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Optimized Joint Stable Routing and Channel Assignment for Mobile Ad-hoc Cognitive Network

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ABSTRACT: Link instability and channel interference cause significant performance degradation to Mobile Ad Hoc Cognitive Networks (MACNets). Existing work designs routing and assigns channels separately or does not consider mobility prediction and channel vacation to primary nodes. The Wireless Sensor Network (WSN) operates in the public unlicensed spectrum band, which has become increasingly crowd because of the emergence of the vast wireless communication technologies. In this paper, we propose a Joint Stable Routing and Channel Assignment (J-SRCA) protocol along with Artificial Bee Colony method based on mobility prediction for the network throughput maximization. We propose an Integrated Data Transmission Cost (IDTC) to quantitatively measure the communication quality of links. In our approach of J-SRCA and ABC, each link selected hop by hop is simultaneously assigned an interference-avoiding channel during a route setup and reduces the delay.

KEYWORDS: wireless sensor network (WSN), joint stable routing and channel assignment (J-SRCA), Mobile Ad Hoc Cognitive Networks (MACNets), Integrated Data Transmission Cost (IDTC), Ant Bee Colony (ABC).

1.INTRODUCTION

The CRNs are also known as secondary networks, DSA networks, or unlicensed networks. The nodes in the CRNs are equipped with the cognitive radios (CRs) that are capable of changing the transceiver parameters based on the changes in the environment within which the CRN nodes operate [01]. The CRNs are further classified into two groups, namely:

- Infrastructure-Based CMS And
- Infrastructure-Less CMS or Cognitive Radio Ad-Hoc Networks (CRAHMS).

The infrastructure-based CRNs have one central network entity, such as the base station for communication control. Examples of such networks are cognitive radio cellular networks (CRCNs) and wireless regional area networks (WRANs). A CRN may have a spectrum broker that maintains and distributes the spectrum resources among various CRNs.

Figure 1 shows architecture of the CRN. The SUs can utilize both the available licensed portions of the spectrum owned by a PU and the unlicensed portions of the spectrum. The CR base station communicates with a secondary node at channel on which the secondary receiver node is tuned. The colour of a wireless link in diagram shows the spectrum band whereas a number on the wireless link represents the channel ID. The devices on the horizontal spectrum separating line have multiple available channels. The operations involved in accessing and using a particular portion of a spectrum vary according to the type of spectrum band. The licensed band is normally used by the PUs; the basic architecture of the CRN is depicted in Figure 1.

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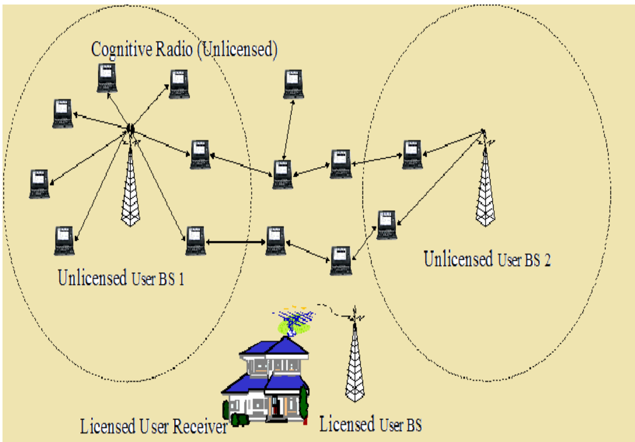

Figure 1: The CRN Architecture

II. CHALLENGES OF SPECTRUM SENSING

Some challenges arise when considering spectrum sensing for obtaining knowledge of the operational environment. One of them is the hidden node problem. Furthermore, spectrum sensing requires high sensitivity, sampling rate, resolution analogue to digital (A/D) converters with large dynamic range, and high speed signal processors. When wideband sensing is considered terminals are required to capture and analyse a wide band, which imposes additional requirements on the radio frequency (RF) components. Wideband sensing also means that a wide range of signals with different characteristics needs to be detected which adds to the complexity of sensing since it needs to adapt to e.g. different energy levels or cycle stationary features of the primary signal [01].

Therefore it might be useful to utilize sensing technologies in a limited frequency range in which the range of technologies used by the other existing systems in the band is limited. It should also be noticed that if sensing is to be used in a band where there is a need to sense several different signals, and this requires implementation of several sensing technologies in a device, the complexity and cost of the devices will rise.

The work proposed in this paper that includes the channel assignment for the user using ABC method that will optimize the best path from the available path to the user. The section 2 will include already worked algorithm discussion and next module 3 includes the details of current work methods and algorithms. Section 4 gives the final results of the proposed work in brief.

III. REALTED WORK

Author YasirSaleemet.al, [01] worked on the channel assignment module in his work. The fixed spectrum allocation causes inefficient utilization of licensed spectrum bands, due to which Cognitive Radio Networks (CRNs) emerged as a promising solution. Cognitive radio networks opportunistically utilize the spectrum holes, i.e., spectrum not in use by Primary Users (or PUs or licensed users) and allocate the spectrum dynamically. For every network including cognitive radio networks, routing is very important. Routing is the backbone of communication for transferring data from one machine to another in a multi-hop fashion. A good routing protocol is required for efficient communication and a good routing protocol is based on channel selection strategy. Therefore, a good channel selection strategy is required for efficient routing protocol so that routes should be stable and exist for longer time. In this paper, we focus on joint channel selection and routing from the perspective of cognitive radio networks. In this context, we provide a comprehensive survey on routing and channel selection in CRNs. More specifically, the importance of joint channel selection and routing for cognitive radio networks is first highlighted. Then classification and challenges of channel selection and routing are discussed in details. Routing with efficient channel selection in cognitive radio networks is then discussed by describing many routing strategies for cognitive radio networks, routing metrics, performance

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parameters, primary user activity modelling and spectrum aware strategies. Then guidelines for the development of efficient routing protocols are discussed. Subsequently, in last, a case study for channel selection strategy 'Spectrum Aware Dynamic Channel Assignment' (SA-DCA) is presented and illustrated that how routing can get benefit from it.

Author Hangshenget.al, [02] worked on cognitive radio spectrum properties. Since secondary users (SUs) should vacate the channel in use immediately after detecting the reappearances of primary users (PUs) in cognitive radio networks (CRNs), the route reliability is a distinctive challenge for routing in CRNs. Furthermore, the throughput requirement of an SU session should be satisfied and it is always preferable to select a route with less negative influence on other current or latish sessions. To account for the route reliability challenge, we study the joint link and channel assignment routing problem for CRNs. An on-demand route discovery algorithm is proposed to find reliable candidate paths, while a joint link and channel assignment routing algorithm with sequentially-connected-link coordination is proposed to choose the near-optimal route for improving the route reliability and minimizing negative influence.

Author Osamah S. et.al, [03] presented a work on Probabilistic quality-aware routing protocol in cognitive spectrum. A probabilistic routing metric is introduced in this paper that considers the peculiar characteristics of the operating environment of cognitive radio networks (CRNs). This metric captures the dynamic changes in channel availabilities due to the randomness of primary user's activity and the rich channel diversity due to the fact that a CRN is expected to operate over highly separated frequency channels with different propagation characteristics. Probability of Success (PoS), statistically quantifies the chances of a successful cognitive radio (CR) packet transmission over a given channel. Based on the PoS metric, a joint probabilistic routing and channel assignment protocol is proposed for multi-hop CRNs that attempts at selecting the path with the maximum probability of success among all possible paths for a given CR source-destination pair. Selecting such a path results in minimizing the number of disruptions to CR packet transmissions, this consequently improves network throughput.

Author ShraddhaSajal et.al, [04] developed a work that consist of details of MANETs. Mobile communication in MACNets suffers instability due to channel disturbances in network. It also suffers from speed reduction due to channel congestion. The efficiency of the MAC Net depends not only on primary nodes but also on other factors like channel congestion, channel conflict among the cognitive nodes. In a network with huge number of nodes this problem is magnified because of multiple nodes trying to access the same channel at the same time. In this project, we propose a distributed approach called Transition Predicting-Cognitive Routing and Channel Assignment (TP-CRCA) to maximize the network throughput by avoiding channel conflict, congestion and determining the life time of the primary node availability in the network range. To numerically measure the network quality, a new metric named Channel Quality Test (CQT) that captures the mobility of the nodes, impact to primary nodes, channel conflict and life time of the primary node in the range among the cognitive nodes is included.

Aparna S Menonet.al, [05] developed a work on stable routes for better results. Data communication is severely affected in the mobile adhoc cognitive networks (MACNets) due to link instability and channel interference. The availability and stability of each link in MACNets highly depends on not only the relative movement of neighbour nodes but also the adjacent communication among primary nodes and among cognitive nodes. So, in the existing system a cross-layer distributed approach, called mobility-prediction-based joint stable routing and channel assignment (MP-JSRCA), is used to maximize the network throughput by jointly selecting stable routes and assigning channels avoiding inter- and intra-flow interferencesbased on mobility prediction. In MP-JSRCA, each relay node selects the best link with the smallest DTC as the next hop, within aspecified sector region towards the destination. To quantitatively measure the communication quality of links, a new metric data transmission cost (DTC) is used that captures node mobility, impact to primary nodes, and channel conflict among cognitive nodes. The problem of improving energy efficiency is also an important concern in mobile adhoc cognitive networks.

IV. IMPLEMENTATION

The objective of the J-SRCA problem is to maximize system throughput of multi-hop multi-channel multi-flow MACNets. The proposed system also includes the optimization algorithm

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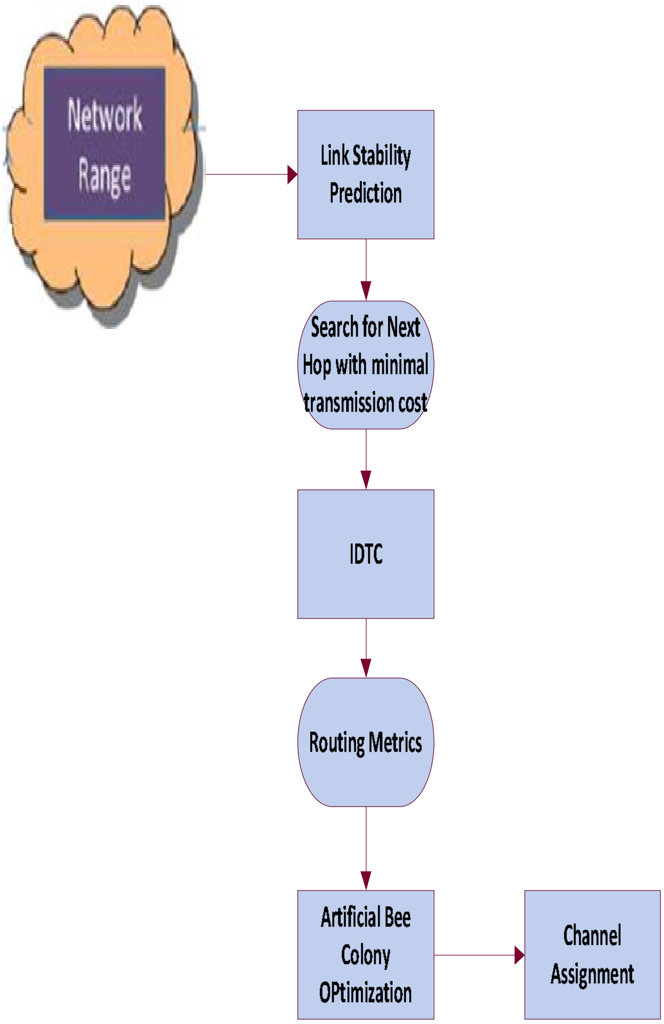

Figure2: Architecture for Proposed System.

Known as Artificial Bee Colony (ABC) method. Our approach minimizes the channel interference. Any link that potentially impacts PNs due to lack of available channel is completely excluded by our J-SRCA protocol. Moreover, our J-SRCA pays higher priority to avoiding the inter-flow interference than the intra-flow interference. The ABC helps to reduce the delay between end nodes. The networks with users are asked for the routing of the packets for with the best path. Figure 2 represents the proposed architectural diagram.

A. Joint Link and Channel Assignment Routing

Based on the eligible candidate paths and channel availability information attained from the path discovery, the destination node *d* constructs the desired route to solve *Problem 2*. The aim of the proposed joint link and channel assignment routing (JLCAR) algorithm through sequentially-connected-link coordination is to construct a route that has minimal interference-impact ratio and satisfies the throughput requirement. *Problem 2* is in the form of binary programming and is still NP-hard in general. The main complexity arises from the constraint which requires a channel not to be assigned to two or more interfering links. As we take 0.5 in this study, three sequentially-connected links on a path are sure to interfere with each other if they use the same channel. The basic idea of JLCAR is to coordinate the

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channel assignment within the threesequentially-connected links rather than the whole path, in order to avoid the exponential complexity [07].

$$\min \emptyset^{m}_{i0i1}$$

$$s.t.\, B^{m}_{i_0 i_1 \geq b_0} \qquad (01)$$

$$Y^{m}_{i_0 i_1} + \sum_{<p,q> \in Y^{m}_{i_0 i_1}} Y^{m}_{pq \leq 1}$$

B. Routing Phase

The concept of checking the neighbouring node is to verify the nodes available most nearest to the individual nodes.The flow-chart of this program is given is the Figure 3. To perform this transmission range is to be fixed initially in the network. That means the maximum range in which each node can be able to communicate with its adjacent node without any loss of information. Then condition will check for the individual node to specify the given transmission range.

Every single node willcalculate its distance with respect to every other node in the network. If the condition satisfies for the less transmission range than the calculated present set of nodes then that particular node will selected as an adjacent node of that particular node. Selection of the path is the most important task here. To do so we are first initializing the parameters stored for the proper path selection. The calculation will begin from the generating the difference matrix that will be consisting of the distance values of the individual nodes in the network. With the distance matrix sight matrix will be created. Manually the start and end phases have to be decided previously. Probability will be calculated for the selected matrices. The probability will provide the cost of the network. The cost which is lower one will be selected as the path to the router.

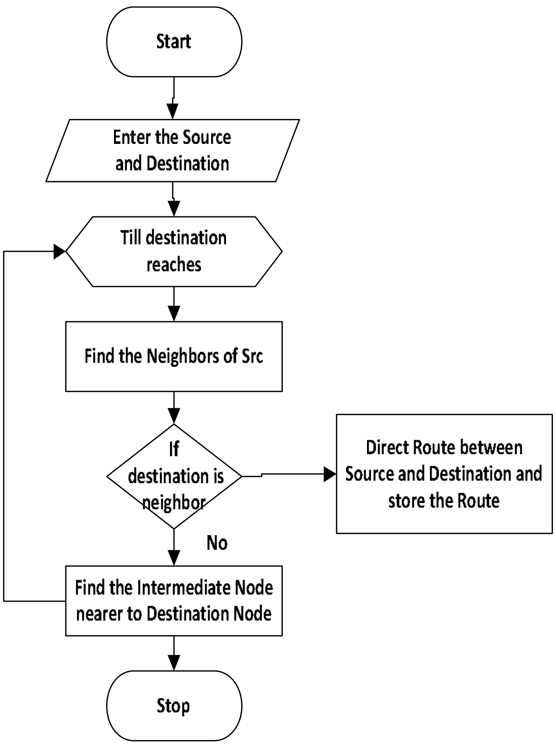

Figure3: Flow chart of Routing Phase

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C. Artificial Bee Colony (ABC):

The ABC Algorithm Used for Unconstrained Optimization Problems in ABC algorithm [08], the colony of artificial bees consists of three groups of bees: employed bees, onlookers and scouts. First half of the colony consists of the employed artificial bees and the second half includes theonlookers. For Artificial Bee Colony (ABC) Optimization Algorithm 791 every food source, there is only one employed bee. In other words, the number of employed bees is equal to the number of food sources around the hive. The employed bee whose the food source has been abandoned by the bees becomes a scout. In ABC algorithm, the position of a food source represents a possible solution to the optimization problem and the nectar amount of a food source corresponds to the quality (fitness) of the associated solution. The number of the employed bees or the onlooker bees is equal to the number of solutions in the population. Detailed pseudo-code of the ABC algorithm is given below:

Algorithm: ABC

Step 1: Initialize the population of solutions $x_{i,j}$, i = 1 ...SN,j = 1 ...D

Step 2: Evaluate the population

Step 3: cycle=1

Step 4: repeat

Step 5: Produce new solutions $\upsilon_{i,j}$ for the employed bees by using (2) and evaluate them

Step 6: Apply the greedy selection process

Step 7: Calculate the probability values $P_{i,j}$ for the solutions $x_{i,j}$ by (1)

Step 8: Produce the new solutions $\upsilon_{i,j}$ for the onlookers from the solutions $x_{i,j}$ selected depending on $P_{i,j}$ and evaluate them

Step 9:Apply the greedy selection process Artificial Bee Colony (ABC) Optimization Algorithm 793

Step10: Determine the abandoned solution for the scout, if exists, and replace it with a new randomly produced solution $x_{i,j}$by (3)

Step11: Memorize the best solution achieved so far

Step12: cycle=cycle+1

Step13: until cycle=MCN

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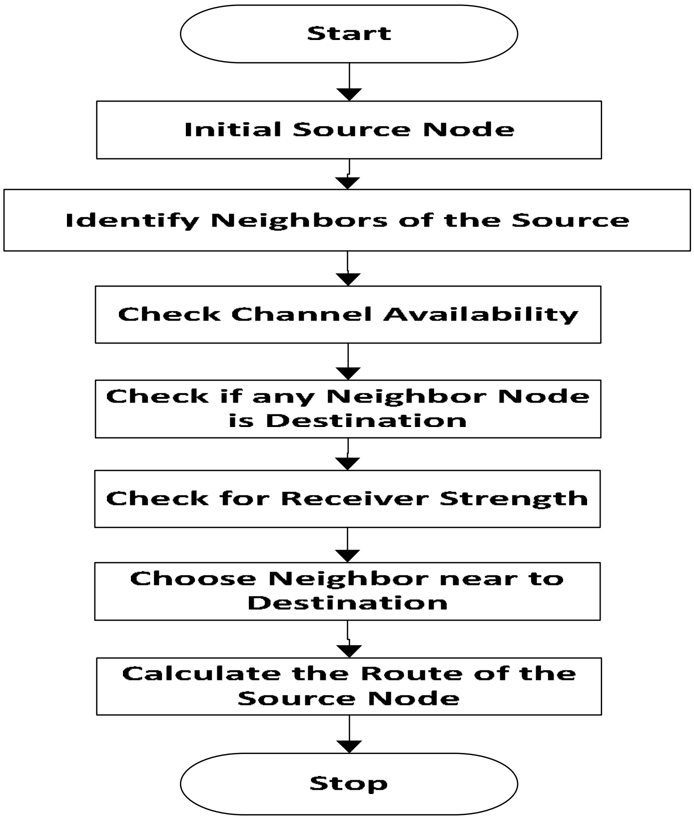
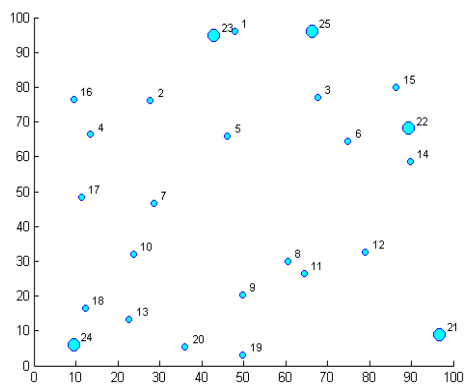
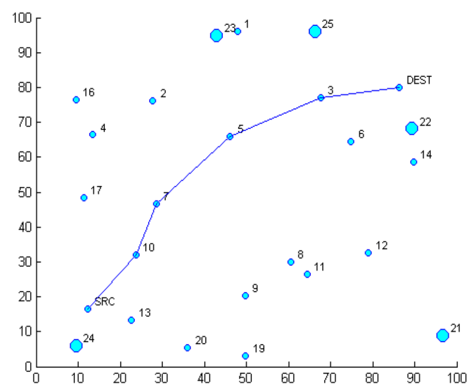


Figure 4: Flow Chart of ABC Algorithm.

The concept of checking the neighbouring node is to verify the nodes available most nearest to the individual nodes. To perform this transmission range is to be fixed initially in the network. That means the maximum range in which each

Results / Case	Initialized Network	Optimized Route	
Case1			

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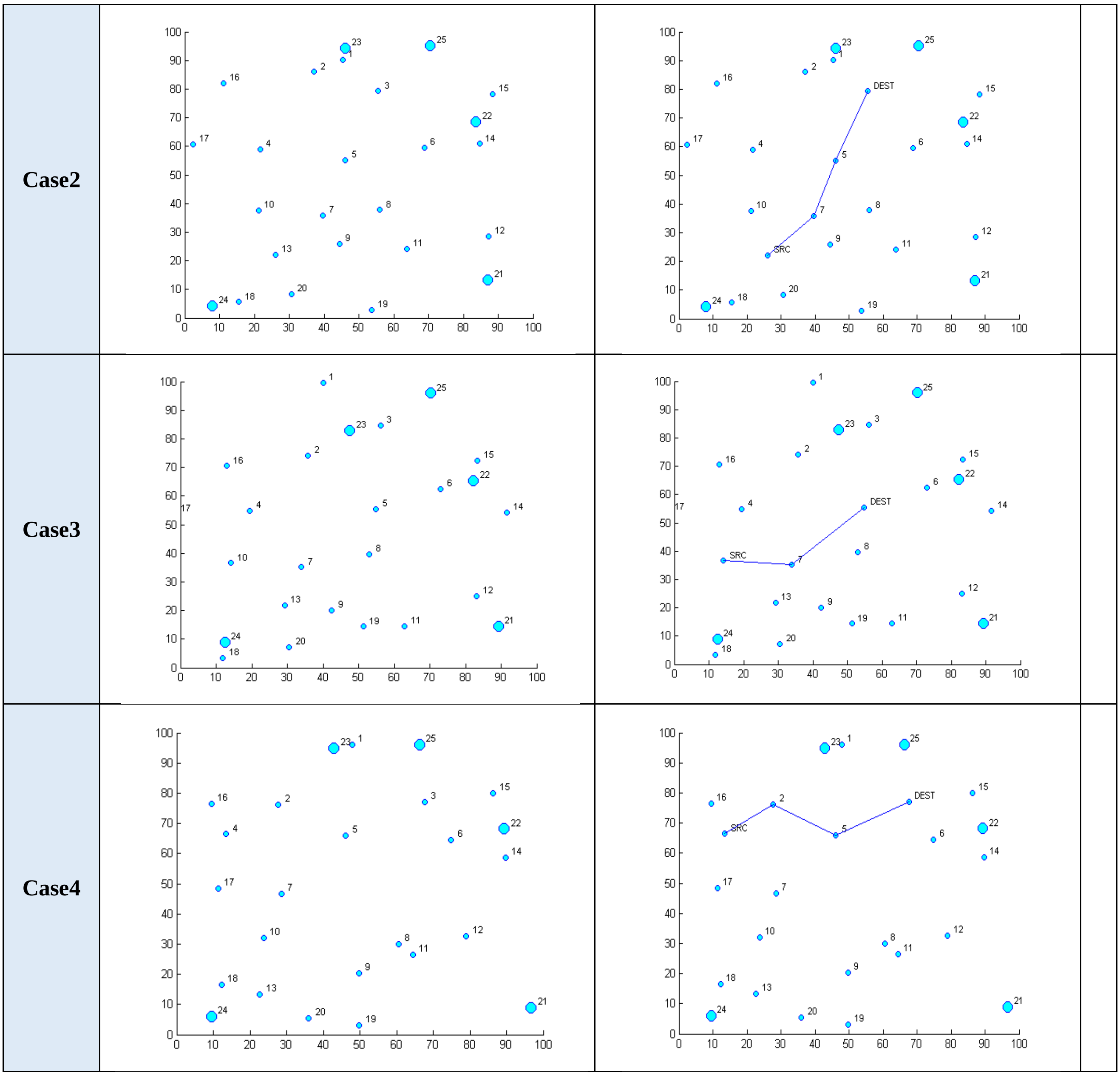

Figure 5: Results of Optimized Route Selection for Different Cases.

node can be able to communicate with its adjacent node without any loss of information. Then condition will check for the individual node to specify the given transmission range. Every single node will calculate its distance with respect to every other node in the network. If the condition satisfies for the less transmission range than the calculated present set of nodes then that particular node will selected as an adjacent node of that particular node. Selection of the path is the most important task here. To do so we are first initializing the parameters stored for the proper path selection. The calculation will begin from the generating the difference matrix that will be consisting of the distance values of the individual nodes in the network. With the distance matrix sight matrix will be created. Manually the start and end phases have to be decided previously. Probability will be calculated for the selected matrices. The probability will provide the cost of the network. The cost which is lower one will be selected as the path to the router.

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V. RESULTS

Results for the different cases of network creation and then finding the best route out of several options is presented in this paper by making different cases. The generated results will be as given below:

a) Network Initialization:

The simulation based network is created with the number of nodes available in the network. The Nodes are created at different locations making non-overlapping nodes in the network. These network nodes will try to communicate among each other, to do so the process has to be begun to calculate the area of the network. With these calculations for the neighbour nodes is also done. The results of both are and distance will be stored in the fixed variable to make use of this information while deciding the best path among all the nodes. To do so the algorithms are used for the optimized results. The process will give an opportunity to user to give the source and destination nodes numbers.

b) Selection of Source and destination Node:

The user is given an interaction with the proposed module and he may select any one node as the source node and any one node as the destination node among the complete network. This is done by generating one output variable for the user to provide the number as shown in the results section.

c) Channel Availability:

The channel availability will verify the available all the routes from the source to the destination node by making use of different interacting nodes in the network.

d) Channel optimization:

Based on the ABC algorithm from the available set of routes the optimized route will be picked up by the ABC technique for the path generation between the source and destination node. Figure5 depicts the results section for different Cases one. The similar concept is checked for different set of source and destination cases. All the case results are represented in the upcoming figure snaps in this chapter.The results at different cases are shown in the Figure 5.

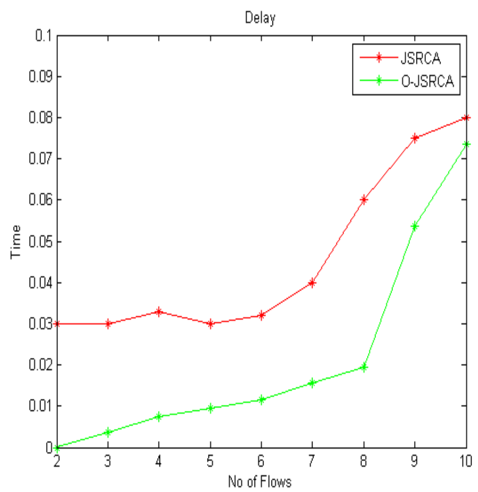

Figure 6: Delay Comparison of ABC.

At different cases different users are willing to find the optimized path for the communication purpose from source to the destination. The available routes of all possibilities will be considered first. From these available routes the optimized route will be picked up for the efficient channel assignment, this work is performed by the method Ant Bee Colony (ABC). By analysing the results given, it is concluded that the proposed work generates the optimal routes selection from the available list of routes based on the less hop counts.

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The comparison of the proposed work is done by comparing two parameters i.e. the packet drop ration which is calculated by taking the division of total number of packets to the packets dropped in the network. Second one is ABC routing performance comparison with JSRCA. The results of these parameters are given below Figure 6 and 7.

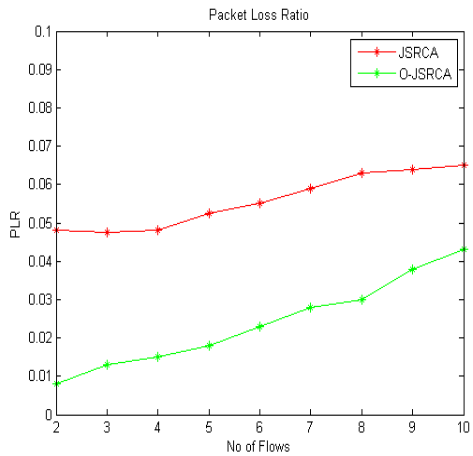

Figure 7: Packet Loss Ratio Comparisons

VI. CONCLUSION

We presented the J-SRCA protocol that jointly selects stable route and assigns interference-avoiding channels for MACNets. Firstly, we developed a transmission cost metric IDTC that captures the link stability, channel interference with PNs and CNs, node workload and path length. Among the selected links the optimized link prediction is done in the work that adds the extra efficiency. Then Optimization is performed by making use of Artificial Bee Colony(ABC) technique in the work that enhanced the performance.

REFERENCES

[1] YasirSaleem, FarrukhSalim and Mubashir Husain Rehmani, "Routing and channel selection from cognitive radio network's perspective: A survey", ELSEVIER, Computers and Electrical Engineering, Volume 42, pp: 117–134, 2015.

[2] Hangsheng ZHAO1, Jianzhao ZHANG1, Weihua ZHUANG2, "A Joint Link and Channel Assignment Routing Scheme for Cognitive Radio Networks", RADIOENGINEERING, VOL. 22, NO. 4, pp: 1128 – 1137, 2013.

[3] Osamah S. Badarneh and HaythemBanySalameh, "Probabilistic quality-aware routing in cognitive radio networks under dynamically varying spectrum opportunities", ELSEVIER, Computers and Electrical Engineering, 2012.

[4] ShraddhaSajal, RajeshwariSivakumar and Y. BevishJinila, "An Improved Method For Distributed Stable Routing And Channel Assignment In Mobile Ad-Hoc Cognitive Networks", International Journal of Pharmacy & Technology (IJPT), Volume 8, Issue 2, pp: 11894-11903, 2016.

[5] Aparna S Menon and S. Nikilla, "Selection of Energy Efficient and Stable Routes over Multihop and Multiflow Mobile Ad Hoc Cognitive Network ", International Journal Of Advanced Research Trends in Engineering and Technology (IJARTET), Volume 2, Issue 8, pp: 59-64, 2015.

[6] Tong Zhou, Feilong Tang, Jie Li, Yanqin Yang, WenchaoXu, Bin Yao and MinyiGuo, "Joint Routing and Channel Assignment for Delay Minimization in Multi-Channel Multi-Flow Mobile Cognitive Ad Hoc Networks", IEEE, 2015.

[7] Syed HashimRazaBukhari, Mubashir Husain Rehmani, and SajidSiraj, "A Survey of Channel Bonding for Wireless Networks and Guidelines of Channel Bonding for Futuristic Cognitive Radio Sensor Networks", 2016.

[8] Marco Di Felice, Kaushik Roy Chowdhury, Wooseong Kim, Andreas Kassler, and Luciano Bononi, "End-to-end protocols for Cognitive Radio Ad Hoc Networks: An evaluation study", Elsevier, Performance Evaluation, Volume 68, pp: 859–875, 2011.

[9] HichamKhalife, Satyajeet Ahuja, NaceurMalouch and Marwan Krunz, "Joint Routing and Spectrum Selection for Multihop Cognitive Radio Networks", Research gate, 2007.

[10] Wen-KuangKuo and Shu-Hsien Chu, "Energy Efficiency Optimization for Mobile Ad Hoc Networks", VOLUME 4, pp: 928-940, 2016.