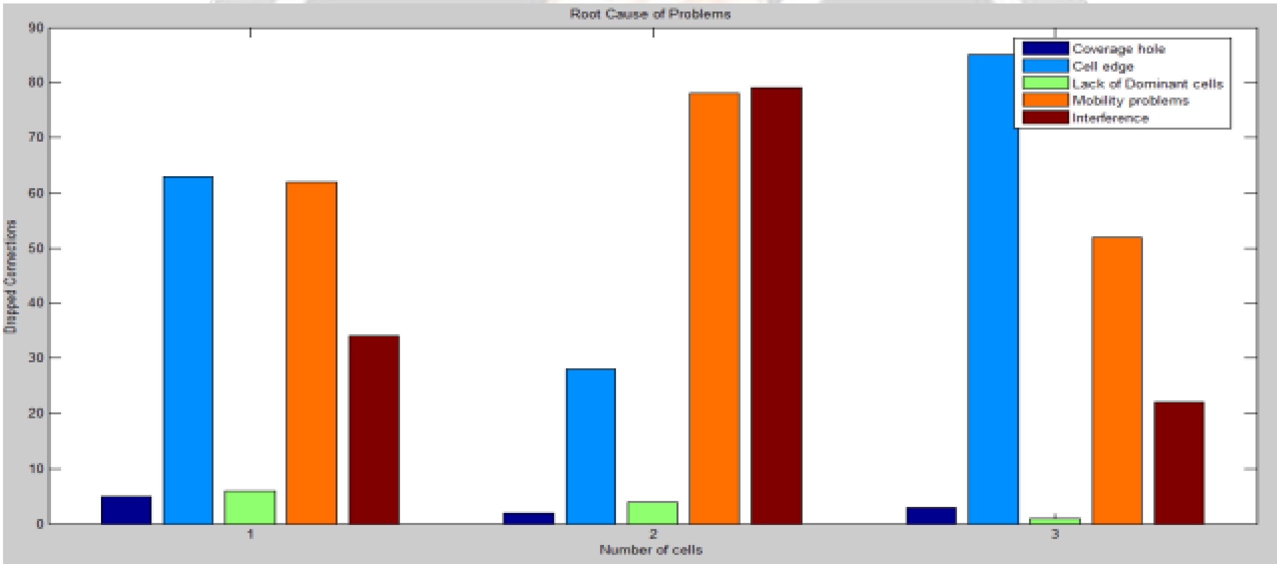

Fig.4 Result of automatic root cause analysis

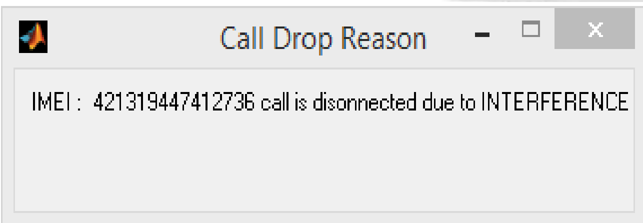

Fig.5 Call Drop Reason of Individual Client

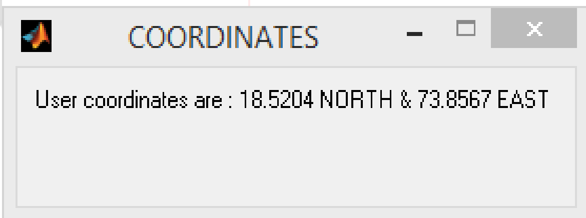

Fig.6 Coordinates of Individual Client

CONCLUSION

By using this technique 4G SON accuracy is further enhanced by identifying the particular RF issue resulting in dropped connection. The network can be analyzed almost instantly by service provider. Another advantage is that this method also allow service provider to know the faulty location of user at which call is dropped. The obtained result shows the advantages of knowing the actual cause of problem that has negative impact on users which will help service provider to take necessary action in order to improve the service.

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