ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com
International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 3, Special Issue 7, January 2016

THROUGHPUT ENHANCEMENT IN COGNITIVE RADIO NETWORKS USING SELF-SCHEDULED MULTICHANNEL MAC PROTOCOL WITH BACKOFF ALGORITHM

G.Aysha Begum[1], Nathiya.B[2]
Assistant professor, PG Scholar
Department of ECE
Sri Krishna College of Engineering and Technology[1 2]
ayshabegumb@skcet.ac.in [1] , nbmnathiya@gmail.com[2]

Abstract

The concept of backoff algorithm is used in self scheduled MAC protocol to enhance the number of successful cognitive users by reducing the collision during reservation of idle licensed channels.Hence the throughput of cognitive network is increased.

***Key terms*-Backoff algorithm,contention interval, sensing-sharing,throughput.**

I.INTRODUCTION

The fixed channel allocation in the communication systems leads to spectrum scarcity problem.So to reduce the problem we go for cognitive radio technique which uses unutilized spectrum in effective manner by constantly sensing and utilizing the available spectrum. Cognitive radio uses dynamic spectrum access(DSA) and opportunistic spectrum access(OSA).This access techniques identifies the unused radio spectrum and uses it opportunistically [1].The cognitive radio networking involves two steps,in which first step is to identify the spectrum holes in licensed user's spectrum band. After identifying the spectrum holes,decision on optimal sensing,transmission time and proper coordination with other users for accessing the spectrum is made.Next step is to use the spectrum in effective manner.The throughput of cognitive radio networks can be maximized by frame structure [3].
The major characteristics of the MAC protocol are discussed in [4].MAC protocol is used for better spectrum sensing and sharing.There are many challenges on designing MAC protocol, because they have to overcome three major problems as

- To limit interference on primary users during communication of secondary users.
- Synchronization between secondary users
- Hidden terminal problem.

There are various cognitive radio MAC protocols. The hardware-constrained cognitive MAC(HC-MAC) protocol [5],is used toconduct efficient spectrum sensing and make spectrumaccess decisions on considering hardware constraints. This protocol doesn't require network synchronization but the major limitation of this protocol is multichannel hidden terminalproblem. The distributed spectrum-agile MAC protocol is a multichannel carrier sense multiple access (CSMA) -based protocol [6] which uses a dynamic channel selection algorithm. However this protocol requires network synchronization.The C-MAC protocol [7] uses rendezvous channel (RC) for coordinating nodes in different channels.But this

ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com
International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 3, Special Issue 7, January 2016

protocol has problems in rendezvous channel availability and also requires network synchronization which makes this protocol more complex.The cognitive radio enabled multi-channel (CREAM) MAC protocol overcomes the problem of hidden terminal problem and also this protocol doesn't require network synchronization. But the major issue of this protocol is communication overhead. Christo Ananth et al. [8] proposed a system which is an innovative congestion control algorithm named FAQ-MAST TCP (Fast Active Queue Management Stability Transmission Control Protocol) is aimed for high-speed long-latency networks. Four major difficulties in FAQ-MAST TCP are highlighted at both packet and flow levels. The architecture and characterization of equilibrium and stability properties of FAQ-MAST TCP are discussed. Experimental results are presented comparing the first Linux prototype with TCP Reno, HSTCP, and STCP in terms of throughput, fairness, stability, and responsiveness. FAQ-MAST TCP aims to rapidly stabilize high-speed long-latency networks into steady, efficient and fair operating points, in dynamic sharing environments, and the preliminary results are produced as output of our project. The Proposed architecture is explained with the help of an existing real-time example as to explain why FAQ-MAST TCP download is chosen rather than FTP download.

In the self- scheduled MAC (SMC-MAC) protocol [9] used in our proposed method, the network synchronization is not required.This protocol is used for better co-operation among cognitive users to enhance the throughput. But the major limitation of SMC-MACis fixed cycle time.And once the collision is detected in the contention interval,the users should wait till next cycle time to selectthe other contention slots.So the backoff mechanism has been applied to resolve this problem of contention among collided cognitive users and thereby increases the number of successful users.In the backoff mechanism,once the collision is detected,the collided cognitive users can once again select the contention slot in the same cycle time, and hence the users can transmit data during data transmission interval.In this mechanism,the contention interval is made flexible according to the number of collisions between collided cognitive users.By this backoff mechanism, throughput of cognitive radio networking is maximized.

II.EXISTING METHOD

In existing method, the SMC-MAC protocol is being used for sensing and sharing the unutilized licensed channels for better coordination among the cognitive users.In this protocol the cycle time is fixed. And once the collision is detected among the cognitive users during contention interval,the users cannot attempt to select the slot once again.The users will be given the next chance only in the next cycle time.So the collided users cannot transmit data during data transmission interval,hence reduces the number of successful cognitive users.The algorithm in existing method is shown below.

ALGORITHM:

Step 1:Variable declaration

N_ch= total number of licensed channels

which can be sensed by cognitive user.

Q = total number of contention slots in

contention Interval.

Count_idle= total number of idle licensed channel.

Step 2:Cognitive user senses the status of licensed

channel and broadcasts the sensed

information.

Step 3:Cognitive user selects contention slot

Randomly.

N_CU cognitive users select contention slot.

IF cognitive users have selected different contention slots then

N_CU users are successful

ELSE

Wait for next cycle time

END

ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com
International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 3, Special Issue 7, January 2016

III.PROPOSED METHOD

In this paper,the backoff mechanism is used for resolving contention among collided cognitive users to increase the number of successful cognitive users. Here once the collision is detected among the users during the contention interval,then the users again attempt to select the contention slot during the same cycle time.So they can transmit data during data transmission interval.So the successful users are increased and hence enhance the throughput of the cognitive radio network.

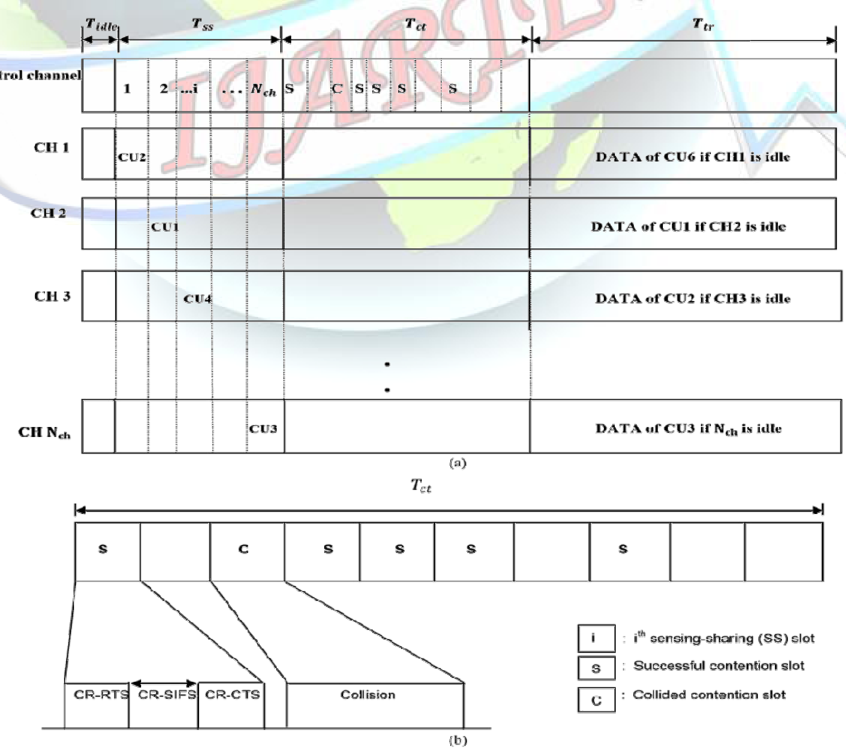
The MAC protocol consists of control channel on which the users can share the sensing results. Each channel is divided into cycle time, Tcycle, which is further divided into four intervals as idle Tidle, sensing-sharing Tss, contention Tct and data transmissionTtr as shown in the figure.1(a).Further,the sensing-sharing and contention interval are divided into number of slots as shown in the figure.1(b).The number of slots in the sensing-sharing interval has to be equal to the number of licensed channels. For the Tidle and Tss, the cognitive users are tuned to control channel.

A.SENSING-SHARING

Each cognitive users select a slot randomly from sensing-sharing interval and sense that particular channel. The users sense the channel in the first sub-slot of a selected slot and broadcast the sensed information in second and third sub-slot of that particular slot. If two users have selected the same slot, then collision occurs, while broadcasting the information. So to avoid collision, the users will not broadcast the information for a particular time after sensing the particular channel. This method of sensing and sharing is performed by all cognitive users and hence each users has sensing information of channel selected by it and by other users.

B.CONTENTION

In contention interval, the cognitive users selects a slot randomly and if two users have chosen a same slot, then the collision is detected. After selecting the slot, source cognitive user sends CR-RTS frame to the destination cognitive user. The slot selection will be successful only if the source cognitive user receives the CR-CTS frame sent by the destination cognitive user.If the user fails to receive the CR-CTS frame then collision is detected. Once the collision is detected, the backoff mechanism is applied where the contention window size is increases hence increases the number of contention slots. Then the



ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com
International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 3, Special Issue 7, January 2016

Fig. 1. (a) MAC protocol for distributed cognitive network. (b) Contention slot expansion of MAC protocol.

users again attempt to select a contention slot to reserve the unutilized licensed channel.

The source cognitive users sends list of available idle channels with CR-RTS frame to the destination cognitive user because there is a possibility that destination cognitive user location all those channels are not idle,so destination cognitive user sends list of selected idle channels/channel with CR-CTS frame,on which they will transmit data during data transmission interval.Once the cognitive user selects the contention slot during contention interval,it will switch cognitive node to that particular channel.And

afterthat,on the selected channel if primary user signal is detected by the cognitive node,the node will stop its transmission to protect the primary user's transmission.The sensing-sharing is performed almost throughout the cycle time by the cognitive users. So sensing results are shared with other users to incorporate cooperation, and hence enhance the throughput of the network. The co-operation of six cognitive users is shown in the figure.1(a).

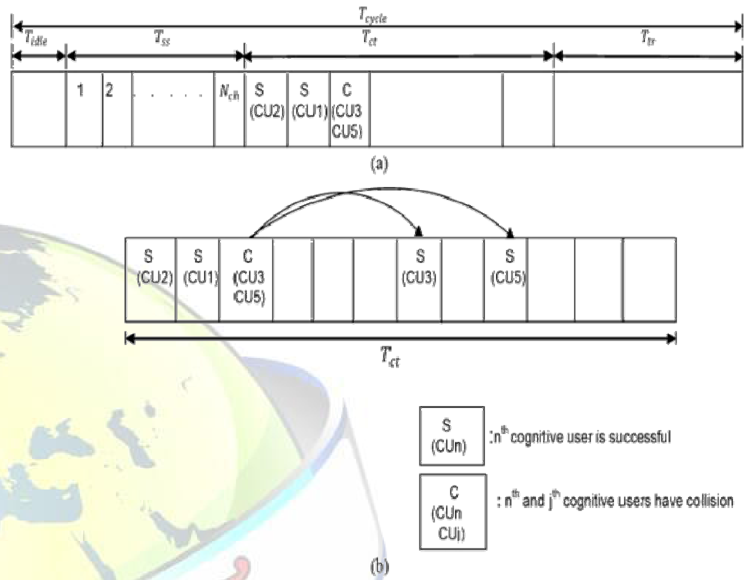


Fig.2. Control channel structure (a) without the backoff algorithm during the contention interval and (b) with the backoffalgorithm during contention interval.

C.DATA TRANSMISSION

The cognitive users can transmit data only after selecting a slot successfully during contention interval. The data transmission interval Ttr is computed by subtracting idle time Tidle, sensing-sharing time Tss and contention time Tct from cycle time Tcycle. The maximum throughput of the network can be achievedonly when all sensed idle channels are being used by the cognitive users.

The maximum achievable throughput can be defined as,

$$\text{Thmax} = \frac{E[N]TtrR}{Tcycle}$$

where ,E[N] = Average number of

sensed idle channels.

R =Datarate

Ttr/Tcycle = Data transmission per cycle interval.

The throughput without backoff algorithm Thwo_bo is given as, minimum of the (Chidle×S) and average number of sensed idle channel.

$$\text{Thwo\_bo} = \frac{E[\min(chidle \times S, E[N])]TtrR}{Tcycle}$$

Where, Chidle = number of idle channels that cognitive user allowed to use.

S = number of successful cognitive users.

The throughput with backoff algorithm Thw_bo is given as,

ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com
International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 3, Special Issue 7, January 2016

$$Thw\_bo = \frac{N \times Chidle \times Ttr \times R}{Tcycle}$$

Where, N= number of successful users after backoff algorithm.

The below flowchart shows the whole procedure involved in self scheduled MAC protocol with backoff mechanism in contention interval.

1. The cognitive users senses the status of particular licensed channel. After sensing the channel , it broadcasts the information to all the cognitive users. This process is repeated until all the licensed channels are being sensed.

2. After sensing the channel, cognitive users randomly select contention slot from the total contention slot. Then the source cognitive user sends CR-RTS frame to destination user.

3. If the CR-CTS frame is received successfully by the source cognitive user, then the data can be transmitted on that contention slot.

4.If the CR-CTS frame is not received by the source cognitive user,then the collision is detected.

5.Then the backoff algorithm is applied to resolve collision by choosing the other contention slot.

6. If the selected slot is again collided,then the above step is repeated.This is done till the users choose the different contention slot.Then the users transmit data duringdata transmission interval.

FLOWCHART:

ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com
International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 3, Special Issue 7, January 2016

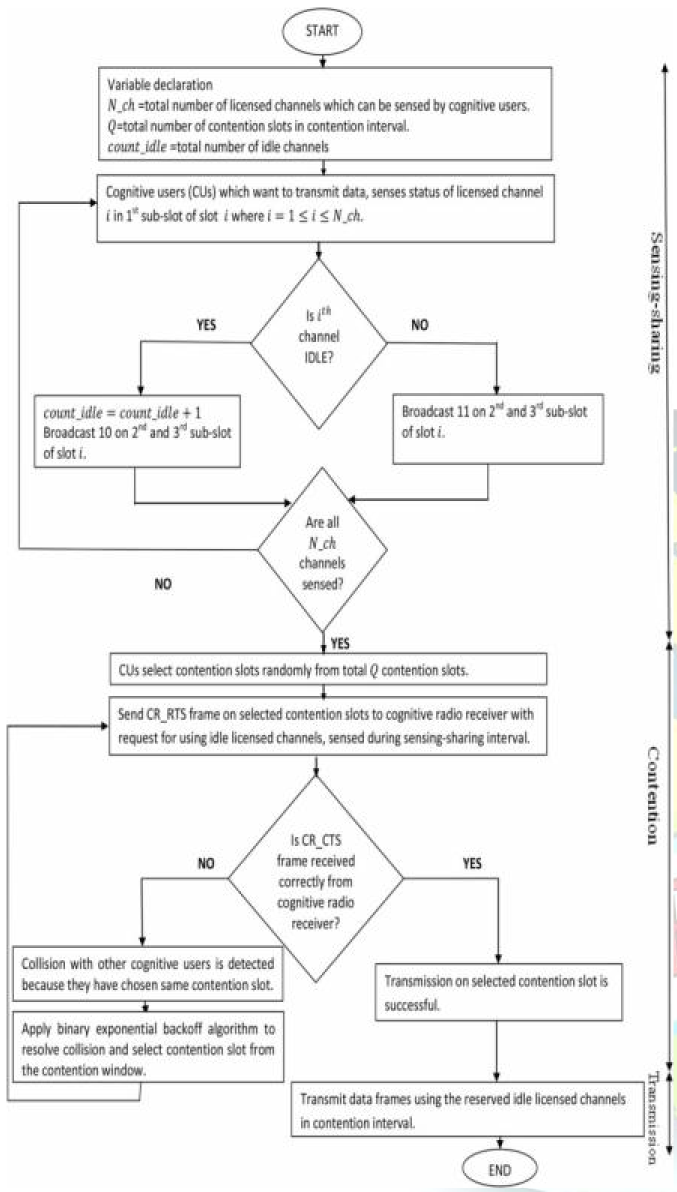


Fig.2.Packetdeliveryratio with and without Backoffalgorithm.

IV.CONCLUSION

In this paper,the self scheduled multi channel MAC protocol with backoff mechanism is been proposed.In this method,the maximum throughput is attained for cognitive network by increasing the number of successful users.The successful users are increased by resolving contention using backoff algorithm during the contention interval.In proposed method,the maximum possibility of collision has been avoided and number of successful users are increased.In this method, eventhough collision is minimized using backoff mechanism, it consumes time and there may be data loss during contention. In future,the method of providing priority to secondary users can be performed to overcome the time consumption and data loss.

V.SIMULATION RESULTS

The simulation results are given below.

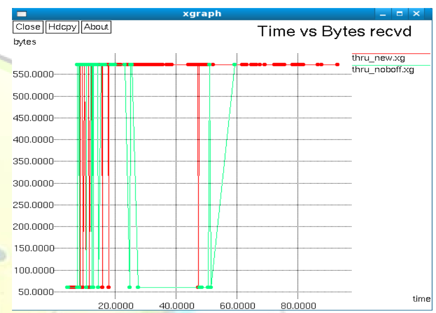
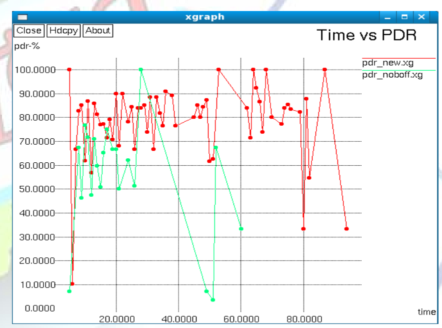


Fig.1.Throughput with and without Backoff algorithm.



REFERENCES:

[1]. Y.-C. Liang, K.-C. Chen, G.-Y. Li, and P. Mähönen, "Cognitive radio net-working and communications: An overview," *IEEE Trans. Veh. Technol.*, vol. 60, no. 7, pp. 3386–3407, Sep. 2011.
[2]. R. Tandra, S. M. Mishra, and A. Sahai, "What is a spectrum hole and what does it take to recognize one?" *Proc. IEEE*, vol. 97, no. 5, pp. 824–848, May 2009.
[3]. S. Pandit and G. Singh, "Throughput maximization with reduced data loss rate in cognitive radio network," *Telecommun. Syst.,* Aug. 17, 2013, DOI: 10.1007/s11235-013-9858-z.
[4]. "Distributed MAC protocol for cognitive radio

ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com
International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 3, Special Issue 7, January 2016

networks: Design, analysis, optimization," *IEEE Trans. Veh. Technol.*, vol. 60, no. 8, pp. 3990–4003, Oct. 2011.

[5]. J. Jias, Q. Zhang, and X. Shen, "HC-MAC: A hardware-constrained cog-nitive MAC for efficient spectrum management," *IEEE J. Sel. AreasCommun.*, vol. 26, no. 1, pp. 106–117, Jan. 2008.

[6].A. Motamedi and A. Bahai, "MAC protocol design for spectrum-agile wireless networks: Stochastic control approach," in *Proc. 2nd IEEEInt. Symp. New Frontiers DySPAN*, Dublin, Ireland, Apr. 17–20, 2007, 448–451.

[7].C. Cordeiro and K. Challapali, "C-MAC: A cognitive MAC protocol for multi-channel wireless networks," in *Proc. 2nd IEEE Int. Symp. NewFrontiers DySPAN*, Dublin, Ireland, Apr. 17–20, 2007, pp. 147–157.

[8]. Christo Ananth, S.Esakki Rajavel, I.AnnaDurai, A.Mydeen@SyedAli, C.Sudalai@UtchiMahali, M.Ruban Kingston, "FAQ-MAST TCP for Secure Download", International Journal of Communication and Computer Technologies (IJCCTS), Volume 02 – No.13 Issue: 01 , Mar 2014, pp 78-85

[9].S. Lim and T.-J. Lee, "A self-scheduling multi-channel cognitive radio MAC protocol based on cooperative communications," *IEICE Trans.Commun.*, vol. E94-B, no. 6, pp. 1657–1668, Jun. 2011.