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RESEARCH ARTICLE

Simulation Analysis of MCQ Based Topology Control in MANET Using NS2

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Abstract: ***Mobile ad-hoc network (MANET) is the wireless network where the communication and routing is independent from the infrastructural components and devices. Apart from them, all the functionalities were handled by the mobile nodes. MANET is been thoroughly studied over the last few years and its various implemented simulations are extensively analysed against the practicalities and applicability issues. As the MANET is a mobile nodes network hence the nodes must support mobility with connection continuity in any topology situations. Here the topology means network connection which a network has made for establishing the communications. But as the nodes were regularly changing their positions hence their topology also changes which requires a dynamic handling mechanism. Also there are some other factors which need to be maintained during this topology handling. The work suggested with MCQ-TC covers the theoretical aspects and formal drafting of the concept. The work suggested that mobility, quality and connectivity will affects the topology of the system. Thus is the following factors are watched then the topology can be maintained dynamically. This paper works towards making a robust experimental analysis of the suggested work using the well known simulator NS2.***

Index Terms: MANET, Topology Control (TC), Mobility, Connectivity, Quality (MCQ), AODV, Dynamic Topology

I. INTRODUCTION

In today's world wireless technologies are growing very rapidly due to their wide applicability and device supports. Here the devices which are communicating with each other must have mobility and portability aware transmission support for a specific range. Ad-hoc network is one of the wireless network where connections are establishes for temporary duration and can be destroyed after the communication is over. The communication using wireless ad-hoc network into two major areas based on their requirements: Infrastructure Dependent and Infrastructure Independent. For getting the communication between two farthest devices or nodes wireless infrastructure is required such as routers, towers, power backups, switches etc. But as the distance and the information values gets shorter investments on such networks are getting high cost burdens for the user and its organizations. Even if the distance of communication is shorter the line of sight must be clear between the devices and infrastructure must be present over there. But when the second category of network is developed the first condition is to design a network having zero routing and infrastructural device dependencies.

MANET (Mobile Ad-Hoc Network) is a wireless network which supports short range radio communication without any infrastructural components. Here all the operations including routing are performed by the device itself. All the mobile nodes can acts as router which discovers the path to the destination node, maintains the routing records, distance and hop count calculations, energy consumptions, etc. Here all the functionality is directly embedded to the movable devices and they are of small size hence the protocols which supports communication and data exchanges must also be designed is such a way which

reduces the complex operations into smaller executions. 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.

Wireless communication using MANET is depends on various factors such as nodes location, direction, energy, robustness, reliability, quality etc. Among them the nodes motion is the most important aspects of the mobile devices because it's the factors whose value is continuously changing during the lifetime of the node and hence causes disconnection. 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 occur.

Mobility aware routing must be taken as a significant behaviour of mobile ad-hoc network. The mobility is well covered by the traditional stationary network model because this factor is always low with that type of network. But with the mobility aware network such as MANET, most of the communication and routing strategies depends on the motion of nodes. Topology control maintains the nodes mobility information in dynamic connection properties. Here the nodes which are changing their position are termed as dynamic topologies. For older network topology control is performed periodically or when there are some changes in the positions. As the number of nodes and their mobility is increased, the topology control is gets more complicated. Topology control must acquire the information from the nodes movement, their direction of motion, their protocol for transmission, range etc information for maintaining the connection records. The data can be fetched from the local points or the global points. But the devices which process the data could be of same configuration and hence the mobility or power factors might affect them also which may disturb or mislead the calculations. Therefore the TC protocol designed for mobile instance of network should be fast enough to track the changes in the network. The fact that resulted topology will be probably outdated soon after its establishment is strongly connected with network wide property, which we are able to ensure. It is pointless to provide topology which preserves connectivity for sure, because it could lose this property quickly by node mobility. Therefore algorithm should just try to ensure connectivity for most of nodes and for most of network life time. Several widely used mobility models were introduced in the past, which allow both simulation on individual nodes movement and statistical analysis of behaviour of whole mobility model.

II. BACKGROUND

Topology control deals with handling the connections during the nodes mobility and supports dynamic changes of the network. 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. Serving topology control with effective results 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. This paper focuses its intensions towards making the dynamic topology control by using some of the factors such as mobility, connectivity and quality.

Here the devices or nodes are continuously in motion and hence the communication going through them must maintain the connections continuity. The information required to do the above task requires fast and efficient processing of real time data. Also the mobile ad-hoc network is scalable in nature where the connection and their organization types can be vary as the time changes and hence to maintain the topology information gets more complicated. The calculation involves must be completed in real time and have the minimal consumption of resources. The topology control maintains the quality of service which formally represents the rules and the behaviour which of the nodes from which the better delivery is assured. Along with the other factors the utilization of devices and overall performance must also be improved. Some of the quality based factor are jitter and delay which is given in most of research articles [4].

Topology control depends on the various factors and among them the most used are quality, connection property and mobility. Thus, the system which is able to work simultaneously with the topologies and considering the above factors also must give hive impact on the performance and will definitely increases the packet delivery ratio. It could be passed according to their working environment such as homogeneous and non homogeneous [5]. This work presents a topology control and analysis using some of the suggested improvements for MANET. It focuses on effectively applying the approach on simulation

scenarios created for proving the results on NS2 tool. To solve the problems associated for serving the robust topology control taking the mobility and quality as the major factors, following steps needs to be performed:

(i) Evaluating the topology control using quality based estimations of data transmissions and energy constraints

(ii) Dynamic handling of topologies connections with mobility based modifications

The work also provides an implementation analysis of the above topology control on AODV protocol algorithms.

III. LITERATURE SURVEY

During the last few years topology control is studied extensively which represents the behaviour of the nodes in different communication environment. MANET support dynamic topologies along with optimal resource constraints. Some of the authors worked on the factors of topology control. This study will restricts itself to the three factors i.e. mobility, connectivity and quality. In the paper [7], the topology control is presented for the different protocols of MANET like AODV, DSR and DSDV. Mainly the routing serve by them will uses TC respectively based on them routing category. This may be further divided into table driven, on demand and hybrid approaches. The paper gave a study on these protocols using NS2 simulation through mobility based topology model. Overall, the work concludes that under group mobility model, node's velocity has little impact, but number of FTP connections has significant impact on the performance of the routing protocols from QoS perspective. The DSR protocol emerges as the best in all respect. In the paper [8] mobility-sensitive topology control method is proposed that extends many existing mobility-insensitive protocols. Two mechanisms are introduced: consistent local views that avoid inconsistent information and delay and mobility management that tolerate outdated information. A buffer zone mechanism guarantees (under low mobility) or enhances (under high mobility) the connectivity of the effective topology. At the analytical and mathematical evaluations level the works seems to be effective. In the paper [9] the author studied the effect of some new parameters of QoS on topology control. QoS is usually defined as a set of service requirements that needs to be met by the network while transporting a packet stream from a source to its destination. The network is expected to guarantee a set of measurable pre-specified service attributes to the users in terms of end-to-end performance, such as delay, bandwidth, probability of packet loss, delay variance (jitter), etc. The idea of leveraging node mobility to improve QoS can potentially be applied to any QoS-aware routing scheme. To demonstrate this idea with the modification of the AODV routing protocol another extended model is given named as Q-AODV, which enhances AODV to be aware of resource requirements. Extending the work a model is given which is QoS based topology control in the paper [10]. The new protocol DACME is a probe-based admission control mechanism that performs end-to-end QoS measurements according to the QoS requirements of multimedia streams. Simulation results show that the probabilistic admission control technique used in DACME is effective at different levels of congestion, and that delay and jitter constraints are met with a good level of accuracy. Another paper [11]

Flexible QoS model for MANETs (FQMM) is given in the paper [12] which considers the properties of MANETs and generates the high quality of IntServ and DiServ (Service differentiation). The main purpose of introducing the IntServe is to make successful communication of telephonic B-ISDN using virtual circuits. The paper also uses a approach named as Resource ReSerVation Protocol (RSVP) as a signalling approach which configures and maintains the virtual topologies. Initial simulation results show that the suggested approach of FQMM gives better performance in terms of throughput. Continuing the work of topology, the paper [12] gives an adaptive QoS based Topology control system based on smart logical antennas. The AQTC controls the topology by forming and initial topology during the start of communication and later on changing the values dynamically. The dynamic modification performed on topologies is based on the MAC and routing properties changing during the communications. Extensive simulation analysis shows the effective results of the approach. The paper [13] shows an another approach named as COCO (Capacity Optimized Cooperative) topology control which improves the current topology by taking the interaction between the upper layer of network and the physical layer. It selects the best relaying mechanism pro actively before the transmission gets started. The approach mainly suggests the way for handling the cooperative transmission, interferences and multi-hop communications. The approach mainly works towards identifying the optimal way of selecting the relay and transmission.

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. Initially the approach work towards maintaining the continues topology controlling mechanism which is able to update itself dynamically based on the factors of routing load, throughput and the packet delivery ration. Some additional factors are also taken such as jitter and end to end delay. The complete solution is covered with the next section of the paper. Thus, a better topology control approach can be developed by resolving the above issues.

IV. PROPOSED MCQ-TC ANALYSIS

This paper gives an extensive analysis of the MCQ-TC [14] suggested in initial article of this works. The approach provides an effective topology analysis and dynamical improvements on its connection management during the worst conditions where the topology change causes the disconnections. The MCQ (Mobility, connectivity and Quality) approach uses AODV protocol for proving its results. The approach takes certain parameters for maintaining the topology for the mobile ad-hoc network.

These factors are mobility, connectivity and quality of service (QoS). The proposed work is also capable of maintaining the records between the homogeneous and heterogeneous connection environment. The approach is also minimizing the requirements for maintaining the topology behaviour of the nodes which directly increase the network lifetime. The selected three factors are used which contains the most related information on the basis of which the topology control depend. Among them the mobility is the major reason on the basis of which the topology disconnection occurs. This when there is a motion improve with the mobile nodes then it must maintains the dynamic information for processing the correct topology behaviour.

Once the correct information gets retrieved from the nods direction of motion the new topology is suggested y which the connection can be maintained. 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.

For suggesting the solution with improved performance primitives & dynamic topology control frequent data processing and decision formation is required. The information which is fetched represents the information which guides in forecasting the topologies. It shows the mobility directions, connection status and the nodes organizations. The connection process starts with broadcasting the route request message which is forwarded by each node until the destination address matches the field. The destination herewith replies with the route reply message and getting all the required information for generating the new topology. The values are passed into some neighboring 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. Then current and the newly generated topologies are calculated using two methods link quality estimation and performance factor monitoring. The first one is used for getting the link status. Means if the link status is weak then there is probability involve that the connection would be discontinue within a specified time bound. Also if the data is not completely transferred or if the transfer is remaining then the link is holding a flag which shows it as incomplete. This approach will also work towards checking that the transmission is completely done or not. Once the data is complete at the current node then only it forwards this to its next node. The second factor work towards interpreting the topology condition based on some performance primitives such as PDR, throughput, jitter, end to end delay and routing overhead. These factors are watched regularly for detecting any abrupt behaviour of the nodes from which expected direction of node motion can be detected. Now some verifications and conditional checks are performed. Now if the link quality, power requirement and performance factors is lower than the defined threshold value, then the communication is continued else it will be stopped and is shifted to the newly formed topology.

Algorithm

1. MCQ-TC Topology Control Algorithm
2. Broadcast RREQ;
3. Destination Generates RREP with same route;
4. From the above information calculate the hop counts
5. Communication Starts;
6. Monitors Node (a, b, c); // Function Call
7. Check Link quality, Power Requirement and Mobility Direction from signal strength
8. Monitor (PDR, Throughput, Jitter)
9. {
10. If (Values<= Normal)
11. Topology Discontinues;
12. Else
13. Topology Maintains;
14. }

The above algorithmic steps are easy to interpret. But the formal analysis requires the simulated parameters analysis. For showing the implemented simulation analysis the work used NS2 simulator along with its Xgraph utility for visualizing the behaviour. To prepare simulation for desired network utility the following given network setup is provided.

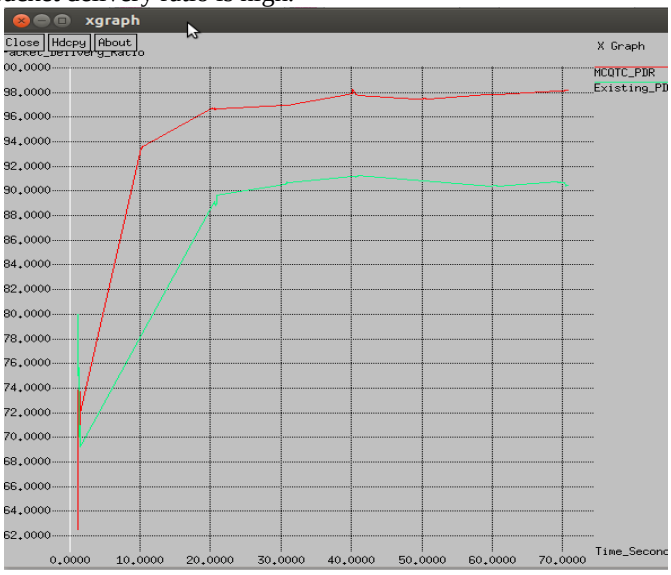
Table 1 Network Setup

No of nodes	30
Radio-propagation	TwoRayGround
Antenna model	OmniAntenna
Routing protocol	AODV
Simulation dimension	750 X 550
Initial energy(Joules)	1000
Simulation time	150 seconds
Traffic	TCP
Channel type	Wireless Channel

Using TCL script the network scenario is created then Simulation is executed. And by using AWK file RREQ packets send, received is captured and also used for the remaining energy of the nodes. When the simulation starts then trace file and nam file generated. fig shown below is the scenario of the Wireless mobile ad-hoc network with six nodes. To implement the desired system first a network is created using nodes and the above defined configurations required to simulate. System contents are the mobile nodes and they are free to perform communication with each other. The graphs on the performance factors are shown below which interprets the actual behaviour of the system for topology analysis and dynamic changes.

PDR (Packet Delivery Ratio) Graph

Packet delivery ratio is the ratio of number of packets received at the destination to the number of packets sent from the source. The performance is better when packet delivery ratio is high.

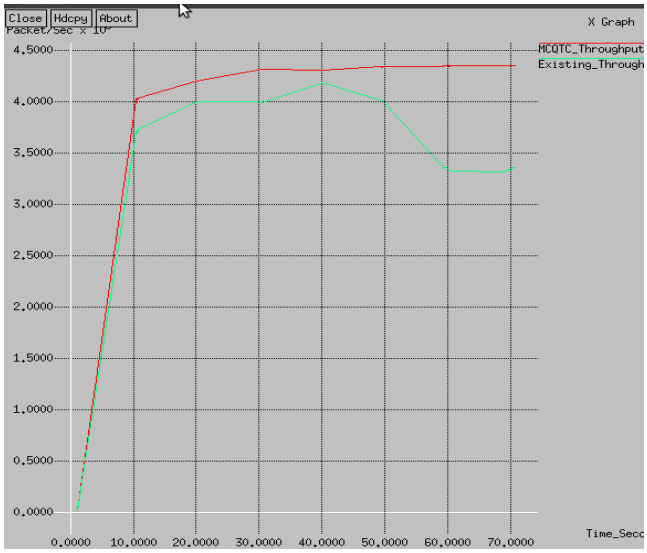


Graph 1: Comparison of PDR Ratio between existing and Proposed MCQ-TC

Graph Summary: As the PDR ratio is used to identify the performance of the approaches using the packet delivery ratio. It is the ration of number of packet sent to the number of packet received. In ideal condition it should be high as possible. For comparing the suggested work of MCQ-TC, the above graph interprets the result as an improved PDR ration than the existing approaches.

- **Throughput**

It is one of the dimensional parameters of the network which gives the fraction of the channel capacity used for useful transmission selects a destination at the beginning of the simulation i.e., information whether or not data packets correctly delivered to the destinations.

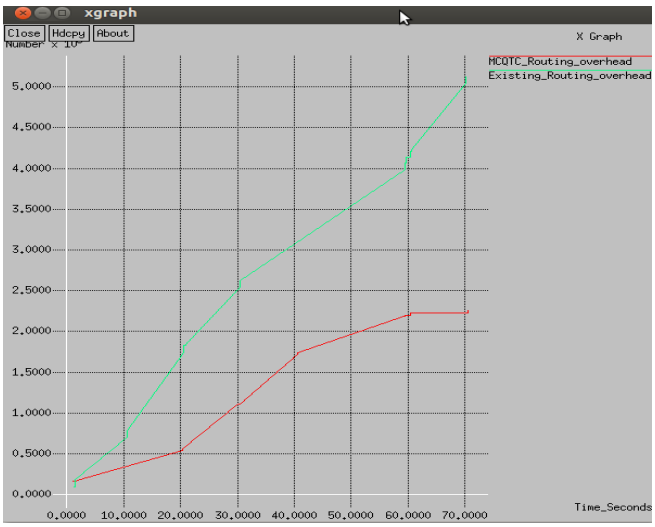


Graph 2: Comparison of Throughput between Existing and Proposed MCQ-TC

Graph Summary: As throughput measure the transmission efficiency in terms of successfully delivered packets in unit time for a specified channel bandwidth. The above graph shows the effectiveness of the suggested approach while comparing it with the existing. The graph interprets the constant throughput for several cases which justify the approach.

- **Routing Overhead Load**

Routing Load is the ratio of total number of the routing packets to the total number of received data packets at destination. The amount of control traffic generated (in bits) per data traffic delivered (in bits). It should be taken in terms of the extra load started while executing the suggested approach than the normal protocol load for the system.. Considering the factors

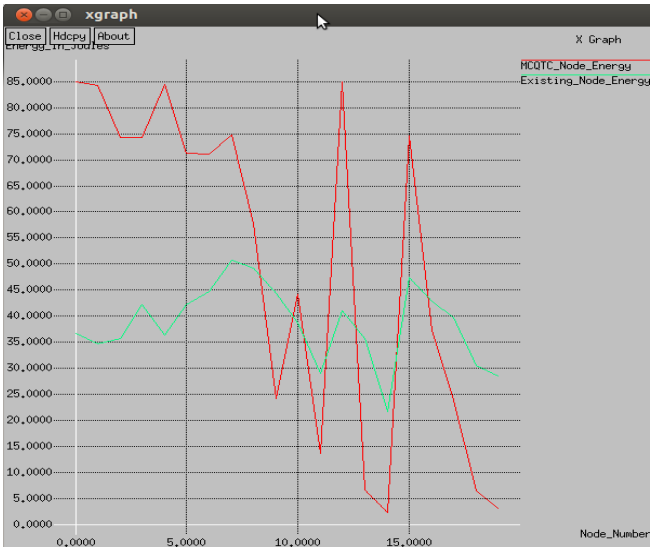


Graph 3: Comparison of Routing Overhead between Existing and Proposed MCQ-TC

Graph Summary: The above graph verifies its results by minimum routing overhead associated with the suggested approach. It also shows that the complexity of using the proposed method is quite less in comparison with the existing.

- **Energy**

The graph 4 shows the remaining energy of the nodes with respect to the traditional AODV and the proposed approach.



Graph 4: Comparison of Remaining Energy between Existing and Proposed MCQ-TC

Outcomes

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.

The simulations of QoS based traffic scenarios brought out the behaviour and priority details in multi-hop network.

V. CONCLUSION

The work in this thesis addresses two selected issues in the context of Mobile Ad-Hoc Network for emergency and rescue operations, i.e. mobility and topology control. The aim is to investigate the shortcomings of current solutions with respect to the dynamic topology handling issues through QoS based transmissions, and bring forth new solutions to improve the performance of the network as a whole or for the individual nodes. With respect to the issue of mobility, and traffic distribution, the work focuses to investigate the factors that affect the rerouting time in proactive routing protocols. That is, the time duration needed to reroute and restore a broken communication path due to node mobility. The aim is to provide an effective topology control solutions for minimizing the rerouting time such that the packet loss can be minimized and the performance in the network is maximized. The paper had surveyed various papers and had identified 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 fore casted 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.

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