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Survey on software defined radio platform for MIMO-OTA measurement and its Testing applications.

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ABSTRACT

A radio system is classified into SISO(Single input single output),SIMO,MISO and MIMO. In radio the SISO system uses an antenna in the transmitter and receiver. The SISO systems are typically less complex than the MIMO(Multiple input Multiple Output)systems. In this paper we are presenting a 2 × 2 MIMO OTA measurement system. FPGAs are used for applications like signal processing, image processing, communications and control systems. The SDR are radios that provide software control on a variety of modulation techniques In this system real-time FPGA(Field programmable gate arrays) based software-defined radio are used. Vestigial signal transceivers are used for the signal generation and channel emulation. Many different MIMO OTA test methods have been proposed. Wireless communication industry groups such as Third generation partnership project (3GPP) and international association for wireless telecommunication are working on the standardization of the two-stage MIMO OTA. The test equipment we are using is the (TD-LTE) duplex scheme.

Keywords: MIMO,3GPP,SDR,TD-LTE.

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INTRODUCTION

The use of wireless communication has become imminent in the modern world. SDR is a collection of hardware and software technologies that enable reconfigurable system architectures for wireless systems. The main advantage of the SDR is that it is inexpensive and provides an efficient solution to the problem of building multimode, multi-band, multifunctional wireless devices that can be adapted, updated or enhanced by using software upgrades.

The effective use of wireless communication has encouraged the use of extensive research on the development of MIMO system for wireless communications. It is important to perform the testing on these systems. There are different methods for testing the Multiple-input-multiple-output systems [1]-[4]. Since the transmission and reception takes place from one end to the other to understand this concept OTA testing is required. The testing of the MIMO system is done by the TD-LTE. The capability of equipment required for testing the MIMO under the 4GLTE and the COST action [5]-[6] prove the traceability issues are incomplete.

Furthermore, nowadays the test equipments are made user programmable and reconfigurable because they provide fast evaluating and can implement various algorithm. Hence Field programmable gate arrays (FGPA's) based software defined radios are used by the 3GPP which have been dominant in the modern world wireless communications. The 2 × 2 MIMO OTA FGPA based SDR presented in this project consists of a channel emulator, signal analyzer and these are implemented using vestigial signal transceivers (VST'S).The VST is the combination of a 2 signal generators and 2 signal analyzers. The channel emulator is responsible for fast evaluating and enabling flexible traceability. It can be operated in 2 modes, the scholastic mode and the deterministic mode. In this paper we are going to treat the channel emulator in the scholastic mode.

An Interim Channel Model for Beyond-3G Systems

Daniel S. Baum et al has proposed an interim channel model for systems beyond 3G systems. This model comprises of a spatial channel model which is comprehensive to the frequency bands 2 and 5HZ and also in environments with three different outdoors it supports up to 100MHZ bandwidths. It can be further applied in delay line model tapped with reduced variability which results in improved accessibility in comparison and calibration simulations. It also has a feature to challenge advanced algorithms on communication using the system level parameters of the time evolution.

Many multiple input and multiple output wireless techniques have drawn large attention in the recent years regarding their development and research due to their benefits in throughput, spectral efficiency and quality of service. However, the technologies which has been considered for inclusion in wireless communication are IEEE 802.11n for wireless LANs (WLAN), IEEE 802.16 for broadband fixed wireless access (FWA), and 3GPP high-speed downlink packet access (HSDPA) for cellular mobile communication

The SCM is a ray-based model and also a geometric model. It is based on assumptive scattering models. It mainly defines three environments namely the Urban Micro Suburban Macro and the Suburban macro where Urban Micro is differentiated in line-of-sight (LOS) and non-LOS (NLOS) propagation. A fixed digit of paths are present where each one correspond to a Dirac function in delay domain, though these make up to 20 distinct sub-paths in admittance the sinusoidal sums method. Factors like angular properties, path delays and path powers are developed as a random variables for either sides of the link. The probability density functions (PDFs) are generated using the defined cross-correlations. Rest all parameters, except for fast-fading, are used in communications which do not depend on time and usually termed as drops.

MID PATH POWER-DELAY PARAMETERS

Urban Micro		Suburban Macro, Urban Macro		Scenario	
4		3		No. mid-paths per path	
0 ns	6/20	0 ns	10/20	1	Mid-path power and delay relative to paths
5.8 ns	6/20	7 ns	6/20	2	
13.5 ns	4/20	26.5 ns	4/20	3	
27.6 ns	4/20	-	-	4	

The idea of drops can be viewed in SCM as comparatively a powerful separation of periods in short channel regarding the space or time in a way that the parameters of the channel become distinct and independent during the process. This type of concept is extended virtually in terms of lengths by summing up with the short-term time-variability of some channel factors within the drops. These channel factors do not dependent between the drops. The following are the consequences of the model short channel observation periods that are significantly separated from each other in time or space such that the channel parameters become constant and independent during these periods. Our approach is to virtually extend the lengths of these periods by adding short-term time-variability of some channel parameters within the drops. All channel parameters remain independent between drops. The three effects we model are

a)Drifting of Path Delays and Angles
b)Drifting of Shadow Fading
c)Tapped Delay-Line Model

Simulation Models With Correct Statistical

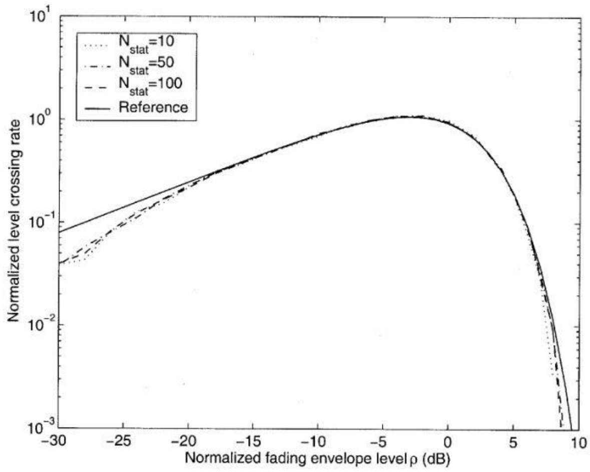
Properties for Rayleigh Fading Channels

Yahong Rosa Zheng et al 2003 has proposed a sum of sinusoidal models on simulation based on statics for the Rayleigh fading channels. The specified models are applied to random Doppler frequency conditionally, random gain in path and random initial phase for all sinusoids individually. The results show that cross correlations and autocorrelations of the orthogonal components and the composite envelope of the unique imposter which match the required ones even when the quantity of sinusoids is really small as that of one digit number. Furthermore, the probable density process of the phase and envelope, the mean fade duration, the level crossing rate and the autocorrelation of the quadratic fading envelope containing squared statistics of the imposters. These asymptotically relate with the exact ones as the quantity of the new imposters reaches further to infinity but the better convergence is obtained though the quantity of sinusoids is really small. The output simulators can be used in multiple-input multiple-output channels, for multiple uncorrelated fading waveforms generation for frequency selective fading channels and diversity combining scenarios. These statistical factors can be calculated by mathematical results.

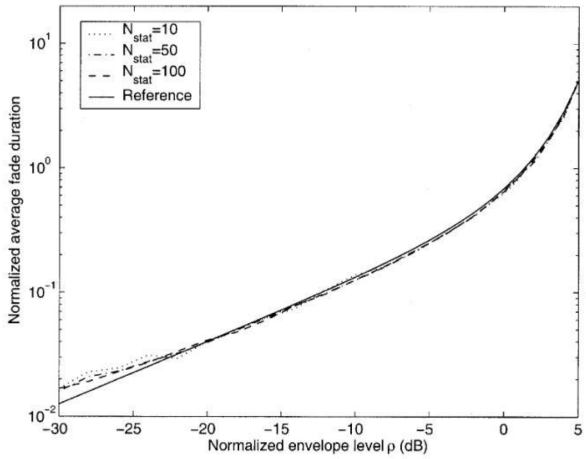
Generally the mobile radio channel imposters used in laboratory as the can be used in the laboratory because they allow system tests and assessments which are inexpensive and are reproducible than the other related work. Many methods have been introduced for the simulating and designing of the mobile radio channels. Comparing all the results the model developed by *Clarke* and its reduced model by *Jakes* have been used widely for their Rayleigh properties in fading channels. Though the Jakes model for simulation is an intended setup, it has problems in generating no correlation waveforms in multiples for a frequency selective channel and also in MIMO channel. Hence a different modifications and corrections are required.

In this paper, a unique summing of the sinusoids in mathematical simulation model was proposed for Rayleigh fading channels. As compared to the Jakes' summing of the sinusoids a intended model and its corrections, the new model puts forth the indirect achievement to gain in path. It is observed that the initial phase and the Doppler frequency has a no intended simulator with better mathematical properties. It is also declared that the quadratic components' cross correlations, and the autocorrelation of the complex envelope of the unique imposter corresponds to the required ones exactly, though quantity of sinusoids which are used to produce a fading channel is small as a digit integer.

It has also shown the LCR(level crossing rate) and AFD(average fade duration) for a fading envelope.



Lcr of simulated fading envelope



ACD of simulated fading envelope

It has shown that the autocorrelation of the orthogonal envelope, which had fourth type of statistics, the LCR and ACD of the unique simulator corresponds to the numerical model as the quantity of the sinusoids as they reach infinity along with better convergence. The output simulator is been calculated using extensive results using all the mathematical factors with accomplished agreement in all situations except the phase of fading. It is observed that with unchanged statistical factors the proposed model of simulation can be redesigned in distinct ways using other alternatives. It is also pointed that the new model of in simulation can be used directly to produce uncorrelated multiple fading waveforms which are required to analyze some original frequency selective fading channels, diversity-combining scenarios and MIMO channel.

MIMO-OTA research development and testing

The simulation reports for MIMO OTA systems for the examination of performance statistics has become a very popular research in recent years. The wireless association(CTIA), the European cooperation in science and technology(COST) and the third generation partnership project(3GPP) have often been conducting tests on the standardization of MIMO from the past few years. The need to develop precise, realistic and economical test standards for LTE has forged the development of MIMO. Despite the availability of MIMO systems there is burden to finish the test standards by 2012. the

The MIMO systems were developed 2 years after the origins of the systems, however there are no test standards for testing the performance. The development of test standards is difficult in MIMO systems when compared with SISO OTA systems and the standards are require much time to develop. The MIMO systems interacts highly on the receive antennas of the UE and the propagation characteristics of the radio channel unlike SISO systems. these systems have relatively straight forward approach. MIMO test methods had been proposed depending on the factors like propagation channel characteristics, size, and cost.

The main challenge of the optimal channel models and test standards is to find one test methodology which is standard . Modern developing standards activities are concerned if the proposed test standards relying on the goal to provide systems that are able to differentiate the good from bad MIMO systems. The motive of this issue is to provide a valuable source of information for the state of this important research area.

MIMO STANDARDIZATION ACTIVITIES

The SISO OTA standards were developed by the CTIA in 2001 and the MIMO OTA standardization methods have been developed by the 3GPP. The SISO OTA consists of two figures of merit (TRP) total radiated power and (TRS) total reference sensitivity. Since its inception of MIMO systems, and introduction of spatial multiplexing the methods proposed by SISO OTA can no longer be applied for the MIMO systems. Hence, the reverberation chambers for MIMO device testing have been implemented by the late 2007. Later in April 2009 the CTIA introduced the anechoic chambers to study the development of MIMO.

In March 2009 The MIMO OTA worked together with the COST action 2100 and approved the study “Measurement of radiated performance for MIMO and multi-antenna reception for HSPA and LTE terminals”.

Test Plan for 2x2 Downlink MIMO and Transmit Diversity Over-the-Air Performance

Purpose

The purpose of this paper is to define the CTIA Certification program test methodology for radiated performance measurements of LTE 2x2 downlink MIMO wireless devices. This test plan also includes methods for assessing radiated performance of non MIMO operation.

Scope

General requirements for the test plan requires equipment configurations, test systems, test configurations, laboratory techniques, test methodologies, and evaluation criteria in order to ensure the repeatable, accurate and uniform testing of wireless devices capable of supporting LTE **2x2** downlink MIMO. In Future developments will include the test methodologies, equipment configuration and evaluation criteria required to assess the EUT’s transmit diversity performance. This test plan provides basic test equipment configuration and high level test procedures information but does not include details of test instructions by which to execute certification testing. These procedures must be presented by the CTIA Authorized Test Lab (CATL) as part of the CTIA authorization process and subsequently employed and maintained by the CATL to remain authorized to perform Certification testing.

Overview

Wireless devices like MIMO spatial multiplexing is supported by the Downlink 2x2 MIMO receiver implementations to support data rates almost twice as high as the data rates available from a 2x1 MISO downlink. In spatial multiplexing, the device's serving network simultaneously transmits two independent, spatially-diverse data streams to the wireless device ,due to this technique the higher data rates occur . *The full benefit can be of spatial multiplexing can be utilized if the wireless device must be able to differentiate between the two downlink data streams*. The Radiated Downlink 2x2 MIMO performance can be assessed , the MOSG's test methodology creates a standardized spatial channel within the test zone, with characteristics similar to real-world radio environments.

Proposed Work

The difference between a Traditional radio and a software defined radio is that a SDR can locate satellites nearby us in less processing time. A SDR can locate satellites nearby us by using the autocorrelation process and the cross correlation process. Field programmable gate arrays are used as reconfigurable architecture so that the system can be used for various applications.

CONCLUSION

In this paper we have presented various test standards for the MIMO systems **.**The correlation scheme is used because random (RAW) data cannot be transmitted over the satellite.The data between [0-5v] cannot be transmitted over the satellite.0 is to be represented as -1 and 1 is to be represented as 1 to produce higher signal strength. In order to identify which satellite is near us we should check which satellite has higher signal strength.

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