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Performance Study of Fifth Generation Scalable Channel Emulator for Wideband MIMO Systems

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Abstract: The number of wireless devices, diversity of communication standards and class of modulation schemes area unit increasing dramatically annually. The Fifth Generation (5G) cellular communication system is calculable to arrive around 2020. The goals of 5G area unit to attain ten to one hundred times higher typical user knowledge rates, starting from one to ten Gbps in dense urban environments. With every resultant generation of technology, the value of testing wireless devices mistreatment the normal techniques additionally has enlarged. Wireless channel emulation is turning into more and more vital, notably with the arrival of multiple-input–multiple-output (MIMO) systems, wherever system performance is very enthusiastic about the correct illustration of the channel condition. As technology moves forward to require advantage of a lot of advanced channel characteristics like MIMO, the channel modeling required to accurately emulate the radio surroundings becomes even a lot of crucial to a check setup. A large effort has been taken by American state to style a vast MIMO (16X20) channel human to accurately emulate the radio surroundings for testing subsequent Generation Network (NGN) by generating most range of noise samples and achieving a most delay unfold and providing a most range of channels. The design specifications area unit obtained mistreatment MATLAB. The alpha-lipoprotein cryptography is carried for the look to be enforced on Altera FPGA.

Keywords: MIMO, channel emulation, Altera FPGA.

I. INTRODUCTION

Future wireless communication system must be designed to integrate options like high knowledge rates, prime quality of service and multimedia system within the existing communication framework. These options and particularly higher knowledge rates is achieved by the employment of Multiple-Input Multiple-Output (MIMO), additionally called terribly massive MIMO or Full-Dimensional (FD)-MIMO. It's associate degree antenna technology that's used each in transmission and receiver instrumentation for wireless radio communication.

MIMO takes advantage of multipath. There are numerous MIMO configurations. Radio channel emulators or radio channel simulators square measure tools for air interface testing in wireless communication.

In a very check atmosphere, radio channel emulators replace the real-world radio channel between a transmitter and a receiver by providing a pale illustration of a transmitted signal to the receiver inputs. The radio channel imitator should have channel models that accurately simulate multiple antenna performance, together with correlation between antenna components

It is argued that within the current text of disruption of rising technologies huge 16 X 20 MIMO channel imitator is that the most suitable option for testing future generation wireless evolution for 5G.

II.RELEATED WORK

Debbah .M and Muller. R [2] planned theoretical grounds for constructing channel models for multiple-input multiple-output (MIMO) systems supported information-theoretic tools. The paper provides a general methodology to derive a channel model that is in keeping with one's state of information. Cui.S et.al [4] planned channel estimation in MIMO wireless communication systems play a key role within the performance of the house time decoders that depends on the accuracy of the channel data. During this paper the study of the performance of the MIMO channel estimation victimization coaching sequence is administered. The smallest amount sq., MMSE and new scaled least sq. approaches to the channel estimation are studied and also the elective alternative of the coaching signals is investigated for every of those techniques. Saux et.al (2006) planned a MIMO system with OFDM has larger potential like reduction in inter-symbol interference, decrease in weakening and increase in information measure and increase in knowledge rates. The performance of MIMO system degrades because of inaccurate channel estimation over frequency selective fast-varying channels. Pilot-aided turbo channel estimation improved by addition of linear algorithmic rule within the repetitious method is mentioned. This improves the channel estimation and reduction within the use of range of pilots

III. MIMO IN WIRELESS COMMUNICATION

In radio, multiple-input and multiple-output, or MIMO is that the use of multiple antennas at each the transmitter and receiver to enhance communication performance. Multiple associate degreetennas could also be wont to perform good antenna functions like spreading the overall transmit power over the antennas to attain an array gain that incrementally improves the spectral potency or achieving a diversity gain that improves the link responsibility or both. However, these days the term "MIMO" sometimes refers to a technique for multiplying the capability of a link by exploiting multipath

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propagation. This contemporary MIMO is a vital component of wireless communication standards like IEEE 802.11n (Wi-Fi), IEEE 802.11ac (Wi-Fi), 4G, 3GPP long run Evolution (LTE).

IV. MATHEMATICAL DESCRIPTION

In MIMO systems, a transmitter sends multiple streams by multiple transmit antennas. The transmit streams undergo a matrix channel that consists of all NTNr ways between the Nt transmit antennas at the transmitter and Nr receive antennas at the receiver. Then, the receiver gets the received signal vectors by the multiple receive antennas and decodes the received signal vectors into the first info. A narrowband flat attenuation MIMO system is sculptural as

$$y = Hx + n$$

Where y and x receive and transmit vectors, respectively, and H and n are the channel matrix and the noise vector, respectively.

V. MIMO TESTING

MIMO signal testing focuses 1st on the transmitter/receiver system. The random phases of the sub-carrier signals will manufacture instant power levels that cause the electronic equipment to compress, momentarily inflicting distortion and ultimately image errors. Signals with a high PAR (peak-to-average ratio) will cause amplifiers to compress erratically throughout transmission. OFDM signals square measure terribly dynamic and compression issues will be laborious to find owing to their noise-like nature.

VI. CHANNEL MODELS

A channel may be sculptured physically by making an attempt to calculate the physical processes that modify the transmitted signal. as an example in wireless communications the channel may be sculptured by calculative the reflection off each object within the surroundings. A sequence of random numbers may additionally be another in to simulate external interference and/or electronic noise within the receiver. Statistically a channel is sometimes sculptured as a triple consisting of AN input alphabet, AN output alphabet, and for every try of input and output parts a transition chance p. Statistical and physical modeling may be combined. as an example in wireless communications the channel is commonly sculptured by a random attenuation (known as fading) of the transmitted signal, followed by additive noise.

Channel Performance Measures:

These are examples of commonly used channel capacity and performance measures are as follows Spectral in Hertz, Symbol in baud, pulses/s or symbols/s, Digital bandwidth bit/s measures: gross bit rate (signaling rate), net bit rate (information rate), channel capacity, and throughput, Channel, Link, Signal measures: signal-to-interference ratio, carrier-to-interference ratio in decibel, Bit (BER), packet-error rate (PER),Latency in seconds: propagation time, time, Delay

VII. REAL TIME MIMO CHANNEL EMULATOR

ACE MX2 MIMO Channel Emulator

2G/3G/4G LTE and on the far side wireless access technologies promise speeds of 350 Mbps and better for delivery of high-speed information, video and voice services. High output delivery for LTE is achieved exploitation orthogonal frequency-division multiplexing (OFDM) and advanced antenna techniques like Multiple-Input, Multiple-Output (MIMO). MIMO performance depends on the radio channels during which it operates, and correct and repeatable research lab characterization of RF environmental effects like multipath and weakening is essential for reliable testing of conformity, performance and ability of the systems. Testing such conditions will solely be achieved through the employment of channel emulation.

VIII. PROPOSED WORK

The profile of received signal is obtained from that of the transmitted signal if we've got a model of the medium between the 2. This model of the medium is termed channel model.

$Y(t) = H(t) * X(t) + Noise$

The Channel Model block will receive the data serially and which store in a memory (X-Matrix).The received Matrix (X-matrix) has to be convolved with the Channel matrices (H-matrix) (H (t) * X (t)).

Also Noise variance has to be calculated and it has to be multiplied with the matrix generated for noise. Then the convoluted Data (H (t)*X (t)) will added with the matrix which has the noise values.

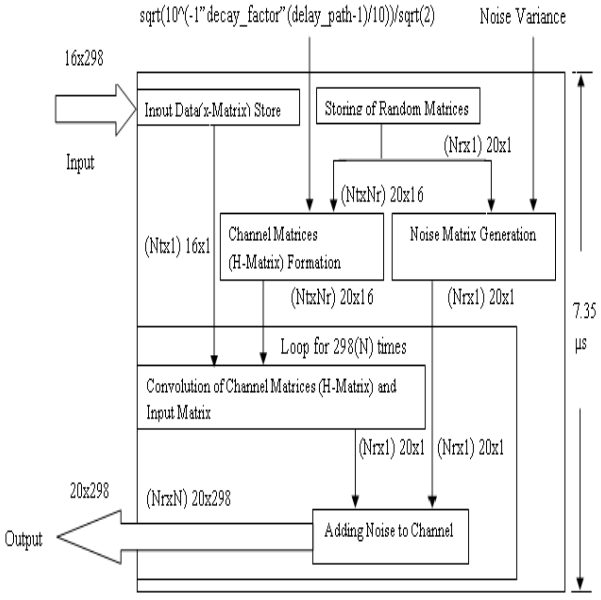

Figure 1 Constraint diagram of channel model

In the above diagram, Channel and Noise matrices will be used from mat lab code generated. The square root calculation and noise variance calculation will not happen in the FPGA.

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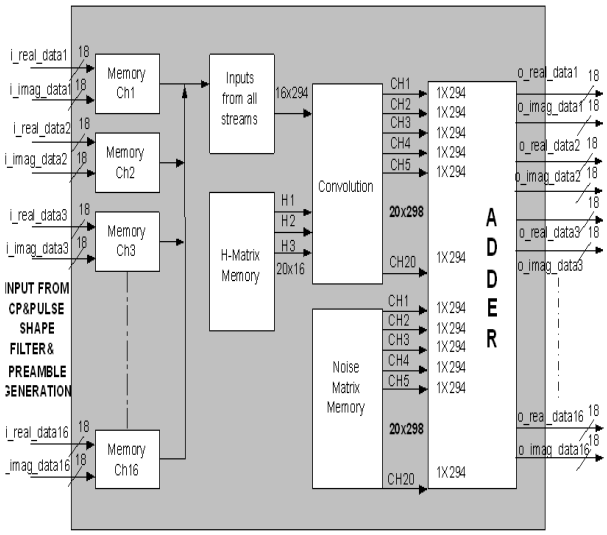

Figure 2 Interface diagram of channel model

Total Number of Required Memories in Input Register:

In one stream the total no of elements will be 298. So for 16 streams, it will be 298x16=4768 elements.

Total no of memory in Input Register = Total no of elements / 512.

Total No of Memory in Input Register = (298 X 16)/ 512 (Total no of Address in a RAM). =9.3~=10 RAMs (Without Optimization)

For easier data handling, we can have 16 RAMs for 16 streams and 32 RAMs are required, if we are using ping-pong memory**.** The Input memory architecture is shown below.

IX. RESULTS AND DISCUSSION

SIMULATION RESULTS:

The tool used to design and simulate the 16X20 channel model is Altera Quartus II 15.0 and ModelSim 10.3.Figure 3 shows x input sequences and related channel errors. In Figure 4 represents the channel bit error changes with convolution process. Figure 5 shows the channel model with noise variation MIMO. The table 1 shows the different range of Maximum RF bandwidth, Maximum no. of channels, Delay spread.

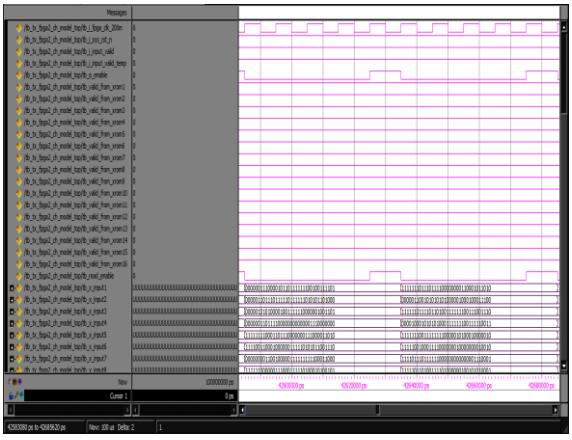

Figure3. X-input sequences

In box Muller method the number samples increases and also delay spread spectrum is high.

The input sequence varies with channel selection and bandwidth allocation. The maximum number of transmit and receive antenna depends on the channel size.

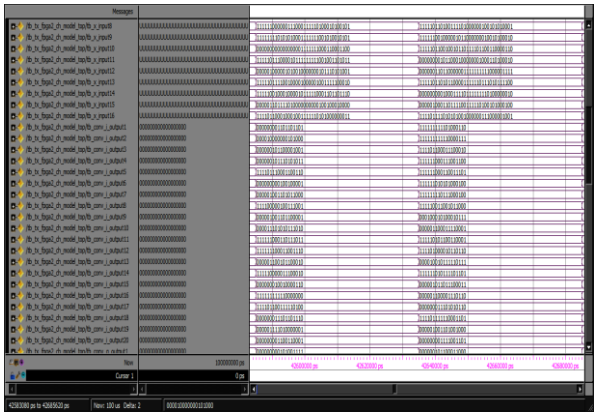

Figure 4.Output of convolution process

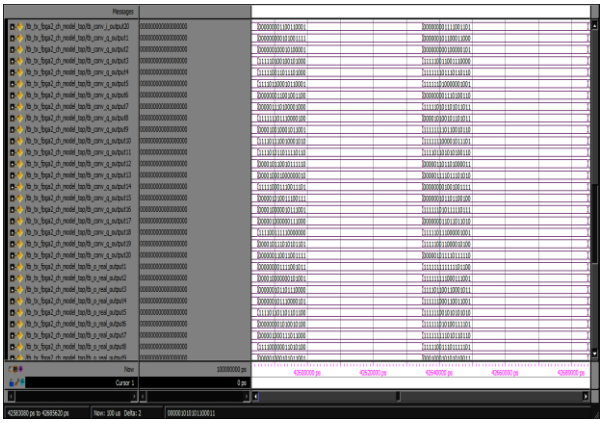

Figure5. Output of channel model with noise

Table 1.Comparison of existing and proposed system

S.NO.	PARA METERS	EXISTING SYSTEM	PROPOSED SYSTEM
1	Maximum no. of transmit antennas	8	16
2	Maximum no. of receive antennas	8	20
3	MIMO configurations supported	2x2, 4x4, 8x8	Extended up to 16x20
4	Maximum no. of channels	64	320
5	Maximum RF bandwidth	80MHz	40MHz
6	Method	Normal	Box-Muller
7	Number of samples	Minimum	Maximum
8	Delay spread	Lower	Higher delay spread is achieved
9	Application	Limited to 4G	Can be used for 5G

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X. CONCLUSION

The goals of 5G ar to realize ten to a hundred times higher typical user knowledge rates starting from one to ten Gbps in dense urban environments. to realize higher knowledge rates within the future generation of communication systems, an oversized or huge MIMO system is needed. Since the system performance is very hooked in to channel conditions, the channel modeling required to accurately emulate the radio setting. an oversized 16x20 MIMO network ape is planned to make a take a look at setup that accurately emulates the $64000 world channel conditions for the testing of future generation of wireless network. during this style the mathematician noise samples ar generated by victimization Box-Muller and central limit algorithmic program. the look provides a most variety of channels and achieves the next delay unfold for the testing of future generation of wireless network. the look specifications ar obtained victimization MATLAB. The lipoprotein committal to writing is carried for the look to be enforced on Altera FPGA.

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