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Comparison of Routing Protocol AODV and WCETT in Cognitive Radio Network

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Abstract

Cognitive radio is a technology aims to improve the spectrum resource utilization and allows a cognitive radio transceiver to detect and sense spectrum holes without causing interference to the primary users (PUs). Routing in CRN is a challenging task due to the diversity in the available channels. In this paper, Cognitive radio adhoc network (CRAHN) simulation environment is used with AODV and WCETT routing protocols used to address the problem of efficient route selection between the source and destination. The performance of AODV with WCETT protocol is evaluated in CRAHN on the basis of average throughput, average end to end delay, routing overhead and packet delivery ratio. The simulation result shows that performance of WCETT is better than the AODV because of its better route selection strategy in CRAHN.

Keywords- Cognitive radio, AODV and WCETT.

1. Introduction

With increase demand of wireless operated electronic gadgets, there is tremendous research taken place in the fields like wireless communication, signal processing, VLSI. So, lots of wireless communication technologies have been deployed in personal area network to wide area network to fulfill users need. This has increased the use of radio spectrum. Thus radio spectrum is one of the most heavily used resources. The recent radio spectrum measurements show that the fixed spectrum allocation policy is not suitable for current wireless system[1]. Moreover, most of the licensed bands assigned for licensed users are under-utilized, many portions of the radio spectrum are not utilized for a significant period of time or in particular areas, while unlicensed bands used to operate by various well-known wireless technologies, such as Wi-Fi ,cordless phones, Bluetooth, NFC (Near Field Communication), and so on, are always crowded, approved by Federal Communications Commission (FCC)'s experiment results [2].

Cognitive radio (CR) [3][4][5] is a important technology for future wireless communications and to solve the problems of limited availability of spectrum and spectrum underutilization as well as to address the increasing congestion in the unlicensed bands by enabling unlicensed users to opportunistically access the vacant portions of the spectrum bands, referred to as Spectrum Opportunities (SOP) [5], which is always statistically underutilized by licensed users (also known as primary users: PUs). In accordance with the network architecture, cognitive radio networks (CRNs) can be deployed as both an infrastructure network and an ad hoc network. The infrastructure-based CRN has a central network entity (base station) to coordinate communication. In Cognitive radio adhoc network, a CR user can communicate to other CR user through adhoc connection on licensed and unlicensed spectrum bands.

In fact, cognitive radio network (CRN) is an emerging research technology and there are still so many issues that remained to be solved. Most of the research on CRNs has focused on lower layer (PHY and MAC) issues, the study of CRNs routing protocol, on network layer, has been largely not evaluated.

Remaining part of the paper is organized as follows. In section I, the description of routing protocols AODV and WCETT is given. Simulation result is presented in section II. Finally, conclusion is discussed in section III.

2. Description of Routing Protocol.

In On-Demand routing protocols, routes are created only when it is required to establish it between a source and destination node pair in a network topology. In this section description of two on demand ad-hoc routing protocols, AODV and WCETT are discussed.

2.1. Cognitive Ad-Hoc on-Demand Distance Vector

In [5], the Cognitive Ad-hoc on-demand Distance Vector (CAODV) routing protocol is introduced. The protocol was designed in accordance with three principles: 1) During the process of route establishment and packet discovery the area of PU's activity is avoided; 2) applying a joint path and channel selection to reduce the route cost; 3) multi-channel communication is provided to improve the overall performance. The protocol supports a dynamic CRN with mobile secondary user (SU) and stationary primary user (PU). The SUs communicate with each other through the primary spectrum bands without requiring the dedicated channel. During data transmission of secondary user, if activity of primary user is detected, the channel which overlaps the primary user's transmission frequency, as well as the adjacent channels, cannot be used by the secondary users that are located in the PU transmission range due to impact of interference.

For establishing a route, a source node starts sending a route request packet within the network through each channel, which does not interfere with the activity of primary user. .

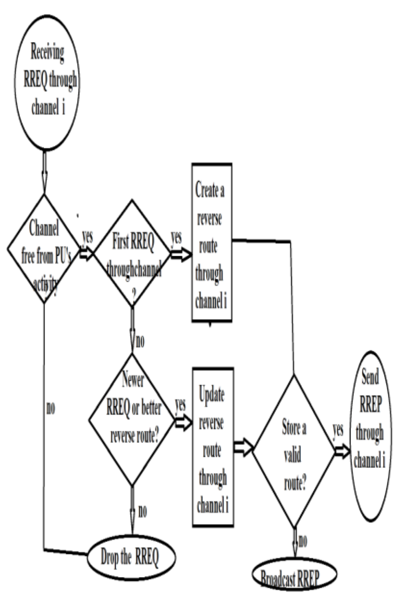

Figure1. Flow diagram of RREQ

In Figure 1 when an intermediate CU receives the route request packet through a channel which is free from activity of primary user than it establish a reverse path toward the sender cognitive user through the same channel. If the receiving cognitive user have valid route for the desired destination, then it sends a route reply packet to the sender through the same channel. Otherwise, it again sends route request packet through the channel. If an additional route request is received through the same channel than cognitive user checks whether the route request is newer or not, if route request is not new than it refers to a better reverse route among one stored in routing table or if it is new, it sends a route reply packet or route request packet. In both cases the node updates the route discovery processes of each channel are independent to each other & it can happen that routes on different channels can be create by different intermediate nodes he reverse path.

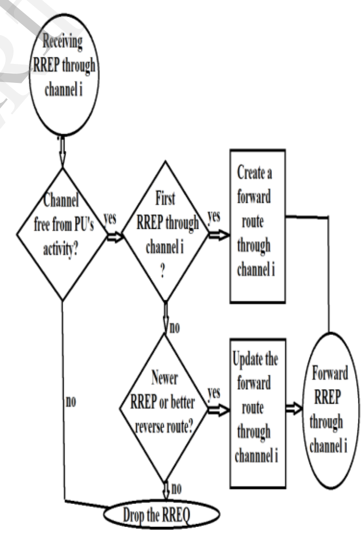

Figure2. Flow diagram of RREP

In Figure 2 When an intermediate cognitive user (CU) receives the route reply (RREP) through a channel which is free from PU's activity, it sets up a forward route through the same channel to the route reply (RREP) sender and it forwards the route reply (RREP) along the reverse path through same channel. If an additional RREP will be received through channel, the cognitive user (CU) will update the forward path only if the route reply (RREP) is newer or it refers to a better forward route.

2.2.Weighted Cumulative Expected Transmission Time.

WCETT protocol that is similar to Ad hoc On Demand Distance Vector (AODV) protocol. The protocol uses [6]. On-demand weighted cumulative expected transmission time (WCETT) metric based routing the weighted cumulative expected (WCETT) metric [7] to select the best path between source cognitive user node and Destination cognitive user node. When a route is needed between two nodes than routing process is start and the source node sends a route request (RREQ) packet across the network. The route request RREQ packet transmitted by a node on channel contains the calculated value of weighted cumulative transmission time WCETT. When a route request (RREQ) packet receives at a node, it starts resending the RREQ in two cases:

In case the sequence number of route request (RREQ) packet is new, the weighted cumulative expected transmission time (WCETT) value of the path is stored in a routing table.

In second case the sequence number of route request(RREQ) is not new, that means an route request RREQ of the same sequence number has been processed, but its WCETT value is smaller than the previous RREQ of the same sequence number. This condition will help in finding the lowest cost route.

$$WCETT = (1-\beta) \sum_{i=1}^{n} ETTi + \beta * \max_{i \le j \le k} Xj$$

In above equation Xj is the sum of ETT(expected transmission time) values of links that are on channel j and β is a control parameter whose values lie between $0 \le \beta \le 1$, which allows controlling preference over path lengths versus channel diversity. k specifies the total number of different channels used in a path. The first term in equation is summation of the individual link ETTs, and therefore it provide shorter and high quality paths. The second term in the equation is summation of ETT of all links of a given channel and takes maximum over all Channels. So, this gives higher value for a path with larger number of links operating on same channel i.e. it approval the channel diversity and low intra flow interference.

In Figure 3 When an intermediate node receives a route request(RREQ) packet, and have valid route to the destination specified in the route request(RREQ), it send a route reply (RERR) packet to the source if the received RREQ's destination sequence number is less than or equal to destination sequence number in the route entry.

When a node receives the RREQ is the destination node, it sends back a route reply (RREP) if the received RREQ's cost is smaller than the previous received RREQ with the same sequence number. The source will finally use the path having the lowest cost for data transmission and stores locally the other best paths. The flow diagram of route discovery process of weighted cumulative expected transmission time protocol.

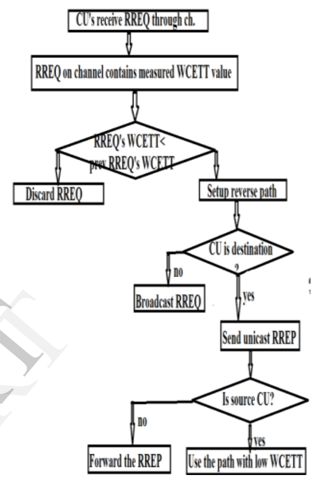

Figure 3. Flow diagram of WCETT

3. Simulation Parameters

In this section the performance of routing protocol AODV and WCETT are evaluated by the multiple random topology named as random.tcl where secondary user's placed in 500x500 m^2 and use IEEE. 802.11 with FTP as traffic source. Each simulation is run for 50 seconds with increasing the number of nodes. The simulation is done using CRCN patch [9] into network simulator ns-2.31[8]. Simulation parameters are summarized in the following table 1:

Table 1. Simulation parameters

Parameter	Values
Topology	500 X 500 m^2
Traffic type	FTP
Packet size	512 bytes
Simulation duration	50 seconds
Node speed	20m/s
MAC layer	IEEE 802.11
Transport layer	TCP

The graphical representation of results are shown in Figure 4, 5, 6 & 7

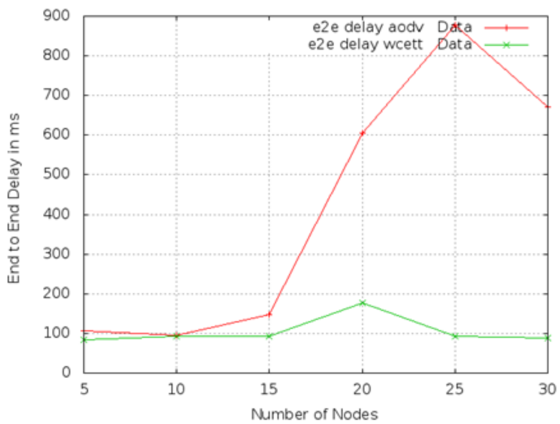

Figure 4. No. of nodes Vs. end to end delay

In Figure 4, average end-end delay are evaluated for WCETT protocol. It can be observe from the Fig. 4 that average end-to-end delay of WCETT protocol is very low as compare to that of AODV, as the number of nodes increases the delay in data transmission also increases.

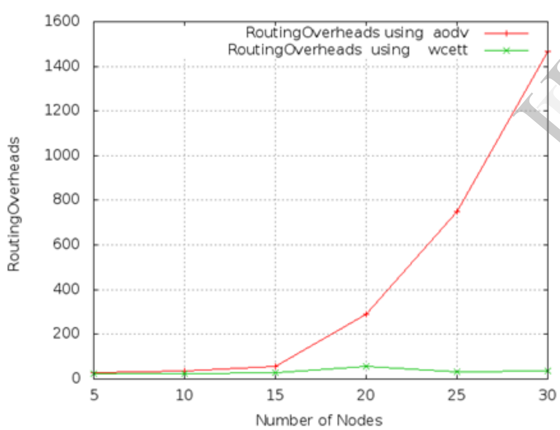

Figure 5. No. of nodes Vs. routing overhead

In Figure 5, routing overhead is evaluated for WCETT protocol, it is ratio of total number of routi ng packets generated to total number of data packets routed successfully It can be analyzed from Figure 5 that routing overhead of WCETT protocol is very low as compare to that of AODV ,this is due to the better route selection strategy of the WCETT as wells as the better channel selection with the help of cognitive radio of CRCN, which reduces the number of control packets required by avoiding the bottleneck channels which may cause the link failure in CRAHN.

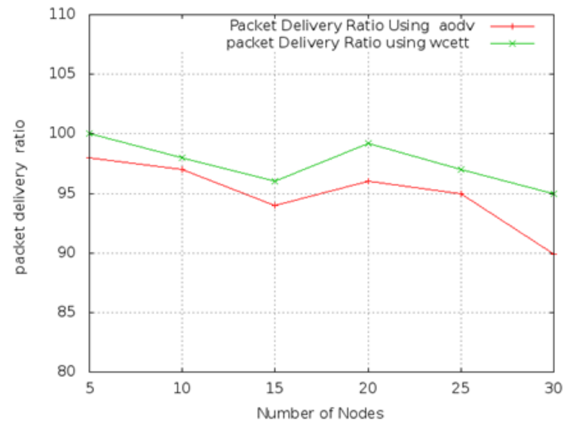

Figure 6. No. of nodes Vs. PDR

Figure 6, it can be observe that packet deliveryratio of the WCETT based routing remains higher than that of the AODV routing throughout the simulation.

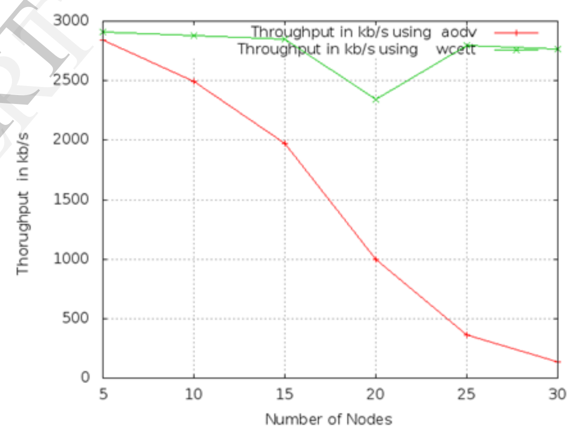

Figure 7. No. of nodes Vs. throughput

In Figure 7, shows that end-to-end throughput of the WCETT based routing while raising the number of nodes, and it is observed that WCETT protocol outperforms the AODV. Because it use WCETT as metric which increases the performance of the routing protocol by reducing the number of nodes which uses same channel and in other words it reduces intraflow interference and allocates better available channels, while AODV simply use the number of hops as metrics.

4. Conclusion

In this paper , WCETT routing protocol on a multi-channel CRAHN is evaluated using the CRCN simulator and compare its performance to AODV, so from above figure average end-to-end delay of WCETT protocol is very low as compare to that of AODV, as the number of nodes increases the delay in data transmission also increases, routing overhead of WCETT protocol is very low as compare to that of AODV, this is due to the better route selection strategy of the WCETT ,So the performance of WCETT routing protocol is very well in selecting the best path between source and destination.

5. References

[1] M. McHenry, "Spectrum white space measurements," in Presentation to New American Foundation, Broadband Forum,June2003.http://www.newamerica.net/files/nafmigration/archive/Doc_File_185_1.pd

[2]Communications Commission (FCC). (2008,November) FCC Adopts Rules for Unlicensed Use of Television White Spaces, ET Docket No. 08-260 A1.pdf.

[3] I. F. Akyildiz, W. Y. Lee, M. C. Vuran and M.Shantidev," Nextgeneration / dynamic spectrum access/cognitive radio wireless networks: a survey," Computer Networks, vol. 50, no. 1, pp. 2127–2159, May, 2006

[4] S. Haykin, "Cognitive radio: brain-empowered wireless communications", IEEE Journal on Selected Areas of communication.

[5] IEEE Xplore-CAODV "routing in mobile ad-hoc cognitive radio" ieeexplore.ieee.org,wireless days 2010 IFIP.

[6] R. Draves, J. Padhye, and B. Zill, "Routing in multiradio, multi-hop wireless mesh networks," in Int. Conf. on Mobile Computing and Networking (ACM Mobicom'04), 2004, pp. 114–128.

[7]Puneeth Kumar& T PSuresh Patel, Assistant Professor Department of Computer Science and Engineering *Acharya Institute of Technology, Bangalore*"An On-demand Routing Technique for Cognitive Radio Ad Hoc Network" International Journal of Engineering Research & Technology (IJERT)Vol. 2 Issue 5, May – 2013ISSN: 2278-0181

[8]"The Network Simulator NS-2," http://www.isi.edu /nsnam/ns/, 1996

[9]"Cognitive radio cognitive network simulator," http://stuweb.ee.mtu.edu/~ljialian/, 2009.

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