A High Data Rate Wireless System using STBC MIMO Technique to Control Microgrid in Smart Grid System for Remote Areas

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Abstract -The rising requirement on real time application to attain high throughput, reliable wireless system and network capacity for third generation Universal Mobile Telecommunication System, a MIMO (Multiple Input Multiple Output) technique is mainly smart technique in wireless communication system and it is very trendy for high data rate capacity and beside multipath fading.This paper presents MIMO technique with Space Time Block Code (STBC) multiplexing. The result of using these MIMO techniques is higher data rate or longer transmits range with not requiring any extra bandwidth or transmits power. These Space Time Block Code techniques are examined for performance according to their bit-error rates using16-QAM modulation scheme for getting high signal to noise ratio (SNR). There are numerous standardized wired and wireless communication technologies existing for different smart grid applications. To get high transmission ,there are several methods from which 16 QAM has been used to reduce time delay.

Keywords*: Communication Technologies, Microgrid , MIMO, QAM, Smart Grid, STBC, UMTS , Wireless techniques*

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I. INTRODUCTION

Communication plays a vital role to control and get higher efficiency in the microgrid of Smart grid system. In this paper work is proposed to get and control power by reducing delays in communication using 3G UMTS to design droop control .Few techniques had been used to control microgrid but at present to get and control the parameters of microgrid, a specified UMTS technique has been used to overcome the problems. The increasing demand of wireless communication in real time application proved that it gives high throughput, reliable and secure data transmission through limited bandwidth. Wireless communication also plays a crucial role and an integral component in transmission, distribution and management of electrical energy in smart grid.

Smart grids are the new version of power grid which put together the use of modern communication and control technologies with physical grid. It digitally enhances the robustness, efficiency and flexibility. In order to make stable bidirectional transmission of data flow, control and monitoring instructions between smart grid and utilities control centers, it is necessary to connect intelligent electronic devices in distributed locations in smart grid communication network. Two main communication technologies wired and wireless can be used for data transmission. Both wired and wireless techniques are having advantages and limitations. Wireless techniques have low cost infrastructure and ease of connection for unreachable areas where wired solutions do not have interference problems and their functions are not dependent on batteries, as wireless solutions do.

The main features of smart grid linked to the wireless communications are demand response (DR), demand side management (DSM), decentralized power generation, and price signalling.[1]With DR and DSM, the power generators and users can interrelate to get better the efficiency of power supply and consumption.

Smart grid is the intelligent electric power network, which can achieve the goals of fair transaction of electricity and at the same time reducing the peak power and maximally supplying local loads from the distributed power generators (e.g. renewable energy sources), to efficiently use the electric power networks. The smart grid uses the communication network to receive and send information, which implies some constraints on the information sent and received. Among these communication constraints, time delays have been identified as a factor that can degrade the overall system performance.

The rest of the paper is organized as follow: The basic of smartgrid and microgrid is described in section 2. Section 3 depicts about different modulation schemes used for universal mobile telecommunication system whereas section 4 gives the discussion and paper is concluded in section 5.

II SMART GRID AND MICROGRID

Smart grid is an interdisciplinary region where the mainly advanced technologies in control, communication, network, and computation have been implemented. The deployment of communication in power system smart grid and microgrid can progresses the power distribution system modernization and improve the distribution system performance with high level consumption of renewable and distributed energy resources. A consensus has been reached that reliable and secure communication is essential for smart grid [2] [3].

A communications system is the main component of the smart grid infrastructure. [4],[5],[6]. Various applications of wireless technologies have been recognized considering the most recent available data rates, distance coverage, and other important technology features in smart grid environment.

Microgrid is termed as an element of electric power distribution network that embed distributed generators, energy storage devices and loads. Microgrid may be cut off from the rest of the power system, under emergency conditions or as planned. Micro-grid can work in two modes: grid-connected and islanded. In grid-connected mode, the voltage and frequency of micro-grid are forbidden by the utility grid while the distributed generators provide constant active power and reactive power.[7] In islanded mode, the voltage and frequency of micro-grid are used to by one dominant distributed generation in micro-grid. Distributed energy comprises solar (photovolatics), wind and microsources such as micro turbines and fuel cells. Among these resources solar and wind power cannot use for sensitive loads because they are no dispatch able. Droop controllers are employed as power sharing controllers of microgrid generators.

The major task of droop control is to regulate the fundamental frequency & the voltage magnitude of microgrid with various distributed generations (DGs) in autonomous mode so that the suitable powers are shared [8]. Normally used droop control technique to get better power sharing and the voltage/ frequency harmonization are real power–frequency (P–F) droop control and reactive power–voltage magnitude (Q–V) droop control. Consequently its realization is simple and it allows decentralized control of many distributed generations [9].

Load sharing between distributed generation systems is one of the mainly important task in wireless-enabled smart microgrids, where a set of power inverters at various geographical locations work synchronized and shared through wireless networks to meet the load requirement. However, existing work in the area of load sharing has basically ignored the outcome of wireless communication delay. Study has revealed that the time-varying wireless communication delay can have a major impact on the performance of power inverters.

III UMTS

Universal Mobile Telecommunication System (UMTS) is employed for third generation (3G) wireless communication in which the Wideband Code Division Multiple Access (WCDMA) method is used to increase data bandwidth for high speed multimedia purpose. There are some digital modulation schemes that have been suggested but there is a trade off between data rate and variance of the three basic parameters as phase, frequency and time between the transmitter and receiver**.** These digital modulation systems include basic methods such as MPSK (M-ary Phase Shift Keying), MPAM (M-ary Pulse Amplitude Modulation), MQAM (M-ary Quadrature Amplitude Modulation), MFSK (Mary Frequency Shift Keying), and GMSK (Gaussian Minimum Shift Keying).

The communication infrastructure in smart grid commences important information exchange responsibilities, which are the basis for the functions enlarged and location distributed electric power appliances to exert properly. Inadequate communication performance not just limits the smart grid from getting its full energy efficiency and service quality, although in addition creates potential damages to the grid structure. To keep the smart grid and ensure optimal operation, the communication infrastructure should meet a number of constraints.

Multi-Input-Multi-Output (MIMO) technology assures a cost effective way to fulfil the requirement of the wireless communication for higher data rates, improved feature service, fewer dropped calls, higher network ability with limited accessibility of radio frequency spectrum and transmission problems caused by different aspects like fading and multipath distortion. MIMO is a fundamental method for carrying data. It functions at the physical layer, below the practices used to carry the data, so its channels may work with effectively any wireless transmission protocol.

In MIMO, the system utilizes the information that the received signal from one transmit antenna can be unlike than the received signal from a second antenna. This is mainly widespread in indoor or dense metropolitan areas where there are many reflections and multipath between transmitter and receiver. It is significant to note that each antenna element on a MIMO system operates on the identical frequency and therefore does not need any extra bandwidth.

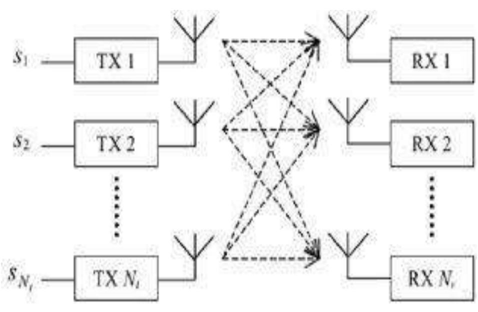

Fig. 1. Transmit 2 Receive (2x2) MIMO channel

Spatial multiplexing is employed to give additional data capacity by utilizing the diverse paths to take additional traffic, i.e. increasing the data throughput capability. Spatial diversity is used in this narrower sense frequently refers to transmit and receive diversity. These two methodologies are used to give enhancements in the signal to noise ratio and they are characterized by improving the reliability of the system with deference to the range of types of fading.

The space-time coding technique is basically a two dimensional space and time processing method. Although multiple antennas both for transmission and reception are used to get better wireless communication systems facility and data rate in space-domain. In time-domain, different signals can be transmitted at distinct time periods using the similar antenna at the same time. Relationship of time and space is found between signals which are transmitted by dissimilar antennas so that the receiver antennas can realize diversity reception.

Following tables show the work done for number of transmitters and receivers with different modulation scheme for analysis of BER and SNR.

TABLE 1: BER and SNR for BPSK Modulation

S.No.	**Year**	**BER**	**SNR dB**	**Number of Transmitter**	**Number of Receiver**	**Reference number**
1.	2011	Between 10^0 to 10^{-1}	<20	1	1	[11]
		Between 10^0 to 10^{-1}	<20	2	2	
		Between 10^0 to 10^{-1}	20	4	4	
		Between 10^0 to 10^{-1}	15	8	8	
2.	2012	Between 10^0 to 10^{-1}	18	1	1	[12]
3.		Less than 10^{-1}	<20	1	1	[13]
		Less than 10^{-1}	20 to 25	1	2	
		Less than 10^{-1}	20 to 25	2	1	
		Less than 10^{-1}	12	2	2	
4.		Nearby 10^{-1}	10	1	1	[14]
5.	2014	Nearby 10^{-1}	<25	1	2	[17]
		Less than 10^{-1}(ZF)	21	1	2	
6.		Nearby 10^{-1}	<25	2	2	[18]
7.		Nearby 10^{-1}	<20	1	1	[19]
8.		Between 10^0 to 10^{-1}	13	1	1	[20]
		10^{-1}	12	1	1	[21]

From the study of BPSK modulation technique for different number of transmitters and receivers it is analyzed that the BER performance under BPSK modulation scheme is gradually changed by changing the number of antenna either in transmitter side or in receiver side. BPSK modulation with Zero Forcing equalizer gives better performance only in theoretical assumptions.

TABLE 2: BER and SNR for QPSK Modulation

S.No.	**Year**	**BER**	**SNR dB**	**Number of Transmitter**	**Number of Receiver**	**Reference number**
1.	2010	Between 10^0 to 10^{-1}	13	1	1	[10]
2.	2011	Between 10^0 to 10^{-1}	<25	1	1	[11]
		Between 10^0 to 10^{-1}	<20	2	2	
		Between 10^0 to 10^{-1}	<20	4	4	
		Between 10^0 to 10^{-1}	20	8	8	
3.	2012	Between 10^0 to 10^{-1}	21	1	1	[12]
4.		Nearby 10^{-1}	10	1	1	[14]
5.	2013	Between 10^0 to 10^{-1}	20	2	1	[16]
6.	2014	Between 10^0 to 10^{-1}	18	2	1	[20]
7.	2015	Less than 10^{-1}	18	1	2	[22]

From the study of QPSK modulation it is concluded that QPSK show better response at lower SNR but degrades the WCDMA system as mobility increased. QPSK scheme is suitable for low capacity, short distance application and it is more sensitive to fading. It gets better by increasing the number of receiver antennas.

TABLE 3: BER and SNR for QAM Modulation

S.No.	**Year**	**BER**	**SNR dB**	**Number of Transmitter**	**Number of Receiver**	**Reference number**
1	2010	Between 10^0 to 10^{-1}	15	1	1	[10]
2	2011	Between 10^0 to 10^{-1}	<15	1	1	[11]
		Between 10^0 to 10^{-1}	<18	2	2	
		Between 10^0 to 10^{-1}	<18	4	4	
		Between 10^0 to	20	8	8	

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		10^{-1}				
3.	2012	Between 10^{0} to 10^{-1}	20	1	1	[12]
4.	2013	Less than 10^{-1}	<9	1	1	[15]
5.	2014	Between 10^{0} to 10^{-1}	17	1	1	[20]
6.	2016	Between 10^{0} to 10^{-1}	<25	2	1	Proposed Work

From analyzing the above paper it is concluded that QAM is most suitable modulation schemes for high data. It is seen that 16QAM which is more vulnerable to noise and interference due to its trust on amplitude requires comparatively more power for a given BER, however it should be noted that it has an advanced spectral effectiveness when evaluated with BPSK or QPSK. It is to be noted that QPSK gives only half the data rate possible with 16 QAM.s

Figure 2 shows BER vs. Eb/No performance analysis of BPSK, QPSK and 16-QAM modulation technique over Additive White Gaussian Noise channel. BPSK has lower BER than QPSK and 16QAM. Lower order of modulation techniques is better to use in communication system if spectral efficiency is not considered or taken in an account.

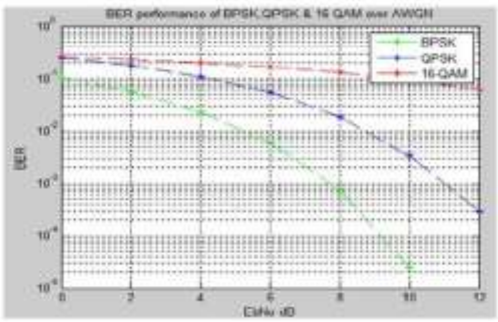

Fig 2 Conventional Comparison of BPSK, QPSK and QAM

Figure 3 shows different M- QAM modulation techniques with their BER & SNR. Error rate of 8-QAM is 0.5 better than 16 QAM but its data rate is only ¾ times that of 16 QAM. Higher Data Modulation schemes required more power for transmission due to which efficiency of system degrades. Hence 16 QAM is most suitable techniques.

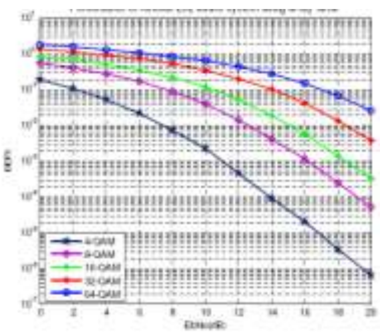

Fig. 3 Conventional Result of papers for M-QAM

In the proposed work MIMO technique is used which is more suitable for applications that require high data rates.

Following are the two important advantages of MIMO :-

1. There is a foremost increase in the system's capability and spectral efficiency in MIMO. The functionality of a wireless link increases linearly with the minimum of the number of transmitter or receiver antennas. The data rate can be enhanced by spatial multiplexing without using more frequency resources and without increasing the total transmit power.
2. In MIMO, there is a remarkable reduction of the consequences of fading due to the increased diversity. This is especially useful when the distinct channels fade independently.

IV DISCUSSION

The performance of a data transmission system is generally examined and evaluated in terms of the probability of error at given bit rate and SNR. The parameter Eb/No, where Eb is bit energy and No is noise energy, is regulated every time by modifying noise in the devised channel. For exacting Eb/No value, system is simulated and consequent probability of error is noted. Review of different paper shows that on increasing the Eb/No value, BER reduces. In evaluation of BER performance for M-PSK, it is examined that use of an advanced M-ary constellation is superior for high capacity transmission

CONCLUSION

In this article, discussed about communication technologies that could be adopted for the smart grid communication infrastructure on smart grid distribution and customer domains. It shows that implementation of wireless technology offers many advantages over wired, e.g. low installation cost, mobility, remote location coverage, rapid installation, etc. , but also more suitable for remote areas applications. There are several standardized wireless communication technologies available for various smart grid applications.

Furthermore, here MIMO technique is proposed for data transmission in smart grid. In the above discussion a basic introduction of Space-time coding is provided by presenting Alamouti's scheme. It is concluded that to reduce time delay of transmission 16 QAM technique is more suitable with MIMO to get high SNR.

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