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Cooperative Communication Based on Power Consumption Control in MANETS

[1]Upasarthi Babu Rao, [2]Shaik Mohammad Rafi

[1]Student, Sri Mittapalli College of Engineering and Technology, Guntur Dist, Andhra Pradesh, India

[2] Associate Professor, Sri Mittapalli College of Engineering and Technology, Guntur Dist Dist, Andhra Pradesh, India

Abstract: Cooperative communication is the main accessing point in present days. These results can be accessed through proactive protocol like route request packet sending and route request packet receiving. The main issue is how communication can be done in MANETS. Mobile Adhoc networks are self-configurable networks; each node behaves like server and client in MANET. Duo to this reason previously COCO (Capacity Optimized Cooperative Communication) model was developed for accessing these types of resources in Manets. This model can't provide sufficient communication for overall network performance. This model provides sufficient capacity optimization in mobile adhoc networks, but this model will be taking more power resources for doing this work. So in this paper we propose to extend COCO model to Quorum based Asynchronous Power Saving technique. In this technique we will provide low power consumption losses in cooperative communication between every node present in the Mobile Adhoc Networks. Experimental results show efficient communication between source and destination.

Key Words: mobile ad hoc networks, network capacity, Topology control, cooperative communications, Proactive protocol

I. INTRODUCTION

The demand for speed in wireless networks is continuously increasing. Cooperative communication methods in wireless networks have been shown in recent years to offer significant performance gains over traditional approaches that ignore the broadcast nature of the wireless medium and are particularly valuable in environments prone to channel shadowing and fading, such as mobile ad-hoc networks. The traditional layered design of wireless networks has followed a similar approach to wired networks that route between a source and a destination is determined in advance and each node along the route is solely responsible for delivering the respective data frames to its next hop.

The concept of *cooperative communications* has attracted considerable research attention in recent years. The majority of cooperative methods considered in the literature fall under the category of physical-layer cooperation or *cooperative relaying*. This range from amplification of the analog source signal directly (*amplify and-forward*) to retransmission of the frame after its decoding (*decode-and-forward*) or transmission of error correcting code bits allowing the receiver to decode the frame by combining the signals from both the original source and the relay (*coded cooperation*). The mobile ad hoc network (MANET) has attracted a lot of attention recently. Generally, MANET consists of a set of mobile hosts, and does not have the support of any base station.

Cooperative wireless communication has received tremendous interests as an untapped means for improving the performance of information transmission operating over the ever-challenging wireless medium. It has emerged as a new dimension of diversity to emulate the strategies designed for multiple antenna systems. By exploiting the broadcast nature of the wireless channel, cooperative communication allows single-antenna radios to share their antennas to form a virtual antenna array, and offers significant performance enhancements. Most of current works on wireless networks attempt to create, adapt, and manage a network on a maze of point-to-point non cooperative wireless links.

A node in MANETs can function both as a network router for routing packets from the other nodes and as a network host for transmitting and receiving data. Due to the lack of centralized control, the MANETs nodes cooperate with each other to achieve a common goal. Topology control is very important for the overall performance of a MANET. Using topology control the node carefully selects a set of its neighbors to establish logical data links and dynamically adjust its transmit power accordingly. Capacity-Optimized COoperative (COCO) topology control scheme to improve the network capacity in MANETs by jointly optimizing transmission mode selection, interference control and relay node selection in MANETs with cooperative communications. Power saving is a critical issue for portable devices supported by batteries. The battery power is a limited resource, and it is expected that battery technology is not likely to progress as fast as computing and communication technologies do. This paper investigates the power mode management problem in an IEEE 802.11-based MANET with cooperative communications that is characterized by multi-hop communication.

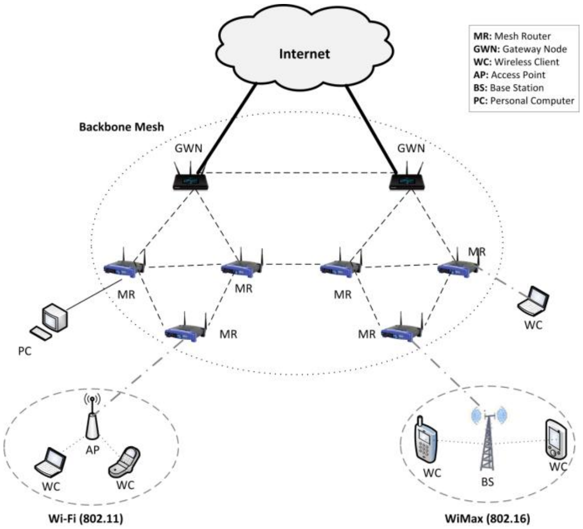

Fig.1. Figure shows the MANET network

MANET [4] has defined its power-saving (PS) mode for *single-hop* (fully connected) MANETs based on periodical transmissions of beacons. There are two major issues that need to be addressed in the power mode management problem in a multi-hop MANET:

Wakeup prediction: Since a host entering the PS mode will reduce its radio activity that send packets to the PS host need to know when the host will turn its radio on so as to correctly deliver packets to it at the right time.

Neighbor discovery: Because hosts' transmission/reception activities are reduced under the PS mode to detect the arrival and departure of other hosts in its radio covered range. Hosts may become less sensitive to neighborhood change. A host may incorrectly report that another host is unreachable if the route to this host has to go through some PS hosts that are not detectable by their neighbors on the path.

Time synchronization in a large-scale distributed environment is generally very costly. The MANET may be temporarily partitioned at any time, even infeasible in a mobile environment since communication delays are typically long. Another solution is to develop asynchronous power-saving protocols. This is first investigated in [5] there has proposed three solutions. Over the three solutions the best probably most interesting one is the *quorum-based* protocol. It has the merit of sending the fewest beacon signals. The central idea in the quorum-based protocol can be related to the *grid quorum system* [6]. The result can potentially bridge the important quorum system concept in traditional distributed systems to the area of mobile computing. We correlate the asynchronous power saving problem to the concept of *quorum systems* that are widely used in the design of distributed systems [7, 8, and 6]. A quorum system is a collection of sets such that the intersection of any two sets is always non-empty. We identify a *rotation closure* property for quorum systems. Through our mechanism any quorum system satisfying this property can be translated to an asynchronous power-saving protocol for MANETs. Any quorum system satisfying the rotation closure property. We identify a group of quorum systems that are optimal or near optimal in terms of quorum sizes that can be translated to efficient asynchronous power-saving protocols.

II. MOBILE AD HOC NETWORKS WITH COOPERATIVE COMMUNICATIONS FOR TOPOLOGY CONTROL

The topology control problem in MANETs with cooperative communications is presented.

Cooperative Communications:

Cooperative communication typically refers to a system where users share and coordinate their resources to enhance the information transmission quality. Early study of relaying problems appears in the information theory community to enhance communication between the source and destination [9]. Increased understanding of the benefits of multiple antenna systems shows the tremendous interests in cooperative communications [1]. It is difficult for some wireless mobile devices to support multiple antennas due to the size and cost constraints. In a simple cooperative wireless network model with two hops (i.e. Sender/Source, Receiver/Destination). The basic idea of cooperative relaying is that some nodes that overheard the information transmitted from the source node. Hence, instead of treating it as interference it may relay it to the destination node. Since the destination node receives multiple independently faded copies of the transmitted information from the source node and relay nodes. Relaying could be implemented using two common strategies:

a. Amplify-and-forward
   The relay nodes simply boost the energy of the signal received from the sender and retransmit it to the receiver.
b. Decode-and-forward
   The relay nodes will perform physical-layer decoding and then forward the decoding result to the destinations.

It is shown that cooperation at the physical layer can achieve full levels of diversity similar to a Multiple Input Multiple Output system. Most existing works about cooperative communications are focused on physical layer issues like decreasing outage probability and increasing outage capacity. Cooperation offers a number of advantages in flexibility over traditional wireless networks that go beyond simply providing a more reliable physical layer link. Direct transmissions and multi-hop transmissions can be regarded as special types of cooperative transmissions. A direct transmission utilizes no relays while a multi-hop transmission does not combine signals at the destination.

Topology Control:

The network topology in a MANET is changing dynamically due to user mobility, node, and traffic, so on. The topology in a MANET is controllable by adjusting some parameters like channel assignment, transmission power, etc. topology control is such a scheme to determine where to deploy the links and how the links work in wireless networks to form a good network topology that will optimize the energy consumption, capacity, end-to-end routing performance of the network. Topology control is originally developed for wireless sensor networks and wireless mesh networks to reduce energy consumption and interference. In a simpler network topology with small node degree and short transmission radius will have high-quality links and less contention in medium access control (MAC) layer. Symmetry can facilitate wireless communication and two way handshake schemes for link acknowledgment while planarity increases the possibility for parallel transmissions and space reuse. Power control and channel control issues are coupled with topology control in MANETs while they are treated separately traditionally. The goal of topology control is then to set up interference free connections to minimize the maximum transmission power and the number of required channels. Topology control focuses on network connectivity with the link information provided by MAC and physical layers. In the network topology there are two aspects:

- Network nodes
- Connection links

We present the proposed Capacity-Optimized COoperative (COCO) topology control scheme for MANETs with cooperative communications.

A. *The Capacity of MANETs*

Network capacity has attracted tremendous interests as a key indicator for the information delivery ability [2]. There are different definitions for network capacity. There are two types of the network capacities:

- Transport Capacity

  It is similar to the total one-hop capacity in the network. One bit-meter means that one bit has been transported to a distance of one meter toward its destination.

- Throughput Capacity

  It is based on the information capacity of a channel. It is the amount of all the data successfully transmitted during a unit time.

Link interference, which refers to the affected nodes during the transmission has the significant impact on the network capacity. The spatial reuse is the major ingredient that affects network capacity. Higher interference may reduce simultaneous transmissions in the network. The MAC function should avoid collision with existing transmission. Nodes within the transmission range of the sender must keep silent to avoid destroying on-going transmissions.

B. *Improving Network Capacity Using Topology Control*

We can set the network capacity as the objective function in the topology control problem to improve the network capacity in MANETs with cooperative communications using topology control. We need to obtain the link capacity and inference model when a specific transmission manner, in order to derive the network capacity in a MANET with cooperative communications. Multi-hop transmission can be illustrated using two-hop transmission. In the first slot messages are transmitted from the source to the relay and the messages will be forwarded to the destination in the second slot. We adopt the decode-and-forward relaying scheme. The two signals of the source and the relay are decoded by maximal rate combining at the destination.

III. PRELIMINARIES

Power Saving Modes in IEEE 802.11:

Under the PS mode the host can reduce its radio activity by only monitoring some periodical signals (such as beacons) in the network. Under the ad hoc mode divides the time axis into equal-length beacon intervals, each of which starts with an ATIM (Ad hoc Traffic Indication Map) window. PS hosts must remain active during the ATIM window so as to be notified by those intending senders, and may go to doze in the rest of the beacon interval if no one intends to send packets to it. Any successful beacon serves the purpose of synchronizing mobile hosts' clocks as well as inhibiting other hosts from sending their beacons. A host with buffered packets can send a direct ATIM frame to each of its intended receivers in the PS mode. It is transmitted by contention in accordance with the DCF (Distributed Coordination Function) access procedure. The buffered unicast packets are then sent based on the DCF access procedure after the ATIM window. If a mobile host is unable to transmit its ATIM frame in the current ATIM window or has extra buffered packets.

Overview of Quorum Based PS Protocol:

IEEE 802.11 only considers single-hop MANETs. The following two issues have to be addressed: wakeup prediction and neighbor discovery. The quorum-based one has the merit of sending the fewest beacon signals. We briefly review the quorum-based protocol proposed in [4]. Hosts can be arbitrarily asynchronous in their clocks. As shown in the fig.2 Beacon intervals are classified into two types:

- Quorum interval: It starts with a beacon window followed by a MTIM window.
- Non-quorum interval: It starts with a MTIM window.

The beacon window is for hosts to compete sending their beacons as similar in 802.11. The MTIM window is similar to the ATIM window. A host with buffered packets can compete to send notifications to intended receivers in the PS mode to wake them up.
We assume that beacon windows are not longer than MTIM windows. We say that a PS host is *active*

when it is currently in a beacon window a MTIM window.

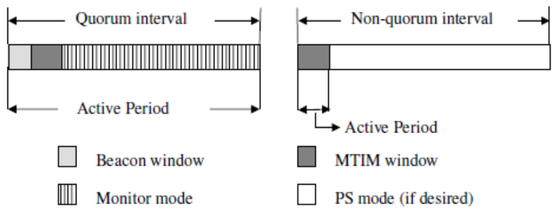

Fig.2. Structures of quorum intervals and no quorum intervals.

It is proposed that each host divides its beacon intervals into groups such that each group consists of n consecutive intervals. The host then picks intervals along an arbitrary row and an arbitrary column from the array as quorum intervals and the remaining intervals as non-quorum intervals. It is shown that no matter how asynchronous hosts' clocks, and PS host always has two or more beacon windows that are fully covered by another PS host's active period in every n consecutive beacon intervals.

IV. QUORUM SYSTEMS WITH THE ROTATION CLOSURE PROPERTY

Although there are volumes of works devoted to quorum systems, but none of them discusses the rotation closure property to the best of our knowledge.

The Grid Quorum System

The grid quorum system arranges elements of the universal set U ={0,…..,n-1} as a $\sqrt{N}$ X $\sqrt{N}$ array. It of elements in the array. Thus, each quorum has a near optimal size of 2 $\sqrt{N}$- 1. Simplify the lengthy correctness proof of the work needs to deal with complicated timing relation between quorum and non-quorum intervals among different asynchronous hosts.

Torus Quorum System

The torus quorum system as also adopts an array structure as similar to the grid quorum system. The rightmost column in the array is regarded as wrapping around back to the leftmost column. A quorum is formed by picking any column c plus [w/2] elements, each of which falls in any position of column. As shown in the fig.3 illustrates the construction of two torus quorums G and H under U with t = 3 and w = 6.

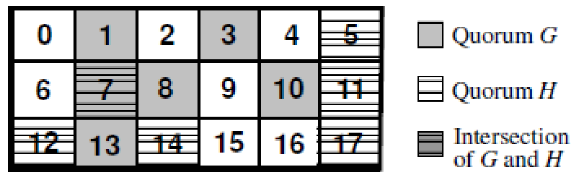

Fig.3. Two quorums of the torus quorum system in a** 3 X 6 **torus.

The Finite Projective Plane Quorum System

The fi*nite projective plane (FPP) quorum system* arranges elements of the universal set U ={0,…..,n-1} as vertices on a hyper graph called the *finite projective plane.* A quorum can be formed by the set of all vertices connected by the edge and thus has a size of k. the FPP construction is associated to the construction of Singer difference sets, and it is shown that the FPP quorum system can be regarded as a special case of the cyclic quorum system.

An Adaptive QPS Protocol

Two asynchronous mobile hosts picking any two quorums have at least *one* intersection in their quorums. Quorum would be desirable to have an adaptive solution in the sense that the number of intersecting elements can be dynamically adjusted. The number of beacons that two hosts can hear from each other is proportional to the number of intersecting elements. A host with higher mobility may like to have more intersections with its neighboring hosts so as to be more environment-sensitive. We assume that a host is able to calculate its mobility Levels or simply by evaluating the number of hosts that are detected to leave/enter the host's radio coverage.

V. SIMULATION RESULTS

The number of nodes is changed in the simulations. We compare the performance of the scheme with that of an existing well-known topology control scheme called LLISE. We also show the worst network capacity among all the topology configurations for comparison. It is clear that this topology lacks any physical layer cooperative communications. Fig. 4 shows the network capacity per node in different topology control schemes with different numbers of nodes in the MANET. The COCO scheme has the highest network capacity regardless of the number of nodes in the network. The COCO can achieve a much higher network capacity than LLISE.

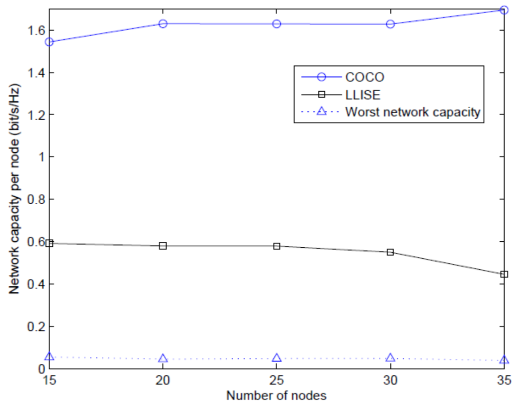

Fig. 4. Network capacity versus different numbers of nodes in the MANET.

We compare the proposed quorum-based protocols by analyses and simulation results. We omit all the results due to space limitation. We can refer to [10] for more details.

VI. CONCLUSION

To improve the network capacity of MANETs with cooperative communications with the less power consumption. We have addressed the asynchronous power mode management problem for an IEEE 802.11-based MANET. A Capacity-Optimized COoperative (COCO) topology control scheme that considers both upper layer network capacity and physical layer relay selection in cooperative communications. We have proved that any quorum system satisfying the rotation closure property can be translated to an asynchronous power-saving protocol for MANETs. We have proved that any quorum system satisfying the rotation closure property can be translated to an asynchronous power-saving protocol for MANETs. We have derived a quorum size lower bound for any quorum system. Optimal or near optimal quorum systems are preferable because in a quorum-based power-saving protocol. The number of beacons sent and the ratio of a host remaining active are both proportional to the quorum size. We have further proposed a new e-torus quorum system that can be translated to an adaptive power-saving protocol allowing hosts to dynamically tune to different quorum systems according to their mobility.

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