Journal of Theoretical and Applied Information Technology
15 May 2012. Vol. 39 No.1

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

A CROSS-LAYER FRAMEWORK FOR IEEE 802.16 OFDM NETWORKS

[1]S. PRAVEEN PRAKASH, [2]V.SAKTHIVEL

P.G. Student, SASTRA University, Thanjavur-613401, India
Sub Divisional Engineer, Bharat Sanchar Nigam Limited, Chennai-600027

Email: [1]spraveen8@yahoo.com, [2]vsvrgmttc@gmail.com

ABSTRACT

OFDM is a promising technique for high bit rate transmission systems. In previous for a given transmit power constraint, the capacity region can be regarded as the set of low optimal operational with low number of users. In order to improve the QOS we need a new system. The Bit Error Rate (BER) of the scheme for binary phase-shift keying (BPSK) is also presented. Specifically, an algorithm is proposed that exploits the structure of the OFDM channel and whose convergence speed is essentially insensitive to the number of subcarriers. To improve the capacity dynamic routing, traffic scheduling, burst allocation and load balancing concepts are used. In dynamic routing the network destination is dynamically discovered. Traffic scheduling is used to improve the fairness. Load balancing is used to distribute the load evenly among the cell nodes. Burst allocation is used to choose the cyclic prefix.

Keywords:- *OFDM, QOS, QAM, PAPR, CDMA*

1. INTRODUCTION

OFDM is used in many applications due to its robustness to frequency selective fading or narrowband interference, high bandwidth efficiency and efficient implementation. The presented MIMO aware RRM algorithms and transmission schemes, detailed system-level multi-cell simulations have been carried out to evaluate the performance. The 3GPP Macro Cell case #1 and LTE Micro Cell (outdoor-to-indoor) scenarios in a frequency reuse 1 network have been evaluated. All terminals in a cell are assumed to be active, have low mobility (3 kmph) and utilize the same type of MIMO transmission scheme. The interfering cells are assumed to operate at full load and the interference signal at the receiving terminal is calculated based on the assumption that it originates from a MIMO Rank 1 transmissions with the same number of transmit antenna ports. The (self) inter-stream interference at the receiver is explicitly calculated when estimating the SINR and CQI measures at the output of the LMMSE receivers. The 3GPP SCM MIMO-correlated channel model has been used. The MIMO scheme, is a trade-off solution between the fast-adaptive (per TTI) and the G- factor based (per 5ms to 10 ms) schemes, and can be used in both medium and low mobility scenarios, thus yielding a good trade-off between the DL signaling overhead and MIMO performances. It has to be noted, that in our study the MIMO rank adaptivity implies only the rank selection and not the precoding vector/matrix selection. Thus, after the selection of a given transmission rank, the optimum pre-coding is updated based on the current channel conditions.

Space-time block code (STBC) is a simple scheme that achieves a full diversity order and enjoys the simple maximum likelihood decoding algorithm. As a special case with two transmits antennas, the Alamouti scheme has been proposed for OFDM standards. Owing to the size and power limitation, most of the current hand-held devices can accommodate only one or at most two antennas. Therefore STBCs designed for a large number of transmit antennas have to be employed to achieve a high diversity order. However, the STBCs could not achieve a full code rate and also not reach optimal QoS for more than two transmit antennas with complex constellations. Even for real signal constellations, full rate can be maintained only for particular numbers of transmit antennas. Compared with the receive diversity maximal-ratio combining (MRC) scheme of the

Journal of Theoretical and Applied Information Technology
15 May 2012. Vol. 39 No.1

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

same diversity order, STBCs incur signal-to-noise ratio (SNR) loss owing to the power spreading across transmit antennas. This SNR loss increases as the number of transmit antennas increases. To address the issue of difficulty of STBC design and SNR loss, the combination of transmit antenna selection (TAS) with the Alamouti scheme is considered. Two transmit antennas, which maximize the SNR at the receiver, are chosen out of all the available transmit antennas to transmit the Alamouti scheme. However, the impact of antenna selection on the system performance is not directly investigated. The bit error rate (BER) of the scheme for binary phase-shift keying (BPSK) in flat Rayleigh fading channels is presented.

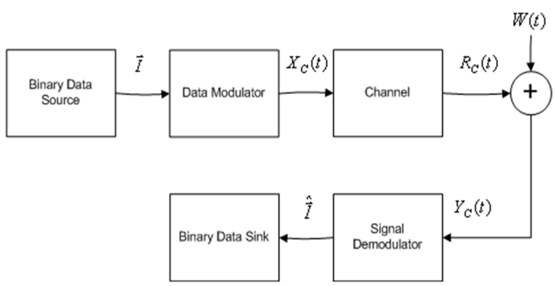

Figure 1: *First Transmit Antenna*

In the existing system capacity region of the Gaussian broadcast channel has been characterized. For a given transmit power constraint, the capacity region can be regarded as the set of low optimal operational which attains low number of users in optimum level and also when the number of users increase the optimum level decreases. The average optimum per users (i.e., maximum fairness Quality of Service (QoS)) has not been reached. The disadvantages are

- Limited bandwidth: Each sensor node may be called upon to send data from many different sensors.
- Power issues: Sensor nodes may transmit signals from many adjacent nodes.
- Cost: Complex Software and hardware needed for routing algorithms on each sensor node.

The present work addresses the problem of selecting the optimal solution and satisfies given constraints on the ratios between rates achieved by the different users in the network. This problem is usually known as rate balancing. To this end, the optimum iterative approach for general MIMO channels is revisited and adapted to an OFDMA transmission scheme. Specifically, an algorithm is proposed that exploits the structure of the OFDM channel and whose convergence speed is essentially insensitive to the number of subcarriers.

Major goal is to provide the energy efficient data path planning for the mobile system. This project is to develop the Wireless Distributive System Management with high reliability, mobility and routing. The choice of implementing algorithm depends upon the power allocation, nodal analysis, data gathering and node localization.

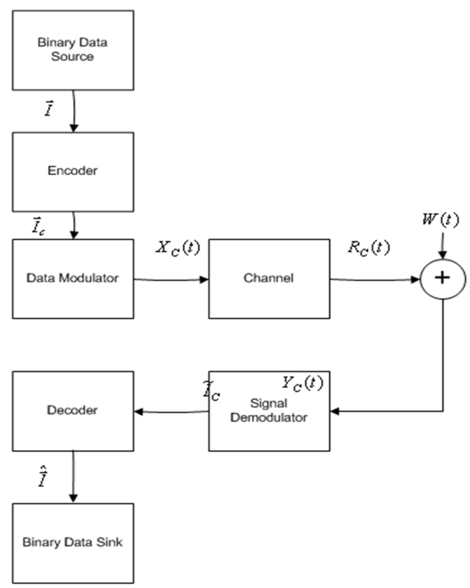

Figure 2: *Second Transmit Antenna*

2. BACKGROUND

The phase sequences are generated randomly from set {±1, ±j}. Neumann phase sequences are used as phase sequence set. Monomial phase sequences for SLM and found that the cubic phase sequences offer better PAPR reducing capability. A phase sequence has a small number of components of the phase sequences have magnitude larger than one while the rest of the components are exactly one. The rows of the Hadamard matrix are selected as phase sequence set for PAPR reduction in SLM technique. The chaotic phase sequence set outperforms Walsh-Hadamard sequence and Shapiro-Rudin sequence set. Pseudo random interferometry code sequence was used to reduce PAPR in MC-CDMA. Generation of phase sequence, which is one of the important aspects of SLM technique, is very random in existing phase sequences sets. For example, in Shapiro-Rudin sequence, which is constructed recursively, the

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

initial sequence, is random. Same is the case with phase sequence set defined, chaotic sequence etc. In the proposed method, the row vectors of normalized Riemann matrix are selected as phase sequence set for PAPR reduction in SLM technique. Riemann matrix has a definite structure which will be seen in section 3. Moreover, in all the existing SLM techniques with different phase sequences, the reduction in PAPR was 4-6.6dB compared to original OFDM (without any PAPR reduction techniques). In the proposed method, through simulations, a reduction of 8.9 dB was observed compared with original OFDM.

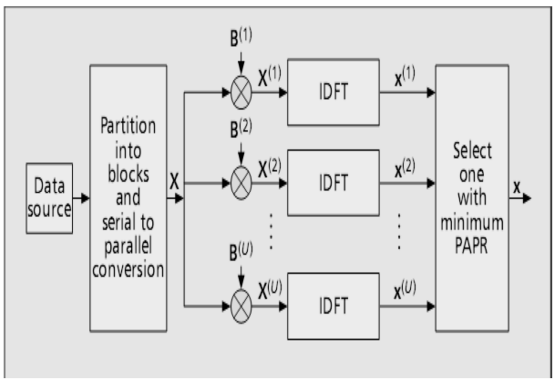

Figure 3: *Generation Of OFDM Signal*

3. PROPOSED SYSTEM

A novel formulation with a novel low-complexity centralized algorithm is developed that achieves a ubiquitous coverage, high degree of user fairness and enables intra-cell load balancing in downlink OFDMA-based multi-cell fixed relay networks. The proposed scheme utilizes the opportunities provided in channel dynamism, spatial, and queue and traffic diversities. We show that the scheme provides an efficient tradeoff between network throughput and fairness to all UTs, even to those at the cell edge. We demonstrate the learning ability of the dynamic routing strategy. We also show how substantial savings in complexity and feedback overhead can be attained distinguishing the proposed scheme from traditional centralized schemes.

OFDM is a promising technique for high bit rate transmission systems. It is used in many applications due to its robustness to frequency selective fading or narrowband interference, high bandwidth efficiency and efficient implementation. One major drawback of OFDM is the large PAPR ratio of the signal. Some of the PAPR reduction schemes are clipping, coding, SLM, tone injection, tone reservation, constellation extension and partial transmit sequence; Among them, SLM scheme is relatively attractive since it can obtain better PAPR by modifying the OFDM signal without distortion. Selecting of proper phase sequences to achieve good PAPR reduction is very important in SLM technique. A good amount of literature exists on phase sequences sets for SLM. A brief look at those follows:

3.1 Dynamic Routing

Dynamic routing is a networking technique that provides optimal data routing. Unlike static routing, dynamic routing enables routers to select paths according to real-time logical network layout changes. In dynamic routing, the routing protocol operating on the router is responsible for the creation, maintenance and updating of the dynamic routing table. In static routing, all these jobs are manually done by the system administrator. Dynamic routing uses multiple algorithms and protocols. OFDM uses this technique to switch between various frequencies for different users.

3.2 Traffic Scheduling

Fairness as defined in wire line network cannot be achieved in wireless packet networks due to the burst and location dependent channel errors of wireless link. Channel-state dependent scheduling and compensation mechanism for error flows are generally employed to improve the fairness in wireless packet scheduling algorithms. Most of the wireless scheduling algorithms, however, have two common significant problems. One problem is that they operate incorrectly unless all flows have the same packet size. This is due to the incorrect lead-and-lag model and the swapping-based rough compensation mechanism of the algorithms. The other problem is the degradation of error-free flow during compensation. The root of the degradation is that the bandwidth for compensation cannot be reserved since it is very difficult to predict.

3.3 Burst Allocation

Our basic assumption is the use of a HARQ chain with 6 asynchronous Stop and Waits (SAW) processes. The HARQ mechanism for a multi-stream MIMO transmission has to handle the individual spatial streams. Assuming we have selected a rather optimal MIMO HARQ mechanism, Dual HARQ, with independent HARQ chains for each code word. There is no HARQ

Journal of Theoretical and Applied Information Technology
15 May 2012. Vol. 39 No.1

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

process synchronization between the two HARQ chains and two separate ACK/NACK signaling is required from the terminal. From spectral efficiency point of view this is the optimal solution because the code-words are handled completely independently as two separate transmissions. (In the proposed algorithm we have used Cyclic Prefix Extension)

while maintaining users' quality of service (QoS). Although this load balancing function will be an integral part of any prospective RRM scheme, in the literature of OFDMA-based relay networks, researchers often associate the term "load balancing" with a different function which aims at distributing the load evenly among the cell nodes. The number of OFDM subcarriers handled by a node is often employed in literature as a good estimate of its traffic load. As such, an even distribution of subcarriers balances the load among the nodes cell-wide. Although the scheme aims at achieving the conventional load balancing among cells using boundary RSs, it employs the number of sub-channels as a measure of the traffic load. A balanced traffic load reduces the packet processing delays at the regenerative relays. Moreover, load balancing results in the so called 'relay fairness'; a fair utilization of the energy sources of the RSs if the network employs battery/solar-powered RSs.

4. PROPOSED OFDMA SYSTEM

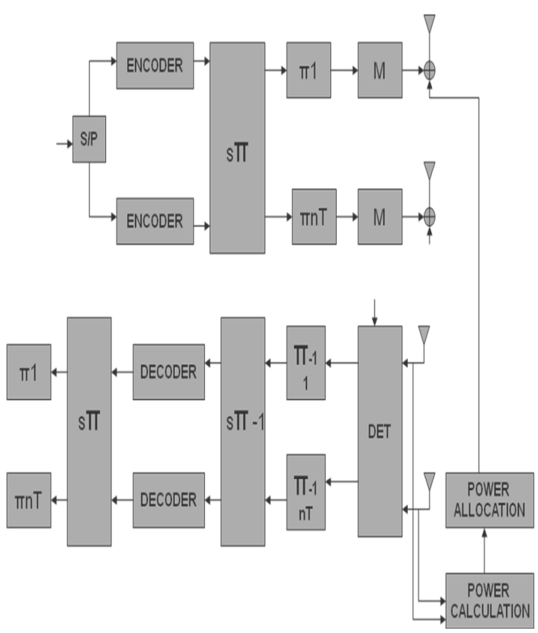

Figure 4: *Block Diagram For Proposed OFDMA Transceiver*

3.4 Load Balancing

Load balancing is usually incorporated with power allocation algorithm. The connection admission control mechanisms in conventional cellular networks and it refers to the hand over (hand-off) of some UTs between adjacent cells to distribute the traffic load among BSs network-wide

The functional block diagram of the transmitter and receiver for OFDMA is shown in the figure 5. This sub clause specifies the general processing of the WRAN baseband signal. The binary data for transmission is supplied to the PHY layer from the MAC layer. This is input to a channel coding processor which includes data scrambler, encoder, puncturer, and bit inter-leaver. The interleaved data is mapped to data constellations for QAM modulation. The subcarrier allocator assigns the data constellations to the corresponding sub channels. In order to support the synchronization, channel estimation, and tracking process, the preamble is inserted in the first 1 or 2 OFDM symbols of each frame, and the pilot subcarriers are transmitted at fixed positions in the frequency domain within each OFDM symbol. In the frequency-domain, an OFDM symbol contains the data, pilot, and null subcarriers. The resultant stream of constellations is subsequently input to an inverse discrete Fourier transform after serial-to-parallel conversion. The inverse Fast Fourier Transform (IFFT) is the expected means of performing the inverse Discrete Fourier Transform. In order to prevent inter-symbol interference (ISI) and inter-carrier interference (ICI) due to delay spread, the OFDM symbol is cyclically. Finally the OFDM signal is transferred to the front-end modules via an analog-to-digital converter. The OFDM receiver basically performs the operations of the transmitter in reverse order. .

Figure 4 shows the proposed OFDMA system. Here the incoming signal is encoded using codec block then it is transmitted to inter-leaver which converts 1 x M signals to M x N signal. Then it is transmitted to QAM mapping. Then modulated signal is transmitted through antenna to receiver antenna. Power allocation algorithm is used in the receiver base station. In receiver side reverse process takes place.

Journal of Theoretical and Applied Information Technology
15 May 2012. Vol. 39 No.1

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

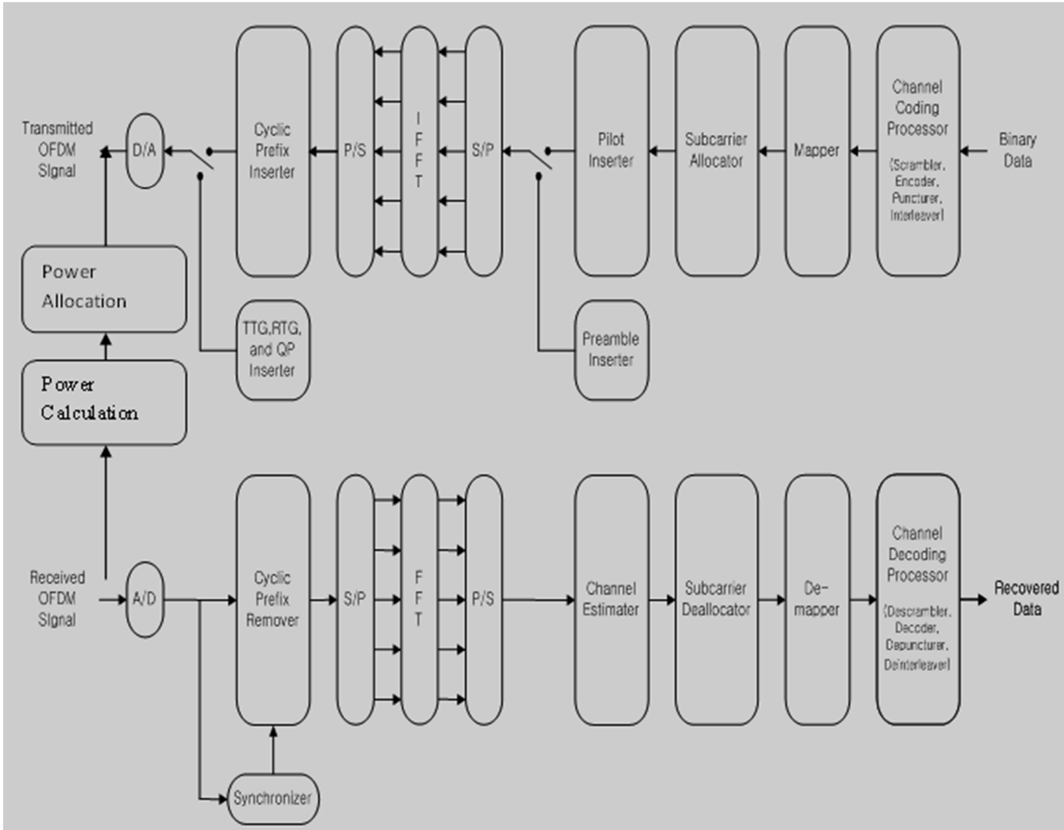

Figure 5: *Detailed Block Diagram For Proposed System*

4.1 Advantages of OFDM

- Increased efficiency because carrier spacing is reduced (orthogonal carriers overlap)
- Equalization simplified, or eliminated
- More resistant to fading
- Data transfer rate can be scaled to conditions
- Single Frequency Networks are possible (broadcast application) because of advances in signal processing Horsepower

4.2 Comparing OFDM Systems

- All use complex IFFT to generate symbol pulse
- All use the general concept of a guard interval, although there are some variations
- Some systems do not require equalizers in the receiver
- Some systems do not use a rectangular pulse
- Pilot and sync symbols (and carriers) vary from system to System

4.3 Orthogonal Signal

Two signals are orthogonal if their dot product is zero. That is to say that if you can take two signals, multiply them together and then integrate over some interval, and the result is zero, then they are orthogonal in that interval. TDMA isn't normally considered an orthogonal coding scheme; however the idea applies if you consider the time interval to be the burst width. Over that interval, the other signal is zero, so the dot product is zero. Walsh codes which are used in CDMA systems are orthogonal, and are probably the most common form of orthogonal signaling. For example in IS-95, length 64 Walsh codes provide 64 possible code channels. OFDM with power allocation is actually very closely related to CDMA. Instead of Walsh codes, the basic functions are sinusoids. In a given period, the sinusoids will be orthogonal provided there are an integral number of cycles. The amplitude and phase of the sinusoid, which will be used to represent symbols, does not affect the orthogonality property. Using sinusoids instead of Walsh codes produces a spectrum where it's possible to associate a carrier frequency with a code

Journal of Theoretical and Applied Information Technology
15 May 2012. Vol. 39 No.1

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

channel. For a single OFDM carrier, we can model the transmitted pulse as a sinusoid multiplied by a RECT function. In the frequency domain, the resulting spectrum has a sin(x)/x shape centered at the carrier frequency. The sin(x)/x spectrum has nulls at adjacent carrier frequencies, provided the sinusoid is on frequency and has zero bandwidth, and the RECT function is the proper width. The RECT function can have the wrong width if the ADC/DAC sample rates are incorrect in either the transmitter or receiver. The zero-width assumption can be violated by phase noise, again in either the transmitter or the receiver. Relative to SCM system using Nyquist filtering, the OFDM carriers occupy a significant amount of spectrum relative to the symbol rate. This characteristic is not a problem given the carriers can overlap. The slow sin(x)/x roll off are really only an issue at the edge of the channel. Standards like 802.11A allow the RECT pulse to be modified such the rising and falling edges are softer. This helps constrain the spectrum without affecting data transmission.

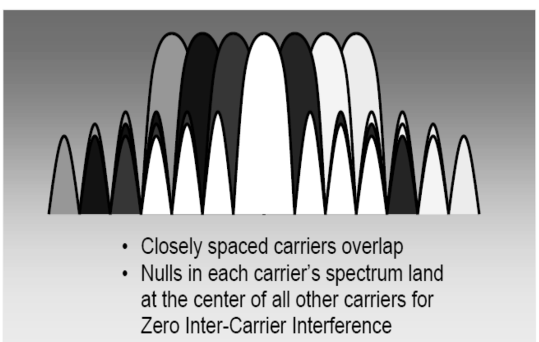

Figure 6: *Carrier Spectrum*

As was mentioned, in FDM systems, the channel spacing is typically greater than the symbol rate to avoid overlapped spectrums. In OFDM the carriers are orthogonal and overlap without interfering with one another. The idea is similar to that of Nyquist filtered SCM signals. The symbols in a single-carrier system overlap in the time domain, but don't interfere with one another because of the symbol (T) spacing of the zero crossings. For OFDM, the carriers have spectral null at all other carrier frequencies.

4.4 Real Time Application of OFDM with Power Allocation

The basic principle of the space domain power allocation for MIMO OFDM signal is to perform spatial domain optimization of the transmit power in function of the channel state information (CSI) and the expression of the global BER for the specific QPSK modulation. By simply performing transmit power allocation from the estimate value of the BER, we propose to optimize the transmit power allocation by performing Lagrangian method on the BER expression. Constraint is added in order to keep the global transmit power at the transmitting part constant.

4.5 The OFDM Spectrum

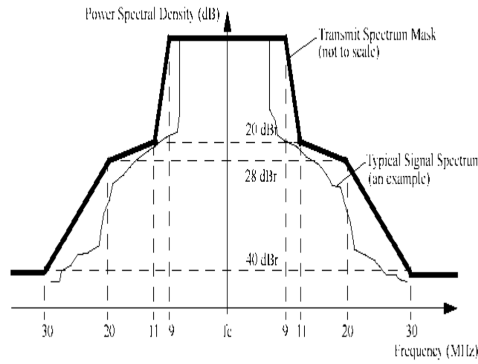

Figure 7: *OFDM Spectrum*

The OFDM spectrum is very flat across the top. As drawn in the 802.11A standard, you might think the side lobes were caused by third-order distortion. In fact, the side lobe structure of this signal is part of the modulation as was shown in the previous slide.

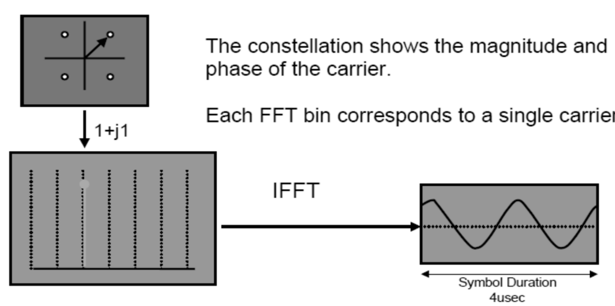

Figure 8: *OFDM Constellation And Single Carrier Signal*

In this example we are going to create an OFDM signal with only one carrier. The magnitude and phase of the carrier are determined from the symbol to be transmitted, as shown in the constellation diagram. The complex number representing the symbol is loaded into an FFT buffer, and an inverse-FFT performed. This produces a set of time-domain samples. These samples are then transmitted. In 802.11A and HIPERLAN/II the FFT size is 64. 52 of the FFT bins are loaded with data

Journal of Theoretical and Applied Information Technology
15 May 2012. Vol. 39 No.1

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

and pilots. After the IFFT, all 64 time samples are transmitted. For simplicity this is shown using a baseband FFT where the left most bin represents DC. In real systems, a complex IFFT is used where the center bin is DC and equates to the carrier frequency.

5. CONCLUSION

Wireless sensor networks (WSNS), composed of low cost, low-power, multifunctional sensor nodes. Applications of such WSN are medical treatment, environmental monitoring, outer-space exploration, emergency response, etc. In this work we have achieved a maximum capacity, high performance, low error rate and high QOS by using the four concepts as discussed above. The four concepts are dynamic routing, traffic scheduling, burst allocation and load balancing. Four different algorithms are used to achieve the above factors. High bit error rate transmission is also achieved by using Orthogonal Frequency Division Multiple Access (OFDM) system. It's now finding its way into broadband internet access systems such as wireless LANs and Point-to-Multipoint distribution systems. Inter-symbol interference (ISI) is eliminated and multipath effects can be compensated with a much simpler equalizer. As a modulation format, OFDM is very flexible in that it can be easily scaled to meet the needs of a particular application.

In the near future, sensor devices will be produced in large quantities at a very low cost and densely deployed to improve robustness and reliability. This project may be extended by introducing the concept of multiple-point-to-multiple-point, which enables free communications between any two nodes in network to fulfill quicker, convenient and economical data transmission which involves the automatic mapping and improved power saving.

REFERENCES:

[1] J. N. Laneman, D. N. C. Tse, and G. W. Wornell, "Cooperative diversity in wireless networks: efficient protocols and outage behavior," IEEE Trans. Inf. Theory, vol. 50, no. 12, pp. 3062–3080, Dec. 2004.

[2] S. G. S. Katti and D. Katabi, "Embracing wireless interference: analog network coding," in Computer Science and Artificial Intelligence Laboratory Technical Report, Feb. 2007.

[3] B. Rankov and A. Wittneben, "Spectral efficient signaling for halfduplex relay channels," in Proc. Annual Conference on Signals, Systems, and Computers, Pacific Grove, USA, Oct. 2005, pp. 1066–1071.

[4] B. Rankov and A. Wittneben, "Achievable rate regions for the two-way relay channel," in Proc. IEEE ISIT, Seattle, USA, July 2006, pp. 1668–1672.

[5] S. J. Kim, N. Devroye, P. Mitran, and V. Tarokh, "Achievable rate regions for bi-directional relaying," submitted to IEEE Trans. Inf. Theory, avalaible at arXiv:0808.0954v1.

[6] T. Cui, T. Ho, and J. Kliewer, "Memoryless relay strategies for two-way relay channels: performance analysis and optimization," in Proc. IEEE ICC, Beijing, China, May 2008, pp. 1139–1143.

[7] T. Cui, F. Gao, T. Ho, and A. Nallanathan, "Distributed space-time coding for two-way wireless relay networks," in Proc. IEEE ICC, Beijing, China, May 2008, pp. 3888–3892.

[8] S. Sen and A. Nehorai, "Adaptive OFDM radar for target detection in multipath scenarios," Signal Processing, IEEE Transactions on, vol. 59, pp. 78–90, January 2011.

[9] S. Sen and A. Nehorai, "OFDM MIMO radar with mutual-information waveform design for low-grazing angle tracking," Signal Processing, IEEE Transactions on, vol. 58, no. 6, pp. 3152–3162, 2010.

[10] S. Sen and A. Nehorai, "Target detection in clutter using adaptive OFDM radar," Signal Processing Letters, IEEE, vol. 16, no. 7, pp. 592–595, 2009.

[11]D. Garmatyuk, "High-resolution ultrawideband SAR based on OFDM architecture," April 2006. White paper.

[12] C. Sturm, T. Zwick, and W. Wiesbeck, "An ofdm system concept for joint radar and communications operations," in Vehicular Technology Conference, 2009. VTC Spring 2009. IEEE 69th, pp. 1–5, IEEE, 2009.

[13] M. Braun, C. Sturm, A. Niethammer, and F. K. Jondral, "Parametrization of joint ofdm-based radar and communication systems for vehicular applications," in Personal, Indoor and Mobile Radio Communications, 2009 IEEE 20th International Symposium on, pp. 3020–3024, IEEE, 2009.

[14] C. Sturm, M. Braun, and W. Wiesbeck, "Deterministic propagation modeling for joint radar and communication systems," in Electromagnetic Theory (EMTS), 2010 URSI

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

International Symposium on, pp. 942 945, IEEE, 2010.

[15] Y. Sit, C. Sturm, and T. Zwick, "Doppler estimation in an ofdm joint radar and communication system," in Microwave Conference (GeMIC), 2011 German, pp. 1–4, IEEE, 2011.

[16] Y. L. Sit, L. Reichardt, C. Sturm, and T. Zwick, "Extension of the OFDM joint radar-communication system for a multipath, multiuser scenario," in IEEE Radar Conference, 2011.