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Research Article

Improving Manets Qos Services using Dynamic Topology and Spectrum Sharing in Cognitive Radio-Manets

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ABSTRACT

MANETs is the best wireless network and helps for unlimited mobility without depending on other infrastructure. The mobile network is a challenging task for maintaining quality of service, protective routing and dependable communication. The purpose model with QOS routing is to select a secure optimal route from starting to ending and have to satisfy two or more QOS constrains. In MANETs the Cognitive Radio technology is the top layer in mobile ad hoc networks. The role of CR is to control the topology in Cognitive Radio-MANETs. In existing system there is no fixed topology because of the interference, multi path propagation mobility. So, in proposed system to do network function properly we enhanced the efficient scheduling techniques and topology with ant colony optimization techniques. The QOS service is processed in heterogeneous networks. The algorithm such as cognitive radio spectrum sharing algorithm, and Hungarian algorithm are used to evaluate the data rate and spectrum utilization. The experimental results are performance detect spectrum utilization and increase the data rates. The simulation result is implemented in NS-2 shows better performance in throughput and data rates.

Keywords: *Cognitive Radio Networks, QOS, MANETs, Dynamic Topology, Data Rates, Network Throughput, Spectrum Sharing, Hungarian Algorithm, Ant Colony Optimization.*

1.1 INTRODUCTION

A Mobile Ad hoc Network (MANETs) carries there may be less network infrastructure even though the transfer nodes in the network connections within transmit packets. The figure 1 shows the simple structure of MANETs between server and receiver.

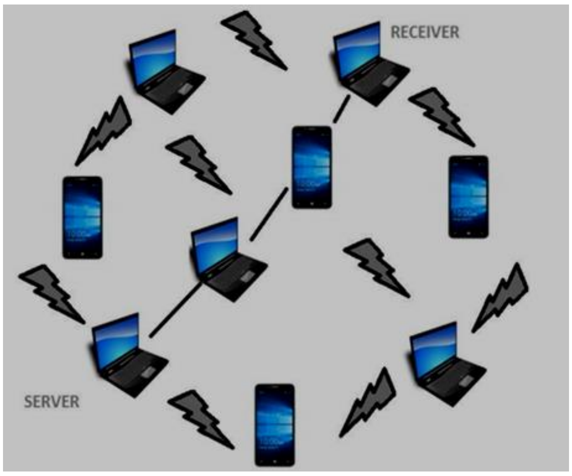

Figure 1 Servers to Receiver Structure of MANETs

In MANETs wireless mobile electronic devices are growing faster. The electronic devices have capability to provide real-time applications such as audio streaming, digital video and it is rigorous the quality of service (QoS). The High quality is specifically difficult in MANETs. This problem arises because of more energy and less resource availability. The quality of wireless networks causes more interference.

MANETs are self-dispense and self-classify and mobile node accesses each node inside network. In MANETs topology makes a wireless network. The multiple hop process takes location so each node appears within the MANETs as a host and router. Manet's family categorizes the power limitation, routing path variables, dynamic topology. Improve efficiency using Topology control by reducing energy consumption on the nodes and it takes the MAC Layer to place the interfering. Topology Control has lowered the cost of distributed algorithm in the resultant topology. A multiple number of protocols are proposed for topology control in MANETs. The main challenge in the design of algorithms in mobile ad hoc networks its topology in dynamic. The network topology can change quickly and unpredictably and affecting the routing paths. The figure 2 represents the MANET Topology.

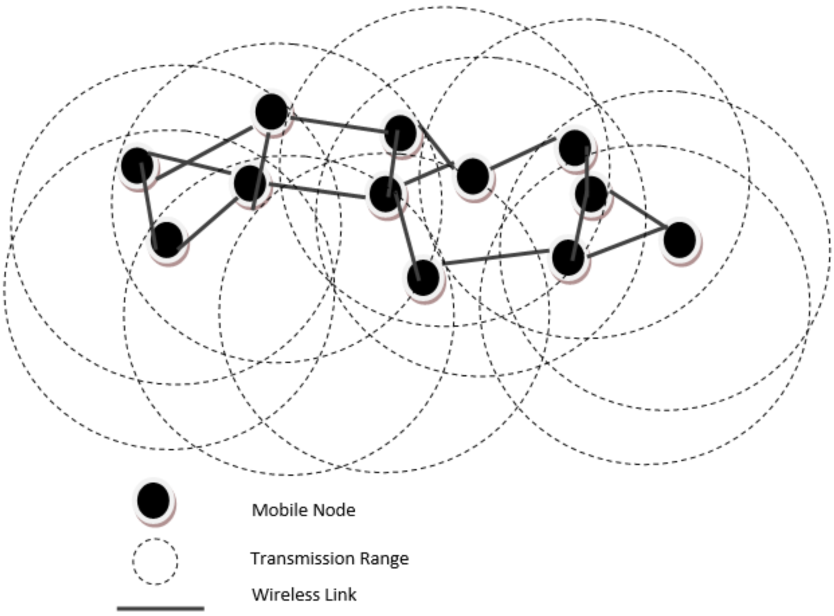

Figure 2 MANET Topology

The ad hoc network depends on the interface within communication attributes. A node starts communication will discover the nodes into direct communication range. If the information is gathered then the node keeps into an internal data and used in multiple networking activities such as routing. To sense the medium than the neighbors' nodes is depends on the ad hoc node behavior before transmitting data packets to nodes within interfering nodes and that may cause collision in any nodes. It will achieve the transmission of beacon packets to detect the communication.

1.1.1 TOPOLOGY CONTROL ALGORITHMS

It communicates nodes within a range and maintain a network topology in various aspects such as node mobility, routing algorithm and energy preservation. The ad hoc networks of topology control algorithms can be classified into clustering algorithm or hierarchical. It is centralized, distributed or localized. The Topology with Ant Colony Optimization is a search technique used to find the path between the source and destination nodes in MANET. It is overcome of the randomization technique to find the route discovery. The Ant Colony Optimization (ACO) is found an optimal solution near optimization problem on their real ant's behavior. ACO represents a heuristic approach that takes all the ants available in the network. The results of ant-based algorithm are capable of performing the Dynamic topology by using suitable MANET routings.

1.1.2 COGNITIVE RADIO-MANETs

Cognitive Radio (CR) is a wireless technology and aims are a better utilize and manage the spectrum. Two types of cognitive radio network users are primary users and secondary users. The primary users are used to give authentic to benefit the radio spectrum particular portion at any convenient process. The secondary user is not given any licensed to process the spectrum and wait until the spectrum is unoccupied. The Cognitive Radio Networks has two main schemes are the distributed schemes and centralized. The centralized is dependable for collecting the information about the radio spectrum and optimum sharing is under the secondary users. The primary users are not known about cognitive network behavior and need to specific processes. When a primary user is detected, then the cognitive networks immediately react by rate and their transmission should not degrade the QOS. The Table 1 shows the functionality levels of CR.

Table 1 Functionality levels of CR

LEVEL	CAPABILITY	COMMENTS
0	Pre-Programmed	A Software Radio
1	Goal Driven	Selects goal requirements according to the environment
2	Context Awareness	Analysis knowledge of the users
3	Radio Aware	Analysis the cognitive radio and network components
4	Capable of Planning	Analyze Level 2 and 3 and determine the QoS
5	Conducts Negotiations	Settle on a plan with another radio
6	Environment Learning	Determines Structure of the environment
7	Plans Adaptive	Generates the goals
8	Protocols Adaptive	Proposes new protocols

The cognitive users have coordinated their way in spectrum/channel and avoid collision among multiple cognitive radios. In each slot, several (CR) users want to transmit to a Base Station (BS) and can resolve the conflict by opportunistically scheduling a node with the maximum value for some metric. The metric value of a user may be known to itself and not to others. By choosing the metric properly, different objectives can be attained. A simple scheme is to let all the users feedback their metric to the central node following which the BS selects the user with the highest metric. But, when the number of users is large, the overhead required for the transmission of the control information from each user can become prohibitively large.

1.1.2.1 Advantages of Cognitive Radio

The main purpose of using a cognitive radio over a primitive radio is because of the following advantages:

1) Senses the radio frequency environment for the presence of white spaces.

2) Manages the unused spectrum.

3) Increases the efficiency of the spectrum utilization significantly.

4) Improves the spectrum utilization by neglecting the over occupied spectrum channels and filling the unused spectrum channels.

5) Improves the performance of the overall spectrum by increasing the data rate on good channels and moving away from the bad channels.

The rest of this paper is illustrated as follows. In Section II the related works about cognitive radio networks and describes about the proposed functionalities. The proposed methodology work and algorithm implementation is described in section III. Section IV presents the experimental results. Finally, Section V concludes the paper.

1.2 RELATED WORKS

Gokila et. al. [2025] proposed disjoint routing protocol to improve equal allocation of network burden over various routes, resulting in improvements to QoS. Thiyagarajan et. al. [2021] proposed that the discovery of QoS route in multi-constrained network is a complex problem, this is solved optimally using heuristic algorithms. In that, specifically used for intrusion detection programs in such challenging set ups would be Grammatical Evolution (GE). For finding out familiar threats in MANETs, the natural evolution-motivated GE scheme has been applied.

Nadir H. Adam et.al. [2016] proposed a spectrum allocation in Cognitive Radio Networks. The spectrum allocation depends on the interference graph. The interference graph is nothing but topology network and controls the traffic flows. The scheme will improve the spectrum efficiency and maintaining the interference at its acceptable level. The Hungarian Algorithm aims are to maximize the total bit rate of cognitive networks under the different secondary users and transmission power is follows some threshold values and interference in the primary users. So, the proposed algorithm is used to improve the system throughput and compared that algorithm display the simulation results based on values.

Ant Colony Optimization [Jipeng Zhou et al [2016]] provides efficient solutions and obtain the optimization problems. The ACO create a node traverse over the network to search paths between two nodes ants. The quality of paths depends on the number of hops and energy of nodes on the path. ACO routing algorithm exhibits interesting properties for MANETs and it works fully distributed way and provides multi-path routing.

Nadir et. al. [2015] describes those Cognitive radios provides of a top level of complexity in whole of its processes follows. The permanent interactions throughout the network elements such as licensed and unlicensed can created the develop procedures, algorithms and protocols to achieve the cognitive radio. Wireless networks are an active and changeable medium in nature and the lack of directive and full analytical knowledge of its performance may direct to degradation in the expected performance and QoS.

1.3 THEORETICAL BACKGROUND

1.3.1 COGNITIVE RADIO-MOBILE AD HOC NETWORKS

The MANET is a Mobile ad hoc network with mobile nodes as self-organizing networks. It is kind of applications such as military operations and communication, disaster management, data sharing, robust data acquisition. The mobile nodes in the MANET have some advantages such as small storage needs, utilization of low bandwidth, low error rate in packet transmission, easy and quick deployment and less-infrastructure. Figure 3 shows the PU and SU of CR-MANETs.

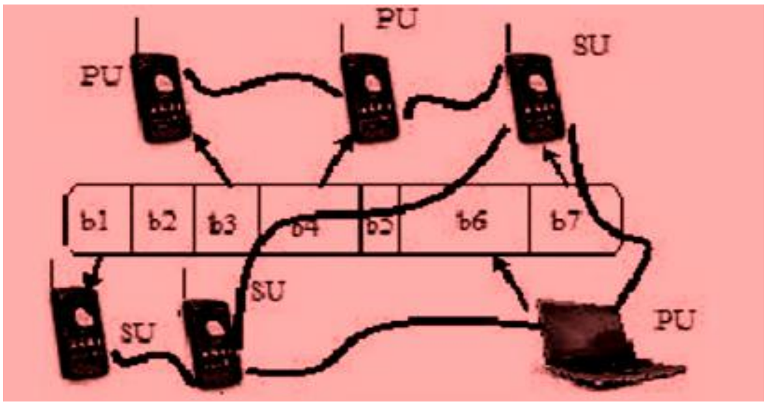

Figure 3 CR-MANETs

The distinct characteristics of the CRs initiate novel non-trivial issue to CR-MANETs. The main importance is protecting the transmission of the licensed users of the spectrum mainly characteristics classical MANETs from CR-MANETs. Dynamic Spectrum Access, Protocol design and optimization of CR-MANETs are some of the problems related to the CR-MANETs.

1.3.2 PROPOSED COGNITIVE RADIO SPECTRUM SHARING

The proposed cognitive radio system flow is as figure 4. In the beginning, an initial spectrum is performed the status of the frequency. Based on the spectrum sensing, the secondary users (SU) communicate using higher transmit power that is primary users are detected to be idle and lesser power.

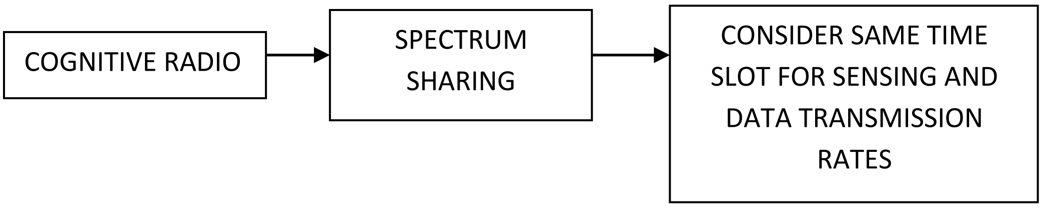

Figure 4 Proposed Flow Graph of Spectrum Sharing

In the following, the secondary user (SU) decodes the signal sent by the secondary transmitter, flooring it away from the received signal and uses the balanced signal to evaluates spectrum sensing and determine the action of the cognitive radio system in the next frame. At the end of the frame, if the status of the primary users(PU) has changed after the initial spectrum sensing was performed, the secondary users(SU) will change their transmit power from higher to lower or vice versa, based on the spectrum sensing decision (which is sent back to the transmitter via a control channel), in order to avoid causing harmful interference to the primary users. At last, the process is repeated.

1.3.3 COGNITIVE NETWORK MODEL

In the cognitive radio system presented in figure 5 that operates based on the proposed spectrum sharing scheme that is described in the following. It is described how the proposed spectrum sharing scheme operates and present the receiver in this cognitive radio system. Let g and h denote the instantaneous channel power gains from the secondary transmitter (SU-Tx) and the primary receiver (PU-Rx), respectively. It estimating the received signal power from the PU-Rx when it transmits, under the assumptions of the pre-knowledge on the PU-Rx transmits power level.

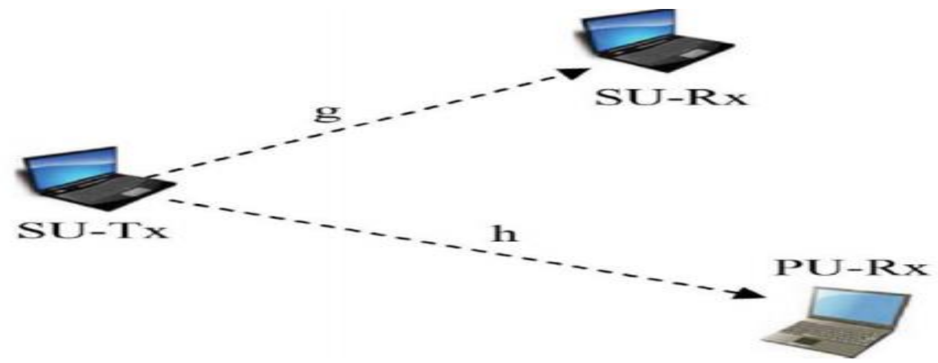

Figure 5 Proposed Network Model

1.3.4 PROPOSED SPECTRUM SHARING ALGORITHM

The proposed algorithm is presented and its constraints are explained mathematically

1) Generate the cost matrix
2) Suppose entire channels meet the QoS with minimum requirements it applies the Hungarian algorithm to the cost matrix else move to next step.
3) The whole rows search the minimum element value and minus that value from whole row elements
4) Do same search process for columns to minimum element value and minus that value from whole elements.
5) Search the number of zeros in each row.
6) Suppose number of zeros in all rows is higher than 1 means assign the first Secondary User (SU) to the first acceptable channel
7) Exclude this user from accessing other channels and exclude other secondary users from accessing this channel.
8) If the number of zeros in a row equals one, assign the secondary user with the only acceptable channel.
9) Repeat from step 5 until all secondary users are assigned to the best matched available channel (perfect matching) or until no channels can be matched due requirement constraints.

In this case, the secondary user (SU) with the minimum highest required data rate will be assigned the available channel to achieve higher spectrum utilization.

A **pseudo code** for the proposed algorithm is shown below:

```
1: C ←    Cost Matrix
2: For All Ci.j do
3: Check C(i,j)
4:         if C(i)>C(j) then
5:             Allocate using Hungarian Algorithm
6:         else
7:         for all rows i
8:         mi=min(i,j)
9:         Ci,j=Ci,j-mi
10:        Repeat from 7 for all columns j
11:        n=number of zeros in each row
12:        if n ≥0
13:        Sui → Ci
14:        if all the channels not occupied
```

15: Goto 13

16: else

17: end

18: end

The proposed algorithm object is to minimize the cost function and maximizes the number of secondary users (SU). The proposed algorithm can be represented mathematically as:

Minimize : $\sum_{i=1}^{N}\sum_{j=1}^{K} Ci^j Xi^j$---------------------(1.1)

Maximize:$\sum_{j=1}^{K} Xi^j$ ---------------------(1.2)

Maximize:$\sum_{j=1}^{N} Xi^j$ ---------------------(1.3)

Subject to:

$\sum_{j=1}^{K} Xi^j \leq 1$ ---------------------(1.4)

$\sum_{j=1}^{N} Xi^j \leq 1$ ---------------------(1.5)

$Xi^j \in \{0,1\}$,where Xi^j is the cost function.

1.3.5 ANT COLONY OPTIMIZATION

It is a bio-inspired algorithm by the behavior of real ants. The simulation of ACO steps is explained in the results. The steps of an ACO-based algorithm are as follows:

Construction Graph:

A graph $G_c = (V_c, E_c)$ it represents the optimization problem. The Vertices represents as V_c and Edges represents as E_c. The whole path can be represented by the vertices or edges with a possible solution of the optimization problem.

Initialization of Population

It will memorize the traversed paths and it is considered as an intelligent agent to traverse the graph and sequence of the vertices or edges traversals.

An Initial State

It is assigned and determines the starting vertex of the construction graph.

Probabilistic Transition Rule

This rule is used to make a decision to move to the next vertex j or choose the next edge (i,j). It is defined on the basis of three parameters are set of feasible vertices, intensity and heuristic function.

Heuristic Function

It indicates choosing vertex j or edge (i,j) from the deciding ant is located on the vertex i.

Intensity

It represents the choosing vertex j or edge (i,j) is finds a complete path with the optimum solution. It is updating rule, intensity is modified to find the effects. The intensity is modified by the greatest comprehensive ant.

Set of Feasible Vertices

It determines the set of the vertices of the graph and it is placed on vertex i. A set of feasible vertices is essential to stay away from loop throughout the path construction.

Cost Function

It is function based on the problem and assigned to each and every overall path to representing the beneficial complete paths.

1.4 EXPERIMENTAL RESULTS

The proposed methodology experimental results are explained with the minimum QoS requirements for the used applications in the simulation are given in Table 2. In this table, Application is mentioned as (x), Data Rates are Kbps, Density Ratio is (dB), and Bandwidth is Hz.

Table 2 Minimum QoS requirements for used applications

Application (x)	Data Rates (Kbps)	Density Ratio (dB)	Bandwidth (Hz)
Web Browsing	31.5	7	11
Audio	57	10	16
Video	320	13	63
Chat	1	14	1

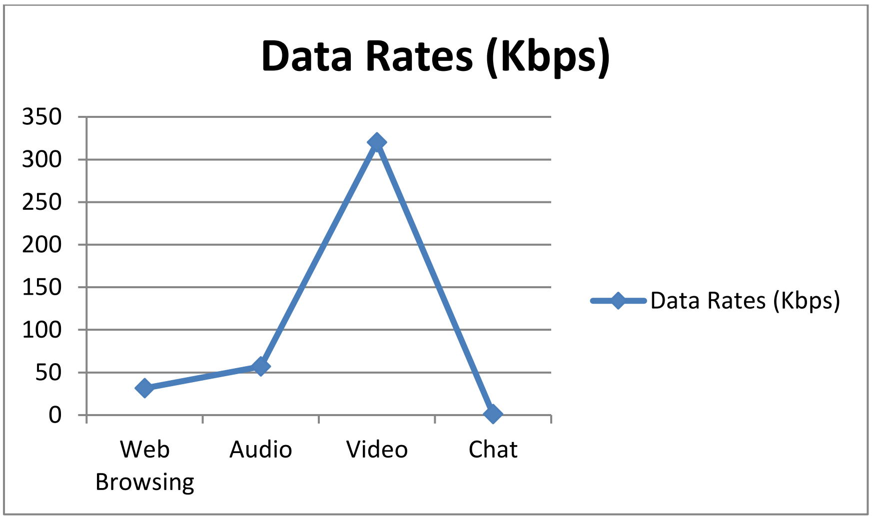

Figure 6 Data Rates Result of Various Applications

The above figure 6 shows the data rate of various applications such as web browsing, audio, video and chat.

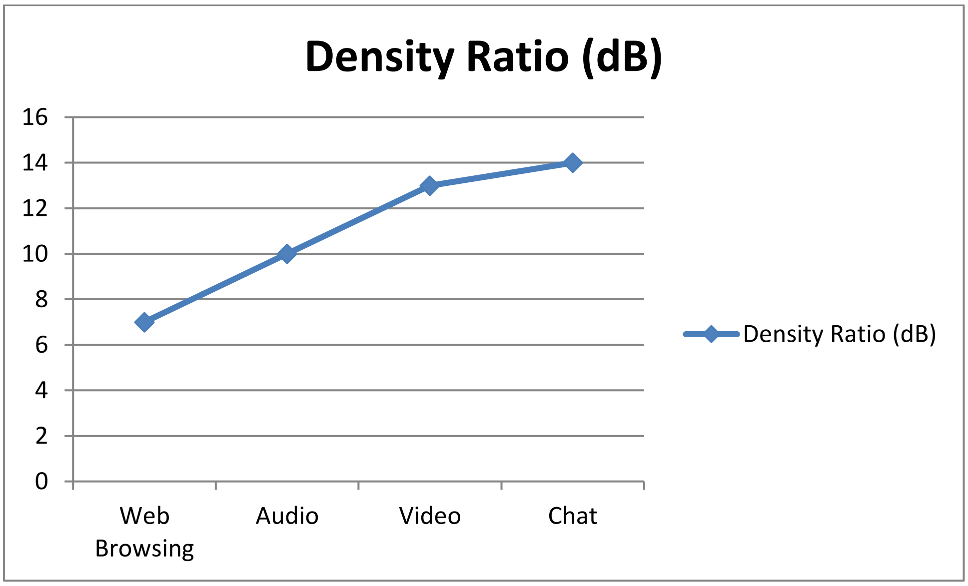

Figure 7 Density Ratio Results of Various Applications

The above figure 7 shows the density ratio of various applications such as web browsing, audio, video and chat.

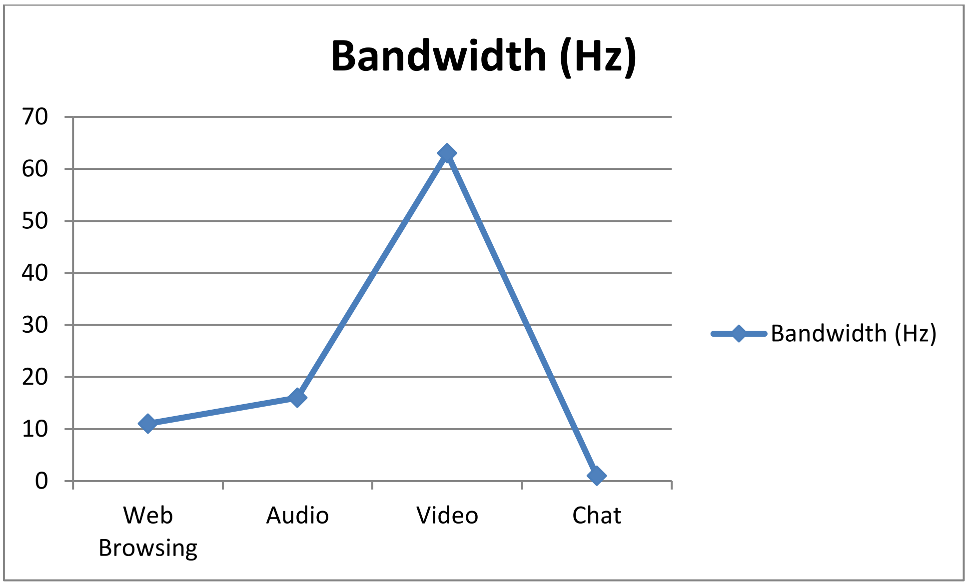

Figure 8 Bandwidth Results of Various Applications

The above figure 8 shows the bandwidth of various applications such as web browsing, audio, video and chat.

The below Figure 9 shows the heterogeneous network spectrum utilization based on the number of secondary users and the average required of the SUs applications for 4 available channels with average of 14.5 db. The graph shows the clearly that whole the secondary users were assigned a channel and thus the utilization grew linearly from 25%-100% for 1 to 4 SUs and as the number of SUs exceeded the total number of channels the spectrum utilization settled at full utilization. On the other hand, as the required Signal to Radio increases, the spectrum utilization decreases as the number of available channels that satisfy the required QoS becomes more limited. Increasing the number of secondary users results in an increase in the spectrum utilization, which reaches about 95% for 6 SUs. Figure 5.8 illustrates the required SUs applications on the system performance, as the required SNR increases the spectrum utilization decreases and as the number of SUs increases the utilization increases as well.

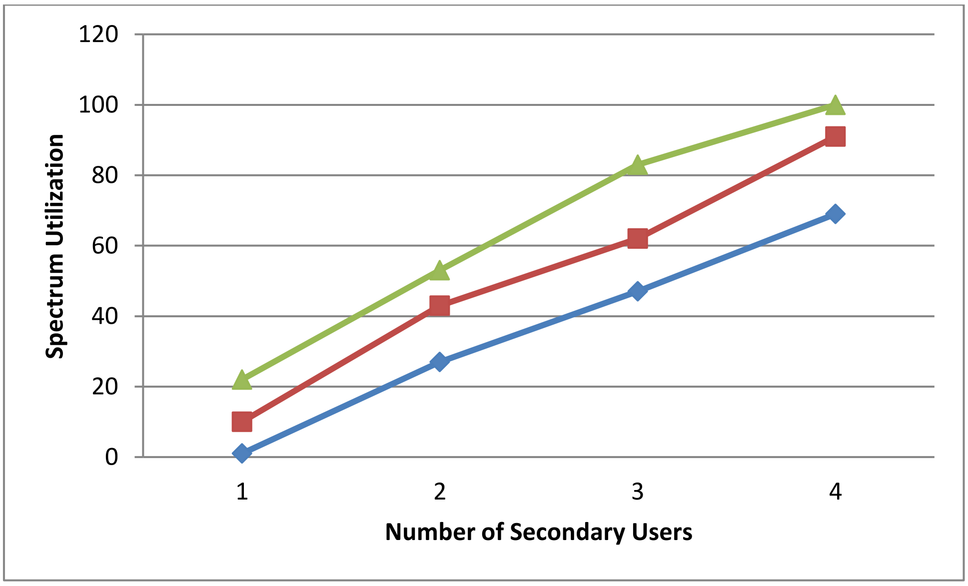

Figure 9 Spectrum utilization for different number of SUs

The below figure 10 shows the number of Cognitive Radio Users affect the performance of spectrum sharing algorithm. Its traits the overall throughput of the Cognitive Radio Network (CRN). The figure 10 shows increasing the number of CR users and the decreases throughput.

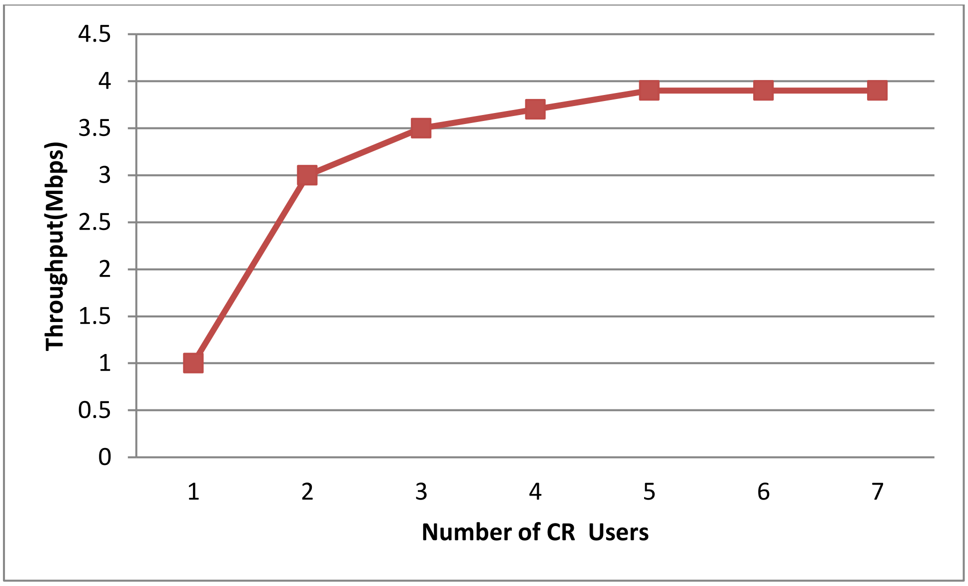

Figure 10 Analysis Performance of CRN Throughput

The simulated several scenarios of mobile ad hoc networks with the following assumptions:

1) Number of mobility nodes have been considered.
2) Each node represents like disc shaped communication area and interference area.
3) Entire nodes are uses similar transmission power and it is unchanged the cluster and channel rules.
4) The performance measurement factor evaluates the ACO – based clustering method. NS2 is used to simulate results of the networks.
5) As the first experiment, networks with: 30, 40, 50 nodes
6) with different transmission ranges (i.e., TR=20,30, 40 and 50
7) meters), are considered. The nodes are uniformly distributed
8) in a 100 times 100 meters square area. Table 1 lists the
9) obtained results from the ACO-based clustering algorithms

As the experiment results has network with values of and with different transmission ranges are considered. Table 2 lists the results from the ACO based clustering algorithms. The Clustering ACO has less than other ACO. So, it is concluded that Clustering ACO provide a best result with minimizing number of clusters.

Table 3 Comparisons between ACO and Clustering-ACO

As the first experiment, networks with: 30, 40, 50 nodes

with different transmission ranges (i.e., TR=20,30, 40 and 50

meters), are considere

METHOD	NODES VALUES	CLUSTER POPULATION MEAN VALUES
ACO	23	14
	35	8
	43	7
CLUSTERING-ACO	20	12
	32	6
	40	3

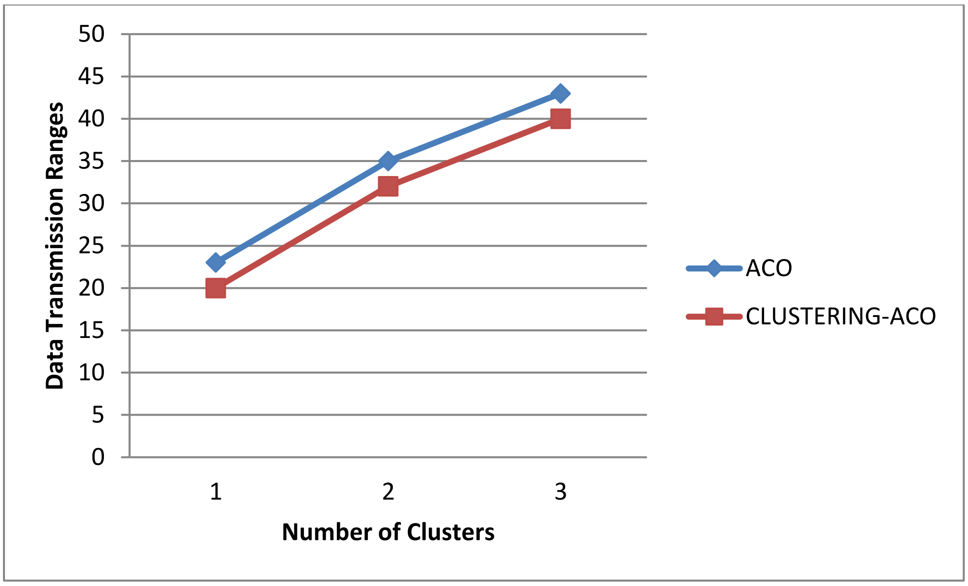

Figure 11 Transmission Range of ACO and Clustering ACO

The above figure 11 shows the transmission range of ACO and Clustering ACO and the below figure 3 shows the mean values of ACO and Clustering ACO.

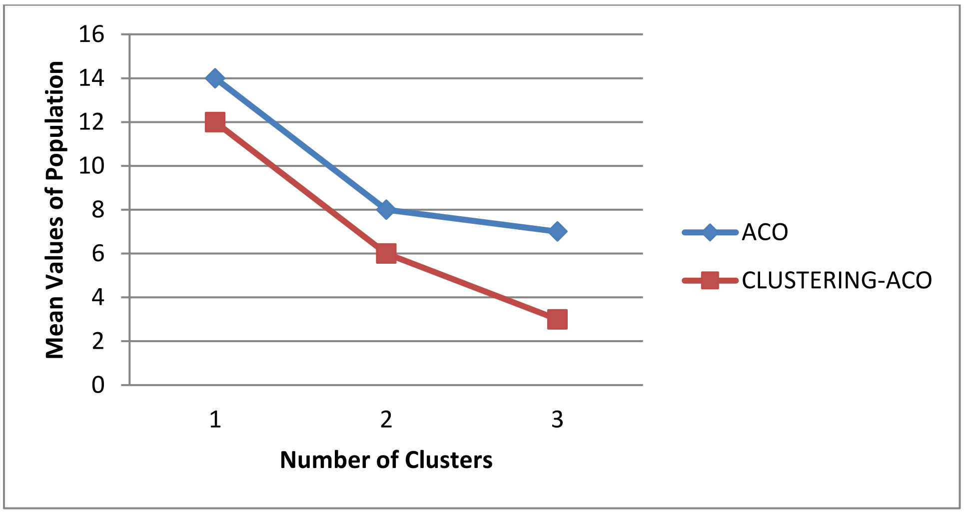

Figure 12 Mean Values of ACO and Clustering ACO

1.5 CONCLUSION

In this paper, cognitive radio networks describe a spectrum sharing algorithm and Hungarian Algorithm for heterogeneous networks in cognitive radio networks is proposed, and the performance of the algorithm is analyzed based on the spectrum utilization and applications' data rate for secondary networks. Simulation results showed that the algorithm provided the required QoS for applications in terms of Signal to ratio, data rate and achieved higher spectrum utilization. The performances of the models were measured in terms of the total spectrum utilization and the secondary users' data throughput. It was found that, as the number of available channels decreases, the total network utilization increases due to the primary users' activities and the secondary network throughput decreases. The result shows that our proposed technique enhanced the quality of cognitive radio spectrum sharing algorithm and had find the best optimization solutions.

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