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***Research paper***

# Development of efficient VoIP application using cognitive radio networks

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**Abstract**

There is an increased usage of wireless communication for personal use, commercial use etc. Nowadays Cognitive Radio has become the prime topic of interest in wireless network. It is an intelligent radio technology, which easily adapts to the network and automatically detects the vacant channels which are available in a wireless spectrum. It then changes the transmission parameters enabling concurrent communica-tions thereby improving the radio operating behavior. VoIP mobile applications are used worldwide for making audio and video calls using internet. But they face many disadvantages such as reflection of voice/echo, breaking of voice, delay in voice etc and have reduced quality with low Wi-Fi or 3g signals. Therefore we are designing an efficient and effective system to improve throughput and bit error rate of VoIP mobile applications by implementing them using cognitive radio networks.

***Keywords***: *Bit Error Rate; Cognitive Radio; VoIP Application; Throughput.*

## 1. Introduction

Cognitive radios are designed in order to provide highly dependable communication for all users of the network whenever, wherever needed and to assist constructive utilization of the radio spectrum. It is an intelligent radio and network technology and can automatically detect the available channel in a wireless spectrum [1]. The secondary (unlicensed) systems are allowed to expediently utilize the unused primary (licensed) bands that are commonly referred to as white spaces. Cognitive radio can change its transmission parameters enabling more communication to run concurrently. Cognitive radios can implement function spectrum sensing in many ways. The two categories are co-operative spectrum sensing and non co-operative spectrum sensing [2] [3]. In cognitive networks, the most important consideration is given to the primary user compared to the secondary user. The main intention is to make spectrum sensing without causing any intrusion to the primary user.

The secondary user checks whether there is an active channel within its range. It will not be able to transmit the signal in the presence of primary user because it might lead to intrusion to the primary user. Therefore to avoid the intrusion problem to the primary user it is necessary to continually check the presence of any active primary channel [4].

The secondary user also taps the functions of the primary user to find the spectrum holes. The spectrum is classified into three types based on the interference level in it. The black spaces have maximum interferers, the grey spaces have average interferers and the white spaces have scarce interferers. These white spaces which are ideal for communication are known as spectrum holes. VoIP applications which are in wide usage in recent days face a few disadvantages such as reflection of voice /echo, breaking of voice and delay in delivery of voice and have reduced quality with low Wi-Fi signals. We are designing a prototype to overcome these disadvantages in VoIP application [4] using Cognitive Radio Networks. Matched filter detection is the ideal method for spectrum detection in mobile applications. Main purpose of this filter is to decrease the noise and probability of error at the same time.

Cognitive radio is an intelligent wireless radio and it automatically detects the available channel. Its transceiver is used to design the best wireless channel. It facilitates effective communication by altering the transmission parameters of a specific spectrum band in a location [5]. For an effective usage of radio frequency spectrum, cognitive radio allows the secondary user to occupy the spectrum whenever primary user is not using it.

## 2. System design

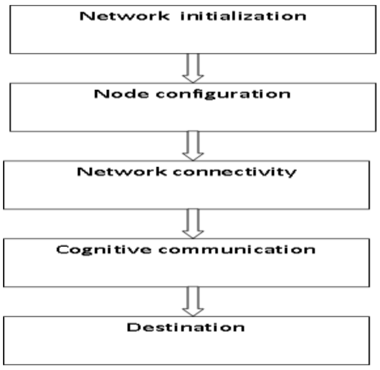


**Fig. 1:** Design of the VoIP Application Using CRN.

The design implementation for the system is as shown in above Fig. 1. It comprises of the following steps.

### 2.1. Network initialization

Initialization is the process of locating and using the defined values for variable data that is used by a computer program. It configures the network and the nodes to be used by it.

### 2.2. Node configuration

The design of the node is organized in a hierarchical manner. Configurations are stored in configuration files and can be extended by variables, parameters and external resources.

### 2.3. Network connectivity

It connects various part of the network together providing efficient functioning of the design. The forwarding of data packets is determined based on the connectivity of nodes within a network

### 2.4. Cognitive communication through spectrum sensing (matched filter detection)

When many users use the application simultaneously during peak time or an emergency, the system might face delay or link failure which may disrupt the communication between the users. During such a condition, the cognitive radio detects unused spectrums of other users and utilizes those spectrums for the current communication processes.
Therefore the detection of unused spectrum i.e. spectrum sensing forms the major function of the cognitive radio. Out of the various spectrum sensing techniques, matched filter technique proves to be efficient for our design. Matched filter which is an optimal linear filter to maximize the signal to noise ratio, is constructed based on noise spectrum.

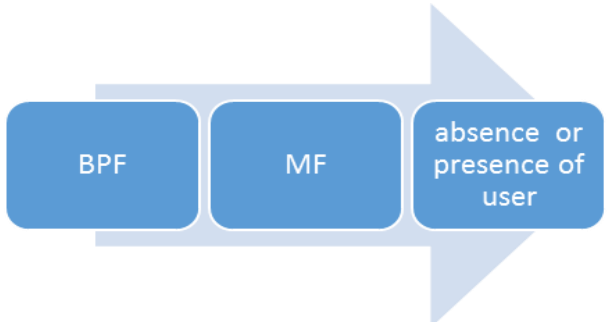


**Fig. 2:** Matched Filter Technique for Spectrum Sensing.

The basic requirement for the matched filter detection technique is that the cognitive radio user needs to have the knowledge about the primary signal transmitted by the primary user. Detection time will be less compared to the other techniques. The matched filter which is as shown in fig.2, detects the primary user when the channel is identified. For a specified input it will give a high SNR. The sensitivity of the matched filter is said to be complicated and the SNR increases in the presence of noise [6], [11]. High processing gain is achieved in less time. Using the fake alarm and probabilities the performance of the matched filter is detected.

### 2.5. Destination

The user in the other end is effectively able to utilize the VoIP application.

## 3. Results and discussion

Simulation Results:
The design is simulated using NS2 where we configure several nodes to create a network as shown in Fig.3
Graphs and Plots:

### 3.1. Packet delay comparison

Packet delay variation is the difference in end to end one way delay between selected packets in a flow with any lost packets being ignored.
Average delay is given by the ratio of summation of the delay samples to total number of samples. The delay sample involved is related with a packet.

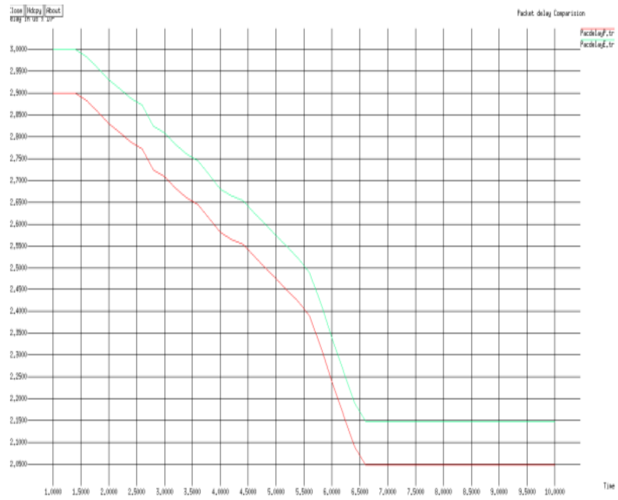

**Fig. 3:** Packet Delay Analysis.

In the graph shown in Fig.3, the proposed design is indicated in (red) and existing value is high (green). Our design exhibited lesser delay comparatively.

### 3.2. Throughput comparison

It is the measure of rate of production or it is the measure of the effectiveness of the system that runs many applications simultaneously. It can be calculated by determining the transmission time from eqn [1] and then by using eqn [2].

Transmission Time = File Size / Bandwidth (sec) (1)

Throughput=File Size/Transmission Time (bps) (2)

In the graph shown in fig. 4, the throughput of proposed is said to be high (red) and existing value is low (green). Our throughput is slightly high when compared to the existing one.

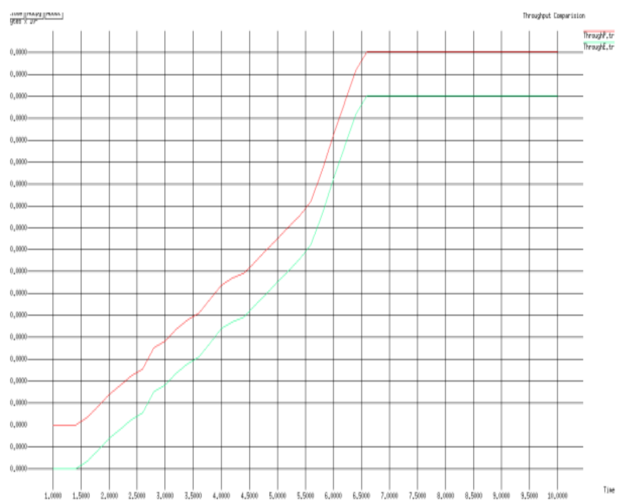

**Fig. 4:** Throughput Analysis.

### 3.3. Energy consumption comparison

Energy consumption is a measure of the amount of power used. Energy consumption is usually based on the following metrics: packet arrival rate (data generation interval, or inter-arrival time), number of nodes in the network, packet size and the range (and hops in case of multi-hop network).

In the graph shown in fig.5, the proposed value is said to be low (red) and existing is high (green) as our protocol consumes less energy compared to the existing one.

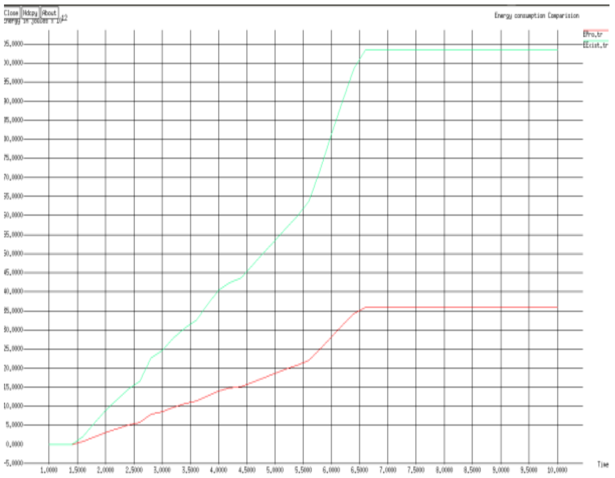

**Fig. 5:** Energy Consumption Analysis.

### 3.4. Packet delivery ratio comparison

The ratio of packets that are successfully delivered to a destination compared to the number of packets that have been sent out by the sender.

PDR= S1÷ S2

Where, S1 is the sum of data packets received by the each destination and S2 is the sum of data packets generated by the each source.

In the graph shown in fig. 6, the proposed is found to be high (red) and existing is low (green). Our ratio of packet delivery is high when compared to the existing one.

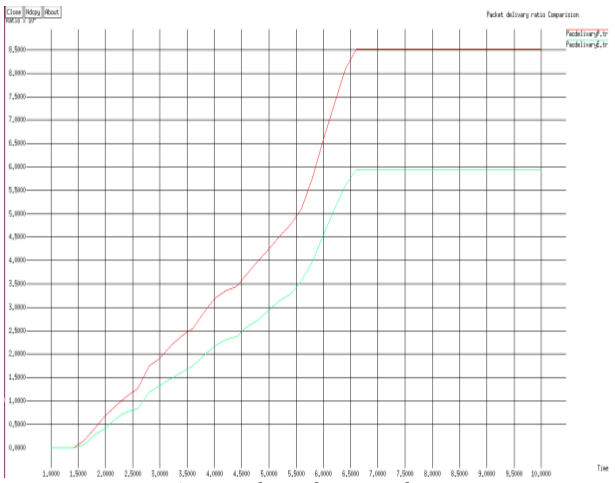

**Fig. 6:** Packet Delivery Analysis.

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## 4. Conclusion

This paper brings out a new cognitive radio defined design which overcomes the disadvantages of existing VoIP application by presenting better throughput and packet delivery ratio. It also consumes comparatively less power and exhibits lower packet delay ratios.

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