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High Energy Efficiency and Spectral Efficiency Analysis for CRN Based Spectrum Aggregation

Umamageswari.G[1], Umamaheswari.B[2]

PG Scholar, Department of CSE, Vandayar Engineering College, Thanjavur, India [1]

Assistant Professor, Department of CSE, Vandayar Engineering College, Thanjavur, India [2]

***Abstract*—Co-operative routing and range spectrum aggregation are two promising methods for Cognitive Radio Ad-Hoc Networks (CRAHNS).Propose a range spectrum aggregation –based cooperative routing protocol, termed as routing protocol. The essential target of spectrum aggregation-based cooperative routing protocol is to give higher vitality productivity, enhance throughput, and reduces system delay for CRAHNS. In such manner, plan the MAC and Physical (PHY) layer, and proposed distinctive range total calculations for intellectual radio (CR) clients. We propose two distinctive classes of directing conventions; primary user for accomplishing higher vitality productivity and throughput, and secondary for decreasing end-to-end dormancy. In light of stochastic geometry approach, assemble a far reaching systematic model for the proposed convention. In addition, the proposed convention is contrasted and the best in class helpful what's more, non-helpful steering calculations with range accumulation. Execution assessment exhibits the adequacy of spectrum aggregation-based cooperative routing protocol as far as vitality effectiveness, throughput, and end-to-end delay**

***Index Terms*— Cognitive Radio, Proper Carrier Sensing Range, Asynchronous Distributed Data Collection, Dynamic Spectrum Access, QoS, Signal to noise ratio.**

I. Introduction

An Ad-hoc Network is a collection of wireless mobile hosts forming a temporary network without the aid of any established infrastructure or centralized administration. Each node is considered to be alike here. It is needed to introduce some intelligence to the ad-hoc networks in order to improve their throughput efficiency. The concept of Cognitive Radio (CR) has been employed to achieve this. CR enabled devices are clever and can listen to the surrounding wireless environment and can select appropriate frequency band, modulation scheme or specific power level as per the requirement. In this way an ability of self-decision making can be incorporated in the wireless ad-hoc networks. Frequency spectrum is a limited resource for wireless communications and may become congested owing to a need to accommodate the diverse types of air interface used in next generation wireless networks. This spectrum if utilized in an efficient manner, can lead to better utilization of the network.

Wireless technology has enabled the development of increasingly diverse applications and devices resulting in an exponential growth in usage and services. These advancements made the radio frequency spectrum a scarce resource, and consequently, its efficient use is of the ultimate importance. To cope with the growing demand, network design focused on increasing the spectral efficiency by making use of advancement in Cognitive Radio technology. Cognitive Radio can reduce the spectrum shortage problem by enabling unlicensed users equipped with Cognitive Radios to reuse and share the licensed spectrum bands. The research mainly focuses on the development of efficient spectrum sensing and selection techniques, thereby providing valuable insights on how such CR networks may be designed. Cognitive Radio Networks (CRNs) is a kind of two-way radio that automatically changes its transmission or reception parameters, in a way where the entire wireless communication network of which it is a node communicates efficiently, while avoiding interference with licensed and unlicensed users This alteration of parameters is based on the active monitoring of several factors in the external and internal radio environment, such as radio frequency spectrum, user behavior and network state. Regulatory bodies in various countries (including the Federal Communications Commission in the United States, United Kingdom) found that most of the radio frequency spectrum was inefficiently utilized.

For example, cellular network bands are overloaded in most parts of the world, but many other frequency bands, such a similarity, amateur radio and paging frequencies are not. Independent studies performed in some countries confirmed that observation, and concluded that spectrum utilization depends strongly on time and place. Moreover, fixed spectrum allocation prevents rarely used frequencies (those assigned to specific services) from being used by unlicensed users, even when their transmissions would not interfere at all with the assigned service.

This was the reason for allowing unlicensed users to utilize licensed bands whenever it would not cause any interference (by avoiding them whenever legitimate user presence is sensed). This paradigm for wireless communication is known as cognitive radio. Since the spectrum present is limited, all users cannot be allowed to access this network. Hence users are divided into two basic

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categories.

Since the spectrum present is limited, all users cannot be allowed to access this network of any other unlicensed users. Primary users do not need any modification or additional functions for coexistence with the Secondary Users or Unlicensed Users: They access the licensed spectrum as a visitor, by opportunistically transmitting on the spectrum holes. A cognitive radio is an intelligent radio that can be programmed and configured dynamically. Its transceiver is designed to use the best wireless channels in its vicinity.

Such a radio automatically detects available channels in wireless spectrum, then accordingly changes its transmission or reception parameters to allow more concurrent wireless communications in a given spectrum band at one location. This process is a form of dynamic spectrum management.

In response to the operator's commands, the cognitive engine is capable of configuring radio-system parameters. These parameters include waveform, protocol, operating frequency, and networking. This functions as an autonomous unit in the communications environment, exchanging information about the environment with the networks it accesses and other cognitive radios (CRs). A CR monitors its own performance continuously, in addition to reading the radio's outputs; it then uses this information to determine the RF environment, channel conditions, link performance, etc., and adjusts the radio's settings to deliver the required quality of service subject to an appropriate combination of user requirements, operational limitations, and regulatory constraints.

Some smart radio proposals combine network dynamically changing the path messages take between two given nodes using cooperative diversity, cognitive radio dynamically changing the frequency band used by messages between two consecutive nodes on the path; and radio dynamically changing the protocol used by message between two consecutive nodes. The idea of cognitive radio (CR) was first presented officially in an article by Joseph Mitola and Gerald Q. Maguire, Jr in 1999. It was a new approach in wireless communications that Mitola described as the point in which wireless personal digital assistants (PDAs) and the related networks are sufficiently computationally intelligent about radio resources and related computer to-computer communications to detect user communications needs as a function of use context, and to provide radio resources and wireless services most appropriate to those needs. This is an intelligent wireless communication system that is cognizant of its surrounding environment and uses a understanding methodology by building to learn from the environment, adapt its internal states to statistical change in the incoming radio frequency stimuli by making corresponding variation in certain operating parameters in real time and with two primary objectives:

i) Highly reliable communications whenever and wherever needed

ii) Efficient utilization of radio spectrum. It was thought of an ideal goal towards which a software-defined radio (SDR) platform should develop: a fully reconfigurable wireless black-box that automatically varies its communication variables with network and user demands.

Cognitive radio (CR) is a form of wireless communication in which a transceiver can intelligently detect communication channels which are in use and which are not, and instantly move into unused channels while avoiding occupied ones. This optimizes the use of available radio-frequency spectrum while interference minimized to other users. CR technology is a paradigm for wireless communication in which transmission or reception parameters of network or wireless node are changed to communicate avoiding interference with licensed or unlicensed users. A spectrum hole is generally a concept which is the latent opportunities for safe use of spectrum as non-interfering and considered as multidimensional areas within frequency, time, and space. The main challenge for secondary radio systems is to be able to sense when they are within such a spectrum hole.

Full CR considers all parameters, a wireless node or network can be aware of every possible parameter observable by a wireless node or network is considered. Spectrum-sensing cognitive radio detects the channels in the radio frequency spectrum and considers radio frequency spectrum.

The requirements of the performances for cognitive radio system are:

i) Authentic spectrum hole and detection of primary user.
ii) Precise link estimation between nodes.

A. CHARACTERISTICS OF THE COGNITIVE RADIO NETWORKS

1. Cognitive capability: The ability of the radio technology is to capture or sense the information from its radio environment.
2. Re-configurability: Spectrum awareness is provided by the cognitive capability whereas the radio to be dynamically programmed according to the radio environment is enabled by the re-configurability.

B. APPLICATIONS

CR can sense its environment and, without the intervention of the user, can adapt to the user's communications needs while conforming to FCC rules in the United States. In theory, the amount of spectrum is infinite; practically, for propagation and other reasons it is finite because of the desirability of certain spectrum portions. Assigned spectrum is far from being fully utilized, and efficient spectrum use is a growing concern; CR offers a solution to this problem. A CR can intelligently detect whether any portion of the spectrum is in use, and can temporarily use it without interfering with the transmissions of other users. According to Bruce Fette, Some of the radio's

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other cognitive abilities include determining its location, sensing spectrum use by neighboring devices, changing frequency, adjusting output power or even altering transmission parameters and characteristics. All of these capabilities, and others yet to be realized, will provide wireless spectrum users with the ability to adapt to real-time spectrum conditions, offering regulators, licenses and the general public flexible, efficient and comprehensive use of the spectrum.

Wireless spectrum is one of the most precious resources or wireless networks. With the fast growth of wireless networks, communications over the free (unlicensed) spectrum have become more and more crowded. On the contrary, according to the report from the Federal Communications Commission (FCC), the utilization of the spectrum assigned to licensed users varies from 15% to 85% temporally and geographically, which is very inefficient. This necessitates a new communication paradigm, named Cognitive Radio Networks (CRNs), enabling a user equipped with a cognitive radio to sense and learn the communication environment, and further exploit the instantaneous assigned (licensed) spectrum opportunistically without causing unacceptable interference to the licensed users.

Under the CRN communication paradigm, a secondary network, which consists of Secondary Users (SUs) (unlicensed users) equipped with cognitive radios, is coexisted with a primary network, which consists of Primary Users (PUs) (licensed users).

The SUs sense and exploit spectrum opportunistically and share the same space, time, and spectrum with PUs. For an SU, when it has some data for transmission, it begins to sense the communication environment. If there is a spectrum opportunity, i.e. the data transmission of the SU will not cause unacceptable interference to any PU, meanwhile, the receiver of this data transmission is out of the interference range of any primary transmitter, and then the SU can initiate a data transmission.

During the data transmission of an SU, if a PU comes back to transmit/receive data, the SU has to immediately handoff the spectrum being occupied to guarantee that its data transmission does not interfere with the communications of PUs. Numerous efforts have been spent for different issues in CRNs, including spectrum sensing, spectrum access, scheduling, and management, capacity/ throughput/delay scaling laws, network connectivity, routing protocols, multicast communication and etc. Data collection is a common and important operation in wireless networks, as well as in CRNs, which can be used to gather data from an entire network. However, not too much effort has been devoted on data collection for CRNs, especially practical distributed data collection in asynchronous CRNs.

Intuitively, CRNs are distributed asynchronous systems and thus prefer distributed algorithms. First, CRNs tend to be large-scale distributed wireless systems, for which it is difficult and expensive (sometimes, even impossible) to obtain real-time network running information for network management and configuration. Second, the deploy environment of CRNs may be ever-changing, which may induce significant degradation of centralized and synchronized algorithms. Third, in CRNs, some existing SUs might leave the network and some new SUs might join the network at any time. In this case, centralized and synchronized algorithms cannot adapt to these network changes in real time. Finally and most importantly, SUs should not cause any unacceptable interference to PUs, which makes the status of a CRN change more frequently and unpredictably.

Hence, centralized and synchronized algorithms are not preferable for CRNs. Therefore, investigate the distributed data collection issue in asynchronous cognitive radio networks. Without overall network information and time synchronization, it is very complicated to study distributed data collection algorithms in asynchronous CRNs. There are four main challenges.

Such as:

1. Data transmissions of SUs should not cause any unacceptable interference to PUs. Therefore, how to guarantee that a secondary network does not interrupt the primary network in a distributed manner is a challenge.
2. Centralized algorithms can make an overall optimized decision; however, it is difficult for distributed algorithms to guarantee an overall optimized solution by using only local network information. Hence, how to design an effective distributed data collection algorithm for CRNs is another challenge.
3. In an asynchronous CRN, many data collisions, interference, and retransmissions occur due to lack of time synchronization, followed by capacity degradation and unfairness among data flows. Therefore, how to overcome the problems induced by lack of time synchronization and meanwhile taking fairness into consideration is also a challenge.
4. Theoretically analyze the performance of the proposed data collection algorithm and obtain the corresponding delay bound is another challenge issue. To address the aforementioned challenges, propose a distributed data collection algorithm for CRNs without time synchronization requirement. First, study the Proper Carrier-sensing Range (PCR) for an SU. Working with the PCR and the Re-Start (RS) mode1, an SU can successfully conduct data transmission as long as there is no active PUs or SUs within its PCR, and will not cause unacceptable interference to any activities of PUs. Considering these restrictions, it proposes a Connected Dominating Set (CDS) - based data collection algorithm, named Asynchronous Distributed Data Collection (ADDC), for CRNs. Through theoretical analysis, it shows that ADDC is order-optimal as long as an SU has a positive probability

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to access the spectrum. Also conduct extensive simulations to validate the performance of ADDC. Simulation results show that ADDC can effectively gather all the data packets to the base station and significantly reduce data collection delay.

II. Related Works

A. *Ning Zhan get al. [1]*

Implemented the wireless applications and services demands more spectrum bands, which consequently results in the spectrum scarcity. On the other hand, recent studies reveal that the allocated spectrum is largely under-utilized with the development of cognitive radio technologies, dynamic spectrum access (DSA) has been envisaged to be promising solution to improve the spectrum utilization, which allows unlicensed/secondary users (SUs) to utilize the unused spectrum owned by licensed/primary users (PUs) in an opportunistic fashion .

G.S.Kasbekar and S.Sarkar [22] utilized the spectrum making of Federal Communications Commission (FCC) has indicated CR as the candidate to implement opportunistic spectrum sharing. Moreover, IEEE has proposed the first standard IEEE 802.22 to utilize CR for reuse the unused TV spectrum on a non-interfering basis spectrum sensing in multi-channel scenarios, from the single user's perspective, the quickest detection is studied with the objective of finding an idle period from multiple channels as fast as possible using the theory of partially observable Markov decision process.

It focus on distributed channel selection algorithms that provide a secondary radio with the maximum possible throughput under the constraint that PR transmissions are not negatively affected by this selection. Cognitive radios have been proposed as the enabling technology for Opportunistic Spectrum Access (OSA).

B. *T.Shu and M.Krunz [4]*

Implemented model for exploit channel diversity such as opportunistic spectrum access (OSA). The novel approach uses channel quality as a second criterion in selecting channels to use for opportunistic transmission. The difficulty of the problem comes from the fact that it is practically infeasible for a CR to first scan all channels and then pick the best among them, due to the potentially large number of channels open to OSA and the limited power/hardware capability of a CR. As a result, the CR can only sense and probe channels sequentially. To avoid collisions with other CRs, after sensing and probing a channel, the CR needs to make a decision on whether to terminate the scan and use the underlying channel or to skip it and scan the next one. This problem is further complicated by practical considerations, such as sensing/probing overhead and sensing errors. An optimal decision strategy that addresses all the above considerations is derived by formulating the sequential sensing/probing process as a rate-of-return problem, which it solve using optimal stopping theory. It further explore the special structure of this strategy to conduct a second-round optimization over the operational parameters, such as the sensing and probing times.

It turns out that this optimization is non-convex when probing is used (and thus leads to a non-binary multi-rate setup) in the presence of sensing error. However, by exploiting the special structure of the problem, it still achieves a good solution that gives provably near-optimal performance.

C. *I.F.Akyildiz et al. [6]*

Networks are being developed to solve current wireless network problems resulting from the limited available spectrum and the inefficiency in the spectrum usage by exploiting the existing wireless spectrum opportunistically.

XG Networks, equipped with the intrinsic capabilities of the cognitive radio, will provide an ultimate spectrum-aware communication paradigm in wireless communications. In this survey, intrinsic properties and current research challenges of the xG networks are presented. it investigate the unique challenges in xG networks by a bottom-up approach, starting from the capabilities of cognitive radio techniques to the communication protocols that need to be developed for efficient communication. Moreover, novel spectrum management functionalities such as spectrum sensing, spectrum analysis, and spectrum decision as well as spectrum mobility are introduced. The discussions provided in this survey strongly advocate spectrum-aware communication protocols that consider the spectrum management functionalities. This cross-layer design requirement necessitates a rethinking of the existing solutions developed for wireless networks. Many researchers are currently engaged in developing the communication technologies and protocols required for xG networks. However, to ensure efficient spectrum-aware communication, more research is needed along the lines introduced in this survey.

D. *S.Huang et al. [9]*

Cognitive radio offers a promising technology to mitigate spectrum shortage in wireless communications. It enables secondary users (SUs) to opportunistically access low-occupancy primary spectral bands as long as their negative effect on the primary user (PU) access is constrained. This PU protection requirement is particularly challenging for multiple SUs over a wide geographical area. It studies the fundamental performance limit on the throughput of cognitive radio networks under the PU packet collision constraint. With perfect sensing, it develops an optimum spectrum access strategy under generic PU traffic patterns. Without perfect sensing, it quantifies the impact of missed detection and false

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alarm, and proposes a modified threshold-based spectrum access strategy that achieves close-to-optimal performance. Moreover, it develops and evaluates a distributed access scheme that enables multiple SUs to collectively protect the PU while adapting to behavioral changes in PU usage patterns.

Cognitive radio (CR) technology can potentially alleviate spectrum shortage in wireless communications by allowing secondary users (SUs) to opportunistically utilize spectral white spaces of primary users (PUs). Because primary (legacy) users have access priority, secondary cognitive radio networks are required to exert minimal effect on PUs if and when PUs becomes active. For example, in the XG project, one of the three major test criteria in the field test is “to cause no harm”. The protection of PUs is vital to the future of cognitive radio system because no PU operators would be inclined to accommodate secondary cognitive networks without such assurance. Thus, the spectrum access strategy of the SU should aim to maximize the performance of SUs while operating under the strict protection requirement of PUs. The protection of PUs is more challenging when there are multiple (decentralized) SUs accessing a common PU channel. Because these SUs may be widely distributed in a geographic location, one SU may not be able to sense all other SUs’ transmissions. On one hand, this enables spatial reuse among SUs, which improves secondary network capacity.

E. D.Xue and E.Ekici [11]

To maximize the throughput of a multi-hop CRN with a constraint on time-average collision rate experienced by PUs. It provides a deterministic upper-bound for queue backlogs under the optimal algorithm. It shows that with a control parameter V, the throughput of the CRN under the proposed optimal algorithm can approach close to optimality with the tradeoff in queue backlog/delay. Next, it proposes a class of suboptimal algorithms to reduce complexity while achieving at least a fraction of the optimal throughput. In addition, it apply the optimal algorithm to a fixed-routing setting and obtain the corresponding lower-bound of average end-to-end **delay across a link set. In the future, it will** investigate distributed scheduling algorithms for multi-hop CRNs. future work of the project will also involve 1) specific imperfect sensing schemes to estimate PU channel behavior and 2) possible delay reducing schemes for heavily loaded CRNs.

It develops opportunistic scheduling schemes that maximize the throughput utility of the secondary (or unlicensed) users subject to maximum collision constraints with the primary (or licensed) users in a cognitive radio network.

Online flow control, scheduling and resource allocation algorithm for a cognitive network that maximizes the throughput utility of the secondary users subject to a maximum rate of collisions with the primary users. This algorithm operates without knowing the mobility pattern of the secondary users and provides explicit performance bounds.

III. PROPOSED SYSTEM

Wireless networks are based on a fixed spectrum assignment policy that is regulated by governmental agencies. Although spectrum is licensed on a long-term basis over vast geographical regions, recent research has shown that significant portions of the assigned spectrum are utilized, leading to waste of valuable frequency resources. To address this critical problem, the FCC recently approved the use of unlicensed devices in licensed bands. Toward this end, cognitive radio (CR) technology is envisaged that enables the identification and use of vacant spectrum, known as spectrum hole or white space. In this article we focus on the challenges faced in CR ad hoc networks (CRAHNs), which do not have infrastructure support and must rely on local coordination for different CR functionalities.

Since most of the spectrum is already assigned, a key challenge is to share the licensed spectrum without interfering with the transmission of other licensed users (also known as primary users or PUs). If this band is found to be occupied by a licensed user, the CR user moves to another spectrum hole to avoid interference. In CRAHNs the distributed multi-hop architecture, dynamic network topology, diverse quality of service (QoS) requirements, and time and location varying spectrum availability are some of the key factors that must be considered in network design. These challenges necessitate novel design techniques that simultaneously address a wide range of communication problems spanning several layers of the protocol stack.

In CRAHNs CR users are mobile and can communicate with each other in a multi-hop manner on both licensed and unlicensed spectrum bands, as shown in Fig. 1a. Furthermore, due to the lack of central network entities, CRAHNs necessitate each CR user having all the spectrum related CR capabilities, and determining its actions based on local observation, leading to distributed operation. In order to adapt to the dynamic spectrum environment, the CRAHN requires spectrum-aware operations, which form a cognitive cycle, the steps of the cognitive cycle consist of four spectrum management functions: spectrum sensing, spectrum decision, spectrum sharing, and spectrum mobility. To implement CRAHNs, each function needs to be incorporated into the classical layering protocols.

IV. SYSTEM ARCHITECTURE

By working with this PCR, an SU can successfully conduct data transmission without disturbing the activities of PUs and other SUs. Subsequently, based on the PCR, it propose an Asynchronous Distributed Data Collection (ADDC) algorithm with fairness consideration for CRNs. ADDC

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collects data of a snapshot to the base station in a distributed manner without any time synchronization requirement .

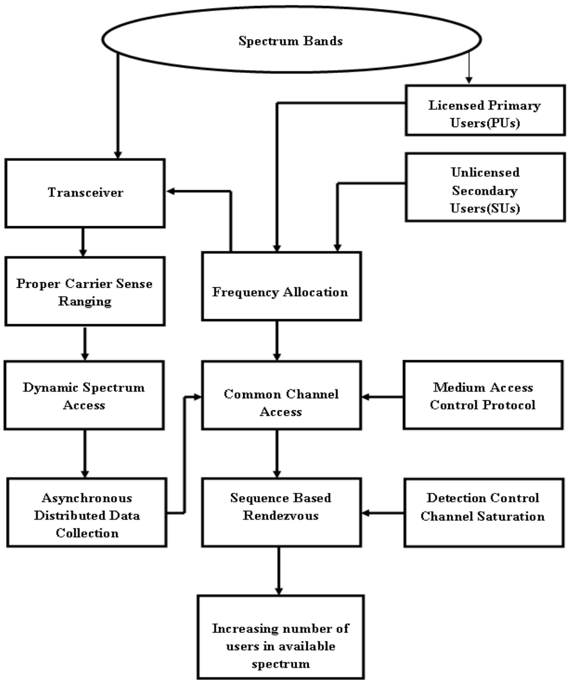


Fig 1: Architecture Overview

The following are the objectives of the proposed system:

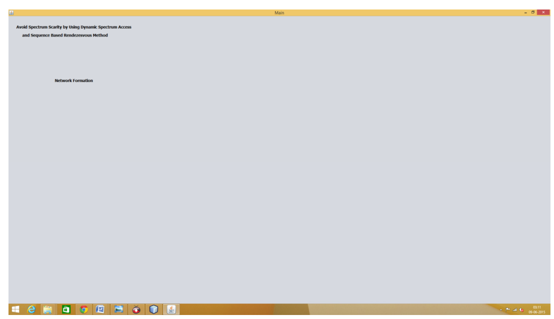
1. To prove an efficient data transmission to secondary users by utilizing the unused spectrum of the primary users
2. To provide a fair consideration for CRNs Asynchronous Distributed Data Collection (ADDC) algorithm is used to collect the data of snapshot from the base stations
3. To increase the number of the available user in the spectrum to avoid the spectrum wastage.

The distributed data collection problem for asynchronous CRNs, which has not been addressed before. The Common Control Access (CCA) is composed of the method of using MAC and Sequence Based Rendezvous. In this method the Denial-of-service attack is prevented and increases the number of users and also increase throughput and reduce the resource wastage in Cognitive Radio Networks (CRNs).

System architecture, explains how to reuse spectrum band reused from the rest of licensed spectrum allocate to unlicensed users. Enabling a user equipped with a cognitive radio to sense and learns the communication environment. Cognitive Radio Networks (CRNs) have paved a road for Secondary Users (SUs) to opportunistically exploit unused licensed spectrum without causing unacceptable interference to Primary Users (PUs).By working with the PCR, an Asynchronous Distributed Data Collection (ADDC) algorithm is proposed. Proposed distributed data collection algorithm, allow all the SUs to carrier-sense the spectrum to obtain a spectrum opportunity.ADDC deals with the continuous data collection problem. It analyzes the delay and capacity performances of ADDC for continuous data collection. However, a basic requirement is to ensure that the existing licensed users are not adversely affected by such transmissions.

It develops opportunistic scheduling schemes that maximize the throughput utility of the secondary (or unlicensed) users subject to maximum collision constraints with the primary (or licensed) users in a cognitive radio network.

V. Experimental Analysis



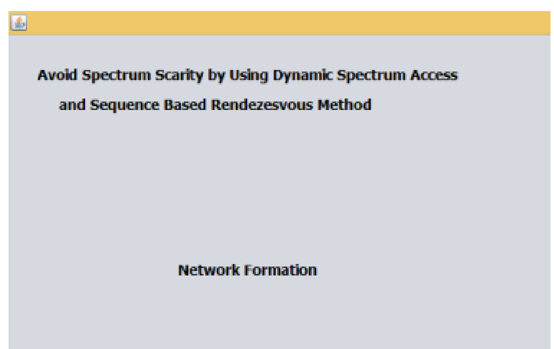
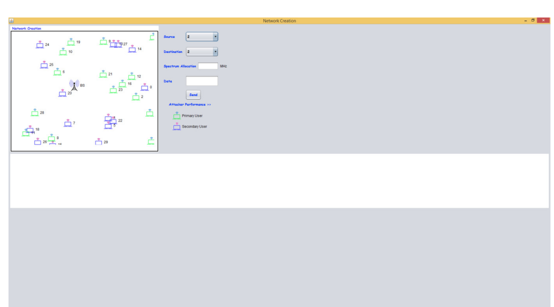


Fig 2: Home Page Of Avoid Spectrum Scarcity Using DSA and Sequence Based Rendezvous



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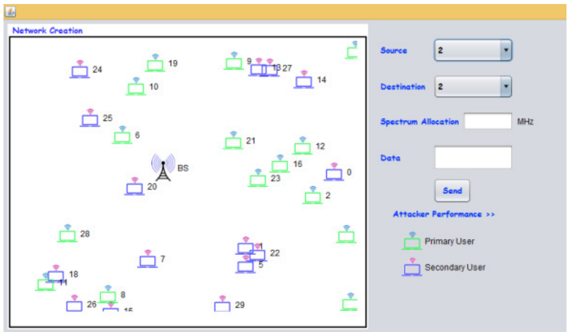
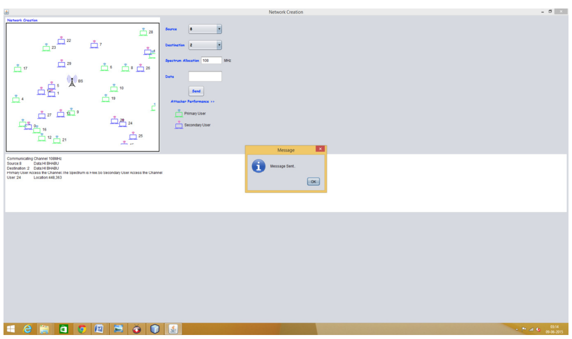


Fig 3: Selecting Source Node and Destination Node



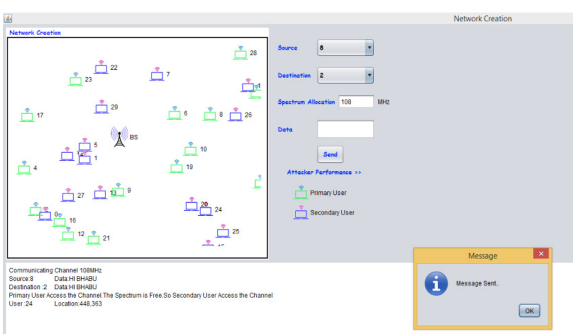
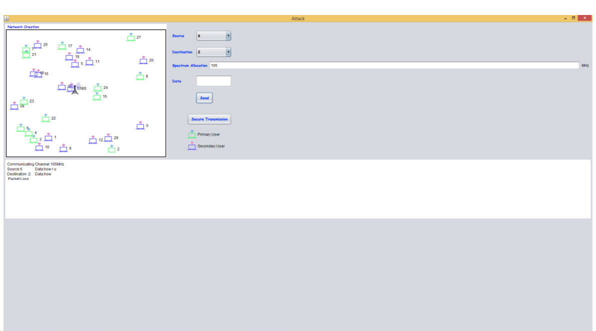


Fig 4: Message Delivered Successfully



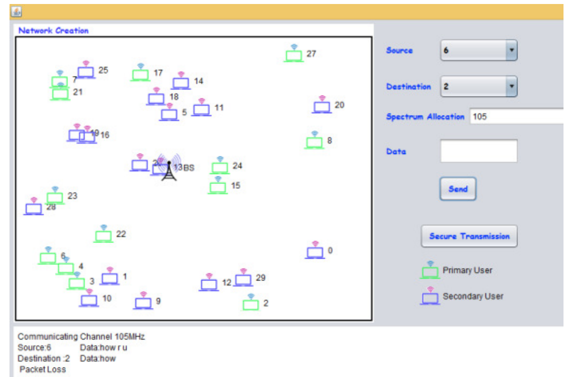
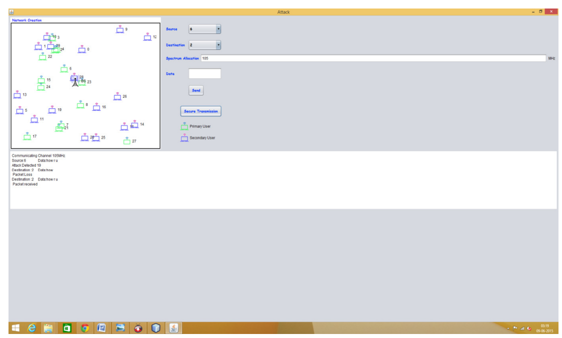


Fig 5: Data Pocket Loss While Communicating between Sources to Destination



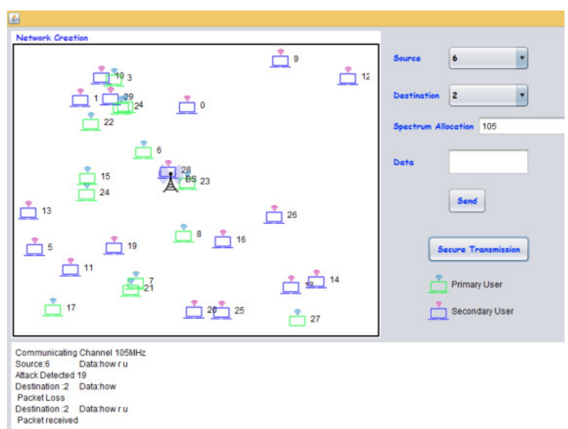


Fig 6: Secure Transmission and Detecting Hackers

VI. CONCLUSION

CRNs introduce a novel promising communication paradigm, where SUs can opportunistically access unused licensed spectrum without harming the communications among primary users. By setting a Proper Carrier Sensing Range for secondary users. It obtains an Asynchronous Distributed Data Collection algorithm for Cognitive Radio Networks with fairness considerations. The proposed distributed algorithm collects the data from a available

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spectrum in a timely order to reduce the delay and increase the capacity of the bandwidth. When the bandwidth availability increases it enhance the possibility for secondary users to access the available spectrum. When the available spectrum access is declared in the timely manner, it results in minimal data loss.

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