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HYBRID EFFICIENT BANDWIDTH ALLOCATION TECHNIQUE FOR COGNITIVE LTE NETWORKS

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ABSTRACT
Now days, use of IEEE 802.22 based LTE network is growing worldwide due to its high speech capability. IEEE 802.22 is nothing but cognitive radio networks which are suffering from problems like efficient bandwidth and spectrum allocation, delay and loss ratio etc. In addition to this there is another research problem in this domain called power efficiency. Many methods already presented in literature, however most of methods failed to achieve the tradeoff between, transmission power, transmission rate, and bandwidth. In this paper we are extending two kinds of techniques presented such as QBC1 and QBC2 which are variants of main QBC (Queue Based Control) algorithm presented. QBC1 and QBC2 mean for different conditions of LTE network. Performance of QBC1 and QBC2 showing that QBC1 is having better Delay and Los performance as compared to QBC2, and QBC2 is having better power consumption performance as compared to QBC1. Therefore we are presenting hybrid technique which is known as HQBC (Hybrid QBC), which is main goal of improving performance in terms of los, delay, and power consumption as compared to QBC1 and QBC2. This can be achieved by using concept of multilevel queues and dynamic network adaptation.

KEYWORDS: IEEE 802.22, LTE, Cognitive Radio, QBC, HQBC, Multilevel Queue.

INTRODUCTION
To address problem of limited bandwidth or inefficient bandwidth allocation methods, in 2004 a special IEEE working group was set up to develop a new 802.22 cognitive radio (CR) standard. It has been proposed that the wireless access be provided by a Wireless Regional Area Network (WRAN) comprising a number of SPs with their base stations. Within the network, the SPs share the total available bandwidth among each other according to some predefined flexible spectrum usage policy using a spectrum manager (SM) [1]. The standard describes the overall network topology, and on physical (PHY) and medium access control (MAC) layers. However, the exact algorithm for spectrum allocation is not specified [2]. In addition, to realize the great opportunity offered by the CR architecture, it is very important to develop an applicable DSA policy which will help to increase the overall spectrum efficiency and improve the quality of service (QoS) for the individual network users. Efficient spectrum allocation method development is tough process given the known difficulty of modelling and measuring the wireless medium [4]. Although some significant progress has been made in diverse cognitive techniques during the last few years, many challenges still remain [3]. For example, most research has been focused on techniques for identifying and reducing the interference (by controlling transmit power, carrier sense, or scheduling) for the users of CR network (CRN), see e.g., [5], [6], [7]. In general, however, the system performance depends on many external factors, including user behaviour, traffic load, channel quality, etc [3]. Some theoretical models of the user behaviour and traffic load in CRNs have been proposed in [8], [9], [10], [11], but the assumptions in these models are often quite restrictive under realistic operating conditions. This is mainly due to the fact that a system may operate in diverse environments (e.g., in different types of city, rural, campus, and indoor deployments) [3]. Hence, it is very difficult to obtain some general theoretical model which can be applied for different network deployment scenarios.

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Along with spectrum allocation efficiency in IEEE 802.22 wireless networks; there is another performance metrics which is related to energy efficient dynamic spectrum access (DSA) in a cognitive Third Generation Partnership Project (3GPP) long-term evolution (LTE) network based on IEEE802.22 architecture. According to the IEEE802.22 standard, wireless access is offered by a wireless regional area network (WRAN) consisting of a number of service providers (SPs), which share the total available spectrum using a spectrum manager (SM). The SM uses some flexible dynamic spectrum access (DSA) policy to maximize the capacity and quality of service (QoS) for their users [12]. Motivated by this concept of CR network (CRN), many papers have developed various forms of spectrum access strategies to assign the available network resources (bandwidth, transmission rate and transmission power). Most papers assume non-strategic non-greedy users following some general resource allocation policy. The recent methods do not have efficient tradeoff between transmission power, bandwidth and transmission rate. This becomes research problem in this domain.

In this paper we are presenting new hybrid method for spectrum allocation in IEEE 802.22 based LTE networks. This new method is called as HQBC, as it is based on existing QBC method. Main idea behind HQBC is use of multiple queues to handle different kinds of data efficiently and dynamically. In next section II we are presenting the literature survey over the various methods those are introduced for the energy efficient spectrum allocation. In section III, the proposed approach and its system block diagram is depicted. In section IV we are presenting simulation results and discussion. Finally conclusion and future work is predicted in section V.

REVIEW OF LITERATURE

In literature different methods introduced to investigate the problem of energy efficient dynamic spectrum access (DSA) in a cognitive Third Generation Partnership Project (3GPP) long-term evolution (LTE) network based on IEEE802.22 architecture. Motivated by this concept of CR network (CRN), many papers have developed various forms of spectrum access strategies to assign the available network resources (bandwidth, transmission rate and transmission power). Most papers assume non-strategic non-greedy users following some general resource allocation policy.

- In [13], author presented performance metric based channel allocation scheme for IEEE802.22 networks in which the base station allocates interference free channels using a spectrum map. In this scheme the spectrum map is created by using the raw spectrum usage data that are shared by a small subset of consumer premise equipments. The usage data are fused at the base station using a modified version of Shepard's interpolation technique. The authors construct a continuous and differentiable spatial distribution of spectrum usage that the base station consults to estimate the spectrum occupancy vector at any arbitrary location in its cell. Such spectrum usage is then utilized to proactively evaluate some key network and radio performance metrics which in turn help allocating the best candidate channel to a given consumer premise equipment ensuring highest achievable performance.
- In [14] the authors consider adaptive modulation and power control for multi-access wireless sensor networks which mainly reduces power consumption to achieve energy efficiency. Cluster head node of each link adaptively adjusts its power control level and modulation type according to the signal to noise ratio (SNR) and target bit error rate (BER). The efficiency of this approach is further illustrated via numerical comparison with the original scheme. Simulation results demonstrate that the proposed scheme, which alleviates to save much transmission power and maintains the target bit error rate, can significantly improve the system performance.
- In [15], the opportunistic spectrum access (OSA) in LTE Advanced (LTE-A) networks has been investigated. It has been shown that implementation of the OSA in LTE-A enhances the overall system performance by intelligently aggregating otherwise unutilized spectrum. However, the set-up parameters of the system (such as sensing periods and amount of signaling) should be carefully chosen to increase the feasibility of the implementation in a real network.
- In [16], authors studied the trade-off between transmission delay and transmission power in wireless networks where a delay-power control (DPC) scheme to balance delay against transmission power in each wireless link has been formulated. It has been shown that DPC converges to a unique equilibrium power with several key properties related to the nature of bandwidth sharing achieved by the links.
- In [17], authors presented distributed resource allocation based on queue balancing in multi-hop CRNs has been investigated. Here the problem of resource (power, channel and data rate) allocation is formulated as a multi-commodity flow problem assuming dynamic link capacity to model dynamically changing spectrum

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availability in the network. Based on the optimization results, a distributed algorithm is proposed for joint flow control and resource allocation in the nodes of CRN. Simulation results show the performance improvement by the proposed scheme.

- In [18], Joint power control and spectrum access in CRNs has been investigated. In this paper, the power allocation and DSA aim to improve the throughput and guarantee the fairness for secondary (unlicensed) network users, without imposing overlarge interference to the primary (licensed) network users. Numerical results reflect that, compared with previous studies, this scheme presents advantages in comprehensive performance (e.g., spectrum efficiency, fairness and throughput). Beyond a theoretical framework, the authors solve the optimization problem with the Differential Evolution (DE) algorithm which is more feasible to be implemented in practice.

PROPOSED METHODOLOGY

With defined aim of this paper which is to present hybrid technique for spectrum allocation with goal of achieving the efficient tradeoff between transmission rate, bandwidth, and transmission power in IEEE 802.22 based LTE networks. Figure 3.1 is showing proposed system architecture and practical analysis flow. HQBC is proposed method is compared against recently presented QBC1, QBC2 and PCSA spectrum allocation techniques.

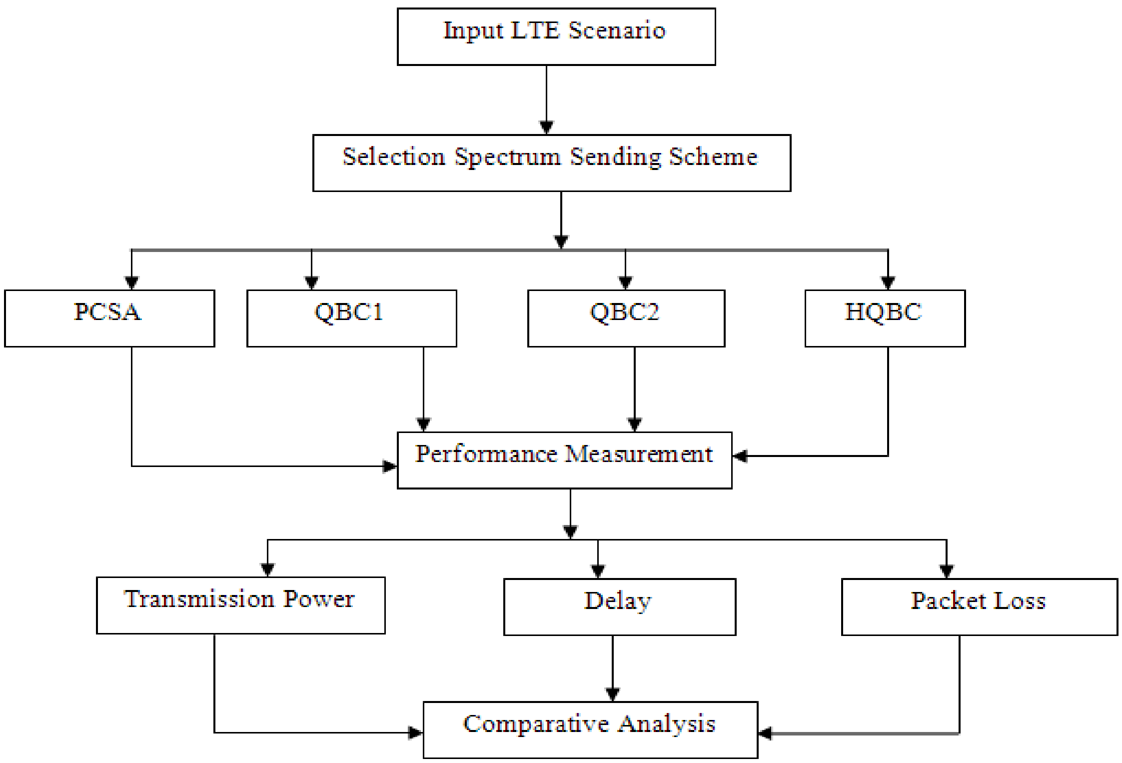

Figure 3.1: Proposed System Architecture

Limitations of Existing Methodology

There are two variants of previously presented power efficient method for spectrum sensing such as QBC1 and QBC2, from the practical analysis we come to below conclusion and limitations:

- QBC1 is having better performance in terms of loss and delay as compared to QBC2.
- QBC2 is having better performance in terms of transmission power as compared to QBC1.
- Therefore there is no tradeoff between loss, delay and transmission power performance in either QBC1 or QBC2.
- QBC1 is efficient in delay and loss whereas worst in transmission power.
- QBC2 is efficient in transmission power whereas worst in delay and loss.
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Proposed Algorithm

To overcome above listed limitations of QBC1 and QBC2, in this paper we are presenting hybrid technique which is based on QBC1 and QBC2. In short, proposed technique is combined extension of both QBC1 and QBC2. The proposed spectrum sensing scheme is called as HQCB. This method is includes the concepts of multilevel priority queues, in which different kinds of network data is divided into multiple queues, and hence efficiency of spectrum allocation improves, which in terms improves the QoS performance and transmission power performance. Below is algorithm which is combined with QBC algorithm for further improvement. Figure 3.2 is showing the flowchart of proposed multilevel queue algorithm:

Algorithm: Dynamic Bandwidth Allocation Algorithm

- Initially set high and low thresholds as T2 and T1
- At each node
  1. Receive Packet.
  2. Classify packet according to priority.
  3. Check intermediate buffer occupancy for number of packets initially occupied.
  4. Calculate transmission of number of packets to intermediate buffer according to threshold value.
  5. Push packets into intermediate buffer.
  6. Repeat steps 3-5 for all priority buffers.

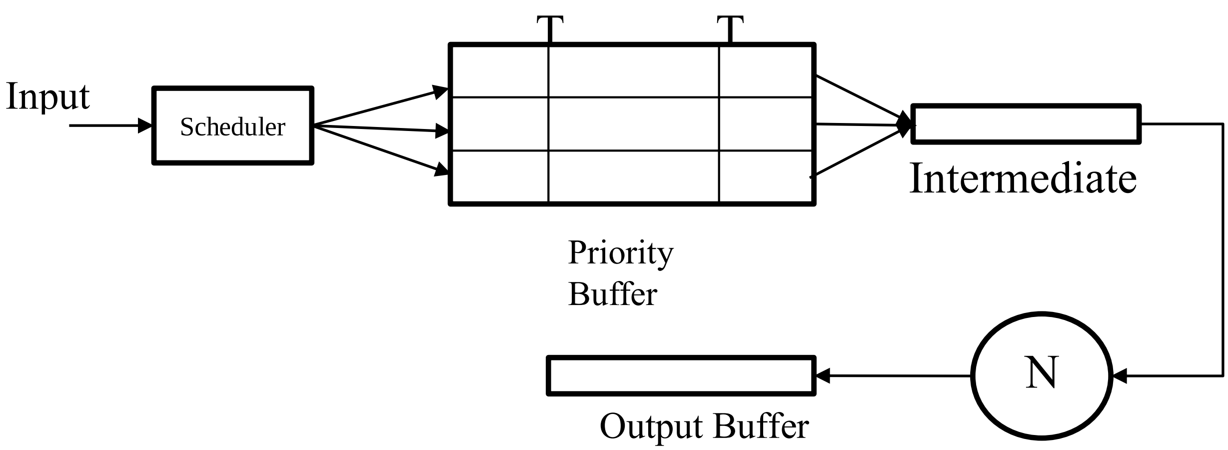

Figure 3.2: The architecture for a single network user.

RESULTS AND DISCUSSION

Network Simulators

"According to dictionary, Simulation can be defined as ―reproduction of essential features of something as an aid to study or training." In simple words, the process where we can construct the one model of mathematic is called as simulation in order to solve the system problem. Such process frequently uses to reproduce the characteristics of the complex work. In order to simulate the network like mobile ad hoc networks called MANET, number simulators are available such as OPNET, Qualnet, and NS2 etc. For our simulation, we are using NS2 as:

- NS2 provides the network simulation environment for both wired, wireless means MANET networks.
- It is open source.
- Provides the modules for the wireless channel such as 802.11, 802.16, 802.21, 802.22 etc.
- Provides the number of routing protocols for choice in which the routing is done along multiple paths.
- Simulations of the cellular networks possible as the mobile hosts are simulated as well.

Network Scenario and Configurations

Number of Nodes	50/100/150/200/250/300
Traffic Patterns	CBR (Constant Bit Rate)

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Network Size (X x Y)	1000 x 1000
Max Speed	5 m/s
Simulation Time	100s
Transmission Packet Rate Time	10 m/s
Pause Time	1.0s
Routing Protocol	AODV
MAC Protocol	802.22
Spectrum Sensing	PCSA/QBC1/QBC2/HQBC
Number of Flows	5
PDCCH symbols per subframe	3
UL / DL loading factor	1
Inactive bearer timeout	20s
Periodic timer	5 sub fames
Retransmission timer	2560 subframes
Reserved size	2 RBs
Allocation periodicity	5 sub frames
Operation mode	FDD
Cyclic prefix type	Normal (7 Symbols per Slot)
EPC bearer definitions	348 kbit/s (Non-GBR)
Subcarrier spacing	15 kHz
Transmitter/receiver antenna gain	10 dBi (pedestrian), 2 dBi (indoor)
Receiver antenna gain	10 dBi (pedestrian), 2 dBi (indoor)
Receiver noise figure	5 dB
Number of preambles	64
Number of RA resources per frame	4

RESULT ANALYSIS

In this research methodology, we simulated the three different spectrum sensing methods for IEEE 802.22 of LTE networks such as PCSA, QBC and proposed HQCB. The aim of this project was to propose HQBC with goal of improving performance against QBC method. In this section we will summarize the results achieved through different LTE network scenarios and compare performances against investigated existing methods. Below is figure 4.1 of showing NAM representation in NS2. From NAM visualization, we cannot measure or predict any performance parameter.

The performance difference between methods is evaluated using the trace file of each scenario and AWK script to measure each performance metrics. Below section presents the graphical comparative analysis of both routing protocols.

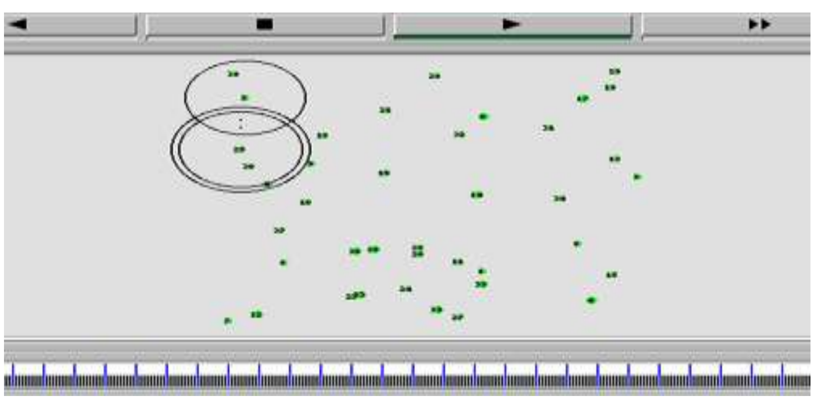

Figure 4.1: HQBC 50 Nodes NAM Result

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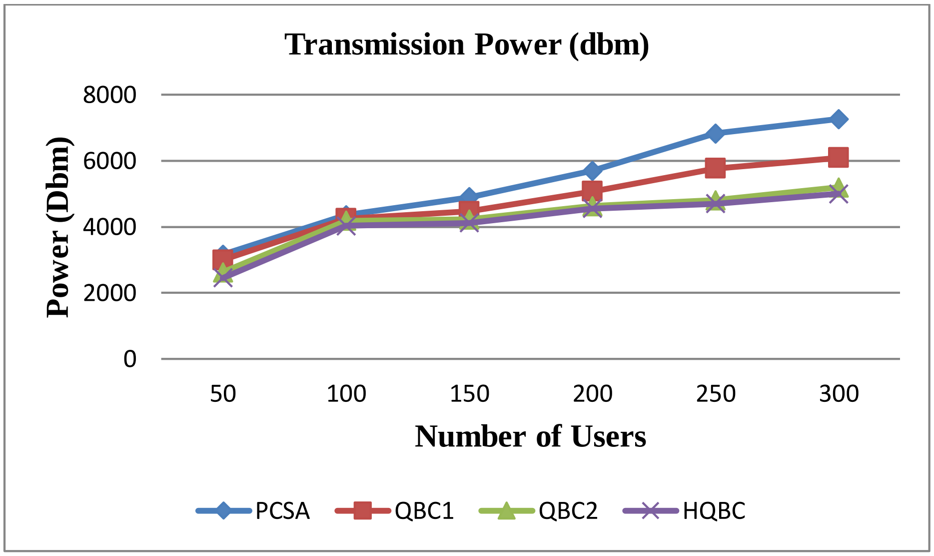
Transmission Power Analysis

Transmission power is nothing but the amount of energy consumed during the data transmission over IEEE 802.22 LTE network. Below figure 4.2 is showing the current performance of different spectrum sensing methods with varying number of end users in LTE network.



From above result of transmission power for methods like PCSA, QBC1, QBC2 and HQBC, performance of HQBC is better than all other existing methods, HQBC outperforming QBC2 which is most recent energy efficient technique. For each kind of network, HQCB is delivering energy efficient spectrum allocation for data transmission and communication.

Packet Loss Analysis

The aim of proposing HQBC technique is to achieve the fairness and tradeoff between transmission power, packet loss, and delay parameters. By considering this, below two graphs in figure 4.3 and 4.4 are showing performances of Packet loss results and delay results.

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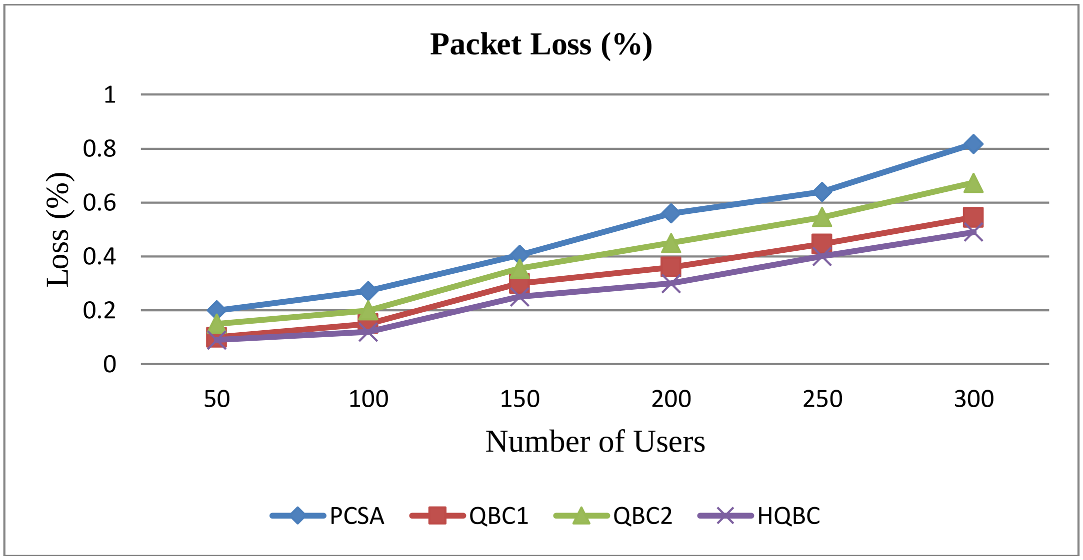

Figure 4.3: Loss performance analysis

From above result, it is clear that performance of HQBC is improved as compared to all other existing spectrum sensing algorithms. This is one, which cannot be achieved by any of previous methods. Along with loss, delay is another important parameter spectrum sensing technique. If we achieving good performance for loss, it means that delay is better too. Below figure 6.4 is showing delay performance, in which HQBC outperforming existing methods. As per the goals of this project, practically we claim the efficiency of proposed method.

Delay Analysis

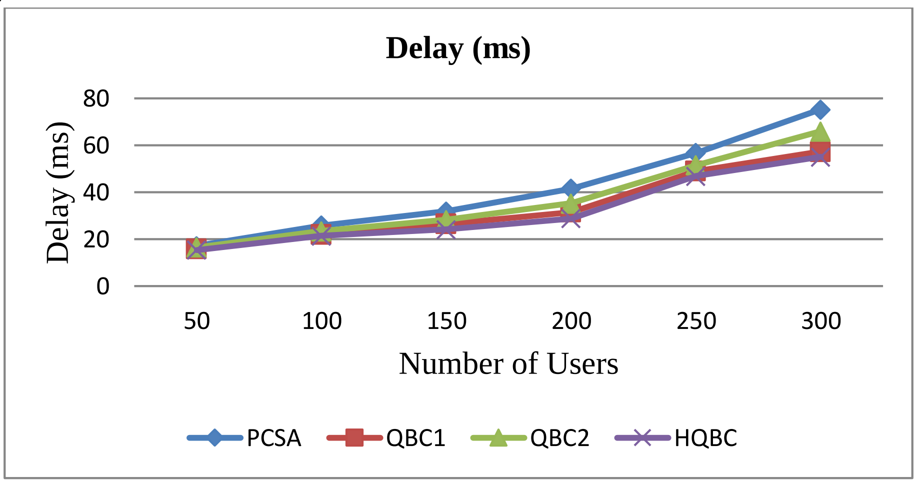

Figure 4.4: Delay performance analysis

CONCLUSION AND FUTURE WORK

The Objective of this project is to investigate the performance of recently presented efficient spectrum sensing allocation method for LTE cognitive radio networks based on 802.22 frameworks, then discussing the limitations of investigated methods, and then proposed new hybrid technique to overcome said limitations. We have presented basic architecture of IEEE 802.22 standard, after that presented algorithm and architecture of proposed bandwidth allocation method. The investigated algorithm is named as QBC. To overcome the limitations of QBC, we have presented HQBC based on concepts of multiple priority queues for both real time and non-real time data transmission. The aim of this method is to achieve the efficient tradeoff analysis between performance of transmission power, delay, and loss. The proposed work is totally based on cognitive radio networks with use of IEEE 802.22 LTE networks. Practical

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simulation of investigated method and proposed method is done using NS2. Performance results outperforming existing methods for loss, delay and transmission power. For future work, we will suggest to deploy this method in real time environment and check its tested results.

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