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A STUDY ON AD HOC NETWORKS FOR EFFICIENT MULTIPATH ROUTING SURVEY

Jadhav Hemantkumar Balasaheb[1] & Piyush Pandey[2], Ph. D.

Abstract

Mobile ad hoc networks (MANETs) pose particular challenges in terms of Quality of Service (QoS) and performance. This is due to the effect of numerous parameters such as; bandwidth and power constrains, delays, security issues, etc. On the there hand, the degree of freedom enables the wireless mobile nodes to enter and leave the network dynamically. The latter offers redundant paths and dynamic coverage. Particular attention is given to the multipath transmission capability as well as load balancing to have efficient routing possible for heavy multimedia traffics. Multi-path routing represents a promising routing method for wireless mobile ad hoc networks. Multi-path routing achieves load balancing and is more resilient to route failures. Recently, numerous multi-path routing protocols have been proposed for wireless mobile ad hoc networks. The study provides an overview of eight dissimilar protocols by presenting their uniqueness and functionality, and then provides an association and discussion of their respective merits and drawbacks. In order to facilitate communication within the network, a routing protocol is used to discover routes between nodes. Route construction should be done with a minimum of overhead and bandwidth consumption.Multi-path routing achieves load balancing and is more resilient to route failures. Recently, numerous multi-path routing protocols have been proposed for wireless mobile ad hoc networks. Performance evaluations of these protocols showed that they achieve lower routing overhead, lower end-to-end delay and alleviate congestion in comparison with single path routing protocols. However, a quantitative comparison of multi-path routing protocols has not yet been conducted. In this work, we present the results of a detailed simulation study of three multi-path routing protocols (SMR, AOMDV and AODV Multipath). Mobile ad hoc network (MANET) consists of several wireless mobile nodes which dynamically exchange data among themselves without the reliance on a fixed base station or a wired backbone network. Due to the limited transmission power, multiple hops are usually needed for a node to exchange information with any other node in the network. So routing discovery and maintenance is crucial issues in MANET.

Keywords: *AD HOC Networks, Multipath Routing,MANETs, Service, performance, load balancing, wireless, protocols, functionality, etc.*

INTRODUCTION:

An ad-hoc network is a local area network (LAN) that is built spontaneously as devices connect. Instead of relying on a base station to coordinate the flow of messages to each node in the network, the individual network nodes forward packets to and from each other. In

Latin, *ad hoc* literally means "for this," meaning "for this special purpose" and also, by extension, improvised or impromptu.Wireless networks are an emerging new technology that will allow users to access information and services electronically, regardless of their geographic position. Wireless networks can be classified in two types: - infrastructure network and infrastructure less (ad hoc) networks [1]. Infrastructure network consists of a network with fixed and wired gateways. A mobile host communicates with a bridge in the network (called base station) within its communication radius. The mobile unit can move geographically while it is communicating. When it goes out of range of one base station, it connects with new base station and starts communicating through it [2]. This is called handoff. In this approach the base stations are fixed.This study discusses proposed routing protocols for these ad hoc networks. These routing protocols can be divided into two categories: table-driven and on-demand routing based on when and how the routes are discovered. In table driven routing protocols consistent and up-to-date routing information to all nodes is maintained at each node whereas in on-demand routing the routes are created only when desired by the source host. Next two sections discuss current table-driven protocols as well as on-demand protocols [3].

A mobile ad hoc network (MANET) is a collection of mobile nodes with no pre-established infrastructure forming a temporary network. Each device in a MANET is free to move independently in any direction, and will therefore change its links to other devices frequently. Because of the limited transmitter range of the nodes, multiple hops may be needed to reach other nodes. Due to the mobility of the nodes, the structure of the network changes dynamically [1]. In MANET, each node participates in routing by forwarding data for other nodes, and so the determination of which nodes forward data is made dynamically based on the network connectivity. Mobile Ad Hoc networks find its application in many areas and are useful for many cases. Routing protocols in MANETs are classified under two major fields of protocols: Proactive or table-driven and Reactive or on-demand. Some of reactive or on-demand protocols are Dynamic Source Routing (DSR), Ad-hoc On-demand Distance Vector Routing (AODV) and Ad-hoc On demand Multipath Distance Vector Routing (AOMDV). These protocols employ a minimum-hop metric for choosing a route and do not consider energy. DSR is a simple and on-demand routing protocol for MANET. DSR uses source routes to control the forwarding of packets through the network [2].

In contrast to infrastructure based networks, in ad hoc networks all nodes are mobile and can be connected dynamically in an arbitrary manner. All nodes of these networks behave as routers and take part in discovery and maintenance of routes to other nodes in the network.

Ad hoc networks are very useful in emergency search-and-rescue operations, meetings or conventions in which persons wish to quickly share information, and data acquisition operations in inhospitable terrain. In the Windows operating system, ad-hoc is a communication mode (setting) that allows computers to directly communicate with each other without a router.In the traditional circuit-switching network, alternate path routing was used to decrease the probability of call blocking. In this scheme, the shortest path between two exchanges is used until it fails or reaches its capacity, when calls are routed through a longer, alternate path [4].Multipath routing is a technique that exploits the underlying physical network resources by utilizing multiple source-destination paths. It is used for a number of purposes, including bandwidth aggregation, minimizing end-to-end delay, increasing fault-tolerance, enhancing reliability, load balancing, and so on. The idea of using multiple paths has existed for some time and it has been explored in different areas of networking.

REVIEW OF LITERATURE: Most routing protocols maintain routing tables to store the next hop towards the desired destination. Many routing protocols preserve a caching mechanism by which multiple routing paths to the same destination are stored. Multipath routing is essential for load balancing and offering quality of service. Other benefits of multipath routing include [4]: the reduction of computing time that routers' CPUs require, high resilience to path breaks, high call acceptance ratio (in voice applications) and better security. Special attention should be given to transport layer protocols as duplicate acknowledgments (DUPACKs) could occur, which might lead to excessive power consumption and congestion.

Multipath routing in Reactive Protocols: On-demand routing protocols are inherently attractive for multipath routing, because of faster and more efficient recovery from route failures. MSR "Multipath Source Routing Protocol" [5] is an example of such protocols that supportsmultipath routing. MSR is a direct descendant of DSR. By incorporating the multipath mechanism into DSR and employing a probing based load-balancing mechanism, the throughput, end-to-end delay, and drop-rate have been improved greatly. The drawback of MSR would be the processing overload of originating the packets, which could become more negligible as the processing power of computers increase day-by-day. Another routing protocol offering multipath routing in this category is the AOMDV "On-Demand Multipath Distance Vector Protocol" [6], that extends the single path AODV protocol to compute multiple paths. There are two parts in AOMDV contributing to multipath routing, one of which is the notion of an advertised hop-count to maintain multiple loop-free paths at each nodes and the other is the modification of route discovery mechanism in the AODV protocol for link-disjoint multiple paths from source and intermediate nodes to the destination. Under wide range of mobility traffic scenarios, AOMDV offers a significant reduction in delay and up to 20% reduction in the routing load and the frequency of route discoveries.

Multipath Routing in ProactiveProtocols: Proactive routing algorithms, such as DSDV "DestinationSequenced Distance-Vector Routing" [7], maintain route updates among all nodes all the time. In fact, many proactive protocols tend to offer shortest path to each destinations. This is done by continuously monitoring the network topology. Unlike reactive routing algorithms, proactive routing protocols are capable of repairing broken routes in a short time. This is done by collecting network topology continuously. The drawback of DSDV however is the requirement of parameters such as the periodic update interval, maximum value of the "settling time" for a destination and the number of update intervals, which may become known before a route is considered stale. These parameters will likely represent a tradeoff between the latency of valid routing information and excessive communication overhead [9]. Another example of proactive routing protocol is discussed in [8]. TERA "Tree Exchange Routing Algorithm" is an extension to standard distance vector routing algorithms, which is based on multipath. This paper discusses the necessary modifications to enable multipath routing. This modification does not require any additional messages; therefore no extra cost is incurred to add multipath capability to the scheme.

Multipath Routing in Hybrid Protocols: Hybrid routing protocols incorporate the merits of both on-demand and proactive routing protocols. An example of this category is Zone Routing Protocol "ZRP", which is similar to a cluster with the exception that each node acts as a cluster head and a member of other clusters. The routing zoneforms a few mobile ad hoc nodes within one, two or more hops away where the central node is located. The fact that both reactive and proactive schemes are found in the functionality of hybrid routing protocols, better performance is expected. However, due to hierarchical nature of the schemes more memory will be required compared to the identical reactive or proactive scheme [9]. Reference [10] describes another hybrid algorithm, AntHocNet "Ant Agents for Hybrid Multipath Routing in Mobile Ad Hoc Networks", an ACO algorithm for routing in MANETs. The route setup of this scheme is performed by reactive algorithm and the route probing and exploration are done by proactive scheme. The related simulation experiments show that AntHocNet can outperform AODV in terms of delivery ratio and average delay, especially in more mobile and larger networks. Scalability is also promising in this scheme. However, relatively large amount of overhead could be mentioned as a drawback and also less adaptability to the network situation.

Multipath Routing in Security Protocols: Security has gained a lot of attentions recently and many attempts in proposing end-to-end security schemes have been carried out, one of which is by the use of multipath routing. The scheme presented in [19] tries to tackle the security issue by presenting trust and key management models for intrusion detection and prevention. The existence of multiple paths between nodes in an Ad hoc network is exploited to increase the robustness of transmitted data confidentiality. The proposed algorithm is tested against time for intrusion detection and robustness. Another multipath routing algorithm for data security enhancement, Multipath TCP Security “MTS”, is discussed in [20]. In MTS, the source node chooses the available routes adaptively rather than testing the “stored routes” one by one exhaustively. Simulation results show that the algorithm provides a reasonably good level of security and performance. Compared to AODV and DSR, MTS has a better number of participating nodes and highest interception ratio. The average end-to-end delay between MTS, AODV and DSR shows that beyond speeds of 1.7 m/s, MTS delay drops rapidly and performs better in respect to the other two routing protocols. So far, security options for ad hoc elements from the transport layer point of view was discussed, however the security option could be implemented in the application running on wireless nodes. The reference [21] shows a scheme in which a secret message is divided into multiple shares and through the use of multipath routing, the shares can be delivered to the destination via multiple paths. This enhances data confidentiality in a mobile ad hoc network and is expected to reduce the message compromising and eavesdropping probability. This is done by the distribution of a secret among multiple independent paths while it is transmitted across the network. As drawbacks, it shows that multipath routing causes more collision among correlated routes themselves thus degrades network performance such as packet delivery ratio.

Table Driven Routing Protocols: In Table-driven routing protocols every hub keeps up one or more tables containing steering data to each other hub in the network. All hubs overhaul these tables in order to keep up a steady and up and coming perspective of the network. On account of different and various promotions hoc protocols there is a conspicuous requirement for a general scientific categorization to classify protocols considered. Conventional order is to divide protocols to table-driven and to source-started on-interest driven conventions [1]. Table-driven routing protocols attempt to keep up steady, progressive routing information from every hub to each other hub. Network nodes keep up one or numerous tables for routing data. Hubs react to network topology changes by propagating route overhauls all through the network to keep up a consistent network view [5]. Source-started on-interest protocols create routes only when these routes are required. The need is started by the source, as the name recommends. At the point when a node requires a course to a destination, it starts a route discovery process within the network. This procedure is finished once a route is found or all conceivable course stages have been analyzed. After that there is a course support system to keep up the substantial routes and to expel the invalid courses. At the point when the network topology changes the hubs engender update messages all through the network in request to keep up predictable and a la mode routing information about the entire system [6]. These routing protocols contrast in the technique by which the topology change data is disseminated over the network and the quantity of necessary routing-related tables.

Dynamic Destination-Sequenced Distance-Vector Routing Protocol: The Destination-Sequenced Distance-Vector (DSDV) Routing Algorithm is based on the idea of the classical Bellman-Ford Routing Algorithm with certain improvements.Each mobile station keeps up a routing table those rundowns every accessible destination, the quantity of bounces to achieve the destination and the succession number doled out by the destination hub. The arrangement number is utilized to recognize stale routes from new ones and along these lines keep away from the development of circles. The stations intermittently transmit their routing tables to their quick neighbors. A station likewise transmits its routing table if a critical change has happened in its table from the last overhaul sent. In this way, the upgrade is both time-driven and occasion driven. The routing table overhauls can be sent in two ways: - a "full dump" or an incremental redesign. A full dump sends the full routing table to the neighbors and could traverse numerous parcels though in an incremental overhaul just those passages from the routing table are sent that has a metric change subsequent to the last redesign and it must fit in a bundle. In the event that there is space in the incremental upgrade parcel then those passages might be incorporated who's grouping number has changed [7]. At the point when the network is moderately steady, incremental updates are sent to maintain a strategic distance from additional movement and full dump are generally rare. In a quick changing network, incremental bundles can develop enormous so full dumps will be more incessant. Each route update parcel, notwithstanding the routing table data, additionally contains a novel grouping number relegated by the transmitter. The route labeled with the most astounding (i.e. latest) grouping number is utilized. On the off chance that two courses have the same succession number then the route with the best metric (i.e. shortest route) is utilized. In view of the past history, the stations gauge the settling time of routes. The stations defer the transmission of a routing upgrade by settling time in order to dispose of those overhauls that would happen if a superior route were discovered soon.

The Wireless Routing Protocol (WRP): The Wireless Routing Protocol (WRP) is a table-based distance-vector routing protocol. Each node in the network maintains a Distance table, a Routing table, a Link-Cost table and a Message Retransmission list.The Wireless Routing Protocol (WRP) [7] is a proactive, destination-based protocol. WRP belong to the class of path finding algorithms. The Distance table of a node x contains the distance of each destination node y via each neighbor z of x. It also contains the downstream neighbor of z through which this path is realized. The Routing table of node x contains the distance of each destination node y from node x, the predecessor and the successor of node x on this path. It also contains a tag to identify if the entry is a simple path, a loop or invalid. Storing predecessor and successor in the table is beneficial in detecting loops and avoiding counting-to-infinity problems. The Link-Cost table contains cost of link to each neighbor of the node and the number of timeouts since an error-free message was received from that neighbor. The Message Retransmission list (MRL) contains information to let a node know which of its neighbor has not acknowledged its update message and to retransmit update message to that neighbor.

Fisheye State Routing: Fisheye State Routing (FSR) is an improvement of GSR. The large size of update messages in GSR wastes a considerable amount of network bandwidth. In FSR, each update message does not contain information about all nodes. Instead, it exchanges information about closer nodes more frequently than it does about farther nodes thus reducing the update message size. So each node gets accurate information about neighbors and the detail and accuracy of information decreases as the distance from node increases [8]. Figure 1 defines the scope of fisheye for the center (red) node. The scope is defined in terms of the nodes that can be reached in a certain number of hops. The center node has most accurate information about all nodes in the white circle and so on. Even though a node does not have accurate information about distant nodes, the packets are routed correctly because the route information becomes more and more accurate as the packet moves closer to the destination. FSR scales well to large networks as the overhead is controlled in this scheme.

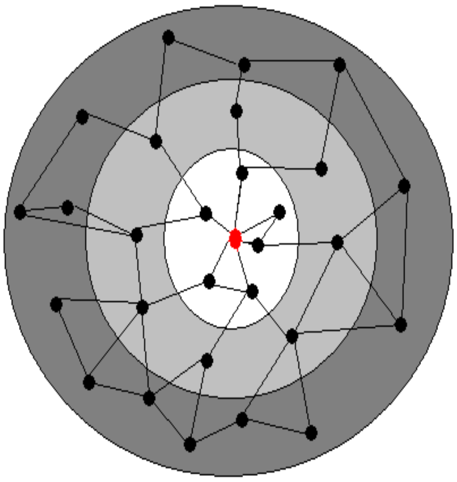


Figure- 1- Accuracy of information in FSR

Hierarchical State Routing: The characteristic feature of Hierarchical State Routing (HSR) is multilevel clustering and logical partitioning of mobile nodes. The network is partitioned into clusters and a cluster-head elected as in a cluster-based algorithm. In HSR, the cluster-heads again organize themselves into clusters and so on. The nodes of a physical cluster broadcast their link information to each other. The cluster-head summarizes its cluster's information and sends it to neighboring cluster-heads via gateway. As shown in the figure 2, these cluster-heads are member of the cluster on a level higher and they exchange their link information as well as the summarized lower-level information among each other and so on. A node at each level floods to its lower level the information that it obtains after the algorithm has run at that level. So the lower level has hierarchical topology information. Each node has a hierarchical address. One way to assign hierarchical address is the cluster numbers on the way from root to the node as shown in figure 2. A gateway can be reached from the root via more than one path, so gateway can have more than one hierarchical address. A hierarchical address is enough to ensure delivery from anywhere in the network to the host.

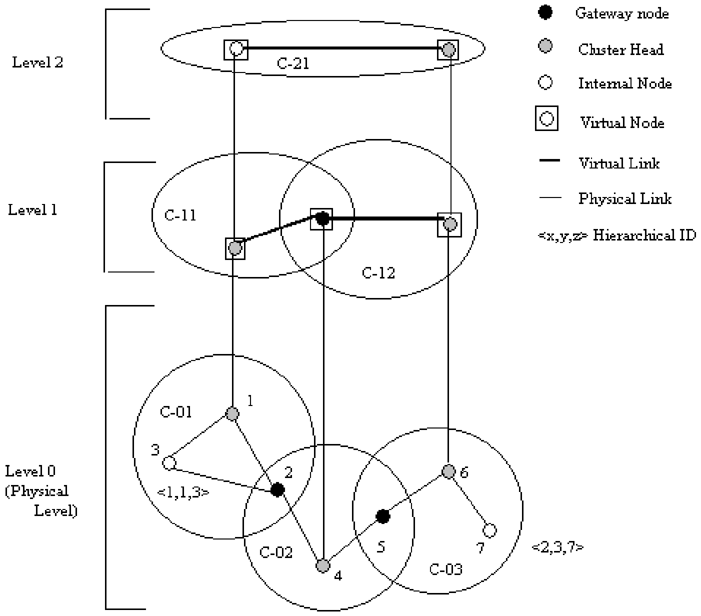


Figure-2- An example of clustering in HSR

In addition, nodes are also partitioned into logical sub networks and each node is assigned a logical address <subnet, host>. Each sub network has a location management server (LMS). All the nodes of that subnet register their logical address with the LMS. The LMS advertise their hierarchical address to the top levels and the information is sent down to all LMS too. The transport layer sends a packet to the network layer with the logical address of the destination. The network layer finds the hierarchical address of the hierarchical address of the destinations LMS from its LMS and then sends the packet to it. The destinations LMS forwards the packet to the destination. Once the source and destination know each other's hierarchical addresses, they can bypass the LMS and communicate directly. Since logical address/hierarchical address are used for routing, it is adaptable to network changes.

Cluster head Gateway Switch Routing Protocol: Cluster head Gateway Switch Routing (CGSR) uses as basis the DSDV Routing algorithm described in the previous section.The mobile nodes are aggregated into clusters and a cluster-head is elected. All nodes that are in the communication range of the cluster-head belong to its cluster. A gateway node is a node that is in the communication range of two or more cluster-heads. In a dynamic network cluster head scheme can cause performance degradation due to frequent cluster-head elections, so CGSR uses a Least Cluster Change (LCC) algorithm. In LCC, cluster-head change occurs only if a change in network causes two cluster-heads to come into one cluster or one of the nodes moves out of the range of all the cluster-heads.The general algorithm works in the following manner. The source of the packet transmits the packet to its cluster-head. From this cluster-head, the packet is sent to the gateway node that connects this cluster-head and the next cluster-head along the route to the destination [9]. The gateway sends it to that cluster-head and so on till the destination cluster-head is reached in this way. The destination cluster-head then transmits the packet to the destination. Figure 3 shows an example of CGSR routing scheme.

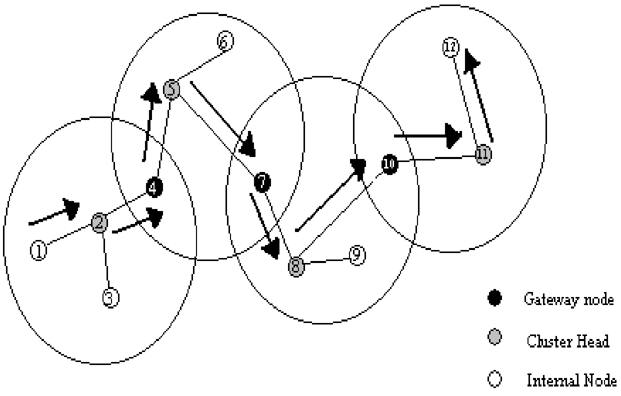
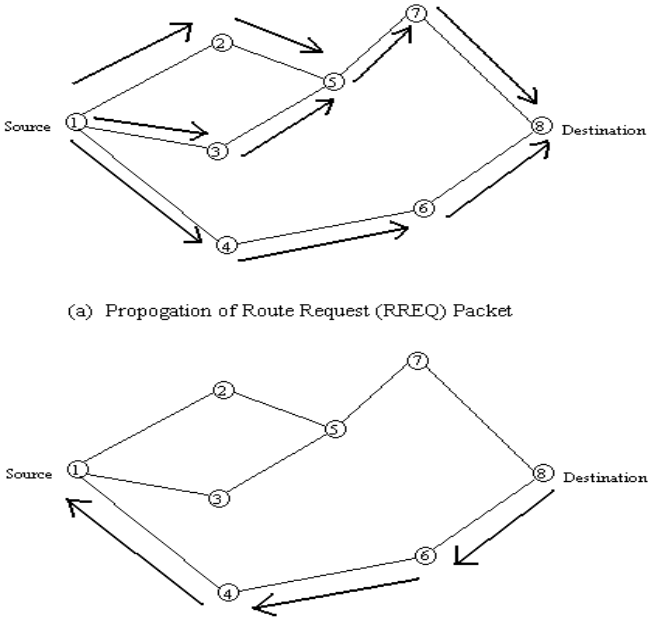


Figure- 3- Example of CGSR routing from node 1 to node 12

Each node maintains a cluster member table that has mapping from each node to its respective cluster-head. Each node broadcasts its cluster member table periodically and updates its table after receiving other nodes broadcasts using the DSDV algorithm. In addition, each node also maintains a routing table that determines the next hop to reach the destination cluster.

Ad hoc On-demand Distance Vector Routing: Ad hoc On-demand Distance Vector Routing (AODV) is an improvement on the DSDV algorithm. AODV minimizes the number of broadcasts by creating routes on-demand as opposed to DSDV that maintains the list of all the routes.To find a way to the destination, the source communicates a route demand bundle. The neighbors thus communicate the parcel to their neighbors till it achieves a moderate hub that has late course data about the destination or till it achieves the destination (Figure4a). A hub disposes of a course ask for bundle that it has as of now seen. The route request bundle utilizes succession numbers to guarantee that the routes are loop free and to ensure that if the middle of the road hubs answer to route demands, they answer with the latest information only.



(a) Propogation of Route Request (RREQ) Packet

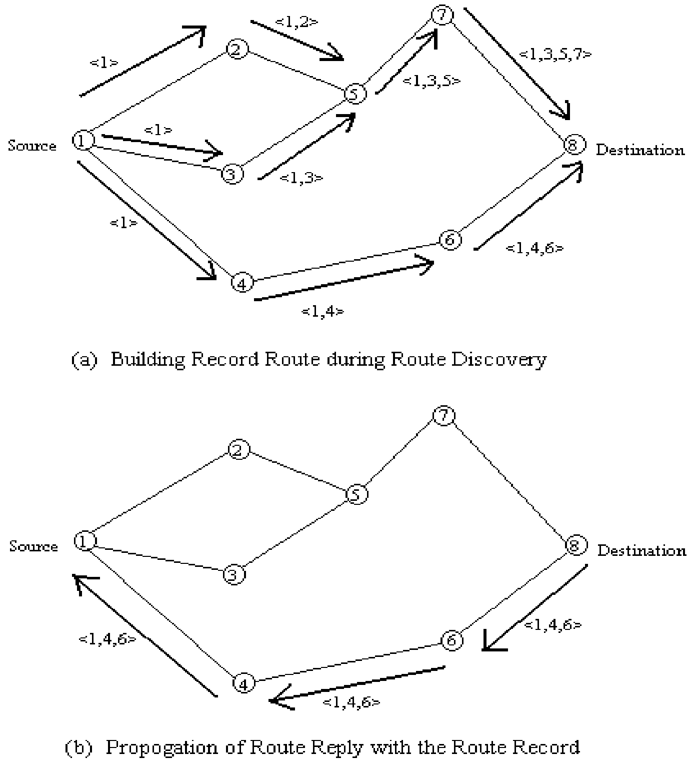
(b) Path taken by the Route Reply (RREP) Packet

Figure-4- Route discovery in AODV

At the point when a hub advances a route demand parcel to its neighbors, it additionally records in its tables the hub from which the principal duplicate of the request came. This information is used to build the opposite way for the route reply bundle. AODV utilizes just symmetric connections on the grounds that the route reply parcel takes after the opposite way of route request bundle. As the route reply packet navigates back to the source (Figure4b), the hubs along the way enter the forward course into their tables. In the event that the source moves then it can reinitiate route discovery to the destination. On the off chance that one of the middle hubs move then the moved hubs neighbor understands the connection disappointment and sends a connection disappointment warning to its upstream neighbors thus on till it comes to the source upon which the source can reinitiate course disclosure if necessary.

Dynamic Source Routing Protocol

The Dynamic Source Routing Protocol is a source-routed on-demand routing protocol. A node maintains route caches containing the source routes that it is aware of. The node updates entries in the route cache as and when it learns about new routes.The two major phases of the protocol are: route discovery and route maintenance. When the source node wants to send a packet to a destination, it looks up its route cache to determine if it already contains a route to the destination. If it finds that an unexpired route to the destination exists, then it uses this route to send the packet. But if the node does not have such a route, then it initiates the route discovery process by broadcasting a route request packet. The route request packet contains the address of the source and the destination, and a unique identification number. Each intermediate node checks whether it knows of a route to the destination [10]. If it does not, it appends its address to the route record of the packet and forwards the packet to its neighbors. To limit the number of route requests propagated, a node processes the route request packet only if it has not already seen the packet and its address is not present in the route record of the packet. A route reply is generated when either the destination or an intermediate node with current information about the destination receives the route request packet. A route request packet reaching such a node already contains, in its route record, the sequence of hops taken from the source to this node.As the route request packet propagates through the network, the route record is formed as shown in figure 5a. If the route reply is generated by the destination then it places the route record from route request packet into the route reply packet. On the other hand, if the node generating the route reply is an intermediate node then it appends its cached route to destination to the route record of route request packet and puts that into the route reply packet. Figure 5b shows the route reply packet being sent by the destination itself.



(a) Building Record Route during Route Discovery

(b) Propogation of Route Reply with the Route Record

Figure-5- Creation of record route in DSRP

To send the route reply packet, the responding node must have a route to the source. If it has a route to the source in its route cache, it can use that route. The reverse of route record can be used if symmetric links are supported. In case symmetric links are not supported, the node can initiate route discovery to source and piggyback the route reply on this new route request.

CONCLUSION:

Multipath routing was the main focus of this paper and we investigated its effects of multipath routing in variety of protocols including flat topologies (reactive, proactive and hybrid), hierarchical topologies, geographic position assisted routing protocols, power-aware and security enhancement routing protocols.Mobile ad hoc networks (MANET) are networks which routing is based on multi-hop routing from a source to a destination node or nodes. These networks have quite a many constrains because of uncertainty of radio interface and its limitations e.g. in available bandwidth. Also some terminals have limitations concerning battery energy in use.There are numerous applicable protocols for ad hoc networks, but one confusing problem is the vast number of separate protocols. Each of these protocols is designed to perform its task as well as it is possible according to its design criteria. The protocol to be chosen must cover all states of a specified network and never is allowed to consume too much network resources by protocol overhead traffic.

REFERENCES:

M Gerla, X. Hong, G. Pei. Fisheye State Routing Protocol (FSR) for Ad Hoc Networks, IETF Draft, 2001.

R. Sivakumar, P. Sinha, V. Bharghavan. CEDAR: a Core-Extraction Distributed Ad hoc Routing algorithm. IEEE Journal on Selected Areas in Communications, Vol 17, No 8, August 1999.

A. Vahdat, B. Becker: Epidemic Routing for Partially-Connected Ad Hoc Networks.

E.L. Madruga, J.J. Garcia -Luna-Aceves. Scalable Multicasting: The Core-Assisted Mesh Protocol. 1999.

C-K Toh. Ad Hoc Mobile Wireless Networks, Protocols and systems. Prentice Hall PTR. 2002. ISBN 0-13-007817-4.

Clausen, Jacquet, Laouiti, Minet, Muhlethale, Qayyum, and Viennot. OLSR RFC3626, experimental edition, October 2003.

C. Perkins, E. Belding-Royer, and S. Das.

AODV RFC3561, experimental edition, July 2003

E.M. Royer, and Chai-KeongToh, "A review of current routing protocols for ad hoc mobile wireless networks", IEEE Personal Communications, vol. 6, n. 2, pp. 46-55, 1999.

Ron Banner, and Ariel Orda, "Multipath routing Algorithms for Congestion Minimization", IEEE/ACM Trans.On Networking, vol. 15, n. 2, pp. 413-424, 2007.

A. Napisuri, R. Castaneda, and S.R. Das, "Performance of Multipath Routing for On-Demand Protocols in Mobile Ad Hoc Networks", Mobile Networks and Applications, vol. 6, n. 4, pp. 339-349, 2001.