Improving Channel Selection for Routing Protocols in Cognitive Radio

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Abstract—The radio spectrum is one of the heavily used and costly natural resources in wireless communication. Cognitive radio is an emerging technology to tackle the problem of radio spectrum shortage and spectrum underutilization. In Cognitive radio, channel selection is the method by which one can select a desired channel and it is one of the important issues to be taken into account. In this project, improvement of channel selection will be done for routing protocol such as AODV (Ad-hoc On Demand Distance Vector) and DSR (Distance Source Routing) using the technique which is based on no. of packets and based on access time by the primary user. The evaluation of the performance of these routing protocols will be done using simulations in NS-2.

Keywords- *Cognitive radio , AODV (Ad-hoc on demand distance vector), DSR (Distance source routing), Channel Selection*

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I. INTRODUCTION

. Cognitive Radio is a new method of implementing radio communications which allows for more efficient use of the frequency spectrum. This is essential since currently there is a large part of the spectrum which is underutilize[1].Existing spectrum resources are lack due to nonflexible spectrum sharing regulations and underutilization of licensed band for primary users (PUs). Cognitive radio (CR) technology is planned to tackle this problem. CR technology enables secondary users (SUs) access temporally unused licensed spectrum in opportunistic manner. Benefit from high spectrum efficiency, CR technology has been widely utilized in various wireless networks. The overall purpose of opportunistic spectrum access (OSA) is provide spectral access to secondary users without disturbing the consistency or performance of the primary users service. Cognitive networks (CN) are wireless networks which consist of two types of users primary and secondary (or cognitive) users.

• *Primary users*: These wireless users are the primary license-holders of the spectrum band of concern. In general, they have priority access to the licensed spectrum, as well as matter to certain Quality of Service (QoS) constraints which should be guaranteed.

•*Cognitive users (SUs*): These users could access the spectrum which is licensed toward the primary users and can opportunistically communicate in licensed spectrum by varying their communication parameters in an adaptive approach when spectrum holes are available. There are various standard unlicensed bands. Some of the types of unlicensed radio bands are as and other devices that operate in the 900 MHZ, 2.5 GHz, and 5.9 GHz bands. Unlicensed National Information Infrastructure (U-NII): This type defines the terms for the use of wireless devices such as WLAN access points and routers in the 4 GHz band. Unlicensed Personal Communications Services (UPCS): This kind defines the terms for devices operating in the 1.8 GHz band, wherever DECT6 cordless phones operate. Unlicensed National Information Infrastructure (U-NII): This type defines the terms for the use of wireless devices such as WLAN access points and routers in the 5 GHz band. Unlicensed Personal Communications Services (UPCS): This type defines the terms for devices operating in the 1.8 GHz band, wherever DECT6 cordless phones work.

II. CLASSIFICATION OF ROUTING PROTOCOLS

Classification of routing protocols in mobile ad hoc network is done in various ways; the routing protocols are divided as Proactive (Table Driven), Reactive (on-demand) and Hybrid based on the network structure.

A. PROACTIVE ROUTING PROTOCOLS

Proactive protocols performs routing operations among all source destination pairs from time to time, irrespective of the need of such routes. These protocols try to uphold shortest path routes by using occasionally updated views of the network topology. These are usually maintained in routing tables in every node and updated with the attainment of new information. Proactive protocols have the advantage of providing lesser latency in data delivery and the possibility of sustaining applications that have quality-of-service constraints. Their main disadvantage is due to the consumption of bandwidth in sending update packets periodically even when they are not required, such as when there are no link breakages or when only a few routes are needed Examples of Proactive MANET Protocols include: Optimized Link State Routing (OLSR), Destination-Sequenced Distance Vector (DSDV) etc.

B. REACTIVE ROUTING PROTOCOLS

Reactive routing protocol (or on demand) routing protocol, the routes are established only when they are desired[6].In this group of protocol there is an initialization of a route discovery mechanism by the source node to get the route to the destination node when the source node has data packets to send. When a route is determined , the route

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protection is initiated to maintain this route until it is no longer required or the destination is not accessible. The advantage of these protocols is that overhead messaging is getting less. One of the disadvantages of these protocols is the delay in finding a new route. The examples of reactive routing protocols are Dynamic Source Routing (DSR), Ad-hoc On-Demand Distance Vector routing protocols
We shall now discuss and summarize AODV and DSR Protocol.

i) Ad Hoc On-demand Distance Vector Routing (AODV) Protocol:

The Ad-hoc On-demand Distance Vector Routing (AODV) protocol is a reactive routing protocol. It is the mixture of DSDV and DSR protocol. It simply wants to keep the routing information about the active paths. A next hop routing table is maintained by very mobile node, which contains the destinations to which it presently has a route. If no route is available to the destination, it initiates a route discovery process.
The transmission route will be created on demand (only when it is required) by flooding the network with Route Request (RREQ) packets. In contrast to the original AODV, if a source node needs to transmit data to a destination node whose route is not known, it will broadcast a RREQ packet through all interfaces. After the RREQ packets are received by intermediate nodes which do not know the information of fresh route towards the destination, the nodes update their routing information and forward the RREQ packet over all interfaces except the one on which the packet is previously received in order to form a multi-hop path composed of links using non-overlapping radios. When the RREQ packet are arrived at the destination or any intermediate nodes that has a fresh route to the destination, a Route Reply (RREP) packet will be generated and forwarded back along the reverse path using same interfaces, as used by the RREQ, to the source node. Once the RREP packet reaches the source node, the transmission path is established and then the data transmission process is activated. [6]
The AODV supports both unicast and multicast packet transmissions even for nodes in constant movement..It has great advantage in having less overhead over proactive protocols, responds quickly to the topological changes in the network, updates only the nodes that may be affected by the change, using the RRER message. The Hello messages, which are responsible for the route maintenance, are also limited. Thus unnecessary routing overhead in the network is minimized.

ii) Dynamic Source Routing(DSR):

Dynamic Source Routing (DSR) is a routing protocol for wireless networks. It is related to AODV in which it forms a route on-demand when a transmitting node requests one. However, it uses source routing as an alternative of relying on the routing table at each intermediate device. The Dynamic Source Routing protocol (DSR) is a easy and well-organized routing protocol deliberate specifically for use in multi-hop wireless ad hoc networks of mobile nodes. DSR allows the network to be fully self-organizing and self-configuring, with no need for any existing network infrastructure or administration. The protocol is composition of the two mechanisms of Route Discovery and Route Maintenance, which work together to permit nodes to find and maintain source routes to arbitrary destinations in the ad hoc network. It avoids the need for up-to-date routing information in the intermediate nodes through which packets are forwarded, and allow nodes forwarding or overhearing packets to cache the routing information in them for their own future use. During the process of route maintenance, if the transmission path is broken and a node detects the failure, it instantly sends a RERR packet to the source of the route.

C. HYBRID ROUTING PROTOCOLS

A hybrid protocol means the combinations of reactive and proactive protocols and takes advantages of these two protocols .So routes are found quickly in the routing zone. Example Protocol: ZRP. In this case various approaches of routing protocols are combined to form a single protocol. ZRP protocol combines the proactive and reactive approach. Combinations of selected features of proactive and reactive protocols and Adaptive to network condition are main characteristics of ZRP. We shall now discuss and summarize AODV and DSDV Protocol[9].

III COGNITIVE RADIO FUNCTIONS

It consist of four spectrum management functions: spectrum sensing, spectrum decision, spectrum sharing, and spectrum mobility. The main features of spectrum management functions are as follows:
a) ***Spectrum Sensing***: In Spectrum sensing, CR user must examine the vacant spectrum bands, capture their information, must sense portion of frequency band that is not being used by the primary users called as spectrum white space or spectrum holes, and utilize the vacant spectrum. In sensing-based spectrum sharing cognitive radio users first listen to spectrum allocated to the licensed user to detect the state of the licensed user. Based on the detection result cognitive radio user decide their transmission strategy. On the other hand, when primary users start using the licensed spectrum again, CR can detect PU activity through sensing, to reduce any harmful interference generated due to secondary users‟ transmission.

b*)* ***Spectrum Decision***: After recognizing the spectrum white space by sensing, spectrum management and handoff function of CR enables secondary users to select the best frequency band according to their QoS requirements. Spectrum decision involves undertaking spectrum selection and the route creation jointly. When a primary user reclaims frequency band, the secondary user who is using the licensed band can direct their transmission to other available frequencies.

c**)** ***Spectrum Sharing***: Spectrum sharing cognitive radio networks permit cognitive radio users to share the spectrum bands of the licensed band users. The cognitive users have to control their transmit power so that the interference caused to licensed band users to kept less than a certain threshold. Primary users have the spectrum rights.

d) ***Spectrum Mobility***: It consists the process by which cognitive-radio user changes its frequency of operation. If the specific portion of the spectrum in use is required by a PU, then the Secondary user should switch communication to another vacant portion of the spectrum. To avoid link breakages and interruption in communication, appropriate spectrum handoff method using protocols at the transport layer that are closely coupled and routing protocols is required

IV PROPOSED TECHNIQUE

We are improving channel selection for routing protocols on the basis of channel selection technique.

A. Based on no. of packets :

In this approach, selection of a threshold of packets sent by the primary user, if the no. of packets go beyond the particular threshold then one secondary user packet will be sent on the channel. This will make sure that the secondary user does not starve of communication & the packet flow is continuous without disturbing the primary user.

SUs utilize unused spectrum bands adaptively by enabling spectrum sensing and recording the activity of the primary and secondary users. Energy detection, matched filter and cyclostationary feature detection are used to detect the activity of the PUs and SUs.

i)Matched Filter detection is an most favorable detection technique with little computational cost, but it requires prior knowledge of the PUs.

ii)Cyclostationary detection needs partial knowledge of the PUs but comes at high computational cost. In contrast, the energy detection technique requires a short sensing time and is of low complexity. Additionally, it does not require prior information of the PUs. When selecting a sensing method, some trade-offs should be considered with respect to hardware and SU requirements, such as whether the sensing time is long or short and whether prior knowledge of the PU is required.

iii)Energy Detection technique is useful during the initialization of the activity of the protocol because the implementation is simple and efficient when compared to other techniques. In addition, it does not need prior information of the PUs signal features, which is not usually known by the SUs.

B. Based on Access time by the primary user:

In this case, first scanning of channel will be done. If the primary user is not accessing the channel for some amount of time then that channel will be allocated to the secondary user.

thereby optimizing the utilization of channel for both the user.

It uses time division multiple access. TDMA systems divide each FDMA channel into time slots. Each user get a cyclically repeating time slot. TDMA can allow different number of time slots for separate user.

It consists the Preamble for Address and synchronization information for base station and subscriber identification and

Guard times for Synchronization of receivers between different slots and frames. Data Transmission for user of TDMA system occurs in discrete bursts. The result is low battery consumption. Handoff process is simpler. Since different slots are used for T and R, duplexers are not required. Equalization is required, since transmission rates are higher than FDMA channels.

V. SIMULATION TOOL(NETWORK SIMULATOR 2)

Simulation of wired and wireless network functions and protocols (e.g., routing algorithms, TCP, UDP) can be done using NS2. It consists of two simulation tools. The network simulator contains all commonly used IP protocols and the network animator i.e. nam can be use to visualize the simulations. NS2 having two key languages: C++ as well as Object-oriented Tool Command Language (OTcl) while the C++ defines the internal mechanism and the OTcl sets up simulation[9].

VI. SIMULATION RESULTS AND ANALYSIS

In this paper, we have taken two on-demand(reactive) routing protocols, namely ad hoc on-demand distance vector routing (AODV), dynamic source routing (DSR). The simulation are performed in multi-hop network topology where 50 nodes are placed randomly deployed in an area 300*300 m. The source-destination node pairs are randomly selected to create random UDP connections. Each UDP connection transmit CBR traffic with 1000 byte packets at packet interval of 0.01sec. The type of the wireless propagation is Two-ray ground model. The IEEE 802.11 standard is used as MAC protocol. Table 1 depicts the simulation parametres shown below.

TABLE 1:

Sr. no.	Parameters	Values
1	Simulation area	300-300m
2	Propagation model	Two way Ground
3	Traffic type	CBR
4	Transport layer	UDP
5	No of Nodes	50
6	Data packet size	1000 bytes
7	Packet interval	0.01 sec
8	Interface queue type	Drop tail Pre Queue

Performance metrics are as follows:-

End-to-end Delay- This metric represents average end-to-end delay and indicates that how long it took for a packet to travel from the source to the application layer of the destination. Figure 1. shows the graph of End-to-End delay

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against the increased simulation period . As illustrated , the AODV performs better than the DSR.

Throughput: Throughput is define as the total packets successfully delivered to individual destination over total time divided by total time. Figure 3 displays a comparison of AODV and DSR routing protocols. We observe that the increased simulation period, the throughput improvement is more rising. DSR has a lower throughput as compared to AODV due to higher drop rates.

Jitter: Jitter is defined as the measure of the variability over time of the data packet latency across the network. From the graph i.e. Figure 4, it is clear that the AODV provides higher jitter as compared to the DSR.

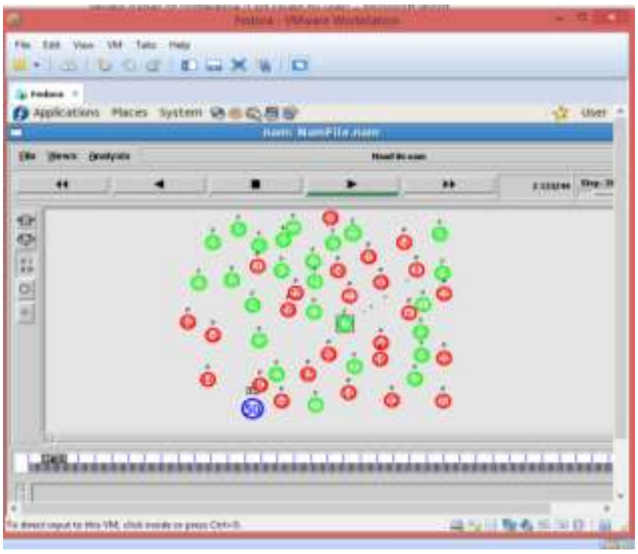

Figure 1. Formation of Network

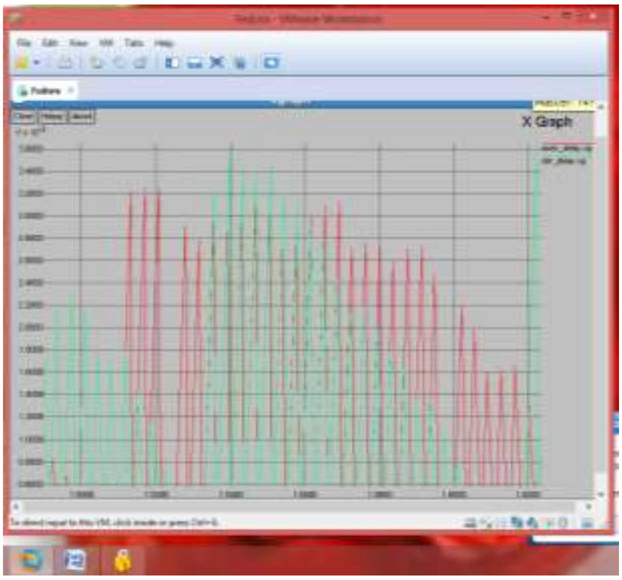

Figure 2. End to End delay

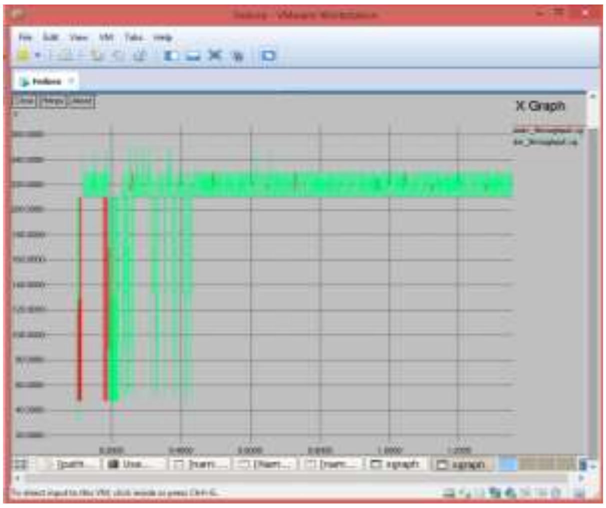

Figure 3. Throughput Graph

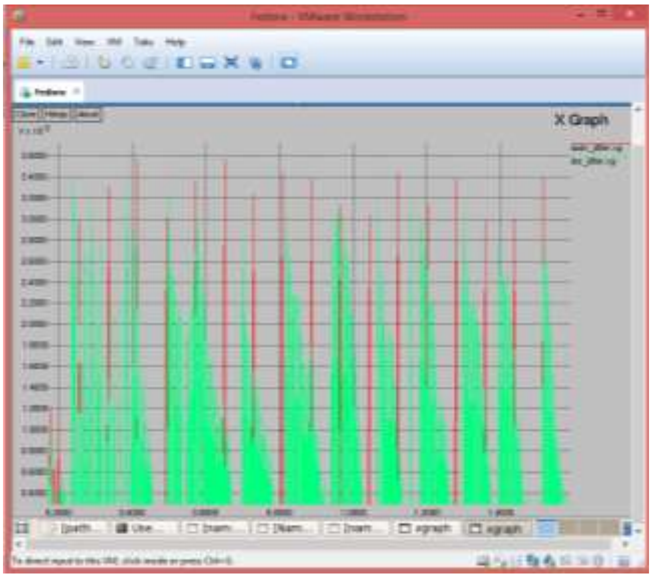

Figure 4. Jitter Graph

VII. CONCLUSION

In the previous system, channel selection was limited to only some selected routing protocols. This made application of cognitive radio restricting to only selected routing protocols. In this project, the concept of channel selection can be extend between primary user and secondary user in a flexible manner for the AODV and DSR routing protocols. Performance metrics depicts the overall performance the routing protocol in terms of end-to-end- delay, throughput and jitter.

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