A Study of Topological Problems and controlling methods in Mobile Ad Hoc Networks

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Abstract:

In wireless networks so many algorithms are proposed to reduce the level of interference between nodes in the networks, in this paper I studied existing techniques to reduce level of interference and increasing the capacity of the network. Mobile Ad Hoc Networks (MANET) recommend multi-hop connectivity between self-configuring and self-organizing mobile hosts. These Networks are characterized by dynamic network topology, lack of central administration and limited resources such as power and bandwidth. Topology control will increase the performance of the network. Different techniques are studied to control topology of the network.

Index Terms—Topology, control, network capacity, MANETs, bandwidth, connectivity.

I. Introduction

Topology change occurs with every move of a mobile node. The main aim of topology control is to save energy, reduce interference between nodes and extend lifetime of the network. The network size of a MANET is given by the whole number of nodes in the network, which is a fixed number (assuming that no nodes enter or leave the network). Hefty networks are represent by a sizeable number of nodes of up to 10000, while tiny networks correspond to networks with very few nodes within the equal environment size. While the number of nodes may be a good approximation of network density in homogeneously distributed networks, this value might not be indicative of any specific network characteristics in a heterogeneous network where nodes are randomly positioned in the environment.

I can recognize a small number of key troubles related with network topology, that are faced by routing protocols in ad hoc networks with varying network sizes and densities. In sparse networks with low node densities, network partitions may be formed while mobile hosts move with different patterns and cause the network to divide into two or more disconnected portions. This can lead to low connectivity and lack of routes to targeted destinations, resulting in higher packet loss and higher control overhead. Even though path lengths strength is comparatively shorter, this is because routes to more destinations cannot be discovered. The throughput is also lower in such partitioned networks.

As node densities increase, it may be probable to establish pathway routes to destinations that are further away. Predictably, the occurrence of link breakages within active routes will also increase. More Route Error (RERR) messages will have to be transmitted to nodes which utilize these broken links, resulting during higher rate of occurrence of route repairs. These factors will lead to
higher control overhead, increased congestion, greater contention for bandwidth and lower packet delivery ratio.

Dense networks are also described by higher node degrees, where each node has large number of neighbors’ within its transmission range. This means higher connectivity between nodes in the network, which can lower the mean number of hops needed between a source and its destination and get better data delivery ratio. However, a high node degree can also result in more collisions between Neighboring nodes, which means that more energy is wasted at the broadcasting level.

But, the network size and density are often unchanged parameters in an ad hoc environment. The main focus the work has been to reduce the routing overheads caused by routing protocols in dense networks that have consistent node densities and hierarchical routing methods which can acquire additional overhead. These methods do not take into account the dynamic network topologies due to node mobility in MANETs, and are inefficient for heterogeneous networks which may not have consistent node distributions.

Topology change occurs with every move of a mobile node. The main aim of topology control in this MANET is to save energy, reduce interference between nodes and extend Lifetime of the network control on some parameters of the network.
1. Transmission power of the nodes
2. State of the nodes (active or sleeping)
3. Role of the node (gateway, regular, Cluster-head)
4. Adding new nodes to the network. By modifying these parameters, the topology of the network can change.

The requirement for speed in wireless networks is always increasing. Recently, two link wireless communications has received tremendous benefit as an untapped means for improving the performance of information transmission operating over the ever-challenging wireless medium. Two way link communications has emerged as a new dimension of diversity to follow the strategies designed for multiple antenna systems, since a wireless mobile machine may not be able to support multiple transmit antennas due to size, cost, or hardware restrictions.

By developing the broadcast nature of the wireless channel, two way link communications allows single-antenna radios to share their antennas to form a virtual antenna array, and offers significant performance enhancements.

II. Related Work

[1]Capacity-Optimized communication topology control scheme to improve the network capability in MANETs by together considering both upper layer network capacity and physical layer two level link communications.

Most existing works are focused on link-level physical layer issues, such as outage probability and outage capacity. As a result, the impacts of two way link communications on network-level upper
layer issues, such as topology control, routing and network capacity, are largely ignored. Definitely, 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. Such architectures can be seen as composite networks of simple links. But have some problems they are Low Network Capacity, and Communications are focused on physical layer issues, such as decreasing outage probability and increasing outage capacity, which are only link-wide metrics.

2.1 Relaying Strategies

- Amplify-and-forward
- Decode-and-forward

[2] In amplify-and-forward, the relay nodes simply boost the energy of the signal received from the sender and retransmit it to the receiver. In decode-and-forward, the relay nodes will perform physical-layer decoding and then forward the decoding result to the destinations. If multiple nodes are available for cooperation, their antennas can employ a space-time code in transmitting the relay signals. It is shown that cooperation at the physical layer can achieve full levels of diversity similar to a system, and hence can reduce the interference and increase the connectivity of wireless systems.

Three transmission protocols:

a) Direct transmissions via a point-to-point conventional link;

b) Multi-hop transmissions via a two-hop manner occupying two time slots; and

c) Cooperative transmissions via a cooperative diversity occupying two consecutive slots. The destination combines the two signals from the source and the relay to decode the information.

2.2 Multi-hop communication

Multi-hop transmission to pass through one or more intermediate queue managers when there is no direct communication link between a source queue manager and the target queue manager.

[3] In common, a wireless network can be mapped into a graph $G(V, E)$, where $V$ is the set of nodes in the network and $E$ is the edge set representing the wireless links in the network. A link is generally composed of two nodes which are in the transmission range of each other in classical MANETs. The topology can be controllable by the parameters, which determine the existence of wireless links directly. Generally, these parameters can be transmitting power and antenna directions, etc. A general topology control problem can be expressed as

$$G^* = \arg \max f(G) \text{ or } G^* = \arg \min f(G)$$

*eqn(1)*

s.t. network connectivity
The above topology control problem consists of three elements (M, P, O), where M represents network model, P represents the desired network property, and O refers to the optimization objective. The eqn(1) uses the original network topology G, which contains mobile nodes and link connections, as the input. According to the objective function, a new good topology G*(V, E*) will be constructed as the output of the algorithm. G* should contain all mobile nodes in G, and the link connections E* should protect network connectivity without partitioning the network. The arrangement of resulting topology is strongly related to the optimization objective function, which is f(G).

For MANETs, it is difficult to collect the entire network information. Therefore, the above centralized topology control should be solved using a distributed algorithm, which generally requires only local knowledge, and the algorithm is run at every node independently. Consequently, each node in the network is responsible for managing the links to all its neighbors only. If all the neighbor connections are preserved, the end-to-end connectivity is then assured via a hop-by-hop manner.

The wireless links in two way link communications are extra complex than the predictable point-to-point wireless links. A two way link usually consists of three nodes: source (S), relay (R) and destination (D). As a result, the link is presented by (S,R,D) and the topology becomes GC(V, EC) in which

\[ EC = \{(S,R,D)|S,R,D \in V\} \]

If the relay is changed, the link is then changed. Therefore, relay selection criteria can have significant impacts on the network topology. By considering three types of transmission protocols for a link: point-to-point direct transmissions, predictable multi-hop transmissions and two way link transmissions. Direct transmissions and multi-hop transmissions can be considered as special types of two way link transmissions. A direct transmission utilizes no relays while a multi-hop transmission does not combine signals at the destination.

[5] The scalability of AODV using different combinations of alterations which can be integrated into generic reactive routing protocols. These modifications include the increasing ring search for Route Requests (RREQs), query localization and local repair of link breaks in active routes. The local repair is extra effective in improving the performance of large scale networks of up to 10,000 nodes, but it may waste processing power and acquire additional overhead because more than one repairs for the same route can occur concurrently.

[6] Query Localization, The on-demand protocols depend on query floods to discover routes whenever a route is needed. The Technique utilizes preceding histories to localize the query flood to a limited region of the network.

The Figure of AODV will be shown below.

The above figure is the general AODV protocol condition. If any relay node fails then the RERR route error message will be send to Sender.

But in the presence of Local Repair Concept in AODV.
But in the presence of Local Repair, if a route fails, then a route error message will be sent to its upstream neighbors to repair without sending RERR message to the source. So the route chooses another route to travel to the destination.

Two new schemes – Fisheye State Routing (FSR) and Hierarchical State Routing (HSR) – aim to address the shortcomings of existing proactive and reactive protocols via a hierarchical approach. As compared to flat, table driven routing schemes, the proposed solutions are able to scale better at the cost of increased routing inaccuracy and complexity. As compared to reactive schemes, the solutions are able to provide lower control overhead and lower latency but at the cost of routing table storage overhead.

[7] Passive Clustering (PC) and Landmark Routing are suggested as techniques to overcome scalability problems faced by conservative proactive link state routing protocols. Passive clustering is a cluster development protocol that can dynamically reconfigure clusters during mobility and topological changes. Landmark routing uses truncated local routing tables and summarized routing information for remote groups of nodes. Both techniques help to reduce the routing table size and the control overhead effectively for dense and large scale networks.

The existing methods which attempt to improve the scalability of routing protocols use hierarchical routing strategies or mechanisms which acquire additional overheads. In addition, they are unable to adapt to rapid changes in network environments, which is typical of MANETs. As such, there is a need for an adaptive scheme that is perspective to network dynamics and can improve the scalability of MANET routing protocols.

The topology of a network can have a tremendous effect on the performance of the network because it influences the way which packets are routed to their destinations. Sparse networks face the possibility of being partitioned while dense networks are subject to high collision rates and bandwidth contention amongst nodes. Furthermore, nodes in MANETs are constantly in motion, making it harder to predict distribution patterns and handle routing decisions.

Examine the energy efficient QoS (Quality of Service) topology control problem and tries to find an appropriate network topology that can meet certain QoS requirements such as bandwidth and delay constraint while minimizing the maximum transmitting range of nodes.

III. Conclusions and future work

This paper will consists only study of different controlling methods of topology and improvement protocols of MANET transmission. Future work will be going to implement Critical Neighbor Links (CNL) scheme, which adaptively adjusts the transmission power of individual nodes according to route and traffic demands, reduce the level of interference amongst nodes and collisions in the Network, Resulting in higher throughput and lower end-to-end delay. And also uses Capacity- Optimized Neighbor Links topology control scheme improve the network capacity in MANETs. Dynamic traffic pattern and dynamic network without a fixed infrastructure.
IV. References


