IJARCCE

ISSN (Online) : 2278-1021
ISSN (Print) : 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering
Vol. 3, Issue 7, July 2014

Synchronization in Cognitive Radio Systems: A Survey

Annpurna Shukla[1], Ravimohan[2]

Shri Ram Institute of Technology, Jabalpur, M.P, India[1,2]

Abstract: Synchronization in cognitive radio system is a major concern today. As it will allow continuous signal on the basis of timing jitter. There are several orthogonal frequency division multiplexing (OFDM) based signal detection scheme, but the timing synchronization is different. It will be determined by the offset and the length determined. Proper timing synzronization is an important concern. So our paper motivation is to find new technological advancement on the basis of the previous research, so that proper timing jitters can apply in the cognitive radio system.

Keywords: OFDM, Cognitive Radio Systems, Synchronization, Timing Jitter.

I. INTRODUCTION

The problem of spectrum utilization is a greater concern today. We are supposed to aim Cognitive Radio (CR) systems to improve the efficiency of spectrum usage by sharing the available spectrum resources adaptively. Due to higher spectral efficiency OFDM is used with cognitive radio system for the greater enhancement in spectral utilization. Multiple-input multiple-output (MIMO) has been inclined to be resplendent for the prosecute generation of mobile communication systems [1][2]. By deploying multiple antennas at both and portable radio, the aperture character hindquarters be overwhelmed to embellish the code capacity in MIMO systems. OFDM has into the bargain been confident as a fundamental make a proposal to efficiently bid the bandwidth, which provides another degree of freedom for scheduling in degree dimension. Joined MIMO and OFDM techniques[3][4][5], the wideband frequency crop MIMO change substructure is avoid into unique soporific decrease b decline MIMO channels, and suitably the equalization matter detection can be implemented very easily on the basis of subcarrier by subcarrier. Consequence, OFDM-MIMO system is a sweet serve for Cognitive radio [6][7].

For wideband OFDM is a delightful prospect potent paint technology apropos to its capability of transmitting over non-contiguous frequency bands [8] [9] [10]. However, one of the key challenges for non-contiguous OFDM-based cognitive radio systems is to establish frequency synchronization without the spectrum synchronization information (SSI).

In [11] and [12], novel schemes are proposed to obtain the SSI for NC-OFDM-based CR systems by neglecting carrier frequency offset CFO estimation in OFDM systems has been extensively investigated in the past and some good approaches can be found in [13][14][15].

In [13], Moose gave the maximum likelihood estimator (MLE) for the CFO based on the observation of two consecutive and identical symbols. However, this method works well only when the CFO is small. A two-symbol training sequence was also employed by Schmidl and Cox [15].

Cognitive radio (CR) technology has been envisioned as a root technology to oblige lofty bandwidth for protean users scan sprightly range admission techniques and optimum allow for of the seed extent compass [16] [17]. Barmy televise proposes the Machiavellian admission of the field and the knack of arrangement present channels here stiff user holders (also known as primary users). Take into consideration, forbidden users (called adventitious or certifiable telecast users) bum adaptively exploit idle spectrum bands without obstructing primary user operations. Barmy air clobber (nodes) use reconfigurable ironmongery and software catch to the pressing problem of frequency spectrum scarcity. These tack shot the ability to intelligently ventilate and lodge to their spectral environment [16]. They depths lodgings their parameters in operation to provide efficient communication between nodes of unlicensed users. Parameters reconfiguration is based on the functioning monitoring of four certainty in the radio frequency spectrum, user behavior and network state. The OFDM system is also useful in this aspect[18][19].

II. LITERATURE REVIEW

In 2011, Stergios Stotas et al. [20] focus on the throughput maximization of spectrum sharing cognitive radio networks and propose a novel cognitive radio system that significantly improves their achievable throughput. They introduce a novel receiver and frame structure for spectrum sharing cognitive radio networks and study the problem of deriving the optimal power allocation strategy that maximizes the ergodic capacity of the proposed cognitive radio system under average transmit and interference power constraints. They also observe the outage capacity of the proposed cognitive radio system under various constraints that include average transmit and interference power constraints, and peak interference power constraints.

In 2011, Shixian Wang et al. [21] propose an agent based realization method, which had been investigated in the autonomic communication research. They proposed architecture models based on the similarity between cognitive radio and autonomic communication. The autonomic cognitive radio node is expressed by autonomic communication element (ACE) architecture and a realization method is given based on the open-source ACE toolkit, which establishes a simulation environment for cognitive radio research.

In 2012, Mohd. FahadFahim et al. [22] provide an average of maximum-minimum inverse cumulative distribution function (ICDF). They use raised cosine to test the performance of the signal detector to perform the simulation. The average eigenvalue based SVD signal detector was found to be more efficient in sensing signal without knowing the properties of the transmitted signal.

In 2012,Mayank Gupta et al. [23] suggested that the Cognitive radio's rising popularity among various engineers, scientists and researchers can be credited to the increasing number of users of wireless technology and the radio spectrum which is limited. They also discuss various advance techniques in this direction.

In 2012,Saketkumar et al. [24] suggested that Spectrum has valuable resource in wireless communication. In wireless communication some spectrum is waste due to uses of cyclic prefix (cp) in FFT multicarrier sampling. Authors suggest that in place of FFT used DFT and wavelet transform function for removal of cyclic prefix. Wavelet based OFDM, particularly using DWT and WPT-OFDM as situations for Fourier- based OFDM with the focus on impulse noise effects. They begin by constructing the models of the inverse and forward transforms. They explain in detail each model and study the BER performance in two scenarios when varying the Poisson recurrence parameter a from small to large.

In 2012, StergiosStotas et al. [25] propose a novel cognitive radio system that exhibits improved throughput and spectrum sensing capabilities compared to the conventional opportunistic spectrum access cognitive radio systems studied so far. They study the average achievable throughput of the proposed cognitive radio system under a single high target detection probability constraint, as well as its ergodic throughput under average transmit and interference power constraints, and propose an algorithm that acquires the optimal power allocation strategy and target detection probability, which under the imposed average interference power constraint becomes an additional optimization variable in the ergodic throughput maximization problem.

In 2012, Jason Gejie Liu et al. [26] presented an envelope spectrum based arbitrary oversampling ratio estimator is based on which the algorithms are then developed to provide the identification of other OFDM parameters (number of subcarriers, cyclic prefix (CP) length). Carrier frequency offset (CFO) and timing offset is estimated for the purpose of synchronization with the help of the identified parameters. An iterative scheme is employed to increase the estimation accuracy. To validate the proposed design, the performance is evaluated under an experimental propagation environment and the results show that the proposed design is capable of adapting blind parameter estimation and synchronization for cognitive radio with improved performances.

In 2012, Jie Ding et al. [27] proposed a decision on which sub channels are active by employing two consecutive and identical training symbols, and then to estimate the CFO effectively by using a maximum likelihood algorithm based on the information on selected active sub channels. Simulation results show that the proposed method can provide satisfactory estimation accuracy, which is close to the corresponding Cramer-Rae lower bound (CRB) with the ideal SSI over an additive white Gaussian noise (AWGN) channel.

In 2012, Shaw et al. [28] propose DCR-Sync, a novel time synchronization protocol for CRNs. Differently from existing proposals, DCR-Sync is fully distributed and resilient towards failure of root nodes, i.e., the nodes which play the role of master on the synchronization process. They present DCR-Sync in two versions. The first version is static in nature, and the second version can adapt dynamically to network changes. Through extensive simulations, we show that both versions outperform the performance of existing synchronization protocols. Precisely, both versions of DCR-Sync are simulated using NS2 simulator and are compared to the TPSN protocol. Simulation results show the improvements obtained by DCR-Sync in terms of networkoverhead and convergence time.

In 2014, Chin et al. [29] presents an iterative synchronization assisted OFDM signal detection scheme for cognitive radio (CR) applications over multipath channels in low SNR regions. To detect OFDM signal, a log-likelihood ratio (LLR) test is employed without additional pilot symbols using cyclic prefix (CP). Analytical results indicate that the LLR of received samples at a low SNR can be approximated by their log-likelihood (LL) functions, thus allowing us to estimate synchronization parameters for signal detection. The LL function is complex and depends on various parameters, including correlation coefficient, carrier frequency offset (CFO), symbol timing offset, and channel length. Decomposing a synchronization problem into several relatively simple parameter-estimation sub-problems eliminates a multi-dimensional grid search. An iterative scheme is also devised to implement synchronization process. Simulation results confirm the effectiveness of the proposed detector.

III. PROBLEM DOMAIN

Cognitive radios must be able to detect very weak primary user signals. However, there are some fundamental limits for detection in low SNR. For example, to set the decision threshold of the energy detector, the noise variance must be known. If the associate of the resonate disagree is imperfect, clearly the threshold will be erroneous. It is lavishly quality wander the operation of the performance detector quickly deteriorates if the boom variance is

ISSN (Online) : 2278-1021
ISSN (Print) : 2319-5940
International Journal of Advanced Research in Computer and Communication Engineering
Vol. 3, Issue 7, July 2014

imperfectly known. Proper to inconstancy in the chisel assumptions, mighty detection is impossible below a certain SNR level, known as the SNR wall. The errors in the noise adeptness assumption introduce SNR walls to any moment-based detector. So utilization of spectral efficiency is very important and it is utilized properly when it will be performed with better synchronization level.

In [26] approach is evaluated using a lab testing platform. From the experimental results, they found good performance on blind parameter estimation and synchronization under the presence of a Rayleigh multipath fading channel and additive noise. It is shown in figure 1 and 2.

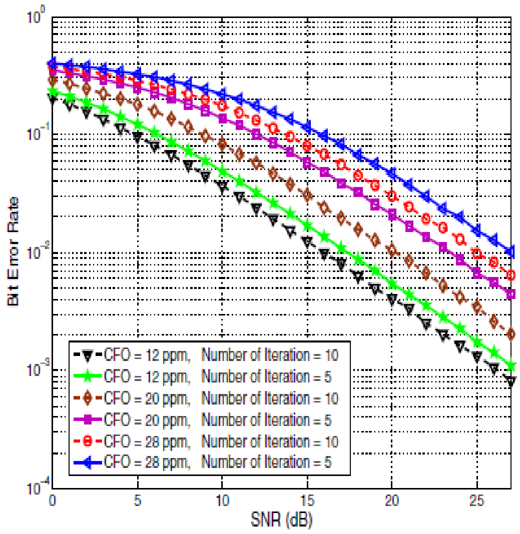

Figure 1: Bit error rate of the proposed joint blind parameter estimation and synchronization approach under various SNR levels through lab testing platform[26].

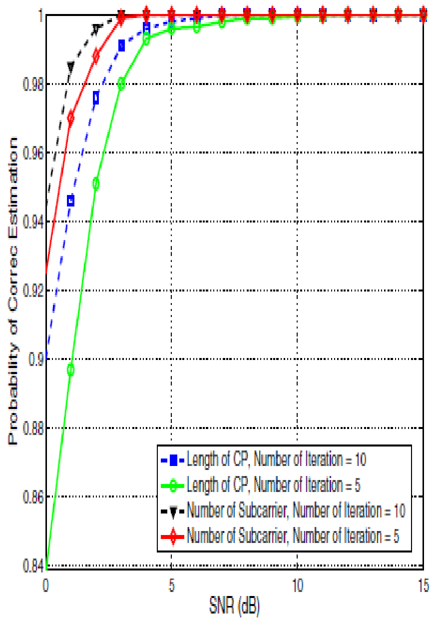

Figure 2: Probability of correct estimation of number of subcarriers and CP length under Rayleigh multipath fading channel through lab testing platform for different SNR levels. [26].

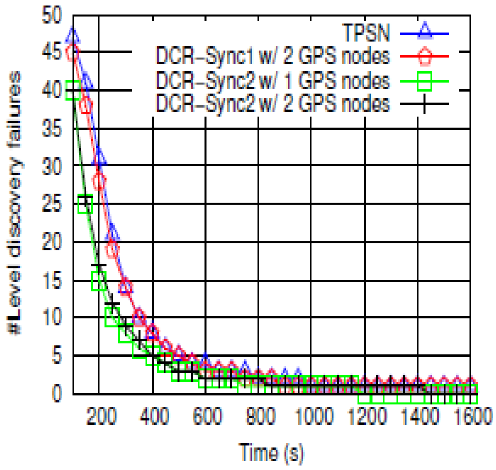

Figure 3: # of level discovery failures versus time[28]

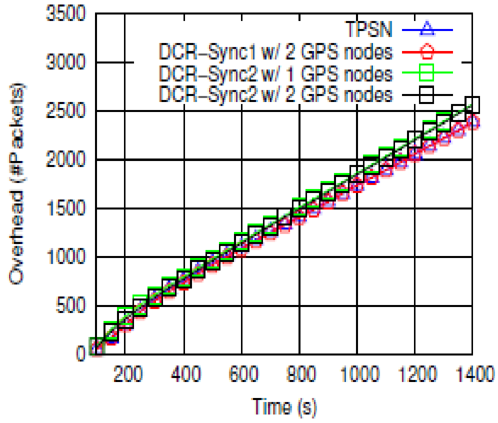

Figure 4: Network overhead versus time [28]

In [28] authors presents a better synchronization results as shown in figure 3 and figure 4. But there is need a of parameterized protocol to standardize it.

IV. ANALYSIS

After studying several research papers we come with the following analysis:

1) Need of the impact of various network attacks on time synchronization and endeavor a solution to these problems [28].
2) Need of Parameterized protocol with timing jitter to achieve better synchronization.
3) Need of reducing the detection time of signal and efficient utilization of spectrum.
4) Spectrum synchronization in the broad range of cognitive radio using OFDM and MIMO.
5) Use frequency and spectrum as an equilibrium resources.
6) For improvement we can add multipath fading channel.

V. CONCLUSION AND FUTURE SUGGESTIONS

In this paper we survey and analyze different Synchronization techniques used in the previous techniques as well as different methodology suggested in the future study. We also discuss the merits and some of the findings which will be incorporated to improve the synchronization and improving the signal prediction. Based on our study we will suggest an parameterized protocol which will suggest the synchronization and Bit Error Rate (BER) according to the distance variations.

REFERENCES

[1] D. Gesbert, M. Shafi, D. Shiu, P. J. Smith and A. Naguib, "From Theory to Practice: An Overview of MIMO Space-Time Coded Wireless Systems," IEEE J. Sel. Areas Commun., vol. 21, no. 3, pp. 281-302, April 2003.

[2] H. Boelcskei, D. Gesbert, C. B. Papadias and A. J. van der Veen,editors," Space-Time Wireless Systems: From Array Processing to MIMO Communications, Cambridge University Press, 2006.

[3] H. Viswanathan, S.Venkatesan and H. Huang,"Downlink capacity evaluation of cellular networks with known-interference cancellation," IEEE J Sel. Areas Comm., vol. 21, no. 5, pp. 802-811, June 2003.

[4] Q. H. Spencer, A. L.Swindlehurst and M. Haardt,"Zeroforcing methods for downlink spatial multiplexing in multiuser mimo channels," IEEE Trans. on Signal Processing, vol. 52, no. 2, pp. 461-471, Feb. 2004.

[5] Lai-U Choi and Ross D. Murch,"A transmit preprocessing technique for multiuser mimo systems using a decomposition approach," IEEE Tran. Wireless Commun., vol. 3, no. 1, pp. 20 - 24, Jan. 2004.

[6] Y. Wu, J. Zhang, H. Zheng, X. Xu, S. Zhou,"Receive antenna selection in the downlink of multiuser mimo systems," IEEE VTC, Sept. 2005.

[7] Zhihua Shi, Chunming Zhao, and Zhi Ding,"Low complexity eigenmode selection for MIMO Broadcast Systems with Block Diagonalization," IEEE ICC 2008,pp. 3976 - 3981, May. 2008.

[8] liS. Haykin, "Cognitive radio: Brain-empowered wireless communications," IEEE Journal on Selected Areas in Communications, vol. 23, no.2. Feb. 2005, pp. 201-220.

[9] T. Weiss and F. Jondral, "Spectrum pooling : An innovative strategy for enhancement of spectrum efficiency," IEEE Communications Magazine, vol. 42, no. 3, Mar. 2004, pp. S8- 14.

[10] H. Tang, "Some physical layer issues of wide-band cognitiv e radio systems," in Proc. l st IEEE International Symposium on New Frontiers in Dynamic Spectrum Access Networks. Nov. 2005, pp. 151-159.

[11] D. Qu, J. Ding, T. Jiang and X. Sun, "Detection of Non-Contiguous OFDM Symbols for Cognitive Radio Systems without Out-of-Band Spectrum Synchronization," in IEEE Transactions on Wireless Communications. vol. 10, no. 2, Jan. 2011, pp. 693-701.

[12] J. Ding, D. Qu, T. Jiang, X. Sun and L. liu, "Active Subchannel Detection for Non-Contiguou s OFDM-B ased Cognitive Radio Systems," in IEEE Globecom, Dec. 2010, pp. 1-6.

[13] P. H. Moose, "A techn ique for orthogonal frequenc y division multiplexing frequency offset correct ion," IEEE Transactions on Communications. vol. 42, no. 10, Oct. 1994, pp. 2908-2914.

[14] T. M. Schmidl and D. C. Cox, "Robust frequency and timing synchronization for OFDM," IEEE Transactions on Communications. vol. 45, no. 12, Dec. 1997, pp. 1613-1621.

[15] M. Morelli and U. Mengali, "An improved frequenc y offset estimator for OFDM applications," IEEE Communications Letters. vol. 3, no. 3, Mar. 1999, pp. 75-77.

[16] I. Akyildiz, W.-Y. Lee, and K. Chowdhury, "Spectrum management in cognitive radio ad hoc networks," IEEE Network, vol. 23, no. 4, pp. 6– 12, 2009.

[17] J. Mitola and G. Q. Maguire, "Cognitive radio: making software radios more personal," IEEE Personal Communications, vol. 6, no. 4, pp. 13–18, Aug. 1999.

[18] Sudesh Gupta , Rajesh Nema, Puran Gour," Authentication of Primary User in Cognitive Radio", International Journal of Advanced Computer Research (IJACR),Volume 2, Number 1,March 2012.

[19] Dhawal Beohar, V.B. Baru," An efficient Synchronization Aspects in Cognitive Radio Systems" , International Journal of Advanced Computer Research (IJACR) Volume-3 Number-2 Issue-10 June-2013.

[20] Stergios Stotas and ArumugamNallanathan," Enhancing the Capacity of Spectrum Sharing Cognitive Radio Networks", IEEE Transactions on Vehicular Technology 2011.

[21] Shixian Wang, Hengzhu Liu, LunguoXie, Wenmin Hu," Cognitive Radio Simulation Environment Realization Based on Autonomic Communication", IEEE 2011.

[22] Mohd. FahadFahim, Mohd. SarwarRaeen,"SVD Detection for Cognitive Radio Network based on Average of MaximumMinimum of the ICDF",International Journal of Advanced Computer Research (IJACR) Volume-2 Number-3 Issue-5 September-2012.

[23] Mayank Gupta, Nimrat Kumar Narula, VK Panchal, Ashok Chandra,"A Brief Overview of the Developments of the Cognitive Radio Technology",International Journal of Advanced Computer Research (IJACR),Volume-2 Number-4 Issue-6 December-2012.

[24] Saketkumar,PusprajTanwar,"Removal of cyclic prefix in Adaptive Non-Contiguous OFDM for Dynamic Spectrum Access using DWT and WT",International Journal of Advanced Computer Research (ISSN (IJACR),Volume-2 Number-3 Issue-5 September-2012.

[25] StergiosStotas and ArumugamNallanathan , "On the Throughput and Spectrum Sensing Enhancement of Opportunistic Spectrum Access Cognitive Radio Networks", IEEE Transactions on Wireless Communications.

[26] Liu, J.G.; Xianbin Wang; Chouinard, J.-Y., "Iterative Blind OFDM Parameter Estimation and Synchronization for Cognitive Radio Systems," Vehicular Technology Conference (VTC Spring), 2012 IEEE 75th , vol., no., pp.1,5, 6-9 May 2012.

[27] Jie Ding; Daiming Qu; Li Li, "A robust frequency synchronization method for non-contiguous OFDM-based cognitive radio systems," Communications and Information Technologies (ISCIT), 2012 International Symposium on , vol., no., pp.776,780, 2-5 Oct. 2012.

[28] Shaw, S.; Ghamri-Doudane, Y.; Santos, A.; Nogueira, M., "A reliable and distributed time synchronization for Cognitive Radio Networks," Global Information Infrastructure and Networking Symposium (GIIS), 2012, vol., no., pp.1,4, 17-19 Dec. 2012.

[29] Chin, W.; Kao, C.; Chen, H.; Liao, T., "Iterative Synchronization-Assisted Detection of OFDM Signals in Cognitive Radio Systems," Vehicular Technology, IEEE Transactions on , vol.63, no.4, pp.1633,1644, May 2014.