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Experimental Investigation of the Performance of the WCDMA Link Based on Monte Carlo Simulation Using Vector Signal Transceiver VST 5644

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Abstract
WCDMA is wideband digital cellular technology used for third Generation (3G) cellular communication. This paper evaluates experimentally the performance of wideband code division multiple access (WCDMA) by using the Monte Carlo simulation based technique. The generated output of the WCDMA link using VST 5644R is used to collect random samples of EVM at the different frequency bands 1800MHz and 2100 MHz at QAM and QPSK modulation schemes and then the link up time probability is being calculated from the statistical data obtained experimentally from Vector Signal Transceiver. The results obtained shows that WCDMA link based on QAM modulation out performs QPSK.
Index Terms- *Code division multi-access, digital modulation, Error vector magnitude (EVM), VST-Vector Signal Transceiver, phase-shift keying (PSK), quadrature amplitude modulation (QAM).*

Introduction

Third generation system are designed for multimedia communication at high data rate. WCDMA technology is the most widely used third generation system which is spreading over a wide bandwidth by multiplying the user information with spreading sequence in WCDMA[1]. Due to increasing the demand of high data rate, more complex modulation schemes are used in various wireless communications resulting tightened error vector magnitude (EVM) requirement[5]. For example, 64-QAM on LTE requires 8% of the minimum EVM level and 256-QAM on 802.11ac will adopt 2.5% of the EVM limit[2]. Error vector magnitude of system requires low value for complex modulation schemes. The error vector magnitude of system depends on the spreading factor. Spreading factor used to support high bit rate and mitigate the effect of inter-symbol interference. The main property of the spreading code is that they need to orthogonal to each other[3]. Using the low value of the spreading factor, the error vector magnitude of the system is increase. Using the high value of the spreading factor, the error vector magnitude of the system is decrease. The aim of this paper was to precisely evaluate the performance of WCDMA system with different Modulation schemes. WCDMA is designed to allow many users to share the same RF channel by dynamically reallocating data rates and exactly match the demand of communication link of each user in the system [5]. WCDMA is wideband code division multiple access system. As different from Time division multiple access (TDMA) is that in WCDMA all users transmitting at the same time. Frequency divisions are still using in WCDMA because they provide very high bandwidth. During transmission of the signal, the each user's using the same frequency carrier with a unique code that appear as noise to all except the correct receiver. Correction technique allow at a receiver to decode one signal among many signal that are transmitting on same carrier frequency at same time[4][5]. In WCDMA, each base transceiver station (BTS) output signal from all of its data channels multiplied with unique pseudo noise

(PN) code, referred to as a scrambling code. The users equipment (UE) receiver can differentiate one BTS from another by correlating scrambling code that unique provided to each BTS's. Similarly, each UE output signal is multiplied with a unique scrambling code that allows the BTS receiver to differentiate one UE from another. The scrambling code with fixed chip rate 3.84 Mcps is applied. The scrambling code is not independent code, the two user equipment having same scrambling code. The WCDMA radio link between BTS and UE have multiple data channels like video, packet data, bi-directional voice and background signalling messages, each represent a unique data channel with same carrier frequency. A BTS will transmit unique channels to many mobile users, and each mobile receiver distinguish it own channel from all other channels by using channelization codes, known as orthogonal variable spreading factor (OVSF) codes. Each channel originating from a BTS or from UE multiplied with different OVSF code also known as spreading factor. The length of OVSF code in WCDMA varies from 4 to 512 chips. The resulting downlink bitrate equal to system chip rate (3.84 Mcps) divided by the spreading factor (SF).

The scrambling codes allow reusing of spreading factor code among UE and BTS in same or different geographical area. The combination of scrambling code and spreading factor provide a unique communication channel between UE and BTS. During WCDMA communication, we used different modulation scheme like BPSK, 16QAM, 64QAM according to his transmission rate requirement. In BPSK modulation, they transmitting user data by using two phase of the carrier frequency. For example, if user data bit is '0' then they used 0^0 phase of carrier signal. If user data bit is '1' they used 180^0 out of phase of carrier signal. In QAM modulation, they generate output carrier frequency signal by varying phase with amplitude. In WCDMA we use 16QAM, 64QAM modulation. For high data rate communication, we used 64QAM, 16QAM modulation. For low data rate communication we used BPSK modulation. Two mode of communication used in WCDMA, Frequency division duplex (FDD) mode and Time division duplex (TDD) mode. In FDD mode they equal dividing the bandwidth allocation to the user during simulation transmission between users. In TDD mode they use same bandwidth during communication between users but different time period.

For practically checking the performance of WCDMA, we use the VST (Vector Signal transceiver) 5644R device. The NI Vector Signal Transceiver combines radio frequency Input/output functionality in traditional box which contain Vector Signal Analyzers (VSAs) and Vector Signal Generator (VSGs) along with user defined functionality implemented on Field Programmable Gate Array (FPGA). The two independent local oscillators used for RF input and RF output coverage from 65 MHz to 6 GHz and bandwidth up to 200 MHz [4][5].

Simulation Set-Up & Results

Figure 1 shows the Experimental arrangement for WCDMA LINK Evaluation using VST 5644R

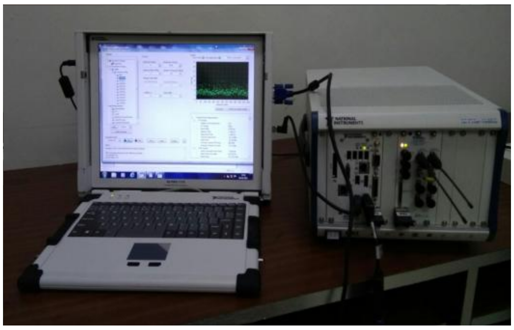

Figure 1: Experimental arrangement for WCDMA link using VST 5644R

This real time simulation is based on the real time experimentally collections of the random samples at different frequency bands of 2100MHz and 1800 MHz at QPSK and QAM Modulation scheme using VST based on WCDMA pre designed link and then Calculating the overall probability of the network to obtain the link up time.

After checking the output performance of the network in the EVM form, then we check the probability of network to attain the threshold value. This can be done by collecting number of sample at same frequency band with same modulation scheme at same spreading factor. After collecting that samples, we plot the scatter diagram to check the probability of the network to provide high performance. We select 'X' axis with number of samples and 'Y' axis with EVM value. Figure 2-5 show the scatter plot based on Monte Carlo simulation. The acceptable value of SNR ratio is 7 decibels. Maximum EVM value that corresponds to minimum acceptable SNR value of 7 decibels is 45.Figure 2 shows the Scatter plot at 1800MHz using BPSK, we note that there are 8 sample values for which EVM is more than45 ,so for these eight samples the link will be disrupted so probability of link up time is 77 percent for BPSK at 1800MHz.

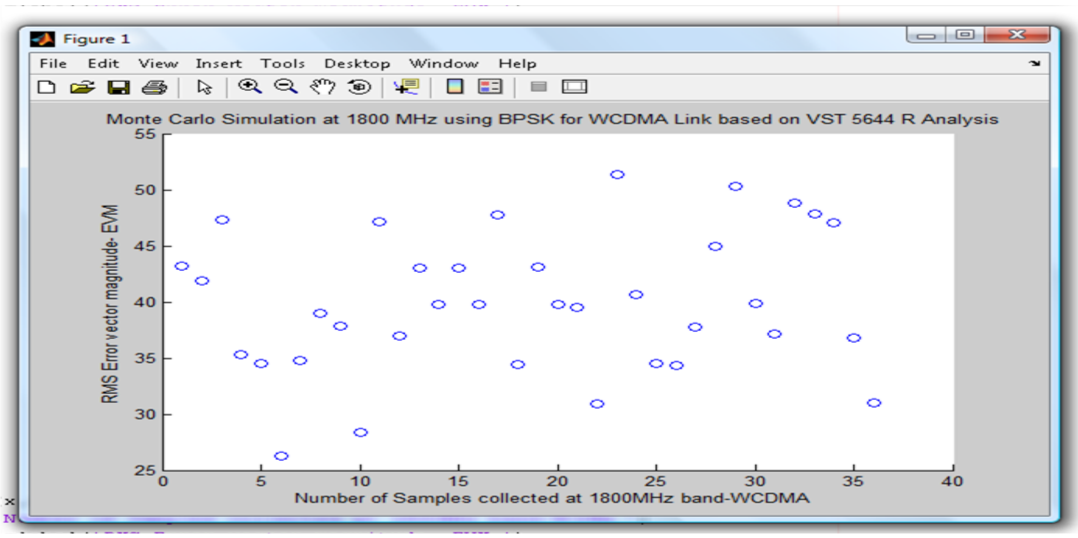

Figure 2 : Scatter plot at 1800MHz using BPSK

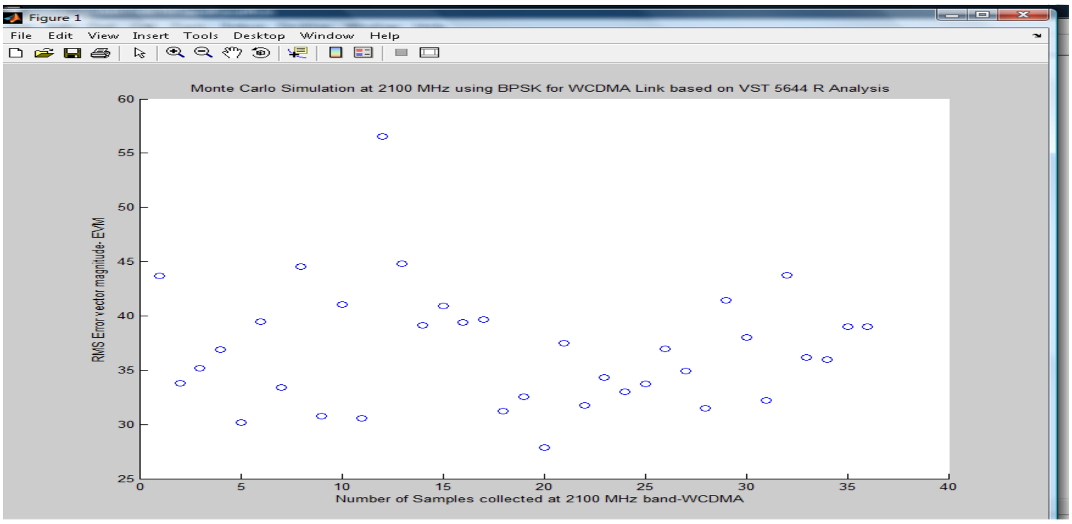

Figure 3: Scatter plot at 2100MHz using BPSK

Similarly the results shown in figure 2-5 shows that the link up time probability for 16 QAM at 1800 MHz and 2100MHz is approximately 99.2 percent.

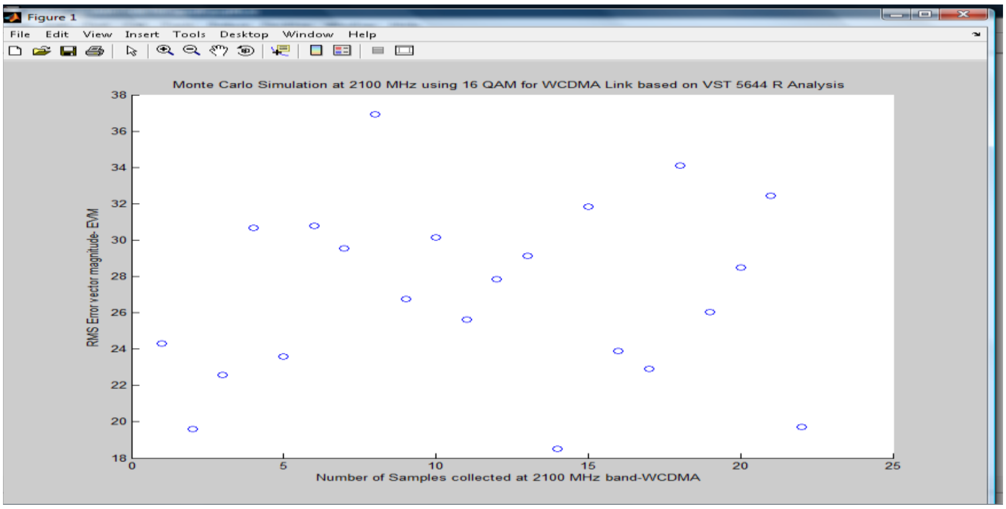

Figure 4: Scatter plot at 2100 MHz Using 16 QAM

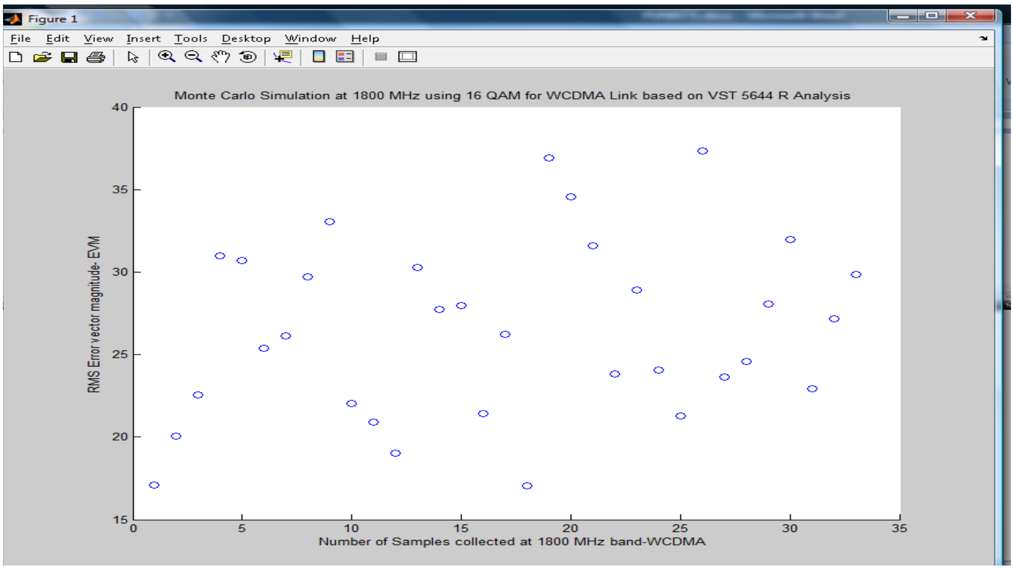

Figure 5: Scatter plot at 1800 MHz Using 16 QAM

Conclusion

The performance of WCDMA is analysed experimentally by considering various bandwidth with different modulation schemes like QPSK and QAM. It is concluded from the simulation results that the WCDMA link designed using 16 QAM have given far better results and up time link probability using 16 QAM is 99.2 percent wchich is better than QPSK.

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Gaurav Soni received his B-Tech Degree in Electronics and Communication from Punjab Technical University, Kapurthala in the year 2005 and M-Tech Degree in Electronics and Communication from D.A.V.I.E.T, Jalandhar. He has more than ten years of teaching and research experience. He has to his credit 81 research papers in various refereed international journals like JOC and IEEE conference Proceedings. He investigated a high-speed optical transceivers and electrical-optical circuit board (EOCB) technology for chip-to-chip optical interconnects. He completed his master thesis in the latest field of research in Free Space Optical Communication. He designed a Free Space Optical Communication Link with speed of 2.5Gbps. His research interests are Wireless communications, next generation optical access networks, high-speed optical transmission systems, and Optical wireless communications. He is currently working as Associate Professor in Department of Electronics and Communication Engineering, Amritsar College of Engineering and Technology, Amritsar. He is a member of the IEEE and ACM, OSA. He has served as reviewer to IEEE Journal of Lightwave Technology, reviewer and editor of Advances in Science, Technology and Engineering Systems Journal, He has served as the reviewer to various IEEE conferences like CSNT 2016.gaurav.ece@acetedu.in

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