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Performance Metric Evaluation for Cognitive Radio Network

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ABSTRACT: Cognitive radio is a prominent technique for improving the effective utilization of the radio spectrum resource i.e., the radio electromagnetic spectrum. The cognitive radio, built on a software-defined radio, is defined as an intelligent wireless communication system that is aware of its environment and uses the methodology of understanding by building to learn from the environment and adapt to statistical variations in the input stimuli, with two primary objectives. Primary objectives are highly reliable communication whenever and wherever needed and efficient utilization of the radio spectrum. Two type of users are available for spectrum utilization. They are primary user and secondary user. A secondary network (cognitive radio network) shares the radio spectrum of a primary network (licensed network). The secondary network is an unlicensed network. A cognitive radio system with one secondary user accessing multiple channels through spectrum sensing method and spectrum handoff is to be addressed. The throughput of the cognitive radio network along with how it is influencing the energy efficiency of the network is analyzed. The level of increase in the proposed throughput is shown through network simulation.

KEYWORDS: Cognitive Radio, Spectrum Sensing, Efficient Communication, Throughput.

I.INTRODUCTION

Nowadays, there is an unpredictable increase of the laptops and smart phones in every year. So we need advanced multimedia facility and high data rate services. To satisfy this need we force to secure new radio spectrum. But the electromagnetic radio spectrum is a rare and natural resource. The government licensed the use of spectrum by both transmitter and receiver. So there is a limited spectrum band available for wireless uses. Instead of this, the federal communication commission (FCC) has reported that a significant amount of radio spectrum is not properly used. This thought results to the implementation of cognitive radio network.

Cognitive radio is one of the new long term developments taking place and radio receiver and radio communications technology. After the Software Defined Radio (SDR) which is slowly becoming more of a reality, cognitive radio and cognitive radio technology will be the next major step forward enabling more effective radio communications systems to be developed.

The use of a cognitive radio network provides a number of advantages. They are improved spectrum sensing and improved coverage. With Cognitive Radio being used in a number of applications, the area of spectrum sensing has become increasingly important. As Cognitive Radio technology is being used to provide a method of using the spectrum more efficiently, spectrum sensing is key to this application. The ability of Cognitive Radio systems to access spare sections of the radio spectrum, and to keep monitoring the spectrum to ensure that the Cognitive Radio system does not cause any undue interference relies totally on the spectrum sensing elements of the system. For the overall system to operate effectively and to provide the required improvement in spectrum efficiency, the Cognitive Radio spectrum sensing system must be able to effectively detect any other transmissions, identify what they are and inform the central processing unit within the Cognitive Radio so that the required action can be taken.

II.SYSTEM MODEL AND ASSUMPTIONS

The electromagnetic radio spectrum is a natural resource, the use of which by transmitters and receivers is licensed by governments. In November 2002, the Federal Communications Commission (FCC) published a report prepared by the

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Spectrum-Policy Task Force, aimed at improving the way in which this precious resource is managed in the United States .The task force was made up of a team of high-level, multidisciplinary professional FCC staff (economists, engineers, and attorneys)from across the commission's bureaus and offices. Among the task force major findings and recommendations, the second finding on page 3 of the report is rather revealing in the context of spectrum utilization: "In many bands, spectrum access is a more significant problem than physical scarcity of spectrum, in large part due to legacy command-and-control regulation that limits the ability of potential spectrum users to obtain such access."

Indeed, if it were to scan portions of the radio spectrum including the revenue-rich urban areas, it would find that :
1) Some frequency bands in the spectrum are largely unoccupied most of the time
2) Some other frequency bands are only partially occupied
3) The remaining frequency bands are heavily used.

The underutilization of the electromagnetic spectrum leads us to think in terms of spectrum holes, for which offer the following definition: A spectrum hole is a band of frequencies assigned to a primary user, but, at a particular time and specific geographic location, the band is not being utilized by that user. Spectrum utilization can be improved significantly by making it possible for a secondary user (who is not being serviced) to access a spectrum hole unoccupied by the primary user at the right location and the time in question. Cognitive radio, inclusive of software-defined radio, has been proposed as the means to promote the efficient use of the spectrum by exploiting the existence of spectrum holes.

Cognitive radio is an intelligent wireless communication system that is aware of its surrounding environment (i.e., outside world), and uses the methodology of understanding-by-building to learn from the environment and adapt its internal states to statistical variations in the incoming RF stimuli by making corresponding changes in certain operating parameters (e.g., transmit-power, carrier-frequency, and modulation strategy) in real-time, with two primary objectives in mind:
1) Highly reliable communications whenever and wherever needed;
2) Efficient utilization of the radio spectrum.

CR networks can be classified under two categories, namely interference-free and interference-tolerant CR networks. In the former CR networks, secondary transmitters (STs) can only use those spectrums which are not occupied by primary receivers (PRs) .Whereas in the latter CR networks, the STs can share the spectrum as long as they do not cause any outage to the primary network operation and the interference to PRs is kept below a threshold.

The given work discusses about a spectrum sensing technique with distributed q learning in spectrum decision (i.e. selecting unused licensed bands).In the given work the secondary node selects a communication band and starts communicate. When the licensed user arrives the secondary user should leave the channel. If the secondary node leaves the channel on arrival of primary user it is called reactive spectrum decision i.e. on arrival of primary user the secondary node leaves the channel, search for a new channel and continue communication. Another method is proactive spectrum decision, i.e. secondary node predict the arrival of primary user, selects the next channel to communicate before the primary user appears and when the primary user appears it immediately switches to the selected channel.

In Cognitive Radio Networks, the Transceiver can intelligently detect the vacant channels and move to it as well as avoids the occupant channels to use again to congest the bandwidth usage. Optimizing the RF spectrum to all used or working nodes. Unlicensed users can use the vacant channels without interference, but when the licensed channel comes into action it gets stopped. Normally the Secondary User can transmit data without any disturbance but when the licensed primary user enter into the region for transmission then the secondary user stop using the bandwidth and it is allotted to primary user. Block diagram of cognitive radio network is shown in figure 1

Primary Nodes used licensed channel and the Secondary nodes used unlicensed channel. Incase if lots of secondary nodes used the channels simultaneously then congestion occurs.

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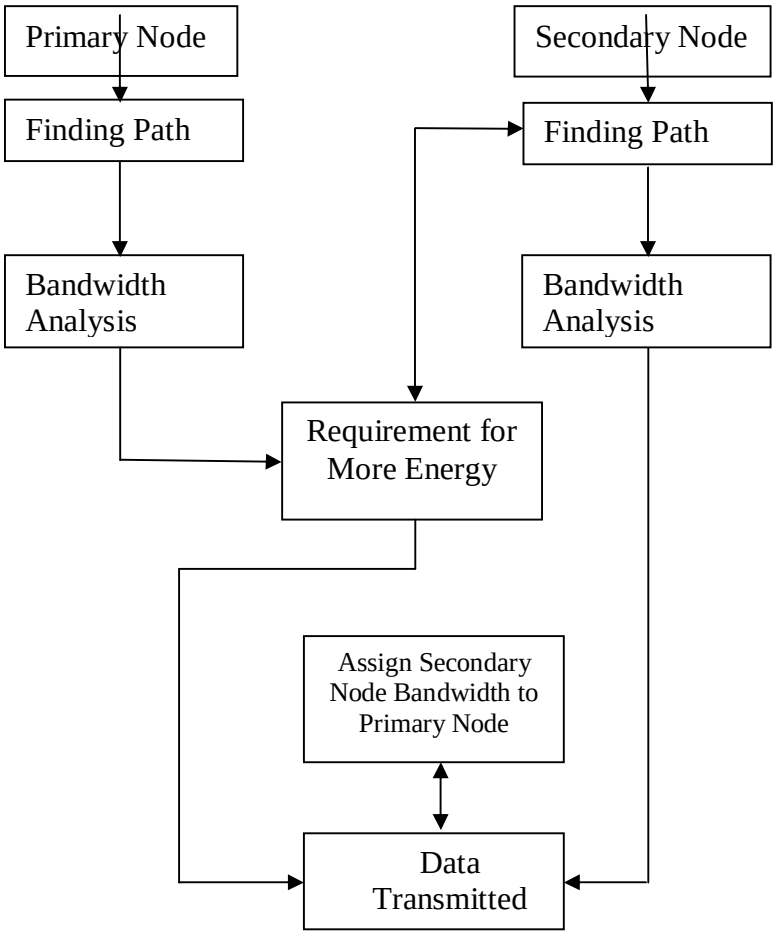

Fig 1 Block diagram of cognitive radio network

A mobile node is an Internet-connected device whose location and point of attachment to the Internet may frequently be changed. This kind of node is often a cellular telephone or handheld or laptop computer, although a mobile node can also be a router. Special support is required to maintain Internet connections for a mobile node as it moves from one network or subnet to another, because traditional Internet routing assumes a device will always have the same IP address. Therefore, using standard routing procedures, a mobile user would have to change the device's IP address each time they connected through another network or subnet.

III.SECURITY

Spectrum sensing: Detecting unused spectrum and sharing it, without harmful interference to other users; an important requirement of the cognitive-radio network to sense empty spectrum. Detecting primary users is the most efficient way to detect empty spectrum. Spectrum-sensing techniques may be grouped into three categories:
Transmitter detection: Cognitive radios must have the capability to determine if a signal from a primary transmitter is locally present in a certain spectrum. There are several proposed approaches to transmitter detection:
1. Cooperative detection: Refers to spectrum-sensing methods where information from multiple cognitive-radio users is incorporated for primary-user detection.
2. Interference-based detection.

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Since primary user networks have no requirement to change their infrastructure for spectrum sharing, the task falls to CRs as secondary users to detect the presence of primary users through continuous spectrum sensing. Spectrum sensing by CRs can be conducted either individually or cooperatively. Recently, the efficacy of cooperative spectrum sensing has gained a great deal of attention. There are several advantages offered by cooperative spectrum sensing over the non-cooperative methods. However, due to the randomness of the appearance of PUs, it is extremely difficult to achieve fast and smooth spectrum transition leading to limited interference to PUs and performance degradation of SUs. Locally collected and exchanged spectrum sensing information is used to construct a perceived environment that will impact CR behaviour. This opens opportunities to malicious attackers. In cooperative spectrum sensing a group of secondary users perform spectrum sensing by collaboratively exchanging locally collected information. Malicious secondary users may take advantage of cooperative spectrum sensing and launch attacks by sending false local spectrum sensing results to others, resulting in a wrong spectrum sensing decision.

IV. RESULT AND DISCUSSION

The throughput is the number of messages successfully delivered per unit time. The CR network consist of one ST (base station) i.e., macro BS, which transmits signals to multiple SRs. It is determined according to the channel conditions. Throughput of the cognitive radio network is the total number of packets received in a timeslot at a data rate.

Throughput is depend on

1, Number of primary channels considered as unused by the secondary users 'L'

2, Data rate 'R'

Throughput 'T' is given below

$$T = \frac{L*R*T_{CP}}{T_S} \quad (1)$$

Where T_{CP} is the Time available for secondary users to transmit their data through the primary channel and T_S is the Time slot.

In the fig 2, it shows that the graph of time Vs throughput of receiving packet. Throughput is the average rate of successful message delivery over a communication channel. Throughput is expressed in 'bps'. It is directly proportional to the energy efficiency. Energy efficiency is the required energy per bit for a reliable communication. Comparison of throughput of both existing and proposed system are shown in Figure. The proposed throughput is 98.5bps and the existing throughput is 95bps. So here throughput is increased by around 3.5bps.

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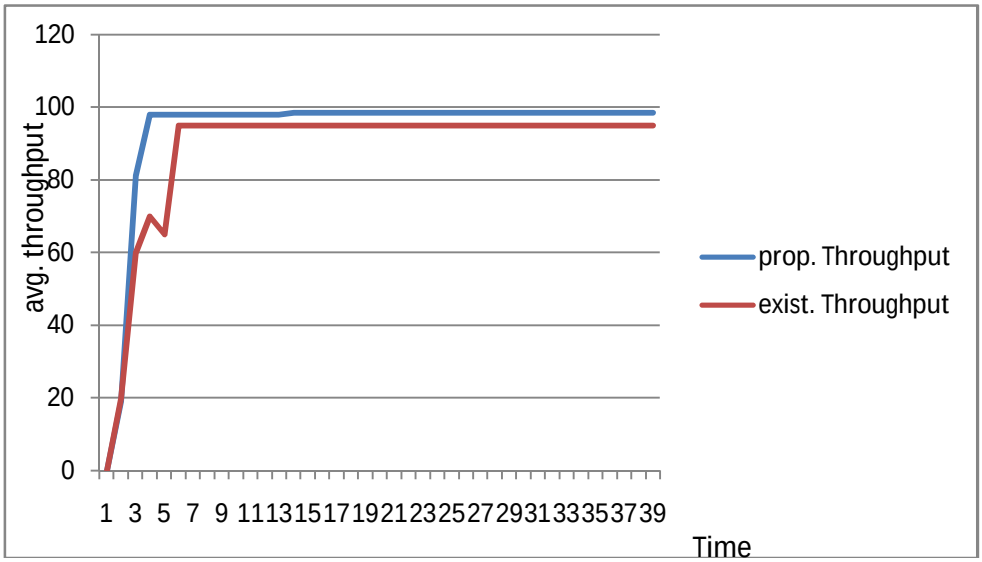

Fig 2 Throughput Vs Time

V.CONCLUSION

In this paper, find out the increase in energy efficiency by analyzing the throughput of the cognitive radio network. First analysis is carried out by the formation of the cognitive radio network. For the formation of cognitive radio network 47 fixed nodes are used. Communication is takes place according to the spectrum sharing between secondary and primary node. By using spectrum sensing method, the availability of channel is determined. Water filling algorithm support spectrum sensing method. Here the spectrum sensing is carried out by using distance and received signal energy measurement. A threshold value is set for both distance and received signal energy. Second analysis is throughput analysis. The throughput of proposed system is increased to 98.5 bps from 95bps of existing system throughput. Here got around 3.5bps increase in throughput. So the energy efficiency is increased.

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