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Experimental Analysis for BLER / Data Transmission Parameters in Mobile Terminals for EDGE and WCDMA Networks

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Abstract

This work presents the experimental results related to performance measurements in EDGE and WCDMA cellular data networks. Two Mobile Terminals were used, in order to take place the scenario. BER/BLER and Data transmission were the main parameters under consideration.

Keywords: EDGE, WCDMA, mobile terminals.

1. Introduction

WCDMA (Wideband Code Division Multiple Access) is a technology of third generation 3G that increases data transmission rates by broadening the signal at the air interface through the Multiple Access Code Division Multiplexing instead of Time Division used by GSM systems. WCDMA supports multimedia services with very high speed and full-motion video, Internet access and videoconferencing. It also easily handles applications that make use intensively of bandwidth such as data and image transmission via Internet.

In a communication system based on multiple access, an amount of users want to access the channel simultaneously. To implement a multiple access communication there are several techniques that allow users to share the channel. In the technique of multiple access code division -CDMA-, users can access the channel simultaneously and share the same bandwidth.

WCDMA is a spread spectrum technology [1], which expands the signals over a bandwidth of 5 MHz and is capable of carrying voice and data at the same time. These features allow a data rate of 384 Kbps in Release 5, and a transfer rate in the downlink of up to 2 Mbps in the Release 6, which includes HSPA, and average processing speeds (for file downloads) of 220-320 Kbps [2].

Spread spectrum is a technique used to transmit data on a bandwidth considerably larger. Its basic foundation is the "widening" of the transmitted signal over a very wide frequency band, much wider than the minimum bandwidth required transmitting the information that you want to send. This higher bandwidth can be obtained by encoding information with a pseudo-random signal. The coded information is transmitted in the frequency that works for which the sender uses a much higher bandwidth than no encryption is used (direct sequence). The spreading operation is the multiplication of each bit of user data with a sequence of 8 bits of code, called chips [3,4].

Currently WCDMA is the wireless access technology broadest deployed worldwide. WCDMA is a wide band system where the transmitted signal with a rate R is spread by combining it with a wideband spreading signal, creating a spread signal with a bandwidth W. The effective bandwidth for a WCDMA air interface is 3.84 MHz and with guard bands, as a result the required bandwidth is 5 MHz [4]. The WCDMA system uses several codes; when the signal is transmitted from the Base Station carries a unique code called Scrambling Code SC, used in the downlink direction for cell/sector separation. This SC is also employed in the uplink direction to separate every user from each other.

Cellular networks were created to transmit voice calls, but currently it is able to carry multimedia services like data and video. In the following section, the cellular communication generations are described.

1.1 *FIRST GENERATION (1G).*

The 1st Generation in cellular networks appeared in the market in 1979 and its principal characteristics were the analogical system and that was just for voice transmission. The quality of link was very poor; it had low speed, around 2,400 bauds. If we are talking about the transfer among cells it became imprecise, because its capabilities were low (It was based in FDMA (Frequency Division Multiple Access)), in addition these system did not have a security scheme. The most important technology in that moment was AMPS (Advanced Mobile Phone System) [1].

1.2 *SECOND GENERATION (2G).*

The 2G arrived in 1990, the most important characteristic in these technology is that it was digital [1]. The 2G system uses different coding protocols more sophisticated than the last generation and nowadays it is used by the current cell phone systems. The predominant technologies are: GSM (Global System for Mobile Communications); IS-136 (it is known like TIA/EIA136 ó ANSI-136), CDMA (Code Division Multiple Access) y PDC (Personal Digital Communications), this last one it is used in Japan.
The protocols employed in the systems 2G can support high speeds of transmitted voice, but it has a limit on data transmission. It is possible to offer auxiliary services like: data fax, SMS (Short Message Service). Most of protocols into 2G offered a lot of different coding levels. At United States 2G are known like PCS [1].

1.3 *THIRD GENERATION (3G).*

The main features of the 3G are the voice convergence and wireless access on data; in other words it can be used for multimedia applications and high bit data rates. The protocols have been used by the 3G systems can support high speed of transmission and it is focused to applications beyond the voice, just like audio (MP3), real time video, video conference and the quickly access to the Internet, this only to mentioning some of them.

2 PERFORMANCE PARAMETERS IN MOBILE TERMINALS IN EDGE AND WCDMA SYSTEM

The mobile terminal is a critical issue inside of a Cellular Communication System, due to its characteristics of transmission and reception; they defined the quality in the data and voice transmission. In this work, some experiments of the most important parameters in Mobile terminal were carried out. In order to make the experimental analysis for EDGE and WCDMA, the following scenario was deployed [2,3].

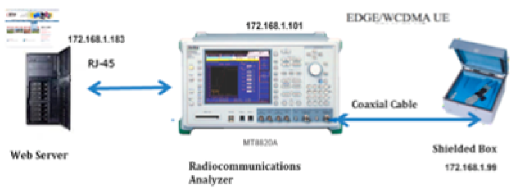

Figure 1. General Test Scenario for EDGE and WCDMA Measurements

2.1 *Experimental scenario*

The elements that are necessary to figure out the experimental scenario are:

- MT8820A Radiocommunications Analyzer, it has a range of frequencies between 30 MHz to 2.7 GHz, the range result enough to get the experimental measures into the cell phones. This equipment allowed getting measurements of Transmission/Reception in technologies like: W-CDMA/HSDPA, GSM/GPRS/EGPRS, cdma2000, 1x (IS-2000), cdma2000 1xEV-DO, PDC and PHS/ADVANCED. [2,3]

- A Shielded Box is used to avoid interferences from the surrounding Base Stations. Such device works between 800 and 2500 MHz, and gives 60 dB of isolation [2,3].
- Coaxial cable is used to connect the MT8820A to the Shielded box. Type-N connectors are used
- Two mobile terminals that operate in EDGE and WCDMA technology. (iPhone 3G and Nokia 6210).
- A USIM card is installed for the test. It was necessary to register the USIM with the Radiocommunications analyzer.
- A data Server (http) is connected into the same network segment that the MT8820A, and the connectivity between them is verified.

3 EDGE MEASUREMENTS

To implement the test scenario shown above (Figure 1) Radio analyzer was configured with the parameters shown in Figure 2.

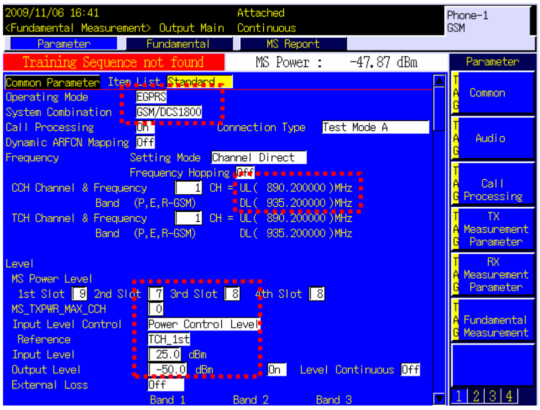

Figure 2. Parameter configurations for EDGE Technology

From Figure 2, we see that when EGPRS operation is selected, the power level of base station power is -50dBm, the power level of the Mobile Terminal is 25 dBm, the frequencies of the uplink and downlink are 890.2 MHz and 935.2 MHz respectively, and sets the power control, the power level received from the base station by the mobile is 7.89 dBm

In addition to GMSK, 8PSK is used by EDGE for higher modulation/coding schemes, this means that for every phase shift we can get a 3-bit word, resulting in three times the rate of transmission of GSM. EDGE uses an adaptive algorithm that adapts the transmission rate (scheme of modulation/coding) according to the radio link quality. This technology theoretically can carry data rates of up to 236.8 Kbps in 4 time slots in packet mode. EDGE is 4 times more efficient than GPRS. GPRS uses four coding schemes (CS-1 to 4), while EDGE uses nine schemes of modulation / coding (MCS-1 to 9) [4].

BLER Test Mode permits to estimate the error rate calculated by the mobile terminal and reported to the base station, it is recalled that BLER mode only transmitted GMSK modulation. Just as in GPRS, the BLER is the ratio between the numbers of blocks without acknowledge (errors in the transmission of the block) to the number of blocks successfully confirmed (block successfully transmitted) by the mobile terminal. Figure 3, shows the EDGE settings that are used.

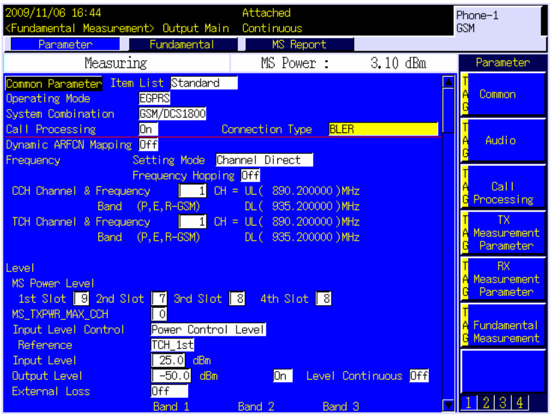

Figure 3. BLER TEST Mode for EDGE

For the BLER mode, two schemes of modulation/coding were selected: MCS-4, which has a GMSK modulation, and MCS-9, which uses 8PSK. The Mobile handsets (Nokia and iPhone) were connected to the MT8820A and its power level was continuously decreasing until we can observe errors in the screen. The results are shown in Table 1.

Table 1. BLER Test results

Terminal Mobile	**Scheme of modulation/coding**	**Minimum power level without errors**
Nokia 6120	MCS-4	-79dBm
Nokia	MCS-9	-69dBm

6120		
iPhone	MCS-4	-72dBm
iPhone	MCS-9	-64dBm

As we can see (the results in Table 1), MCS-9 is used to transmit a greater number of bits, but requires more power to carry out their work, while with MCS-4 needs lower power level and continues transmitting without errors. Figures 4 and 5 show the power level measurements.

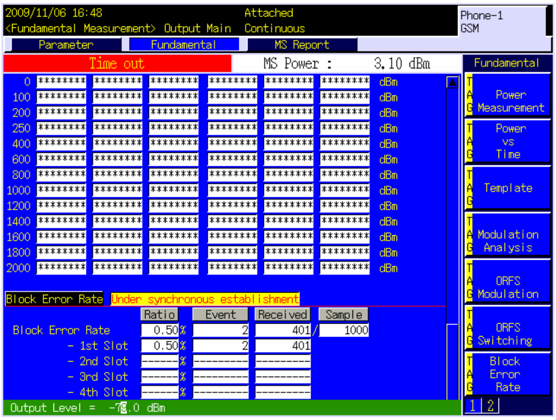

Figure 4. BLER Test with MSC-4

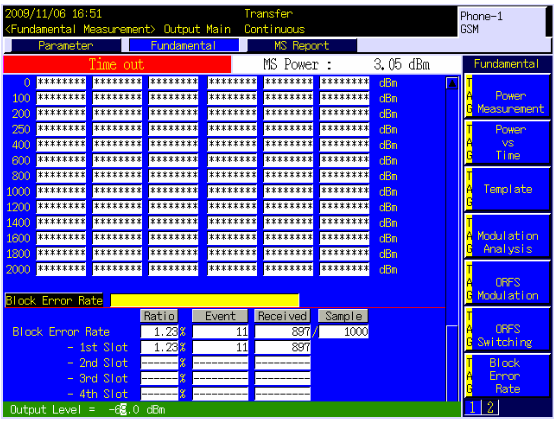

Figure 5. BLER test with MSC-9

Since EDGE can assign multiple time slots for data transmission, 4 slots for the uplink were configured (UL) and 1 slot for downstream (DL) with a MCS-9 scheme, but the power level to which errors were observed is -69 dBm (like the previous measurement). In the same way, when we configured a MSC-4 scheme with 4DL, 1UL; the power level to which errors occur is -79 dBm (like to that found with a single uplink and downlink)

4 WCDMA MEASUREMENTS

For the WCDMA measurements, the MT8820A were configured as follows (Figure 6);

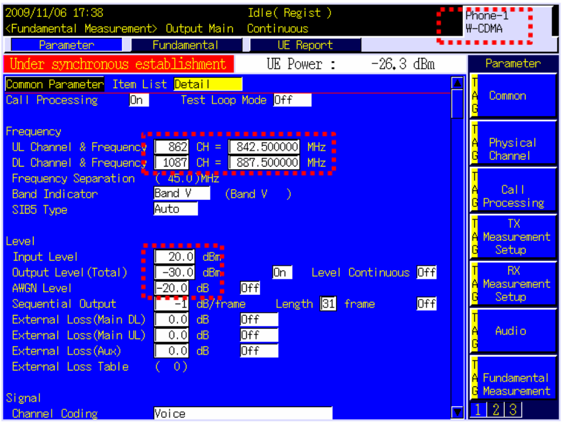

Figure 6. MT8820A configuration for WCDMA

For the testing of WCDMA, the band V of the UMTS channels is selected [5], corresponding to Mexico; the channels 1087 (887.5 MHz) and 862 (842.5 MHz) are used respectively for downlink and uplink. We used a power level of -30 dBm for the transmission of MT8820A

4.1 *BER/BLER Measurements*

As in EDGE, BER test mode is configured in the MT8820A and it proceeded to decrease the power level until we observe errors in the Analyzer. The Table 2 and Figure 7 show the results of the two terminals under evaluation.

Table 2. BER/BLER results

User Equipment	Power level without errors	Power level with errors
Nokia 6120	-80dBm	-82dBm

iPhone	-74dBm	-75dBm

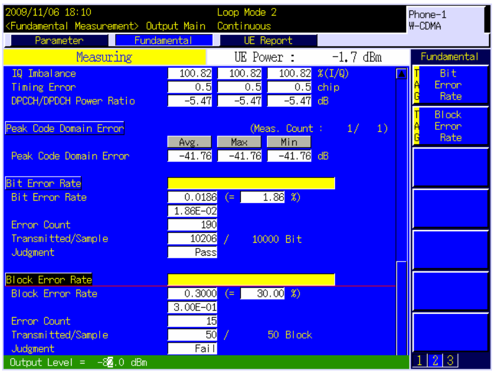

Figure 7. BER/BLER results for Nokia 6120

4.2 External Data Measurements

As with GPRS and EDGE, WCDMA technology allows data transmission tests from an external server to the mobile terminal via PPP and IP connections. Radio Analyzer (MT8820A) enables communication between a server and a client using the air interface of the mobile terminal. The scenario is shown in Figure 1.

For this test, the following parameters were configured in the MT8820A [4]

- ✓ The IP Default Gateway field is set to 0.0.0.0
- ✓ Call Processing parameter must be enabled,
- ✓ The Test Loop Mode must be disabled and
- ✓ The Channel coding must be Packet, to indicate that we establish a data session.
- ✓ The IP addressing is shown in Figure 1.

Subsequently, we introduce the mobile terminal within the shielded box and the Analyzer proceeds to Register the equipment under test, and once this is done, the Communication mode is set indicating that the equipments are linked and data transfer can take place. In this case, due to the characteristics of the measuring equipment, we can only test the downlink 384 Kbps theoretical speed [6,7]. The power level configuration of the base station and mobile terminal was carried out according to what is specified in Figure 7. Once that is done all the configuration and connectivity testing, we proceed to the download of information from a local web site to test the transmission rates using different coding schemes.

The user equipment downloaded a file (200KB) from a local web server (Figure 1). Table 3, shows the results of the test.

Table 3. Data rate for WCDMA

Size of the File (KB)	Size of the File (bits)	Time of Transfer (seg)	Rate of Measured Transmission (Kbps)	Rate of Theoretical Transmission (Kbps)
200	1600000	5.67	292.68	384

As we can see, there is a difference between the data rate measured and data rate theoretical provided by the WCDMA downlink. As with GPRS, the information added by the IP transmission, as well the WCDMA air interface caused an increase in the amount of information transmitted in the communication, which influence the transmission rate measured.

5. Conclusions

In this paper is shown the experimental results done to the two mobile terminals in EDGE and WCDMA systems. Measurements were based on BER/BLER and data transmission. In first place, we were able to find out the minimum power level, which user equipments can transmit without errors. This fact is too important for planning the cell dimension for EDGE and WCDMA networks. In the other hand, as shown in the Table 3, the measured results differ from what shows the specification. This difference can be attributed to any of the following.

- ✓ The headers and trailers added by each of the layers in the IP segment (TCP, IP, Ethernet, Physical Layer) as well as the wireless segment of EDGE and WCDMA.
- ✓ Different processing capabilities of mobile terminals.
- ✓ Network Congestion.

The limit power is an important data for designing and planning of a radio network. This task established the tests for a deep analysis from the point of view of coverage in capacity of radio. In future tasks analysis of capacity in transmission will be presented depending on the distance, slots and modulation schemes. It should be remarked that this kind of research is important, due to their results has a great impact at different levels; like that planning, research, manufacturing, scientific and academic areas.

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