International Journal of Innovative Technology and Exploring Engineering (IJITEE)
ISSN: 2278-3075 (Online), Volume-9 Issue-1, November 2019

A Novel Multicast Routing Protocol for Mobile Ad-Hoc Networks

G.Jose Moses, N.Supriya

Abstract: We present a novel approach multicast routing protocol using Ant Colony Optimization and Cross Layer Technique. This protocol is an enhancement of the existing on-demand multicast routing protocol (ODMRP). Establishing communication through portable devices without any central infrastructure is possible in Ad-hoc networks. This feature of the absence of a central infrastructure and the random mobility of the devices give rise to multiple problems involving in security and routing. The challenges encountered by these multicast routing protocols are to provide a secured and efficient routing in these networks. In this paper we intend to present a novel approach of on-demand multicast routing protocol using Ant Colony Optimization and Cross Layer Technique. With this enhanced feature of cross layer technique and by applying ant colony optimization the proposed protocol performs more efficient with minimal overhead. The performance levels of the proposed algorithm at higher traffic load in comparison to the existing algorithms are evident from the simulations performed using NS-2.

Keywords : Ant Colony Optimization, Cross Layer Technique, Multicast Routing Protocol, ODMRP.

I. INTRODUCTION

Several routing schemes have been proposed to provide efficient performance in ad hoc networks. routing protocols are mainly divided into two categories [1] Table Driven/Proactive routing protocols and On-Demand/Reactive routing protocols. Table driven routing protocols are derived from Internet distance-vector and link-state protocols. They attempt to maintain consistent and updated routing information for every pair of network nodes by propagating, proactively, route updates at fixed time intervals. As the routing information is usually maintained in tables, these protocols are sometimes referred to as Table-Driven protocols. On-demand routing protocols, on the other hand, establish the route to a destination only when there is a demand for it. Source node discovery the route once the route is requested. Once a route has been established, it is maintained until the destination becomes inaccessible, or until the route is no longer available [2]. In addition, the validity of the pre-determined routes in an ad hoc network may rapidly be lost corresponding to its rapidly changing topology.

Revised Manuscript Received on November 30, 2019.

***** Correspondence Author

Dr. G. Jose Moses*, Professor, Department of CSE, Raghu Engineering College(A), Visakhapatnam, INDIA. Email:josemoses@gmail.com

Dr. N.Supriya, Assoc. Professor Department of CSE, Raghu Institute of Technology(A), Visakhapatnam, INDIA. Email:nsupriyacse@gmail.com

Prior studies prove that the on-demand protocols perform better than the proactive protocols [3].

In recent years several multicast [4] routing protocols along with the existing unicast routing protocols have been proposed for ad hoc networks. The proposed multicast routing is as tree-based and mesh-based. Tree-based protocols [5] create a tree connecting all its multicast members. tree-based protocols are considered more efficient in comparison with mesh-based protocols. But, the absence of an alternate path between the source and destination conditions it as less robust in the contexts of changing topologies. Consequently, failure of every link in a multicast tree may trigger a series of exchanges of control messages for tree re-build. In contrast to the tree-based protocols having only on existing path between any two nodes, mesh-based protocols permit existence of redundant paths between the nodes with their built-in mechanism of provision for alternate paths and as a result failure of a link need not require or initiate a re-computation of a mesh. Mesh-based protocols are proved to be robust as per the previous studies.

II. RELATED WORK

In recent studies, the objective is on the discovery of multipath and Quality of Service of the on-demand routing protocol. Ant colony-based multi-path QoS-aware routing (AMQR) [6] integrates link and disjoint multipath route and swarm intelligence to choose multiple paths for providing QOS [7]. The on-demand multicast routing protocol (ODMRP) is a protocol based on mesh for mobile ad hoc networks. Due to its mesh based features, ODMRP has the capability to exploit redundant route also when the shortest route becomes invalid. Hence is the robustness of ODMRP to the mobility of host and failure of connectivity. Besides, the protocol overhead is reduced because the multicast route and maintenance of membership are completely on-demand. There are two phases, a request phase and a reply phase in ODMRP, just as in the other on-demand routing protocols. When a packet is sent for the first time to a multicast group, a JOIN REQUEST message is broadcasted to the total network by the sender. When a non-duplicate JOIN REQUEST message is received by a node, it saves the relevant upstream node ID in a backward learning technique, and then received JOIN REQUEST is rebroadcasted. When the non-duplicate JOIN REQUEST message is received by a multicast member, it verifies and updates its member table. Periodic rebroadcasting of a corresponding JOIN TABLE message is made by the receiver to its neighbor, if a valid entry is in existence. In continuation of this, the neighbor on receiving the JOIN TABLE message, checks to find an entry in the message having itself as a next node ID. The success of the search assures it is on the forward path towards the multicast group. FG_Flag is set and broadcasts its own message of JOIN TABLE which is created from the previously matched entry. Repetition of the process continues till the JOIN TABLE message is received by the source. Consequently, a mesh that connects all the forwarding nodes and multicast group members are constructed. In order to update the multicast routing mesh, the source also broadcasts the JOIN REQUEST message. Mesh building process is illustrated in Fig: 1. Here the nodes marked S, R and F denote the source, the multicast group members and nonmember forwarding nodes respectively, while JOIN REQUEST message is represented by arrows consisting line tail and JOIN REPLY message by arrows consisting dash tail. The figure shows that F1, R2, and R3 make up a mesh. R2 gets multicast packets first, from R3. In the event of R2 moving out of the range of R3 and still within the reach of F1, then it replies to JOIN REQUEST with new JOIN TABLE can be sent from F1 on behalf of R2 and then R2 receives multicast packet from F1.

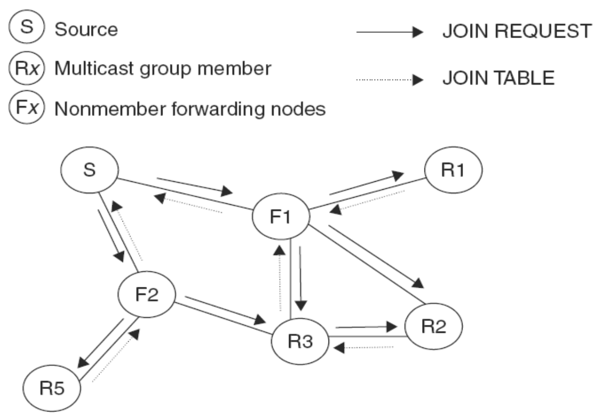

Fig: 1 Multicast route process of ODMRP.

There is no need for any explicit control message in ODMRP to leave the existing multicast group. What all sender needs to do in case of leaving the group is to simply discontinue sending the JOIN REQUEST message while the receiver side can accomplish similar results by halting its send JOIN TABLE messages. It is evident from the above illustration that if mesh is more complex, the protocol to host mobility is more robust. In spite of the several advantages of ODMRP, it still suffers from forbidding degree of high overhead. This overhead is largely attributed primarily to delivery structure of the mesh and the network wide broadcasting of join query packets. Significant increase in data and control overhead, especially in case of large networks, can be perceived when there are several nodes or multicast sources in the network. However, increase in reliability with higher ratio of packet delivery under mobility conditions can result because of the redundant paths within the mesh delivery structure. Hence a method of reducing the overhead in creating and maintaining the mesh becomes an important point of consideration. Identifying which nodes and links participate in the delivery, based on mesh is yet another aspect that determines the performance. As a principle, it must be understood, that it is not possible for all the nodes to have equal performance (owing to factors like low battery for some nodes or low CPU processing facilities for some other) and all the links to have a high degree of reliability or availability of bandwidth. So, in the mesh creation phase, link quality and availability of resource are important considerations. Cross-layer ODMRP [8] addresses the first issue. The parameters of network layer as well as MAC layer are crossed here. We consider the minimum hop count from the network layer and (load of the node and bandwidth available) from MAC layer. Due to this, the metric of cross layer becomes the product of minimum hop count and load of the node with bandwidth available. CL-SODMRP can offer a solution to the second problem. By following rate-guard technique, the attacks based on measurement are identified and through accusation reaction technique, the detected node is accused for a specific period of time from forwarding the data.

III. PROPOSED METHODOLOGY

Cross-layer AMR (Cross-Layered Ant Colony Optimization Multicast Routing Protocol) proposed is enbled with QoS, This proposed multipath routing protocol is developed on the foraging behavior of ant colony. The source generates both the ant agents called reactive FORWARD_ANT to find the multiple paths to the destination and BACKWARD_ANT to set up the return paths. The qualities of the paths are indicated in the pheromone table. Next Hop Availability is considered as a metric during the route discovery phase to assess the goodness of the highly available links and nodes. With the help of Next Hop Availability the path is constructed. Next Hop Availability is calculated with the availability of nodes and links. It is the probability to find the next hop, which is the node available and the link available for routing on a path.

Next Hop Availability = Probability of Link × Probability of node -------- (1)

In the phase of route discovery, the source node which transmits information to the destination node and verifies the available trusted neighbours first. Then the nodes with greater Next Hop Availability above the threshold are selected. Next, the source node initiates broadcasting FORWARD_ANT to all its neighboring trusted nodes having the Next Hop Availability in order to control the routing overhead.

Fig: 2 illustrate the structure of packet of the FORWARD_ANT. Addresses of all the nodes traversed along the source to destination path are contained in <Path fields>.

Any intermediate node receiving the FORWARD_ANT, first verifies if its address figures in the field path. If the address is available, it discards the FORWARD _ANT at that stage itself to eliminate further loops. Or else it attaches its address to FORWARD _ANT and then initiates broadcasts by its NEXT HOP AVAILABILTY values to all its trusted and stable neighbors. In the process of searching for the destination, the FORWARD _ANT collects delay transmission of each link available, delay of processing at every node, each link's available capacity and visited number of hops. On FORWARD_ANT arriving the destination node D, the destination node D first computes the path preference value, by considering the end-to-end delay parameter for only such paths meeting the threshold values prescribed by user and thus generate BACKWARD_ANT.

Dynamically growing

Source Address	Destination Address	Sequence Number	Hop Count	End-to End Delay	Start Time	Path Fields

Fig: 2 Packet format of FORWARD_ANT

Fig: 3 display the packet structure of BACKWARD_ANT. The nodes that are visited in the path are stacked in the FORWARD_ANT. By performing pop operation on such nodes present in the stack, the BACKWARD_ANT is unicasted to the source node.

Destination Address	Original Source Address	Start Time	Received Path Field	Path Preference

Fig: 3 Packet structure of BACKWARD_ANT

When the BACKWARD_ANT meets the intermediate node i the pheromone value gets updated from node n in the routing, pheromone table of node i as $T_{i,n}$ and it is updated as

$$T_{i,n} = \left(1 + T_{i,n}\right) P\left(K\right)_d \quad \text{------------------ (2)}$$

Where $P\left(K\right)_d$ is the path preference value of the kth path that satisfied the Quality of Service requirements for the destination d.

IV. ODMRP WITH ANT COLONY OPTIMIZATION

In the mesh based ODMRP, packets are transmitted to the destination by employing the concept of a forwarding group. It can be termed a 'reactive protocol' as it makes use of 'on-demand' procedures for dynamically building up routes and maintaining multicast group. We intend to provide an elaborate explanation of the functioning the process of mesh creation of enhanced ODMRP duly considering the ant colony optimization. The network is flooded with FORWARD_ANT message whenever the source node has data to transmit. The intermediate node, after receiving a (non-duplicate) FORWARD_ANT packet, stores and updates the information regarding the upstream node. The Intermediate nodes continue to flood the FORWARD_ANT packet. After receiving the FORWARD_ANT packet, the receiver builds the PHEROMONE TABLE [9] and transmits the BACKWARD_ANT to its neighbors. Then, all the nodes receiving the BACKWARD_ANT packets verify their individual IDs against the ID contained in the BACKWARD_ANT packet. If a matching is found, the node becomes the forwarding member of the group by setting the FG_Flag(Forward Group Flag). Further propagation of FORWARD_ANT packet continues, till it arrives at the source. Through the broadcasting of FORWARD_ANT packets at regular intervals, the senders maintain an update of the multicast group. The following data structures are required to be maintained by each host that runs ODMRP:

• **Routing table** – Each node reactively creates a route table and maintains it. When a non-duplicate FORWARD_ANT containing high pheromone value is received, corresponding entry is inserted or updated. The node stores the information regarding the destination and the subsequent hops to the destination. Next hop information during the transmission of BACKWARD-ANT is provided by the route table.

• **Forwarding group table** – The multicast group information is stored in the forwarding group table by the node acting as a forwarding group node of a multicast. It records the group ID of the multicast and the time stamp.

• **Trust Pheromone table** – It is a table that contains the trust value of the neighbors depending on the threshold value from end-to-end delay.

• **Neighboring Information table** – This table contains the required information about all the set of neighbors in any specific network.

V. CROSS LAYER MODEL

In the proposed cross layered model MAC and NETWORK layers are fused in order to achieve a cross layer factor. The load of the node and the bandwidth available for a specific node are calculated. We derive a cross layer factor clfactor [10] on the basis of these calculations. This cross layer factor can be used as a metric for determining the path from source to destination. Use of the enhanced ODMRP mechanism with Ant Colony Optimization [11] can find all the source-to-destination corresponding routes in network layer. We compute the length of the node and the available bandwidth in each node of the specific routes.

Let B(s) be the available bandwidth at source node S. and B(r) be the available bandwidth at receiver node r, then

$$B(s,r) = Min(B(s), B(int1), B(int2)\ldots\ldots B(r)) \quad \text{----- (3)}$$

Where B(s,r) is the available bandwidth for the entire link between source node s and receiver node r.

Then, we apply this mechanism of cross layer to the paths provided by the network layer and select such route having effective clfactor for the given data rates. In comparison to the original ODMRP mechanism, we get more efficiency and reduced overhead.

1. Calculate the node load for a node i in the network.

$$nodeload_i = \frac{queue\_len_i}{queue\_len\_nodes} \quad \text{---- (4)}$$

2. Calculate the available bandwidth for a node i

$$Bdw_i = Bdw_{ch} * \left(\frac{t_i}{tot\_time}\right) * 0.8 \quad \text{---- (5)}$$

Where Bdw_i is the bandwidth of node i, Bdw_{ch} is the channel bandwidth and 0.8 is the weight factor.

3. Apply cross layer design over network and Mac layer parameters.

$$clfactor = \left(Max(Bdw_i, nodeload_i)\right) \quad \text{---- (6)}$$

Algorithm:
Change Node:
case *ForwardGroup*:
On receiving a FORWARD_ANT do
Create a BACKWARD_ANT (assign all the fields)
Pass it towards the FORWARD_ANT->lastAddress
End

On receiving a BACKWARD_ANT do
This is an invalid case as the first FG that receives a FORWARD_ANT replies it with a BACKWARD_ANT
End
end case
case *Group member*:
If the JOIN timer is lapsed
Pass a FORWARD_ANT message
End
On receiving a FORWARD_ANT do
Create a BACKWARD_ANT (assign all the fields)
Pass it towards the FORWARD_ANT-> FinalAddress
Set the ForwardGroup flag to TRUE
End
On receiving a BACKWARD_ANT do
If (address of node = = BACKWARD_ANT -> rxAddress)
Select this as it is the correct node waiting for a reply
Else
This case is invalid (similar to an Forward Group node)
end
end case
case *Non-member*:
On receiving FORWARD_ANT do
If (FORWARD_ANT->TTL > 0)
--FORWARD_ANT->TTL and broadcast it to the available neighbors
Else discard the message
On receiving a BACKWARD_ANT do
If (BACKWARD_ANT ->nextHop == node's address)
Set the ForwardGroup flag to TRUE
Set BACKWARD_ANT ->nextHop according to FORWARD_ANT TABLE value
Pass it to BACKWARD_ANT ->nextHop
Else discard the message
end
end case
End

VI. RESULTS AND ANALYSIS

For the purpose of simulation, we utilized NS-2 [12] network simulator. A network model of 50 randomly placed nodes covering an area of 1000m x 1000m figure in our simulation. The simulator functions with a range of 250 meters radio propagation with channel capacity of 2 Mbits/Sec. The size of the multicast group varies with one source in each group sending at the rate of 20 Packets/Sec. 300 seconds of simulation is executed in each simulation. We collected data and averaged over the results arrived at by changing the send numbers in different multiple runs for each changing scenario.
The following metrics is used to estimate the performance of the proposed mechanism:

- **Packet Delivery Throughput**
- **End-to-End Delay of Data Packet**
- **Attack detection scenario**

Performance of our approach is evaluated by a comparison against the approaches ODMRP and CL-ODMRP. The performance appears to be much enhanced from the Fig. 4, Fig.5 and Fig.6.
1) Packet Delivery Rate:

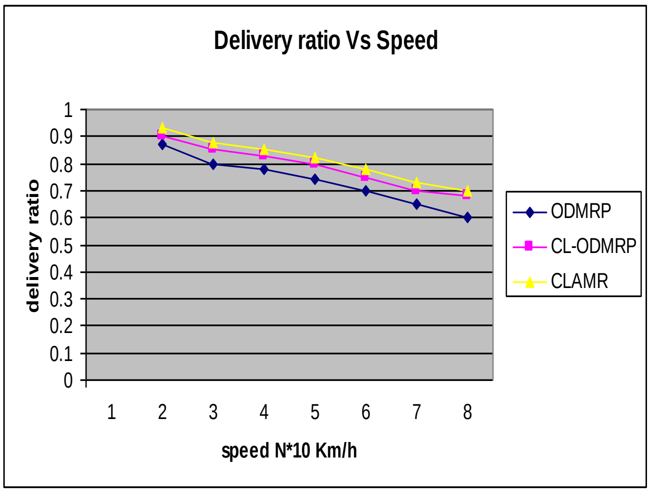

Fig. 4 Packet delivery rate vs speed

Fig. 4 shows the performance of packet delivery ratio of the proposed protocol CL-AMR with CL-ODMRP and ODMRP with varying moving speed. Similarity in performance can be seen with CL-ODMRP and ODMRP at low speed, The efficiency of the proposed model clearly displays the increased packet delivery ratio with respect to the speed.
2) Route load and delay:

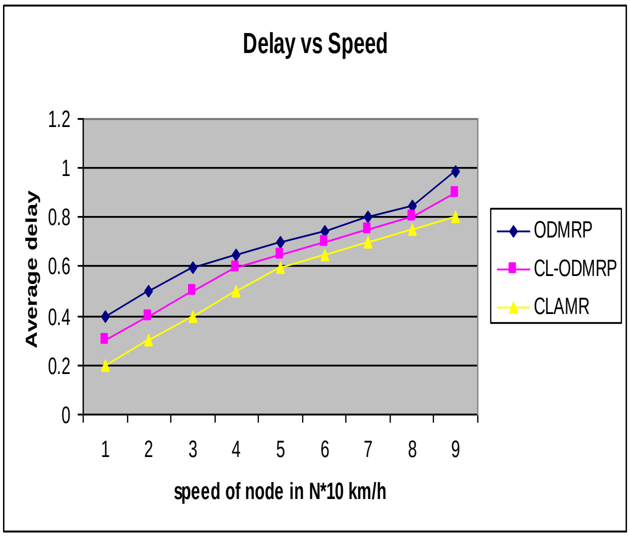

Fig. 5 Comparison of Average delay with CLAMR

Fig. 5 shows the comparison of the average delay of CL-AMR against CL-ODMRP and ODMRP, with varying moving speed. We can clearly observe the reduction of delay upto 15% as against ODMRP through the proposed model Cross-layer AMR(Cross-Layered Ant Colony Optimization Multicast Routing Protocol).
3) Attack detection scenario:
Fig.6 shows The effectiveness of CL-AMR against the number of attacks when compared to ODMRP. We also compared the Packet drop ratio of ODMRP, S-ODMRP AND CL-ODMRP. From the results we can clearly see that both CL-ODMRP and CL-AMR results in less packet drop ratio compared to the traditional ODMRP as the number of attackers increase.

Retrieval Number: A3941119119/2019©BEIESP
DOI: 10.35940/ijitee.A3941.119119
Journal Website: www.ijitee.org

Published By:
Blue Eyes Intelligence Engineering
& Sciences Publication

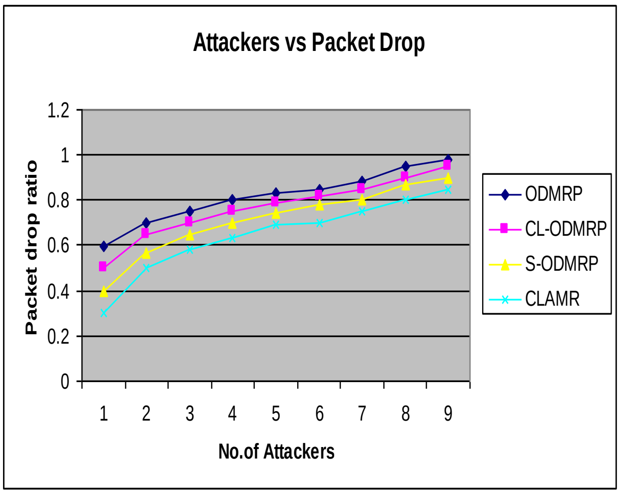

Fig. 6 No. of Attackers vs Packet Drop Ratio

VII. CONCLUSION

In this Paper, we discussed about the working model of the proposed model of Cross-layer AMR(Cross-Layered Ant Colony Optimization Multicast Routing Protocol). From the results and analysis we can examine the performance of the proposed protocol. It clearly shows that the proposed routing protocol is more efficient when compared to existing ODMRP, CL-ODMRP protocols.

REFERENCES

1. E.M.Royer.,Chai-Keong.Toh., April 1999. A review of current routing protocols for ad hoc mobile wireless networks, IEEE Personal Communications, Vol.6(2), pp. 46–55.
2. Freebersyser, J.A., and Barry Leiner, 2001. A DoD perspective on mobile ad hoc networks, Charles E. Perkins (Ed.), Ad Hoc Networking, Addison Wesley, pp. 29 - 51.
3. G.Jose Moses, Dr.P.Suresh varma, N.Supriya, 2012.'A Review on routing protocols in mobile adhoc networks'. IJARCS; Vol.3,No.1,Jan-Feb,pp.59-64.
4. Asis Nasipuri, Samir R.Das, Oct.1999.'On-demand multipath routing for mobile ad hoc networks'. Proc. Eighth Int. Conf. on Computer Communications and Networks,; pp. 64–70.
5. Zhang, B., Mouftah, H.T., 2006.'Destination-driven shortest path tree algorithms', J. High Speed Network.,Vol.15, (2), pp. 123– 130.
6. Misra, S., Obaidat, M.S., Dhurandher, S.K., Verma, K., Gupta, P., 2009 'Using ant-like agents for fault-tolerant routing in mobile ad-hoc networks'. ICC, pp. 1–5.
7. P. Venkata Krishna, V. Saritha, G. Vedha, A. Bhiwal and A.S. Chawla, 2012 "Quality-of-service-enabled ant colony-based multipathrouting for mobile ad hoc networks", IET Commun., Vol. 6, Iss. 1, pp. 76– 83.
8. G.Jose Moses, Dr.P.Suresh varma, N.Supriya, 2012.'CL-S-ODMRP- A Cross Layered Secure ODMRP for Achieving High-Throughput in Wireless Networks', European Journal of Scientific Research,Vol. 87, No 2, pp.251-260.
9. Misra, S., Obaidat, M.S., Dhurandher, S.K., Verma, K.,,2009.'Using ant-like agents for fault-tolerant routing in mobile ad-hoc networks'. ICC, 2009; pp. 1–5.
10. P. Venkata Krishna and Iyengar, 2007. "A Cross Layer Based Qos Model For Wireless And Mobile Networks" Journal of Mobile Communication. Iss.1 (4), pp. 114-120.
11. Sivakumar, D.; Suseela, B.; Varadharajan, R, 2012, "A survey of routing algorithms for MANET," Advances in Engineering, Science and Management (ICAESM), International Conference, vol.30,pp.625-640.
12. NS-2, the NS Manual (formally known as NS Documentation) available at http://www.isi.edu/nsnam/ns/doc.

AUTHORS PROFILE

Dr. G. Jose Moses working as Professor, in the department of CSE. He is Approved Research Supervisor for JNTUK. He obtained his B.Tech(CSE) from JNTUH, M.Tech(CSE) from ANU, Ph.D(CSE) from AKNU. He has presented and published papers in International conferences and International Journals. His current research is focused on Communication Networks and Cloud Computing.

Dr. N.Supriya is working as Associate Professor, in the department of CSE. She obtained her M.Tech(CSE) and Ph.D(CSE) from ANU, Guntur. She published papers in International Journals. Her current research is focused on Software Engineering and Communication Networks.