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Routing Protocol in Cognitive Radio Network

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Abstract: **Cognitive radio network is a reconciling intelligent radio network that mechanically detects available channels in a wireless spectrum and makes changes in the transmission parameters sanctioning more communication to happen at the same time. Secondary users can use primary users channel when it's idle. In this paper, we propose AODV routing protocol suitable for cognitive radio network for secondary user's communication. The various parameters are analyzed by implementing protocol in NS3 software.**

***Keywords*—Cognitive radio network, primary user, secondary user, unicast routing protocol.**

I. INTRODUCTION

Cognitive radio (CR) technology aims to extemporize the spectrum utilization in the licensed frequencies, and also facilitate the congestion in the ISM band. Federal Communications Commission (2004) (FCC)[1,8] has allotted many frequencies to every individual users bounded in the geographical area. The user using its own allotted frequency is known as primary user (licensed user) and the one using its neighboring frequency is known as secondary user (unlicensed user)[7].However first priority is given to the primary user[1] .CRN uses the vacant licensed frequency bands, which in turnmeliorates the spectrum utilization without interfering with the primary or licensed users .

A) Types of cognitive radio user

1) Primary user (licensed user) In Cognitive radio network, primary user is given the first priority than the secondary user to occupy the particular band or frequency .once a primary user is detected, secondary user must automatically get terminated to avoid the packet loss[1,7].

2) Secondary user(unlicensed user)
The secondary user communicates with each other using the primary users frequency, when the primary user demands for its channel, then the channel will be switched to the primary user and the secondary user searches for other available channels to communicate [1,7].

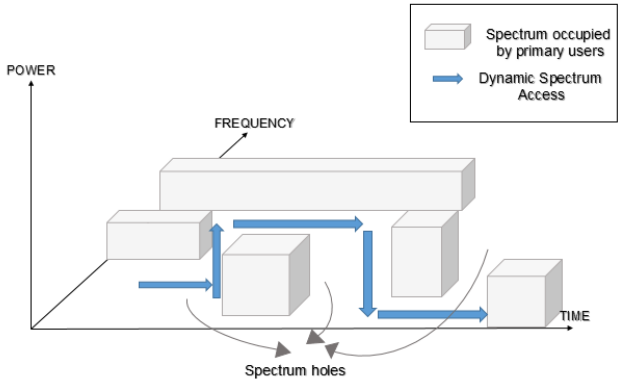

Fig:1 Spectrum Holes

Fig:1 dipicts the frequency utilization. Blocks represent the spectrum occupied by primary users and vacant space indicates the frequency left idle by the primary users which can be utilized by the secondary users.

B) Architecture of cognitive radio network

Architecture is classified into infrastructure and infrastructure less [2].

1) Infrastructure architecture in the infrastructure architecture, one node communicates with the other node within the same cell through the base station which is called access point.

2) Infrastructure less architecture Infrastructure less architecture is called as Ad-Hoc architecture with no base station .Nodes communicates within themselves and there is no need for access points.

C) Routing Protocol

Routing protocol enables to select routes between any two nodes and specifies how devices find a path between source and destination [3]. There are two types of routing protocol namely proactive and reactive.

Unicast routing protocol Unicast is a term used to describe the communication where a piece of information is sent from one point to another. There is only one source and one destination.

II. RELATED WORK

This paper[4] deals with the CR routing protocol for ad hoc network for the evaluation trade off which makes certain contributions like precisely protecting the undetected PU receivers ,multiple access of the routes based on service differentiation, innovative route spectrum selection. There are five different spectrum bands composed of 5MHZ channels. PU have range of 150m, transmitted packets of size 1000bytes at 11Mbps data rate. The path latency of data packets is less than 50%, the collision is greatly reduced by more than 50%.It shows the tradeoff acquires the CR performance to reduce the interference in the PU receivers, thereby initiating separate routing classes based on operational limits.

In the paper [5], Ad- hoc on demand vector routing protocol has been proposed which leads to three key features to avoid the activity of primary users region without any specific control channels, to assess any of the available channel's quality by means of RREQ and RREP packets , to accomplish multiple available channel thereby improving the overall performance. This paper shows when the cu number is low

PDR is also low and performance is increased to almost 90% when the CU rate is high.

Authors in the paper [6] have proposed QOS multicast routing protocol for designing six cognitive radio network for every network node by taking in account the requirements of interconnection network, designing the protocols in wired cognitive network. Thereby reducing the human intervention in network administration and also supports group communication. The paper[7] deals with the routing protocol for cognitive radio ad hoc network(RPCRAN)which study's the activity of CR users in CRAHNS.NS2 has been used to supply multi radio and multichannel support to address CR routing. The transmission range is 120m and its coverage is 300m, no of mobile nodes present is 10 with the packet size of 500 . Typically the protocol is sensitive to the primary user and does not affect the performance of the licensed user, it also increases the performance of CRAHNS by utilizing multiple channel present.

III. METHODOLOGY

The process of finding the path between source to destination involves two steps.1) Route request (RREQ) 2) Route reply **(RREP)[9].**

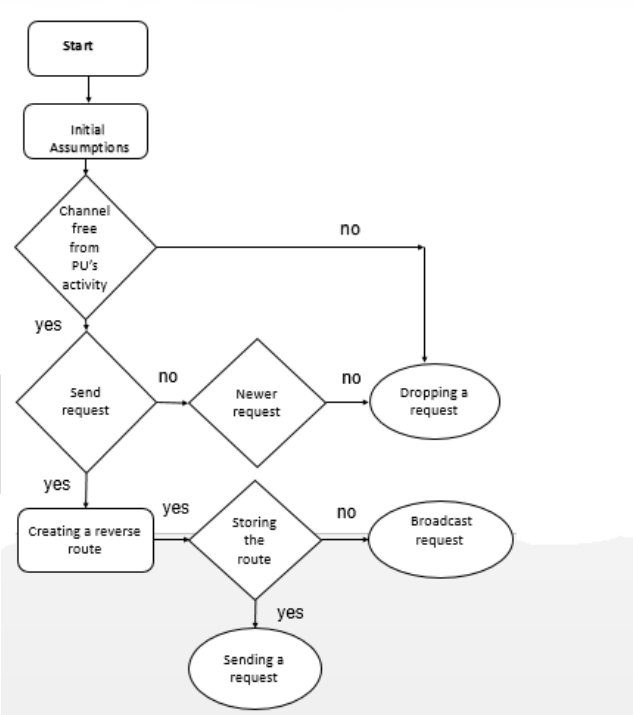

Fig:2 Route Request

The above flowchart explains how the routing protocol finds a forward route from source to destination by sending a route request. Initially it checks for the availability of the vacant primary users channel, if the channel is free, a request is sent through the channel and in turn reverse route is created and stored .Through the stored route a request is sent from source to destination. When the primary users channel is busy or occupied the routing protocol checks for the vacant channel to send the request, if there is no availability of vacant channel then the request is dropped.

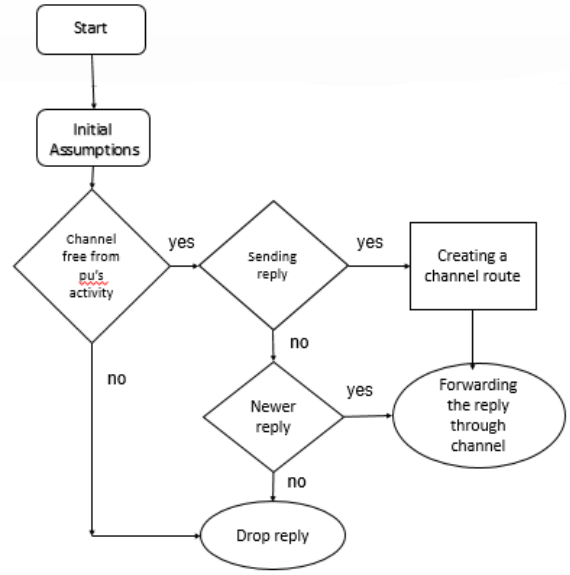

Fig:3 Route Reply

Fig:3 explains how a reverse route is formed from destination to source. Once the destination receives the forward request it checks for the idle primary users channel to send the route reply back to the source which creates a channel between source to destination to send the data. When the primary users channel is busy the routing protocol checks for the availability of vacant primary users channel to send the reply, if there is no available channel then the route reply is dropped. This is how data transmission takes place.

IV. PERFORMANCE ANALYSIS

NS-3 has been proposed to evaluate the QOS parameters of the secondary users namely,
1) End to end delay
2) Throughput
3) Packet Ratio.

1) End to end delay
It is the delay experienced by a packet from the time it was sent by the source till the time it was received in the destination [7].

2) Throughput
It is the data packets transmitted in bits per second (bps) [7].

3) Packet ratio
The percentage of packet loss during 100 ping of data [7]. The output has been viewed in Terminal, Net Animation and Wire shark. The CRN has 3 primary users and 7 secondary users. The frequency of the channel is 2.41Ghz which falls under unlicensed frequency spectrum. The size of packets transmitted is 64bytes and the time taken for transmission is 49999ms. The minimum range and maximum range of a node is 210-250meters respectively. Initially, the secondary users communicate with each other using primary users frequency. When the primary user is in need of channel the communication between secondary users get terminated and frequency is given to the primary user.

No of primary users	3
No of secondary users	7
No of packets	50
Data packet size	64bytes
Bandwidth	2.41GHz-2.49GHz
Node range	220m
No of packets transmitted	48
Time taken for transmission	49999ms

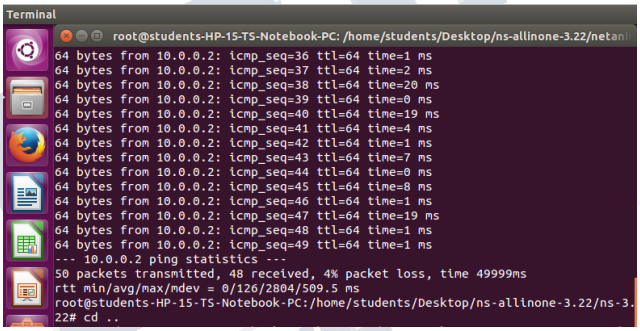

Fig:4 Terminal screenshot

Fig: 4 tells us that 50 packets are transmitted and 48 packets are received within the time 49999ms. Total percentage of packet loss calculated is 4%.

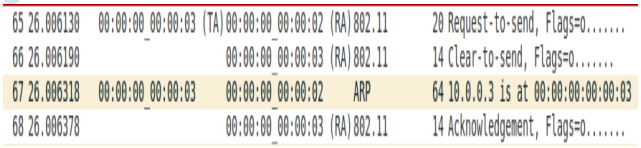

Fig:5 Output in wireshark

The above fig:5 shows the output viewed in wireshark. An RTS is sent from node 0 to node 2, CTS is being broadcasted among the nodes. The data is sent from node 0 to node 2 and an acknowledgement of the data being received is sent back to node 0.

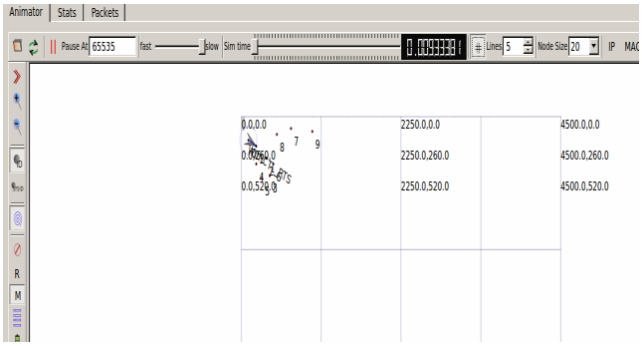

Fig: 6 NetAnim screenshot

This fig:6 shows RTS sent from node 0 to node 2. A Request to send(RTS) message can be used by a node to indicate its wish to transmit data. The receiving node can allow this transmission by sending a grant using Clear to send (CTS) message.

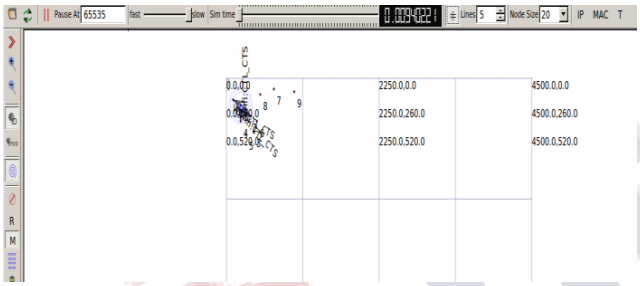

Fig:7 CTS screenshot

The fig:7 depicts CTS message among nodes. Since CTS has a nature of broadcasting, the neighbor of sender and receiver are informed that the medium will be busy, thus preventing from transmitting and avoiding collision.

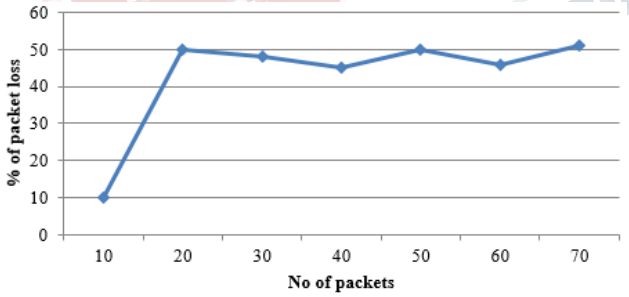

Fig:8 No of packets vs Packet loss

The graph in fig:8 shows the percentage of packet loss occurred during transmission. The no of packets are varied and the respective packet loss has been noted and graph is plotted with the respective values.

V. RESULT

In this paper, routing protocol in cognitive radio networks is implemented with three primary and seven secondary users using NS3 software. AODV protocol is used for the secondary users to communicate. Therefore conjestion is minimized and % of packet loss is evaluated. Future work includes the evaluation of other (Qos) parameters such as throughput and end to end delay.

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