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Optimum Utilization of Spectrum Holes in Cognitive Radio Networks using Opportunistic Spectrum Band Allocation Policy for Handoff Prioritization

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OPTIMUM UTILIZATION OF SPECTRUM HOLES IN COGNITIVE RADIO NETWORKS USING OPPORTUNISTIC SPECTRUM BAND ALLOCATION POLICY FOR HANDOFF PRIORITIZATION

Strictly as per the compliance and regulations of :

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I. Introduction

Two critical problems play important role on the wireless communication network and they are (1) limited available spectrum (2) inefficiency in the spectrum allocation policy [5]. As the available spectrum is becoming insufficient due to growing demand, many schemes have been proposed to utilize the spectrum more effectively and efficiently. Actually a large pool of spectrum remains unused due to improper channel allocation policy. New paradigm called xG network, dynamic spectrum access network or the cognitive radio networks have been proposed to address the above mentioned problems [1][5]. The key enabling technology of xG networks is the cognitive radio. Cognitive radio techniques provide the capability to use or share the spectrum in an opportunistic manner.

Dynamic spectrum access techniques allow the cognitive radio to operate in the best available channel. More specifically, the cognitive radio technology will enable the users to determine which portions of the spectrum is available and detect the presence of licensed users when a user operates in a licensed band (spectrum sensing), select the best available channel (spectrum management), coordinate access to this channel with other users (spectrum sharing), and vacate the channel when a licensed user is detected (spectrum mobility). The main functions for cognitive radios in xG networks can be summarized as follows:

Spectrum sensing : Detecting unused spectrum and sharing the spectrum without harmful interference with other users.

Spectrum management : Capturing the best available spectrum to meet user communication requirements.

Spectrum mobility : Maintaining seamless communication requirements during the transition to better spectrum.

Spectrum sharing : Providing the fair spectrum scheduling method among coexisting xG users.

These functionalities of xG networks enable spectrum- aware communication protocols.

The xG network communication components and their interactions are illustrated in Fig 1. It is evident from the significant number of interactions that the xG network functionalities necessitate a cross-layer design approach [5].

Entire wireless network is divided into a number of cells also known as zones. Each cell serves two kinds of requests (1) Initial access request and (2) hand-off request [1]. Once a communication starts, user may not be fixed to a particular station but roams from one location to the other and demands for ubiquitous network access. While moving, user actually goes through a number of cells between both the locations, each time he leaves the currently occupied cell and enters into a new one. This is known as inter-cellular hand-off [2] and the call is known as hand-off call.

While leaving the existing cell and entering into a new one, the base station of the destination cell provides a new spectral band to continue the communication. If the destination cell does not have enough spectral bands the call will be blocked.

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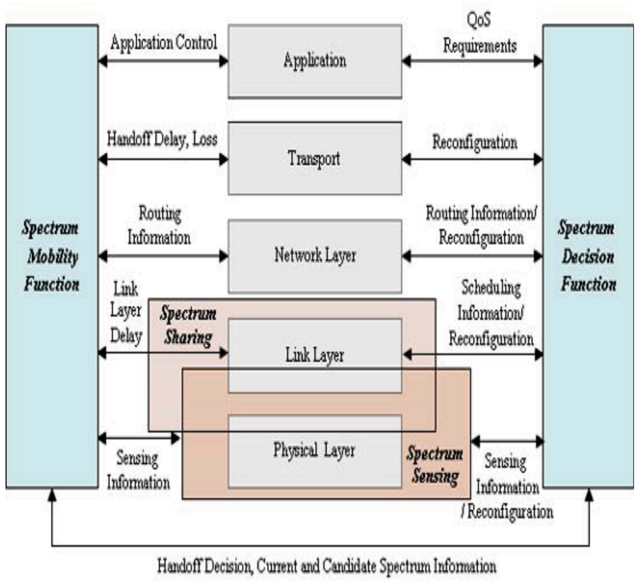


Figure 1 : xG network communication functionalities

Our approach is to limit the probability of this forced termination of an ongoing call. We can reduce the chances of unsuccessful hand-off by assigning higher priority to hand-off request than that assigned to initial access request. Efforts are made to propose a spectrum assignment policy having a tradeoff between minimization of the call blocking rate of an ongoing call for smooth hand-off and risk of compromising the whole traffic due to a priority based treatment of the calls.

a) Handoff Technique

The large geographic area covered by the network is divided into small zones called *cells*. The base station of each cell in the network has to serve two streams of requests, one coming from the cell itself (*initial access requests*), and the other coming from neighbor cells (*hand-off calls*). Once a call has started, the mobile station (MS) might leave the initial cell, entering a neighbor one, while remaining connected to the network. Mobiles crossing the cell boundary cannot continue to use the same frequency channel because different channels are assigned to adjacent cells to avoid radio interferences in the shared transmission medium. Intercellular handoff is the procedure by which the user, while releasing the old frequency channel belonging to the initial cell, is provided with a new one by the base station of the destination cell. This procedure is fundamental to avoid any interruption of the initiated connections. If the destination cell does not have enough channels to support the handoff, the call is blocked. It is important to limit the probability of forced termination, because from a user's perspective, the forced termination of an ongoing call is less desirable than getting a busy signal due to the block of an initial access attempt. The system can reduce the chances of unsuccessful handoff by assigning higher priority to handoff requests than that assigned to initial access requests.

These handoff prioritizing schemes provide improved performance at the expense of a reduction in the total admitted traffic [1].

CR users are generally regarded as `visitors' to the spectrum. Hence, if the specific portion of the spectrum in use is required by a PU, the communication needs to be continued in another vacant portion of the spectrum. This notion is called spectrum mobility. Spectrum mobility gives rise to a new type of handoff in CR networks, the so-called spectrum handoff, in which, the users transfer their connections to an unused spectrum band. In CR ad hoc networks, spectrum handoff occurs: 1) when PU is detected, 2) the CR user loses its connection resulting from the mobility of users involved in an on-going communication, or 3) with a current spectrum band cannot provide the QoS requirements.

In spectrum handoff, temporary communication break is inevitable because of the process for discovering a new available spectrum band. Since available spectrums are dis-contiguous and distributed over a wide frequency range, CR users may require the reconfiguration of operation frequency in its RF front-end, which leads to a significantly longer switching time.

Spectrum handoff has been done for cognitive radio networks especially in the case when transmissions are done over multiple channels in parallel. The spectrum handoff occurs when licensed users are detected in the channel. Thus, CR user has to leave the channel immediately and search for a new available one. During the handoff operation, the communication of CR user has to be interrupted and packets must wait in the transmission buffer. The communication can be resumed when the connection is successfully moved to the new channel. From this point of view, large waiting delays can be incurred and packets may be lost. Sometimes, licensed users may use the channel only for short periods intermittently. The frequency of spectrum handoff can be reduced if CR users wait until licensed users finish their transmission to send again over the same channel. Here, predicting the behavior of licensed users in the near future assists CR users to decide whether it should keep the current channel or leave it. Typically, prediction should improve the performance of the spectrum handoff [10].

In CR networks, the unlicensed devices (also Known as Secondary users) share the licensed spectrum without interfering with the transmission of other licensed users (also known as primary users). If this band is found to be occupied by a licensed user, the CR user moves to another spectrum hole to avoid interference, which is referred to as spectrum mobility. CR cellular networks lies in spectrum mobility, which gives rise to a new type of handoff in CR cellular networks, the so-called spectrum handoff [14]. Similarly in the DSA schemes, the SU and PU transmissions are treated as calls which are assigned dedicated frequency bands. However, an SU should relinquish its frequency band when a PU call claims it, because the PU call assignment is oblivious of any ongoing SU calls. The central controller admits an SU call if the requested bandwidth is available, and performs spectrum handoff (i.e., reassigning an SU call to another vacant frequency band when it interferes with a new PU call). an incoming SU call was queued till a new transmission opportunity was found. Also, the SUs which experienced handoff failure were dropped.

The effect of a buffer for SU call arrivals was considered. SUs which experienced handoff failure were dropped. The SUs were queued upon handoff failure and reassigned to channels when they are available. Thus, the SU transmissions were prevented from forced termination due to a PU arrival. Hence DSA scheme which considered channel reservation for SU handoff. An incoming SU call was assigned a channel only when the number of idle channels in the licensed spectrum exceeds the number of channels reserved for SU handoff. According to the DSA scheme, the central controller assigned as much as possible bandwidth to the SUs to improve the spectrum utilization. This bandwidth assignment was performed whenever the system state changed [16].

This paper in section-1 has a brief introduction of the problem, section-2 provides the problem objective and problem definition, section-3 consists of two spectrum allocation policies, section-4 gives analysis of the initial as well as revised scheme, section-5simulation results and section-6 concludes the paper with future work.

II. Problem Formulation and Goal

The two critical problems that are tackled using the concept of Cognitive Radio or Dynamic Spectrum Access are (1) Limited available Spectrum (2) Inefficiency in the spectrum usage and spectrum allocation policy [5]. These two problems mainly leads to the blocking of a hand-off call. Framework of a wireless cellular network is built up of a number of cells; each cell serves two types of request (1) Initial Attempt Request (2) hand-off Request [1].

a) Initial Attempt Request

Initial Attempt request is nothing but the request that has originated from the same cell for allocation of the spectrum to begin a communication in a cellular network.

b) Hand-off Request

The request to provide the spectrum bands as the user switches through different cells is made by the cellular user to achieve uninterrupted communication. This request is called hand-off request. A hand-off request may occur in following conditions with both primary (licensed) user and secondary (unlicensed) user [5].

c) Hand-off request with

Primary user : Hand-off occurs with primary users

- When quality deteriorates
- A spectrum band with better quality of service becomes available.

Secondary user: Hand-off occurs with secondary user

- When inter-cellular hand-off results due to roaming.
- When the licensed user for the band that is being utilized by a secondary user appears.
- When a better spectrum as per the requirement becomes available.

Problem occurs when the destination cell does not have enough spectrum bands as a result of it the hand-off call is blocked. It is less desirable to have the forced termination of an ongoing call and to provide the band to an initial request of which the communication has not yet been started.

Our efforts are projected to deal with the following issues:

- ➢ To overcome the problem of limited available spectrum through opportunistic usage.
- ➢ Improvement in spectrum allocation policy.
- ➢ Maximum possible utilization of available spectrum.
- ➢ To come up to the requirements and expectations of both licensed as well as unlicensed users.
- ➢ To allow the utilization of licensed spectrum in unlicensed user's zone opportunistically without any interference with the licensed users.

d) Why the problem is being addressed?

Today's trend is to have the exclusive rights of a specific portion of the spectrum, no matter whether the spectrum is really being utilized to the full of its strength or not. Spatially and temporally, the spectrum band stays idle most of the time with no communication activities being carried out by the primary user[5].

e) Our approach to solve the problem

Our approach is to minimize the probabilities of unsuccessful hand-off by assigning higher priority to the hand-off requests in comparison to the initial attempt request. This prioritizing scheme suggests better utilization of spectrum and also causes the reduction in total admitted traffic. This priority assignment treatment can be extended to the limit where the reduction in the over-all traffic due to the insufficient weight to the initial access request can be afforded. We have developed a prioritization scheme in which each incoming request will be classified based on four existing classes and treated accordingly.

All the incoming request are classified into four categories

- Primary hand-off request (PH)
- Primary initial request (PI)
- Secondary hand-off request (SH)
- Secondary initial request (SI).

The priority assignment policy will be in the order PH > PI > SH > SI.

III. Proposed Work

The proposed scheme has been designed through two phases and the second phase is an improvement of the first phase. Initially, we started out with a priority assigning policy in which the priority was being assigned to two different calls competing for spectrum band in various scenarios. The revised scheme deals with priority assignment and spectral band allocation among a set of requests.

a) Initial Scheme

The whole available spectrum is divided into two parts; (1) hand-off channels (2) Initial channels. The hand-off channels constitute that portion of the spectrum which has already been dedicated entirely for hand-off calls. On the other hand initial channels are to serve initial access request. The users are divided into two classes; (1) primary user (licensed user or exclusive right holder of the spectrum band) (2) secondary user (unlicensed user, has no exclusive right on spectrum). Finally the calls are categorized into four streams; (1) primary hand-off (PH) call (2) primary initial (PI) call (3) secondary hand-off (SH) call (4) secondary initial (SI) call.

- A PH call occurs when either the quality of the spectrum band deteriorates or a band of spectrum with better quality of service becomes available.
- A PI call occurs when a call generated from a licensed user.
- A SH call appears due to mobility of the user after the communication has been started. This can be due to (1) when the primary user of the band (currently used by secondary user) appears (2) when quality deteriorates (3) when a spectrum band with better quality of service becomes available.
- A SI call occurs when an initial access request from an unlicensed user originates

In this scheme, we have developed several rules to resolve the conflict between any two calls and one of the four possible scenarios in which bands occur in spectrum holes. In each case, a conflict is being considered between two users.

Conflict for channel accessibility between user one and user two can have following cases:

1) primary user (PU) vs primary user (PU)
2) secondary user (SU) vs secondary user (SU)
3) primary user (PU) vs secondary user (SU)

There are four scenarios assumed for the spectrum hole;

(1) No band is available (2) one band is available
(3) Two bands are available (4) More than two bands are available.

The notion in this initial approach is to first compare the priority of both the calls and one of the following scenarios will be examine.

- If bands are available then they will be allocated to each call smoothly.
- If only one free band is available then it will be allocated to the higher priority call and the other call will have to wait for a time duration ‘t’ (prespecified), within this time duration successive holes will be examined till a free band is achieved.
- If within this time duration no free band could be found, then the call will be dropped.
- If no band is available successive spectrum holes will be searched till a free band is accessed within the time duration ‘t’. The first free band will be allocated to the higher priority call while lower has to wait. If no free band occurs within time limit‘t’, then both the calls will be dropped.

As the spectrum is divided in two parts initial and the handoff, if at any point of time initial bands are available then they can be directly allocated to the calls irrespective of their type.

In case of hand-off bands if the requirement is to allocate them to some initial calls, first following three parameters will be examined.

1) Handsuccdur: Time between two successive hand-off
2) Handfreq: Frequency of occurrence of hand-off call
3) ExpectedHandTraffic: Expected hand-off traffic

If first parameter is greater than a specific threshold and second and third are less than their respective thresholds then hand-off band can be allocated to an initial call. Each time when an initial band is allocated to a hand-off request, first this band’s entry is made in the pool of hand-off bands and when a hand-off band is allocated to an initial request, first it is admitted to a pool of initial bands, after this allocation first free band will be assigned to the pool from which the band was borrowed.

b) Revised Scheme

The spectrum is divided into a number of primary user groups. In each primary user group, there are a number of mobile hosts or users. A specific licensed frequency band provided to each group with respect to which that group is a primary user group, rest of the spectrum band is unlicensed zone for the mobile hosts of that specific user group. With each primary user group four queues are associated;

1) Primary hand-off queue 2) Primary initial queue 3)Secondary hand-off queue 4) Secondary initial queue All the holes in the licensed zone of a specific primary user group are detected.

This proposed scheme has following two steps:

1) Spectrum is sensed to detect the primary users who are currently active.
2) Based on above information spectrum holes or white spaces will be recognized.

IV. Analysis of the Proposed Scheme

In this section, we are going to analyze both the schemes Initial as well as revised.

a) Analysis of Initial scheme

This scheme takes care of all the possible configurations in which a conflict for spectral band between two requesting calls can be resolved. In this scheme our effort focuses on three dimensions of wireless communications (1) Scarcity of available spectrum, (2) Inefficient spectrum allocation policy and (3) Reduction in the probability of forced termination of an ongoing call. The key idea that is being taken into consideration is giving priority to the band allocation to a hand-off request in comparison of the initial access request.

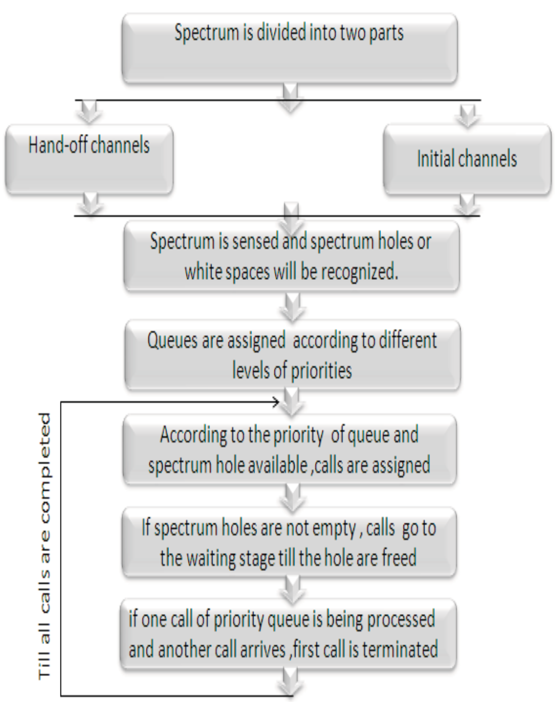


Figure 2 : Data Flow Diagram

Thus in the scheme first call is classified into four categories: a) Primary hand-off Request, b) Primary Initial Request, c) Secondary hand-off Request, d) Secondary Initial Request.

i. *Justification of priority assignment*

Primary hand-off is given highest priority as it is a request from a licensed user and also for ongoing communication. Second highest priority is given to primary initial, though it's a request to initiate a communication, but this request is made by a licensed user. Third higher priority is allocated to the secondary hand-off, though this request is from unlicensed user but is for an ongoing communication. Secondary initial is given the lowest priority because it is a request from an unlicensed user and it is to initiate a communication.

In this scheme total spectrum is divided into two parts 1) hand-off spectral bands and 2) initial spectral bands. The idea is to again give preference to the hand-off request. Thus the assumption is to dedicate some of the bands of this spectrum for hand-off calls.

The good part of the theorem is that if an initial band exists it can be allocated to the hand-off request directly but if a hand- off band is to allocate to an initial call then first three important parameters will be examined.

1. Average time duration between two successive occurrences of hand-off calls.
2. Frequency of occurrence of hand-off calls
3. Expected hand-off traffic

When all the three parameters will be satisfied only then a spectrum band will be allocated to an initial call. Each time an initial band is allocated to a hand-off request, the band's entry is made in the pool of hand-off bands and when a handoff band is allocated to an initial request, it is admitted to a pool of initial bands. This policy is to balance the population of both types of bands at any instant. It keeps a check on the number of bands shifted from hand-off to initial pool and returns the equal number of bands from the initial pool to the hand-off pool (vice versa).

b) Analysis of Revised Scheme

In our scheme we are taking into consideration four candidates PH, PI, SH, SI. The hand-off calls are assigned with more priority in comparison to initial calls and primary user calls are given higher priority in comparison of the secondary user. Our approach to minimize the probability of forced termination of an ongoing call is achieved, as hand-off calls are being provided a higher priority in comparison to the initial access request. Priority assignment policy assigns highest priority to the primary hand-off. Next priority is given to the primary initial though it's an initial call but is being generated by a licensed user. Third priority level is assigned to secondary hand-off which again is significant as being a handoff call though coming from a secondary user. The lowest priority is assigned to secondary initial, a request from an unlicensed user to originate a call.

The usage of four priority queues PHQ, PIQ, SHQ, SIQ is used for allocation of spectrum when a higher priority request is occurring along with other lower priority requests. If in the request pool multiple primary hand-offs, primary initials, secondary hand-offs and secondary initials are present, then all will be queued in appropriate queue and the queues will be processed according to the assigned priority and within each queue in FIFO order.

This scheme improves the spectrum utilization as all available spectrum holes or white spaces are observed periodically. Each time after assigning all the available bands of the spectrum hole, we move to a new white space. Unused holes due to non-existence of primary users at different instances and locations are exploited opportunistically. Once the communication is over, the band will be released and will again constitute a white space. With limited available spectrum and increasing number of users, this opportunistic usage of the spectrum bands leads to minimum wastage of the spectrum resources. Instead of utilizing the best available spectrum hole, this approach is based on the first available spectrum hole that satisfies the desired communication quality requirements. If there are many spectrum holes then the first hole which satisfies quality requirements will be selected instead of the best hole. This approach is used to have fast response time requirement.

A specific time duration is set when a call occurs (whether hand-off or initial) and a band if free is provided to the call immediately. But, in case when no spectral band is free in the current spectrum hole, a band is searched in next white space. If a new band is found within't' time, it will be allocated to the communication otherwise the call will be blocked.

This scheme also provides seamless communication as a call that appears in the PH queue will be allocated band but if it appears in SH hand-off queue and still many candidates are in the PI and PH are waiting to be serviced, this call may leave this spectrum hole and try in another zone where it can get a better priority. In the new zone, it will occupy the same priority level queue, but there may not be many candidates in the higher level queues. This is used to exploit the existing spectrum optimally as well as opportunistically.

Forced drop of a hand-off calls are minimized because

1) Hand-off request will always be provided with resources even if an initial access request is to be blocked
2) If enough bands are not available in current spectrum hole, it switches to the next available spectrum hole as all the holes have been detected.

V. Simulation Results

Extensive simulations were carried out with varying parameters. The simulation program is implemented using C#, using .Net frame work, and run under windows environment. Object oriented approach is adopted to simulate the real world environment. In the simulations, a spectrum was divided into a number of cells consisting of four queues and a group of primary users each. A fixed number of bands were taken into consideration on total communication traffic was increased gradually and we record the Average waiting time, communication success rate for both cognitive radio network and normal wireless network and call blocking rate. The developed application is built for handoff calls.

After running the application, the display menu is shown in Figure 2, in which we can select the algorithm (Handoff Scheme) and different options of parameters such as sensing range, simulation range, message sending duration and concurrent data transmission respectively.

While simulating the Opportunistic spectrum allocation Scheme, following assumptions are made. For this Proposed Scheme, we have assumed following ranges. Where all of having different ranges as follows:

- Sensing range-40 to 80m
- Simulation rang-1 to 1000
- Message sending duration-100 to 200mSec
- Concurrent data transmission-30 to 80
- Power supply values-10 to 100mJ

The details of each button are explained here as follows below:

- View Topology: To see the communication model and nodes.
- Start Simulation: To start the simulation and set up communications and handovers for continuous time period.
- Reinitialize Simulation: To simulate and set up communications and reinitialize.
- Test_config: To select algorithm and different parameters such as sensing range, simulation range, message sending duration and concurrent data transmission respectively.

Analysis Control: Plotting the graphs (results) for Call blocking rate of PH/PI/SH/SI communications and Total Communication Traffic Vs Average Waiting Time.

Figure 2 : Select the algorithm and the parameters as per your ease

In Figure 3, the infrastructure-based CR (cognitive radio) network is developed. In the network topology includes 32 wireless access nodes. Each wireless access node has Omni-directional antenna. They are assigned that 15 access nodes for primary users (licensed), and remaining15 wireless access nodes for secondary users (unlicensed) and access nodes are placed in random manner. Framework of a CR network is divided into eight cells, each cell have group of four access nodes.

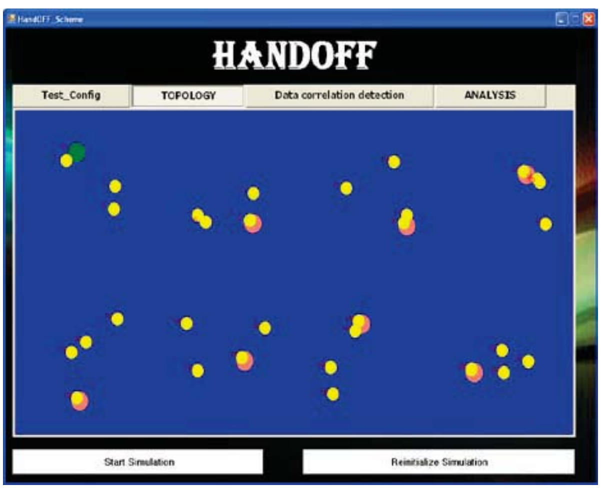


Figure 3 : Node Formation

Users take the handoff process in within the network, where a packet dropping will be occurred in the network because of improper spectral selection. The hand-off calls are assigned with more priority in comparison to initial calls and primary user calls are given higher priority in comparison of the secondary user. Handoff scheme will be different for different ranges (areas).Here there are two different kinds of handoff schemes are shown in Figure 4 (a) for simulation range of 1000 and Figure 4 (b) for simulation range of 10.

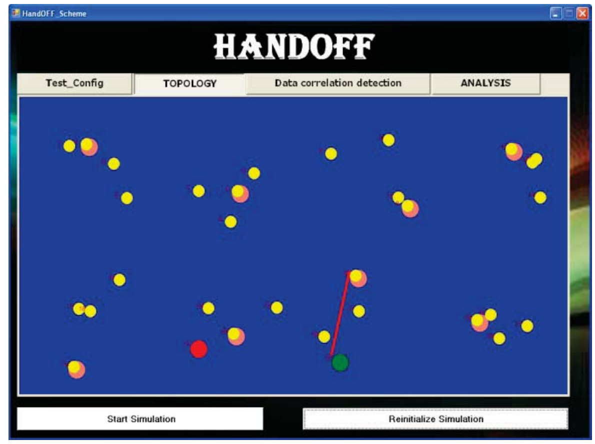


Figure 4 (a) : Handoff process (simulation range-1000)

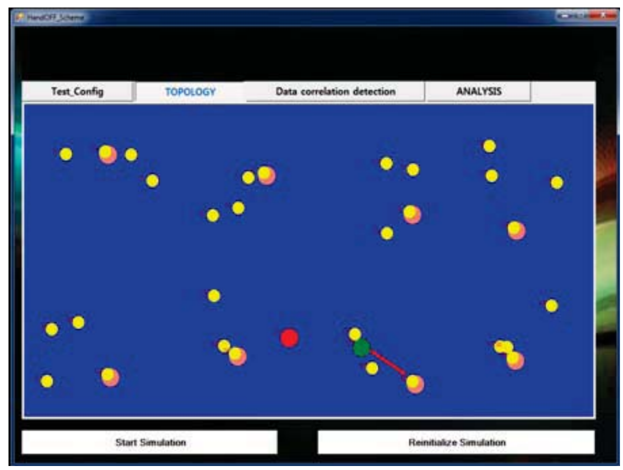


Figure 4 (b) : Handoff process (Simulation range-10)

Case 1 : In this case, select the algorithm (Handoff scheme) and different options of parameters, such as sensing range-50, simulation range-1000, message sending duration-170 and concurrent data transmission -60 respectively. And then run the application, the display menu is shown in Figure 5 and Figure 6, shows the data correlation detection table for node connection.

Figure 5 : Select the algorithm and the Parameters

The graph (Fig-7) drawn shows that the average waiting time, when there are number of bands in the network is 5 to 6 and the traffic at a point in time zero, is zero. But as the traffic increases from 0 to 10, the average waiting time increases to 60 but remains almost constant for very high traffic intensity also. The curve almost reaches to the stability beyond a certain point in the traffic where

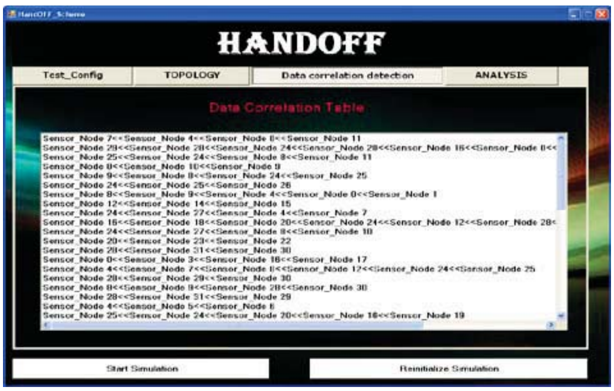


Figure 6 : Data correlation Detection(Node connection)

after increasing the amount of traffic it has very less affect on average waiting time. This curve proves that the algorithm is designed in such a way that there is not big variation in average waiting time even if the traffic is sufficiently increased against a certain number of bands in the network. Average waiting time is considered in units of 'tick' where a 'tick' represents the time to make an attempt of band allocation.

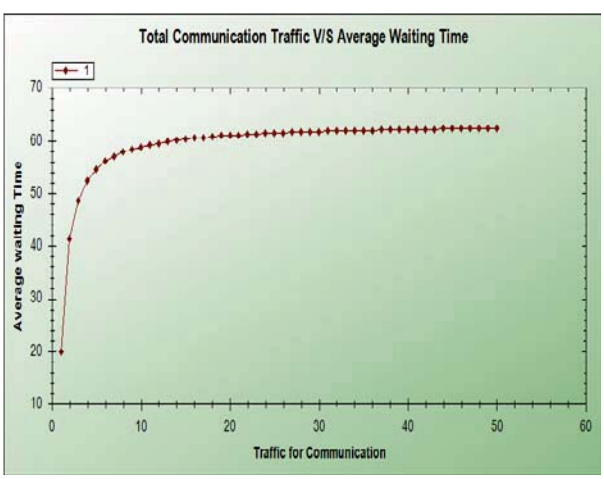
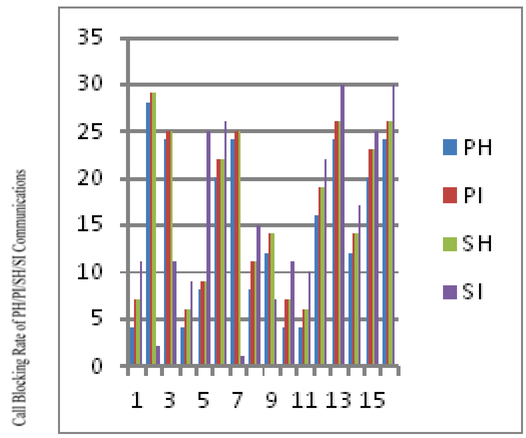


Figure 7 : Total communication traffic Vs average waiting time

The graph (Fig-8) is drawn between overall traffic for communication in a point of time and call blocking rate of primary hand-off, primary initial, secondary hand-off and secondary initial communications. When the number of requests is equal to the number of free bands call blocking rate is zero for all four types of communications.

When this traffic increases and becomes twice the available free bands the call blocking occurs only in secondary initial communications. It is noticed that while increasing traffic 3 times, 4 times and up to 30 times with the same band strength no call blocking occurs in primary handoff communication. A small increase is found in primary initial with the increase in the traffic. This increase seems almost stable with a rapid increase in the traffic. The scenario is almost same with secondary handoff communications. The only significant blocking rate is with the secondary initial communication.



Traffic for Communication

Figure 8 : Call blocking rate of PH/PI/SH/SI communications

Case 2 : In this case, first select the algorithm (Handoff scheme) and different options of parameters, such as sensing range-70, simulation range-1, message sending duration-180 and concurrent data transmission of 80 respectively.

And then run the application, the handoff takes place and finally the Figure 9, shows the data correlation detection table for node connection as follows in below:

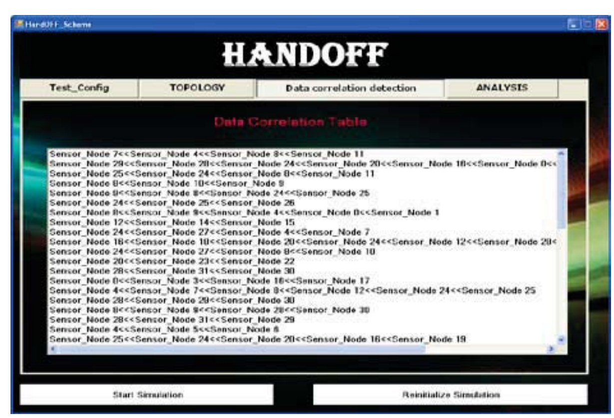


Figure 9 : Data correlation Detection (Node connection)

The graph (Figure 10) shows that the average waiting time, when there are number of bands in the network is 5 to 7 and the traffic at a point in time zero, is zero. But as the traffic increases from 0 to 2, the average waiting time increases to 64 but remains almost constant for very high traffic intensity also. The curve almost reaches to the stability beyond a certain point in the traffic where after increasing the amount of traffic it has very less affect on average waiting time.

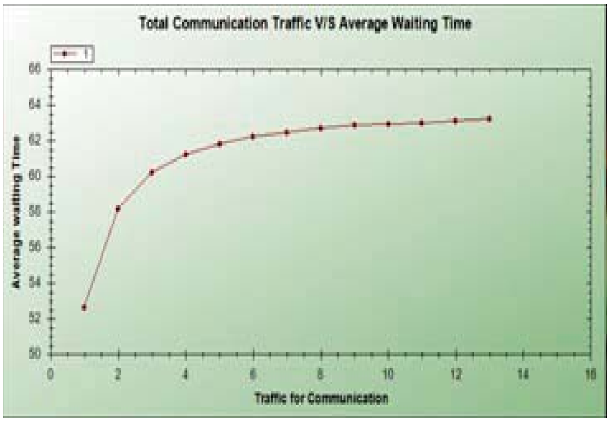


Figure 10 : Total communication traffic Vs average waiting time

Case 3 : In this case, first select the algorithm (Handoff scheme) and different options of parameters, such as sensing range-40, simulation range-100, message sending duration-160 and concurrent data transmission of 60 respectively. And then run the application, the handoff takes place and finally the Figure 11, shows the data correlation detection table for node connection as follows below.

The graph (Figure 12) shows that the average waiting time, when there are number of bands in the network is 4 to 6 and the traffic at a point in time zero, is zero.

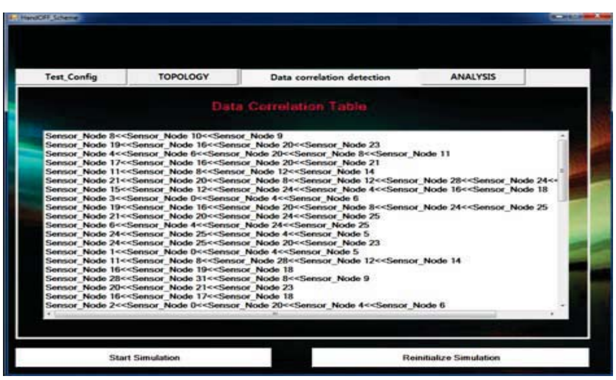


Figure 11 : Data correlation Detection (Node connection)

But as the traffic increases from 0 to 10, the average waiting time increases to 60 but remains almost constant for very high traffic intensity also. The curve almost reaches to the stability beyond a certain point in the traffic where after increasing the amount of traffic it has very less affect on average waiting time.

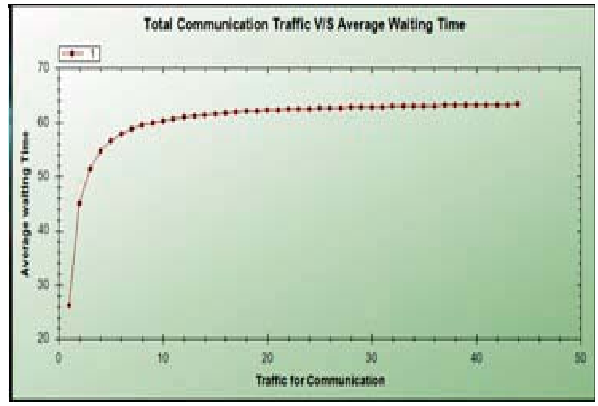


Figure 12 : Total communication traffic Vs average waiting time

VI. Conclusion and Future Work

Cognitive radio networks are the next generation networks which are developed to resolve the constraints in current wireless communication. The current problems in the wireless communications are discussed and the need to switch from wireless networks to next generation networks xG or cognitive radio networks is introduced. A two-phase scheme is introduced for spectrum allocation. In the first phase of the proposed scheme, a collision between two calls for spectral band allocation is resolved. In second phase of the scheme, allocation of spectral bands among a number of different types of calls is considered. The main objective is to have opportunistic spectrum band allocation policy and minimization of forced termination of a handoff request. This new spectrum allocation policy will fill the gaps of wireless spectrum and will satisfy the needs of both licensed as well as unlicensed zone without any compromise.

Although, the current scheme is focused on spectrum allocation policy and dynamic spectrum access/xG, it has the ability to carry out extensive research in all fields of the cognitive radio. And in future work, collision between more than two calls can be eliminated among unlicensed users in a multiuser spectrum handoff scenario.

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