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Adaptive MIMO-OFDM Technology for 4G & Study of 4G Communication for Social Networks

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Abstract
Modern communication protocols often require very complex and time-consuming operations. The communication industry is one of the fastest growing industries. The cellular systems started in the 80's with 1G have now reached to 4G. The growing demand of high data rates are increasing exponentially with time. The typical goals of a communication engineer are high speed communication for which the data rate should be high, better quality of signal for which we have to minimize the bit error rate as low as possible, less power consumption and VLSI implement ability. The 4G system ensures us data rate of 1Gbps which cannot be achieved by SISO systems and hence we go for MIMO system. The various benefits of MIMO and then the various methods of channel estimation are discussed and simulated. The proposed MIMO system has distinguished advantages over the conventional SISO systems and this is being implemented in 4G cellular, MIMO radar and in various other emerging communication technologies. Orthogonal frequency division multiplexing (OFDM) is a popular method for high data rate wireless transmission. OFDM may be combined with antenna arrays at the transmitter and receiver to increase the diversity gain and/or to enhance the system capacity on time-variant and frequency-selective channels, resulting in a multiple-input multiple-output (MIMO) configuration. As a promising technology for future broadband communication, MIMO –OFDM has gained more and more interests in recent years. the performance of MIMO-OFDM system employing Quadrature Amplitude Modulation (QAM) is analyzed. Simulation results show that this is a promising technique for next generation wireless systems.
Keywords: 4G, MIMO, OFDM ,SISO,QAM,ARQ.

1. Introduction

The typical aspirations of a system designer are high data rate, low bit error rate, low power consumption, low cost and easy implement ability. The MIMO system ensures us very high data rates even more than 1Gbps while minimizing the bit error rate. By Shanon's theorem the rate of transmission is always less than or equal to the capacity. Practically it is less than the capacity. The capacity depends on the bandwidth of the channel and SNR of the channel. Both the bandwidth and signal to noise ratio are characteristics of the channel. The SNR can be improved either by reducing noise power or by increasing signal power. Reduction in noise power is not possible while increase in signal power requires more power for transmission which should be avoided for a good design. The improvement of bandwidth is not possible. However there are techniques like OFDM (orthogonal frequency division multiplexing) which assure us efficient use of the channel i.e. spectral efficiency. But however the use of multiple antennas at the transmitter and at the receiver that is use of MIMO meets the ongoing requirements in 4G. The bit error rate in MIMO is very less as compared to conventional SISO systems.

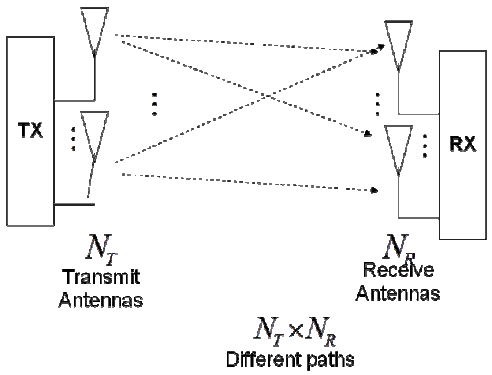


Fig. 1 MIMO Antenna system

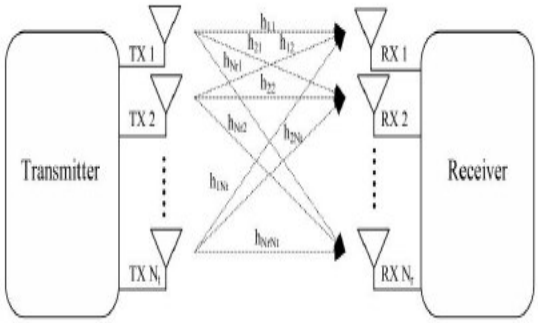


Fig 2: MIMO System

2. 4G TECHNOLOGY

Mobile Internet World is now incorporated into 4G World, focusing on the business strategies that will drive operator and service provider revenue growth. Just as the broadband technologies have transformed the Internet into an always-on commercial worldwide web, 4G mobile broadband technologies offer anywhere and anytime Mobile Internet access to rich media content, mobile commerce, Web 2.0 applications and social networking from a wide range of devices ranging from smart handsets to net books, cameras and other consumer electronics. Building on two years of success, MIW 2009 will include keynotes and track sessions on Open Mobile Development, Mobile Internet Devices, rich media, mobile commerce services and M2M applications. The Mobile Internet World program will examine the prospects for recovery in the Anywhere Mobile Internet Economy in key industry sectors including media and advertising, retail commerce, transportation, energy utilities and health care.

User requirements are growing faster than ever and the limitations of the current mobile communication systems have forced the researchers to come up with more advanced and efficient technologies. 4G mobile technology is the next step in this direction. 4G is the next generation of wireless networks that will totally replace 3G networks. It is supposed to provide its customers with better speed and all IP based multimedia services. 4G is all about an integrated, global network that will be able to provide a comprehensive IP solution where voice, data and streamed multimedia can be given to users on an "Anytime, Anywhere" basis. At present we have many technologies each capable of performing functions like supporting voice traffic using voice over IP (VoIP), broadband data access in mobile environment etc., but there is a great need of deploying such technologies that can integrate all these systems into a single

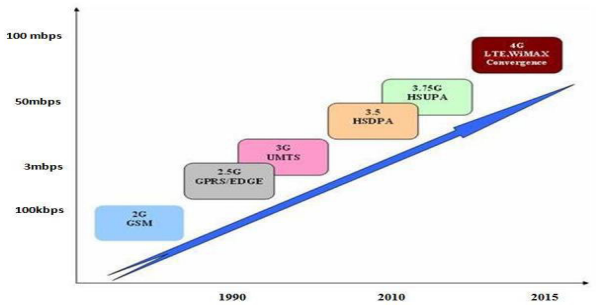


Fig 3: Evolution of 4G Technology

unified system. 4G presents a solution of this problem as it is all about seamlessly integrating the terminals, networks and applications. The race to implement 4G is accelerating as well as quite challenging.

3. MIMO -OFDM

The general transceiver structure of MIMO-OFDM is presented in Fig. . The system consists of N transmit antennas and M receive antennas. the cyclic prefix is assumed to be longer than the channel delay spread. The OFDM signal for each antenna is obtained by using inverse fast Fourier transform (IFFT) and can be detected by fast Fourier transform (FFT). the received MIMO-OFDM symbol of the n:th subcarrier and the m:th OFDM symbol of the i:th receive antenna after FFT can be written as

$$R_i[n,m]=\sum_{j=1}^{N}H_{i,j}[n,m]A_j[n,m]+W_i[n,m], \quad i=1,2,..,M$$

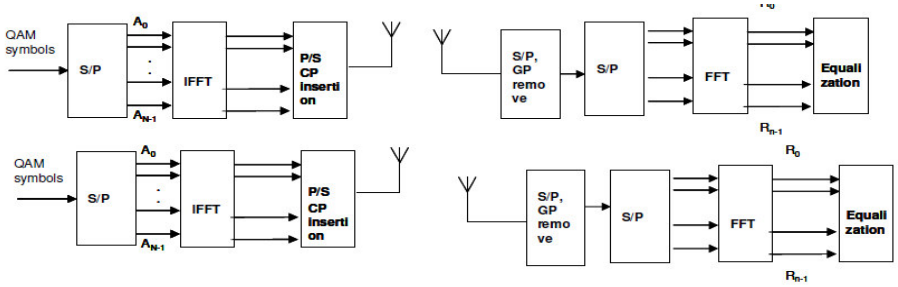


Fig 3: MIMO-OFDM Transceiver

where Aj[n,m] is the transmitted data symbol on n:th carrier and m:th OFDM symbol, Wi[n,m] is the additive noise contribution at i:th receive antenna for the corresponding symbol in frequency domain and Hi,j[n,m] is the channel coefficient in the frequency domain between the j:th transmit antenna and the i:th receive antenna. The channel coefficients in frequency domain are obtained as linear combinations of the dispersive channel taps.

$$H[n,m]=\sum_{i=0}^{I-1}h_i[m]e^{-j2\pi\tau_i n/T}, \quad n=0,...,N-1$$

where I is the number of channel taps in time domain and hm is modeled as an independent zero-mean random Gaussian process. The impulse response of the Rayleigh fading channel can be expressed as

$$h(t,\tau)=\sum_{i=0}^{I-1}h_i(t)\delta(\tau-\tau_i(t))$$

where hi is the tap gain and _i is the delay associated to the i:th tap. This delay can be considered to be time invariant. The channel impulse response is assumed to be static over one OFDM channel symbol duration T channel =T+T', where T is the OFDM symbol duration and T' is the cyclic prefix duration. This corresponds to a slowly varying channel where the coherence time is longer than the channel symbol duration. This assumption prevents from experiencing inter-carrier interference (ICI). The channel matrix *H* is an NxM matrix corresponding to the n:th subcarrier and m:th OFDM symbol.

$$\bar{H}[n,m]=\begin{bmatrix} H_{1,1}[n,m] & H_{1,2}[n,m] & \cdots & H_{1,N}[n,m] \\ H_{2,1}[n,m] & H_{2,2}[n,m] & \cdots & H_{2,N}[n,m] \\ \vdots & \vdots & \ddots & \vdots \\ H_{M,1}[n,m] & H_{M,2}[n,m] & \cdots & H_{M,N}[n,m] \end{bmatrix}$$

Taking the received data symbols of all antennas into account, the expression of the received data symbol can be presented in the matrix form as follows

$$\bar{R}[n,m]=\bar{H}[n,m]\bar{A}[n,m]+\bar{W}[n,m]$$

where

$$\bar{A}[n,m]=\begin{bmatrix}A_1[n,m] & A_2[n,m] & \cdots & A_N[n,m]\end{bmatrix}^T$$

and

$$\bar{R}[n,m]=\begin{bmatrix}R_1[n,m] & R_2[n,m] & \cdots & R_M[n,m]\end{bmatrix}$$

are the Nx1 and Mx1 vectors of the transmitted and received data symbols. To obtain the transmitted data symbols equation (5) should be solved which is called MIMO-OFDM equalization.

$$\bar{A}[n,m]=\bar{H}[n,m]^{-1}(\bar{R}[n,m]+\bar{W}[n,m])$$

This equalization works well in case of small noise and no ISI or ICI. In the presence of ICI and ISI the received signal can be written as in [2] development of a computer based expert system to provide a numerical index.

4. SOCIAL NETWORKING AND 4G TECHNOLOGIES

The social networking process is an involved Varity of networks such of Corporate Network , ome area network , Wireless Personal area network n Internet and vehicle area network . The Combinational network represented below with its possible connectivity architecture.

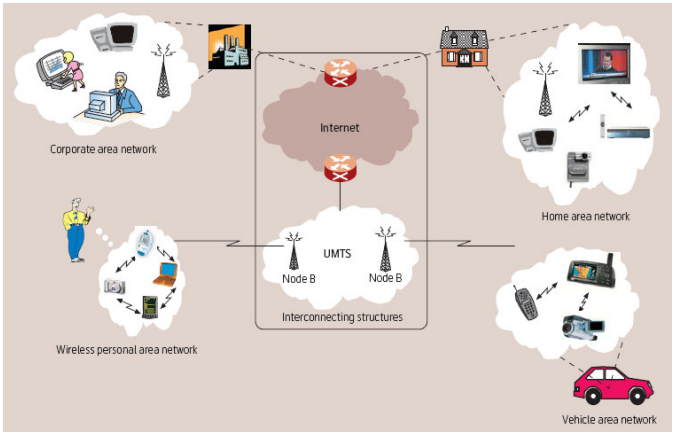
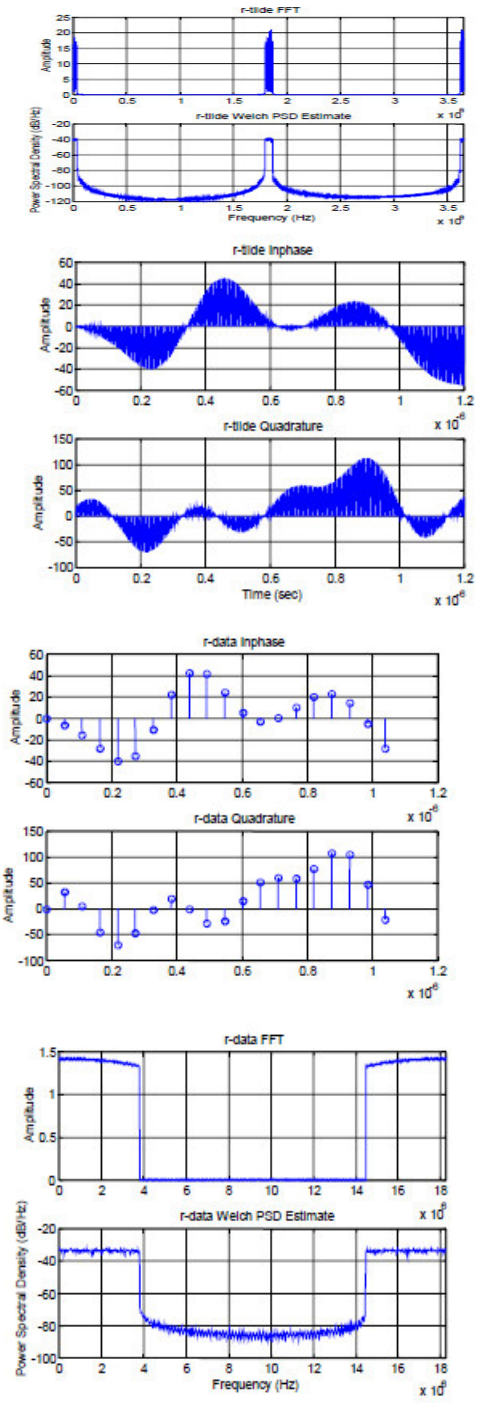


Fig 4: 4G Network Device Connectivity

While we are constructing the social network that will provide infrastructure service , web site content and application , relation control and participation model . Relation control and participation model work together to enrich the social presence of the registered user of the social network group member, Actor profile and Social Graph. The infrastructure model provides the facility to Collaboration & Content service and Social Networking services. The social network architecture is simulates the Cloud computing architecture.

5 RESULTS



6. Conclusion & Future Recommendations

It is quite clear that MIMO meets the requirements of 4G. Hence it can be used. It provides enormous data rate while limiting the probability of error as verified both theoretically and by simulation. The MIMO can be accomplished with OFDM resulting in MIMO-OFDM which uses the spectrum efficiently. the MIMO radar system is a breakthrough in military research and advancement. The MIMO technology will play an important role in coming generation wireless standards. The MIMO is being implemented in advanced radar systems. It ensures us better performance. In military this has become a very popular and important field of research. Radar is a device that gives

information about the motion of objects (such as air crafts) in the air. The MIMO radar improves the parameter identifiability. It is the maximum number of targets that can be uniquely identified by the radar. The phased array send scaled version of same narrow width signals. Unlike the conventional phased array, MIMO radar sends independent signals of narrow width from different antennas. Hence the number of objects that can be detected is increased by th number of times transmit antennas are used. This is vast field of research and many researchers are working in this field.

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