RESEARCH ARTICLE OPEN ACCESS

Qos Enabled Communication Support over Multicast Ad Hoc Networks: An Overview

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ABSTRACT
Multicasting Routing in Mobile Ad hoc networks faces various issues related to Quality of Services (QoS) which suffer from behavior of routing protocols, topology, group management, security and group mobility. QoS constraints can be categorized by their application domains also i.e. for military, we need to maintain QoS for confidentiality and data integrity by compromising with control overhead, in case of real time applications, we need to maintain QoS for throughput by maintaining jitter, delay and packet delivery ratio etc. In this paper, we will give an overview of the different approaches that have been recently developed to resolve the issues related to QoS support over Multicast Mobile Ad Hoc Networks.
Keywords- MANETs,Multicast Routing, QoS.

I. INTRODUCTION

Multicast based communication is an important network service, which sends the data from a source to multiple destinations simultaneously by creating copies only when the links to the destinations split. Multicast routing tree can be constructed to transmit the data from the source to all the destinations with a minimum multicast tree cost that is used to evaluate the utilization of network resources [1]. As shown in Figure:-1, a multicast packet is transmitted to all members of its with the same reliability as regular unicast packets. Multicasting can reduce the cost of communication, consumption of bandwidth, sender and router processing and delivery delay [2].

Ad hoc networks support various applications for civilian and defense operations where set up and maintenance of infrastructure based network may not be feasible. Efficient communication over ad hoc networks can be achieved using multicasting protocols [3] with the provision of Quality-of-Service which focuses on the various parameters such as Faded Signal-to-Noise Ratio, Residual Channel Capacity, Connection Life Time, handover delays, End-to-End delays, Jitter, packet loss ratios, Packet Delivery Ratio etc and it very challenging to manage QoS support over Multicast Mobile Ad hoc network due to unique characteristics of MANETs. Multicast Ad hoc network should support the real time applications support with the provision of QoS constraints which are used to ensure QoS enabled communication. QoS provision can be ensured on the different layers such as application layer, network layer, data link layer, transport layer and physical layer. To maintain QoS, we can also use some approaches i.e. Congestion and Contention Control, Bit Error Control and Cross layer communication etc. [5]

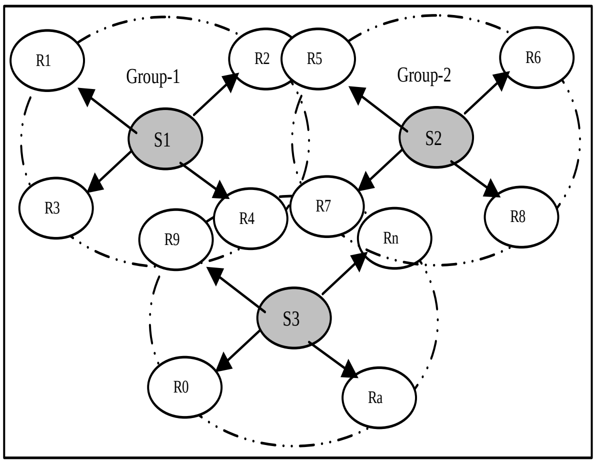

Figure:-1 Multicast communication over MANETs

II. CHALLENGES FOR MULTICAST AD HOC ROUTING PROTOCOLS

Traditional wired Multicast protocols are not suitable for ad hoc networks because routing tree becomes unstable due to the dynamic network topology. Ad hoc networks have different resource constraints like limited bandwidth, error prone shared channel, limited energy resources, security threats etc. Due to all these facts, it is very difficult to design a multicast protocol for such kind of networks. Following are the major issues related to the multicast routing protocols [3] having impact over the QoS support:

I. Reliability: In Multicast Ad hoc network, there may be packet drop due to the dynamic nature of network topology that can reduce the network performance and increase the delay and jitter. So multicast routing should be able to operate in different situations such as mobile environment, heavy traffic load, scalability in order to achieve high packet delivery [3].

II. Efficiency: Multicast Ad hoc network has limited bandwidth and efficiency of multicast routing protocol is defined as the ratio of the total number of data packets received by the receivers to the total number of (data and control) packets transmitted [3] but unfair allocation of shared channel may lead to contention over the network.

III. Resource Management: Multicast Ad hoc networks contain the various nodes arranged in different groups having limited power resources and memory. Multicast routing protocol should be able to manage all these resources for all groups [3].

IV. Scalability: A multicast routing protocol should be able to provide an acceptable level of service in a network with a large number of nodes [4]. It is very important to take into account the nondeterministic characteristics (power and capacity limitations, random mobility etc.)

V. Control overhead: Multicast groups are managed by transmitting and exchanging the control packets that consumes unnecessary bandwidth. Multicast Routing protocol should be able to manage the groups by using limited control packets [3].

VI. Quality of Services: QoS Support is essential for ad hoc Multicast communication and it is quite challenging to maintain it over MANETs . It deals with the different QoS parameters such as end to end delay, Packet delivery ratio, Routing Load, bandwidth constraints, Packet Loss Ratio etc [3].

VII. Security: Secure communication over ad hoc Multicast networks is another major challenge due to dynamic behavior of groups/group members/topology and it is very difficult to manage the security keys and its distribution for each group and individual group member [3][13].

VIII. Support of Unicast Routing Protocols: Multicast routing protocols may require the support of unicast routing protocols and it is difficult to manage and exchange the routing information for heterogeneous routing environments [3].

IX. Mobility: Multicast routing protocols must adopt the mobility of nodes. A Multicast group or any group member can move to another location using different mobility patterns. So routing protocol should be able to manage the communication in highly mobile environments [3][8][9].

III. MULTICAST AD HOC NETWORK MODEL

Multicast ad hoc network model deals with the following layers:

I. MAC Layer: MAC Layer handles the channel scheduling, maintains the multicast state information and controls transmission and reception of the packets.

II. Routing Layer: Routing Layer maintains the information related to network topology, route cache, Unicast/Multicast sessions etc.

III. Application Layer: Application Layer consumes the services provided by the Routing layer and responsible for session initialization and termination. It also deals with the data packet controllers. [3]

IV. CLASSIFICATION OF MULTICAST AD HOC ROUTING PROTOCOLS

Multicast routing protocols can be classified on the basis of Topology, Initialization approach, Maintenance approach etc.Table:1 below describes the classification of some multicast ad hoc routing protocols:[3]

Multicast Routing Protocols	MAODV	MZRP	ODMRP	DCMP	FGMP	CAMP	BEMRP	ABAM	PLBM	AMROTE
Supported Topology										
Source Tree		X					X	X	X	
Shared Tree	X									
Mesh			X	X	X	X				
Hybrid										X
Initialization Approach										
Source		X	X	X				X		
Receiver	X				X		X		X	
Hybrid						X				X
Maintenance Approach										
Hard	X	X				X		X	X	X
Soft			X	X	X		X			

Table 1: Classification of Multicast Ad Hoc routing Protocols

V. LITERATURE REVIEW

Lot of research has been already done to provide the QoS support over Mobile Ad hoc Networks but it faces some different challenges and issues those can be considered for further investigation. Researchers explored the different issues related to Quality of services and developed various solutions to improve the QoS support for multicast ad hoc networks. Now we will discuss the research done by some authors in the relevant field.

Salim Bitam et al. [6] proposed a QoS multicast routing protocol called MQBM for mobile ad hoc networks based upon the bees communication. It finds the routes between the source and the head of multicast group responsible to communicate the packet toward the group members. Figure:1 below shows the basic MQBM components on bee area.

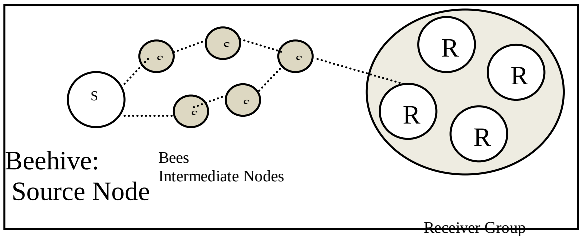

Figure 2: Projection of MQBM components on bee area[6]

A node can transmit the data only if average end-to-end delay and the average bandwidth satisfy the QoS constraints. Simulation results show the efficiency and the performance of the proposed protocol after comparisons against MAODV in terms of the average end-to-end delay and the average bandwidth as QoS metrics. As per the complexity analysis, route discovery phase uses O(pD1N+N) time units Where p:= stochastic broadcast ratio (0<p<1), Dn:= Neighbors, N:=Node. Maximum packets transmitted during route discovery can be defined as O((pD1+D2+D3)N) packets during the routes discovery. Finally we can say that MQBM performs in a linear complexity.

Zheng Sihai et al. [7] proposed a QoS-based multicast routing protocol, called QMMRP. This protocol utilizes the entropy of node (which is a metric to measure the stability of ink) and bandwidth reservation policy to find a stable link with enough bandwidth. Simulations results show that the network load of QMMRP protocol is much higher than that of ODMRP protocol. On the basis of experiments it can be concluded QMMRP performs better than the ODMRP. In case of unidirectional links complexity of QMMRP is $O(n^2)$.

V. R. Budyal et al. [8] proposed a fuzzy agent based QoS multicast routing protocol for MANET by extending ODMRP. A group of agents are used to form a mesh based multicast network and a fuzzy logic system is used to select QoS nodes which are selected on the basis of different parameters like speed, energy and delay etc. For packet routing, QoS mesh is used. The simulation results show the better packet delivery ratio with increase in number of nodes and mobility of the nodes.

G. Santhi et al. [9] proposed a Fuzzy cost based Multi constrained Quality of Service Routing (FCMQR) protocol that selects an optimal path by using multiple independent QoS metrics such as bandwidth, end-to-end delay, number of intermediate hops etc. This is based on multi criterion objective fuzzy measure in which all the available resources of the path are converted into a single metric fuzzy cost. The path with the maximum lifetime (which is based on Mobility prediction) and minimum fuzzy cost will be considered to be the optimal one and used for 10 transmissions. Simulation results show that the FCMQR provides an accurate and efficient method to estimate and evaluate the QoS routing stability and cost in dynamic mobile networks.

INPUT			OUTPUT
Bandwidth	End to End Delay	Hops	Cost
1	1	3	1
2	1	3	0
5	1	3	0
1	2	2	2
2	2	2	2
5	2	2	2
1	5	4	6
2	5	4	6
5	5	4	6

Table:2 Fuzzy Logic Rules [9]

Table:2 shows the three inputs and one output variable used for fuzzy logic. Each input variable has 3 linguistic states and the total number of possible fuzzy inference rules is 3*3*3 = 27. Values for input/output can Vary from low=:0, Low=:1, Medium=:2, Short=:3, Long=:4, High=:5, Very high=:6. [9]

Usha Devi G et al. [10] evaluated the different multicast protocols (MAODV, ODMRP, PIM, MOSPF) over the ad hoc network using various QoS metric constraints like throughput, packet delivery ratio & average end to end delay etc. Simulation results show that different protocols have different output. MAODV performs better than others but it has higher Average end-to end delay. PIM and MOSPF have lower average end-to-end delay as compared to ODMRP and MAODV but having less throughput.

Ting Lu et al. [11] proposed a genetic energy-efficient delay-constrained multicast routing algorithm to resolve the QoS multicast problem. It depends on bounded end-to-end delay and minimum energy cost of the multicast tree. This algorithm is a source-based algorithm that calculates the route on the basis of energy consumption as well as on the end-to-end delay. Results show that the proposed algorithm is effective and efficient.

G. Santhi et al. [12] described a method to select best paths from source to destination node in MANETs using fuzzy cost which is calculated on the basis of multiple independent QoS metrics such as bandwidth, end to end delay and number of nodes to transfer data from the source to the destination. Authors compared their method with MAODV protocol and results show that proposed method performs well.

Hui Xia et al. [13] presented the concept of trust into multicast routing problem which is made as another QoS constraint, and finally they proposed a multicast trusted routing algorithm with QoS multi-constraints based on a modified ant colony algorithm. According to this algorithm, ants move constantly on the network in order to find out an optimal constrained multicast security tree. Results show that proposed algorithm can easily find the feasible solution to solve constrained multicast security routing issues.

P.Deepalakshmi et al. [14] proposed a source initiated mesh and soft-state based QoS Probabilistic multicast routing protocol (SQMP) for mobile ad hoc networks. SQMP finds the routes on the basis of ant colony's route discovery principle. SQMP uses probabilistic forwarding and soft state to build the forwarding decisions with QoS constraints which are automatically reflected to the mobility of nodes in ad hoc networks. Authors compared this method with ODMRP protocol with different parameters like packet delivery ratio and number of packets/bytes transmitted per data packet received.

M. M. Qabajeh et al. [15] proposed a hierarchical scheme for multicast routing protocol with multiple QoS constrains over mobile ad hoc networks. This scheme is optimized to utilize the limited resources and reduces the overhead significantly. It searches for QoS paths from a single source to a set of destinations. As shown in Figure:3 below, entire physical space is divided into equal size hexagonal cells and a leader (CL) and backup leader (CLB) node is selected those are responsible to maintain network topology.

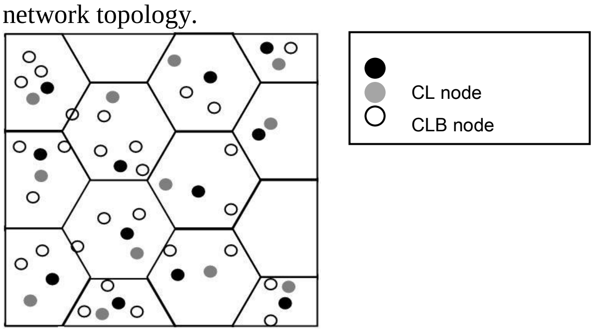

Figure:3 Network Architecture [15]

The CL node maintains information about all the nodes in a cell including their positions and Cell IDs and it is responsible to maintain information about the CLs of the neighboring cells as shown in the figure: above. The CLB node maintains a backup copy of the data saved at the CL to avoid any data loss when the CL node is in off state or it is moving. By knowing the coordinates of a node position, nodes can perform self-mapping algorithm of their physical locations onto the current cell and calculate its Cell_ID easily. Authors compared the purposed scheme with the another multicast routing protocol, called Demand Multicast Routing Protocol and results show that it performs well by reducing control over head with less packet drop ratio.

Salim Bitam et al. [16] proposed a novel bee colony optimization algorithm (BLA) for QoS multicast routing problem (QoS-MRP) over vehicular ad hoc networks as NP-Complete problem with multiple constraints. BLA solved the QoS-MRP by achieving different constraints i.e. cost, delay, jitter and minimum bandwidth. Results show the performance of this method by comparing with genetic algorithm (GA), bees algorithm (BA) and marriage in honey bees optimization (MBO) algorithm using same QoS constraints.

Xingwei Wang et al. [17] proposed a QoS multicast routing protocol, called CogMRT. Route discovery done hop by hop and each node is responsible to manage local route information. Authors used competitive co evolutionary algorithm (CCA) for the multicast tree construction that adopts novel encoding method and genetic operations. They used NS-2 for implementation and simulation results show the effectiveness of CogMRT over the traditional routing protocols.

Xu Li et al. [18] proposed a Multicast Ad hoc On-demand Vector with Backup Branches (MAODV-BB) that is an enhancement of MAODV by merging the advantages of the tree structure and the mesh structure. It uses shorter tree branches and constructs a multicast tree with backup branches. Mathematical analysis and simulation results show that the MAODV-BB protocol can manage the quality of services even during heavy network load.

Ting Lu et al. [19] focused on the power consumption in ad hoc networks and presented an energy-efficient genetic algorithm to reduce the power consumption and it depends on bounded end-to-end delay and minimum energy cost of the multicast tree. Simulation results show the effectiveness of proposed scheme.

Ya-li WANG et al. [20] proposed an ant colony-based multi-constrained QoS energy-saving routing algorithm (IAMQER) algorithm based on the analysis of local node information that considers various parameters related to nodes like queue length, number of forwarding data packets, residual energy etc. It can manage the throughput and the energy consumption simultaneously to improve the network performance in multi-constrained QoS routing. Simulation results show that IAMQER algorithm can handle the constraints like end-to-end delay and packet loss ratio and can find out the QoS routes and reduces average energy consumption and improves packet delivery ratio.

Rajneesh Gujral et al. [21] has done a survey work to improve the performance regarding inference, efficiency, security and various other issues related to mesh and tree based multicast routing protocol in MANET. From the survey of these protocols, it has observed that to design a single protocol which can satisfy all the above mentioned issues is a still an open challenge for researchers.

VI. CONCLUSION

In this paper, we discussed the various solutions developed by the researchers for QoS enabled communication support over Multicast Mobile Ad hoc networks. Concept of Quality of services deals with the various performance parameters like end-to-end delay, jitter, bandwidth, load, packet delivery ratio etc. Using all these parameters, QoS metric can be formed. In case of Multicast communication over mobile ad hoc networks, various factors affect the QoS parameters such as behavior of multicast routing protocols, unfair channel allocation, limited resources, error prone wireless links, unstable network topology due to nodes mobility, unnecessary control overhead due to insufficient group management techniques, dependency upon unicast routing protocols etc. Researchers tried to resolve the QoS related issues by managing the constraints like control overhead, delay, energy consumption, optimal path selection for routing etc. but no single solution exists which can maintain all the QoS metric parameters and there is need to develop a solution which can support the QoS enabled communication over multicast ad hoc networks while keeping the above discussed factors under control which can affect the network performance.

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