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An Evaluation of MANET Routing Protocol

Neha Gupta[1], Manish Shrivastava[2]
Department of Information Technology Lakshmi Narain College of Technology Bhopal, India
I.T. Department[1], Director (PG) [2]

Abstract

Clustering in Mobile Ad Hoc Networks (MANETs) has much better utilization compared to the conventional system. Other than the highly active and unbalanced nature of MANETs makes it hard for the cluster based routing protocols to split a mobile network into clusters and determination of cluster heads for each cluster. In this paper, we analyze and compare some of existing works on cluster based routing in MANETs. This paper also categorizes the clustering techniques and routing protocols for ad hoc network. This paper gives advantages and disadvantages of these on the observation.

Keywords

Clustering, mobile AD hoc network (MANET), routing protocols, wireless networks, AODV, CBRP.

1. Introduction

A mobile ad hoc network, or MANET, is a short-term infrastructure less network, created by a set of mobile nodes that created dynamically their network, without depending on any central supervision. Mobile nodes used in MANET to make specific the roles that were guarantee by the potential fixed infrastructure in conventional networks. This is a difficult task, as these devices have limited resources. Moreover, the network's background has some features that add additional difficulty, such as the frequent topology modify reason by nodes' moving, and the non reliability and the bandwidth restriction of wireless channels.

A Mobile Ad Hoc Network (MANET) is a collection of wireless mobile nodes shape a impermanent/short-lived network lacking any permanent infrastructure where all nodes are open to move about randomly and where all the nodes organize themselves. It is a self-configuring network of mobile nodes associated by wireless media the combination of which results an uninformed topology. In MANET, all nodes perform both action as a router and as a host & still the topology of network might also modify quickly. Some of the challenges in MANET include: Unicast routing, Multicast routing, Dynamic network topology, Speed, Frequency of updates or network overhead, Scalability, Mobile agent based routing, Quality of Service, Energy efficient/Power aware routing, Secure routing.

2. Literature Review

Many researchers have developed lots of routing protocols in MANET. The on-demand routing is that set up a route to a target node when ever required in place of static route path. Almost every on-demand routing protocols reestablish a fresh route subsequent to a route break. In Paper [1], authors propose a new route maintenance algorithm based on AODV to avoid route breaks because each intermediate node on an active route detects a danger of a link break to an upstream node and reestablishes a new route before a route break. Routing in MANET is a critical task due to highly dynamic environment. This paper provides an overview of these protocols by presenting their characteristics, functionality, benefits and limitations.
The main objective of an ad-hoc network routing protocol is well-organized path organization between a pair of mobile nodes so that data could be delivered without delay.

Paper [6] point on cluster-based routing protocol (CBRP).Many algorithms have been proposed to optimize the procedure for election of CH. Even though clustering algorithms offer power effectiveness into large-scale Wireless Networks, but load unbalancing silent occurs. apart this problem balancing traffic loads equally within network is also a problem, this problem further makes the network unstable so longer due to short-life of cluster heads [7].
The cluster heads is responsible for nearly all activities in inter-cluster and intra-cluster communications. Along with the selection of cluster heads located nearest to a center of their clusters will equally distribute load balancing even more. Paper [7], give solution for cluster head election in efficient manner, not only the results verified that the this algorithm could distribute

load balancing with energy efficiency better than others, but the results also implied that the this work could extend the network performance and the network lifetime even more.

3. Clustering

Main duty of adhoc network cluster is to be sure routing. Clustering is process of dividing the network into interconnected substructures and the interconnected substructures are identified as clusters. The cluster head (CH) in every cluster proceed as a controller inside the substructure. Each CH is a temporary controller for base station within region or cluster. It also communicates with other CHs [3]. The combination of network nodes into a number of overlap clusters is the main design in clustering. The cluster head manage the cluster activities inside the cluster. The ordinary nodes in cluster have direct access only to cluster head and gateways. The nodes that can hear two or more cluster heads are called gateways [4].

The clustering introduced for the election of cluster heads in mobile ad -hoc networks include schemes as Highest-Degree, the Lowest-Identifier, Distributed Clustering Algorithm, and the Weighted Clustering Algorithm (WCA). These schemes can be understood as Highest-Degree (HD) algorithm elects the cluster head from the highest neighborhood node. In the Lowest-Identifier algorithm node with the minimum identifier (ID) is elected as a cluster head. In the Distributed Clustering Algorithm each cluster chooses its cluster head from its neighboring nodes having the lowest ID. In this algorithm each node can determine its cluster and only one cluster, and can send one message. Weighted Cluster Algorithm In order to calculate a weight factor Wv for every node v a number, including node degree, CH serving time and moving speed. The cluster set-up procedure is invoked, when a node moves into area which is not cover up by the clusterhead, throughout the whole system [3].

3.1. Advantages of Clustering

Clustering in Ad Hoc networks has many advantages compared to the traditional networks. It permits the improved performance of the protocol for the Medium Access Control (MAC) layer by improving the spatial reuse, throughput, scalability and power consumption. It helps to improve routing at the network layer by reducing the size of the routing tables. It decreases transmission overhead by updating the routing tables after topological changes occur [4]. It helps to aggregate topology information as the nodes of a cluster are smaller when compared to the nodes of entire network. Here each node stores only a fraction of the total network routing information. It saves energy and communication bandwidth in ad-hoc networks [3].

3.2. Problems in Clustering

MANET's main difficulty for the Cluster based routing as its property of dynamic topology and protocol to split a mobile network into clusters and election for cluster heads for each cluster. Clustering decrease communication and manage overheads due to pre determined paths of communication from cluster heads [3]. Routing protocols which think only bidirectional links may have link irregularity due incompetent or irregular routing. Unused network ability is instead of by the undiscovered unidirectional links, which decrease the network connectivity [4].

A great number of mobile nodes are supervised by a MANET using a cluster topology. The building and preservation of a cluster formation requires extra expenditure compared with a topology manage without cluster. Clustering has some side effects and negative aspects. Such as maintenance expenditure for a big and dynamic mobile network have need of explicit message swap between mobile node pair. It required network topology modify rapidly and concerns a lot of mobile nodes, the number of information message exchange raise. These control signals uses lots of network bandwidth and power in mobile nodes. Re-clustering may also occurs if basic events happened like the movement or the death of a mobile node, as a result a new cluster-head election. It may cause re-elections in the whole of the cluster formation. Thus, performance is affected by re-clustering. One of the major drawbacks of clustering in MANETs is that few nodes consume extra power when compared to others nodes of the same cluster. Special node such as cluster-head or cluster-gateway handle and forward all messages of the current cluster their power expenses will be more compare to normal nodes. It may cause premature blackout of nodes [3].

4. Routing Protocols

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and printed in Times New Roman 10-point, non-boldface type.

A routing protocol is needed whenever a packet needs to be transmitted to a destination via number of nodes and numerous routing protocols have been proposed for such kind of ad hoc networks. These protocols find a route for packet delivery and deliver the packet to the correct destination. The studies on various aspects of routing protocols have been an active area of research for many years.

Many protocols have been suggested keeping function s and type of network in vision. Basically, routing protocols can be broadly classified into two types as Table Driven Protocols or Proactive Protocols and On-Demand Protocols or Reactive Protocols. In Table Driven routing protocols each node maintains one or more tables containing routing information to every other node in the network. All nodes keep on updating these tables to maintain latest view of the network. Some of the existing table driven or proactive protocols are: DSDV, DBF, GSR, WRP and ZRP [1],[2],[5],[6]. In on Demand protocols, routes are created when it is required. When a transmission occurs from source to destination, it invokes the route discovery procedure. The route remains valid till destination is achieved or until the route is no longer needed. Some of the existing on demand routing protocols are: DSR [1], AODV [2] and CBRP [3].

4.1. Dynamic Source Routing

Dynamic Source Routing (DSR) is an Ad Hoc routing protocol which is based on the theory of source-based routing rather than table-based [2]. This is use in multi hop wireless ad hoc networks of mobile nodes. DSR protocol does not require any predefine network infrastructure and this allocate the Network to be completely self-organizing and self-configuring. This Protocol is combination of two crucial parts of route find and route preservation. Every node keeps a memory to store recently discovered path. When a node needs to send a packet to same node, it primarily checks its entry in the memory. If it is there, then it utilizes that path to send out the packet and also add its source address on the packet. If it is not there in the memory or the entry in memory is terminate (because of long time unused), the sender broadcasts a route request packet to all of its neighbours for finding a path to the destination. The sender will be waiting until the route is found. During this waiting, sender can perform supplementary tasks such as distribution of further packets. As the route request packet appear to any of the nodes, they ensure from their neighbour or from their memory s whether the destination asked is identified or unidentified. If route information is known, they send back a route reply packet to the destination otherwise they broadcast the same route request packet. When the route is discovered, the required packets will be transmitted by the sender on the discovered route. Also an entry in the memory will be inserted for the upcoming use.

The node will also preserve the period information of the entry so as to know whether the memory is clean or not. When a data packet is received by any intermediate node, it first verifies whether the packet is destined for itself or not. If it is destined for itself (i.e. the intermediate node is the destination), the packet is received otherwise the same will be forwarded using the path attached on the data packet. In Ad hoc network, any link may stop working anytime. So, route preservation procedure will continuously observes and will as well inform the nodes if there is any breakdown in the path. Consequently, the nodes will modify the entries of their route memory.

Advantage and problems of DSR

Main advantage of DSR protocol is that there is no require to maintain routing table so as to route a given data packet as the whole route is contained in the packet header. The problem of DSR protocol is that this is not scalable to huge networks and even requires significantly more processing resources than other protocols. In order to obtain the routing information, each node must waste lot of time to process any control data it receives, even if it is not the intended recipient.

4.2. Ad Hoc On-Demand Distance-Vector

AODV is a variation of Destination-Sequenced Distance-Vector (DSDV) [6] routing protocol which is collectively based on DSDV and DSR. It aims to minimize the requirement of system-wide broadcasts to its extreme. AODV does not maintain routes from every node to every other node in the network rather they are discovered as and when needed & are maintained only as long as they are required.

Routing in AODV

When a node wants to send a data packet to a destination node, the entries in route table are checked to ensure whether there is a current route to

that destination node or not. If there is route, the data packet is forwarded to the appropriate next hop toward the destination. If there is no route, the route discovery process is initiated. AODV initiates a route discovery process using Route Request (RREQ) and Route Reply (RREP). The source node will create a RREQ packet containing its IP address, current sequence number, destination's IP address, destination's last sequence number and broadcast ID. Broadcast ID is incremented each time the source node initiates RREQ. Basically, sequence numbers are used to determine the timeliness of each data packet and the broadcast ID & the IP address together form a unique identifier for RREQ so as to uniquely identify each request.

The requests are sent using RREQ message and the information in connection with creation of a route is sent back in RREP message. The source node broadcasts the RREQ packet to its neighbors and then sets a timer to wait for a reply. To process the RREQ, the node sets up a reverse route entry for the source node in its route table. This helps to know how to forward a RREP to the source. Basically a lifetime is associated with the reverse route entry and if this entry is not used within this lifetime, the route information is deleted. If the RREQ is lost during transmission, the source node is allowed to broadcast again using route discovery mechanism.

Setting up of Forward Path

When the destination node or an intermediate node with a route to the destination receives the RREQ, it creates the RREP and unicast the same towards the source node using the node from which it received the RREQ as the next hop. When RREP is routed back along the reverse path and received by an intermediate node, it sets up a forward path entry to the destination in its routing table. When the RREP reaches the source node, it means a route from source to the destination has been established and the source node can begin the data transmission.

Route Maintenance

A route discovered between a source node and destination node is maintained as long as needed by the source node. Since there is movement of nodes in mobile ad hoc network and if the source node moves during an active session, it can reinitiate route discovery mechanism to establish a new route to destination. Conversely, if the destination node or some intermediate node moves, the node upstream of the break initiates Route Error (RERR) message to the affected active upstream neighbors/nodes. Consequently, these nodes propagate the RERR to their predecessor nodes. This process continues until the source node is reached. When RERR is received by the source node, it can either stop sending the data or reinitiate the route discovery mechanism by sending a new RREQ message if the route is still required.

Advantage and problems of AODV

The benefits of AODV protocol are that it favors the least congested route instead of the shortest route and it also supports both unicast and multicast packet transmissions even for nodes in constant movement. It also responds very quickly to the topological changes that affects the active routes. AODV does not put any additional overheads on data packets as it does not make use of source routing. The limitation of AODV protocol is that it expects/requires that the nodes in the broadcast medium can detect each others' broadcasts. It is also possible that a valid route is expired and the determination of a reasonable expiry time is difficult. The reason behind this is that the nodes are mobile and their sending rates may differ widely and can change dynamically from node to node. In addition, as the size of network grows, various performance metrics begin decreasing. AODV is vulnerable to various kinds of attacks as it based on the assumption that all nodes must cooperate and without their cooperation no route can be established.

4.3. Cluster Based Routing Protocol

In CBRP the nodes of a wireless network are separated into several disjoint or overlapping clusters. Each cluster votes for one node as the so-called clusterhead. These particular nodes are liable for the routing process. But clusterheads are capable to correspond with each other through gateway nodes. A gateway is a node that has two or more clusterheads as its neighbors or when the clusters are disjoints at least one clusterhead and another gateway node[2]. This is shown as in the Fig.1.

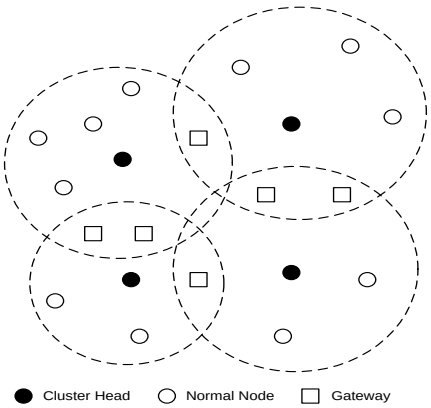

Fig 1: Formation of Cluster in MANET

The following states describe the clustering process depending on the current node state. These states are Undecided and member. This means of undecided that node does not belong to any cluster, this usually take place if a new node appears in the network. If a clusterhead detects that it has a bi-directional link to another clusterhead for a time period, it changes its state clusterhead to member if the other clusterhead has a lower ID. Each member node belongs at least to one cluster.

Improved Routing in CBRP

CBRP concern two data structure the cluster adjacency table (CAT) and the two-hop topology database. The CAT keeps neighboring clusters information. They can bi-directionally or uni-directionally link. Bi-directional link present between two nodes of the clusters, or at least two opposite uni-directional links between two nodes. Uni-directionally linked is just one uni-directional link between them. The two-hop topology database is build from the information received by HELLO messages. It contains all nodes that are at most two hops away. The routing process works in two steps. First, it discovers a route from a source node S to a destination node D, afterwards it routes the packets [5].

Route find is done by using source routing. In the CBRP only cluster heads are spread with route request package (RREQ) [2]. Gateway nodes collect the RREQs as well, but not broadcasting them. They forward them to the only subsequently cluster head. This strategy reduces the network traffic. Here node movement, disappearance of nodes or failures, the CBRP includes two mechanisms to improve a route, the first is Local Repair and the second is Route Shortening. If a connection between two nodes stops work, the CBRP is intelligent to fix the route. Sometimes a node may find out a connection between itself and another succeeding node of the route that is not its direct successor respectively. This can be done by investigative the information stored in the two-hop topology database. If so, it shortens the route by not including the redundant node from the route [2].

Advantages and problems of CBRP

This scheme is very useful in such situations where lots of devices wants to share network with in short area space hence density is very high. In such conditions CBRP is very effective due to small cluster formation. Cluster approaches on routing in mobile ad-hoc networks are high-quality technique to reduce network traffic and routing drawbacks. Like other routing protocols, CBRP has some limitations and problems which compared to other protocols. If networks and clusters become too big, the overhead per packet increases due to source routing. Another problem of the CBRP is its support of uni-directional links. When using a network with 802.11 link layer technology these links cannot be supported, because the 802.11 protocol knows only bi-directional links.

5. Conclusion

This paper focus on the study and analysis of primarily three MANET routing protocols DSR, AODV and CBRP on the basis of reveal detail find that. AODV is a reactive routing protocol which discovers the path on demand or when the path is requisite and CBRP is a hybrid protocol which is also discovers the path on demand by using source routing scheme, In DSDV and CBRP, broadcasting is made periodically to keep routing information updates and in AODV, simply hello messages are spread toward its neighbors to preserve current connectivity. Path discovery is made through source routing. In the CBRP only cluster-heads are spreads with route request package (RREQ). Gateway nodes receive the RREQs as well, but lacking broadcasting them. Gateway nodes forward to the connected cluster-head. This strategy decreases the network traffic signals.

This investigate specify that AODV preserve improvement in high dense mediums and at high node movement. This paper present other important constraints that make a protocol strong and stable in most cases. The evaluation predicts that in spite of

slightly more overhead in some cases DSR and AODV outperforms CBRP in all cases. Till now AODV is enhanced in Route updating and maintenance process among others.

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Neha Gupta received B. Tech. Degree in information technology from Mahatma Gandhi Chitrakoot Gramodaya University, Chitrakoot, India in 2009, and currently pursuing the M. Tech. Degree in information technology at LNCT Rajeev Gandhi Technical University, Bhopal., India. Currently performs research on Optimum cluster head selection Scheme for MANET.

Dr. Manish Shrivastava had started his carrier with Software companies and worked for SIS (P) Ltd. and TCS, at PMU. After completing his graduation in Computer Technology from UIT, RGPV (Technical University) (formerly Govt. Engineering College) Bhopal, India in 1993. He left software industry in 1998 & switched to academics and has been working with reputed private engineering colleges since last fourteen years. He did M. Tech. & PhD from MANIT, Bhopal, India in Digital Communications & Optical Communications respectively. He has software development, teaching and research experience of more than 18years. Presently he is working as Director, PG Education & Research Canter, LNCT Bhopal, India.