A Survey on Load Balancing during Handover in Cognitive Radio Networks using Data Mining

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Abstract

The problem of over loaded traffic on the wireless networks which consists of nodes handle the traffic and are usually responsible for the accurate functioning of the entire network. Even if one single node gets over loaded, then the overall performance network is degraded. Our work targets on the automatic monitoring of the networks so that the load will always stay balanced among various nodes and traffic is reduced. This will help in improving the overall performance of the network by the concept of cognitive radio. The activities of licensed users may cause heavy traffic in some bands while leaving other bands idle, load balancing is first performed to equalize the traffic faced by the users. If the secondary users can prudently adopt the best spectrum decision scheme according to sensing time and traffic conditions, the overall system time can be improved by 70% compared to the existing methods. The Cognitive radio is integrated with the Frequent itemset data mining in order to extract the data's that are stored during load balancing.

Index Terms — *Cognitive Radio, over Loaded, Spectrum Decision, Sensing Time, Frequent Itemset Mining.*

I. INTRODUCTION

Load balancing is a networking method for sharing workloads across multiple computers or a computer cluster, network links, central processing units, disk drives, or other resources. Successful load balancing optimizes resource use, increases throughput, decreases response time, and avoids overload. Using multiple components with load balancing instead of a single component may maximize reliability through redundancy. Load balancing is usually provided by dedicated software or hardware, such as a multilayer switch [1] or a Domain Name System server Process. Cognitive radio networks are smart networks that can be adjusted automatically during the network running time. These networks have the capability of dynamically changing the behavior and node based on the network conditions. These networks usually receive the commands from the operators and based on the received they change their configuration parameter [2][3] The parameter(s) considered in this work are operating frequency. The load will be balanced among various service providers which will be using cognitive networks. Intelligence based load balancing technique has recently become a useful tool for modeling and learning interactions between cognitive radios [4] envisioned to operate in future communications systems. Such terminals will have the capability to adapt to the context they operate in, through possibly power and sum rate control as well as channel selection.

Cognitive Radio (CR) is the category of wireless system in which either an entire network or a single node varies its communication or response parameter to correspond effectively. It avoids obstruction with Primary [5][6] User and Secondary User. It is considered to be an intelligent communication system which is sensitive of surrounding network and uses the techniques to obtain knowledge from the surroundings and adjust its internal conditions to arithmetic changes in the arriving RF by creating consequent variation in definite working factors.

CR is a structure that senses its equipped electromagnetic surroundings atmosphere where the network is available and can separately and dynamically change its radio in service factors to update system action such as minimizing obstruction, take advantage of throughput, [7] easiness interoperability. Cognitive ability indicates to the capability of radio technology to sense the data or capture the data from its radio surroundings. The SU can occupy an idle segment of the spectrum. Thus the SU should capture their information, check the existing spectrum bands and after that identify the spectrum vacancy or holes.

A CR is intended to be alert and responsive to alters in its neighboring nodes that makes spectrum sensing an imperative necessity for the understanding of secondary networks. Spectrum sensing method allows SUs to use the vacant spectrum segment adaptively to the network area. The authorized access of spectrum is usually processes by [8] owner of spectrum; transmit power, frequency, space and the license duration. In general, a license is allocated to one licensee and the use of band by this owner must have the below requirement e.g. highest power of transmit or tht base station location. In present spectrum licensing system, the license cannot vary the application or giving the access to another licenses by identifying itself. This restriction causes in low consumption of the frequency spectrum and complexity in sensing.

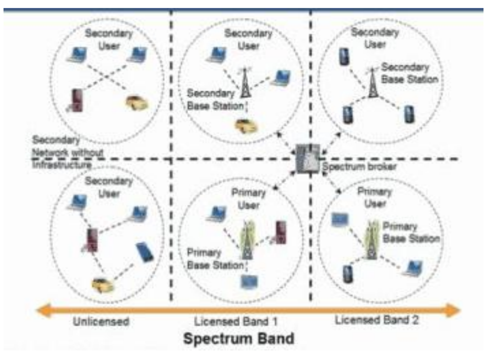

Fig 1. CRN Architecture

The paper is organized as follows: Section 2 presents survey information on spectrum management ,sensing and load balancing. Section 3, provides an in-depth explanation of how data mining is applied. In Section 4, present efficient energy detection method. In Section 5, present network load balancing method and standards are discussed. In Section 6, finally summarizing the paper and conclusions.

II. LITERATURE REVIEW

A. Spectrum Management

The mobile users were provided with higher bandwidth through the technique dynamic spectrum access in order to balancing the load of the traffic[9] occurs during the sensing of spectrum. The spectrum decision, spectrum sensing, spectrum sharing and spectrum mobility are the major challenges during spectrum management.

B. Spectrum Assignment

Cognitive radio assigns the unused spectrum from the primary user to the secondary user by the method of resource allocation. The interference can be reduced by the spectrum management between the primary user and the secondary user in cognitive radio devices. During the [10] spectrum allocation for the secondary users various problems occurs such as traffic can be overloaded which can be controlled using load balancing.

C. Spectrum Utilization

The Spectrum utilization is unevenly distributed, which can cause the problem of spectrum allocation and the spectrum management. IEEE 802.22 is introduced, which is a standard for cognitive radio. Network initialization, network entry and the hidden incumbent problem cannot be overcome by IEEE 802.22.mobility is another problem in cognitive radio networks that is unexplored. A new protocol is introduced to overcome the problem of handover in the survey [11]. The issue can be overcome by the cognitive radio architecture known as the LEO-satellite assisted Cognitive Radio architecture.

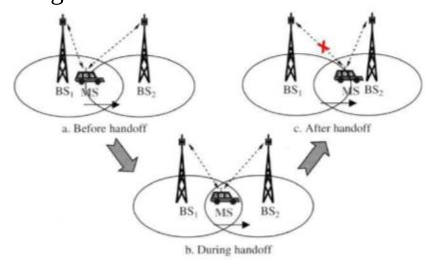

Fig 2. Handover

D. Handover in CRN:

The handover technique is applied by the secondary users in the cognitive radio networks; if the primary user arrives for the allocation then the secondary user should vacate the channel. This forced termination of the secondary [12] user can be overcome by the channel reservation methods, but the reservation parameters cannot be adjusted and it results in increasing throughput of the secondary users. The optimization problem is the proposed method and the target is to exist the trade off between blocking of new sessions of the secondary users and balancing the traffic during the handover.

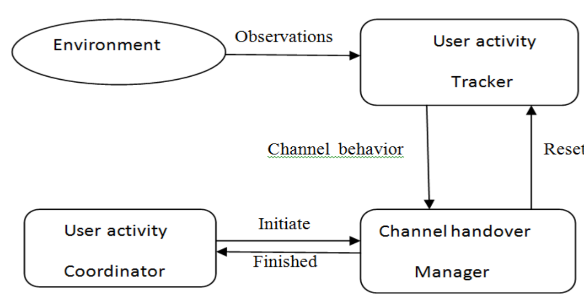

Fig 3. Channel Handover Procedure

Fig shows the adaptive and effective channel handover procedure for Cognitive radio network. In this network CHP is a process which is time consuming method. A new handover strategy is introduced between the channel and the user to identify the optimal trade off in the survey 13]. The Secondary users make a decision to initiate the channel handover or ending up the activity of the ongoing users only by tracking the local information. The system can change according to the dynamic circumstances of the channel resulting in increasing of the throughput and the reduction of handover frequency.

E. Load Balancing

The base station has the knowledge of the effective load factors for all bands, denoted as $\boldsymbol{\eta} = [\eta 1, \eta 2, \cdot \cdot \cdot, \eta b]$. Before allocating specific channels to users, we first associate each user to a certain band based on a load balancing criterion. The band with a large load factor will be considered as having heavy bandwidth utilization, and will be allocated to light traffic users and/or a smaller number of users, such that the bandwidth utilization level of each band is as close to each other as possible. The load balancing is [13] implemented by the greedy algorithm to allocate the resources in the existing. By using the cognitive radio technology the load balancing is implemented by itself in which the idle or vacant spaces are automatically detected and the secondary user occupies the node.

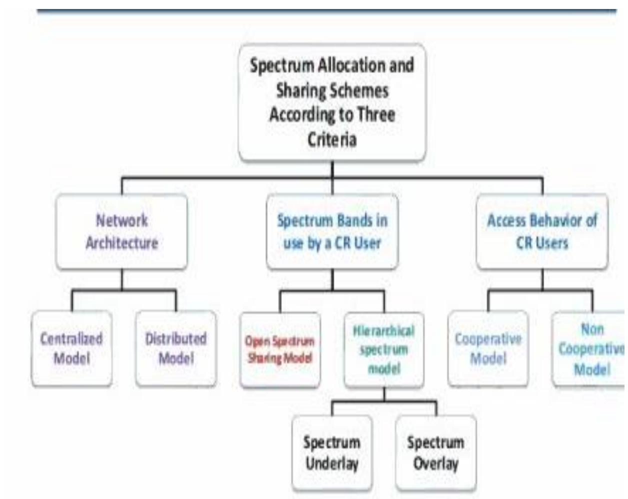

Fig 4.Spectrum Sharing

F. Sharing of Spectrum

The spectrum sharing is done between the two user's primary and the secondary. The spectrum allocation is the main method in which the idle spaces in the primary users are automatically identified by cognitive radio technology and the secondary users are occupied and the traffic can be balanced. Spectrum allocation optimizes the overall performance of the system and it is referred as optimization problem. A better trade-off is provided between the access of the secondary users in the proposed method.

G. Cognitive Radio with Data Mining

Data mining is the process of discovering the patterns in large data sets. The main goal of the data mining is to extract the information from the data set and convert it into the suitable form. The process of data mining has various steps and is widely used in various fields, and not much used in the area of cognitive radio. The cognitive radio is integrated with the data mining to extract the freq uently used application of the user when user moves often to the foreign network. The features used by the user are stored in the database and were extracted with the help of frequent itemset mining concept by cognitive radio.

III. DATA MINING APPLIED TO COGNITIVE RADIO

A modulation classification system consists of a front end and a back end or classifier. The front end converts the received signal r(t) to a vector **x**[k], k = 1, . . . , N composed of N elements. Having **x**[k] as input, the classifier decides the class y ∈ {1, . . . , C} among C pre-determined modulation schemes. The process is depicted in the diagram below:

***r*(*t*) (signal)→ front end →x[*k*] (features)→ classifier →*y* (class)**

The feature selection is a key step in the performance of the classifier. This selection depends on factors such as the modulation type to be classified, the signal to noise ratio, the presence of fading, the frequency offset, etc. The cyclostationarity to extract features of modulation due to its reduced sensibility to noise and interfering signals, and also its ability to extract signal parameters such as the carrier frequency and the symbol rate.

Naïve Bayes Technique

The naïve Bayes classifier is based on Bayes' theorem. This classifier is particularly useful when the input data dimensionality is high. Thus, to represent the classifier in the cognitive radio system, we adopt the nomenclature used in [6], where $P(y|\mathbf{x})$, $P(\mathbf{x}|y)$, $P(y)$ and $P(\mathbf{x})$ are called posterior, likelihood, prior and evidence, respectively, and are related through Bayes' rule,

$$P(y \mid x) = \frac{P(x|y)P(y)}{P(x)}$$

This classifier attempts to select the label

$$F\,(x) = \arg\max_{y=1..,y} P(x|y)P(y)$$

which maximizes the posterior probability. However, neither $P(y)$ nor $P(\mathbf{x}|y)$ is known. Hence, the classifiers use estimates $\hat{P}(y)$ and $\hat{P}(\mathbf{x}|y)$ and maximize

$$F(x) = \arg\max_{y=1..,y} \bar{P}(x|y)\bar{P}(y)$$

In most cases, the prior $P(y)$ can be reliably estimated by counting the labels in the training set, i.e., we assume that $\hat{P}(y) = P(y)$. In order to estimate $\hat{P}(\mathbf{x}|y)$ is often the most difficult task. Hence, Bayes classifiers typically assume a parametric distribution $\hat{P}(\mathbf{x}|y) = \hat{P}\theta y(\mathbf{x}|y)$ where θy describes the distribution's parameters to be determined (e.g., the mean and covariance matrix if the likelihood model is a Gaussian distribution). The naïve Bayes algorithm assumes that the attributes ($x1, \ldots, xK$) of $\mathbf{x}$ are conditionally independent of each other, given y. It means that the algorithm simplifies the representation of $P(\mathbf{x}|y)$, and the estimation problem from the training set. Whereas. In the case where $\mathbf{x} = (x1, x2)$, we have:

$$P(x|y) = P(x_1, x_2|y) = P(x_1|x_2, y)P(x_2|y) = P(x_1|y)P(x_2|y)$$

where $P(x1, x2|y) = P(x1|x2, y)P(x2|y)$ is a general property from conditional probability definition, while $P(x1, x2|y) = P(x1|y)P(x2|y)$ is only valid for conditional independence.
Generalizing Equation , we have:

$$P(x|y) = P(x_1.., x_k|y) = \frac{\bar{\bar{k}}}{i}\, p(x_i|y)$$

When training a naïve Bayes classifier, this will produce a probability distribution $P(\mathbf{x}i|y)$ and $P(y)$ for all values of y, i.e, yk, $k = 1, \ldots, Y$. To calculate the posterior probability of each class y,we use bayes theorem.

$$P(y_k|x) = \frac{p(y_k)p\left(x_1,.,x_k(x_k|y_k)\right)}{\coprod_j p(y_j)\, p\left(z_1,.,(x_k|y_j)\right)}$$

Assuming xi is conditionally independent given y, we can rewrite Equation as:

$$P(y_k|x) = \frac{p(y_k)ip\left((x_i|y_k)\right)}{\coprod_j \left((p(y_j)ip(x_i|y_{kj})\right)}$$

Above equation is the fundamental equation of a naïve Bayes classifier. Given a new sample $\mathbf{x}$, this equation shows how to calculate the probability for each y. Such calculation depends only on observed attribute values and distributions $P(y)$ and $P(xi|y)$ estimated from the datatraining. If it is desired only to the most likely value of y, then we can simplify to

$$F(x) = \arg\max_{y_k} P(y_k)ip(x_i|y_k)$$

or, using the fact that the logarithm is a monotonic function:

$$F(x) = \arg\max_{y_k}[\, logP(y_k) + \coprod_i log\, p(x_i|y_k)$$

IV. DISCUSSION

Here, in the spectrum sensing, the network conjestion in allocating of resources is made efficient with low cost of implementation and avoidance of handover using Cognitive radio Technology. Mobile Communication is made possible through protocol that acts as a management protocol for mobile services. With this protocol, handover is also enhanced to a greater extent that specifies the network efficiency. Future work of implementation done by cognitive radio which detects the idle spaces in the primary user automatically helps in load balancing in order to achieve handover efficiently is under process. Cognitive radio is integrated with the data mining concept. The accessed features of a user in the foreign network are provided by sensing through CR and the data's that are sensed were extracted by data mining concept by use of Naïve Bayes algorithm or technique.

V. CONCLUSION

From the survey, we have concluded that Cognitive Radio Networks is well known concept for preventing the wastage of spectrum by allocating fixed and rigid spectrum through load balancing. Literature reviews have shown that the static spectrum assignment leads to disorganized use of spectrum. Since most segment of the spectrum remain under-utilized or idle most of the time. To overcome this inefficient use of spectrum the CR concept comes into play. The important aspect of dynamic spectrum distribution by the load balancing scheme is a dependable mechanism for providing fair and well organized spectrum allotment or scheduling answers between both users. The frequent itemset mining concept is applied to discover frequently used applications of a user in the foreign network. The data mining concept helps in providing guidelines for future development of the cognitive radio for load balancing.

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