IJCSE International Journal of Computer Sciences and Engineering Open Access
Research Paper Volume-3, Issue- 10 E-ISSN: 2347-2693

A Model for Efficiency Estimation of Routing Protocols for Ad-hoc Network

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Received: Sep/29/2015 Revised: Oct/26/2015 Accepted: Oct /26/2015 Published: Oct /31/ 2015

***Abstract*—** Mobile computing is a new computing paradigm that embeds time, place and person in computing. The combination of networking and mobility induces a new dimension to the application and services. Communications over network consume energy resources of the network. Therefore it is essential to have mechanism that consume fewer resources over network. Comforting communication is the strategy that can improve the life of network by saving resources. Comforting communication is identified as a process by which users contribute and mingle resources relating to transmission of data to improve their performances. In this paper, we proposed a Capacity-Enriched Comforting topology control scheme that considers both upper layer network capacity and physical layer relay selection in comforting communications.

***Keywords*—** Mobile Ad Hoc Network, Comforting Communications, Physical layer, Topology control

I. INTRODUCTION

Mobile environment differs from the stationary environment in many respects. Computers in stationary environments are usually very reliable and efficient during data transfer from one host to another host. A stationary environment can distribute an application's components and rely upon the use of high-bandwidth, small latency networks to provide excellent interactive application performance [1].

Various methods in the past have been developed to optimize the quality of service over wireless communications network. These methods have been developed in order to optimize the operation in standalone node itself. But the development was not focused on optimizing the network performance based on full observation in a network. The advantage of optimizing the network performance based on observations of the full network is to maximize the network throughput. In order to achieve the throughput requirements various methods were developed.

The problems in the MANET such as collision resolution, and routing are resolved using cooperative communications [2]. By investigation of the problem, it is imperative to consider the topology control of MANET in order to increase network capacity. As MANETs have no centralized control, they need cooperation among the nodes for energy efficient communication. The nodes play many roles in the network such as topology organization, neighbour discovery, and topology reorganization. Choosing neighbours is possible in network with topology control which results in reduced energy usage and the increased throughput [3].

Research in topology control in MANET is done by Guan et al. [4] where the author controls topology using cooperative communications strategy. Their study revealed that the cooperative communications in Mobile Ad Hoc Networks can have its impact on the network capacity of the MANET 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 III presents the prototype implementation. Section IV presents experimental results while section V concludes the paper.

II. PROPSOED APPROACH FOR NETWORK CAPACITY IMPROVEMENT

In this section we provide information about our approach used to improve the network capacity in MANETs. The focus is on topology control using comforting communications in MANETs those results in increasing the network capacity.

A. *Comforting Communications*

Comforting communication is identified as a process by which users contribute and mingle resources relating to transmission of data to improve their performances with the aid of each other. This method has the benefit to enhance the transmission coverage of a node in mobile ad-hoc network on account of assorted channel quality, restricted energy and restricted bandwidth wireless environment. Due to cooperation in communication, users having fragile network connection can use quality channels of their partners so as to attain the required quality of service.

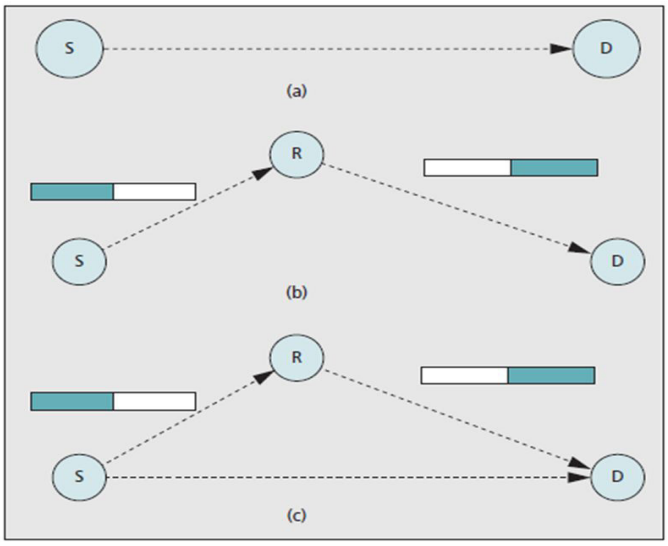

Fig.1 Three transmission protocols.

In Comforting Communications in Existing Network Architectures, the prime network model is a mobile ad hoc network with an existing clustered communications, in which comforting transmission is centrally stimulated and controlled by the cluster access points. The Types of protocols that are used in MANET are shown in Figure 1.
As shown in Figure 1, denoted as (a) Transmission in direct mode via a point-to-point conventional link. (b) Transmissions (Multi-hop) via a two-hop manner occupying two time slots. (c) Comforting transmissions via a comforting diversity occupying two consecutive slots. The destination node combines the two signals from the source and the relay to decode the information.

B. Topology Control

The network topology in a mobile ad hoc network is changing vigorously due to traffic, user mobility, node batteries, etc. In the meantime, the topology in a mobile ad hoc network is controllable by adjusting some parameters such as the channel assignment, transmission power, etc. Generally, topology control is such a method to decide where to deploy the links and how the links work in wireless networks to create a superior network topology, which will optimize the, the capacity of the network, energy expenditure or end-to-end routing performance. It is possible, to increased network capacity by controlling topology of network.

C. Network Capacity of MANETs

As a key indicator for the information delivery ability, network capacity has fascinated marvellous interests. There are different definitions for network capacity. There are two types of network capacity. The first one is transport capacity, which is analogous to the whole one-hop capacity in the network. An additional kind of capacity is throughput capacity, which is founded on the information capacity of a channel. The usual network capacity is determined by a variety of factors: wireless channel data rate in the physical layer, topology control, spatial reuse scheduling with interference in the link layer, traffic patterns, traffic balance in routing, etc.

D. Improving Network Capacity

Network Capacity improved by using topology Control in mobile ad hoc networks with Comforting Communications. To perk up the network capacity in mobile ad hoc networks with comforting communications using topology control, we can set the network capacity as the objective function in the topology control problem (1).

Each node has a utmost transmission power limit P_{MAX} . P_i is the transmission power of node i. α is the path loss exponent and τ is the minimum average SNR for decoding received data. d_{ij} is the distance between node i and node j. For a source node i to talk with node j in a straight line, they must persuade

$$P_i (d_{ij})^{-\alpha} \geq \tau \qquad (P_i \leq P_{MAX}). \quad (1)$$

In order to derive the network capacity in a mobile ad hoc network with comforting communications, we require attaining the link capacity and inference model when a specific transmission manner (i.e., direct transmission, multi-hop transmission, or comforting transmission) is used.

When conventional direct transmission is used, given a minute outage probability, the outage link capacity can be simply derived. In this context it is possible to use two-hop transmission for achieving multi-hop transmission. For achieving this, two time-slots are consumed. For transmitting messages from source to relay node, the first time slot is used while the second one is used to ensure that messages correctly reach the destination. In each hop the recording of interference is done as messages are transmitted over network. As simultaneous communication is not possible, usage of two time slots are to be considered with end to end interference. At each transmission, the outage of transmission is computed and finally the outage of two-hop transmission is computed. Interference occurs in every hop and there needs to be two time slots to have effective communication successfully. For comforting transmission of data in MANET, selection of proactive best relay is used. In this study, we espouse the decode-and-forward relaying scheme. The source broadcasts its messages to the relay and destination in the first slot. The

relay node decodes and re-encodes the signal from the source, and then forwards it to the target in the second slot. The two signals of the source and the relay are decoded by maximal rate combining at the destination. The utmost instantaneous end-to-end mutual information, outage capacity, outage probability, and can be derived [6]. Using link capacity and interference models, the network capacity can be derived [5]. Thus the value that has been derived can be used as an objective function that focuses on controlling topology. The CECT schemes that have been proposed extend physical layer comforting communications from the link-level perspective to the network-level perspective in mobile ad hoc networks. The proposed method can decide the finest type of transmission and the best relay to optimize network capacity.Two conditions are used in the proposed scheme. They are path length and network connectivity in order to derive network capacity. The fundamental requirement of the network is path length. Network connectivity is guaranteed when the computation of objective function is done. In the network each node can act as in charge that takes responsibility for connections of other nodes in the neighbourhood. When neighbours are involved in the communication, this result in end-to-end Connectivity.

III. PROTOTYPE IMPLEMENTATION

We built a prototype application that can simulate the concept of comforting communication in MANET that results in increased network capacity. There are multiple nodes in MANET and communication takes place between the source and destination nodes using intermediate nodes for comforting communication. When a node fails in the process of communication, the relay nodes take the responsibility of data transmission in order to ensure the successful communication between the sender and receiver.

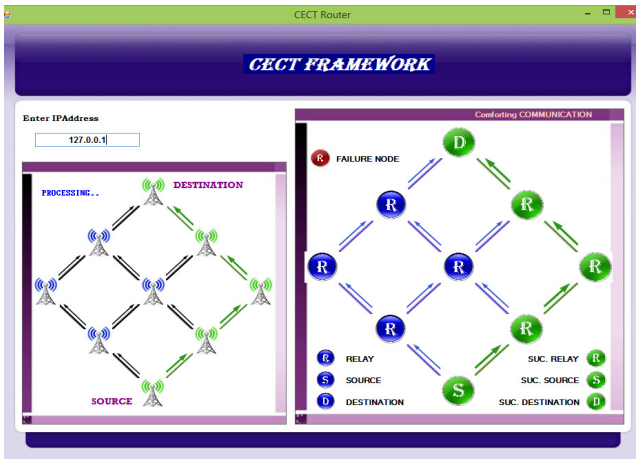

Figure 2. CECT Router

Figure 2 shows, the cooperative approach is used for successful communication between the nodes where the communication process is carried out by source and relay nodes. In case of any failure in the network, the nodes cover this failure and continue communication between the source and destination nodes.

IV. EXPERIMENTAL RESULTS

We built a custom simulator prototype for simulating the MANET with comforting communications that can improve the network capacity. The implementation is done using Microsoft .NET platform. C# programming language is used to attain this. The computing environment used for the application and experiments is a PC with 4 GB RAM, Quad core processor running Windows 7 operating system. The experimental results are compared with LLISE [7] 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 nodes in MANET various experiments are made.

Figure 3 shows the comparison of network capacity is made using many nodes. The comparison is done as per scheme that has been implemented using Comforting Communication in this paper.

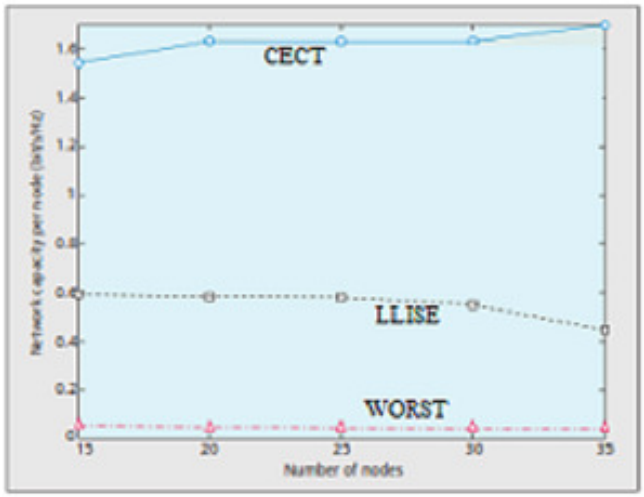

Figure 3. Number of nodes vs. network capacity

V. CONCLUSION

Comforting communication is defined as a process by which users contribute and combine resources relating to transmission of data to gear up their performances with the help of each other. This technique has the advantage to increase the transmission coverage of a node in mobile ad-hoc network on account of diverse channel quality, limited energy and limited bandwidth wireless environment. In this

paper, we have introduced physical layer comforting communications, topology control, as well as network capacity in MANETs. To perk up the network capacity of MANETs with comforting communications, we have proposed a Capacity-Enriched Comforting topology control scheme that considers both upper layer network capacity and physical layer relay selection in comforting communications. In future, the research work can be extended for other parameters which can be very effective in the construction of the topology for rural wireless mesh networks.

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