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Intelligent Load Balancing Approach for Cognitive Radio Networks

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Abstract—Presently most of the wireless service providers are encountering increasing spectrum shortage due to ever increasing demands from users. This spectrum shortage also affects channel utilization due to comparatively high congestion levels. The main reason that leads to useless utilization of the radio range is the spectrum licensing system itself. Due to this static and rigid allocation, wireless systems have to work only on a dedicated band of spectrum and cannot change the transmission band as changing the environment. One of the solutions that have been proposed to solve this critical problem is to use unlicensed devices in the available licensed bands. Therefore, dynamic spectrum access techniques based on load balancing are proposed to provide efficient spectrum utilization. In Cognitive Radio Network (CRN) a large number of very frequent connection requests from both primary and secondary user's results in dynamic demand for a number of target channels. In this work an intelligent load balancing scheme has been proposed whose aim is to help cognitive user to find suitable channel in case of overload so as to enable the resumption of unfinished transmission as quickly as possible. The simulation results of the proposed scheme show that the model works well in reducing channel overload thereby reducing delay time in Cognitive Radio Networks.

Index Terms **- Cognitive Radio Network, Primary Users, Secondary Users, Load Balancing, Dynamic Spectrum Access**

I. INTRODUCTION

Cognitive Radio Network is a category of wireless system in which either an entire network or a single node varies its communication or response parameter to perform effective communication. It avoids obstruction with two main types of users that are classified as primary user (PU) and secondary user (SU) [1]. CRN is considered to be an intelligent communication system that are sensitive to surrounding atmosphere and use the sensing techniques to gain knowledge from the surroundings and adjust its internal conditions to match corresponding changes in the arriving Radio Frequency by creating consequent variation in definite working factors as shown in Figure1.

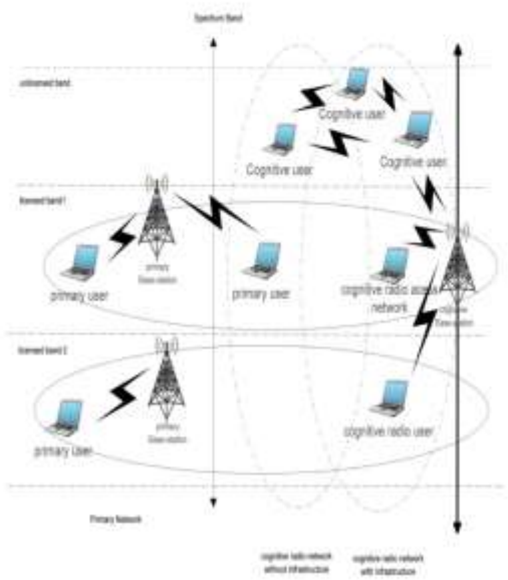

Figure 1. A Cognitive Radio Network

Spectrum is a very limited product and due to the spectrum insufficiency for available spectrum, leads to frequent overloading of spectrum. The main reason that leads to excess utilization of the radio spectrum is that if the allocated radio spectrum is not used by primary users then it also cannot be utilized by SU's [2]. As a result, wireless systems are intended to work only on a devoted band of spectrum for fixed and rigid allocations. It cannot change the band as changing the surroundings. As illustration if one channel of spectrum band is greatly used, the wireless system cannot alter to work on any other more lightly used band.

The authorized access of spectrum is usually defined by owner of spectrum and is governed by factors such as transmit power, frequency, space and the license duration. In general, a spectrum should follow the constraints of high power of transmission and effective base station location [3]. Also, the irregular use of spectrum may result in low consumption of the frequency spectrum resulting in creation of Spectrum Holes. The Spectrum hole is defined as a group of frequencies given to a licensee, except that user is not using the band at exact time and exact geographic location.

Current research has already illustrated that the assignment of spectrum through static assignment schemes results in unpredictable spectrum usage. This causes the spectrum to be either becoming under-utilized in some situations while it may be over-utilized for some other allocations. To overcome this inefficient use of spectrum in CR the concept of Load Balancing (LB) can be utilized. By using LB we can further enhance the main distinctiveness of cognitive networks by allowing consumers of channel to receive appropriate amount of spectrum for their use by utilizing the basic communication parameters for deciding on the amount of spectrum to be allocated.

In this paper we propose a Load Balancing scheme whose aim is to help SU to discover and then use appropriate channel to reassign load from overloaded channels into underutilized channel and thereby achieving more efficient capacity utilization of the spectrum. The proposed intelligent load balancing scheme also attempts to provide more reliable data transmission for SU's. Rest of this paper organized as follows. In Section 2, discuss the existing work and review the existing proposals on load balancing. In Section 3, explain the proposed intelligent Load Balancing approach. Simulation results are discussed in Section 4 and, finally, we close the paper with the conclusions section.

II LITERATURE REVIEW

CRN has been projected as result to both range inadequacy and range shortage troubles. In the past the researchers have proposed a large number of solutions for increasing the efficiency of spectrum usage. The load balancing approaches have started gaining prominence and are gaining increased attention in these networks.

Lee and Akyildiz [3] introduced new network structural design to moderate varied spectrum availability. They developed a combined mobility managing framework to maintain different mobility actions in CRNs which consist of user mobility supervision, inter cell resource allocation and spectrum mobility supervision. They also proposed a spectrum alert mobility managing method for CR cellular networks. Song and Jiang [4] proposed a proactive spectrum hand off structure in a CRN scenario. The authors also devised proactive spectrum hand off criteria and policies based on channel usage figures. SU's proactively guess the upcoming spectrum accessibility position and carry out spectrum changing before a PU reuses the spectrum. Researchers also investigated a channel coordination method and integrated it into the spectrum handover protocol design. The authors proposed a new distributed channel picking method to eliminate conflicts among SUs in a multiple user scenario. Zhu et al. [5] presented Markov series study for range access in licensed bands for CR. The authors derived compelled termination probability, traffic throughput and blocking probability. They also proposed a channel reservation method for CR spectrum handover.

Lertsinsrubtavee et al. [6] proposed and revised a new spectrum handover policy whose aim is to reduce the avoidable hand off operations while bearing in mind a delay bound necessity. In this work a wait parameter was computed on the basis of a row related function for each available channel. Ma and Wang [7] worked on to ensure the optimal use of spectrum, when the primary user occurs; the SUs need to change the spectrum, which is called as the spectrum mobility. The authors studied and simulated switching request strategy based on queuing theory.

Zhang et al. [8] projected a protocol that used some parameters to distinguish between immediate and future spectrum handover policies. Song et al. [9] proposed a proactive spectrum handover formation in a restricted cognitive scenario. The authors also devised proactive spectrum handover criteria and various guidelines based on channel usage statistics. By allowing users to perform intelligent guessing about spectrum availability status the proposed scheme also does spectrum switching before any user attempts to allocate that spectrum.

III. PROPOSED WORK

Basically we are implementing the Load Balancing Scheme (LBS) which means that the load is distributed over the node which is under loaded in cognitive radio network.

Algorithm 1: Algorithm for Load Balancing
Inputs: *Primary and Secondary users.*
Outputs: *Balanced Load for each Node*
Assumptions: N*o user is malicious and provides information about its load*

1. *Begin*
2. *for each station 'x' do*
3. *Sense spectrum usage for x*
4. *if (spectrum usage >= threshold) then*
5. *Discover other free available CH's*
   Compute available signal strength for CH
6. *for each CH do*
7. *Find the available channel capacity*
8. *end for*
9. *Sort all the available capacities in descending order*
10. *Store the sorted channels in a list LI*

else
Check availability for next station
end if
For each item in LI do
Assign free capacity to x
if assignment feasible
Perform Load balancing
end if
end for
End.

For the implementation nodes are created. The nodes are static and communicating with each other in the CR environment through base stations. There communication performance is evaluated by using the network simulator along with CRCN patch. Initially we have created a scenario that includes different channels and communicate to each other. All nodes exchange their information through this base station. When any of node is overloaded and having signal strength below threshold while transmitting its data then load is transfer to under loaded node by using algorithm 1.

In this while transmitting data nodes are utilizing Cognitive radios. They are connecting through a base station. Various channels are used for their communication. While communicating if there are is a node which is having heavy load at that time its signal strength becomes low then threshold. So channel (CH) of that nodes search for new CH and discover new CH with available bandwidth. Now in the next step it will sort all the channels capacities and store their result in the list. CH having maxing capacity above threshold are selected by the serving CH. Now CH send request to the new channel for share load to improve speed. Then new CH receives the request and send acknowledgement.

IV SIMULATION AND RESULT

The simulation for the proposed work has been finished in ns2. The simulations parameters that are taken are shown in Table 5.1.

Parameters	**Values**
Simulation Time	60 second
Number of nodes	50
Number of CRI interfaces	3
Number of PUs	20
Number of SUs	40
Speed	20 m/s
Packet Size	1024 bytes

Table 1: Simulation Parameters for Load Balancing Scheme

Figure 2 shows that comparison of delay time when nodes are varied. Delay is defined as the difference between the expected time of arrival of a packet and the actual time. This graph showed that we are is able to decrease the delay time parameter by using load balancing scheme.

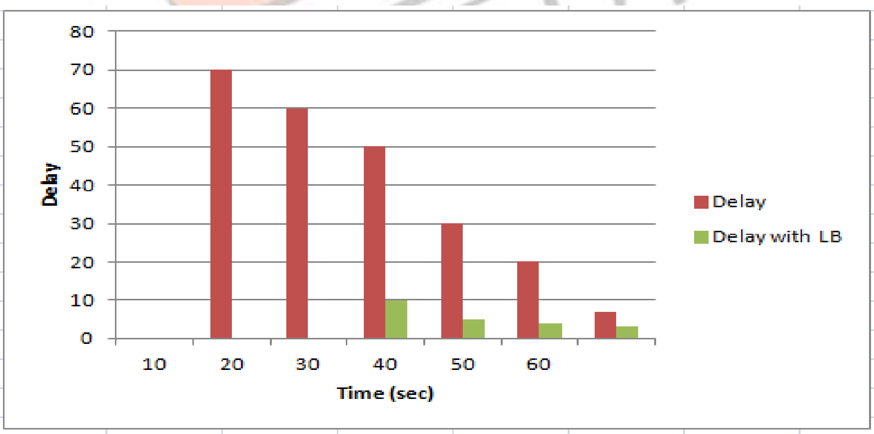

Figure 2: Variation in delay as a function of simulation time

Figure 3 shows the packet delivery ratio between the base station and target node. From Result we find that the by using load balancing packet delivery ratio is more than other.

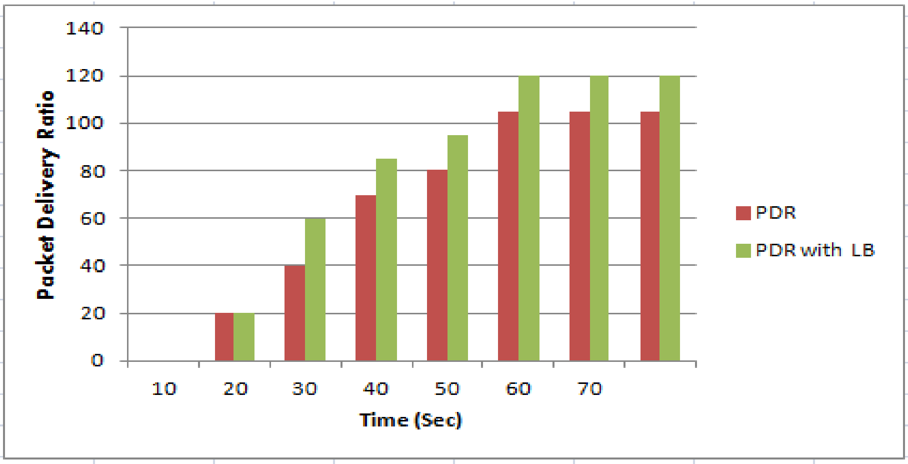

Figure 3: Variation in PDR as a function of simulation time

Figure 4 show that with increase in time throughput also increases. Throughput may be defined amount of data that is delivered from one node to another via a communication link per time unit. From result we find that the by using load balancing throughput is more as compared to other.

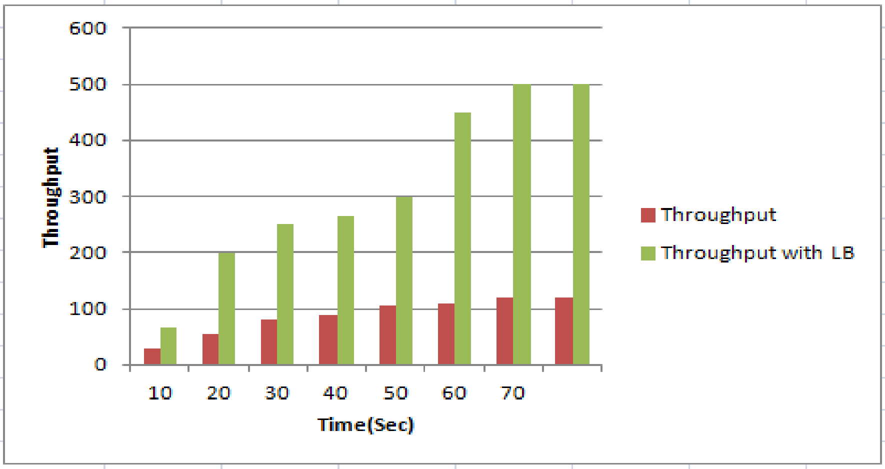

Figure 4: Variation in throughput as a function of simulation time

Figure 5 shows that with increase in time packet loss also increases .But packet loss is less in case of load balancing scheme

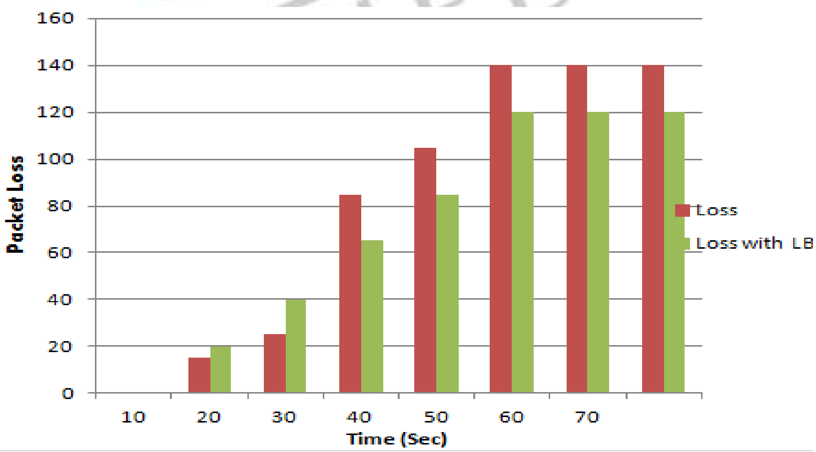

Figure 5: Variation in packet loss as a function of simulation time

V. CONCLUSION

Here, we have presented a simple model to compute performance of the CRNs. Our model assumes a finite number of nodes for specific iterations and ideal channel conditions. The model is suited for various parameters calculation such as delay, PDR, packet loss, throughput for both scenarios. Comparison with simulation results shows that the model is most accurate in evaluating data delivery of both schemes. Using the simulation results of the proposed models, we show that the performance of CRNs with LBS is better than without LBS for large number of nodes and with increase in time it also give better performance.

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