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Maximizing Network Capacity through a Novel Topology Control Scheme

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Abstract -Mobile Ad Hoc Networks comprise nodes connected without fixed infrastructure. The nodes have limited resources. In this context, it is essential in MANET to have cooperative communications. There have been many prior works on the cooperative communications. However, they focus more on issues pertaining to link level physical layer ignoring the impact of issues related to upper layer such as network capacity, routing and topology control. Recently GUAN et al. proposed a topology control scheme in order to improve network capacity. In this paper we implement the scheme using a custom Simulator which demonstrates the proof of concept. The empirical results revealed that the cooperative communications in the physical layer have their positiveimpact on network capacity of MANET.

Index Terms–MANET, physical layer, and cooperative communications

I. INTRODUCTION

There has been increased number of mobile users.The mobile users expect more speed in mobile networks. The wireless medium throws many challenges. The problem with mobile nodes include they are resource constraint, they have mobility problem that causes disconnecting from one network and connecting to another network. Cooperative wireless communications have become more attractive solutions for improving network capacity. It also supports multiple antenna systems and corresponding strategies [1]. The broadcast nature of mobile channel can be exploitedfor achieving cooperative communications. For performance improvement virtual antennas can be used with a single-antenna. IEEE 802.16j has provided support for this kind of development [2]. The existing systems on the cooperative communications focused on physical layer issues at link level. The issues are pertaining to outage capacity and outage probability [3], [4]. At the same time they ignored issues pertaining to network-level upper layer such as network capacity, routing and topology control. As a matter of fact most wireless networks use wireless links where point to point non-cooperative in nature are. They look complex. However, recent technologies let the wireless networks to be more flexible when compared with conventional techniques. Cooperative communication in wireless network reduces problems such as routing, collision resolution for simple networks made up of complex links [5]. Therefore to investigate the problems in depth, further research is needed to know the impact of topologycontrol on the network capacity in case of MANETs. MANETs have no centralized control. The nodes in the network need to cooperate with each other to achieve a common goal. The nodes are responsible for neighbor discovery, topology organization and topology reorganization. The topology control empowers a node to choose neighbors in such way that it results high throughput and low energy consumption [6].

Recently Guan et al. [7] presented a novel l scheme for topology control for MANETs throughcooperative communications. The results of their study revealed that the cooperative communications have significant impact on the network capacity of MANETs. The remainder of this paper is organized as follows. Section II provides details of proposed work that focuses on the network capacity improvement in MANETs. Section IIIpresents the prototype application. Section IV presents experimental results while section V concludes the paper.

II. NETWORK CAPACITY IMPROVEMENT IN MANET

This section provides the details regarding network capacity improvement in MANETs. Before going to this discussion, it throws light into cooperative communications, topology control, and capacity of MANETs.

Cooperative Communications

Cooperative communications is a system where mobile users share resources in order to improve the quality of communications. Relay communication is generalized here. The cooperative communication results in high quality of

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data transmission and improves energy consumption. The figure 1 shows three types of protocols that can be used for communications in Mobile Ad Hoc Networks.

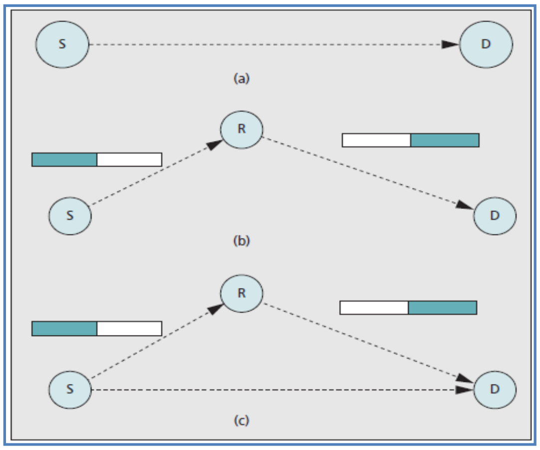

Fig. 1 –Three types of communications (excerpt from [7])

As can be shown in fig. 1, there are three types of protocols used for communications in MANET. The first one denoted as (a) is an example for direct communication through a point to point conventional link. The second protocol, as denoted in (b), shows multi-hop transmissions through two-hop fashion occupying two time-slots. The third protocol denoted by (c) makes use cooperative communications through a cooperative diversity occupying two consecutive slots. At the destination the two signals are combined in order to decode the information.

Topology Control

Topology is nothing but the physical placement of nodes in MANET. However, the nodes in MANET are not static. They move dynamically from one place to another place. This is known as mobility of nodes. Due to the mobility nature of the MANET it is known that the topology is not static and it will change from time to time. By controlling the topology it is possible to improve network capacity. Topology control refers to the process of deploying links in such a way that it improves throughput, network capacity and improves energy consumption in nodes.

Network Capacity of MANETs

The ability of delivery of information in MANET is known as its network capacity. Gupta and Kumar [8] explored the issues with network capacity in their landmark paper. They introduced two categories of network capacities. They are known as transport capacity and throughput capacity. The former resembles one-hop capacity considering distance, while the latter is which depends on the information capacity of a channel.

Network Capacity Improvement

Network capacity can be improved by controlling topology through cooperative communications. First of all network capacity has to be set an objective function. The objective function can be expressed as follows.

$$G^* = \arg\max f(G),$$

s.t.network connectivity

It denotes that there is original network topologyrepresented by G which is made up of multiple nodes and links as input. As per the objective function better topology is constructedwhich is represented as follows.

$$G^*(V, E^*)$$

The link capacity and interference model are considered to derive network capacity. Considering a direct transmission between sender and receiver, if outage probability is known it is possible to compute outage link capacity. Multi hop transmission can also be used in the network. Such transmission can be illustrated using two-hop transmission. There are two time slots consumed in this approach. The first time slot is used to transmit messages from source to relay node. The second time slot is used to ensure that the messages reach the destination. However, in each hop interference is recorded when messages are transmitted over MANET nodes. As the communication can't take place simultaneous and two time slots are being used end to end interference has to be considered. Outage of transmission at each hop can be considered to compute the outage of two hop transmission. At each hop the transmission has interference of its own. Transmissions pertaining to two hops can't be done simultaneously as they need two different time slots; maximum of two interface sets is considered for end to end interference.

Selection of proactive best rely is required when cooperative transmission is used. We have implemented a decode-and-forward scheme for the relay. The first slot is used by the source node to send messages to relay and destination node. When the relay node receives data it will decode and re-encodes data before forwarding it to destination. The signals of source and relay are decoded in destination node. The outage probability and outage capacity can be computed [3]. In order to ensure successful transmission of data in the broadcast period, the covered neighbors of relay and destination node and source need to be silent. Network capacity can be derived using interference models and also link capacity [9]. The derived value can be used to set as an objective function for the selected topology control problem. The proposed schemes, from the link-level perspective, canextent the cooperative communications at physical layer. Based on the objective function, the model can obtain the best type of transmission. In the proposed topology control

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scheme, two conditions are used. They are network connectivity and the path length that determines network capacity. The former is the fundamental requirement of the network for topology control. When the object function is computed in hop-by-hop fashion, network connectivity is guaranteed. Every node can act as in charge of connections for all the neighboring nodes. When the connections are made sure for all the neighbors, it results in end-to-end connectivity. With respect to the former, the system is determined to adapt to only two-hop relying as per the constraints.

III. PROTOTYPE IMPLEMENTATION

The prototype has been implemented as a custom simulator where the cooperative communication is demonstrated. The MANET contains multiple nodes. Between source and destination relay nodes exist. When there is failure in a node, the relay nodes take care of the transmission and ensure that the data reaches destination. Figure 2 shows the communication process.

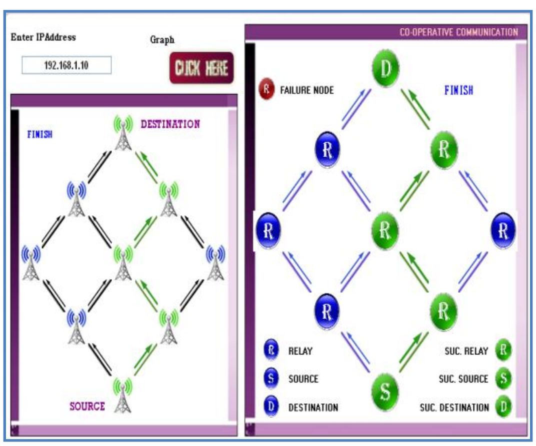

Fig. 2 –Simulation of Cooperative Communications and Topology Control

As seen in fig. 2, it is evident that the communication takes place in cooperative fashion. The source and relay nodes follow the communication process. When any failure takes place, the nodes will cover it and ensure that the data is sent to destination through different route. This is achieved by controlling the topology.

IV. EXPERIMENTAL RESULTS

We built a custom simulator prototype for simulating the MANET with cooperative communications that can improve the network capacity. The implementation is done using Microsoft .NET platform. C# programming language is used to achieve this. The environment used for the application and experiments is a PC with 4 GB RAM, Core 2 dual processor running Windows 7 operating system. The experimental results are compared with LLISE [10] which is one of the well known schemes that do not use cooperative communications. We also considered worst network capacity for evaluating the performance of the proposed system and also the LLISE. By changing different number of node s in MANET various experiments are made. The results are presented in figure 1.

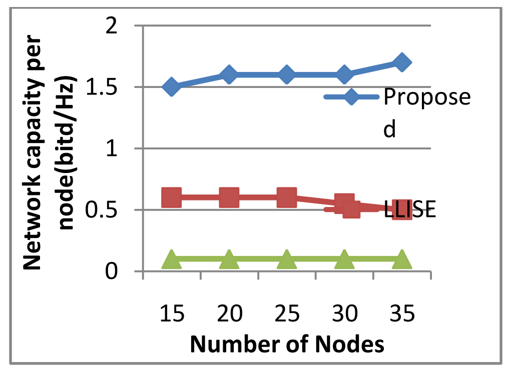

Fig. 2–Number of nodes vs. network capacity

As can be seen in fig. 2, the network capacity per node is comparedagainst the number of nodes. The comparison is made among the proposed topology control scheme, the well known scheme named LLISE which does not use cooperative communications and the worst network capacity scenario. The proposed approach has shown high network capacity per node as it makes use of cooperative communications in physical layer of the network. From this it is understood that the cooperative communications in MANET are better than the one without cooperative communications.

V. CONCLUSION

In this papera scheme is built for improving network capacity of MANET. It considers the cooperative communications in physical layer. Based on the topology control scheme proposed by GUAN et al.[7] we built a prototypecustom simulator application that demonstratesthe usefulness of topology control scheme that makes use upper layer cooperative communications. The empirical results revealed that the cooperative communications in upper layer have impact on improving the network capacity of Mobile Ad Hoc Networks. Considering dynamic traffic patterns to improve the performance of MANET is one possible future direction.

REFERENCES

[1] J. Laneman, D. Tse, and G. Wornell, “Cooperative Diversityin Wireless Networks: Efficient protocols and OutageBehavior,” IEEE Trans. Info. Theory, vol. 50, no. 12,2004, pp. 3062–80.

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[2] P. H. J. Chong et al., "Technologies in Multihop CellularNetwork," IEEE Commun. Mag., vol. 45, Sept. 2007,pp. 64–65.
[3] K. Woraditet al., "Outage Behavior of Selective RelayingSchemes," IEEE Trans. Wireless Commun., vol. 8,no. 8, 2009, pp. 3890–95.
[4] Y. Wei, F. R. Yu, and M. Song, "Distributed OptimalRelay Selection in Wireless Cooperative Networks withFinite-State Markov Channels," IEEE Trans. Vehic.Tech.,vol. 59, June 2010, pp. 2149–58.
[5] Q. Guan et al., "Capacity-Optimized Topology Controlfor MANETs with Cooperative Communications," IEEETrans. Wireless Commun., vol. 10, July 2011, pp.2162–70.
[6] P. Santi, "Topology Control in Wireless Ad Hoc and SensorNetworks," ACM Computing Surveys, vol. 37, no. 2,2005, pp. 164–94.
[7] QUANSHENG GUAN, F. RICHARD, SHENGMING JIANG, and VICTOR C. M. LEUNG, "TOPOLOGY CONTROL IN MOBILE AD HOC NETWORKS WITH COOPERATIVE COMMUNICATIONS", IEEE, pp. 74-80.
[8] P. Gupta and P. Kumar, "The Capacity of Wireless Networks," IEEE Trans. Info. Theory, vol. 46, no. 2, 2000, pp. 388–404.
[9] Q. Guan et al., "Impact of Topology Control on Capacityof Wireless Ad Hoc Networks," Proc. IEEE ICCS,Guangzhou, P. R. China, Nov. 2008.
[10] M. Burkhart et al., "Does Topology Control ReduceInterference?," Proc. 5th ACM Int'l. Symp. Mobile AdHoc Networking and Computing, Tokyo, Japan, May2004, pp. 9–19.

BIOGRAPHIES

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