International Journal of Computer Theory and Engineering, Vol. 2, No. 5, October, 2010
1793-8201

Cluster Based QoS Routing Protocol for MANET

Prof. P.K. Suri [b], Dr. M. K.Soni [c] and Parul Tomar [a]

Abstract—**A Mobile Ad hoc NETwork (MANET) is a temporary network formed by a number of mobile nodes without a centralized administration or wired infrastructure. Because of its dynamic nature and random topology, MANET's routing protocol is different from other networks. The dynamic nature of these ad hoc networks makes support of QoS(Quality of Service) a challenging and difficult task where nodes may leave and join the network or move around anytime. In this paper, we present a new optimized protocol named as "Cluster based QoS routing for MANET" (CBQR) in support of QoS in MANET.**

Index Terms—**Bandwidth, CBQR, MANET, QoS**

I. Introduction

This paper considers a large number of mobile stations which are interconnected by a wireless network. The main feature of the multihop wireless network that differentiate it from the traditional cellular network is the infrastructure less networking i.e. each node in such wireless network can operate without any wired infrastructure or any centralized access point.

Mobile Adhoc Network (MANET) is a wireless network with dynamic topology. In MANET each node is free to move randomly. In mobile adhoc network each node is considered to be equal to other nodes. Each node is capable of transferring the data between the arbitrary source and destination. Thus, each node in MANET can act as a source or destination or router.

The next generation of applications running on the wireless networks should carry diverse multimedia applications such as video, audio and data etc. Thus, it is imperative that MANET provides quality of service (QoS) pertaining to bandwidth and delay sensitive applications. Routing and enabling QoS in MANET becomes extremely challenging especially because of its inherent dynamic nature coupled with constraints like limited bandwidth, limited battery power, etc. In this paper, we are providing a new Cluster Based QoS Routing Protocol for MANET, which not only deals with the bandwidth requirement over the wireless network but also takes care regarding the stale routes, storage overheads and limited battery power.

[b] Prof. P.K. Suri, Dept. of Computer Science and Application, Kurukshetra University, Kurukshetra, India(email: pksurikuk@rediffmail.com).
[c] Dr. M. K.Soni, Executive Director & Dean, F.E.T. MRIU, Faridabad, India(email: ptomar_p@hotmail.com)
[a] Parul Tomar , Dept. of CSE, YMCA University of Science & Technology, Faridabad, India(email: dr_mksoni@hotmail.com).

II. Related Work

According to the United Nations Consultative Committee for International Telephony and Telegraphy (CCITT) QoS is: "The collective set of service performance which determines the degree of satisfaction of a user of the service".

With the increase in technological advancement in the area of wireless network, it becomes mandatory to consider the QoS factors in the routing protocols. To support QoS, information regarding various QoS factors such as delay, bandwidth, cost, loss rate, and error rate in the network should be available and manageable. However, getting and managing these in MANETs is very difficult because of the resource limitations and the complexity associated with the mobility of hosts.

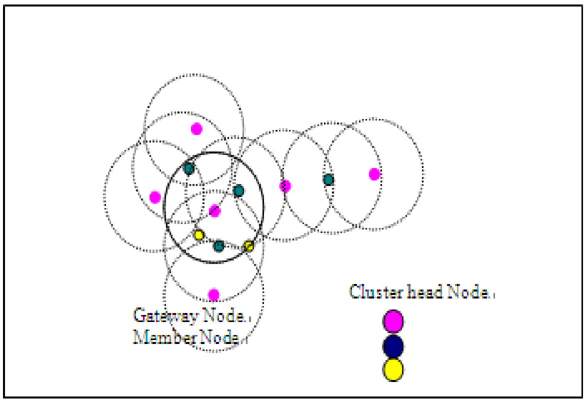

Fig. 1 Cluster representation of MANET

The conventional protocols like link-state protocols are not suitable for the multihop wireless network as they require that each node has the information about whole of the network which is not possible for large networks. On-demand routing protocols also need flooding of data which will increase the communication overhead.

In order to provide quality of service in the adhoc network the following models have been proposed:

1) Integrated Services (IntServ) [1]
2) Differentiated Services(DiffServ) [2]
3) Ad-Hoc QoS on-demand routing (AQOR) [3]
4) Dynamic Source Routing RSVP (DSRRSVP) [4]
5) Flexible QoS Model for MANET(FQMM) [5]
6) Service Differentiation in Wireless Adhoc Network (SWAN) [6]
7) In-band Signalling in Adhoc Network (INSIGNIA) [7]
8) Core Extraction Distributed Ad-hoc Routing(CEDAR)[8]

Each of the above listed protocols has some issues related to optimize routing in adhoc network. These issues will be compared in the subsequent section.

In multihop wireless network the aggregation of several nodes in the form of a cluster (Fig. 1) with a cluster head [9] will provide a better way for routing as well as for the QoS provision over the network. Each node in the cluster will communicate with the help of cluster head. As Cluster head contains all the information about each node with in the cluster like available bandwidth, delay on the nodes etc. Thus, there is no need of maintaining large tables by each node which in turn reduces the storage overhead, saves the battery power.

III. Terminology For CBQR

MN: Mobile Node

R: Required Bandwidth, it signifies the minimum bandwidth required by a MN to transmit the data.

AB: Overall Available Bandwidth at any node say MNi is initially set to its maximum limit say X. However, when ever a node MNi requires a percentage of bandwidth for transmission, it reserve it using 'R' parameter and AB is set to ABi = ABi – R

AB: Available Bandwidth, When the data packet is sent to the destination or intermediate node it will reserve the bandwidth required by it, the maximum available bandwidth now is Min(Overall_Avail_Bandwidth i, Overall_Avail_Bandwidth j)

DPH: Data Packet header (Fig. 2), use for the transmission of data between mobile nodes.

Packet ID	Source _add	Dest_ add	List_of_Visited _node	TTL	R(bps)

Fig. 2 Data Packet Header Format

Where:
Packet id: is a unique number used to identify duplicate
Source_add: contains the IP address of the sender of packet.
Dest_ Add: contains the IP address of the destination node.
List_of_Visited_Nodes: contains list of addresses of previously visited nodes.
Time-To-Live(TTL): contains a count of number of intermediate nodes traversed, limited to some number eg. 16
r(bps): contains the amount of traffic generated.(Req_Bandwidth)

Member_Table: This table maintains the information about its neighboring nodes by broadcasting a Beacon_Request Packet.

TABLE 1 Member table

S. No.	IP Address

Gateway_Table: It maintains the information regarding the gateway node and the available bandwidth over those nodes.

TABLE 2 Gateway Table

IP Address	Available Bandwidth

IV. Cluster Based QoS Routing Protocol For MANET

CBQR is an algorithm which is based on the fact that nodes are aggregated in the form of clusters with the help of least cluster change(LCC) algorithm. At start the cluster head will be selected on the bases of lowest cluster-id to create a cluster and then the cluster head will be changed only under two conditions: a) When two clusterheads comes within the same cluster or b) if a node get disconnected from the other cluster.

Each node in the cluster maintains a table called as member_table (table 1) containing the address of neighbouring node. This table is maintained in the decreasing order of their distance from this particular node. Each node also stores the address of the clusterhead.

Clusterhead also maintains member_table as well as it also maintains a gateway_table which stores the address of gateway nodes in the decreasing order of distance from the centerhead node. This gateway_table stores address as well as the available bandwidth of the gateway nodes.

Whenever a node generates a request to transfer the data to a particular node, it checks the destination node address in its member_table. If the matching node is found in the member_table, packet is transferred to that node. If no match is found, then the data packet will be sent to clusterhead. Clusterhead will again check for the match in its member_table. If no match is found, clusterhead will check for the node in the gateway_node table at which the required bandwidth is available. The data packet is sent to the node at which the required bandwidth is available. The node address will be copied to List_of_Visited_Nodes field of data packet header. This field will help in the prevention of loops. Using this field, same data packet will not be sent to a particular node more than once. Reduce the available bandwidth of the gateway node. This process will continue till the destination node is reached or if the count of visited nodes get increased than the count in TTL (Time to live) field. If this count becomes more than TTL the data packet is dropped and a message is sent to source node.

The whole process of route finding is divided into the following phases:

1) Check for the availability of destination node in the member_table. If destination node is available in the vicinity then send the data packet to the destination node.
2) If no match is found in member_table then move the data packet to clusterhead.
3) Check for the availability in the member_table of clusterhead. Again, if match found then send the data packet to the destination node.
4) If no match is found then check for the gateway node at which the required bandwidth is available in the gateway table. If a node with required bandwidth is found, set available bandwidth = available bandwidth-required bandwidth. Add the address of gateway node to the list of visited nodes and send the data packet to the gateway node.
5) Now gateway node will again check for the destination node in the member table and the process of finding the destination node will repeat from step 1 to step 5 till the destination node is reached or no of visited nodes reaches time_to_live

Algorithm for finding a node in the member_table

```
  FindMember(Data Packet DP)
 For(i=1 to member_table_size)
  {
```

```
If ( ( IP(member_table[i]) == IP(DPH.Dest_Add))
        {
        Send the Data Packet to Dest_add;
        exit();
        }
   }
   Send the data packet to clusterhead;
```

Algorithm ***for finding a gateway node in gateway_table at*** clusterhead

Gateway (Data Packet DP, AB)

```
For(i=0 to member_table_size)
{
   If(Not_Visited(IP(gateway_table[i]),DPH.List_of_Visited
_Nodes)  & (AB>=R)
    {
         Send the packet to gateway_node;
         AB=AB-R;
        List_of_Visited_Nodes
        =List_of_Visited_Nodes+IP(gateway_table[i]);
        TTL = TTL +1;
        exit();
    }

}
```

Algorithm for checking whether a node is visited previously or not

Not_Visited(Gateway node address, List of Visited nodes)

```
   for ( i = 0  to i < SIZE[List_of_Visited_Nodes] )
{
   if ( List_of_Visited_Nodes[i] == Node_Address)
          {
   return false;
          }
   else
          {
   return true;
   }
}
```

V. Analysis And Conclusion

Dynamic and unpredictable topology, limited bandwidth, limited resources in terms of battery and storing capacity are the major characteristics of MANET, and with the increase popularity of the mobile applications, it has become very important to provide quality in terms of bandwidth and delay.

A brief comparison of various QoS based routing protocol is given below:

TABLE 3 Comparison table

S.no.	Protocol	Advantage/Disadvantage
1	IntServ	This protocol provides a high level of assurance in fixed network, limited QoS support for infrastructure less networks. It requires a high processing power. Also this protocol does not support fast QoS changes.
2	DiffServ	This protocol can be easily implemented with MANET but has low level of assurance. It does not guarantee service on end to end basis.
3	DSRRSVP	Easy to implement with DSR routing but this can be implemented to a small network with low mobility.
4	FQMM	FQMM is the first QoS model for MANET.This model is hybrid of both IntServ and DiffServ.Problems of DiffServ and IntServ are present.
5	INSIGNIA	INSIGNIA is the first signalling protocol proposed for MANET. Information is carried out in IP option of IP data packet. Tis protocol does not send error and rejection messages.
6	AQOR	AQOR deals with bandwidth and end to end delay. This protocol includes three main steps: on demand route discovery, signaling function and hop to hop routing. This protocol does not deal with the latency delay.
6	CEDAR	CEDAR was proposed to reduce the control overhead.This model has 3 main components: core extraction, link state propagation, and route computation. It can perform only under centralized network.
7	SWAN	This protocol uses rate control of TCP and UDP traffic to maintain manageable levels of congestion in the network. It uses admission control for real time traffic and varies the rate of TCP traffic based on feedback from MAC layer to maintain delay and bandwidth bounds for real time traffic. The throughput of this protocol is very low. This protocol does not scale well with high mobility.
8	CBQR	CBQR is a table driven routing protocol to provide support to a critical QoS parameter i.e. bandwidth efficiently. With the help of clusterhead it reduces storage space requirement. Also This protocol helps in avoiding loops with the help of list of visited nodes parameter.

CBQR is a table driven routing protocol has handled the core issues of QoS parameter i.e. bandwidth efficiently. CBQR make use of clusterhead which reduce the requirement of storage space in the member nodes in cluster. Each member node does not required to maintain the information regarding whole of the network, rather they require just storing the information about nodes in the vicinity plus information regarding the clusterhead. It also reduces the bandwidth consumption over the network as the initial data communication is between the clusterhead and gateway node. If destination node is associated with clusterhead then the data packet is forwarded to that node otherwise it is forwarded to the next clusterhead through gateway node. This also reduces the delay in hop to hop transfer of data packet. The CBQR thus provides the reduction in data processing, saves the battery backup, reduces the delay in transmission of data packet, and avoid loops.

References

[1] R. Braden, D. Clark, and S. Shenker, “Integrated services in the Internet architecture: an overview,” 1994, IETF RFC 1633.

[2] S. Blake, D. Black, M. Carlson, E. Davies, Z.Wang, andW. Weiss, “An architecture for differentiated services,” 1998, IETF RFC 2475.

[3] Qi Xue , Aura Ganz “Ad hoc QoS on-demand routing (AQOR) in mobile ad hoc networks ”. Journal of Parallel and Distributed Computing,(63), 154-165, 2003.

[4] M. Mirhakkak, N. Schult, D. Thomson, “A new Approach for providing Quality-of-Service in a Dynamic Network Environment”, The MITRE Corporation, Network and Communications Engineering Department, Reston, Virginia.
[5] Hannan XIAO, Winston K.G. SEAH, Anthony LO and Kee Chiang CHUA “ Flexible Quality Service Model for Ad-HOC Networks”. In proceedings of the IEEE Vehicular Technology Conference, Tokio, Japan, May 2000.
[6] SWAN Project: http://comet.columbia.edu/swan, 2002.
[7] [ACLZ99]G-S. Ahn, A.T. Campbell, S-B. Lee, and X. Zhang, “INSIGNIA”, Internet Draft, draft-ietf-manet-insignia-01.txt,Oct 1999.
[8] R. Sivakumar, P.Sinha, and V. Bharghavan.CEDAR: A Core Extraction Distributed Ad Hoc Routing Algorithm, In IEEE JSAC, Special Issue on Ad hoc Networks aand Applications, Vol 3 N 8, august 1999.
[9] C.-C. Chiang, H.K.Wu, W. Liu, and M. Gerla, “Routing in Clustered Multihop, Mobile WirelessNetworks with Fading Channel," Proceedings of IEEE SICON'97, pp. 197-211, April 1997.
[10] C. E. Perkins and E. M. Royer, “Ad-hoc On-Demand Distance Vector Routing," Proceedings of 2nd IEEE Workshop on Mobile Computing Systems and Applications, February 1999.
[11] D. B. Johnson and D. A. Maltz, “Dynamic Source Routing in Ad-Hoc Wireless Networks,"Mobile Computing, ed. T. Imielinski and H. Korth, Kluwer Academic Publishers, pp. 153-181,1996.
[12] Elizabeth M. Royer, C-K Toh, Review of Current Routing Protocols for Ad Hoc Mobile Wireless Networks, IEEE Personal Communications, Vol. 6, April 1999,pp. 46-55.