

Implementation of Advanced Routing Technique for Cognitive Radio

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Abstract

One of the most developing technologies for future wireless communication is Cognitive Radios (CR) networks. The Cognitive Radios are fully programmable wireless devices for supporting dynamic spectrum access, the policy that addresses the channel access method, spectrum use and spectrum scarcity problem. In this a transceiver is designed to use the best wireless channels in its vicinity thereby intelligently detecting which communication channels are available and instantly move into vacant channels while avoiding the occupied ones. Thus the use of RF spectrum is optimized while minimizing interference to end users. To establish a route between source and destination nodes in CRAHN, a routing technique is needed. Various routing methods have been proposed based on performance metrics such as propagation delay, transmitted power, number of intermediate nodes between source and destination (hop count) and spectrum awareness. This paper implements a new routing technique incorporating all the above metrics. The routing strategy can be implemented in MATLAB which may improve metrics like distance, number of intermediate nodes between source and destination (hop count), transmitted power, propagation delay in comparison with shortest path and the MTPR routing technique.

Keywords: Cognitive Radio, CRAHN, FCC, MTPR

1. Introduction

The wireless networks working on Industrial and Medical frequency band increases due to the ever increasing user need caused by the explosion of wireless mobile applications. Because of this, the unlicensed bands are congested this has led to the problem of spectrum scarcity in these frequency bands. In a similar way a high portion of the licensed frequency bands that are reserved for public for various services are under-utilized. To solve this problem of spectrum scarcity, the FCC proposed a new communication paradigm, called as Dynamic Spectrum Access (DSA), which permits the unlicensed users to share the temporarily unused frequency bands of the licensed radio spectrum, called as Spectrum Holes or White Spaces. If the frequency band occupied by a licensed user, called as Primary User (PU), the unlicensed user, called as Cognitive User (CU), must vacate the presently using band and shift to another frequency band, for avoiding the interference to PUs.

2. Routing in Cognitive Radio Adhoc Networks

The routing problem is the major issue in Cognitive Radio, because of the improper availability of frequency bands. This paper gives the overview of the various routing protocols for CRAHN and finally focuses on the implementation of advanced routing method.

The routing Architecture comprises of several building blocks, they are routing process, QOS measurement, learning, decision taking and route formation block. Routing selection is carried with the data transfer of these blocks whose details are provided in the following:

- Routing Information Section: This will provide information about transmission channel quality, data transmission rate, signal modulation and various parameters that are common to each link. The selection of frequency channels may be carried out to reduce the number of channel

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switches along the route by using full path routing data.

- **Learning Section:** By learning the channel history, this section tunes the operation of the routing layer over time and passes the data to the decision section to make better channel and routing path switching decisions.
- **Decision Section:** It gives the sensing data, the results of QOS measurement section and learning section, decision section sort out to change an existed path or switch a channel or continuing the same one.
- **Route Establishment Section:** This section forms a route path from transmitter to receiver with the use of earlier block data for obtaining the best (by using the selected routing metric) routing performance.
- **QOS Evaluation Section:** This section receives the service related data from the application layer structure and identifies how the performance of the current routing technique is to these requirements.

3. Existing Routing Techniques

3.1 Shortest Path Algorithm

This algorithm is used for finding the lowest distance paths between various nodes in a network. The algorithm found the lowest distance path between selected nodes, one node as the “source” node and calculates the distances from the source to all other destination nodes in the network, producing a smallest distance path.

For a selected source node in the network, the minimum distance algorithm finds the smallest path between the selected node and remaining all other. This method is also used for calculating the smallest path from a single source node to a single destination node.

3.2 Shortest Path Routing Algorithm Step 1: Start the creation of network.

Step 2: Create the nodes randomly. ($n = 8$ or 10 or 12)

Step 3: Connect the nodes in the network from every node to all other nodes.

Step 4: Select the initial (source) node and the final (destination) node.

Step 5: With the initial node as reference node calculate all the available possible distances to final node.

Step 6: Measure the path length of the entire available possible routes.

Step 7: Arrange the path lengths in ascending order and the select small distance is the required path.

Step 8: Calculate the various parameters of Hop count, Delay, Power, Distance for the selected path.

Step 9: Repeat the same procedure from step 2 for $n = 12, 20$.

Step 10: Draw the response of the algorithm for the above parameters.

Step 11: Stop.

3.3 Minimum Total Power Routing (MTPR)

By considering the limitations such as radio power, power dissipation and utilization of the channel, a wireless node is not be able to communicate with the other wireless nodes in a wireless network. Many of the ad hoc networks using today are working on DC battery; therefore the power dissipation problem is the major issue. To increase the life period of ad hoc networks, the power dissipation rate for each wireless node must be distributed equally and the total power of transmission for each incoming request must be reduced.

MTPR technique is used to reduce the overall transmission power dissipation for the multiple hop communication. The transmission power rate is directly proportional to the length between two adjacent nodes. The MTPR technique identify a path with less transmission power rate but with large number of hops, because of this, the minimum distance length algorithm was to be used in MTPR technique. But MTPR technique suffers from the drawback i.e. large end-to-end delay time from the large number of hops.

3.4 MTPR Routing Algorithm

Step 1: Start the creation of network.

Step 2: Create the nodes randomly. ($n = 8$ or 10 or 12) **Step 3:** Connect the nodes in the network from every node to all other nodes.

Step 4: Select the initial (source) node and the final (destination) node.

Step 5: With the initial node as reference node calculate all the available possible distances to final node.

Step 6: Measure the path length of the entire available possible routes.

Step 7: Calculate transmission power for the entire possible routes.

Step 8: Keep all the transmitted powers in ascending order and the least power consumption is the required route.

Step 9: Calculate the parameters of Hop count, Delay, Power, Distance for the selected route.

Step 10: Repeat the procedure from step2 for n=12, 20.

Step 11: Plot the graphs for the above parameters.

Step 11: Stop.

4. Proposed ROUTING SCHEME

4.1 Performance Metrics

In this paper e are going to consider the following performance metrics:

- Hop Count: Hop count is nothing but the number of hops between initial node and final node.
- Transmission Power Loss (TPL): TPL is defined as the transmission power rate dissipation between Defined as the total transmission power loss between initial node and final node.
- End-to-End Delay: It is the time consumption for a data packet to transfer with the CBR (Constant Bit Rate) between initial node and final node. In our paper we are taken random delay at each node.
- Packet Delivery Ratio (PDR): It is the ratio of number of data packets received to the number of data packets received sent by various sources.

4.2 Algorithm

Step 1: Start the creation of network.

Step 2: Create the nodes randomly. (n = 8 or 10 or 12) **Step 3:** Connect the nodes in the network from every node to all other nodes.

Step 4: Select the initial (source) node and the final (destination) node.

Step 5: With the initial node as reference node calculate all the available possible distances to final node.

Step 6: Measure the path length of the entire available possible routes using below formula:

$$D = \sqrt{(x_1 - x_2)^2 + (y_1 - y_2)^2}$$

Step 7: Calculate transmission power for the entire possible routes.

$$P = \alpha d^4 + \beta$$

Step 8: Sorting all the values of distance and power in ascending order.

Step 9: Calculate all the parameters for the least distance route and the least power route.

Step 10: Taking shortest path distance as Dmin and MTPR distance as Dmax, then by taking the average (Davg) of this two distances and the path with the Davg distance as the selected path for the proposed routing scheme.

Step 11: Calculate the parameters of Hop count, Delay, Power, Distance for the selected route.

Step 12: Repeat the above from step 2 for n = 12, 20.

Step13: Plot the graphs for the above parameters.

Step14: Stop.

Table 6.1. Comparison among Proposed Routing Technique and other Techniques

Parameters	MTPR	Shortest Path Routing	Proposed Routing
Hop Count	High	Low	Medium
End to End Delay	High	Medium	Low
PDR	Low	Medium	High
TPL	Low	High	Medium

5. Program Results

5.1 Representation of Different Routing Paths

Figure 5.1(a) and (b) shows the snapshots of the simulation process. The blue color lines show the path between each and every node in the network. The red line shows the path from source to destination of our proposed routing strategy while the path with magenta lining represents the MTPR path and the path shown by green lining is of shortest path routing.

Figure 5.1 (c) and (d) shows the snapshots of the simulation process. The blue color lines show the path between each and every node in the network. The red line shows the path from source to destination of our proposed routing strategy while the path with magenta lining represents

the MTPR path and the path shown by green lining is of shortest path routing.

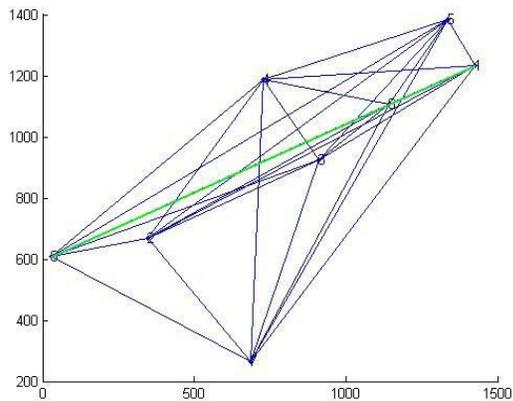


Figure 5.1 (a). Representation of Shortest Path routing in the network having eight nodes.

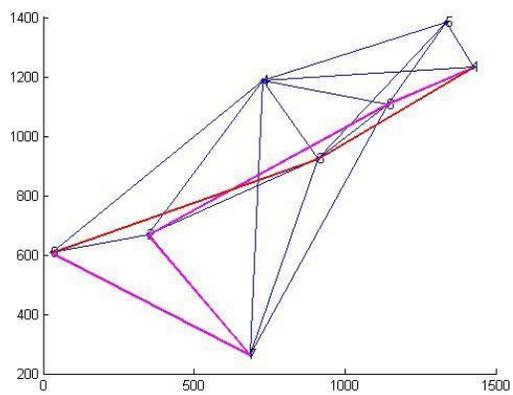


Figure 5.1 (b). Representation of MTPR and proposed routing paths in the network.

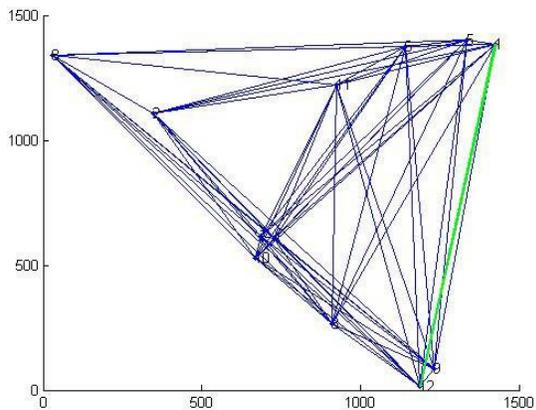


Figure 5.1 (c). Representation of shortest path routing in the network having twelve nodes.

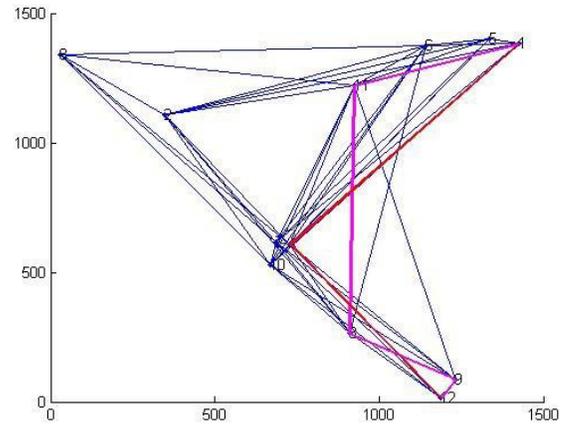


Figure 5.1 (d). Representation of MTPR and proposed routing paths in the network.

Figure 5.1(e) and (f) shows the snapshots of the simulation process. The blue color lines show the path between each and every node in the network. The red line shows the path from source to destination of our proposed routing strategy while the path with magenta lining represents the MTPR path and the path shown by green lining is of shortest path routing.

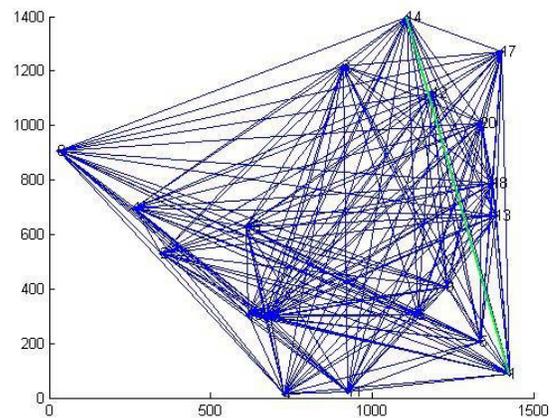


Figure 5.1 (e). Representation of shortest path routing in the network having twenty nodes.

From the above graphs we calculate various parameters for shortest path routing algorithm, minimum total power routing algorithm, proposed routing algorithm. The parameters (hop count, delay, power and distance) for various routing algorithms are calculated for 8 nodes, 2 nodes, 20 nodes. All the algorithms are implemented in MATLAB.

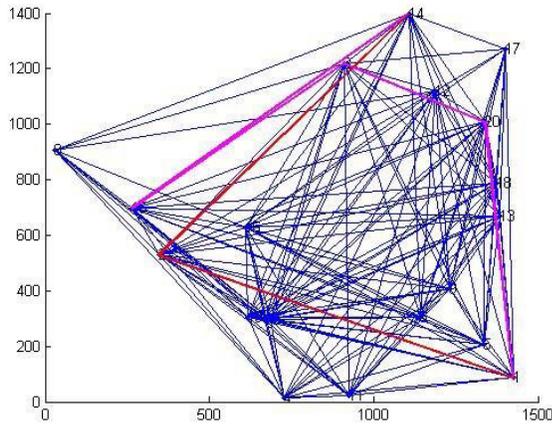


Figure 5.1(f). Representation of MTPR and proposed routing paths in the network.

Outputs:

Source node: 1; Destination node: 8; no. of nodes (n): 8

Table 5.2 (a). Metric calculation for 8 nodes network

NO. OF POSSIBLE PATHS	POWER (units ⁴)	DELAY (ms)
1-6-2-7-8	0.1747	3.414
1-5-7-8	3.26	
1-5-4-8	0.8515	
1-3-8	0.905	0.6
1-6-2-8	0.7059	
1-8	5.483	3.01
1-4-8	0.9214	

Table 5.2 (b). Metric Calculation for 8 nodes network

NO. OF POSSIBLE PATHS	HOP COUNT	DISTANCE (units)
1-6-2-7-8	4	2.48
1-6-3-2-8	4	1.548
1-5-7-8	3	2.2108
1-5-4-8	3	1.7226
1-6-2-8	3	1.5427
1-4-8	2	1.6072
1-3-8	2	1.52
1-8	1	1.53

This Table 5.2 (a) and (b) shows the values distance, hop count, power and delay for all the possible paths that are created for the network with eight nodes.

Metric Calculation for twelve nodes network:
n = 12; Source node: 1; Destination node: 12

Table 5.2 (c). Metric calculation for 12 nodes network

ROUTING SCHEME	HOP COUNT	DISTANCE (units)
SHORTEST PATH	1	1.3884
PROPOSED ROUTING	2	1.7917
MTPR ROUTING	4	2.5829

Table 5.2 (d). Metric calculation for 12 nodes network

ROUTING SCHEME	POWER (units ⁴)	DELAY (ms)
SHORTEST PATH	3.7154	1.93
PROPOSED ROUTING	1.4924	0.935
MTPR ROUTING	1.2162	3.23

This Table 5.2(c) and (d) shows the values distance, hop count, power and delay for all the possible paths that are created for the network with twelve nodes.

Metric Calculation for twenty nodes network:

For n: 20; Source node: 1; Destination node: 14

Table 5.2(e). Metric calculation for 20 nodes network

ROUTING SCHEME	HOP COUNT	DISTANCE (units)
SHORTEST PATH (1-14)	1	1.3489
PROPOSED ROUTING (1-9-14)	2	1.3723
MTPR ROUTING (1-20-12-17-3-14)	5	3.3955

Table 5.2(f). Metric calculation for 20 nodes network

This

ROUTING SCHEME	POWER (units ⁴)	DELAY (ms)
SHORTEST PATH (1-14)	3.3105	3.2
PROPOSED ROUTING (1-9-14)	1.009	0.44
MTPR ROUTING (1-20-12-17-3-14)	0.7486	4.751

Table 5.2 (e) and (f) shows the values distance, hop count, power and delay for all the possible paths that are created for the network with twenty nodes.

8. Conclusion

Various routing strategies have been surveyed based on performance metrics such as delay, power, hop count and spectrum awareness. We are going to implement advanced routing strategy in MATLAB software which may improve the packet delivery ratio as well as the delay parameter for the proposed scheme in comparison to shortest path routing scheme and MTPR techniques that doesn't consider the above mentioned metrics.

Algorithm to implement an intermediate path in between Minimum Total Power Routing (MTPR) and shortest path routing protocol is developed. The end to end delay of the proposed protocol will be made quite low. The PDR value and total transmission power will be optimized using the proposed routing scheme. The reliability of the path formed using this protocol will be more than MTPR but less than shortest path routing scheme.

9. References

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