Vol. 2, Issue 3 (July - Sept. 2014)
ISSN : 2347 - 8446 (Online)
ISSN : 2347 - 9817 (Print)

MCQ-TC: Mobility, Connectivity& Quality Based Dynamic Topology Control in MANET

[I]KushalShinde [II]Narendra Pal Singh Rathore
[I,II]Dept. of CSE, Truba College of engineering and technology, Indore, M.P., India

Abstract

Wireless network is getting popular day by day because of its supportive technologies and wide range of device applicability. Mobile ad-hoc network (MANET) is one of such network which communicates using radio waves in small range. Routing is one of the well knownoperations required for transmitting the data from one node to another. Being a small & infrastructure less network, it contains lights weighted protocols in comparison to other wireless networks. Also, here the routing is directly performs by the devices itself. It supports mobility which sometimes disturbs the communication because of nodes changing position and moving out of range. Thus there must be some mechanism which handles these dynamically changing nodes motion characteristics. Topology control is one of such mechanism which deals with this changing locality of nodes. Traditionally, topology is fixed and is detected by analysing the nodes data which sometimes misguided the accuracy of detection. Thus, this paper proposes a novel Mobility, Connectivity and Quality (MCQ-TC) based dynamic topology control in MANET. After analytical evaluation along with surveyed papers the suggested approach is proving its effectiveness.

Keywords

MANET, Topology Control (TC), Mobility, Connectivity, Quality, Dynamic Topology;

I. Introduction

Wireless networks is getting millions of users accessing the network service on different device types such as laptops, cell phones, PDA,s, tablets etc. These devices are communicating with each other for exchanging the information at mobile locations. To support this communication at farthest locations, a large infrastructural investment needs to be applied for developing a supportive medium. Even if the distance is small, and without any line of sight objects the devices requires infrastructure. Among these infrastructure, routing devices are the most important ones whose work is to route the packets in desired directions. This routing is a decisive operation which depends on various factors.

Among the various types of wireless network, MANET supports ad-hoc connectivity and can be used for small range communication. Also there is one more benefit that it doesn’t require any infrastructure supported devices such as router, switches and hubs. Instead of them, the complete routing functionalities is performed by the mobile devices itself. Here the mobile nodes can act as a router for forwarding the data to the next node. Here the devices and the protocol for communication is light weighted. Here the nodes communicate directly within a particular range of radio communications. Mobility is one of the key requirements of the MANET because here the nodes are freely moving in a specific range. Because of this feature it is having wide applicability are like disaster relief, military, home and business automations etc.

In mobile ad-hoc network (MANET), communication depends on various internal and environmental factors such as nodes motion, location, direction, energy, robustness, reliability, security, quality etc. Among them nodes motion mostly serves the reason for discontinuing the connection. Hence change in position from one location to other might be considered in communication. Thus the mobility causes related movement of nodes which can break links and thus change the topology and this may result in partitioning of the network. Topology controls (TC) aims towards maintain this position connection structures. Thus the ways of organizing the nodes comes under the topology control mechanism. Frequent topology handling manages uncontrollable factors such as node mobility, weather, interference, noise as well as controllable factors such as transmission power, multi-channel communications and directional antennas [1]. It is an important area of work because it handles the connections and if it drops due to mobility loss of data might occurs.

To handle the topology control effectively various factors needs to be added for identifying or forecasting the nodes behaviour regarding its next position. Once the network is partitioned none of routing/broadcast protocol can be successful and very rare chances to form the connected network [2]. The topology control having good quality will always depends upon various factors & consideration failure of which leads to wastage of utilization, channel capacity & communication cost. The design of this topology control should implicitly holds some characteristics for two major scenarios like if the topology is too sparse then the network can get partitioned. However, topology control can provide better control over network resources such as battery power and reduce redundancy in network communications.

Effective Topology control will improve the performance and the capacity of Mobile Ad-hoc networks by building reliable network structure [3]. This paper focuses its intensions towards making the dynamic topology control by using some of the factors such as mobility, connectivity and quality.

II. Background

Topology controls requires effective handling of connection and disconnection status along with deterministic directions of motion. If this information is handled in real time then the information delivery and network resources can be better utilized. Aim is towards making the communication robust and reliable which can be achieved by making the dynamically controlled topologies with mobility. One of the major requirements of MANET is scalability support which always needs topology updates. Primary problem is to find topologies on time along with minimized power consumption and network lifetime.

Here the quality of service represents the rules formation for achieving the identifiable behaviour of the network for better delivering the information. It also assures the effective utilization of the factors which improves the overall performance of the network. The quality based parameters are bandwidth, jitter and delays [4].Once the service request for the quality factor based requirements routing is performed. Along with other factors scalability and expansions are needed with various topological controlling algorithms. Most of the topology control algorithms are mainly dealing with dynamic connectivity and nodes mobility. By identifying the topologies and nodes behaviour the controlling and network lifetime can be improved with minimized power consumption.

Parallel working with quality and topology control will shows qualitative effects on the performance of the system by increasing the packet delivery ratio [5]. The basic topology control techniques are divided into homogeneous and non homogeneous. In homogeneous topology control all the network is performing transmission within a specific range of similar kind of network environment. It is known as critical data transmission range problem. It reduces the formal topology controlling issues for determination of minimum value based transmission. In non homogeneous topology control the nodes are transmitting on different types of networks. Here the range for transmission assignment is based on the local information of its neighbouring nodes. Thus here the decisions are optimal locally.

Topology Control Categories

- Location Based: These approaches are based on accurate location information about the nodes positions.
- Direction Based: When the accurate position of the nodes are not available then for measuring the topology directional movements using relative motion is considered for estimating the correct positions.
- Neighbour Based: Here the protocol depends on the node's capability of discovering its neighboring nodes with the maximum transmitting range and distance.

Some of the papers also give more categorization according to their nature such as distributed or centralized. Some of the examples are; Relative Neighbourhood Graph (RNG), Minimum Spanning Tree (MST), Connect, Noble Topology Control Algorithm (NTC) etc. And for distributed examples are: Local Information No Topology (LINT), Local Information Link-State Topology (LILT), Distributed Relative Neighbourhood Graph (Dist-RNG), Distributed Novel Topology Control Algorithm (Dist-NTC). Later on these strategies is studied more clearly for better understanding of the behaviour of the nodes motion and topology controlling algorithms.

III. Literature Survey

After getting into the topology control, it is found that the behaviour of node has to be identified and used for forecasting the later motion of the node for sustaining the topology continuously. All it depends upon the information which is collected and processed for futuristic usages. During the last few times various researches\s had been published which guides us for this work to be completed. These are given here as surveyed articles.

In the paper [7], some routing protocols are presented specifically designed for controlling the topologies. The categorization is provided with three areas: table driven, on demand and hybrid. All of these categories are based on the type of topology updates which they gets for maintaining the connection based on the quality parameters. These protocols and topology control parameters are continuously changed or improved for accurate identification o number of connections and their orientations. In a way to achieve this, the paper [8] gives mobility-sensitive topology control mechanism. Thesuggested two specific methods here termed as consistent local views for avoiding the inconsistence in information and delay. The second suggested factor is mobility management that tolerates outdated information. Along with the formal topology control some of the authors had focused their intensions towards the QoS based identification of connectivity with existing MANET protocols.

The paper [9] extends the AODV Route Request (RREQ) packet to include the following fields: minimum bandwidth, maximum bandwidth and bottleneck bandwidth. The first two fields specify the bandwidth requirements of the application and are populated by the source node. At the initial level of their simulation results it seems to be an effective mechanism. Some of the paper gives a detailed study of such issues with peer to peer communication. The paper [10] suggests a new DACME protocol based on probe based admission control. It aims to perform end-to-end communication and QoS requirements measurements. Further elaboration of these factors for QoS based topology evaluation is given with FQMM Model [11] which is flexible quality model for MANET. It provides the features of dynamic roles of the nodes, hybrid provisioning and adaptive conditioning. Introductory simulation results show that FQMM achieves enhanced performance.

In the paper [12], an Adaptive QoS Topology Control (AQTC) [12] System using Smart Antennas is proposed. It uses a cross-layer approach to control the topology dynamically where the topology control layer sits between the MAC and the routing protocol. The performance of protocol has been evaluated using extensive simulations. AQTC always forms a topology to facilitate the current communications and improves the network throughput and end-to-end delay. Some of the work had also focused on topological evaluations along with cooperative communications. It serves the physical level issues by sustaining Capacity-Optimized Cooperative (COCO) topology manage scheme. It improves the network capability in MANETs by mutually considering both upper layer network capability and physical layer two-way communications [13].

Few more approaches had been discovered for further improving the performances of traditional topology controls along with quality of service factors. Examples are adaptive routing and reasonable queuing in [14], long detachment topology organize [15], QoS essential backbone (QoS-VBB) [16], disseminated admittance control D-AC [17] etc.

IV. Existing Issues

Network condition in mobile environment always depends on the connection types and topology which can be controlled by power and quality factors. An effective topology control approach is that which defines an optimal solution for connection rather making it denser which decreases the network lifetime. Also it must consume less power with high delivery ratios. Now, on the looser topology end the hop counts between the nodes will be increased and the quality and performance parameters clashes. Thus, the goal should be of finding the best and optimal solution for balanced topology controlling along with quality and connection management. After studying the various approaches related to topology conditions this work had identified few working areas where the issues are remained unsolved. These could be taken as problem for this paper:

(i) Consistent topology conditions for small and large

ISSN : 2347 - 8446 (Online)
ISSN : 2347 - 9817 (Print)

distant movements must be managed simultaneously with nearest neighbour selection.
(ii) Selection of next hop connection is based on information of number of hops, location, energy and connectivity.
(iii) Group of active members must be managed for continuous topology connection.
(iv) QoS based factors must be taken along with mobility and connectivity for higher delivery ration and lower management overheads.

By solving the above issues, effective connection establishment can be achieved with long term connection management. Thus, a better topology control approach can be developed by resolving the above issues.

V. Proposedmcq-Tc Solution

This work proposes a novel mobility, connectivity and quality (MCQ-TC) based topology control for mobile ad-hoc network. Several problems related to topology control is considered for developing this improved solution. It aims towards continuous holding the information which deals with connection managements and their frequent updates. The approach is also capable for providing the topology management in dynamic environment with homogeneous and heterogeneous conditions. It optimizes the requirements for traditional; detection and makes the approach less complex. By applying the detection using suggested approach, network lifetime can be increased. The work also maintains the information about the mobility conditions as low or high. This information helps the controlling algorithms in identification of correct motion direction of the nodes.

The proposed work parameters are mobility, connectivity and quality. According to the several detection conditions these three factors are the most important and critical information which later on derives the topological connections. Some other factors such as data transfer status and residual bandwidths are also important but they are derived from the suggested parameters. The work is also have functionality of buffer zone formation which works at low mobility conditions and high mobility conditions with aims towards making the connection continues and maintains the topologies. The solution is suggested in the form of an algorithm given below. The suggested algorithm contains two basic functions for getting the dynamic topology updates.

Factors Affecting Topology Control

It is shown that a number of factors can affect the efficiency of load balancing as given as Mobility

- Link Breaks
- Location UpdatesOffered load
- Sensing range
- Shape and size of the network
- Location of gateways
- Network Energy
- QoS

However, these factors alone cannot explain why the performance of topology control is high for certain networks while it is poor for others. Obviously, the specific layout of the topology is also an important factor.

Algorithm

MCQ-TC Topology Control Algorithm

```
{Source Node Broadcast RREQ;
Destination Replies with RREP;
Calculate Neighbouring Values (NV);
NV for connecting Links (Hop Count, Mobility Direction)
Neighbouring Value Stored in Table according to Hop Counts;
Communication Starts;
Get Link Quality ();// Function Call
Monitors Node (a, b, c); // Function Call
Refreshes Neighbouring Values;
If (Link Quality==1 && Power Transmission>Threshold)
Communication Continues;
Else
New Route Discovery;
Stops Communication;}
// Function Definition Body
Link Quality Based Forwarding ()
{If (Data ==Complete && Residual Bandwidth==Sufficient)
Forward the data;
Set Link Quality=1;
Else
Wait for Completion;
Set Link Quality=0;
Repeat Above;}
// Function Definition Body
Monitor (PDR, Throughput, Jitter)
{If (Values<= Normal)
Topology Discontinues;
Else
Topology Maintains;}
```

Description

While developing such solution having multiple dynamic controls related to topology controlling, some more factors and frequent data fetching is required. This fetched information about the nodes behaviour and mobility direction helps the detection about the forecasted connection s status and nodes organizations. Initially the source node broadcast the route request message on o the network nodes. This message is further forwarded unlit the destination address matches. Finally the destination node replies with RREP packet. After source node receives the all reply packets with their hop counts. The values are passed into some neighbouring value calculation formula which is having hop count and the mobility parameter. By using that function some values is calculated and stored in table for later usages. Aim is towards the frequent directional updates and link connection status.

The current and forecasted topology is identified by using two defined methods:
(i) Link Quality Based Forwarding: It is used for checking the data status whether it is complete or not. If the data received at intermediate node is incomplete then it should waits till the data is completed and then forwarded it to next hop. It will also check the residual bandwidth required for transmitting the data.
(ii) Monitoring Nodes: This function works as continuous assessment for network performance parameters such as PDR, throughput and jitter. These factors are watched regularly for detecting any abrupt behaviour of the nodes from which expected direction of node motion can be detected.

After calculating the above functions, the communication starts and these factors are regularly watched. Now some verifications and conditional checks are performed. Now if the link status or quality, power require for transmission and connection strength is complete and greater than a threshold value, then the communication is continued else it will be stopped.

Application Areas

1. This Military Operations
2. Electric meters
3. Broadband home networking.
4. Community and neighbourhood networking.
5. Enterprise networking.
6. Metropolitan area networks.
7. Transportation systems
8. Building automation
10. Health and medical systems.
11. Security surveillance systems
12. P2P Communications

Summary Proposed Work

The proposed MCQ-TC localized topology control algorithms maintain the network connectivity while reduces energy consumption which further improvesthe network capacity. These algorithms not only outperform existing approaches in terms of energy efficiency, network capacity, and several other performance metrics, but also provide certain performance guarantees such as the degree bound of optimality.

VI. Performance Factors

To calculate the better topology control we need to add some of the quality measures which analyse various factors for improved bandwidth utilization, power saving & strong connections. For these performance evaluations, metrics includes the following QoS parameters such as PDR (Packet Delivery Ratio), Throughput, End to End Delay, Routing overhead and Jitter.

1) Packet Delivery Ratio (PDR): also known as the ratio of the data packets delivered to the destinations to those gen erated by the CBR sources. This metric characterizes both the completeness and correctness of the routing protocol also reliability of routing protocol.
2) Average End to End Delay: Average End to End delay is the average time taken by a data packet to reach from source node to destination node. It is ratio of total delay to the number of packets received.
3) Throughput: Throughput is the ratio of total number of delivered or received data packets to the total duration of simulation time.
4) Normalized Protocol Overhead/ Routing Load: Routing Load is the ratio of total number of the routing packets to the total number of received data packets at destination.
5) Jitter: Jitter describes standard deviation of packet delay between all nodes.

VII. Expected Benefits

The traditional problems related to quality, mobility and connectivity based topology handling are solved by suggested MCQ-TC. It will focus on other approaches and different aspects of dynamic topology control and evaluating their performance under different network conditions. Comparison of the various simulation results leads to better analysing the results. The work has identified several research benefits:

(i) Dynamic Topology Control w.r.t. Network Traffic
(ii) Identification of the best suitable approach to topology control problem in this particular arrangement of hardware components and scenarios.
(iii) Evaluating the topology control using quality based estimations of data transmissions and energy constraints
(iv) Dynamic handling of topologies connections with mobility based modifications
(v) The work also provides the identification of the usable configuration methods, built-in functions and limitations of hardware communication platform, which can influence the opportunity of the topology control.
(vi) The work also provides an implementation analysis of the suitable and reliable communication protocol.
(vii) The simulations of QoS based traffic scenarios brought out the behavior and priority details in multi-hop network.

VIII. Conclusion

During the last few years various approaches had been suggested for overcoming the issues of dynamic topology handling in ad-hoc network. Among them the quality based requirement and mobility factors are getting high attention because of their nature towards topology modifications. Some of the work had also performed on energy conservation based evaluations. Te paper had surveyed various papers and had indentified certain issue which remains unsolved. These issues are overcome by the suggested MCQ-TC approach. The proposed approach is mobility, connectivity and quality based topology calculation and dynamic handling according to the network conditions. The suggested approach had developed an algorithm and some methods for achieving high quality evaluation with higher accuracy in the forecasted mobility direction of the node. At the primary level of evaluation and analytical comparison, the suggested approach is serving all the needs of effective topology control.

IX. Future Work

1. Incorporating Physical Layer Characteristics in defined simulation script can be performed.
2. Effect of MAC-layer Interference on Network Topology is not considered
3. Capacity of Wireless Networks with Topology Control can be p[resented in future
4. Cross-Layer Design for Topology Control is an open area for future

References

[1] *G. Srivastava, P. Boustead, J.F.Chicharo, "A Comparison of Topology Control Algorithms for Ad-hoc Networks", in School of Electrical, Computer and Telecommunication Engineering, University of Wollongong, NSW, Australia.*

[2] *S. S. Dalu,, M. K. Naskar& C. K. Sarkar, "Implementation of a Topology Control Algorithm for Mobile Ad hoc Networks Using Pursue Mobility Model", in Journal of Applied Computer Science, ISSN:1843-1046, Vol (2), no.2, 2008,*

[3] *S. Karunakaran and P. Thangaraj, "Topology Control Using Efficient Power Management", in Journal of Computer Science, Science Publications, ISSN 1549-3636, Vol 7 , No 4:pp 561-567, 2011.*

[4] *R. K.Gujral& M. Singh, "Analyzing the Impact of Scalability on QoS-aware Routing for MANETs", in IJCSI Issues, ISSN (Online): 1694-0814, Vol. 8, Issue 3, No. 1, May 2011*

[5] *K.Majumder& S. K. Sarkar, "QOS Parameter Based Performance Study of the Gateway Discovery Approaches for*

ISSN : 2347 - 8446 (Online)
ISSN : 2347 - 9817 (Print)

MANET" in International Journal of Computer Applications (IJCA), 2011.

[6] *Surendra S. Dalu, M.K Naskar& C.K Sarakar, " Hardware Implemenatation of a Topology Control Algorithm for MANET's Using Nomadic Community Mobility Model", in Journal of Theoretical and Applied Information Technology, 2009.*

[7] *S. R. Biradar, Subir Kumar Sarkar &Puttamadappa, "Analysis QoS Parameters for MANETs Routing Protocols", in (IJCSE) International Journal on Computer Science and Engineering, Vol. 02, No. 03, 2010.*

[8] *J. Wu& F. Dai, "Mobility-Sensitive Topology Control in Mobile Ad Hoc Networks" in International Parallel and Distributed Processing Symposium,IPDPS- 2004*

[9] *V. Garg1 & C. Kapoor, "A Survey of QoS parameters through reactive routing in MANETs" in IJCEM International Journal of Computational Engineering & Management, ISSN (Online): 2230-7893, Vol. 13, July 2011.*

[10] *C. T. Calafate, J. C Cano, P. Manzoni & M. P. Malumbres, "A QoS architecture for MANETs supporting real-time peer-to-peer multimedia applications", in Polytechnic University of Valencia (UPV), Valencia, Spain.*

[11] *H. Xia, W. K.G. Seah, A. Lo & K. C.Chuaa, "Flexible Quality of Service Model for Mobile Ad-Hoc Networks", in National University of Singapore.*

[12] *S.k.MRokonuzzaman, R. Pose and I.Gondal, "A Cross-layer Approach for QoS Topology Control in Wireless Ad Hoc Networks" in IEEE , 978-1-4244-4547-9/09, 2009.*

[13] *Q. Guan, S. Jiang, F. Richard & Yu, "Topology Control in Mobile Ad Hoc Networks with Cooperative Communications" Univ. of British Columbia, Vancouver, BC, Canada*

[14] *W. K. G. Seah, H. Xian Tan, "Quality of Service in Mobile Ad Hoc Networks", in IGI Global National University of Singapore, 2008.*

[15] *K.Poolsub, B.Lapwilai& D.AtanassovBatovski, "Topology Control for Long Distance Transmission in Multihop Ad Hoc Networks", in AU J.T. 13(4): 213-222 ,Apr. 2010.*

[16] *M.Ayyash, D.Ucci& K.Alzoubi, "A Proactively Maintained Quality of Service Infrastructure for Wireless Mobile Ad Hoc Networks" in International Journal of Communication Networks and Information Security (IJCNIS), Vol. 2, No. 2, August 2010.*

[17] *P. M & A. N, "A Distributed Admission Control Based Quality of Service in MANET's", in International Journal of Engineering Trends and Technology,ISSN: 2231-5381 Volume 4, Issue 4- 2013*