Advanced Science and Technology Letters
Vol.53 (ISI 2014), pp.92-96
http://dx.doi.org/10.14257/astl.2014.53.22

A Routing Mechanism for Cognitive Radio Ad Hoc Networks

Qian Zhao [1], Guangsheng Feng[2], Chen Zheng[2]

[1] School of Computer and Information Engineering, Harbin University of Commerce, Harbin, China
[2] College of Computer Science and Technology, Harbin Engineering University, Harbin, China,
{zhaoqian,fengguangsheng,zhengchen}@hrbeu.edu.cn

Abstract. Node failure and link failure happen frequently in cognitive radio Ad Hoc networks. In order to maintain the connection between cognitive users and resume their communication as soon as possible when the current route is invalid, a reliable routing mechanism is proposed. Meanwhile, how to choose candidate route, maintain or rebuild route are also elaborated. Numerical simulations show that the proposed protocol has a higher performance compared with other typical protocols.

Keywords: Ad Hoc networks, Reliability, Candidate route.

1 Introduction

Cognitive radio Ad Hoc networks, abbreviated as CRAHNs, is a kind of distributed networks combined with cognitive radio technology and Ad Hoc networks, which is proposed to alleviate the crowded ISM spectrum used by CRAHNs terminals as well as other wireless communication systems[1].One typical scheme to enhance route reliability is through warding off the collision regions or links with PUs[2-3].Another reliable route scheme is achieved by means of allocating and switching channels [4-8]. In case of collision, how to resume SUs' connection and communication still remains unsolved. Unlike the conventional research works, we propose a reliable communication route protocol in CRAHNs on the basis of multi-path route, which employs primary route to communicate when there is no link failure or node failure.

In most traditional route mechanisms, the collision with PUs in CRAHNs is impossible to avoid thoroughly. In case of collision, how to resume SUs' connection and communication still remains unsolved. In addition, how to rebuild the route in some extreme conditions is still an open issue. Unlike the conventional research works, we propose a reliable communication route protocol in CRAHNs (CARC) on

This work was supported in part by Science and Technology Research Projects of Department of Education in Heilongjiang Province under Grant 12521135. The Natural Science Foundation of Heilongjiang Province E201452.The Support Program for Young Academic Key Teacher of Higher Education of Heilongjiang Province (1254G030)

ISSN: 2287-1233 ASTL

the basis of multi-path route, which employs primary route to communicate when there is no link failure or node failure, and otherwise the candidate primary can be used to resume the communication.

2 Route protocol

The typical scenario of the multi-hop CRAHNs is shown in Fig. 1, in which more than one PUs and SUs are coexisted in a common network region, and the communication between two SUs is by way of other relay SUs with a multi-hop manner. Here we employ the typical ON-OFF mechanism to denotes PU's activities, i.e., the state 'ON' stands for the authorized channel being occupied by some PU and the 'OFF' for its vacancy. Suppose K denotes the set of authorized channels, and T_{ON}^{k} ($k \in K$) is the duration of the PU's activities, which is an exponential distribution with parameter λ_k. In other words, the duration from a PU's arrival to departure at some channel is exponential distribution. Correspondingly, the T_{OFF}^{k} ($k \in K$) for a PU without accessing the authorized channel is also exponential distribution with parameter μ_k, thus the expected durations for 'ON' and 'OFF' stages are $1/\lambda_k$ and $1/\mu_k$.

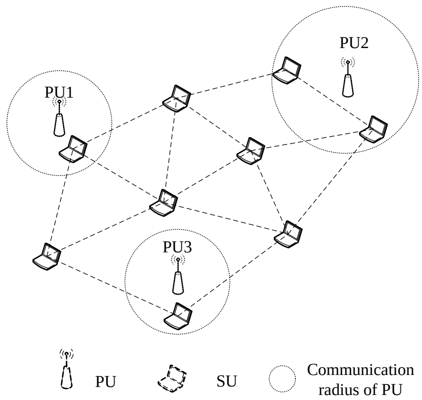

Fig. 1 A typical scenario of CRAHNs

The proposed route protocol is designed on the basis of AODV, and the channel information has been added into the format of control packet, which is used for selecting an optimal primary route as well as candidate route. Just as the conventional AODV, the proposed protocol is also consisted of three parts: route discovery, route response and route maintenance.

In the process of route discovery, the on-demand route manner is employed. When the source node begins to communicate with the destination but there is no any reachable path in the route table, the source node will broadcast the RREQ packet to its neighbors. Once the RREQ packet is received by its neighbor nodes, it will be inspected and one of the following cases will be happen. Firstly, check the field of hop. Secondly, check the set of available channels in the current node. Thirdly, check the relay node IP addresses and make sure whether the current node IP is in the relay IP set or not. Lastly, check whether the received RREQ packet is the destination node.

In cognitive Ad Hoc networks, the changing of network topology will possibly cause some nodes, links failure, or link quality decreased dramatically. Especially the PU's arrival maybe result in the interruption of some connections between SUs, and thus the data communication cannot be completed with high reliability and stability. Therefore, how to handle those problems will be crucial, which is also the key point in route maintenance and rebuilding. When a route path is failed, the related nodes should take the following actions to ensure the communication quality.

3 Simulation analysis and comparison

In order to verify the performance of the proposed protocol compared with JSORP [9]and SEARCH[2], the simulation experiments are conducted with simulation tools ns2. In our experiments, 50 nodes are randomly placed in a 1000*1000 m2 region, and 35 authorized channels are existed in the simulation process. The duration of the authorized channel occupied by PU is obliged to a exponential distribution with a parameter λ , and the remaining duration is also a exponential distribution with parameter μ , where λ and μ are generated in [0.5, 1.0] randomly. The maximum of interference avoiding time Tm is 1.4s and the maximum connections between SUs are set 35. The parameter φ is set 0.6 and the simulation process lasts 300s. The amounts of PU are varying from 5 to 35, i.e., its amount takes value of 5, 10, 15, 20, 25, 30, and 35. The velocity of SU takes value of 1m/s, 4m/s, 8m/s, 12m/s, 16m/s, 18m/s and 21m/s.

Fig. 2 and Fig. 3 show the delivery rates of three kind protocols with different PUs amount as well as connections amount. With the amount increasing of PUs or connections, the delivery rates of JSORP and SEARCH protocols are decreased rapidly, but the proposed protocol descends slowly. The reason is that the PUs activities are taken into account when the protocol is designed, but this factor has been omitted by th

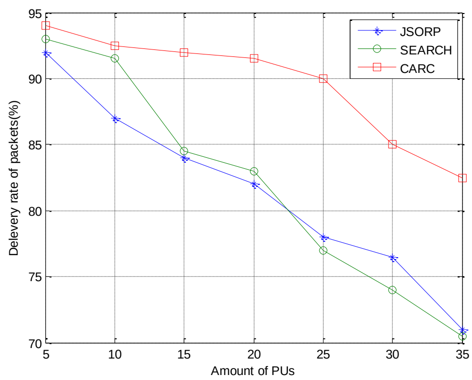

Fig. 2 The delivery rate of SU's packets with different amounts of Pus

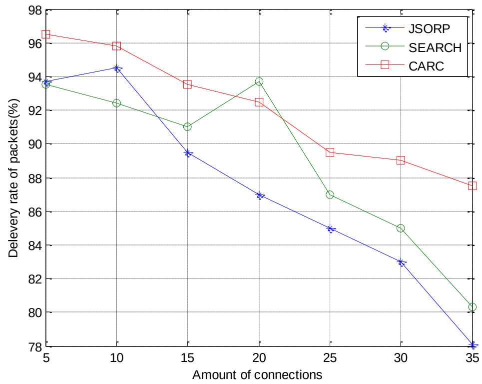

Fig. 3 The de nections

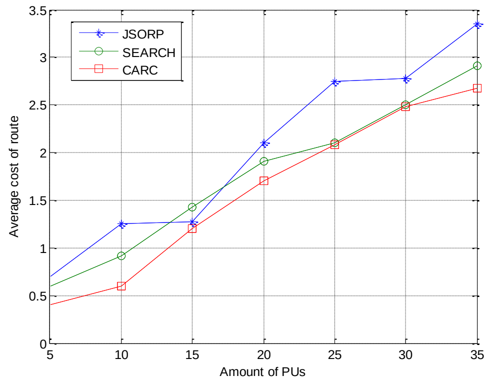

Fig. 4 Average cost of route with different PUs amounts

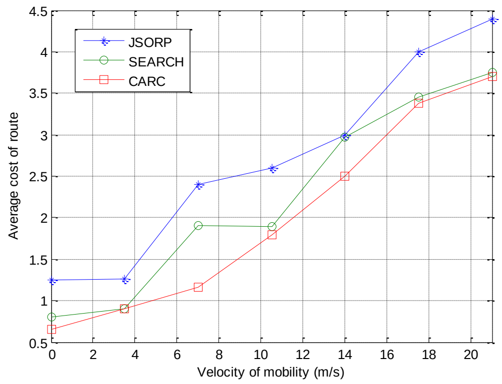

Fig. 5 Average cost of route with different SUs mobile velocities

Fig. 4 and Fig. 5 show the average route costs of three protocols with different amount of PUs as well as different velocities of SUs, which is described as the ratio of total control packets and data packets. The overall trends of those protocols are ascending with increasing of PUs number or SUs velocity, but the proposed protocol has a higher performance because the candidate route could alleviate the network workload and route cost when the communication disconnection events happen frequently.

4 Conclusion

In this paper, we propose a reliable route protocol in cognitive Ad Hoc protocols. Compared with other typical route protocols, the proposed protocol can enhance the reliability of route from the aspects of route discovery and maintenance, which can not only increases the packet delivery rate efficiently, but also decrease the route cost to some extent. On the other hand, our protocol will bear some overhead on the network nodes that maybe has a restricted computation capacity or energy, thus we will continuously explore this kind of route protocol in consideration of energy consumption in further work.

References

1. F. Akyildiz, W.-Y. Lee, and K. R. Chowdhury, CRAHNs: Cognitive radio ad hoc networks, Ad Hoc Networks, vol. 7, pp. 810-836, (2009)
2. K. R. Chowdhury and M. Felice, Search: A routing protocol for mobile cognitive radio ad-hoc networks, Computer Communications, vol. 32, pp. 1983-1997(2009)
3. J.-W. Wang and R. Adriman, Analysis of cognitive radio networks with imperfect sensing and backup channels, 2013 Seventh International Conference on Innovative Mobile and Internet Services in Ubiquitous Computing (IMIS), pp. 626-631.(2013)
4. H. Zhao, L. Huang, Y. Zhang, and H. Xu, A stable Joint routing and spectrum scheduling scheme for cognitive radio ad hoc networks, 2011 Seventh International Conference on Mobile Ad-hoc and Sensor Networks (MSN), pp. 323-329.(2011)
5. F. Yao, J. Zhang, H. Zhao, and Y. Liu, Practical cross‐layer routing and channel assignment in cognitive radio ad hoc networks, Wireless Communications and Mobile Computing(2013)
6. J. Li, Y. Zhou, L. Lamont, and F. Gagnon, A Novel Routing Algorithm in Cognitive Radio Ad Hoc Networks, in Global Telecommunications Conference (GLOBECOM 2011), pp. 1-5(2011)
7. L. Gui, S. Zou, and X. Zhong, Distributed best-route selection for multipath routing in cognitive radio ad hoc networks, Electronics Letters, vol. 48, pp. 1630-1632(2012)
8. Y. Song and J. Xie, Prospect: A proactive spectrum handoff framework for cognitive radio ad hoc networks without common control channel, IEEE Transactions on Mobile Computing, vol. 11, pp. 1127-1139(2012)
9. G. Cheng, W. Liu, Y. Li, and W. Cheng, Joint on-demand routing and spectrum assignment in cognitive radio networks, IEEE International Conference on ICC'07, pp. 6499-6503(2007)

