International Journal of Advanced Computer Research (ISSN (print): 2249-7277 ISSN (online): 2277-7970)
Volume-3 Number-1 Issue-8 March-2013

Renovated Cluster Based Routing Protocol for MANET

Yuvraj Kumbharey[1], Suwesh Shukla[2], Sushil Chaturvedi[3]
Lakshmi Narain College of Technology, Bhopal (M.P) [1,2,3]

Abstract

In this paper, we have proposed a Renovated Cluster Based Routing Protocol (RCBRP) for reducing routing overhead and to improve the routing discovery by integrating the inter-cluster on-demand and intra-cluster table-driven routing, which can increase the performance in the throughput, using simulation with NS-2.3. We are going to compare RCBRP with pure AODV Routing protocol.

Keywords

Adhoc network, Renovated, Inter-cluster, Intra-cluster, Over-head, Throughput.

1. Introduction

A MANET can be defined as a collection of wireless mobile nodes that are capable of communicating with each other without the use of a network infrastructure or any centralized administration. The mobile hosts are not bound to any centralized control like base stations or mobile switching centers. In such a network, each mobile node operates not only as a host but also as a router, forwarding packets for other mobile nodes in the network that may not be within direct wireless transmission range of each other. Each node participates in an ad hoc routing protocol that allows it to discover multi hop paths through the network to any other node. The idea of MANET is also called *infrastructure less networking*, since the mobile nodes in the network dynamically establish routing among themselves to form their own network on the fly. It is formed instantaneously, and uses multi hop routing to transmit information. MANET technology can provide an extremely flexible method of establishing communications in situations where geographical or terrestrial constraints demand a totally distributed network system without any fixed base station, such as battlefields, military applications, and other emergency and disaster situations

MANET has the following features:

i)Autonomous terminal: In MANET, each mobile terminal is an autonomous node. It can function as both a host and a router.

ii)Distributed operation: Since there is no background network for the central control of the network operations, the nodes involved in a MANET should collaborate amongst themselves and each node acts as a relay as needed, to implement functions e.g. security and routing.

iii)Multi hop routing: Single-hop MANET is simpler than multi hop in terms of structure and implementation, with the cost of lesser functionality and applicability. When delivering data packets from a source to its destination out of the direct wireless transmission range, the packets should be forwarded via one or more intermediate nodes.

iv)Dynamic network topology: Since the nodes are mobile, the network topology may change rapidly and unpredictably, mobile nodes in the MANET dynamically establish routing among themselves as they move about, forming their own network on the fly.

v)Fluctuating link capacity: The nature of high bit-error rates of wireless connection might be more profound in a MANET. One end-to-end path can be shared by several sessions. The channel over which the terminals communicate is subject to noise, fading, and interference, and has less bandwidth than a wired network.

vi)Light-weight terminal: In most cases, the MANET nodes are mobile devices with less CPU processing capability, small memory size, and low power storage.

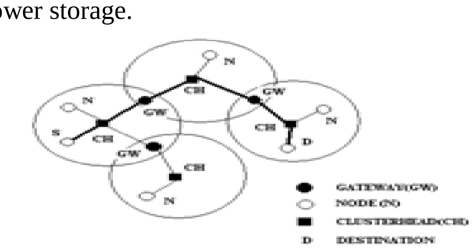

Fig 1: RCBRP

Node S (source) has to send data to node D (destination). S sends route-requests to all the neighbouring cluster-heads, and only to the cluster-heads. When a cluster-head receives the route request, it checks if the node D is in his cluster. If this is the case, the cluster-head sends the request directly to the destination. But when D isn't in the cluster, it sends the route request to all the adjacent cluster-heads. All cluster-head saves his address in the packet, so when a cluster-head receives a route request where his address is saved in the packet, it discards this packet. When the route request packet arrives at the destination, D replies back with the route that had been recorded in the request packet. When the source S doesn't receive a reply from the destination within a time period, it tries to send a route request again.

Figure.1 shows the working of our protocol. However, in a clustering network the cluster-head has to undertake heavier tasks so that it might be the bottleneck of the network. Thus, reasonable cluster-head election is important to the performance of the Ad Hoc Network. Developing a good dynamic routing protocol for Ad Hoc Network with rapid topology variation is not only the key of the network design, but also hot problem of research.

2. Related Work

Routing protocols form the heart of any MANET, which haven't evolved as much to support a large amount of mobile units. The performance of most routing protocols degrades with the increase in mobile nodes, leading to higher end-to-end delay, more dropped packets and low quality of service (QoS).

Existing routing protocols can be classified either by their behavior or by their architecture. The existing protocols can be broadly classified into three groups based on their behavior: reactive protocols (on demand), proactive protocols (table driven) and hybrid protocols that are a combination of reactive and proactive protocols. If classified by architecture, the protocols are either flat or follow a hierarchy.

2.1 Clustering Algorithms

Different clustering algorithms have different optimizations, such as minimum cluster-head election and maintenance overhead, maximum cluster stability, maximum node lifespan, etc. There are probably contradictions among these optimizations. In addition, lots of the optimizations and their combinations are an NP-hard problem. Thus, heuristic Clustering algorithms are used to find sub-optimal solutions in common [13].

Lowest-ID (LOWID) algorithm [1] has the feature of simple calculation. If the cluster structure varies rapidly, the cluster maintenance overhead is relatively small. However, the cluster-head costs excessive resources so that the network lifespan is reduced.

Highest-degree (HIGHD) or highest-connectivity algorithm [2] has the advantage of less cluster number to reduce the packet delivery delay. But when a cluster has too many nodes, the throughput of each node will decline shapely. Additionally when the node has high mobility, the cluster-head updating frequency will increase dramatically, which greatly increase the maintenance overhead.

Distributed Mobility-Adaptive clustering (DMAC) algorithm [3] can reduce the cluster-head updating frequency obviously because the node with lowest mobility is elected as a cluster-head. Its disadvantage is that the frequent computation of node mobility weight costs large calculation overhead.

The above clustering algorithms only take into account one or two factors for the choice of cluster-head, whose optimization is not enough. Chatterjee et al. [4] described a clustering algorithm with weight defined as a combination of a few metrics including node degree, sum of distances to all neighbors, speed of node, and the cumulative time node serves as cluster-head.

2.2 Routing Protocols

In accordance with routing-driven model, Ad Hoc network routing protocols can be divided into table-driven routing protocols (such as DSDV protocol [5]) and on-demand routing protocols (such as DSR, AODV protocol [6]). According to differences in network topology, they can also be divided into flat routing protocols and cluster routing protocols. The routing protocols based on clustering mechanism have CBRP, CEDAR and CGSR, etc.

CEDAR (Core-Extraction Distributed Ad Hoc Routing Algorithm) [7] is a QoS routing algorithm of cluster-based structure. Its advantage is able to support the QoS requirements of real-time business. Its disadvantage is that routing update overhead

sharply increases with the increase of the network size. In addition, the scalability of the network is bad.
CGSR (Cluster-head Gateway Switch Routing) [8] is in agreement on the basic DSDV protocol combining hierarchical routing mechanism. In the actual use, CGSR is more effective than flat routing protocols. Its drawback is that when the cluster-head changes frequently, nodes are busy in selecting cluster-head instead of data transmission.

2.3 CBRP Protocol

CBRP (Cluster Based Routing Protocol) [9] is a cluster on-demand source routing protocol, having many similarities with the Dynamic Source Routing Protocol (DSR). By clustering nodes into groups, the protocol efficiently minimizes the flooding traffic during route discovery and speeds up this process as well. Its route shortening and local repair features make use of the 2-hop-topology information maintained by each node through the broadcasting of HELLO messages.
Compared with other routing algorithms, CBRP has small routing control overhead, less network congestion and search time during routing. In CBRP, cluster-head manages all cluster numbers all the information and behavior in each cluster, and finds the adjacent clusters for routing through the gateway node [14].
Lowest-ID algorithm is used for the cluster-head election.

3. Renovated Clustering Algorithm

The nodes are divided into clusters! When a node comes up, it has the "undecided" state! The first action of this node is to start a timer and broadcasts a HELLO message! When a cluster-head receives this HELLO message, it replies immediately with a triggered HELLO message. After that, when the node receives this answer, it will change his state into the "member" state. But when the node gets no message from any cluster-head, it makes itself as cluster-head, but only, when it has bi-directional link to one or more neighbors! Otherwise, when it has no link to any other node, it stays in the "undecided" state and repeats the procedure with sending an HELLO message again! Cluster-heads are changed as infrequently as possible. Cluster-head has not only the information's about the members of its cluster in the table, but it maintains also a cluster adjacency table that contains information about the neighboring clusters. In this table is the gateway through which the neighbor cluster can be reached saved, and also the ID of the cluster-head.

3.1 Cluster-head Election Algorithms

Step 1: Find the neighbors of each node v (i.e. nodes within its transmission range). This gives the degree, dv, of this node.
Step 2: Compute the degree-difference, Dv=|dv-M|, for every node v.
Step 3: For every node, compute the sum of the distances, Pv, with all its neighbors.
Step 4: Compute the running average of the speed for every node. This gives a measure of mobility and is denoted by Mv.
Step 5: Get the energy Ev of node at time T.
Step 6: Calculate a combined weight Iv=c1Dv+c2Pv+c3Mv+c4Ev, for each node v. The coefficients c1, c2, c3 and c4 are weighing factors for the corresponding system parameters.
Step 7: Choose the node with a minimum Iv to be the cluster-head. All the neighbors of the chosen cluster-head can no longer participate in the election algorithm.
Step 8: Repeat steps 2 to 7 for the remaining nodes not yet assigned to any cluster.

3.2 Cluster Maintenance

There are two parts to cluster maintenance: intra-cluster maintenance and inter-cluster maintenance.

Intra-cluster maintenance: In order to keep the neighbor table and CH information consistent, nodes broadcast and exchange hello messages periodically. A hello message contains information about a node and roles. If no hello message is received from a neighbor during the ALLOW_HELLO_LOST interval, the neighbor is considered lost and is removed from the neighbor table. An ordinary node checks its neighbor table to verify whether a CH still exists. If a node finds that no CH exists, a new CH will be elected in the neighborhood. If a CH fails, local maintenance is carried out.

Inter-cluster maintenance: Each cluster head maintains a K-hop cluster table, which contains all k-hop CHs alive in a network. Each CH notifies other neighbor CHs that it is still alive by sending a Head Alive message. A CH, say, CH1, receives a Head Alive message from another CH, say, CH2. If CH1 finds out that CH2 already exists in its CH table, CH2's expiration time will be updated. Otherwise, a new CH entry of CH2 will be inserted and its expiration time will be set by adding the CH update time to the current time. If no Head Alive message is received from a cluster head during a HEAD_UPDATE_INTERVAL interval, that cluster is considered unavailable. If no Head Alive message is received during an ALLOW_HEADALIVE_LOST interval, the CH is considered unavailable and removed from CH table.

3.3 RCBRP Routing Algorithm

In RCBRP, the route discovery consists of intra-cluster routing and inter-cluster routing. In the cluster, a similar on-demand DSR routing is used to get the advantage that the cluster-head does not necessarily involve in communication in order to reduce its communication burden, extend its survival time and stabilize the cluster structure. In the inter-cluster, RREQ routing request packets are sent between adjacent clusters to form on-demand routing using AODV protocol.

3.4 Intra-cluster routing

In clustering process, each node can form its own KNT (k-hop neighbor table) when require. However, because the biggest distance between the two nodes in the k-hop cluster is 2K, not every cluster member has routing information to other members. Although flooding can find the route, it introduces a lot of delay. Therefore in order to get all intra-cluster routing information among all of nodes, we define the intra-cluster routing control packet (ICRCP). After periodic interaction of information, each node forms an intra-cluster routing information table (some difference from KNT) to make each node know the location of other nodes, the next hop nodes and the required hops so that the route can be determined.

3.5 Inter-cluster Routing

The relationship between two adjacent clusters can be achieved through the intra-cluster routing information table, which sets up inter-cluster routing foundation. The use of on-demand approach to inter-cluster route discovery reduces inter-cluster routing and maintenance costs. General on-demand routing protocols, such as AODV use floods to search route, which increases the delay and overhead. In RCBRP, when the need for inter-cluster routing search comes, the source node sends an inter-cluster routing request packet (RREQ) to its gateway node to obtain routing information within the adjacent cluster.

4. Simulation Set-up And Results

4.1 Simulation Set-up

We have used NS2 to simulate the proposed system. The *NS-2* simulator is a discrete event simulator widely used in the networking research community. The NS2 simulation tool is used for performance evaluation. At the beginning of the simulation, 10 nodes were randomly placed within the simulation area of 600m x 600m. The transmission range was set at 50m. The random waypoint mobility model was used for simulating mobility. The pause time was 10 seconds.

4.2 Results

Fig 4.2.1: Throughput vs number of nodes

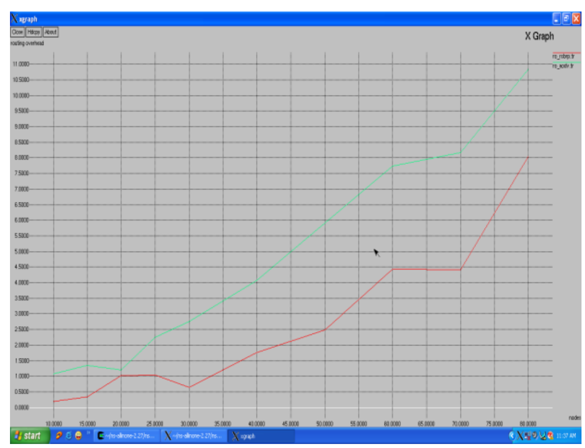

Fig 4.2.2: Routing overhead vs number of nodes

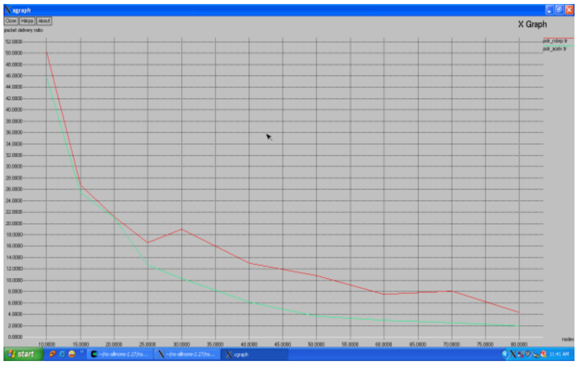

Fig 4.2.3: Packet delivery ratio vs number of nodes

Fig 4.4.4: Average end-to-end delay vs number of nodes

4.3 Simulation Results table

From Fig 2, it can be seen that the throughput, routing overhead, packet delivery ratio and average end-to-end delay of RCBRP is better than that of AODV with increased number of nodes.

Node	Parameters	RCBRP	AODV
10	Throughput (bits/sec)	5.98	5.83
	Routing Overhead	0.1995	1.0834
	Packet Delivery Ratio	50.2173	45.7387
	Avg. End to End Delay (ms)	56.9248	59.1543
15	Throughput (bits/sec)	4.94	4.56
	Routing Overhead	0.3348	1.3543
	Packet Delivery Ratio	26.7909	25.3422
	Avg. End to End Delay (ms)	61.2689	67.4534
20	Throughput (bits/sec)	5.32	4.74
	Routing Overhead	1.0205	1.2005
	Packet Delivery Ratio	21.2284	21.0121
	Avg. End to End Delay (ms)	67.3548	73.3565
25	Throughput (bits/sec)	4.16	4.00
	Routing Overhead	1.0383	2.2445
	Packet Delivery Ratio	16.5761	12.6543
	Avg. End to End Delay (ms)	180.102	182.002
30	Throughput (bits/sec)	5.89	4.01
	Routing Overhead	0.6640	2.7563
	Packet Delivery Ratio	19.0230	10.3453
	Avg. End to End Delay (ms)	127.549	137.456
40	Throughput (bits/sec)	4.67	4.58
	Routing Overhead	1.7654	4.0675
	Packet Delivery Ratio	12.9776	06.1324
	Avg. End to End Delay (ms)	49.0598	50.6543
50	Throughput (bits/sec)	4.23	4.12
	Routing Overhead	2.4775	5.9089
	Packet Delivery Ratio	10.8192	03.6533
	Avg. End to End Delay (ms)	62.3179	66.5464
60	Throughput (bits/sec)	2.93	2.43
	Routing Overhead	4.4279	7.7325
	Packet Delivery Ratio	07.5084	02.9832
	Avg. End to End Delay (ms)	25.3642	39.4567
	Throughput (bits/sec)	3.46	2.11
	Routing Overhead	4.4144	8.1677

70	Packet Delivery Ratio	08.0962	02.5422
	Avg. End to End Delay (ms)	49.3729	52.3455
80	Throughput (bits/sec)	2.40	1.67
	Routing Overhead	8.0454	10.8346
	Packet Delivery Ratio	04.3644	01.9991
	Avg. End to End Delay (ms)	59.7848	66.5645

Fig 2: Comparision Chart

5. Conclusion and Future Work

Based on the improvement of existing CBRP, RCBRP is proposed, which makes cluster number and structure optimal, effectively solves the problem of blindly broadcasting routing control packets, reduces routing overhead, and shortens the route discovery time. NS2 simulation results show that the proposed algorithm clustering technique has better performance in the MANET network of large scale and high mobility. Using simulation, a comparison was made with a pure AODV protocol, then we get our protocol RCBRP is better in performance in all scenario and AODV is also good.

References

[1] M. Gerla, J. T. C. Tsai, “Multicluster, Mobile, Multimedia Radio Network,” Wireless Networks, 1995, 1(3): pp. 255-265.

[2] C. R. Lin, M. Gerla, “Adaptive Clustering for Mobile Wireless Networks,” IEEE Journal on Selected Areas in Communications, 1997, 15(7): pp. 1265-1275.

[3] S. Basagni, “Distributed Clustering for Ad Hoc Networks,” International Symposium on Parallel Architectures: Algorithms and Networks, 1999, pp. 310-315.

[4] M. Chatterjee, S. Das, D. Turgut, “WCA: A Weighted Clustering Algorithm for Mobile,” Journal of cluster Computing (Special Issue on Mobile Ad Hoc Networks), 2002, 5(2): pp. 193-204.

[5] C. E. Perkins, P. Bhagwat, “Highly Dynamic Destination-Sequenced Distance-Vector Routing (DSDV) for Mobile Computers,” Computer Communication, 1994, pp. 234-244.

[6] D. B. Johnson, D. A. Maltz, Y. C. Hu, “The Dynamic Source Routing Protocol for Mobile Ad Hoc Networks,” IEFT Draft, 1999.

[7] R. Sivakumar, P. Sinha, V. Bharghavan, “CEDAR: core-extraction distributed Ad Hoc routing algorithm,” INFCOM’99, 1999, pp. 202-209.

[8] G. Pei, M. Gerla, X. Hong, C. C. Chiang, “A wireless hierarchical routing protocol with group mobility,” Proceedings of IEEE WCNC’99, 1999, pp. 1538-1542.

[9] M. Jiang, J. Li,Y. C. Tay, “Cluster based routing protocol (CBRP) functional specification,” IETF Internet-Draft, 1999.

[10] LU Hong, SUN Xuemei, REN Changming, “An Enhanced Weighted Clustering Algorithm for Mobile Ad Hoc Networks,” Computer Engineering, 2006, 32(11): pp. 147-149.

[11] CHENG Weiming, ZHENG Jianping, SHENG Lingzhi, “A Clustering Model for Mobile Ad Hoc Network,” Journal of Computer Research and Development, 2004, 41(4): pp. 674-678.

[12] MENG Bin, ZHANG Yaoxue, “A Relationship-based Distributed Clustering Algorithm in MANET,” Computer Science, 2005, 32(12): pp. 27-29.

[13] SHAO Guangtao, “Research on Clustering Algorithm of Ad Hoc Network,” Master's thesis, Kunming University of Science and Technology, 2008.

[14] Bager Zarei1, Mohammad Zeynali 2 and Vahid Majid Nezhad 3 “Novel Cluster Based Routing Protocol in Wireless Sensor Networks” IJCSI International Journal of Computer Science Issues, Vol. 7, Issue 4, No 1, July 2010.

Yuvraj Kumbharey was born in Jabalpur(Madhya Pradesh), India on 28 July 1987.He has completed his B.E degree in Computer Science & Engineeering from Shri Ram Institue of Technology,Jabalpur(M.P), India in 2009.He is pursuing M.tech in Information Technology at Lakshmi Narain College of Technology,Bhopal(M.P), India. His area of interest include MANET,Computer Graphics and Soft Computing. He has published two papers in national conferences.