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Cost effective solution to support Capacity and Coverage of live GSM network

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Abstract: accurate tuning of RXLEV_ACCESS_MIN (Receiving level access minimum parameter***),*** CRO (Cell Reselection Offset parameter) and Antenna Tilt parameters balances the traffic between congested cell and its nearest non-congested cell. The benefit of traffic balancing is explored in the proposed design of cost effective solution to support capacity and coverage. The objective of this method is to accomplish the optimum utilization of the available BTS in the network. The power consumption analysis reveals that 21% of cost on power could be saved while using proposed method during night times in the absence of neighbouring base transceiver station.

Keywords: GSM, Traffic, Congestion, Radio parameters at least 4 keywords or phrases

I. INTRODUCTION

GSM (Global system for Mobile communication) standard is more improved after the development of third generation (3G) Universal Mobile Telecommunication Service (UMTS) standard and will evolve further as they deploy fourth generation (4G) Long Term Evolution(LTE) Advanced standards [1,2]. India is the fastest growing GSM market in the world with its high population and development potential. The total number of GSM subscribers has reached 677.85 million as of May 2012 [3]. It is expected that voice usage will dominate data for few more years especially in developing and under developed countries [4]. Currently, GSM networks are expanding due to quantum leap in subscribers [5]. The enormous customer base in certain specific scenarios like fairs, festival season, traffic jams etc., creates impetuous traffic in the network which leads to traffic channel (TCH) congestion at that particular point in time. TCH congestion results in large number of TCH blocking which immensely deters the subscriber satisfaction in turn the revenue of the service provider in the longer run. There are many congestion relief methods found in literature such as carrier expansion, cell splitting, aggressive frequency reuse pattern, microcells for hot spots, and realizing dual band networks [6]. Congestion relief techniques such as carrier expansion and aggressive frequency reuse are not suitable to cater temporary increase in traffic of live GSM network. Other congestion relief methodologies such as cell splitting, planning microcells and expanding frequency band requires capital expenditure (CAPEX) and operational expenditure (OPEX). Like anywhere in the world, the operators will calculate revenue over investment (ROI) before investing money on any of these expansion methods mentioned above. As per the live network results, the ratio of traffic in the busiest hour to the quietest hour is almost equal to 20:1 [7]. Therefore, it is imperative for an operator to ensure that their resources (both hardware and spectrum) are utilized to their full potential and are not over dimensioned. To address this concern, a cost effective solution to support the capacity in peak hour and coverage in non-peak hour is required. In this paper, cost effective solution to support capacity and coverage is discussed which explores the benefit of traffic balancing using radio parameters such as RXLEV_ACCESS_MIN, CRO and Antenna Tilt parameters [8, 9]. The objective of this method is to accomplish the optimum utilization of the available BTS (Base Transceiver station) in the network.

II. METHODOLOGY

The schematic representation of proposed method of cost effective solution to support capacity and coverage of live GSM network is shown in Fig . 1. The proposed method is based on deploying BTS in those places where it can support the coverage of multiple cells and enabling it to work only during capacity or coverage requirement. We have named this BTS as OPEX saving working (OSW) site as it saves the OPEX.

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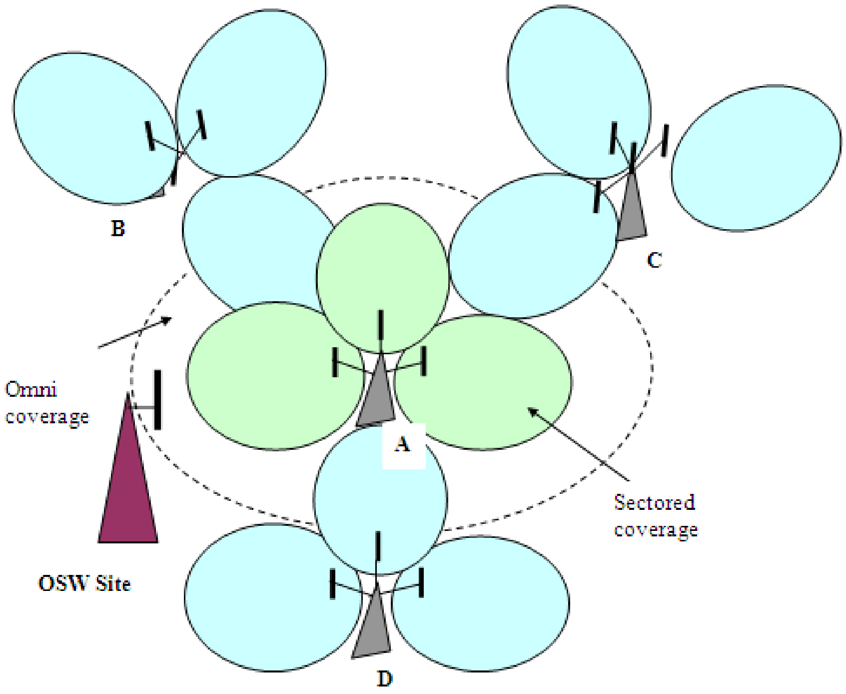

Fig. 1 Schematic diagram of OSW BTS site.

The OSW sites will work as a capacity site during peak hour to support the additional traffic along with existing sites. This is done by tuning RXLEV_ACC_MIN, CRO and Antenna Tilt parameters to balance the traffic between congested cells and it's non-congested nearest cells. The OSW site is also intended to work as coverage sites during non-peak hour especially during night by turning off its nearest neighboring sites. This would help to save the power and reduces the overall maintenance cost of the sites. The proposed design is different from automatic transceiver shutdown design available in the literature where BTS will be in powered "ON" state for entire 24h of the day [10]. An automatic switching off capacity cells based on traffic condition is simulated where self-organizing network selects the appropriate energy saving mechanism and collaborate the reconfiguration of cell parameters with neighboring cells [11]. However the proposed method in [11] does not use capacity cells for coverage purpose, and live network observations are not established. A dense clutter comprising 5 BTS sites is selected for testing the feasibility of the proposed OSW site model. All the selected 5 sites are from Bangalore region of live network. Out of 5 sites, one site is considered as OSW site as its coverage foot print extends to cover the coverage of remaining 4 sites. The OSW site and its associated coverage pattern are predicted using Mapinfo Professional software. During prediction, the antenna gain of OSW site and normal sites is set to 17 dBi with horizontal beam width of 65° as per available database. The BTS antenna height is set to 50 and 15 m for OSW and normal sites, respectively. The results are depicted in Figure 2 where the OSW site coverage is represented by orange color pattern with a cell radius of 2.3 Km while the coverage pattern of normal sites is represented by green color with a cell radius of 0.4 Km.

From coverage pattern, it is found that eight out of twelve cells are completely covered by OSW site while remaining four cells are partially covered. The OSW site is enabled during peak hours (12 PM to 1 PM and 7 PM to 8 PM) to enhance the capacity of the network. It is also turned ON during night (1 AM to 5 AM) by keeping the remaining 4 sites in OFF state to save OPEX. The RXLEV_ACC_MIN, CRO and Antenna Tilt parameters are tuned to offer the optimum performance in terms of capacity and coverage. The setup is monitored for one month by collecting daily channel utilization reports whose result is discussed in the next section.

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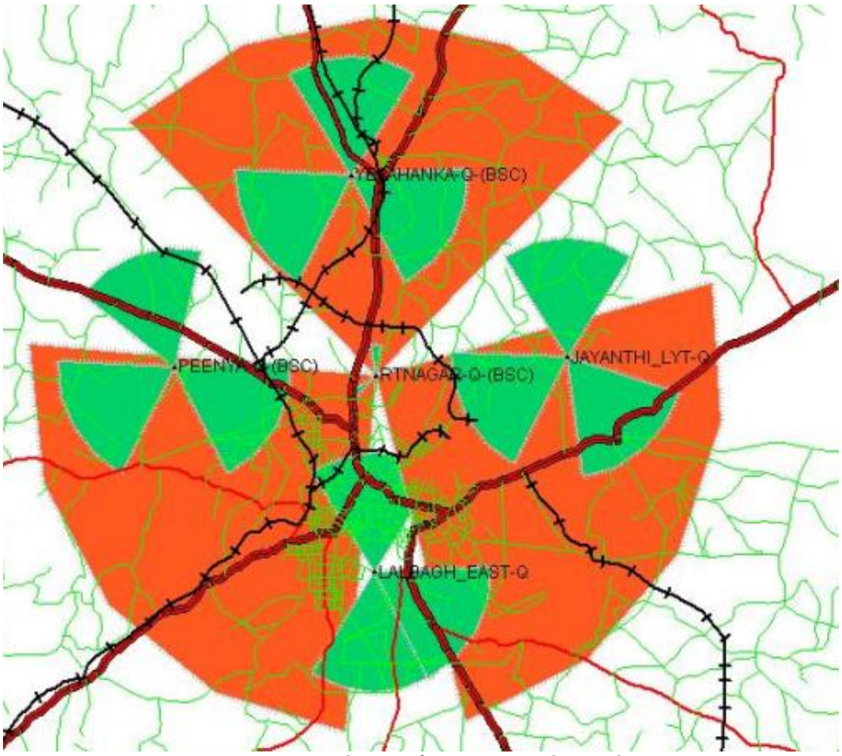

Fig. 2 Coverage prediction of OSW BTS and normal BTS.

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III. Results and Discussion

The results of average channel utilization characteristic of pre- and post-optimization phase are shown in Fig. 3 and 4. From the characteristics, it is observed that the entire traffic of normal sites is extracted by OSW site during night time (1 PM to 5 PM). This will help to save the power and maintenance cost of normal sites during these non-traffic hours. Also during peak hour OSW site has offloaded the traffic of surrounding sites by 27.25 %.

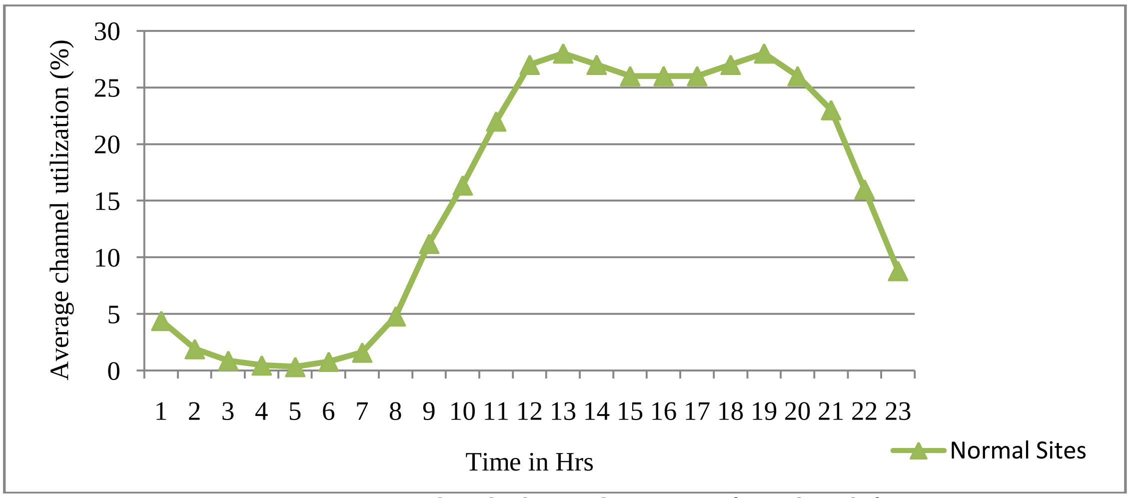

Fig. 3 Average channel utilization characteristics of normal sites before optimization

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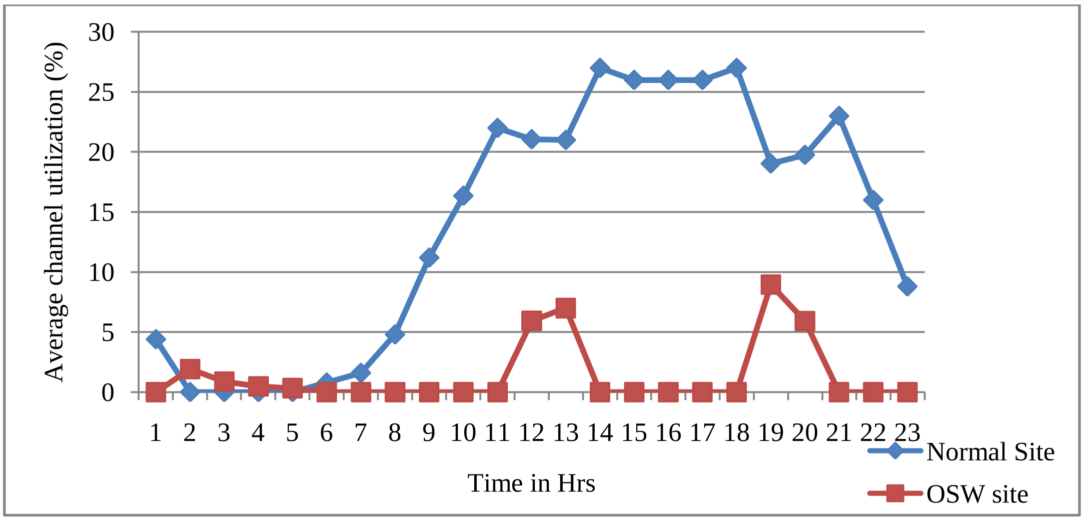

Fig. 4 Average channel utilization characteristics of OSW and normal sites after optimization.

The full load power consumption of various types of BTS used in live network along with monthly power maintenance cost for Indian scenario are presented in Table 1. The percentage of cost saved on power while using OSW site in the absence of its nearest normal sites is presented in Table 2. In live network, an air conditioner will be deployed along with the BTS to maintain the temperature of the BTS within the specified limit. Therefore, the total power consumption per BTS site will be equal to sum of power consumed by BTS and power consumed by respective air conditioner. Because of the electricity deficiency, 20% of the total power is contributed by Diesel Generator (DG). This percentage is based on six months trend observed in live network. The more usage of DG power will lead to higher power cost per site per month.

TABLE I. POWER CONSUMPTION AND COST COMPARISON OF VARIOUS BTS TYPES

Type of BTS	Full Load BTS (S4/4/4)		Air Conditioner	Total Power Consumption per Month (KW)	80% of Total Power	20% of Total Power	Rs 7.68 per unit	Rs 60 per unit	Total Cost per Site per month (in Rs)
	Max. Power Consumption per Hr (KW)	Max. Power Consumption per Month (KW)	Power Consumption per Month (KW)		Total Power due to Electricity only (KW)	Total Power due to DG only (KW)	Total Cost for Electricity per month (in Rs)	Total Cost for DG per month (in Rs)	
ZTE V2 BTS	2.2	1605.1	529.7	2134.8	1707.8	427.0	13116.3	25617.7	38734.0
ZTE V3 Indoor BTS	2.0	1459.2	481.5	1940.7	1552.6	388.1	11923.9	23288.8	35212.7
ZTE V3 Outdoor BTS	2.1	1532.2	505.6	2037.8	1630.2	407.6	12520.1	24453.3	36973.3
ZTE SDR BTS	1.5	1094.4	361.2	1455.6	1164.4	291.1	8942.9	17466.6	26409.5

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TABLE II. PERCENTAGE OF COST SAVING IN PRESENCE OF OSW SITE DURING 1AM TO 5AM

Type of BTS	Total Power Consumption per Site per Month (KW)	Total power Consumption per Cell per Month (KW)	Total Cost per Site per month (Rs)	Total Cost per per Cell per month (Rs)	Total Cost of 8 Cells per month (Rs)	Total Cost per Cell per Hr (Rs)	Total Cost per Cell /month considering 5 Hrs per Day (in Rs)	Total Cost of 8 Cells / month considering 5 Hrs per Day	% Cost Saving for 8 Cells per month
ZTE V2 BTS	2134.8	711.6	38734.0	12911.3	103290.6	17.9	2725.7	21805.8	21.1
ZTE V3 Indoor BTS	1940.7	646.9	35212.7	11737.6	93900.6	16.3	2477.9	19823.5	21.1
ZTE V3 Outdoor BTS	2037.8	679.3	36973.3	12324.4	98595.6	17.1	2601.8	20814.6	21.1
ZTE SDR BTS	1455.6	485.2	26409.5	8803.2	70425.4	12.2	1858.4	14867.6	21.1

IV. CONCLUSIONS

The proposed cost effective solution to support capacity and coverage helps in effective utilization of BTS resources thereby reducing OPEX. The power consumption analysis reveals that 21% of cost on power could be saved while using OSW site during night times in the absence of neighboring sites. The partially covered nearest cells by OSW site should be ensured with sufficient coverage by neighboring sites else overall performance of the network may get affected. The proposed method may not be suitable when inter-site distances are very large.

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BIOGRAPHY

K R Sudhindra received M.Sc (Engg). by from Visvesvaraya Technological University, India in 2007. He is currently a Ph.D student of Department of Electronics and Communication Engineering, PESCE, Karnataka, India. He has total 6 years of experience in Telecom Industry. His research interests include operational research, signal processing & wireless communication.

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