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Intelligent Optimization of GSM Network

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Abstract*—Performance & Quality of service of GSM network is enhance from the optimization. In the present scenario, inputs of drive tests are the one of the main source to optimize the GSM or any other mobile network. Drive test methods are limited to a specific moment in time and a specific test route and it is a time, labor and cost intensive. As most of the calls are made from the indoors & traditional optimization methods can not provide any effective solution for these, as drive test for indoor routes are not possible. So, a new method can be used for the optimization of GSM which deals with measurement reports send by the subscribers (that are generally used for handover purpose only and discarded in certain interval). Various method like RF finger printing and triangularisation method may be used to find out the location of subscriber. Once the system have both, the measurement report send by the mobile station (which consist of received signal strength of serving cell and near by cells) and the location of subscriber then effective optimization solution can be provided with out conducting a costly and time consuming drive test .This new method of optimizing mobile network with more accuracy and efficiency, where almost 100 % serving area can be optimize without going any where is known as Intelligent Optimization.

***Index terms*— Optimization, Measurement Report, Triangularisation Method, RF Fingerprinting Method, Intelligent Optimization.**

I. INTRODUCTION

Optimization involves monitoring, verifying and improving the performance of the radio network. It starts somewhere near the last phase of radio network planning, i.e. during parameter planning. A cellular network covers a large area and provides capacity to many people, so there are lots of parameters involved that are variable and have to be continuously monitored and corrected. Apart from this, the network is always growing through increasing subscriber numbers and increases in traffic. This means that the optimization process should be on-going, to increase the efficiency of the network leading to revenue generation from the network.

Traditional method of optimization consists of optimization on the basis of these:-

1. Drive test results
2. Traffic observation reports/Network statistics.
3. Test calls
4. Call tracing
5. Subscribers feedback
6. KPI (Key performance indicator) monitoring
7. OMC-R,OMC-S reports

Using the above inputs we can determine the optimization requirement and the area which needs to be optimized. The quality of the network is ultimately determined by the satisfaction of the users of the network, the subscribers. Drive tests give the 'feel' of the designed network as it is experienced in the field. The testing process starts with selection of the 'live' region of the network where the tests need to be performed, and the drive testing path. Before starting the tests the engineer should have the appropriate kits that include mobile equipment (usually three mobiles), drive testing software (on a laptop), and a GPS (global positioning system) unit.

When the drive testing starts, two mobiles placed in moving vehicle that are used to generate calls with a gap of few seconds (usually 15-20 s). The third mobile is usually used for testing the coverage. It makes one continuous call, and if this call drops it will attempt another call. The purpose of this testing to collect enough samples at a reasonable speed in reasonable time. If there are lots of dropped calls, the problem is analyzed to find a solution for it and to propose changes.

II. LIMITATIONS OF TRADITIONAL METHODS - DRIVE TEST AND NETWORK STATISTICS-BASED TECHNIQUES [4]

Although drive test assessments provide an indication of network performance, there are several inherent problems with the process. First and perhaps most importantly, is that drive test methods are limited to a specific moment in time and a specific test route. Secondly, the techniques and processes applied in evaluating call quality are time and labor intensive. So, it's not easy to take the volume of measurements required to ensure statistical validity. Driving to test an area and then going back to the same place to review system changes also creates a significant overhead at a time when service providers need to reduce costs. In addition, as much as 70 to 80 per cent of all calls are made indoors – services that cannot be assessed accurately. In addition, data using

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from only network statistics-based techniques are typically aggregated and averaged, and are not truly representative of subscriber behavior. Therefore, a new look at network analysis is required. Further section deals with a enhance optimization solution known as intelligent optimization. The rest of the paper is organized as follows. Measurement report and location finding methods of mobile subscriber that are used for intelligent optimization are explained in section 3. Section 5 describes intelligent optimization and its merits. Finally, section 7 concludes the paper.

III. MEASUREMENT REPORT AND LOCATION TRACING OF SUBSCRIBER

A. Measurement Report

In the active mode, mobile subscriber measure received signal strength of serving cell and seven nearby cells prepare the network measurement report(NMR) .The mobile device regularly forwards the NMR to the serving cell to assist the network to make handoff decisions. These NMRs are discarded after certain intervals and at present they are used for decision of handover only. Apart from the signal strength information, information about TA (timing advance) of serving cell is also transmitted.

B. Timing Advance (TA)

A Timing Advance (TA) is used to compensate for the propagation delay as the signal travels between the Mobile Station (MS) and Base Transceiver Station (BTS). The Base Station System (BSS) assigns the TA to the MS based on how far away it perceives the MS to be. TA can be varies from 0 to 63.

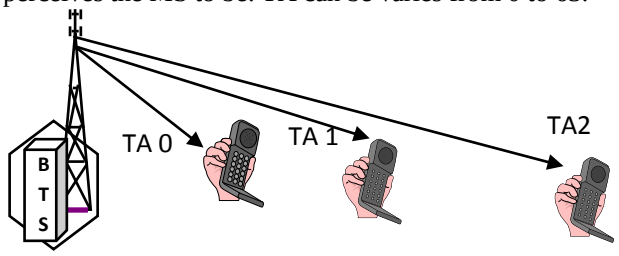

Fig.1 Assignment of TA by the network as per the distance [1]

So, if subscriber will be with in 553.5 m from the BTS TA0 will be assign and if the subscriber will 553.5m to1107m away from the BTS TA1 will be allocated

Table 1: Relation between TA and the distance

TA	Position of subscriber from the BTS
0	0 to 553.5 m
1	553.5m to 1107 m
2	1107m to 1160.5 m
...	...
63	34.87km to 35.42 km

So, it can be said that if we have an idea of TA we may predict that subscriber is situated how much away from the BTS.Table-1 explains the relation between TA and the distance of the subscriber from the BTS.

IV. METHODS TO FIND THE LOCATION OF MOBILE SUBSCRIBER [1] [3]

From the normal practice, we can only find the information about the serving BTS. In this case, position of mobile phone will be the position of cell, in which the mobile phone is registered. But the cell size can be varies from 100m-35 km so this gives the precision of 100 m-35 km. With the help of timing advance (TA) we may find the location of subscriber with the precision of 553.5 m. To find the location of mobile subscriber with the precision of 25 to 50 m following methods can be used.

1. RF Finger printing
2. Tringularisation method
3. Time difference of arrival

RF finger printing deals with collection of data related to received signal strength, TA, received signal speech quality index etc at each point with respect to serving cell and the neighboring cells in various RF conditions. When subscriber sends information about received signal strength, and TA of serving and neighboring cells via

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NMR (network measurement report), network match it with its data base and predict the location of GSM subscriber.

Trainglarisation method also uses NMR and with the help of TA distance of the subscriber is predicted with respect to 3 or more BTSs. The interaction of arc drawn from these BTS gives the idea of subscriber with the precision of 25 to 50 m, MS sent simultaneous signal to two or more BTS.

Each BTS compute the time difference and convert this to distance to MS. This method of location finding of mobile subscriber is known as ***time difference of arrival method.***

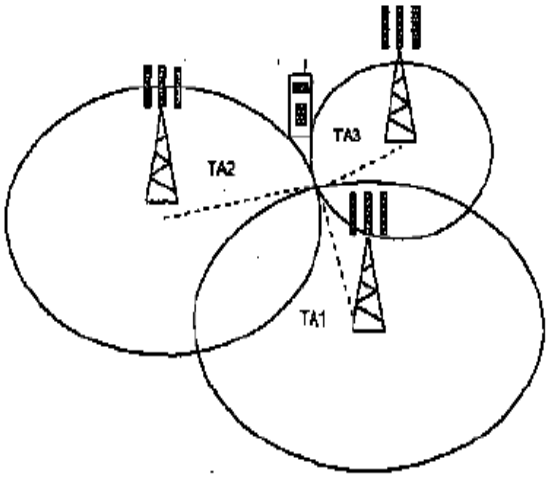

Fig.2 Tringularisation Method Of Locating Finding Of Mobile Subscriber [1][3]

V. INTELLIGENT OPTIMIZATION

Measurement report data are created by subscriber's handset that are used and then discarded by the network. But, by applying Intelligent Optimization System, the information can be retained, processed and analyzed to optimize the network.

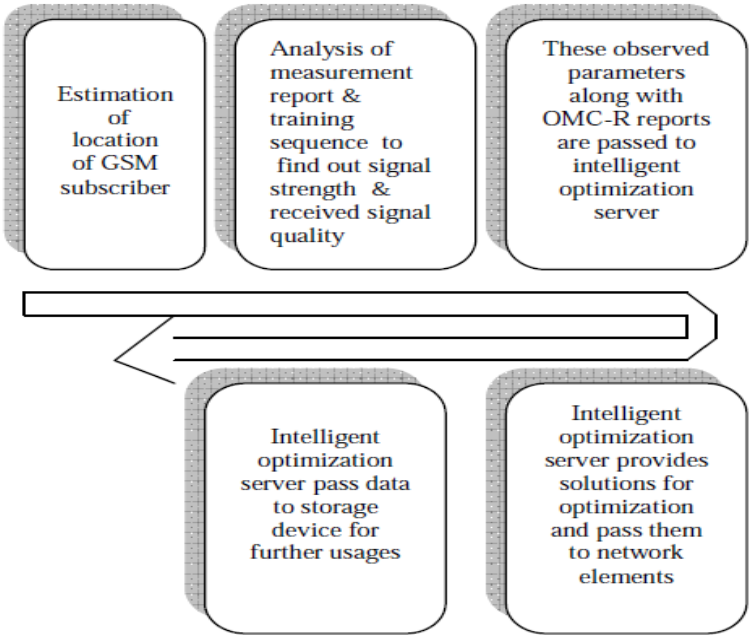

Fig.3 Flow Chart: Intelligent Optimization [2][5]

This technology provides a single 'driverless' multi-vendor assessment tool for the entire network which automatically collects data to provide both a more advanced, but cost efficient monitoring process.

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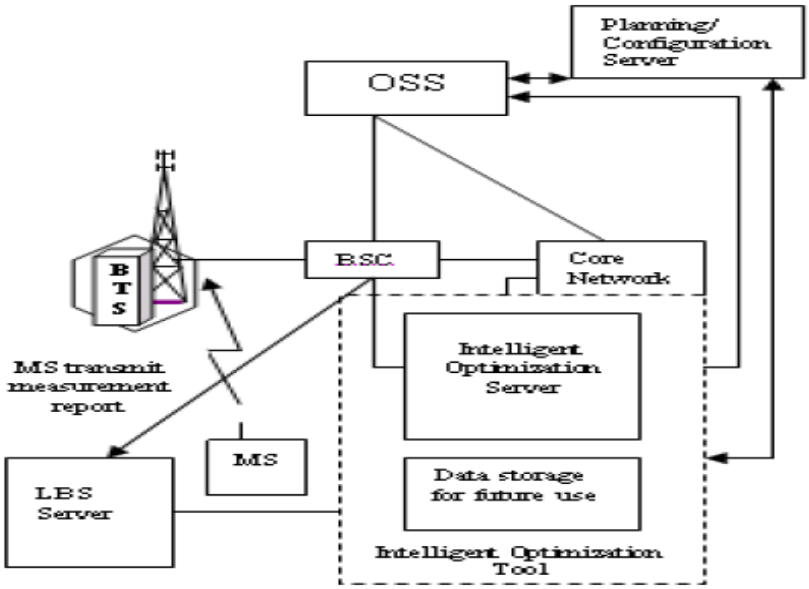

Fig.4 Intelligent Optimization solution for GSM [2]

As shown in figure-3, estimation of location of GSM subscribers is done by location based server (LBS server) by utilizing any methods described in earlier section. GSM subscriber measurement report is analyzed by the intelligent optimization server to find out received signal strength from serving & neighbor cells. Training sequence used in TDMA burst can be utilized to estimate bit error rate (BER). Now intelligent optimization server has idea of signal quality & signal strength at particular position. Intelligent optimization server also utilizes OMC-R report as prepared by OSS/NMS (Operations Support System/Network Measurement Support). Now analyzing various parameters like signal strength, signal quality, timing advance, neighbor details, handover sequence etc at various points, intelligent optimization server may provide dynamic optimization solutions.

Intelligent optimization solution coordinates with BSC, NMS and core network for the implementation of optimization solutions. Now NMS/ intelligent optimization server analyze the QoS after implementing optimization solution & react accordingly. So intelligent optimization solution provides interactive & dynamic optimization solutions that can automatically implemented and the result is also observed automatically to find out its effectiveness.

Figure-4 describes the implementation of intelligent optimization solution in GSM network. LBS server provides position related information to intelligent optimization server. This server is connected with BSC, OSS & core network elements.

Concept of automatic planning / configuration server can also be included here. This server communicates with intelligent optimization server to take input about C/I, co channel interference, inter channel interference and accordingly it takes decision and intimate OSS/NMS. NMS further communicate with BSC for the change in various radio parameters like frequency, handover margin, MAIO, MA & BA list etc.

Intelligent optimization server may be connected with data storage unit that stores data for future purpose. Analysis done by intelligent optimization solution is not based on average or aggregated data but it is based upon real traffic so an independent and accurate picture of service quality can be predicted. Intelligent optimization solution can also be implemented for 3G techniques. So in brief intelligent optimization is a

- Gathering & utilizing subscriber measurement report for providing optimization solutions.
- Automated network performance observation and implementation of optimization solutions.
- Completely drive less method that causes reduction in operational expenditure.
- Accurate picture of service quality can be predicted due to use of real time data.
- It is a way towards self organized network (SON) as introduced as a part of 3GPP LTE.
- Data stored can be a rich source of data for further optimization methodologies.

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Companies like Motorola is providing Multi-Vendor Intelligent Optimization System "MVIOS"[2] that can provide drive- less intelligent optimization solutions for 2G/3G /LTE etc.

VI. ADVANTAGES OF INTELLIGENT OPTIMIZATION SOLUTIONS

Ordinary drive test consist of manual intervention and it cannot be carried out in indoor and geographically unreachable places. With the help of intelligent optimization it's possible to collect entire network data, even indoor coverage data etc. Intelligent optimization provides monitoring of all real time traffic and provide more accurate picture of network performance at various places. It provides automatic network monitoring and self optimization approach. Due to least manual intervention it increases the reliability and decrease operation expenditure. It may provide consistent performance across multi-vendor infrastructure as it can be applied across all infrastructure vendors within an operator's network. Moving into the future, with the consolidation of existing and emergence of new business models, more companies, in order to reduce operating costs, will take a RAN-sharing approach of network resources. It is critical, therefore, for multi-vendor optimization analysis to be applied to these combined network resources. This requirement is also a key feature that can be applied to securely isolate and measure the performance of individual services running across the same infrastructure. For these intelligent optimization techniques can play a big role. So, intelligent optimization is a new approach to optimize the network that provides automatic & dynamic optimization solutions. It can be considered as a path to SON.

VII. CONCLUSION

Intelligent optimization is a powerful technique for the optimization of any mobile network. It can provide optimization solution for almost 100 % of coverage area without going there. This perform automatic collection of data so optimization will become a automatic process that can improve network performance so quickly as compare to traditional optimization methods that deals with costly and time consuming drive test. Due to this, now most of the service providers are moving towards intelligent optimization methods.

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