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Review on Analysis of LTE and Cognitive Radio Network using OFDM signal

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***Abstract*—** Long Term Evolution (LTE) and Cognitive Radio Network (CRN) are built to achieve high data rates with low latency and packet optimized system. Orthogonal Frequency Division Multiple Access (OFDM) is adopted as the access technology for LTE in modern technology. OFDM provides several techniques and advantages for spectrum allocations to network segments, intra-cell Radio Resource Management (RRM) using Dynamic Subcarrier Assignment (DSA), Adaptive Power Allocation and Adaptive Modulation (AM) methods, providing the means for a flexible RRM scheme capable to address the problems of the service or cell area and provide solutions for proper network adaptation..

Keywords *LTE, CRN, OFDM, RRM, DSA,D2D Technology*

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I. Introduction

CRN has been studied extensively in recent years to increase the use of spectrum in the field of communications [1] [4] [7] [13]. Cognitive radio (CR) is a form of wireless communication in which a transceiver can intelligently detect which communication channels are in use and immediately move into vacant channels while avoiding occupied channels [1]. In this way it optimizes the use of available radio frequency (RF) spectrum while minimizing interference to other users [2].The application of the main features of CRN, the adoption of creative and realistic theories, the use of Commercial Off-the Shelf components (COTS) communication is also considered [4]. It is also used as the effort to test wireless sensor network-based scale through the experience detection of target tree with a single transmitter and receiver which is performed to explore the parameters used for the detection or destination [5]. The multiple waveforms detect certain frequency, similar to noncontiguous OFDM (NC-OFDM) with subcarriers and delete the used detection signal [6]. The reception signal power distinction according to objective location is observed in the testing. The effect of the experimentation gives priceless evidence for the hallucination of the amplitude based wireless sensing arrangement [7].

In older technologies the dual radar / detection and the communication system also work well using radar system / sensor in the communication system. Many researches were done for investigation on the convergence of the wireless sensor network and the communications system based on the cognitive radio network [3]. The double use of radar system / detection and OFDM system has become an important research topic, as OFDM signal is intrinsically aligned with the cognitive radio system. From the point of view of the network, the vision is presented to improve the combination of wireless sensor network based cognitive radio network as the backbone.

In mobile social networking systems, LTE support a large number of phone contact social services. An important characteristic of OFDM networks is need for the traffic content through a terminal [8]. Therefore, wireless multicast has the potential to support mobile social networking due to its exceptional resource efficiency for transmitting packets from a sender to multiple receivers almost the same unicast wireless resources. However, the performance of multicast wireless terminal is limited by the worst channel condition [9][10].Considering scarce spectrum resources, for wireless multicast, it remains open for further investigation.

Considering spectrum usages Device to Device (D2D) is able to significantly improve resource efficiency in cellular networks by establishing direct links between terminals without shipping base station (BS) in a cell [11]. Meanwhile, CR is another great technology in improving the use of spectrum resources, providing greater potential for spectrum resources for secondary user (SUS) correctly detect conditions, spectrum utilization and research their signals overlap with those of primary users (PUS) without interfering with them.

It is natural to think that the CR function D2D is capable of improving the use of spectrum resources more efficiently by establishing communication links dynamically with cognitive terminal. It is considered that how more general multicast transmission works and also study the resource allocation algorithm for multicast cognitive D2D [11] [12].

2. REVIEW ON ANALYSIS OF LTE AND COGNITIVE RADIO NETWORK USING OFDM SIGNAL

2.1 Enhanced Context Acquisition For Intracellular RRM:

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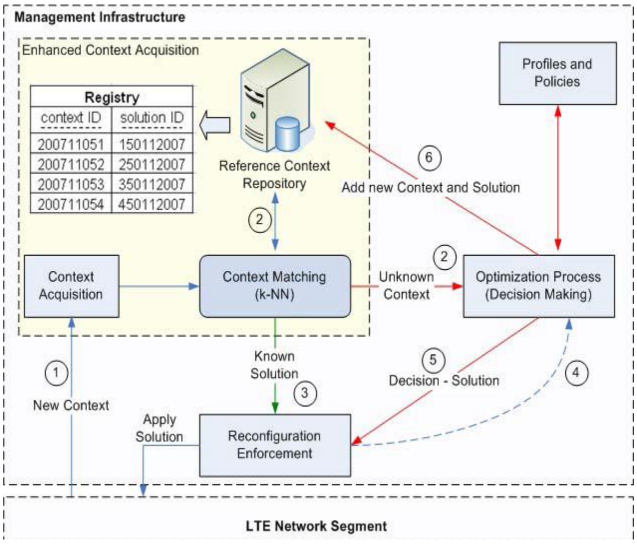

Figure 1: LTE Network Segment

Figure 1 shows the potential interactions between the modules of a LTE Network Segment. In starting phase, Interaction One all the valuable information is retrieved from the LTE network segment by Context Acquisition. In interaction two, context matching and optimization modules access the repository data for finding the reference context that is in close approximation to the current context. If there is no any context close to current content then Optimization module is accessed and it start processing the context as a 'new' situation.

In third interaction, Context Matching passes control to Reconfiguration Enforcement, if match is found otherwise to optimization module if there is no reference context close to the new context. In interaction four, Reconfiguration Enforcement pass the control to the Optimization module, if no any match is found close to the context proposed by Context Matching module. Interaction five, the Optimization module will ask the Reconfiguration Enforcement module to apply the derived configuration to the network segment and interaction six, repository collects and store the new context and solution and apply that solution directly if same context or problem arrives again in LTE network segment. In this way the LTE Network Segment reduce the time needed for context handing by "learning" and apply "known" solutions to solve the problems [3].

2.2 OFDM for Cognitive Radio

OFDM is a special type of Multicarrier Modulation (MCM), where OFDM system uses digital signal processing technology. Digital signal processing algorithm is adopted in the process of sub-carrier generation and reception. Meanwhile, in order to improve frequency spectrum utilization, each sub-carrier is analyzed along with symbol period to ensure the receiving end and recover the signal without distortion. Two major points of an OFDM system are the Inverse Fast Fourier Transform (IFFT) at the transmitter side, where frequency data carrying subcarriers is converted to a time domains signal, then it can be up-converted to desired carrier frequency and is transmitted. At receiver side, Fast Fourier Transform (FFT) reveals the frequency domain information. There is no need of band-pass filters in OFDM and establishing the correct symbol boundary is of utmost importance in any OFDM based system [14]. Apart from the simple waveform generation and reconstruction, OFDM provides significant advantages over single carrier transmissions like: immunity to multipath distortion, scalability and spectral separation, overcomes Inter-symbol Interference (ISI) and Delay spread making it a superior choice for large family of wireless protocols [16] [17]. Cognitive radio (CR) is a form of wireless communication in which a transceiver can intelligently detect which communication channels are in use and which are not, and immediately move into vacant channels while avoiding occupied channels. In this way it optimizes the use of available radio-frequency (RF) spectrum while minimizing interference to other users.

CR is a hybrid technology involving software defined radio (SDR) as applied to spread spectrum communications. Possible functions of cognitive radio include the ability of a transceiver to determine its geographic location, encrypt or decrypt signals, identify and authorize its user sense for wireless devices in operation, and adjust output power and modulation characteristics. This kind of network requires neighboring sensing capability, and fast adaptation to new frequency band for both transmission and reception. Due to various advantages of OFDM, it is used with Cognitive Radio Networks due to its inherent capability of transmission and reception in variable bandwidth and sub channels without using any kind of band pass-filters [18]. Suppression of subcarrier set is done to form NC-OFDM waveform, to serve the purpose for transmitting in a spectrum hole, avoiding the Primary User (PU).

2.3 A Generic OFDM Transceiver

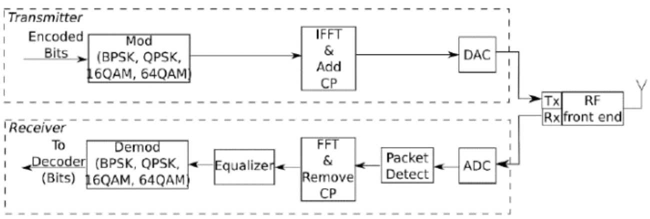

Figure 2: OFDM Transceiver

In figure 2, A Generic OFDM Transceiver should be able to transmit and receive in any set of subcarriers and it should support NC- OFDM transmission and reception [19]. It should adapt to changing spectrum availability as well as its modulation (eg: BPSK, QPSK, 16QAM, 64QAM) at a subcarrier level. Higher level modulation such as superposition coding and hierarchical modulation require a high degree of programmability in the modulation levels [20].

FFT size is varied to control the number of subcarriers used for the transmission depending on spectrum availability and cyclic prefix changes its value depending on channel conditions to combat multipath channel distortions .For eg: WIMAX 802.16 [21] and LTE [22].Equalization provide signal conditioning step to adapt changing environment, the transmitter selects different set of pilot subcarriers to assist in the equalization at the receiver end [23].Pilot locations and

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their relevant phase is an important information that the receiver needs to have in order for equalization. Digital to analog (DAC) conversion is done in transmitter (TX) to transmit data and inverse process is carried out in Receiver (RX) using FFT, Demodulation, and analog to digital conversion (ADC). OFDM is a likely choice for cognitive radio application. This motivates our research in new architectures for software defined radios which will allow innovation in future deployments of cognitive radio networks [24].

2.4 D2D Cognitive Multicast Radio System

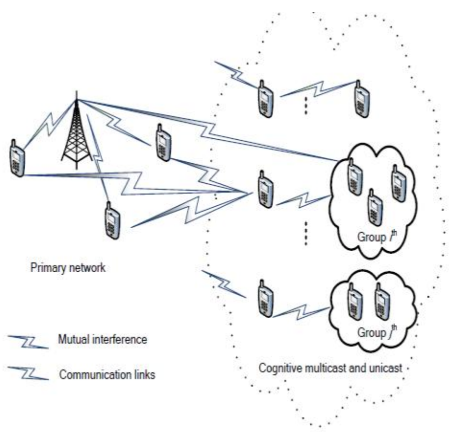

Figure 3: D2D Cognitive Network

The cognitive wireless multicast networks with D2D communication operate in the cellular system as illustrated in Figure 3. Multiple cognitive multicast groups opportunistically access the spectrum licensed to the cellular network in a cell. D2D communication is a local area cellular network. A cellular operator offers cost efficient access to the licensed spectrum enabled by D2D communication as a controlled or constrained underlay to an International Mobile Telecommunications-Advanced (IMT-Advanced) cellular network [25] [26].In D2D session setup, dedicated signaling and automatic handover of network is done by D2D links between nearby (proximity) devices.

D2D communication increases the overall throughput of the cellular network. Therefore, D2D communication serves cellular traffic, offloading, fast and light session setup, low transport delay and high instantaneous data rate. During spectrum sensing, there are vacant subcarriers for SUs to implement the opportunistic spectrum access [27]. The CR network consists of *N* multicast groups and each multicast group contains one SU source node containing several SU members. One source node can send data to multiple members over the allocated subcarriers at a time.

2.5 CogWnet: Cognitive Architecture For RRM

CogWnet is an awareness-based architecture designed for cognitive radio resource management. It aims to provide an abstraction of easy development and cohesive deployment of cognitive elements. It does not only target spectrum allocation, but also uses environment-awareness to optimize the transmission parameters of TCP/IP stack layers such as transmission power, modulation order, bandwidth, etc [4]. CogWnet is a 'real' cognitive system that enables technologies to demonstrate cognitive resource management capabilities. A real cognitive system means that the system is aware of its environment and uses the environmental conditions to adapt to variations in the network conditions while maintaining the quality of service requirements. CogWnet consists of the following layers: communication layer, that consists of interfaces and channels exchanging control signals to collect application requirements and channel information.

The decision-making layer is the core of CogWnet as it accounts for receiving the sensory input from the communication layer and applies optimization algorithms to select the most suitable transmission parameters that improve the cognitive network performance, capacity and spectrum utilization [28].

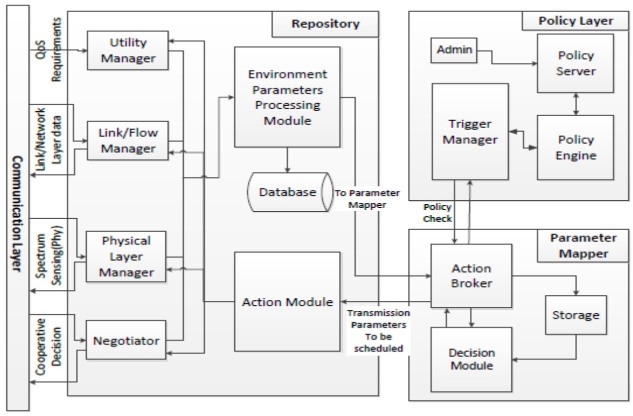

Figure 4: CogWnet Architecture

It consists of two components: repository and parameter mapper. The third layer is the policy layer which is required to enforce stakeholders and the operator's regulations, whether they are static or dynamic based on the geographical location. Trigger manager is the ring that connects the policy layer with the decision-making layer. Figure 4 shows a high level architecture of CogWnet. CogWnet works in a distributed manner which means that it is installed in each base station in the LTE network. We integrated the above model for interference and throughput optimization with the decision-making layer in CogWnet. Learning modules also added to the decision-making layer in CogWnet to expedite and enhance the decision made for parameters adaptation.

3. Conclusion

In this paper, different types of architectures which are used for LTE and cognitive radio networks are discussed. Different architectures use different parameters for their implementation and all these parameters are optimized for various results.It can be seen that cognitive RRM system will be able to perform even better since there are a number of optimization procedures that should take place for each one of the systems separately. The parameters involved in the optimization executed by CogWnet to fulfill the model optimization goals are SINR, modulation index, network load, transmission power and bandwidth and target will be achieved expanding the control functions and different optimization algorithms for RRM in LTE networks.

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