Improvement of Indoor Receive Signal Code Power (RSCP) and Signal-to-Interference Ratio (Ec/Io) and QoS Evaluation in Operational Wireless Network Using Distributed Antenna System (DAS)

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Abstract. All Service Providers (SP) offering many services that needs to regularly measure the values of RSCP and Ec/Io. These two important Key Performance Indicators (KPIs) may assess their network performance and deliver Quality of Service (QoS) to meet both the end user perception and regulatory obligations. In this paper, a well-established real radio network performance evaluation is presented on the basis of Receive Signal Code Power (RSCP) and Signal-to-Interference Ratio (Ec/Io). The focus is to analyze live indoor network performance of the proposed network within the confines of Distributed Antenna Systems (DAS) irrespective of discussions and modelling in the literature. The Tests was carried out by TEMS Investigation, one of the most powerful tools for measuring the mobile wireless network Performance. Results and Analysis section summarizes findings and improvement on the two KPIs.

Keywords: 3G · WCDMA · CPICH · RSCP · RSSI · Ec/Io · QoS BTS · NodeB · DAS · UE · CSSR · SDCCH

1 Introduction

The Wireless Mobile Technology, is aimed to provide and handling high throughput Internet and multimedia traffic. As example it is based on Wideband Code Division Multiple Access (WCDMA) radio platform for 3G and Orthogonal Frequency multiple Access (OFDM) for 4G and 5G. Generally speaking the Access Technology has sophisticated radio interface with great flexibility in carrying and multiplexing a large set of voice traffic and data services with constant as well as variable throughput ranging from low to very high data rates with efficient support for carrying IP traffic [1]. NodeB coverage is designed for multiple services with largely different bit rates and QoS requirements. This necessitates the need for traffic classification based on QoS

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targets for different types of services. A large set of features and well-designed radio link layer modes to ensure very high spectral efficiency in a very wide range of operating environments from large macro outdoor cells to indoor cells is incorporated in the current and future network standards.

RSCP denotes the receive power of the primary CPICH (Pilot channel) as measured by the User Equipment [2]. In the RF front systems a physical channel corresponds to a particular multiple accesses through spreading codes. RSCP can be measured in principle on downlink as well as on uplink; it is only defined for the downlink and thus presumed to be measured by the User Equipment (UE) and reported to NodeB through an uplink channel. RSCP is very important parameter in WCDMA and it serves as an indication of signal strength, a handover criterion, in downlink power control, and also helps to calculate path loss. The relationship between RSSI and RSCP is given in Eq. 1 below:

$$RSSI[dBm] = RSCP[dBm] - \frac{Ec}{Io}[dB] \quad (1)$$

Where, RSSI is the Received Signal Strength Indicator and Ec/Io is the ratio of the received energy per chip (code bit) to the interference level in dB. Ec/Io is most important UE measurement for network planning purposes as it is the basic coverage indicator. In case no true interference (No) is present, the interference level (Io) is equal to the noise level. Ec/Io is also very important for handover decision. The value of Ec/Io varies such that if the value starts to get too low, the user start to have dropped calls, or cannot connect to the network. The value of network Ec/Io of −10 dB to −9 dB is considered to be good by network engineers.

2 Distributed Antenna System (DAS)

Providing uniformly very good Quality of Service (QoS) in a cellular system is challenging due to fading, path loss, and interferences [3]. One of the solution to this problem is to deploy a Distributed Antenna Systems (DAS) where the transmission points are distributed throughout the indoor environment following some type of network topology. The antennas may be connected directly to a nearby BTS or the signal from the BTS may be received off the air. The antennas are networked in the indoor environment using coaxial cable or Optic fiber Cable. DAS are wireless communications architecture where multiple transmission and reception points are connected to single processing unit normally called an equipment hotel. The antennas are spatially distributed in the indoor environment where the QoS improvement is expected as shown in Fig. 1 below.

The distributed antennas are connected to a home base station or equipment hotel using a high bandwidth low latency dedicated connection for distributing the signal to the splitters and then to individual antennas.

In future DAS is expected to dominate the indoor solutions due to the fact that DAS solution is inexpensive and easy to deploy as compared to competing technologies like Femtocells and Picocells [4]. DAS do not use wireless spectrum for transmission between the remote antenna and BTS. Compared to femtocells [5], the distributed

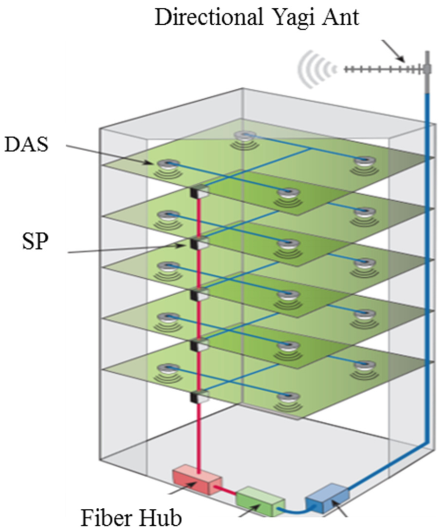

Fig. 1. Indoor DAS system topology

antenna are fully coordinated by a central processing unit normally connected in the site by the operator. Femtocells are a promising solution for improving coverage in residential areas where normally a Drive Test conducted by the Service Provider indicated very low RSSI or dead RF signal zones which resulted in drops calls and call blocking to be very high.

DAS are large scale solution for an entire building and public places while consumers can purchase Femtocells based on their requirements. DAS are also deployed targeting coverage first and then capacity as compared to Service Provider deployed Picocells that are hot spots targeting capacity improvement.

3 Test Configuration

The test was conducted in a sixteen floor Commercial Tower building where the traffic is very high during the normal working hours.

The Distributed Antenna Systems were networked using a network topology as shown in Fig. 1. The Distributed Antennas were installed in the ceiling of the building indoor, and connected using coaxial cable to a NodeB site on the rooftop of the tower building through splitters as shown in Figs. 2 and 3.

RF Measurements were conducted for the RSCP and Ec/Io in the building before and after the DASs installation. The RF measurement was done using TEMS (Test Mobile System) Investigation. The measurement platform is as shown in Fig. 4. TEMS is one of the state of art mobile testing solution that is universally used by telecoms operators to measure, analyze and optimize their mobile networks. It is considered as the basic tool to perform wireless network drive testing, benchmarking, monitoring and analysis. The TEMS Products business was divested to Ascom, Switzerland, on June 2, 2009 [6].

Fig. 2. Splitter connected to DASs and NodeB site on Tower Roof using coax cable.

Fig. 3. DASs installed in the ceiling of the building indoors connected to the splitter.

Fig. 4. Measurement Platform set-up.

Several locations were tested indoor for the RSCP and Ec/Io during the measurement. The tests were conducted before and after DAS installation in the building for comparison. The RF output plots for the Pre- and Post-DAS installation for the RSCP and Ec/Io are shown in Figs. 5(a), (b) and 6(a), (b).

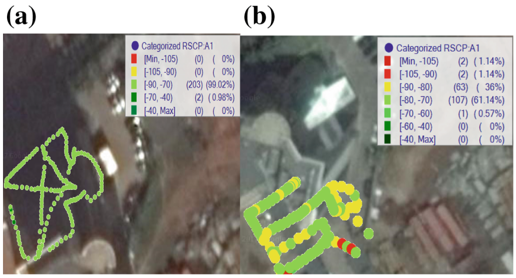

Fig. 5. RSCP RF Plot for Pre-DAS (a) and Post-DAS (b).

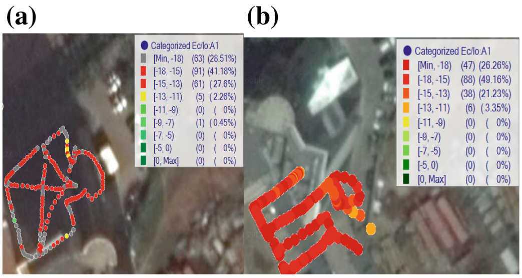

Fig. 6. Ec/Io RF Plot for Pre-DAS (a) and Post-DAS (b).

4 Result and Analysis

1. Call Setup Success Rate (CSSR)

Figure 7 shows the chart for Pre- and Post DAS Call Setup Success Rate (CSSR) for the network. The CSSR is the measure of blocking probability of a network. The lower the CSSR value the higher the blocking probability and vice versa. CSSR is the number of successful seizure of SDCCH channel by the total number of requests for seizure of the channel [7]. It can be seen that the Post-DAS measurement is much better as high as 98% as against Pre-DAS which was 40%.

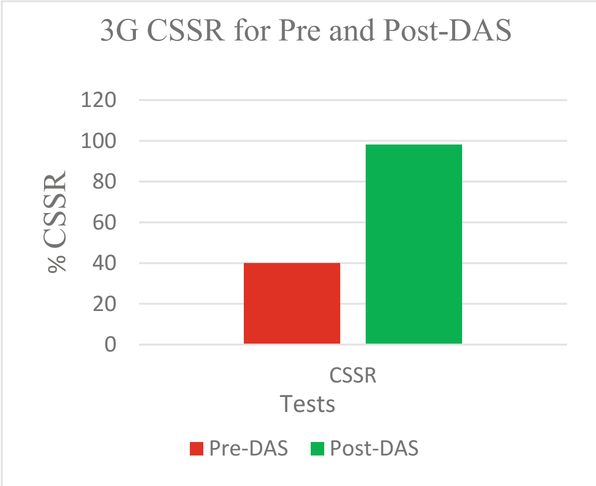

Fig. 7. Call setup success rate

2. Receive Signal Code Power (RSCP)

Figure 8 shows the chart for the RSCP. It can be seen that out of the total number of RF samples measured for the Pre-DAS case, 99.02% of the RF samples were greater than −90 dBm while 99.71% for the Post-DAS case. This indicated that Post-DAS RSCP is better.

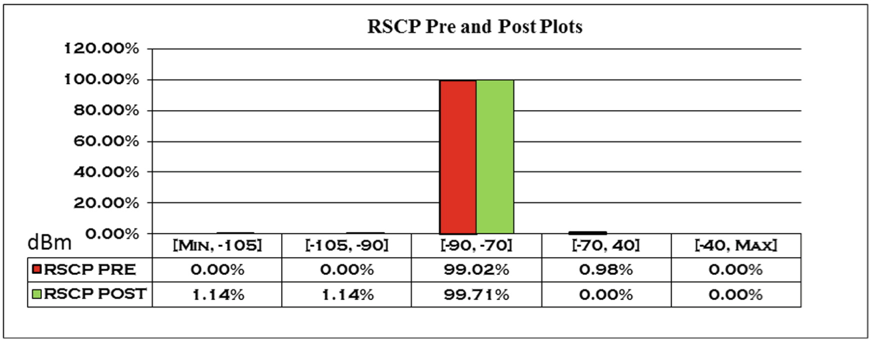

Fig. 8. RSCP chart for Pre and Post DAS

3. Signal-to-Interference Ratio (Ec/Io)

Figure 9 shows the Ec/Io chart in dB. It can be seen that the plot area between -15 dB to Max, the % of the post-DAS RF samples is higher by 2.7%, that is, (49.16% + 21.23 + 3.35 = 73.74% to 41.18 + 27.60 + 2.26 = 71.04%).

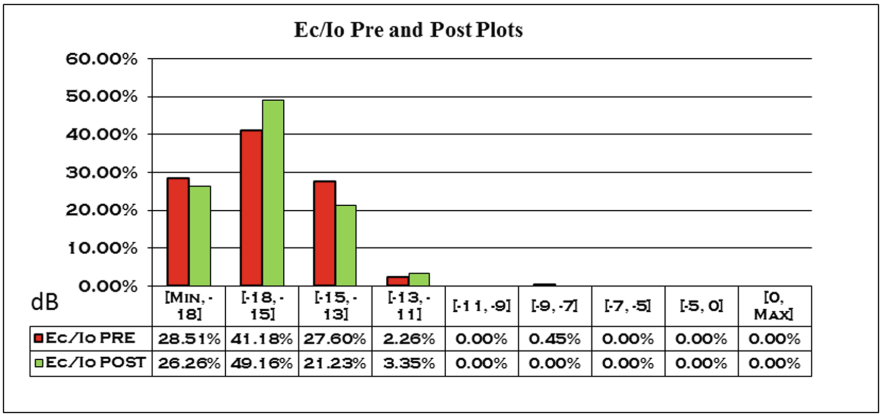

Fig. 9. Ec/Io chart for Pre and Post DAS

5 Conclusion

Practical deployment/ demonstration has proved that Distributed Antenna System is a promising technology for improving indoor coverage and capacity in 3G mobile wireless technology. Installation of DAS in high traffic areas like hotels, malls, railways, public buildings can improve QoS by minimizing call blocking probability and Bit Error Rate (BER). The study shows how DAS can improve both RSCP and Ec/Io which are two important Key Performance Indicators in delivering quality services that leads to better user Quality of Experience (QoE). Further study is needed to investigate effect of interference when multiple DASs are installed in a particular location.

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