A Cross Layer Design between MAC and Routing Protocols for Cognitive Radio Networks

K. Kavyalakshmi*, PG Student, G. Padmavathi, Professor,
*Department of Electronics and Communication,
Sri Venkateswara College of Engineering, Sriperumbudur,

Abstract- **A cross layer protocol design approach for cognitive radio has been presented in this paper. The power adaptation is done in the secondary user transmitter based on the relay node. To enhance the signal transmission of the secondary user (SU) when the receiver moves out of coverage area of the SU transmitter. The efficient data transmission is achieved using relay nodes between the SU transmitter and receiver. The achievable transmission rate in bits/sec is used to evaluate the performance of the secondary user in mobile cognitive radio environment. An Energy Efficient Threshold Sensitive Hierarchical Routing Algorithm (ETSHRA) for Cognitive wireless sensor networks also has been discussed in this paper.**

Keywords- Cross layer, Secondary user, Power adaptation, Routing protocol, Relay node.

I. INTRODUCTION

As the number of wireless devices increases the demand of the radio spectrum has dramatically increased. Thus, for the new wireless devices the spectrum is scarce. Due to the current fixed spectrum allocation policy 85 percent of the assigned spectrum is underutilized. Cognitive radio (CR) technology is a promising solution to alleviate the spectrum insufficiency problem. . Cognitive radio (CR) arises to be a tempting solution for the spectrum scarcity problem by introducing the opportunistic usage of frequency bands that are not heavily occupied by the licensed users. One of the main ideas of the opportunistic spectrum access in a Cognitive radio network is to allow secondary users (SUs) to maintain efficient data transmissions without causing interference to the licensed users. Thus by power adaptation technique controlling the transmission power of SUs the achievable rate is increased. The relative distance changes in a mobile CR network if SUs move away from each other. Thus, the transmission power of the secondary user needs to be adapted to maintain their communications. The transmission range of the SU transmitter under the current transmission power is represented by a circle. The continuous communication is not feasible without power adaptation when the SU receiver moves out of the transmission range. The integration of cognitive radios and wireless sensor networks enables the successful transmission of packets to the base station. Routing in cognitive wireless sensor networks provides maximum utilization of energy and reliability. The routing protocol groups the sensor nodes into clusters with each led by a cluster head. At every cluster change time, the cluster head broadcasts the threshold values to its member nodes. The absolute value beyond which, the node sensing the value must switch on its transmitter and report to its CH is the hard threshold. A small change in the value of the sensed attribute, which triggers the node to switch on its transmitter and transmit, is the soft threshold.

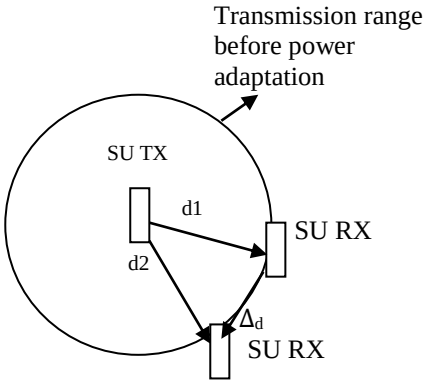

Fig.1 Mobile cognitive radio network

II. POWER ADAPTATION

The continuous communication between the two SUs is feasible by using power adaptation. Assume that the power adaptation capability to each SU in a mobile cognitive radio network. Each SU can transmit at any power which is in the range of the maximum transmission power so that there is a communication between the secondary users.

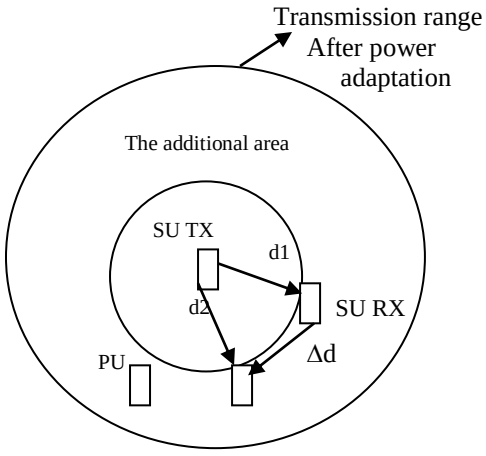

Fig.2. Mobile CRN with power adaptation

Consider a power adaptation scheme in a mobile cognitive radio network. Assume that there are two SUs communicating with each other in mobile cognitive radio environment. In addition, there are PUs distributed in the network area and M channels available. Fig.2 shows the network model, considering the PU and the SU's. First of all, assume that the distance between the SU transmitter and the SU receiver (Rx) is d1. Then, the SU receiver keeps moving away from the SU transmitter the next location of the SU receiver after moving for a certain amount of time is d2. In addition, the information about the speed of the SU Rx is known to the SU transmitter. In this paper, we assume that the SU transmitter and PU do not move. Moreover, the speed of the SU Rx is v and the moving angle is θ with respect to the radial direction.

III. PROPOSED WORK

A. *Power Adaptation in mobile CRN*

The proposed protocol mainly focuses on the following,
To adapt the secondary user transmission power based on the mobility information of the moving SU? When the SUs moves out of the transmission range of each other, to ensure that the communication is not dropped for the secondary users. The received power based on the two-ray ground propagation model,

$$P_r = \frac{P_t G_t G_r h_t^2 h_r^2}{d^a} \quad (1)$$

Where,
P_t- Transmission power
G_t- Gain of the transmitter antennas
G_r- Gain of the receiver antennas
h_t- Height of the transmitter antennas
h_r - height of the receiver antennas
d - Distance between transmitter and the receiver
a - Path loss factor.

Assume that the SU receiver must maintain the received power above Pr. Therefore, the power of the SU transmitter can be given in the following equation:

$$P_t \quad \frac{P_r d^a}{G_t G_r h_t^2 h_r^2} \quad (2)$$

In order to maintain continuous communications the process of adapting the SU transmission power need to perform the power adaptation periodically. We design to address this problem by changing the power at an equal interval time. The power adaptation formulation can be given as follows:

$$P_t(n) = \frac{P_r(d_0 + nv\cos\theta\,\delta_t)^a}{G_t G_r h_t^2 h_r^2} \quad (3)$$

$$P_t(n+1) = \frac{P_r(d_0 + (n+1)v\cos\theta\,\delta_t)^a}{G_t G_r h_t^2 h_r^2} \quad (4)$$

$$P'_t = P_t(n+1) - P_t(n) \quad (5)$$

where,
$P_t(n)$ - Transmission power after the n-th power adaptation
P'_t - The difference of the two consecutive rounds of the power adaptation.
d0 - distance
n - Starts with 0.

B. *Energy Efficient Threshold Sensitive Hierarchical Routing Algorithm Protocol*

All nodes are capable of communicating with each other and to the base station. The cluster head performs data aggregation and data dissemination. The ETSHRA provides good scalability and network life time. Power management is maximum in ETSHRA. The ETSHRA enhances the network lifetime by utilizing the resources efficiently by distributing the load uniformly, aggregating data at the cluster head. The operation of ETSHRA is broken up into the following rounds where each round begins with a setup phase, followed by a steady state phase. Every round begins with a cluster head selection where each node in the network decides whether to become the cluster head for the current round or not. The threshold equation for cluster head selection for any node is given by,

$$T(n) = \frac{P}{1 - P * (r \bmod 1/P)} \quad (6)$$

If $n \in G$, T (n) – 0
Where,

P - Desired percentage of CH,
r - Current round
G - Set of nodes that have not been cluster head in the last 1/P rounds

IV. SIMULATION RESULTS

A. *Achievable transmission rate in mobile CRN*

To enhance the signal transmission between the secondary user transmitter and the receiver when the secondary user is in a mobile environment.

Table 1. Describes the simulation parameters

SIMULATION PARAMETER	VALUE
Source node, N_s	1
Relay node, N_r	2
Destination node, N_d	1
Channel model	Rayleigh fading

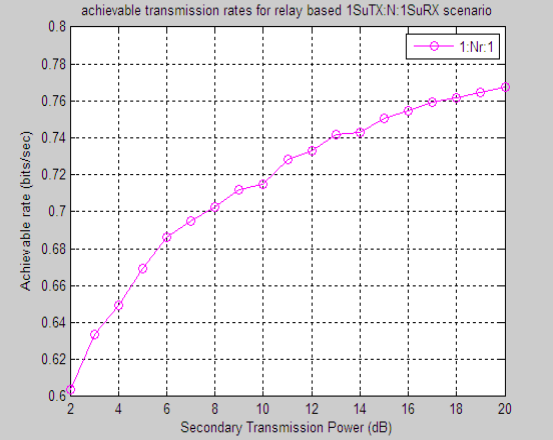

Fig.3. Secondary transmission power Vs achievable transmission rate

V. CONCLUSION

A cross layer design approach between MAC and Routing protocols for cognitive radio network has been demonstrated in this paper. The power adaptation protocol with relay path in MAC layer provides improved achievable rate compared to direct path. The ETSHRA routing protocol in the network layer improves successful packet transmission.

VI. REFERENCES

[1] Monica R Mundada, Savan Kiran, Shivanand Khobanna, Raja Nahusha Varsha and Seira Ann George," A Study On Energy Efficient Routing Protocols In Wireless Sensor Networks", International Journal of Distributed and Parallel Systems (IJDPS) Vol.3, No.3, May 2012.

[2] Usman Mansoor, Muhammad Khalil Shahid,"Cluster based Energy Efficient Sensing for Cognitive Radio Sensor Networks", International Journal of Computer Applications (0975 – 8887) Volume 88 – No.7, February 2014.

[3] Abolarinwa J.A, SalawuN and Achonu A, "Cognitive Radio-based Wireless Sensor Networks As Next Generation Sensor Network: Concept, Problems and Prospects", Journal of Emerging Trends in Computing and Information Sciences, ISSN 2079-8407, Vol.4, No.8 August 2013.

[4] Adnan Aijaz and A. Hamid Aghvami,"Cognitive Machine-to-Machine Communications for Internet-of-Things: A Protocol Stack Perspective" IEEE Internet of Things Journal, Vol. 2, No. 2, April 2015.

[5] Y. Zhang et al., "Cognitive machine-to-machine communications: Visions and potentials for the smart grid," IEEE Netw., vol. 26, no. 3, pp. 6–13, May–Jun. 2012.

[6] I. F. Akyildiz, W.-Y. Lee, M. C. Vuran, and S. Mohanty, "Next generation/dynamic spectrum access/cognitive radio wireless network:A survey in Computer Networks(Elsevier), November 2006.

[7] L.-C. Wang and A. Chen, "Effect of location awareness on concurrent transmissions for cognitive ad hoc networks overlaying infrastructure based system," in IEEE Transactions on Mobile computing, May 2009.

[8] Dan Wang, Yi Song, and Zhitao Yang," A Joint Power Adaptation and Spectrum Handoff Scheme in Mobile Cognitive Radio Networks", International Conference on Computing, Networking and Communications, Wireless Networks Symposium, 2015.

[9] Ameer Ahmed Abbasi and Mohamed Younis, "A survey on clustering algorithms for wireless sensor networks", Computer Communications, 2007.

[10] G. Shah and O. Akan, "Spectrum-aware cluster-based routing for cognitive radio sensor networks," in IEEE International Conference on Communications (ICC) 2013, pp. 2885–2889, 2013.

[11] Tata Jagannadha Swamy, Thaskani Sandhya and Dr. Garimella Ramamurthy, "Energy Efficient Architecture to Cognitive Radio Wireless Sensor Networks", International Journal of Computer Networks and Wireless Communications (IJCNWC), Vol.2, No.6, December 2012.

[12] X. Li, D. Wang, J. McNair, and J. Chen, "Dynamic spectrum access with packet size adaptation and residual energy balancing for energy-constrained cognitive radio sensor networks," Journal of Network and Computer Applications, 2013.

[13] Dan Wang, Yi Song, and Zhitao Yang,"A Joint Power Adaptation and Spectrum Handoff Scheme in Mobile Cognitive Radio Networks", International Conference on Computing, Networking and Communications, 2015.

[14] Dr. K. Vanitha, S. Vishnupriya," International Journal of Advanced Research in Computer Science and Software Engineering", International Journal of Advanced Research in Computer Science and Software Engineering 5(4), April- 2015, pp. 1085-1090.

[15] J. Palicot, "Cognitive radio: An enabling technology for the green radio communications concept," in Proc. ACM Int. Wireless Commun. Mobile Comput. Conf. (IWCMC), 2009, pp. 489–494.

[16] M. Palattella et al., "Standardized protocol stack for the Internet of Things," IEEE Commun. Surveys Tuts., vol. 15, no. 3,pp. 1389–1406, Third Quarter 2013.

[17] M. Palattella et al., "Standardized protocol stack for the Internet of Things," IEEE Commun. Surveys Tuts., vol. 15, no. 3,pp. 1389–1406, Third Quarter 2013.

[18] Wireless Medium Access Control (MAC) and Physical Layer (PHY) Specifications for Low-RateWireless Personal Area Networks (WPANs),IEEE Standard 802.15.4, Sep. 2006.

[19] J. Rudell, V. Bhagavatula, and W. Wesson, "Future integrated sensor radios for long-haul communication," IEEE Commun. Mag., vol. 52,no. 4, pp. 101–109, Apr. 2014.

[20] K. Chowdhury and I. Akyildiz, "CRP: A routing protocol for cognitive radio ad hoc networks," J. Sel. Areas Commun., vol. 29, no. 4, pp. 794–804, 2011.

[21] A. Aijaz, H. Su, and A.-H. Aghvami, "CORPL: A routing protocol for cognitive radio enabled AMI networks," IEEE Trans. Smart Grid, vol. 6,no. 1, pp. 477–485, Jan. 2015.

[22] A. Aijaz and A.-H. Aghvami, "PRMA-based cognitive machine-tomachine communications in smart grid networks," IEEE Trans. Veh.Technol., 2014.