Eurasian Journal of Analytical Chemistry
ISSN: 1306-3057 OPEN ACCESS 2018 13 (6): 178-185

A Proposed Hybrid Approach Combined Qos with CR System in Smart City

Faisal Y. Alzyoud*, Wa'elJum'ah Al_Zyadat, Fadi Hamed, Fayez Shrouf

Received 14 September 2018 ▪ Revised 23 October 2018 ▪ Accepted 24 November 2018

Abstract: The fifth generation of mobile communication technology growth by next few years, the traffic volume of mobile communication that rapidly increase because of the enormous opportunities and applications significant benefit from Internet of Things (IoT) across almost all Industries. Smart cities are considered amongst the top applications of IoT which highly depend on Information Communication Technologies (ICT). Furthermore, frequency spectrum available for mobile communication is limited, thus, the increasing number of users will negatively affect frequency spectrum availability and accessibility. That encouraged utilising cognitive radio communication techniques, in order to overcome the deficiency in frequency spectrum, which drive to introduce a new approach to utilizing the available frequency spectrum in communication and sharing this spectrum between various users. Low-cost communication evaluation system is proposed to utilise idle frequencies owned by licensed users and automatically make it available to other users without distressing licensed user's communication. Two aspects of cognitive radio are investigated; users' classification divided between primary and secondary users and availability of idle frequency spectrums of licensed users. The effect of noise and attenuation is analysed and compared using MATLAB simulation.

Keywords: Cognitive Radio (CR), Internet of Things (IoT), Primary Users (PUs), Secondary users (SUs), and Signalto-Noise Ratio (SNR).

INTRODUCTION

By year 2020, the fifth generation of mobile communication (5G) is expected to be implemented commercially, and the number of users will increase, therefore the demand of wireless communication from all sectors will increase resulting in more IoT opportunities and applications[1];video on demand to be smart for cities, grids, and health treatment are amongst applications highly sought after, and availability of wireless communication bandwidth will face suffer because of these demands[2]. Smart cities' applications require enormous volume of data, Big Data [3]. Even though wireless communication is very convenient channel of communication, frequency bandwidth which considered limited in comparison to the increasing number of users. The upgrade of existing mobile communication technologies, 3G and 4G,forward to 5G is imminent due to the high transfer speed which reaches up to 1G, were increasing number of remote services and mobile devices [4].

The main idea behind cognitive radio is to utilise the frequency spectrum in an effective manner by taking advantage of channel conditions, codebooks, and message transformation to share the spectrum between different users. The mentioned features have empowered researchers to tackle the spectrum scarcity problem, where users are classified into Primary Users (PUs), Licensed users authorised to use the frequency spectrum, and Secondary Users (SUs) who use the spectrum when it is idle.(Yau et al., 2009).

Faisal Y. Alzyoud*, Isra University. Email: faisal.alzyoud@iu.edu.jo
Wa'elJum'ah Al_Zyadat, Isra University.
Fadi Hamed, Isra University.
Fayez Shrouf, Isra University.

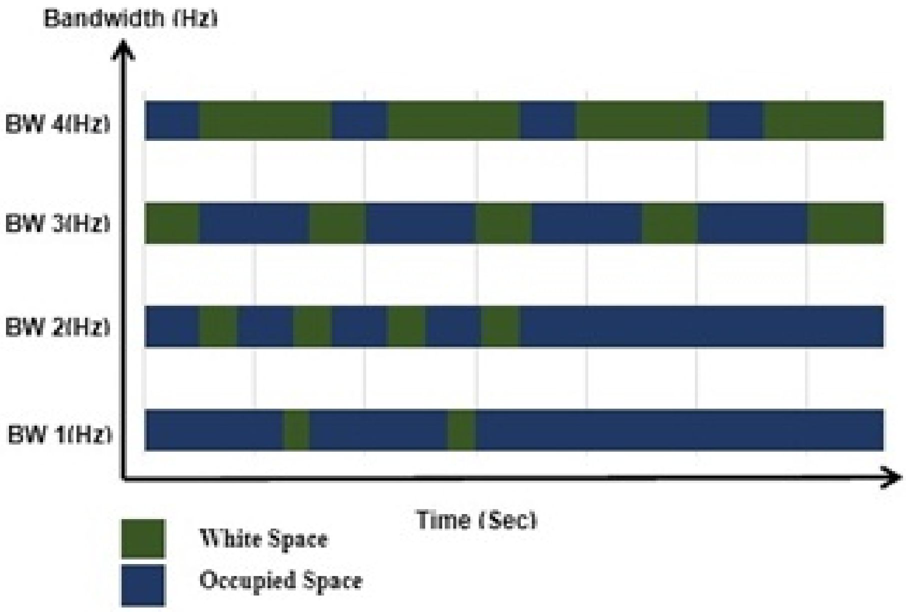

Fig.1: Utilization of White Spaces by Secondary Users

Spectrum Detection Techniques

In CR networks, creating a "friendly" environment for coexistence between the PUs and the SUs is significant. Spectrum sensing is imperative to prevent interference between users.

Several techniques are commonly used in signal processing, these techniques are listed below:

1. Energy detection: the signal is detected when comparing the output energy level in relation to a threshold level. Us are unable to differentiate between primary users signals and noise.[5].
2. Filters Matching: demodulation of a PUs signal is required to perform coherent detection in less time, however this technique needs a special receiver for every PU[6].
3. Cyclostationary based on feature detector, this method able to exploit the inherent periodicity in the received signal to detect primary signals since most signals vary with time periodically, it can exploit the cyclostationarity features of the received signals and it can differentiate noise from PUs signals as well. The issue suffers from longer processing time and higher computational complexity [5].
4. Cooperative detection method senses the number of different radios within a cognitive radio network in a cooperative cognitive radio spectrum sensing system [7].
5. Waveform based detection method is usually utilized in wireless systems to assist synchronization or for other purposes, it is used waveform-based sensing which requires short measurement time [8].

Smart Cities

The rapid growth in cities population and the remarkable growth of digital devices usage such as sensors, actuators, smart phones and smart appliances fulfill the objectives of IoT applications for both population and organizations.. This growth increase the tendency to use the available yet limited bandwidth. Furthermore, growth is a perfect use-case for IoT to perform various activities in many sectors such as transportation sector, cars, parking, merchandise, waste management, street lighting, and building management. IoT uses wide area network and the internet to manage the various heterogeneous objects in smart cities; existing objects can be linked to the internet to communicate with each other [9]. Nowadays, many capital cities such as New York, Singapore, Tokyo, Seou, Shanghai l, Amsterdam, and Dubai have supported smart projects to improve the services for their inhabitants and raise the quality of service provided for them. Smart cities should serve the following tracks: transportation system, healthcare system, weather monitoring systems and supporting people via internet in every place to accessing the database of airports, railways [10]. Transferring to smart cities request to collect a huge volume of data on central network nodes or servers, and this will increase the use of available bandwidth which should be utilized effectively.

Cognitive Radio Applications

In this section, we discuss three existing applications in different scopes including to multimedia, communication and wireless networking.

1. The most promisingapplication for CR systems are multimedia applications in mobile downloads (i.e. download of music/video files, cooperative games) which needed acceptable Quality of Services (QoS) requirements [10].
2. Emergency communications applications all these applications need a moderate data rate and localized coverage (i.e. disasters video transmission, fire video transmission from firemen's' helmets to the emergency control room).
3. Broadband wireless networking applications,these applications need high data rates, but where users may be satisfied with localized "hotspot" services (i.e. using nomadic laptops). Multimedia wireless networking applications: these applications need high data rates transmission (i.e. audio/video distribution within homes). As these applications will increase the inhabitants' satisfaction to smart city platform.

Full CRis likely to emerge in 2030 [10-12], this is bound to happen as conditions are fully flexible, and software defined radio technologies are on the rise, these intelligent systems are able to exploit in CR system. The challenges on hand revolve around applying CR techniques to create suitable cognitive implemented as device, and to apply artificial intelligence to carry on the making decisions for utilize the spectrum dynamically. There are devices that already have some elements of CR such as WLANs and military follower jammers; however these devices are not mature enough for cognitive radio applications.

RELATED WORK COGNITIVE RADIO NETWORKS EXITING QOS

The number of mobile users has significantly increased parallel with mobile services. Therefore, researchers in mobile communications focus on improving the QoS in bandwidth aspect scarce resource. Furthermore, these aspects are considered as major issue for cognitive radio networks. Quality of Service for secondary users is difficult to achieve as SUs use the idle channel which is not occupied with PUs.[13] proposed an analysis model to obtain QoS for cognitive radio networks by taking blocking probability , completed traffic and termination probability of SUs . Meanwhile, it was proposed resources reservation techniques for SUs . Multipath Activity Based Routing Protocol for Cognitive Radio Network (MACNRP) which proposed in [14], a protocol to utilize channel availability and to create multiple node-disjoint routes between the source and destination nodes. Multi-channel approach can increase the network resources and increase the QoS, as well as distributed channel allocation algorithm to utilize multi-channel due to approach the network performance parameters are enhanced, these parameters include network throughput, end to end delay. Their algorithm refer to contention graph and adopts contention factor to evaluate conflicts in a channel [15]. Multichip Multi-Channel Distributed QoS Scheduling MAC scheme (MMDQS-MAC) was proposed to enhance the performance of cognitive radio in Wireless Sensor Networks(WSN) by selecting the best channel for an individual wireless sensor node and supporting dynamic channel assignment mechanism to decrease the probability of collision, interferences and improves the overall network performance of WSNs[16]. QoS differential scheduling CR-based on smart grid communications networks is studied by Rong Yu and others [17], they proposed schedule the flow using a scheduler which is responsible for managing the spectrum resources and arranging the data transmissions of smart grid users (SGUs). They proposed to assign different priorities according to their roles and their current situations in the smart grid. Based on the QoS-aware priority policy, the scheduler adjusts the channels allocation to minimize the transmission delay of SGUs.

HYBRID QOS WITH CR PROPOSED APPROACH

This research focuses in combining QoS differentiated services with cognitive radio techniques to utilize the idle bandwidth, and classify secondary users in term of priority. The objective of this proposed technique allows devices to share the bandwidth efficiently without causing any disturbance to primary users. Secondary users depend on type of service to determine the priority degree assigned to them, in order to use the idle channel in data transmission. Since primary users will use the transmission channel on demand, the secondary users have to wait until primary transmission is done and channel becomes available to them, hence, Hybrid QoS with CR takes effect to determine which secondary user can utilise the idle channel.

In case primary user decided to transmit data, the proposed technique will drop the secondary user with least priority classification to allow primary user to utilize the channel without disturbing secondary users with higher priorities.

Figure 2 illustrates how the hybrid QoS with CR works on channel users' classification; primary users are always assigned with highest priority, and secondary users are given lower priority.

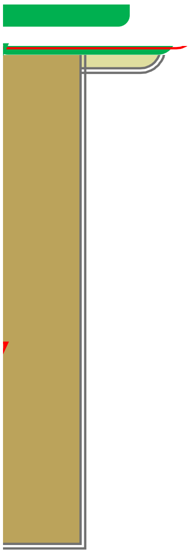

Fig.2: Proposed Hybrid QoS Approach with CR System

When primary users are assigned with highest priority, the Hybrid QoS with CR will check the services of all secondary users, and decide which of one them has higher priority than the other using the differentiated service filed as per Figure 3.

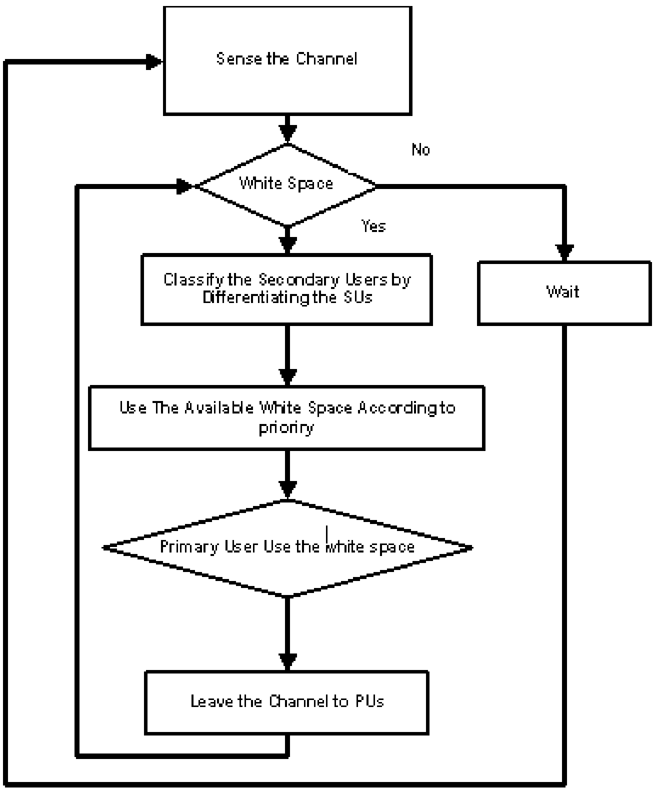

Fig.3: Proposed Cognitive Radio with Differentiated QoS

In order to simulate the technique on MATLAB, we optioned to the cognitive radio configuration shown in Figure 4, where five frequency bands are configured, and Amplitude Modulation is used to carry the signal. The Setup then estimates the Power Spectral Density (PSD) of every band in order to assign the secondary user to the available bandwidth according to its priority degree, PSD is defined as a positive real function of a frequency variable associated with a stationary stochastic process, or a deterministic function of time, which has dimensions of power per hertz (Hz), or energy per hertz. Noise is then added to mimic real environment. [12]

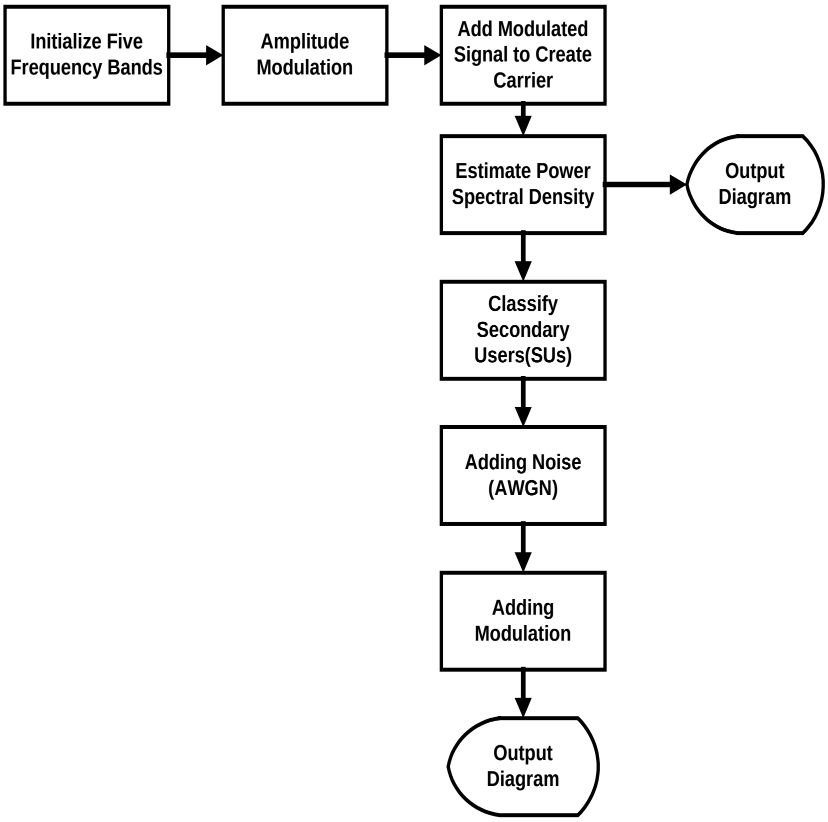

Fig.4: Block Diagram for Cognitive Radio with Differentiated QoS

DISCUSSION AND ANALYSIS OF SIMULATION RESULTS

Based on simulation setup model for cognitive radio starting from initialize 5 carrier frequencies Fc1 = 1000, Fc2 = 2000, Fc3 = 3000, Fc4=4000 & Fc5 = 5000 as and every user's base band data signal is modulated over the spectrum density. Power spectrum density is estimated, and the output is presented using Periodogram. The results can be represented to show the allocated free space see Figure 5, after estimating the free spaces SUs are classified by differentiating them according to their importance and if the Pus take the channel from any of the SUs then the empty slot will be given to the highest priority SUs and so on. Noise is added using Additive white Gaussian noise (AWGN) model, which is basic noise model that occur in nature with constant spectral distribution. The noise is added to mimic real situation. AWGN channel is a good model for many wireless deep space communication links [18]. Attenuation is added to carrier signal to attenuate the designed system.

The simulated system was built using MATLAB to enable the basics of a cognitive radio systems using dynamic spectrum access at run time. Our approach was built by taking decisions by sensing the basis of power spectral density of the channel which can be used cognitively to find out the available gaps those can be assigned to new incoming users to improve the overall channel's throughput.

Power Spread Speed Spectrum with Two Primary User's and Three Empty Slots

First, the simulation is done by checking the available bandwidth by assigning two primary users and leaving three empty slots to check the available gaps in the spectrum, the gathered results are depicted in Figure 5. The results show that the power / frequency ratio is above zero level just for frequency one and two respectively. The empty slot power is lower than zero showing that the channel is empty and can be used.

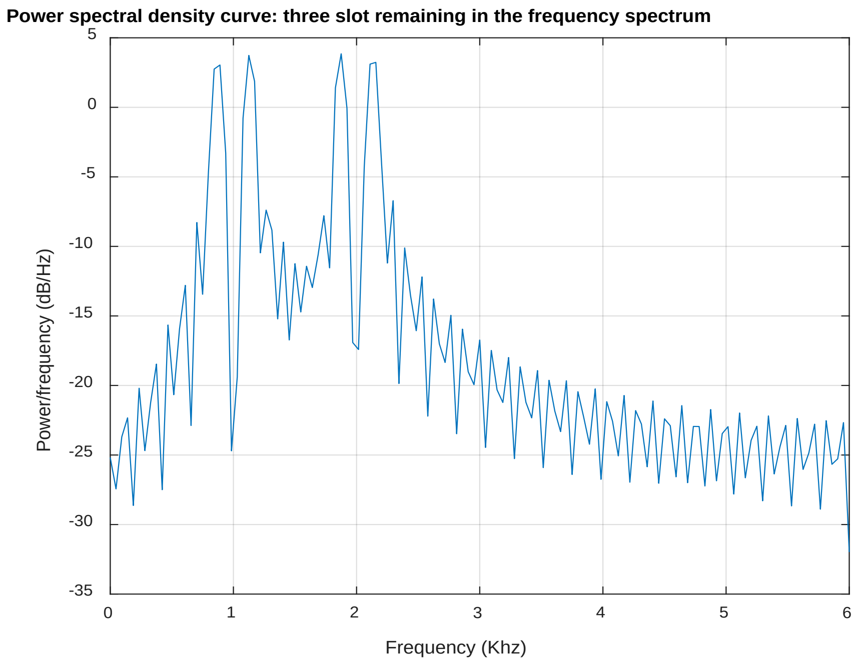

Fig.5: Power Spectrum Density Curve: Three Slots remaining in the frequency Spectrum

Effective Use of Spread Spectrum with SUs QoS Enabled

To optimize the capacity of the SUs, the system will automatically classify secondary users by enabling the Type of Service (ToS) field and assign priorities to the SUs. The SUs will automatically assign to the empty slots according to their priority so the system will be fully utilized as shown in Figure 6, which shows that all the power frequency are above zeroes.

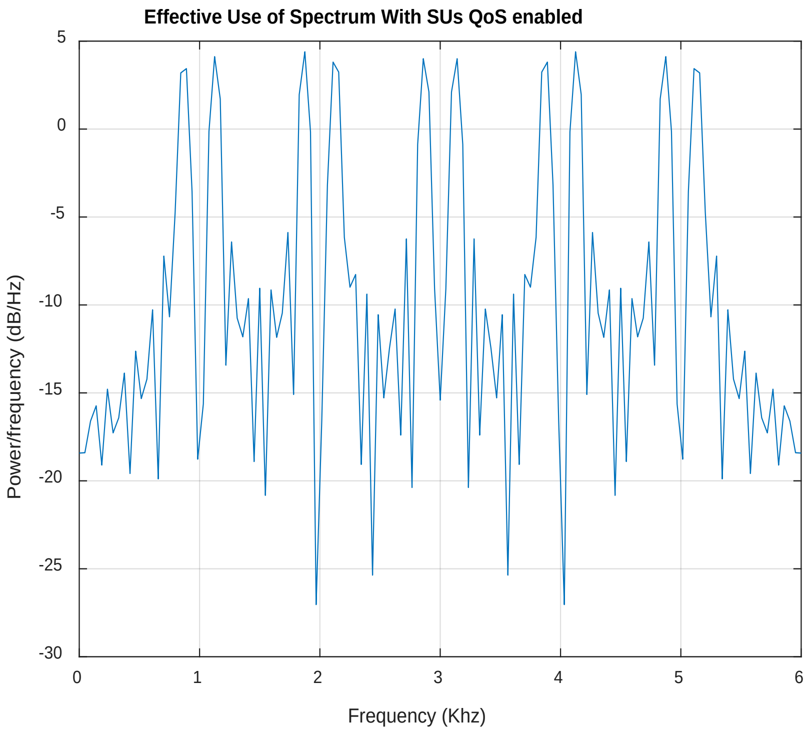

Fig.6: Fully Utilized Spectrum with SUs QoS Enabled

Noise Effect on Spread Spectrum Density

The noise can be reduced using spread spectrum[17], but unfortunately it has an inverse effect on Power Spectrum Density as it is shown in Figure 7. Different Signal to noise ratio (SNR) is used starting from 10, 20, 40 and 60 percentage to investigate their effect on power spectrum density. AWGN channel model is used. The worst SNR effect on Power Spectrum Density is at SNR equal to 40.

Attenuation Effect on Spread Spectrum Density

Signal transmission is affect by different challenges before arriving at the receiver such as weather attenuation losses [18], in this paper the effect of attenuation according to variety percentages of attenuation starting from 10, 20, 40 and 60 respectively as shown in Figure 8. It is noted that Power Spread Spectrum Density decreases with the increases of attenuation.

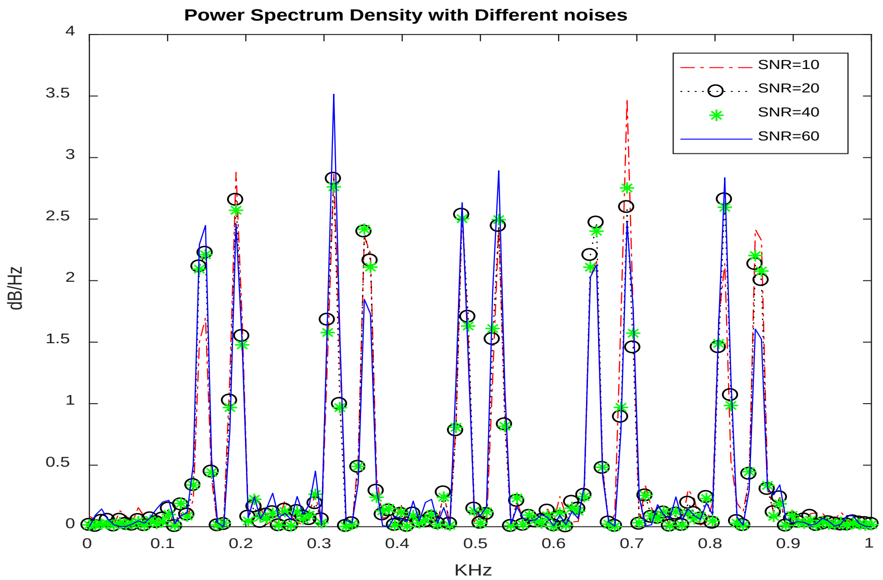

Fig.7: Power Spectrum Density with Different Added Noises

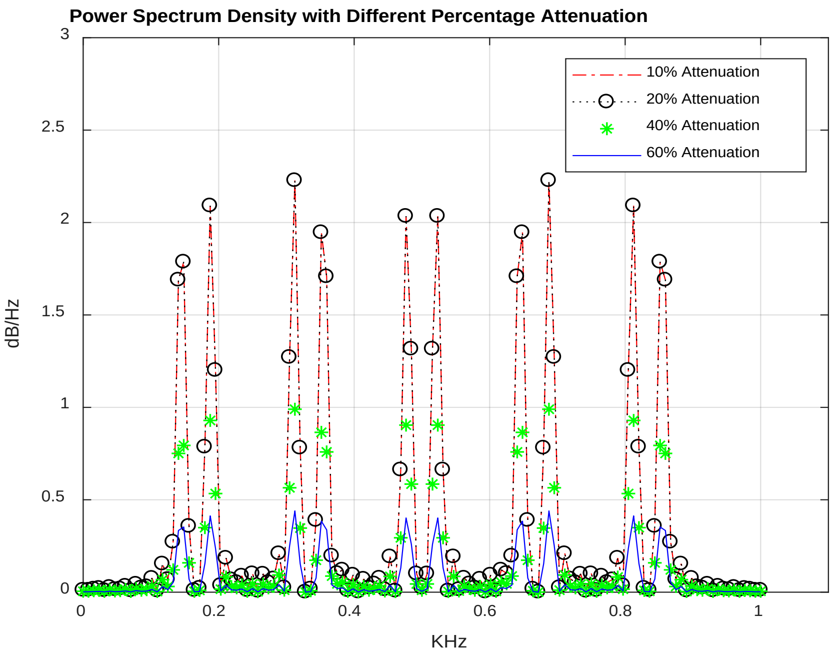

Fig.8: Power Spectrum Density with Different Percentages of Attenuations

CONCLUSION AND FUTURE WORK

Cognitive radio technology is promising technologies, which allow users to utilise the scarcity of spectrum frequency; it can be used in a variety of important future applications as described earlier. By the internet of things, many smart applications become applicable and can facilitate many important aspects for human life such as smart healthcare, smart homes, smart energy, and smart cities. In this paper, cognitive radio technology has been merged with QoS differentiated approach to provide suitable platform of smart cities communications. Cognitive radio has been simulated using MATLAB, primary users and secondary users are classified depending on priority and by enabling differentiated QoS approaches to SUs. The results show that the spectrum was fully utilized, and the effect of noise and attenuation are studied to show their effects on CRs system.

Future work includes setting a new plan that apply cognitive radio on a real environment and compare different sensing techniques. A suggested mathematical model would be proposed for computational variables of Power Spectrum Density.

REFERENCES

[1] Kumar, A., & Gupta, M. (2015). Key technologies and problems in deployment of 5G mobile communication system. *Communications on Applied Electronics*, *1*(3), 4-7.

[2] Kuang, L., Yang, L. T., Wang, X., Wang, P., & Zhao, Y. (2016). A tensor-based big data model for QoS improvement in software defined networks. *IEEE Network*, *30*(1), 30-35.

[3] Raj, S., Anju, R., Permodkumar, C., & Gyanikashukla, A. (2017). Hemicellulolytic activity in the crop residues. *International journal of pharmacy research & technology*, *7*(1), 18-20.

[4] Mathumathi, K.M., & Senthilprakash, K. (2017). Energy sentient qos implemented node-disjoint multipath routing protocolfor manet. *International journal of communication and computer technologies*, *5*(2), 67-75.

[5] Surendar, A. (2018). Short communication: Role of microbiology in the pharmaceutical &medical device. *International Journal of Pharmaceutical Research*, *10* (3).

[6] Kataria, A. (2007). *Cognitive radios: spectrum sensing issues* (Doctoral dissertation, University of Missouri--Columbia).

[7] Anuradha, J. (2015). A brief introduction on Big Data 5Vs characteristics and Hadoop technology. *Procedia computer science*, *48*, 319-324.

[8] Rathore, M. M., Ahmad, A., Paul, A., & Rho, S. (2016). Urban planning and building smart cities based on the internet of things using big data analytics. *Computer Networks*, *101*, 63-80.

[9] Caragliu, A., Del Bo, C., & Nijkamp, P. (2011). Smart cities in Europe. *Journal of urban technology*, *18*(2), 65-82.

[10] El Tanab, M., & Hamouda, W. (2017). Resource allocation for underlay cognitive radio networks: A survey. *IEEE Communications Surveys & Tutorials*, *19*(2), 1249-1276.

[11] Omar, S., El Ghandour , O., & Abd El -Haleem, A. M. (2017). Multipath Activity Based Routing Protocol for Mobile ‎Cognitive Radio Ad Hoc Networks. *Wireless Communications and Mobile Computing*, *2017*.

[12] Yu, X., Shi, X., & Hua, J. (2013). A Distributed Channel Allocation Algorithm for Multi-channel Wireless Networks. *Information Technology Journal*, *12*(1).

[13] Kumaraswamy, M., Shaila, K., Tejaswi, V., Venugopal, K. (2015). Multihop Multi-Channel Distributed QOS Scheduling MAC Scheme for Wireless Sensor Networks. *IOSR Journal of Computer Engineering (IOSR-JCE), 17* (2), 1-10.

[14] Yu, R., Zhong, W., Xie, S., Zhang, Y., & Zhang, Y. (2016). QoS Differential Scheduling in Cognitive-Radio-Based Smart Grid Networks: An Adaptive Dynamic Programming Approach. *IEEE Trans. Neural Netw. Learning Syst.*, *27*(2), 435-443.

[15] Bansal, A., & Mahajan, M. R. (2012). Building cognitive radio system using matlab. *International Journal of Electronics and Computer Science Engineering*, *1*(3), 1555-1560.

[16] Jain, S., & Goel, A. (2017). A Survey of Spectrum Prediction Techniques for Cognitive Radio Networks. *International Journal of Applied Engineering Research*, *12*(10), 2196-2201.

[17] Jayaraman, A., & Pushpam, I. (2013). Performance Analysis of Ds-CDMA System Over AWGN And Fading Channels Based On Diversity Scheme. *Journal of Theoretical & Applied Information Technology*, *52*(1).

[18] Bayaki, E., Michalopoulos, D.S., & Schober, R. (2012). EDFA-based all-optical relaying in free-space optical systems. *IEEE Transactions on Communications*, *60*(12), 3797-3807.