A Review on Cooperative OFDM System for Wireless Communications

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Abstract— In the past few years research on digital communication systems has been greatly developed and it offers a high quality of transmission in cooperation of wired as well as wireless communication environments. Coupled by advances in recent modulation techniques, Orthogonal Frequency Division Multiplexing (OFDM) is a well-known digital multicarrier communication technique along with one of the most excellent methods of digital data transmission in excess of a limited bandwidth. For wireless communication, orthogonal frequency division multiplexing (OFDM) is becoming the selected modulation technique. OFDM can offer high data rate, large spectrum efficiency with adequate robustness to radio channel impairments. Cooperative diversity in wireless communication is a hopeful technique to mitigate multi-path fading, which results in a fluctuation in the amplitude of the received signal. Unmanned Air Vehicles (UAV)

Key words: Cooperative Diversity, OFDM, Modulation Techniques

I. INTRODUCTION

In the past few years, the increasing emphasis on extending the services obtainable on wired public telecommunications networks towards mobile/movable non wired telecommunications users. And now a day, in addition to voice services, just a low-bit-rate data services are existing to mobile users. Though, demands for wireless broadband multimedia communication systems (WBMCS)[1] are anticipated inside together the public as well as private sectors. To wireless mobile networks the wired networks cannot support extension because mobile radio channels are extra contaminated than wired data-transmission channels. We furthermore cannot preserve the high QoS required in wired networks [2]. The mobile radio channel is characterized with multipath reception: the signal offered to the receiver contains not only a direct line-of-sight (LOS) radio wave[3][4], but as well a large number of reflected radio waves so as to arrive at the receiver at dissimilar times. Delayed signals are the result of reflections as of terrain features such as trees, hills, mountains, vehicles, or buildings. These reflected, delayed waves interfere by the direct wave as well as cause intersymbol interference (ISI)[5], which consecutively causes important degradation of network performance. A wireless network has to be intended to minimize adverse effects. To make broadband multimedia mobile communication systems, it is essential to employ high-bit-rate transmission of at least numerous megabits per second. On the other hand, the delay time of the delayed waves is larger than 1 symbol time if digital data is transmitted at the rate of several megabits per second. By adaptive equalization techniques at the receiver is one process for equalizing these signals. There is useful effort in operating this equalization at numerous megabits per second with low-cost compact and low-cost hardware. To conquer such a multipath-fading environment via low complexity through to attain WBMCS[1], this presents a summary of the orthogonal frequency division multiplexing transmission system. OFDM is single of the applications of a parallel-data-transmission system[6], which reduces the influence of multipath fading as well as makes complex equalizers unnecessary.

II. ORTHOGONAL FREQUENCY DIVISION MULTIPLEXING

OFDM is a grouping of multiplexing as well as modulation. The signal is divided into independent channels, modulated and after that multiplexed to make an OFDM signals[6]. In a basic communication system, the data are modulated on a single carrier frequency. The obtainable bandwidth is then entirely occupied by each symbol. In case of frequency selective channel, this kind of system can lead to inter-symbol-interference (ISI)[5]. The fundamental idea of OFDM is to divide the accessible spectrum into numerous orthogonal subchannels so that each one narrowband subchannel experiences approximately flat fading. And the Orthogonal frequency division multiplexing (OFDM)[6] is fetching the selected modulation system for wireless communications. OFDM can give large data rates with adequate robustness to radio channel impairments. Several research centers in the world have specialized teams functioning in the optimization of OFDM systems. In an OFDM system[6], a huge number of orthogonal, overlapping, narrow band sub-carriers are transmitted in parallel. These carriers separate the obtainable transmission bandwidth. The separation of the sub-carriers is such that there is a extremely compact spectral utilization. With OFDM, it is probable to have overlapping subchannels in the frequency domain, therefore increasing the transmission rate. Orthogonal frequency division multiplexing (OFDM) is a process of encoding digital data on top of multiple carrier frequencies. The OFDM has developed into a popular scheme for wideband digital communication, used in applications like as digital television and audio broadcasting, DSL Internet access, wireless networks, powerline networks, and 4G mobile communications[7]. OFDM is a (FDM) frequency division multiplexing system [8] used as a digital multi-carrier modulation method. To carry data, a large number of closely spaced orthogonal sub-carrier signals are used on numerous parallel data streams or channels. Each and every sub-carrier is modulated through a conventional modulation scheme (such as quadrature amplitude modulation or phase-shift keying) at a little symbol rate, maintaining total data rates like to conventional single-carrier modulation schemes in the same bandwidth. The fundamental principle of OFDM[6][8] is to divide a high-rate data stream into a number of lower rate streams so as to are transmitted simultaneously in excess of a number of subcarriers. Because the symbol duration increases used for lower rate equivalent subcarriers, the relative amount of dispersion in time caused by multipath delay spread is decreased. The Inter symbol interference is eliminated approximately totally with introducing a guard time in every OFDM symbol[6][8]. In the

guard time, the symbol is cyclically comprehensive to avoid inter carrier interference. In design of OFDM, a number of parameters are up and about for consideration[6], for example the number of subcarriers, symbol duration, guard time, subcarrier spacing, and modulation type per subcarrier.

III. COOPERATIVE COMMUNICATION

Cooperative techniques in wireless communication networks[9] are the means to adopt the diversity, which is inherent in a wireless medium and the diversity achieved in a communication system, when such techniques are implemented, can be in code, frequency, space and time domains. Cooperative diversity is a wireless transmission technique so as to overcome fading. It is a diversity technique which is obtained by signal relaying nodes. The relay nodes transmit its received signal since the source node to the destination node, which receives two non independent signals from the relay and the source node. Cooperative diversity[10] is a virtual multiple antenna technique which exploits multiple antenna signal processing. It has just been proposed as a promising technology to achieve spatial diversity in wireless networks. Single antenna nodes in wireless networks contribute their antennas and transmit cooperatively as virtual MIMO systems[11]. Thus spatial diversity can be achieved as well as multipath fading can be effectively mitigated. Cooperative diversity networks technology is a hopeful solution for the high data rate coverage required in future cellular and ad-hoc wireless communication systems. There are two main advantages of this relaying technology. The low transmit power requirements as well as the spatial diversity that can mitigate fading. Cooperative diversity networks combine the usual power saving with the spatial diversity provided with the antennas of separate nodes. The basic idea is that between the transmitter and receiver nodes, there can be one more node, which can be used to provide diversity by forming a virtual multi antenna system. In usual cooperative diversity networks, in adding to the direct link all relays participate in sending the source signal to the destination. With enhancing diversity, cooperation in wireless networks allows increasing the transmission reliability and extending the radio coverage with no the need of implementing multiple antennas at the terminals. In wireless networks[7], antenna diversity technique has been normally used to combat the deleterious effect of the fading. These techniques require the terminals to be of reasonable size thus as to support multiple antennas, a requirement that proves to be unfeasible for future wireless terminals which are ordinary to be small as well as light. Recently cooperative diversity in wireless networks have gained a large amount interest in the wireless research community due to its ability to mitigate fading during achieving spatial diversity, while resolving the problems of installing multiple antennas on small communication terminals. Basic idea is in adding to the direct signal from source to the destination, multiple cooperative nodes (relays) collaborate mutually to relay the signal from the source node to the destination node. As a result the destination can receive multiple independent copies of the similar signal along with can achieve diversity through the establishment of a virtual antenna array. Previous benefits are expansion of the radio coverage without using high power levels at the source, increase of connectivity and higher capacity.

IV. LITERATURE SURVEY

Kavita Narayanan et al [12] presented that the simulation result in the bit error rate performance comparison between direct transmission, OFDM transmission, Amplify and forward relaying, AFOFDM system and coded OFDM system. As can be seen from the result coded OFDM system gives a better performance over the amplify and forward-OFDM system as the noise is not getting amplified and the redundancy term added checks and corrects the error before retransmitting the re-encoded message at the relay node. However the performance of AF and AF-OFDM system are almost the same as the noise also gets amplified. The author studied on applying Cooperative Diversity to OFDM system. The result of simulation demonstrates that the OFDM system has a better performance when the cooperation node employs coded cooperative scheme. In the simulation, Rayleigh multi-paths fading channel, convolution coding maximum ratio combining has been considered.

Jiang Liu et al[13] studies an Orthogonal Frequency Division Multiplexing (OFDM) based wireless services employing Radio over Optical Wireless to achieve high performance transmission while eliminating the drawback of possible radio wave interference to electro-medical equipment in indoor communication system. An optical Intensity-modulated Direct-detection (IM/DD) system by RF subcarrier modulation is measured with OFDM RF signals are assumed as the subcarrier. The transmission performance is evaluated by reproduction considering the influence of peak clip of OFDM signal and different radio fading scenarios. Simulation effect shows to the modulation index m, optical transmit power , radio environments are significant factors which influence the communication performance significantly.

Oh-Soon Shin et al[14] proposed a wireless system that realizes theoretical benefits of space-time cooperation. Specifically, authors design a space-time cooperative system based on orthogonal frequency division multiplexing (OFDM), which we refer to as a cooperative (CO)-OFDM system. Author design includes a two-phase space-time cooperation protocol, as well as a transmitter with receiver architecture that facilitates cooperation. Furthermore, we Devise a frame structure, on which we construct practical timing and frequency synchronization algorithms and a channel estimation algorithm. In exacting, the planned frequency synchronization algorithm utilizes the underlying structure of the cooperation protocol, as well as the proposed channel inference algorithm is based on a pair wise orthogonal construction of two sequences. Authors validate the presentation of the proposed synchronization and channel estimation algorithms through simulations.

Pierre Siohan et al [15] presented in their paper as a discrete-time analysis of the orthogonal frequency division multiplex/offset QAM (OFDM/OQAM) multicarrier modulation technique, leading to a modulated transmultiplexer, is presented. The situation of discrete orthogonality are established with respect to the polyphase components of the OFDM/OQAM prototype filter, which is supposed to be symmetrical and with arbitrary length. Fast implementation schemes of the OFDM/OQAM modulator as well as demodulator are provided, which are based on the inverse fast Fourier transform. Non-orthogonal prototypes generate intersymbol as well as interchannel interferences

(ISI and ICI) that, in the case of a distortion-free transmission, are expressed with a closed-form expression.

Wenbing Dang et al [17] studied the joint allocation of three types of resources, namely, power, subcarriers and relay nodes, in supportive two-hop multi-relay OFDM systems. Each relay adopts the amplify-and-forward (AF) protocol. The purpose is to maximize the system transmission rate subject to individual power constraints on each node.

Rashmi.R et al [18] represented in their work as OFDM provides high data rates and is robust in frequency selective channels .It minimizes the effect of ISI. Thus it is suitable for wireless communication. Simulation was performed for OFDM using BPSK along with QPSK modulation in AWGN and in Rayleigh channels. The BER performance is similar for both, but QPSK is expensive in terms of bandwidth when compared to BPSK.

F. Gomez-Cuba et al [20] represented that Diversity, i.e. transmitting multiple replicas of a signal, may mitigate fading in wireless networks. Amongst other diversity techniques, the space diversity of multi-antenna systems is particularly interesting as it can complement other forms of diversity. The recent cooperative diversity paradigm brings the advantages of multi-antenna space diversity towards single antenna networked devices, which, through cooperation and antenna sharing, form virtual antenna arrays. Though, cooperative diversity is a complex technique and research on this topic is still in its untimely stages. The paper aims at providing a general survey on the theoretical framework; and the physical and medium access control proposals in the literature.

Ling et al[21] shown that in order to overcome the detrimental effects of fading, Multiple-Input Multiple-Output (MIMO) technology is an attractive system that employs multiple transceiver antennas to carry the data over the same frequency band over a range of signal paths. This technology has shown great solutions due to its ability to provide better spectral efficiency, capacity, throughput as well as robustness of the data transmission. But in practice, it is impractical to set up multiple antennas on small-sized devices. Hence, to overcome the limitations of MIMO gain in the future wireless networks, cooperative diversity has newly draw in attention due to its ability to circumvent the difficulties of implementing real antenna arrays in Multiple-Input and Multiple-Output (MIMO). By exploiting the broadcast feature of the wireless medium, cooperation among multiple close by nodes is formed for data transmission. At the receiver, the signals are neither coherently nor differentially detected. Coherent detection requires exact channel estimation, which is difficult to apply in a time-varying channel. Therefore, when the nodes are mobile, or when the channel is inaccurately estimated, the differential detection techniques to omit channel estimation become an alternative as compared to coherent detection. The article begins through the development of the differential detection techniques. Then, the concept of double-differential technique by the presence of carrier offset is addressed. The re-evaluate of these studies is presented so as to provide directions for future developments.

Monire Norouzi et al[22] shown that Today, wireless communication systems will be built for cooperation rather than for more coexistence.The Cooperative communication is a hot topic of current research and many researchers believe it to be the then big step after multiple-input multiple output systems. The important idea is that multiple nodes cooperate in order towards increase the link quality, reliability as well as data rate of the system. In the opportunity, the density of active nodes challenging for a general wireless channel in cellular as well as access or ad hoc networks will increase significantly. Consequently, node cooperation is an well-organized means of achieving these gains.

Gurpreet Kaur et al[23] presented a theoretical analysis of cooperative diversity in various fields like wireless sensor networks, cognitive radio and resource allocation for IEEE 802.16j. For wireless sensor network analysis the knowledge of the spatial distribution of nodes is used to determine the number of packets to be transmitted as a function of distance since a sink. This number is a summation of packets due to MHR and due to cooperation. These numbers are then used in an energy investigation to establish the average energy used as a function of distance, thereby predicting network lifetime. In cognitive radio we saw the benefits of cooperation in increasing the agility of cognitive radio networks. A straightforward two user cooperative cognitive network is first considered and showed to improve the agility by exploiting the inherent asymmetry.

A. Mahmood [24] represented in his research work, Transmit Diversity is an effective methodology for improving the quality as well as reliability of a wireless network by falling the effects of fading. As majority of the wireless devices (i.e. mobile handsets, etc) are limited to just single antenna, especially due to hardware constraints, size as well as cost factors; cooperative communication can be utilized in instruct to produce transmit diversity [14]. This enables single antenna wireless devices to divide their antennas during transmission in such a manner that forms a virtual MIMO (multiple-input and multiple-output) system [15] [16]. In this paper, we will analyze the recent developments and trends in this promising region of wireless Ad hoc networks. The article will also discuss various main cooperative signaling methods furthermore will also observe their performance.

Intzar Ansari et al[28] represented in the work as the combination of space diversity and spatial multiplexing is called Multiple-Input Multiple-Output (MIMO). Cooperative diversity, a substitute form of realizing MIMO, it has been newly proposed to recognize the diversity benefit in a distributed manner. Cooperative diversity method exploits the broadcast nature of wireless communication and creates a virtual antenna array system through cooperating nodes. Though,other research in cooperative diversity considers users equipped with single antenna, in realistic scenarios users can be able to contain many antennas due to the new advances in semiconductor industry. Therefore, the main purpose of their this review paper was to study and analysis the performance of the cooperative mobile network employing multi-antenna at cooperating nodes. The purpose was to simultaneously use the enhanced gain with low bit error rate offered by the cooperative diversity network. Cooperative MIMO systems may achieve considerably better performance in bit error rate (BER). The cooperative MIMO scheme may have effective throughput in low SNR regime when compared to the conventional point-to-point system.

Gentian Jakllari et al[29] explored the use of virtual antenna arrays (aka cooperative diversity) for network-wide

broadcasting in ad hoc networks. Author design a new broadcasting protocol that is tightly integrated with the physical layer. The key property that is exploited is that cooperation can yield an extension in the transmission range, due to the diversity gain achieved in fading environments. This extension in range increases the broadcast coverage by as much as three times over what is achieved with the best SISO based approach; the latency is also reduced by up to 50%. We support the above claims with extensive simulations and with an analytical model. In addition, authors also study the optimal network-wide cooperative broadcasting problem. Authors construct centralized approximation algorithms for the problem and simulate these as well. The performance of these approaches serves as benchmarks for evaluating any distributed approach.

J. Nicholas Laneman et al[30] developed and analyzed low-complexity cooperative diversity protocols that combat fading induced with multipath propagation in wireless networks. The underlying techniques exploit space diversity available through cooperating terminals' relaying signals for a different. Authors summarize several strategies employed by the cooperating radios, including fixed relaying schemes such as amplify-and-forward as well as decode-and-forward, selection relaying schemes that adapt based on the channel measurements among the cooperating terminals, as well as incremental relaying schemes that settle in based upon limited feedback from the destination terminal. Author developed performance characterizations in terms of outage events with connected outage probabilities which calculate robustness of the transmissions to fading, focusing on the high signal-to-noise ratio (SNR) regime.

V. CONCLUSION

OFDM is a grouping of multiplexing as well as modulation. We studied that in an OFDM system, a large number of orthogonal, narrow band sub-carriers, overlapping be transmitted in parallel. These carriers separate the obtainable transmission bandwidth. We review the OFDM system and Cooperative techniques which used in the wireless communication. In the OFDM system we overviewed the different techniques used in OFDM systems which are used in wireless communication for better communication.

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