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Editorial

OFDMA Architectures, Protocols, and Applications

Victor C. M. Leung,[1] Alister G. Burr,[2] Lingyang Song,[3] Yan Zhang,[4] and Thomas Michael Bohnert[5]

[1] *Department of Electrical and Computer Engineering, The University of British Columbia, 2332 Main Mall, Vancouver, BC, Canada V6T 1Z4*
[2] *Department of Electronics, University of York, York, YO10-5DD, UK*
[3] *Peking University, China*
[4] *Simula Research Laboratory, 1325 Lysaker, Norway*
[5] *SAP Research CEC Zurich, Switzerland*

Correspondence should be addressed to Yan Zhang, yanzhang@ieee.org

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Welcome to this special issue of the EURASIP Journal on Wireless Communications and Networking (JWCN). This special issue is devoted to the topic of the latest research and development on Orthogonal Frequency-Division Multiple Access (OFDMA) from physical and network layers to practical applications. OFDMA technologies are currently attracting intensive attention in wireless communications to meet the ever-increasing demands arising from the explosive growth of Internet, multimedia, and broadband services. OFDMA-based systems are able to deliver high data rate, operate in the hostile multipath radio environment, and allow efficient sharing of limited resources such as spectrum and transmit power between multiple users. OFDMA has been used in the mobility mode of IEEE 802.16 WiMAX, is currently a working specification in 3GPP Long Term Evolution downlink, and is the candidate access method for the IEEE 802.22 "Wireless Regional Area Networks." Clearly recent advances in wireless communication technology have led to significant innovations that enable OFDMA-based wireless access networks to provide better Quality-of-Service (QoS) than ever with convenient and inexpensive deployment and mobility.

However, regardless of the technology used, OFDMA networks must not only be able to provide reliable and high-quality broadband services but also be implemented cost-effectively and be operated efficiently. OFDMA presents many of the advantages and challenges of OFDM systems for single users, and the extension to multiple users introduces many further challenges and opportunities, both on the physical layer and at higher layers. These requirements present many challenges in the design of network architectures and protocols, which have motivated a significant amount of research in the area. Also, many critical problems associated with the applications of OFDMA technologies in future wireless systems are still looking for efficient solutions. The aim of this special issue is to present a collection of high-quality research papers that report the latest research advances in OFDMA communications, networks, systems, and its application in future wireless systems. In this special issue, we selected 17 papers from 36 submissions. The selected papers may be classified into four categories: Channel Estimation, Coding and Modulation, QoS and resource allocation, and Systems and Implementation. In the first part, 4 papers were included. In the second part, there are 3 papers on the coding and modulation. There are 7 papers about QoS and resource allocation management, and 3 papers were selected for systems and implementation issues. A detailed overview of the selected works is given below.

Channel Estimation. This part describes the recent advances on channel estimation in OFDMA systems.

The first paper, "A fast LMMSE channel estimation method for OFDM systems," reports a fast linear minimum mean square error (LMMSE) channel estimation method for OFDM systems. In comparison with conventional LMMSE channel estimation, the proposed channel estimation method does not require statistical knowledge

of the channel in advance and avoids the inverse operation of a large dimension matrix by using the FFT operation. Therefore, the computational complexity can be reduced significantly. Numerical results show that the NMSE of the proposed method is very close to that of the conventional LMMSE method. In addition, computer simulation shows that the performance of the proposed method is almost the same as that of the conventional LMMSE method in terms of bit error rate.

The second paper, "Linearly time-varying channel estimation and symbol detection for OFDMA uplink using superimposed training," addresses superimposed training-(ST-) based linearly time-varying (LTV) channel estimation and symbol detection for OFDMA systems. The study estimates the LTV channel transfer functions over the whole frequency band by using a weighted average procedure, thereby providing validity for adaptive resource allocation. In addition, an iterative symbol detector is presented to mitigate the superimposed training effects on information sequence recovery.

The third paper, "DFT-based channel estimation with symmetric extension for OFDMA systems," presents a partial frequency response channel estimator for OFDMA systems. The partial frequency response is obtained by using the least square (LS) method. A symmetric extension method is proposed to reduce the leakage power. After IDFT of the symmetric extended signal, the leakage power of channel impulse response is self-cancelled. Simulation results show that the accuracy of the estimator has increased significantly compared with the conventional DFT-based channel estimator.

The fourth paper, "Near optimum detection with low complexity for uplink virtual MIMO systems," proposes two efficient MIMO decoding schemes that achieve near-optimum performance with low complexity for uplink virtual MIMO systems. The system has an iterative channel decoder using bit log-likelihood ratio information. The simulation results show that the proposed schemes achieve almost the same block error rate performance as that of the optimal MLD with only minor increased computational complexity.

Coding and Modulation. The first paper, "Separate turbo code and single turbo code adaptive OFDM transmissions," studies adaptive modulation and adaptive rate turbo-coding in OFDM to increase throughput on the time and frequency selective channel. The adaptive turbo-code scheme is based on a subband adaptive method and compares two adaptive systems: a conventional approach where a separate turbo code is used for each subband and a single turbo code adaptive system which uses a single turbo code over all subbands. Simulation results show that the single turbo code adaptive system provides a significant performance improvement.

The second paper, "Multiresolution with hierarchical modulations for long term evolution of UMTS," investigates mobile TV services over UMTS Long Term Evolution (LTE). By using multiresolution with hierarchical modulations, this service is expected to be broadcasted to larger groups achieving significant reduction in power transmission or increasing the average throughput. The presence of interactivity will allow for a certain amount of link quality feedback for groups or individuals. This study performs a system level simulation of multicellular networks considering broadcast/multicast transmissions using the OFDM/OFDMA-based LTE technology with respect to the number of TV channels with given bit rate and total spectral efficiency and coverage. Multiresolution with hierarchical modulations is able to achieve much higher throughput gain compared to single resolution systems of Multimedia Broadcast/Multicast Service (MBMS) standardized in Release 6.

The third paper, "An opportunistic error correction layer for OFDM systems," proposes a cross-layer approach to reduce the power consumption of ADCs in OFDM systems. The scheme is based on resolution-adaptive ADCs and Fountain codes. The key part of the proposed system is that the dynamic range of ADCs can be reduced by discarding sub-carriers that are attenuated by the channel. Correspondingly, the power consumption in ADCs can be decreased. The receiver only decodes subcarriers (i.e., Fountain encoded packets) with the highest SNR. Others are discarded. With the approach, more than 70% of the energy consumption in the ADCs can be saved compared with the conventional IEEE 802.11a WLAN system under the same channel conditions.

QoS and Resource Allocation. The third part focuses on resource allocation and QoS issues. The issues cover medium access control, cross-layer design, service differentiation, and admission control in IEEE 802.11WirelessLAN and IEEE 802.16 WirelessMAN (or WiMAX).

The first paper, "Service differentiation in OFDM-based IEEE 802.16 networks," proposes several service differentiation approaches, which are based on the contention-based bandwidth request scheme and achieved by means of assigning different channel access parameters and/or bandwidth allocation priorities to different services. Additionally, the study proposes an effective analytical model to study the impacts of the service differentiation approaches, which can be used for the configuration and optimization of the service differentiation services. The service differentiation approaches and the analytical model are evaluated by simulation. It is observed that the analytical model has high accuracy. Service can be efficiently differentiated by initial backoff window in terms of throughput and channel access delay. And the service differentiation can be improved if combined with the bandwidth allocation priority approach without adverse impact on the overall system throughput.

The second paper, "Multiuser radio resource allocation for multiservice in OFDMA-based cooperative relay networks," studies multiservice transmission over OFDMA-based cooperative relay networks. The work proposes a framework to adaptively allocate power, subcarriers, and data rate to maximize system spectral efficiency under QoS constraints. The single user scenario is first investigated in a point-to-point cooperative relay network. Then multiservice transmission is investigated in a multiuser point-to-multipoint scenario. Several suboptimal resource

allocation algorithms are proposed to reduce the computational complexity. Simulation results show that the proposed algorithms yield both high spectral efficiency and low outage probability.

The third paper, "Throughput analysis of band AMC scheme in broadband wireless OFDMA system," performs an analysis of the maximum system throughput for a band-AMC under various system parameters. In particular, the practical features of resource management for OFDMA system are modeled and evaluated within the current analytical framework. The results demonstrate that the band-AMC mode outperforms the diversity mode only by providing the channel qualities for a subset of good subbands, confirming the multiuser and multiband diversity gain that can be achieved by the band-AMC mode.

The fourth paper, "Continuous frequency-time resource allocation and scheduling for wireless OFDMA systems with QoS support," presents a joint scheduling and resource allocation scheme for the OFDMA system with continuous subcarrier permutation. The proposed algorithm provides continuous sets of frequency-time resource units following a rectangular shape, yielding a reduction of the required burst signalling. The joint scheme has two phases: the QoS requirements and the input buffers emptying status. For each phase, a specific prioritization function is defined in order to obtain a trade-off between the fairness and the spectral efficiency maximization.

The fifth paper, "OFDMA-based medium access control for next-generation WLANs," studies a new adaptive MAC design based on OFDMA technology. The design uses OFDMA to reduce collision during transmission request phases and makes channel access more predictable. To improve throughput, the study combines the OFDMA access with a Carrier Sense Multiple Access (CSMA) scheme. Data transmission opportunities are assigned through an access point that can schedule traffic streams in both time and frequency (subchannels) domains. The results demonstrate the effectiveness of the proposed MAC and compare it to existing mechanisms through simulation experiments and by deriving an analytical model for the operation of the MAC in saturation mode.

The sixth paper, "Multiuser resource allocation maximizing the user perceived quality," addresses multiuser resource allocation for time/frequency-slotted wireless communication systems. A framework for application driven cross-layer optimization (CLO) between the application (APP) layer and medium access control (MAC) layer is developed. The objective is to maximize the user perceived quality by joint optimization of the rate of the information bit-stream provided by the APP layer and the adaptive resource assignment on the MAC layer. Assuming adaptive transmission with long-term channel state information at the transmitter (CSIT), the optimization problem is analyzed mathematically, which is then used as the basis for a CLO algorithm. The proposed CLO framework supports user priorities such that premium users perceive a better service quality than ordinary users and have a higher chance to be served.

The seventh paper, "Admission control threshold in cellular relay networks with power adjustment," designs admission capacity planning in a cellular network using a cooperative relaying mechanism called decode-and-forward. The work mathematically formulates the dropping ratio using the randomness of "channel gain." With this, the admission threshold planning problem is formulated as a simple optimization problem. The simplicity of the problem formulation facilitates its solution in real-time. The proposed planning method can provide an attractive guideline for dimensioning a cellular relay network with cooperative relays.

Systems and Implementation. The first paper, "Advanced receiver design for quadrature OFDMA systems," investigates various detection techniques such as linear zero forcing (ZF) equalization, minimum mean square error (MMSE) equalization, decision feedback equalization (DFE), and turbo joint channel estimation and detection, for Q-OFDMA systems to mitigate the noise enhancement effect and improve the bit error ratio (BER) performance. It is shown that advanced detection, for example, DFE and turbo receiver, can significantly improve the performance of QOFDMA.

The second paper, "Residue number system arithmetic assisted coded frequency-hopped OFDMA," presents a residue number system arithmetic-based frequency-hopped (FH) pattern design. The proposed FH scheme guarantees orthogonality among intracell users while randomizing the intercell interferences and providing frequency diversity gains. Simulation results demonstrate the gains due to frequency diversity and intercell interference diversity on the system bit error rate (BER) performance. Furthermore, the BER performance gain is consistent across all cells, which is superior to other FH pattern design schemes since they have larger performance variations across cells.

The third paper, "Implementation of a smart antenna base station for mobile-WiMAX based on OFDMA," presents the implementation of a smart antenna base station for OFDMA-based WiMAX. To implement the Base Station, the paper addresses a number of key issues in baseband signal processing related to symbol-timing acquisition, the beamforming scheme, and calibration. Experimental tests were performed to verify the validity of the solutions. Results showed a 3.5-time (5.5 dB) link-budget enhancement on the uplink compared to a single antenna system.

In conclusion, this issue of EURASIP JWCN offers a ground-breaking view into the recent advances in OFDMA communications and networks. The popularity of submissions indicates that OFDMA is a worldwide focus that has universal appeal in terms of research, industry, and standardization. This issue offers both academic and industry appeal—the former as a basis toward future research directions and the latter toward viable commercial applications. OFDMA communications and networks in the longer-term will be characterized by their criticalness in consumer, business, and government applications in the areas of radio communications, LTE, LTE Advanced, WiMAX, and cognitive radio applications.

Finally, we would like to express our gratitude to the Editor-in-Chief of EURASIP JWCN, Dr. Luc Vandendorpe for his advice, patience, and encouragement from the beginning until the final stage. We thank all anonymous reviewers who spent much of their precious time reviewing all the papers. Their timely reviews and comments greatly helped us select the best papers in this special issue. We also thank all authors who have submitted their papers for consideration for this issue.

We hope you will enjoy reading the great selection of papers in this issue.

Victor C. M. Leung
Alister G. Burr
Lingyang Song
Yan Zhang
Thomas Michael Bohnert