An Optimized Interference Routing for Overhearing MIMO in Ad Hoc Cognitive Radio Networks

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Abstract: **With the wide survey of cognitive radio, the demand for wireless application increases. So the spectrum insufficiency becomes more and more serious problem. On the contrary, the licensed spectrum utilization is always low. So, in order to increase that cognitive radio makes it possible for increasing radio spectrum efficiency. A Multiple-Input Multiple-Output(MIMO) approach provides error-resilient end-to-end transmission. At the time of communication, ensuring opportunistic spectrum utilization in destination node, with the knowledge of a priori erasure probability is exploited. It overcomes decoding challenges raised by the presence of random path erasures. Joint Sphere Decoder along with Minimum Mean-Square Error Sorted QR decomposition (MMSE-SQRD) implements Maximum A posteriori (MAP) probability decoding at the destination. In JSD it is being stormed when frequency co-existence or frequency loop occurs between two nodes at a same interval, resulting in spectrum wastage. The Honey Comb Routing(HCR), Wait and Bound(WB) and Received signal strength Indicator(RSSI) are used avoid collision, frequency overlapping and ensure proper utilization of frequencies. HCR by default is a low interference routing pattern which avoids frequency overlapping at each cornered positions. The WB in addition reduces drop at the transmission due to overlapping frequencies, ensuring an optimized RSSI at the destination. HCR also reduces the delay in spectrum propagation and data transfer.**

Keywords: Multiple-input multiple-output (MIMO), cognitive radio network (CRN), ad hoc networks, path–time code (PTC), sphere decoder (SD), QR decomposition (QRD), and Honey comb network.

I. INTRODUCTION

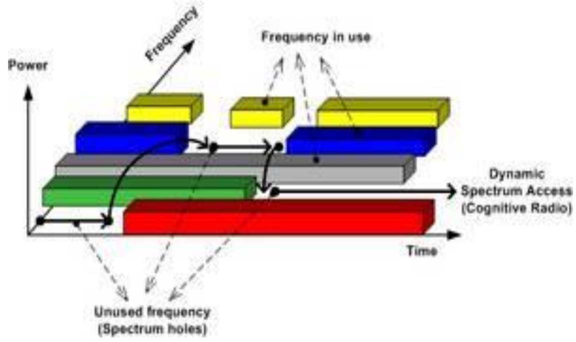
Cognitive Radio (CR) is forms of wireless communication in which the transceiver can detect the communication channel are in use or not and instantly move into the vacant channels while avoiding the occupied ones. This optimizes Radio-Frequency (RF) spectrum while minimizing the interference to other users.

In its basic form, CR is hybrid technology involving Software Defined Radio (SDR) applied to spread spectrum communication. Functions of cognitive radio are the ability of a transceiver to determine geographic location, authorize its user, encrypt or decrypt signals, sense neighboring wireless device in operation and adjust output power and modulation characteristics.

CR is of two main types, full cognitive radio and spectrum-sensing cognitive radio. Full cognitive radio include the parameters that the wireless node or network can be aware of. Spectrum sensing cognitive radio detects channels in RF spectrum.

The Federal Communication Commission (FCC) ruled in November 2008 that unused portions of RF spectrum (white spaces) are made available for public use. White space devices include technologies for preventing interference,

such as spectrum sensing and geo-location capabilities.CRNs require radio device, so it can change various protocol functions at runtime. CRN uses SDR as an ideal platform



CRNs require radio device, so it can change various protocol functions at runtime. CRN uses SDR as an ideal platform. Physical layer processing and MAC protocol functions in hardware are implemented by most of the radios, limiting the degree of runtime adaptively to a small predefined set of changes. On the other hand, SDR attempt to do much processing in digital domain. Digital processing is still used however due to the limitation of analog/digital converter. Converting the signal between radio carrier frequencies and intermediate frequency by the process of analog circuit. Digitizing the signal at intermediate frequency so that all other processing is done digitally in software. This process make easy to change runtime. Even analog circuits are designed as flexible.

A CRN may consist of a set of SDR device that. Collaboratively, incorporate multiple sources of information to dynamically adapt their transmission waveforms, channel across method, and networking protocols as needed for co-existence and good system/application performance.

SDR device collaboratively incorporate multiple sources of information for adjusting transmission waveforms, channel across method, networking protocols needed for co-existence

Some features of cognitive networks include:

Sensing the current RF spectrum:

This sensing includes measuring which frequencies are being used, when they are used detecting the location of transceivers and to determine signal modulation

Policy and configuration databases:

It specifies the radio operation and physical limitation for that radio operation are stored in the radio or made available over the network.

It may also specify in which location which frequencies are being used. Whereas configuration databases describes the physical radio operating characteristics. They used to constrain the radio operations to stay within regulatory or physical limits

Self-configuration:

Radios are assembled from many modules. This module should be self-describing and automatic configuration for operation.

Mission-oriented configuration:

SDR can meet wide set of operational requirements. Configuring SDR to meet a mission requirement called mission oriented requirements. Typical mission requirements include operation within buildings and long distances, substantial capacity and operation while moving at high speed. Selecting a set of radio software modules from library of modules and connecting them into an operational radio

Adaptive algorithms:

During operation, the cognitive radio is sensing its environment, adhering to policy, configuration constraints.

Distributed collaboration:

In their local environment, CR will exchange current information, user demand and radio performance between them on a regular basis. It will use local information and peer information to determine operating settings.

Security:

Radios will join and leave wireless networks. These networks require mechanisms to authenticate, authorize and protect information flow of participants.

II. SYSTEM OVERVIEW

A) Implementing honey comb algorithm

1) Honey Comb Routing Method

The HCR method is proposed to extend the interference to other nodes in a network. In a homogenous network interference can be extended to destination node other than source. In a heterogeneous network, the interference can be implied to intermediate node other than source and destination. HCR is a spreading mechanism. It opts the routing path to reach the other nodes. It supports directed, bi-directional and random paths for improving the states. When a network size varies, HCR opts a routing and can be extended. Thus it supports scalability.

The network is being stormed when frequency co-existence or frequency loop occurs between two nodes at a same interval, resulting in spectrum wastage. The Honey Comb Routing(HCR) and Received signal strength Indicator(RSSI) are used avoid collision, frequency overlapping and ensure proper utilization of frequencies. HCR by default is a low interference routing pattern which avoids frequency overlapping at each cornered positions. HCR also reduces the delay in spectrum propagation and data transfer.

III. SYSTEM MODEL

A. Wait & Bound (WB) Method:

Congestion (deadlock like condition) occurs at the source level when the source is being requested by two different destinations operating in different frequencies. A wait and bound method is proposed to resolve this problem. In this method, the request is being served in the order of priority. The priority is violated allowing the priority message to be addressed first in case of any emergency messages. The source node has to serve either of the requests first when two normal or two priority requests (or even more) approaches the source node. So, the priority is randomly chosen and serve one first. This avoids source level congestion by the resource that is released from the first node served is given the request which is waiting.

1) Conditions for WB method

a) Choose a low priority input (Frequency)

ii Move it wait state and service the high priority

b) The wait time of the low priority must be >= Execution time of the first priority

c) If low priority wait time < first priority wait time, then redirects the connection to the next cell

B. Main objectives

a) Self-Interference cancellation:

In order to improve the spectrum utilization, cognitive radio allowing the unlicensed users to coexist with licensed bands. It becomes a hindrance that the interference caused by sharing the same radio channel limits system performance such as system throughput.

To design an efficient interference cancellation, CR network is equipped with multiple antennas. They deploy precoding and power control to effectively avoiding the interferences at the PR terminals thereby maximizing the throughput of CR links. Other possible methods for interference cancellation and pre-coding are Zero-forcing and Minimum Mean Square Error (MMSE).

b) Retaining signal strength:

The signal strength in telecommunication particularly in radio, it is refers to the magnitude of electric field at a point that is at a meaningful distance from the transmitting antenna. It may also denoted as received signal level or field strength. It is expressed in voltage per length or signal power accepted by reference antenna. In high power transmissions including broadcasting, expressed as dB-millivolts per metre (dBmV/m). On the contrary, for low power systems include mobile phones, signal strength is expressed in dB-micro volts per metre (dBμV/m).

c) Decreasing access delay:

Generally, the access time is the latency between a request to an electronic system, and access being completed. In other words, it is the time a network interface waits before it can access shared network. In telecommunication systems, the delay between the access initialization attempt and successful access. A network delay is a characteristic performance of a network.

It specifies the time it takes for a bit to travel across the network from one node to another. It is measured in fractions of seconds. Such delay may vary slightly according to location of pair of communicating nodes. Network delay is within an IP network, the delay of an IP packet. Reporting both maximum and average delay, the delays are classified into several parts:

Processing delay: Time taken by the routers to process the packet header

Queuing delay: The packet spends the time in routing queues

Transmission delay: Time taken to push the packet bits into the link

Propagation delay: Signal takes the time to reach its destination

From the discussion above, the network itself attempt to ignore many more link co-ordination with that network. It does an important work to overcome the collision effects. Since it highly affects the network performance.

d) Queuing

Setting the normal queue active, when nodes communicate with each other and there is no chance of misbehavior observed. It resembles normal data transfer occur between source and destination where the intermediate node buffering the data transfer.

A Hybrid Sequence Queue Tunneling (HSQT) queue is a type of priority queue where a closed circuit covers the entire queue as much time as the data is present in the queue. The advantage of tunneling is that no attacker can breach the tunneling effect. In case of a one side attack, the IDS scans and neglects packet (contaminated) and updates the packet information and status for further use. Checking the previous entries and denied the packet if the same packet reverses for the second time.

In the case of more than one way attack, i.e., the attackers handle more than one link to Intrusion Detection System (IDS) node causes traffic thereby initiates DOS attack. So, the normal queue become active, when HSQT queue shreds up and drop the incoming packets. During that time the attackers are handled by other IDS. It eliminate the threat for a particular time period within that the HSQT rebuilds to an IDS state.

e) Drop tail

It is simple queue mechanism mainly used by the routers when packets are tends to drop. Each packet is treated identically. Suppose if the queue is filled to maximum capacity, it drops the newly incoming packet until the queue exhibit sufficient space to accept the incoming traffic.

f) Fair Queuing (FQ)

It is also a queuing mechanism is used to allow multiple packets flowing. It comparatively shares the link capacity. Routers contain multiple queues for each output line for every user. When a line is in idle, routers scans the queues through round robin and takes first packet (arrived) to next queue. It also ensures maximum throughput of the network. For more efficiency purpose, weighted queue mechanism is used.

g) Deficit Round Robin (DRR)

It is a modified weighted round robin scheduling mechanism. It has the ability to handle packets with different sizes without the knowledge of their mean size. It keeps tracking the credits for each flow. It derives ideas from FQ and stochastic FQ. With the hashing process, it determine queue which a flow has assigned and collisions automatically reduce bandwidth guaranteed to flow. For each queue a quantum is assigned and sends a packet of size that fit for an available quantum. If not, an idle quantum gets added to meticulous queue's deficit and packet may send in next round. The size of quantum is a vital parameter in DRR scheme, determine upper bound on latency and throughput.

h) Pros

Pros is a queuing mechanism. In order to achieve better performance it uses well-designed idea and is implemented in a cost effectiveness manner. It gives framework for implementing fair queuing efficiently.

i) Cons

Though DRR serves good for throughput side, it provides poor performance at the latency bounds and not operate well for real time traffic. DRR introduces queuing delay have good results on congestion window size.

j) Random Early Detection (RED)

Random Early Detection is a queuing mechanism avoids congestion. It is used potentially, particularly in high speed transit

networks. This queuing management mechanism is very active. Packets are dropped on basis on statistic information and operating in an average queue size. All incoming packets are acknowledged when buffer is empty. Increasing the queue size increases the probability for discarding a packet. The probability becomes equal to one and drops all incoming packets when the buffer is full.

It has capability to evade global synchronization of TCP flows, preserved high throughput, low delay and attained fairness over multiple TCP connections. This mechanism is used to stop congestive collapses.

k) Stochastic Fair Queuing (SFQ)

Having one queue for each conversation SFQ uses a hashing algorithm is impractical. It divides the traffic over limited number of queues. Even though it is not so efficient than other queue mechanism, it requires less calculation.

For this reason it is called “Stochastic” it does not assign queue for every session. It has a hashing algorithm that divides traffic over restricted number of queues. SFQ assign large number of First In First Out (FIFO) queues.

IV. MAIN RESULT

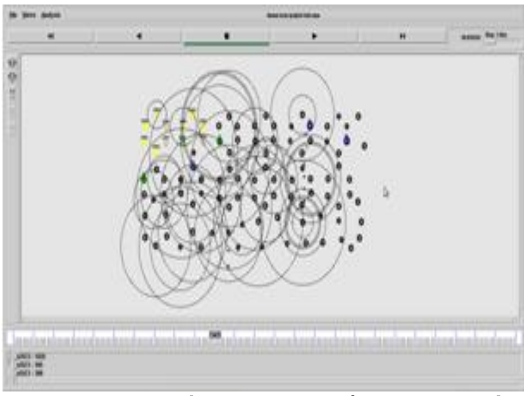


Fig. 1. Network animator output for routing procedure

The structure is pre-defined as Honey comb nodes (Hexagonal structure).The nodes check the condition for every cell. Broadcasting predominates from each nodes. This method extends the interference to other nodes in a network. HC is a spreading mechanism. It opts the routing path to reach the other nodes. It supports directed, bi-directional and random paths for improving the states. When a network size varies, HC opts a routing and can be extended. Thus it supports scalability. Yellow nodes describe the high frequency operating nodes and the tan color indicates the low frequency operating nodes.

AODV protocol is used for path discovery between nodes. Broadcast size is 106bytes. Each and every source initiates broadcast to find the path to the destination.

The network when undergoes overlapping, then only it initiates the interference routing operations. The operations are the device-co existence is introduced between two frequency-co existences. The honey comb structure by default is low interference routing and may have different frequencies and least same frequencies. When the same frequencies meet at a particular instance the drop occurs. The drop may be also in the form of AODV(Ad Hoc On Demand Distance Vector Routing) , TCP(Transmission Control Protocol),CBR(Constant Bit Rate) ,ACK(Acknowledgement). Here our aim is to reduce the drop from the JSD method.

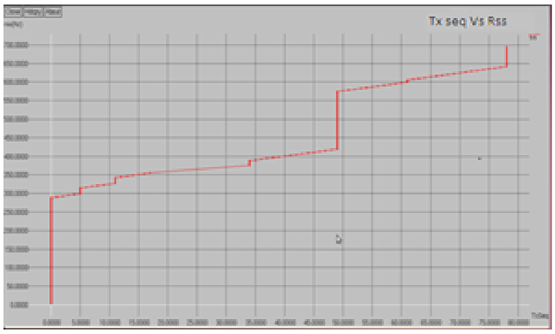


Fig. 2. Frequency graph output

The graph was plotted as transmitted sequence along y-axis and received signal strength indicator (RSSI) along x-axis. It utilizes overall simulation time. The frequency utilized is varying according to routing agents for TCP, UDP. The frequency varies when there an interruption or any other influencing factor. In JSD, the frequency would drop before the entire packet is delivered which is overcome in the above method

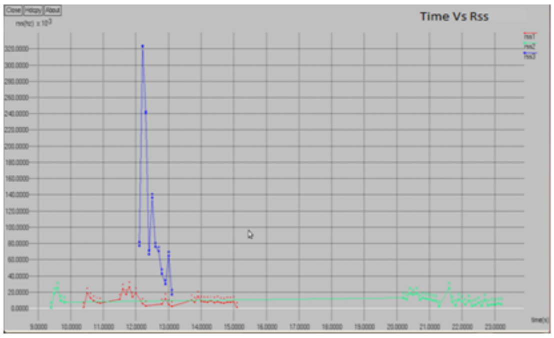


Fig.3, Graph output for Received signal strength indicator (RSSI).The graph was plotted as received signal strength (RSS) along y-axis and time along x-axis. Along the time progress it was recorded frequency in y-axis.. RSS increases when there is minimum or null interference. RSS drops as interference increases.

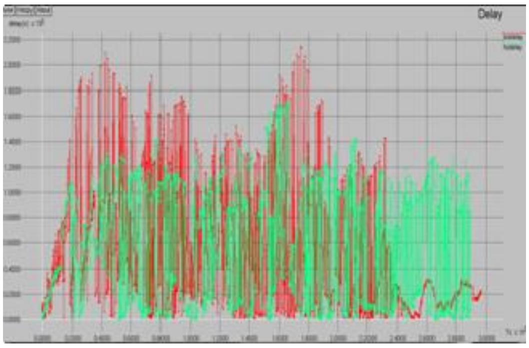


Fig.4, Comparison graph for JSD and HCR systems. This graph shows red color indicates existing system green color indicates proposed system. It represents the delay considerably reduces compared with existing system

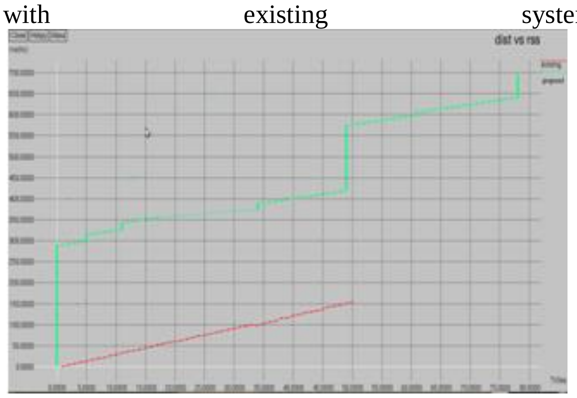


Fig.5, Comparison graph for JSD and HCR systems. This graph shows frequency utilization is more compared with JSD frequencies, ensuring an optimized RSSI at the destination.

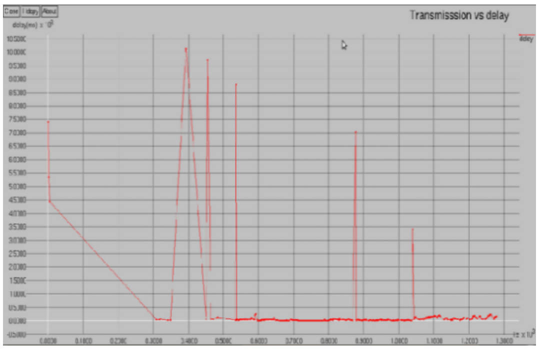


Fig.6, Delay graph for HCR procedure

From this graph above, the transmitted sequence is plotted along X-axis and delay along Y-axis. The delay is measured in terms of milliseconds (ms). Min value is 0, max value is to 10.1

$$\text{Delay} = \frac{0+10.1}{2}$$

$$= 5.55$$

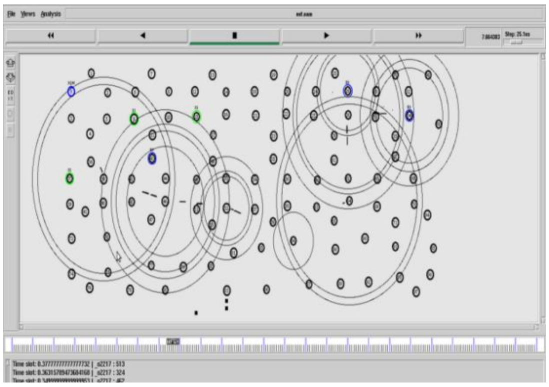


Fig.7, Network animator output for Wait & Bound (WB) with Optical Mobile Relay Configuration (OMRC) procedure.

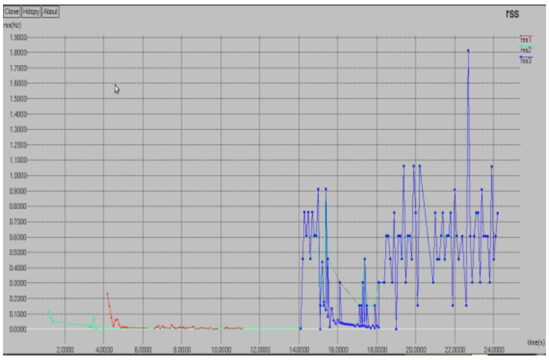


Fig.8, Received Signal Strength (RSS) graph output for WB method. If RSS increases, interference increases. If RSS decreases, interference decreases

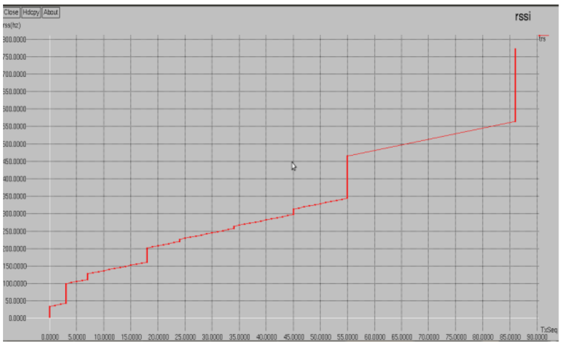


Fig.9, Received Signal Strength Indicator (RSSI) graph output for WB method. If RSSI increases interference decreases. On the contrary, RSSI decreases interference increases

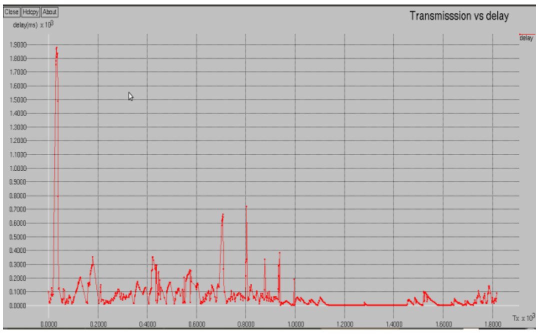


Fig.10, Delay graph output for WB method

From this graph above, the transmitted sequence is plotted along X-axis and delay along Y-axis. The delay is measured in terms of milliseconds (ms). Min value is 0, max value is 2

$$\text{Delay} = \frac{0+2}{2} = 1$$

TABLE I

COMPARISON TABULATION FOR JSD, HCR and WB with OMRC TECHNIQUES

Parameters	Joint Sphere Decoder	Honey Comb Routing	Wait & bound with OMRC
Control messages sent	2191	3539	7102
Control messages received	8200	4780	93862
Data sent	2810	1289	2110
Data receive	2023	1193	1993
Router drop	375	118	201
Delivery ratio	71.99288	92.5523	94.4547

IV.CONCLUSION AND FUTURE WORK

Received Signal Strength Indicator (RSSI) are used to avoid collision, frequency overlapping and ensure proper utilization of frequencies. HCR by default is a low interference routing pattern which avoids frequency overlapping at each cornered positions. HCR also reduces the delay in spectrum propagation and data transfer.With the implementation of Honey comb routing technique with RSSI, it was concluded that transmission delay time and drop are reduced and thereby improving throughput and frequency utilization in Ad hoc cognitive radio network.

The main contribution of this project is to provide efficient end-to-end communication. It also highly concentrates on frequency utilization in Ad Hoc cognitive radio network using MIMO transmission. The proposed technique is honeycomb routing for interference routing. This work can be accomplished by implementing wait and bound method along with optical mobile relay configuration. It reduces drop at the transmission due to overlapping

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