Survey on Routing Mechanisms and Schemes in MANETs

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Abstract— **Mobile Ad Hoc Network (MANET) is a collection of multi-hop mobile nodes that communicate with each other without any pre determined centralized control or infrastructure. MANETs are generating lots of interest due to their dynamic topology and decentralized administration. Due to the mobility of nodes there are many problem occurred during the packet transmission. Mostly in MANETs research people concentrate on routing, synchronization, power consumption, bandwidth considerations etc. This paper concentrates on routing mechanisms and schemes which is the most challenging issue due to the dynamic topology of ad hoc networks. There are different methods proposed for efficient routing. There are different routing protocols proposed for MANETs which makes it quite difficult to determine the protocol is suitable for different network conditions. This paper provides an overview of different routing mechanisms proposed and also provides a comparison between Broad cast Schemes and Protocols.**

Index Terms— **Broadcasting, EAC, Neighbour Knowledge Probability**

I. INTRODUCTION

In Wireless networks single hop and the multi hop are the two kinds of networks. The nodes in single-hop network is started depends on a permanent infrastructure of base stations and servers. The infrastructure was built in advance. Fig.1 displays a simple wireless network with permanent access points called as Access Router. The nodes are connected directly to the access routers.

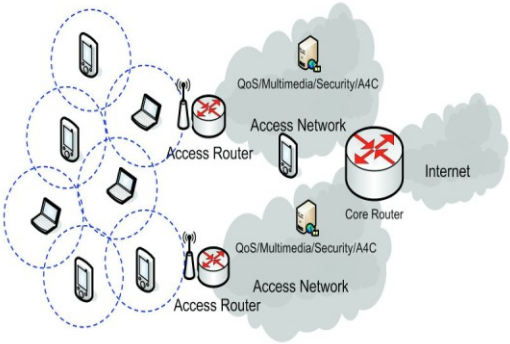

Fig. 1: Example of wireless network with Permanent access points

The Nodes in MANETs, communicate with each other through the in between nodes. MANETs are instantly shaped without any prior setup. It does not depend on any infrastructure. MANETs are highly used in temporary applications. Fig. 2 displays the Example of MANET.

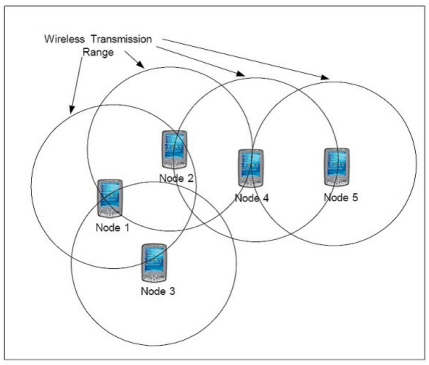

Fig. 2: Example of MANET.

A. *Functions of MANET Layers*

MANET layers [8] are as like OSI, the application, transport, network, data link, and physical layers. Communication between nodes in MANETs operates on the lower levels of OSI model, i.e. layers 1 to 3. The higher layers are only associated to the source and destination pairs.

- **The Transport Layer:** The main aim of this layer is to provide a reliable end-to-end connection between source and destination node pairs. It provides several important services such as supporting data packet's integrity, flow control, and congestion control. The transport layer consists of two important protocols: Transmission Control Protocol (TCP) and User Datagram Protocol. TCP is designed to ensure reliable data delivery to a destination node by using acknowledgment and retransmission methods. In the constant, UDP is a connectionless protocol and provides no reliable or guarantee of a delivery. It is useful for video streaming and time-sensitive applications where error checking and correction is not important.

- **The Network Layer:** It is responsible for all service to discovery and set up a route between source and destination node pairs. This includes, forwarding data packets and routing them through intermediate nodes, link repairing and maintenance [9].

- **The Data Link Layer:** It comprises two sub layers: the Logical Link Control (LLC) layer and the Medium Access Control (MAC) layers. The LLC layer is responsible for link maintenance, controls frame synchronization, flow control and error detection. The MAC layer is responsible to manage access to the shared wireless channel between nodes. So it is considered very

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necessary to prevent collisions and contentions among the node.

- **The Physical Layer:** It is responsible for signal transmission over a physical link connecting devices together. The physical layer contains two sub-layers: the Physical Layer Convergence Procedure (PLCP) and the Physical Medium Dependent (PMD). PLCP prepares the frame received from the MAC layer into a format that PMD can retransmit. When PMD receives the frame from PLCP, it translates it into radio signals for transmission.

B. Flooding

Flooding is a network-wide broadcasting by which a packet is disseminated to all other nodes with some nodes acting as relays. The most used flooding protocol in MANETs is Blind-Flooding. All nodes always retransmit each received flooding packet to all nodes in its transmission range. The only optimization is that each node remembers the flooding messages it received and does not retransmit them again when duplicates are received. Flooding is a fundamental operation in MANETs and extensively used by routing. Blind-Flooding has problems:

• Causes a lot of unnecessary overhead
• Causes collisions, which leads to poor reachability
•Causes contention, which leads to poor performance

II. BROADCAST SCHEMES IN MANETs

Several broadcast schemes have been proposed for MANETs. The mechanisms are used to solve the problems caused by flooding. In general, broadcast schemes fall into four classifications; probabilistic broadcast schemes, deterministic broadcast schemes, position-based broadcast schemes, and hybrid-based broadcast schemes.

A. Probabilistic Broadcasting

The probabilistic broadcast technique is one of the most important and simple solutions to the broadcast storm problem. It basically allows a node to rebroadcast the message with a certain value of probability *Prob* and eliminate it with *1-Prob*. The selection of the value of *P* is decisive and some works have been made so far to find an appropriate measurement to adjust it according to different conditions. Below is a some of suggested methods to select the *Prob* value by different research people.

- **Fixed-Probabilistic Broadcast Scheme** In Fixed Probabilistic Broadcasting all nodes receive a broadcast message for the first time, rebroadcasts it to all other nodes in the network with a certain value of probability *Prob*, apart from the density level of current node. Y-C. Tseng and J-P Heu [4] have shown that the best value of *Prob* in terms of high reachability and rebroadcast reduced approximately equal to 0.07%.

- **Fixed -Density Probabilistic Broadcast method** The Fixed-Density Probabilistic Broadcasting methods [5] uses two values of *Prob*. Adjusts the *Prob* values according to neighbourhood information. In F-DPB a node rebroadcasts a packet with a high probability if the packet is received for the first time, and the number of neighbours of node *N* is less than the average number of typical neighbours of its surrounding environment. Hence, if node *N* has a low number of neighbours, retransmission should be expected. Otherwise, if node *N* has a high degree its rebroadcast probability is set low.

- **Adjusted Probabilistic Broadcasting [6]** When a broadcast packet is received by a node for the first time, it is rebroadcast according to a probability which depends on the neighbourhood information. The packet is re-broadcast with probability *Prob1* if the node is located in a sparser area. Similarly, it is re-broadcast with probability *Prob2* if the node is located in a medium density area. Finally, in a dense area, the node rebroadcasts the packet with a lower probability *Prob3*.

B. Position Based- Broadcasting

In Position Based Broadcasting, the sender and receiver nodes should know their own opposition by using geo-location technique such as GPS devices. It works, upon the reception of a new packet, the node initializes a random waiting time and calculates the Expected Additional Coverage (*EAC*) that the node can cover. When the waiting timer expires, if the *EAC* is less than a predefined *EAC*min, the node will not rebroadcast the packet, as this does not cover a new region. Otherwise the node rebroadcasts it. The basic scheme of position broadcasting in MANETs is suggested Y-C. Tseng and J-P Heu [4]. A further improvement to this scheme is investigated by X.Wu, Y.Yang, and F.Yi [7].

C. Distance Based-Broadcasting

The distance broadcast scheme[4][10] works in the same way as the location scheme, but as an alternative of calculating *EAC*, the distance between the receiver and the sender is considered. In this method, a node decides whether to rebroadcast a packet only if the distance between the source and receiver exceeds a certain fixed Distance Threshold *Dth*. Each node upon receiving the message initializes a fixed timer and calculates distance (*d*) between itself and the sender. If the $d < Dth$ the packet will not be rebroadcasted by this node.

D. Neighbour Knowledge Based-Broadcasting

It is also considered as deterministic schemes. In deterministic groups of forwarder nodes are selected in advance, which should rebroadcast the broadcast packet.

- **Flooding-Self Pruning Scheme**

Lim and Kim [1] have suggested a simple neighbour knowledge-based scheme, which called flooding-self pruning. Here each node periodically exchanges the knowledge of its one-hop neighbours which can be collected by using a "HELLO" packet. When the node broadcasts a message it appends its list of one-hop neighbours to the header of each broadcast message. Each node that receives

this message compares its neighbours list with its sender's neighbours list. The receiver refrains from broadcasting if no additional node can be covered, otherwise it rebroadcasts the message.

The scheme in [2] improves the self-pruning scheme as each node includes the knowledge of its neighbours within a two-hop radius instead of a one-hop radius. The "HELLO" packet technique is used to collect neighbourhood information between nodes. Then the node decides whether it can cover new nodes by rebroadcasting the broadcast packet or not.

- **Dominant Pruning Scheme**

In Dominant Pruning Scheme each node collects its two-hop neighbour's knowledge, which is collected via "HELLO" packets, and uses a greedy set cover algorithm to alleviate the broadcast storm problem [3]. The sender explicitly appends to the broadcast packet a list of forwarding nodes that are responsible for rebroadcasting the packet. When the receiver receives the broadcast packet, it checks the packet header to decide whether it is one of the forwarding nodes or not.

- **Multipoint Relaying Scheme**

The Multipoint Relaying Algorithm (MRA) is suggested to reduce redundant retransmission by limiting the number of rebroadcasting processes to a small set of relay nodes. Each relay node keeps a record for two-hop neighbours' knowledge collected via "HELLO" packets [11]. In this scheme the relay nodes (which are defined as a set of one-hop neighbours) are only allowed to rebroadcast if they can cover a set of two-hop neighbours. Selecting an optimal set of multipoint relays at each node is a NP-complete problem and a heuristics technique should be used with the availability of neighbourhood information.

- **Cluster-Based Scheme**

In a cluster-based scheme [12], the network is partitioned into several groups of clusters. Each group has a Cluster Head (CH) with gateways nodes responsible of rebroadcasting the message and select forwarding nodes on behalf of the cluster. Each host has a unique ID; a host with a local minimal ID will select itself as a cluster head. If a node receives a message from a neighbour that announced itself as CH, it will send a message (to all its neighbours) declaring itself a non-CH node, to enable more clusters to be created (note that two CHs are not direct neighbours in the algorithm). Thus each node broadcasts its clustering decision after its neighbours with a lower ID have already done so. Non-CH nodes that hear two or more CHs will declare themselves as gateway nodes.

E. *HYBRID-BASED BROADCASTING*

The schemes under this classification combine the advantages of two or more different broadcast schemes in order to introduce an optimal broadcasting one to suppress the broadcast storm problem. For instance, the fixed probabilistic scheme is used with the fixed counter scheme as in [13], and an advanced probabilistic based distance scheme is proposed by I.Khan, A.Javaid, and H.L. Quain [14].

- **Position Aware-Counter Based Scheme**

Position Aware – Counter Based Scheme [15] combines the advantages of the position scheme and the counter scheme. Each node has two pre-defined Fixed Counter (*FC*) values and two Expected Additional Coverage (*EAC*) threshold values. Each node, upon receiving a broadcast packet calculates the new additional coverage that can be covered. If the new additional coverage is less than *EAC1* the node will not rebroadcast. Otherwise the new additional coverage is larger than *EAC2* and a shorter timer is assigned for those nodes with a small *FC* value.

- **Energy Aware -Distance Broadcast Scheme**

In this scheme [16] instead of using the distance threshold, the Reception Signal Strength (*RSS)* at each node is considered. When a node receives a message for the first time, it calculates the RSS of the message and compares it with the *Border_Threshold*, which represents the power of nodes that are far from the source node and close to the border. If the minimum signal strength is larger than *Border_Threshold*, the node drops the message. Otherwise it initiates a waiting time which is calculated according to the received power *Power_Delay*, or to a random delay chosen between intervals of [0, *Power_Delay*].

- **Probabilistic Counter-Based Broadcast Scheme**

Probabilistic Counter-Based Scheme[17] uses a packet counter to estimate the neighbourhood density for each node in the network. A high packet counter value means that the node is in a dense area, while a low packet counter value entails that the node moves in a relatively spars area. Here each node keeps a counter for every new packet received within the *RAD* period. The node increases the counter if it receives the same copy. After the *RAD* expires, if the counter value exceeds a predefined threshold, the node cancels its retransmission. Otherwise, it rebroadcasts with a predefined fixed rebroadcast probability *P*.

- **Adjusted Probabilistic Counter-Based Broadcast Scheme**

Adjusted Probabilistic Counter-Based Broadcast Scheme [18] is a further improvement to Probabilistic Counter Based Scheme. In this scheme, rebroadcast probability is set according to the number of duplicated packets in the same manner as in PCBS. Each node counts the number of the identical received packets (i.e. *c*) within a random timer. After timer expiration, the node uses the ratio between the total numbers of received packets (i.e. *c*) within the timer and the predefined Counter threshold *C*, to rebroadcast the packet with a value of mathematical exponential probabilistic

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function unlike PCBS, which uses a predefined fixed rebroadcast probability *P*.

Table.1 Comparison of Routing Mechanisms

Routing Mechanism	Trust worthiness	Re-transmission	Collision	Conflict
Flooding Based	Excessive	Unnecessary	Severe	Excessive
Probability Based	Medium	Controlled	Medium	Low
Distance Based	Medium	Controlled	Low	Medium
Location Based	High	Efficient	Low	Medium
Hybrid	High	Controlled	Low	Low
Deterministic	Medium	Controlled	Medium	Medium

III. ROUTING PROTOCOLS IN MANETs

Many Ad-hoc routing protocols have been proposed to deal with routing problems in MANETs. Such protocols fall into three routing classifications based on routing strategy: *proactive, reactive and hybrid*.

- **Proactive Protocols**

In proactive protocols, each node stores routing information about all of its neighbours regardless of its usefulness. Due to the frequent change of the network topology, each vehicle updates its routing table information constantly even, if no data available should be sent. An advantage of proactive protocols is route availability, which enables the source to immediate route data and thus avoids initial route discovery delay. However, periodic updating of the routing table imposes extra overhead for highly dynamic Ad-hoc networks. Destination-Sequenced Distance-Vector Routing (DSDV) [19] and Optimized Link State Routing Protocol (OLSR) [20] are examples of proactive routing protocols.

- **Reactive Protocols**

In reactive protocols route discovery starts only "on-demand" or when needed. A source attempts to find a route to a destination if routing information is not stored in the routing table. Routing overhead in reactive protocols is less compared to proactive protocols as the routing table at each vehicle is updated only on-demand rather than periodically. The most common examples of reactive protocols is AODV [21]

- **Hybrid Protocols**

Hybrid protocols combine the advantage of reactive protocols scalability and proactive protocols stability, such as Zone Routing Protocol (ZRP) [22]. A vehicle/node using the hybrid protocols divides its neighbours into two zones: "intra-zone" and "inter-zone". Intra-zone uses reactive protocol to establish a route to destination networks, and inter-zone uses proactive protocol to update routing table information at each vehicle only when the topology of the network is changed.

Table. 2 Parametric Comparison of Routing Protocols

Parameters	Reactive Protocols	Proactive Protocols	Hybrid Protocol
Routing Philosophy	Flat	Flat / Hierarchical	Hierarchical
Routing Scheme	On Demand	Table driven	Combination of Both
Routing Overhead	Low	High	Medium
Latency	High	Low	Low in inside zone and High in Outside zone
Availability of Routing information	Available when required	Always available stored in tables	Combination of both
Scalability	Not Suitable for large networks	Low	Designed for large networks
Storage capacity	Low and it depends upon the number of routes	High Due to the routing tables	Depends on the size of the zone.

The advantages and disadvantages are summarized in Table.3.

Table.3. Advantages and Disadvantages

Protocol	Advantages	Disadvantages
Proactive	Information is always available. Latency is reduced in the network	Overhead is high, routing information is flooded in the whole network
Reactive	Path available when needed. overhead is low and free from loops.	Latency is increased in the network
Hybrid	Suitable for large networks and up to date information available	Complexity increases

IV. RESULT

There are various types of routing protocols suitable for different situations. It is seen that due to route discovery mechanism by reactive routing protocols overhead is very low in these protocols in contrast to proactive routing

protocol in which overhead increases due to routing information stored in routing tables. The route discovery process the latency in the Reactive protocols increases whereas latency is very low in proactive protocols because of information related to routing is previously stored in routing table and available for on demand. The Hybrid protocols have combined the advantages of both Reactive and Proactive protocols. The latency is decreased by using proactive protocol inside the zone and overhead is decreased by using reactive protocol outside the zone. Hence a protocol is presented which improves the performance of network by using the advantages of both reactive and proactive protocols.

A. Performance Metrics

Throughput: This is the parameter related to the channel capacity. It is defined as the maximum possible delivery of the messages over the channel. It is usually measured in bits per second. The result is shown in Fig .3.

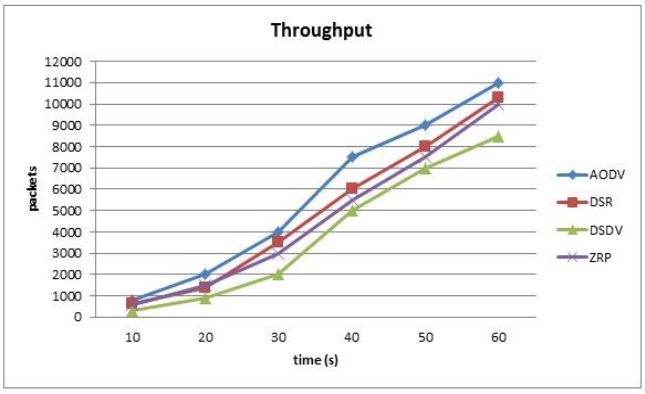

Fig. 3 Result 1(Throughput)

Routing Overhead: It is defined in terms of number of control packets need to be sent for the route discovery as well as route maintenance so as to send data packets. The result is shown in Figure.4.

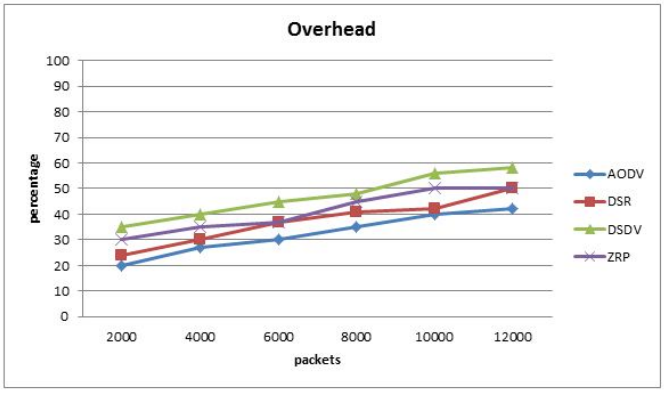

Fig. 4 : Result 2 (overhead)

Average delay: it is defined as the time taken by the packet to reach from source to destination. It is measured in seconds. It is also known as end to end delay. The result is shown in Fig.5.

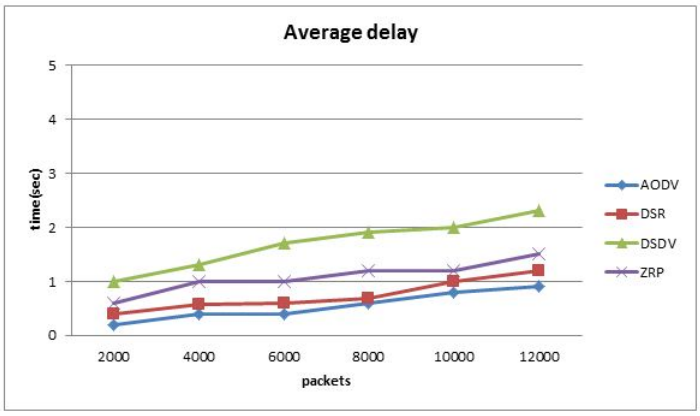

Fig. 5 : Result 3 (Average delay)

Packet delivery ratio: It is defined as the ratio of incoming data packets to the received data packets. We can understand that AODV has the better packet delivery ratio from the result of throughput shown in Figure.3.

Scalability: It is defined as the performance of routing protocols in presence of large number of nodes.Generally the performances of routing protocols degrade in presence of large number of nodes. We can compare this metric among the routing protocols and can say that AODV is the most scalable of all the routing protocol, all other metrics regarding this protocol is better than the others.

V. CONCLUSION

In this paper, a detailed survey is carried out about the routing mechanisms and schemes for MANETs. Also it describes about the Routing Protocols. In this paper an attempt has been made on the comparative study of Routing Mechanisms and Protocols Various advantages and disadvantages of these protocols are also presented. There are various limitation in different routing protocols and it is difficult to choose routing protocol for different situations as there is tradeoff between various protocols. We can hope in future some new efficient routing schemes and protocols would be created

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