**Signal Measurement Parameters and Methodology in Cellular Networks for GSM and CMDA Standards**

## 1. Introduction

This paper is a review of signal measurement parameters and methodology in cellular networks for Global System for Mobile Communications (GSM) and Code-Division Multiple Access (CDMA) standards using transceivers (TRX). GSM is a standard set to describe protocols for second generation digital cellular networks primarily intended to serve users in motor vehicles [1]. Unlike first generation analogue systems, GSM based digital mobile radio networks provide powerful message signaling capabilities that improve roaming capabilities through automatic network location detection and registration [2][3]. CDMA is digital air interface standard for third generation mobile networks. It significantly improves the capabilities of older analog methods with better transmission quality and allows simultaneous digital transmission of radio signals between a base station and a mobile telephone over a shared portion of the spectrum. Unlike GSM which assigns a specific frequency to each user, CDMA uses the full available spectrum where each individual conversation is encoded with a pseudo-random digital sequence [4], [5]. Signal measurement in GSM and CDMA is done based on several parameters such as signal strength, quality level, penetration and power level. Among these parameters, signal strength, quality level and power level tell the efficiency and effectiveness of a cellular network.

## 2. Underlying Technology and Implementation

The received power level and the received quality level in the both uplink (UL) and the download link (DL) are all made in the same TRX. The mobile station (MS) and the base station (BS) continuously measure these levels but these measurements are usually processed in the BS. Hence, MS sends its measurements through the signaling channels periodically. For measuring the power level in the BS-MS radio link, the propagation loss estimation plays a vital role. The propagation loss (L) is measured for both UL and DL by calculating the ratio of the transmitted power from the BS and the receiving power from the MS. The rate of propagation loss for both the UL and DL is computed by taking the ratio of L from UL and the L from DL. Power level for the signal is equal to the logarithm of this rate of propagation loss. To measure the Quality level in the BS-MS radio link, ratio of the normalized signal (power to interference) and noise ratio is calculated for both the UL and DL [6]. Finally, signal strength is measured by using the following equation: $S = \frac{10^{(\frac{p-G}{10})}}{1000} * \frac{4\pi}{\lambda^2}$ where p is the measured power (dBmW), λ is the wavelength of the transmitter frequency (m) and G is the antenna gain (dBi) [7].

To determine if a signal is of optimum quality and uses power efficiently, the two parameters calculated above have to lie within a certain range. If the measured quality level are equal for both the UL and DL, then the logarithm of ratio of quality levels for UL and DL is equal to 0dB. Also, power level has to lie between 0 and an offset β dB where the offset is a result of unbalanced interference between UL and DL. Power control algorithms are used to calculate these in the cellular networks [6].

The hardware needed to do these signal measurements involve the base stations and the mobile stations. Since BS are part of the cellular network, MS is the main tool built to analyze the parameters as it represents/acts our cellular device in the test environment. The MS includes a transmitter and a receiver (transceiver), control software, and digital signal processing algorithms for filtering and measuring. This is usually done on a separate chip which may be an embedded processor or an FPGA. A power source such as a battery powers these parts of the MS. These units can cost from several hundred dollars to a few thousand dollars and vary greatly in the market. For measuring the signal strength, a spectrum analyzer can also be used [7].

There are several devices currently available in the market which can perform signal measurement. For CDMA signal measurement, Anirutsu's Cell Master MT8212B [4] and Agilent Technologies' AN1311 are considered state of the art. For GSM signal measurement, Agilent Technologies' N9071A [9] is very good.

## 3. Commercial Applications

This information can help the wireless communications operators such as AT&T, Verizon, and Sprint etc. to make quick decisions on the optimization of the power control algorithm, handover strategy or frequency planning [4]. Other commercial applications include minimizing power consumption by the equipment used by these cellular networks, and increased signal strength and quality of the signals. This significantly increases the customer satisfaction for the user of cellular phones and helps in distinguishing the services of mobile operators such as AT&T, Verizon and Sprint etc. [1]

## 4. Conclusion

Analysis of Signal measurement parameters discussed in this paper is the key to building efficient and powerful cellular networks. The technologies mentioned here play a vital role in saving several million dollars for cellular network companies such as AT&T, Verizon, and Sprint etc.

## REFERENCES


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