Hybrid MAC Protocol for Channel Allotment in Heterogeneous Cognitive Radio Networks

Bharath Raj D

Assistant Professor, Department of Information Science and Engineering, Brindavan College of Engineering, Bengaluru, India. email:bharathraj0489@gmail.com

Dinesh S

Associate Professor, Department of Information Science and Engineering, Brindavan College of Engineering, Bengaluru, India. email:sdineshgowda@yahoo.co.in

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Abstract—Cognitive radio (CR) is an emergent wireless communication technology. Due to its nature it meets scarcity spectrum, the CR has been provides a keen solution to challenge spectrum scarcity issues by permitting spectrum sharing. The existing static channel allocation system leads to spectrum scarcity. The existing CR medium access protocol CR-MAC protocols have issues like delay, packet collision, and quality of services (QoS) during channel choice randomly. We propose a novel hybrid MAC protocol in light of channel quality approach. The channel quality indicator (CQI) is adopted with each channel in cognitive radio network (CRN). The TDMA based slotted cognitive function (SCF) is used to maintain transmission control. Distributed coordination function (DCF) is used to manage the packets transmission. The priorities are assigned based on the channel weights respectively. The proposed system has minimized the congestion and delay using NS-2 simulation.

***Keywords*—**CQI, CCC, SCF, DCF, Priority, CRN

INTRODUCTION

The wireless communication system is ever-growing demand for great data rate and immense connectivity has required to emerging latest technologies to achieve the great efficiently exploit a finite radio frequency spectrum. The CR has been considered as a shrewd answer for handle the range shortage issue by permitting spectrum sharing [1]. The primary characteristics of CRN are wireless users, random access capability and cognitive radio functionality [2]. The existing static spectrum allocation approach leads to spectrum scarcity. According to CR intelligence, limited spectrum availability and the unused wireless spectrum band, the CRN utilizes these elements to assemble a system to allow its secondary users (SUs) to share and access authorized remote range band with its primary users (PUs) with no mediation with these clients and with no destitution in their QoS [1]. Generally, the idle or free licensed channels are detected by SUs and then it can access the available channels [2]. During the transmission, PUs are occupied the licensed channels and SUs are defer transmission, and voyage to other available channels [3]. In view of the radio nodes that grasps the fitness to make intelligent decision for fluctuating the parameters of transmission, physical layer and those of MAC layer allowing for the deviations in the atmosphere, the capability of cognitive function, CRNs have been strongly recommended [4], [5].

The licensed spectrum should be accessed by SU through the methods such as overlay, underlay or interlace its sign with the present signal [5]. The main objective of the CRs is to reach good existing spectrum the intelligent cognitive functionality and the aptitude of reconfigurable, the problem of the multichannel hidden, sensing error, selection of CCC, delay of sensing the channel, the primary users of interference and the problem of network coordination might cause the MAC protocol to grieve from grave performance degradation [6].

The CR-MAC protocol design could have two methods are institutionalization endeavours prompting the formulation of the IEEE 802.22 working group and application explicit conventions. The prior procedure is particularly focused on framework based systems, in which a brought together coordinator or base station deals with the range designation and sharing among the CR clients. The CR clients, be that as it may, could take an interest inside the range detecting capacity and bear the cost of channel data to the focal controller. The institutionalization endeavours cause consistency in structure and arrangement, consequently allowing various autonomous CR administrators to exist together. On the other hand, application or states of affairs specific protocols are optimized for a particular type of atmosphere, or user specified application goal [7].

Recently, the wireless communication systems seek the better reliability and best QoS levels. For the most part continuously application, divergent clients are plausible to endure different dimensions of deferral for each administration, rendering important to consider the effect of QoS requirement in remote framework's investigation. A satisfactory metric that examines the measurable QoS ensures under time-fluctuating channel conditions is the viable limit metric [8]. In CRN, the architecture of the spectrum sharing mechanism offers the range sharing administration between Primary Networks (PNs) and Secondary Networks (SNs). In underlay approach, the higher need is doled out to PUs. In CRN, the significant job of dynamic range sharing is to permit both PNs and SNs to impart synchronously on the equivalent recurrence with appropriate impedance control to have PNs. In explicit, it is normally basic that a specific impedance temperature limit because of SUs' transmissions must be kept up at every essential beneficiary. Along these lines, control designation

for SUs ought to painstakingly be performed to meet stringent impedance prerequisites in this range sharing model [9].

The SUs should cooperate with all nodes to perform spectrum sensing, cooperative spectrum sensing problems has recently expanded much importance due to its ability fading and interference [10].

In [11] multi-constraint QoS mindful MAC convention (MQ-MAC) for a group based psychological radio sensor organize has created. The information channel and a reinforcement channel are designated to SUs through the separate cluster head (CH) by utilizing dynamic divert needs in MQ-MAC convention. The CHs used to framing the channels into ideal and moderate channels and distribute them among the quantity of hubs standing to their traffic needs. At that point the channels states are portrayed as positive or negative channel. The CH and its individuals are utilized CCC for channel state, is static which prompts clog. In [12] a dynamic asset assignment and need based planning for heterogeneous administrations in CRN has been created. The Secondary Base Station is the most in charge of asset distribution for SU. The SUs in SNs are ordered into four arranged

SU with Minimum-Rate Guarantee (MRG) SU with Minimum Delay Guarantee (MDG)
SU with Minimum-Rate and Delay Guarantee (MRDG) SU with Best Effort Service (BES)
For every approaching bundle streams, the parcels need is determined on the administration type and lining delay. The target capacity of channel quality pointer is evaluated for each stream by increasing the need with channel gain. At that point the streams are put away in the diving request of postulations target esteems, and after that allotted to the individual classification of SU.

As an extension to this work, we propose to plan a channel quality based hybrid MAC protocol CRNs. The remainder of this paper sorted out as pursues, in area II we examined about the related work, in area III Channel quality based hybrid MAC convention is presented, in segment IV Dynamic CCC methodology is presented, in segment V proposed algorithm , in segment VI reproduction results are talked about and in segment VII conclusion.

I. RELATED WORK

They proposed MAC convention with the crash free access to the present information channels and further they introduced the arrangement of reservation of free channels by secondary's for stretched out periods to expand usage without influencing risky obstruction to primaries [14]. They proposed a parallel detecting plan with consecutive channel choice request as a component of MAC convention and they assessed the vitality effectiveness and throughput of the framework [15]. They proposed a lowest ID clustering algorithm and generic algorithm for fairness improvement [16].

They presented an Antenna selection (AS) scheme; specifically, they exhibited a joint transmit and get numerous AS strategy for underlay CR condition, thus keeping up the multiplexing benefit of Multiple Input Multiple Output (MIMO) systems[17]. They proposed an agreeable and a non-helpful multichannel (MC)- MAC convention and the reasonable multichannel (FMC)- MAC convention for subjective radio impromptu system (CRAHN). Besides a scientific model by Markov chain is developed for FMC- MAC and the presentation measures are determined [18].

II. CHANNEL QUALITY BASED HYBRID MAC PROTOCOL

In this paper, we propose to design a channel quality based MAC (CQHMAC) protocol for CRNs. Channel Quality Indicator (CQI) used to find every channel quality in the presented networks [19]. The best quality of channel is preferred as the CCC and dynamically changed in all round. The control of the transmission controlled by Omni- directional TDMA based Slotted Cognitive Function (SCF) and the information transmission is constrained by directional receiving wire based Distributed Co-ordination Function (DCF) [20]. Different weighted values with the channels are assigned to the SUs based on their category [12]. The highest weighted channels are allotted to SU with higher priority.

Channel Quality Indicator

The channel quality indicator (CQI) is utilized to quantify the channel quality amid the correspondence. The CQI is adjusted with each sub diverts in the system. The usefulness of CQI of any sub channels are characterized utilizing signal- to-impedance in addition to clamour proportion (SINR) distinguished by the SU-BS amid channel allotment and getting to access.

The CQI is calculated as

They investigated the joint ideal detecting and appropriated Medium Access Control convention plan issue for CRN.

They investigated the designing problem of cooperative optimal sensing and MAC protocol for CRN. Then, they

$CQI \square \ log 2(1 \square SINR)$

The SINR is calculated as

$\square$signal

(1)

formulated throughput maximization algorithm to boost the complete throughput of the auxiliary system to accomplish

SINR

$\square$

$\square \ i \square \ \square$ (2)

noteworthy execution additions of the ideal detecting and convention setup [9].

They proposed TDMA based vitality proficient psychological radio multichannel MAC convention called ECR-MAC for remote Ad Hoc systems [13]. They built up a multi-obliged QoS mindful MAC convention, MQ-MAC, for a group based CRSN. In MQ-MAC, and organized as for the desperation of their produced information packets [11].

Where ρ_{signal} is an incoming signal power, ρ_i is the power of the interference and σ is the noise respectively.

If $\rho_i = 0$, then the SINR is reduced to Signal-to-Noise Ratio (SNR).

III. DYNAMIC COMMON CONTROL CHANNEL SELECTION We considered G be the cognitive radio, amid the
correspondence the CQI is utilized to gauge channel quality and channel allotment to SU. The CQI can rely upon G area and the spatial circulation of neighbouring Gs and clamour at the season of the estimations.

Common control channel (CCC) is proposed as the token ring system to ensure a reasonable and dispute free medium access for all ring-taking an interest Gs. Token ring convention ensures most extreme inactivity for the system through a token holding time (Tho) parameter.

Tho denotes to the most extreme period that each ring contributing hub is admissible to transmit before passing the token. Considering N ring contributing nodes which are accessing the medium, the network layer can upper bounded by the maximum token rotation time (Tro). Considering N ring partaking hubs which is getting to the medium, the system layer is upper bounded by the maximum token rotation time (Tro)

At the point when the directional RTS and CTS messages are communicated, the hub will start its information transmission and sit tight for affirmation in directional receiving wire. Likewise, hubs inside the system will communicate its application information in their chose real channels. With directional receiving wires, interface total throughput gets improved with insignificant channel conflict delays.

The main advantages of this technique are as follows:

- Data transmission with directional reception apparatuses limits hub and system vitality utilization with obstruction concealment.
- The D_REQ and D_RES in SCF task discovers impact free information channel for directional transmission.

$Tro \square NTho$

(3)

Note: N is announced within the tokens
Thus, the estimation of CQI for one direct can be performed in limited time, as it is ensured that a given Gj can attends every ring-participating neighbor within one Tro period.

In addition, for multiple available channels, the time required by G to scan a set Q of spectrum opportunities,

$Tsc \square QCTho \square Ng$
geG

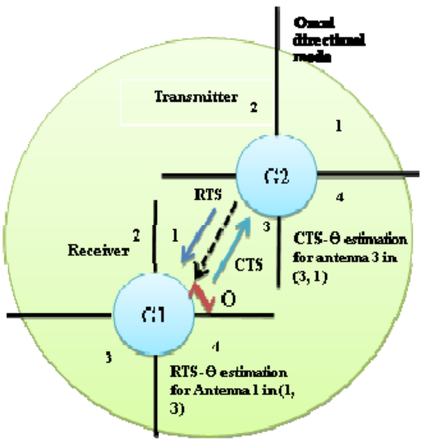

Figure1. AOA Estimation

MRk□*MR*min□*k*□*K* *k*

IV. PROPOSED ALGORITHM

MRk□*MR* *k* min□*k* □ *KA*

The best effort service can be calculated as

MRk

□*MRi*

i□*KB*

MRk

□*MRi*

i□*KB*□ □*k*□*k* □*KB*

□ □*k*□*k* □*KB*

(5)	STEP :1	Define the sub channels with weight
		K1: Minimum-Rate-Guarantee-with- SU
(5)		K2: Best-Effort-Service-with – SU
	STEP :2	SU send the request to SU-BS for sub-channels
(6)	STEP :3	SU-BS checks $\delta_{k,}$ n values and ask BS

about the sub-channel If (δk, n = 1)
Request Terminated Else
where δk, ∀k∈KB is the predetermined value.

The stream with most astounding target work is apportioned to the MRDG, trailed by MRG and MDG. The stream with least target work is doled out to BE
Directional Antenna based Distributed Co- ordination Function (DCF)

In this procedure, a reception apparatus list number (Z) is included RTS and CTS message positions. This causes neighbour hubs to hinder its Network Allocation Vector (NAV) in relating radio wire headings amid information transmission.

STEP :5 N numbers of directional antennas are used.

STEP :6 Then calculate antenna coverage distance Coverage area = 2π/k radians
STEP :7 GPS is embraced to CR for identification of the location information.

If (GPS = Threshold value)

STEP :4 For communication single half duplex radio transceiver is used for communicating in opportunistic PU free channel.

STEP :5 N numbers of directional antennas are used.

STEP :6 Then calculate antenna coverage distance Coverage area = $2\pi/k$ radians
STEP :7 GPS is embraced to CR for identification of the location information.

If (GPS = Threshold value)

Then identified the location information Else
Request terminated

STEP :8 The TDMA based slotted cognitive function is used to control the transmission traffic.

If (SCF = ON)

Then location information transmitted to all neighbors.

If (CR-Transmitter = Location- Information)

Then identified closed channels Avoid overlap
Else

Request Terminated.

STEP :9 TDMA-based-SCF provides strict node synchronization during cognitive control message exchange through TDMA-MAC.

If (Control Channel = Available) then

Channel access and synchronization take place

Else

Request Terminated

STEP :10 Check the channel quality at SU-BS If (CQI = Threshold Value) then Channel Selected
Else

Request Terminated
STEP :11 Priority queue is assigned to each SU STEP :12 Each node is equipped with one
transceiver which is used to control data transmission.

STEP :13 If (CCC = Enable)

Then PU free channel list is identified. Else
Request Terminated.

STEP :14 The highest priority channels are broadcasted to its neighbors then

Priority queue is updated for each transmission

Else

Request terminated STEP :15 Check CQI at SU-BS
If (queue size $>$ Threshold value) Then
Request Terminated

STEP :16 Check the allocated transmission power to the channel

If (Transmission power < Total Power) Then
Data transmission takes place Else
STEP :17 Power allocation take place for selected sub-channel with SU

STEP :18 Data transmission takes place. STEP :19 Check CQI at SU-BS
If (CQI Threshold) then Request terminated
Else

STEP :20 Goto STEP: 8

V. SIMULATION RESULT

The proposed CQHMAC Protocol is simulated in NS2 and compared with Interference Aware Hybrid MAC (IAHMAC) [20] and Cognitive MAC with mobility support (CMMAC) [21] protocols. The simulation settings are summarized in Table 1. The performances of these protocols are evaluated in terms of the metrics CBR-throughput, EXP- throughput, Video-throughput, packet delivery ratio.

In 50 nodes scenario, the data sending rate and number of secondary transmissions are different.

In this experiment, the data transmission rate is varied from 100 to 500kb.

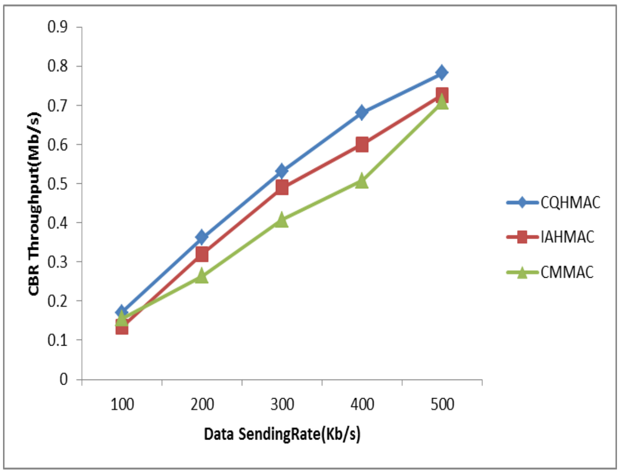

figure 2. CBR-Throughput for varying rate

Figure 2 shows the CBR-Throughput measured for CQHMAC, CMMAC and IAHMAC when the rate is varied. The rate is increased from 100 to 500Kb, throughput of CQHMAC increases from 0.17 to 0.7, the throughput of IAHMAC increases from 0.13 to 0.72 and the throughput of CMMAC increases from 0.15 to 0.7. Henceforth the throughput of CQHMAC is 12% of higher once compared to IAHMAC and 18% of higher than CMMAC.

Figure 3 shows the EXP-Throughput measured for CQHMAC and IAHMAC when the rate is varied. The rate is increased from 100 to 500Kb, the throughput of CQHMAC increases from 0.10 to 0.36, the throughput of IAHMAC increases from 0.06 to 0.33 and the throughput of CMMAC increases from 0.08 to 0.28. Hence the throughput of CQHMAC is 17% of higher when compared to IAHMAC and 21% of higher than CMMAC.

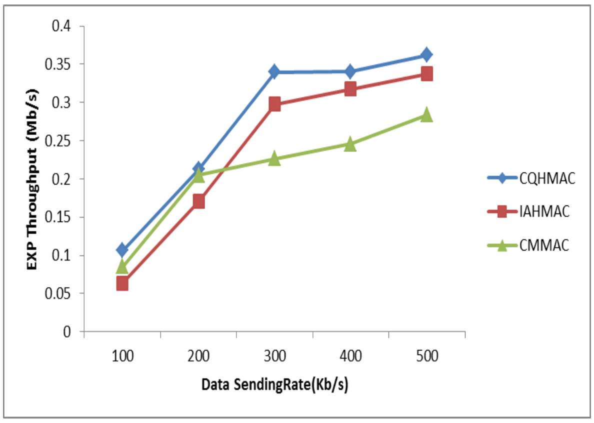

Figure 3. EXP Throughput for varying rate

Figure 4 shows the video-throughput measured for CQHMAC and IAHMAC when the rate is varied. The rate is increased from 100 to 500Kb, the throughput of CQHMAC increases from 9.2 to 9.3, the throughput of IAHMAC decreases from 3.1 to 2.9 and the throughput of CMMAC goes from 2.35 to 2.44. Hence the throughput of CQHMAC is 68% of higher when compared to IAHMAC and 75% of higher than CMMAC.

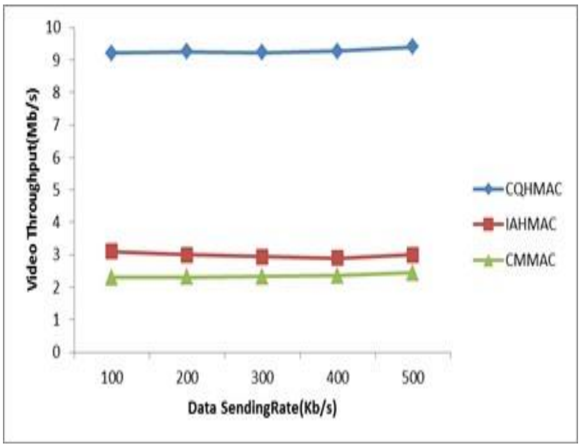

Figure 4. Video Throughput for varying rate

CONCLUSION

In this paper, we have proposed to structure a channel quality based MAC convention psychological radio systems. Here a channel quality indicator (CQI) is utilized as an utility capacity for each channel. At that point a channel with best CQI is picked as the CCC and progressively changed in each round. Omni-directional TDMA based Slotted Cognitive Function (SCF) is utilized for control transmission and directional radio wire based Distributed Co-ordination Function (DCF) is utilized for information transmission The channels with higher loads are doled out to higher need SU. By simulation results, we have shown that the proposed technique minimizes congestion and delay.

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