ISSN 2250-3153

A New Routing Protocol for MANET

Pawan Bhadana[**], Ritu Khurana[**], Chanchal[*], Manisha[*]

[*] Computer Science & Engineering, B.S.A. Institute of Technology & Management, Faridabad, India
[**] Associate Professor, Department of Computer Engineering, B.S.A. Institute of Technology & Management, Faridabad, India

Abstract- Mobile ad-hoc networks (MANETs) are self-configuring networks of nodes connected via wireless without any form of centralized administration. This kind of networks is currently one of the most important research subjects, due to the huge variety of applications (emergency, military, etc...). In MANETs, each node acts both as host and as router, thus, it must be capable of forwarding packets to other nodes. Topologies of these networks change frequently. To solve this problem, special routing protocols for MANETs are needed because traditional routing protocols for wired networks cannot work efficiently in MANETs.

The objective of this paper is to research the current state of the art of existing routing protocols for MANETs, and compare different approaches. There are three main classes of routing protocols for MANETs: reactive, proactive and hybrid. By studying advantages and disadvantages of each one, a new hybrid routing protocol is proposed, considers utilizing merits of both reactive and proactive protocols, and implements them as a hybrid approach. The new protocol allows that a mobile node flexibly runs either a proactive or a reactive routing protocol with its velocity and its traffic. The new routing protocol is evaluated qualitatively.

I. Introduction

Mobile ad hoc networks (MANETs) are autonomous systems of mobile hosts connected by wireless links. This kind of networks is becoming more and more important because of the large number of applications, such as:

1.Personal networks: Laptops, PDA's (Personal Digital Assistants), communication equipments, etc.

2. Military applications: tanks, planes, soldiers, etc.

3. Civil applications: Transport service networks, sport arenas, boats, meeting centers, etc.

4. Emergency operations: searching and rescue equipment, police and firemans, etc.

To achieve efficient communication between nodes connected to the network new routing protocols are appearing. This is because the traditional routing protocols for wired networks do not take into account the limitations that appear in the MANETs environment.

II. PROBLEM DEFINITION

A lot of routing protocols for MANETs have been proposed in the last years. The IETF is investigating this subject and for example, protocols like AODV (Ad hoc On Demand Distance Vector) and OLSR (Optimize Link State Routing protocol) have been proposed as RFC's (Request For Comments). But, none of the existing protocols is suitable for all network applications and contexts.

The routing protocols for MANETs can be classified in three groups: reactive, proactive and hybrid.

The proactive protocols are based on the traditional distributed protocols shortest path based. With them, every node maintains in its routing table the route to all the destinations in the network. To achieve that, updating messages are transmitted periodically for all the nodes. As a consequence of that, these protocols present a great bandwith consumption. Also, there is a great routing overhead. However, as an advantage, the route to any destination is always available. Thus, the delay is very small. The reactive protocols determine a route only when necessary. The source node is the one in charge of the route discovery. As a main advantage, the routing overhead is small since the routes are determinated only on demand. As a main disadvantage the route discovery introduces a big delay.

The hybrid ones are adaptative, and combine proactive and reactive protocols.

This paper proposes a routing protocol for MANETs with the objective that each node works using the most suitable features. To achieve that, every node checks periodically its speed and its traffic. Depending on these two parameters, the node will decide which features to use. The protocol proposed here can be classified as a hybrid one.

III. LIMITATIONS IN THIS WORK

The major part of this work has been to find and study information on the current state of the art in MANETs, the routing protocols that are used (taking into account the advantages and disadvantages of each one depending on the kind of MANET), and to design a new routing protocol using the acquired knowledge. The evaluation of the new protocol has been done qualitatively and not quantitatively.

IV. MOBILE AD-HOC NETWORKS: MANETS

Mobile Ad-Hoc networks or MANET networks are mobile wireless networks, capable of autonomous operation. Such networks operate without a base station infrastructure. The nodes cooperate to provide connectivity. Also, a MANET operates without centralized administration and the nodes cooperate to provide services.

V. ROUTING PROTOCOLS FOR MOBILE AD-HOC NETWORKS

There are three types of routing protocols for MANETS:

• *Table-driven (Proactive):* OLSR, TBRPF, DSDV (Dynamic Destination Sequenced Distance Vector), CGSR (Clusterhead Gateway Switch Routing protocol), WRP (Wireless Routing Protocol), OSPF (Open Shortest Path First) MANET, etc.

• *Demand-driven (Reactive):* AODV, DSR, TORA (Temporally Ordered Routing Algorithm), etc.

• *Hybrids:* ZRP (Zone Routing Protocol), HSLS (Hazy Sighted Link State), etc.

In the proactive protocols, each node has a routing table, updated periodically, even when the nodes don't need to forward any message.

In the reactive protocols, the routes are calculated only when required. When a source wants to send information to some destination, it calls on route discover mechanisms to find the best route to this destination.

The hybrids protocols try to use a combination of both to improve them.

VI. REACTIVE ROUTING PROTOCOLS

These protocols find the route on demand by flooding the network with Route Request packets.

The main characteristics of these protocols are:
• Path-finding process only on demand.
• Information exchange only when required.
• For route establishment, the network is flooded with requests and replies.

In this section the AODV protocol is studied as a representative example.

THE AD-HOC ON DEMAND DISTANCE VECTOR (AODV)

The AODV protocol is a reactive routing protocol. It is a Single Scope protocol and it is based on DSDV. The improvement consists of minimizing the number of broadcasts required to create routes. Since it is an on demand routing protocol, the nodes who are not in the selected path need not maintain the route neither participate in the exchange of tables.

When a node wants to transmit to a destination and it does not have the valid route, it must begin the Path Discovery process. Firstly, it sends a broadcast of the Route Request (RREQ) packet to its neighbours, and they relay the packet to their neighbours and so on until they reach the destination or any intermediate node which has a 'fresh' route to the destination.

Each node maintains two counters: the sequence number of the node (to solve the loops) and the broadcast ID which is incremented when a broadcast is started in the node. To identify only one RREQ it is used the broadcast ID and the IP (Internet Protocol) address of the source node. The RREQ has the following fields:

Source address, Source sequence number, Broadcast_id, Destination address, Destination sequence number, and the number of hops to the destination.

The intermediate nodes only answer to the RREQ if they have a path to the destination with a sequence number greater or equal to the sequence number of the RREQ. Hence, only if they have paths equal (in age) or more recent. While the RREQ is sent, the intermediate nodes increase the field 'number of hops to the destination' and, also store in its routing table the address of the neighbour from whom they first received the message, in order to establish a 'Reverse Path'. The copies of the same RREQ received later which are coming from the other neighbours are deleted.

When the 'destination node/intermediate node with the fresh route' has been found, it answers with a Route Reply (RREP) to the neighbour from which it received the first RREQ. The RREP has the following fields: Source address, Destination address, Number of Hops to the destination, Sequence number of the destination, Expiration time for the Reverse Path. Then, the RREP uses the return path established to the source node. In its path, every node forwarding the RREP sets the reverse path as the freshest path to the destination node. Therefore, AODV can only use bidirectional links.

If a source node moves, it is capable of restarting the discovery protocol to find a new path to the destination. If an intermediate node moves, its previous neighbour (in source-destination way) must forward a RREP not requested with a fresh sequence number (greater than the known sequence number) and with a number of hops to destination infinite to the source node. In this way, the source node restarts the path discovery process if it is still needed.

Hello messages (periodic broadcasts) are used to inform mobile node about all the neighbourhood nodes. These are a special type of RREP not solicited, of which sequence number is equal to the sequence number of the last RREP sent and which has a TTL=1 (Time To Life) to not flood the network. They can be used to maintain the network connectivity, although other methods used more often exist for this function, like for example, to listen to the neighbour nodes transmissions.

Advantages

• AODV has low control signalization because there are not periodic updates about the routing and the overload in terms of packets is small since it is a reactive protocol. Also, the processing signalization is low because the AODV messages are simple and require small calculus. Besides, the loops are solved.

• AODV is a simple protocol that aims to resolve more recent and shorter paths. DSR, on the other hand, employs multiple optimizations, which in some cases result into worse performance e.g. invalid route pollution due to aggressive route learning and caching.

Disadvantages

• AODV works only with bidirectional links. Although AODV only manages the routes between nodes who want to communicate, it uses Hellos messages periodically. Thus, in comparison with DSR the overhead in terms of packets is higher.

• Inconsistent route may appear.

• Multiple RREP can lead to heavy control overhead.

• Periodic beaconing.

Resilience

AODV has a high resilience to mobility and it is very good to be used in highly dynamic environments (over 20 m/s). In the study realized in at very high speeds, despite optimizations that address limitations of DSR's aggressive route caching mechanism, DSR is found inferior to AODV. At these speeds AODV exhibits impressive resilience.

VII. PROACTIVE ROUTING PROTOCOLS

These algorithms maintain a fresh list of destinations and their routes by distributing routing tables in the network periodically. The main characteristics are:

• These protocols are extensions of wired network routing protocols.

• Every node keeps one or more tables.

• Every node maintains the network topology information.

• Tables need to be updated frequently.

In this section the OLSR protocol as a representative example is studied.

VIII. OPTIMIZED LINK STATE ROUTING (OLSR)

OLSR is a proactive link state routing protocol. It is a point to point routing protocol based in the link state algorithm.

Each node maintains a route to the rest of the nodes of the ad hoc network. The nodes of the ad hoc network periodically exchange messages about the link state, but it uses the 'multipoint replaying' strategy to minimize the messages quantity and the number of nodes that send in broadcast mode the routing messages. The strategy MPR (Multipoint Relay) lies in that each node uses 'Hello' messages to discover what nodes are in a one hop distance and makes a list. Each node selects a group of neighbours of that list that are able to reach all the nodes in a distance of two hops with regard to the node that is making the selection.

These neighbours selected are the only nodes in charge to relay the routing packets and are called MPRs (Multipoint Relays). The rest of the neighbourhood process the routing packets that they receive, but they can not relay them. Each node decides an optimum path (in number of hops) to each destination using the stored information (in its topology routing table and in of their neighbours ones). Besides each node stores that information in a routing table for usage when a node wants to sent data. This protocol selects bidirectional links to send packets, and does not use unidirectional links.

The OLSR protocol is more efficient in networks with high density and highly sporadic traffic. The quality metrics are easy to expand to the current protocol. OLSR requires that it continuously has some bandwidth in order to receive the topology updates messages.

Advantages

• The proactive characteristic of the protocol provides that the protocol has all the routing information to all participating hosts in the network. OLSR protocol needs that each host periodically sends the updated topology information throughout the entire network. This increases the protocol bandwidth usage. However, the use of MPRs minimises the flooding in comparison with other proactive routing protocols.

• OLSR protocol is well suited for the application which does not allow the long delays in the transmission of the data packets. The best working environment for OLSR protocol is a dense network, where the majority of the communication is concentrated between a large number of nodes.

• The reactiveness to the topological changes can be adjusted by changing the time interval for broadcasting the Hello messages. It increases the protocols suitability for ad hoc network with the rapid changes of the source and destinations pairs. Also the OLSR protocol does not require that the link is reliable for the control messages, since the messages are sent periodically and the delivery does not have to be sequential.

• OLSR has also extensions to allow hosts to have multiple OLSR interface addresses and provide the external routing information giving the possibility for routing to the external addresses. Based on this information there is the possibility to have hosts in the ad hoc network which can act as gateways to another possible network.

Disadvantages

• As proactive routing protocol, a great number of periodical messages are sent. Besides the HELLO messages, there are Topology Control messages, forwarded around all the nodes in the network. The use of MPRs solves in part that problem, but the overhead in terms of packets is still high in comparison with the reactive routing protocols.

IX. HYBRID ROUTING PROTOCOLS

These protocols are a combination of reactive and proactive routing protocols, trying to solve the limitations of each one. Hybrid routing protocols have the potential to provide higher scalability than pure reactive or proactive protocols. This is because they attempt to minimise the number of rebroadcasting nodes by defining a structure (or some sort of a backbone), which allows the nodes to work together in order to organise how routing is to be performed. By working together the best or the most suitable nodes can be used to perform route discovery.

X. REACTIVE VS PROACTIVE

Proactive routing protocols loose more time updating their routing tables. Therefore when the topology changes frequently, most of the current routes in the tables can be wrong. Hence, these protocols are recommended for ad-hoc networks semi dynamics.

Reactive routing protocols have delay in route determination, because of the flooding mechanism. They are recommended for networks with nodes moving constantly.

Proactive protocol:

Advantages

• A route can be selected immediately without delay.

Disadvantages
• Produce more control traffic.
• Takes a lot of bandwidth.
• Produce network congestion.

Reactive protocol:
Advantages
• Lower bandwidth is used for maintaining routing tables.
• More energy-efficient.
• Effective route maintenance.

Disadvantages
• Have higher latencies when it comes to route discovery.

Reactive protocols face scaling problems when the number of nodes is large and have many "active nodes". But how big this problem is it depends on which protocol is used and in which scenario it is working.

In the Table-driven case, the problem is the time to update the routing tables. These protocols require nodes to exchange their routing tables periodically (or if changes in the topology happen each). Thus, each node has its routing table updated. However, this information exchange can cause message broadcast storm when the mobility is high.

XI. FLAT VS. HIERARCHICAL

Both architectures have strengths and weaknesses. The flat architecture has the following advantages over the hierarchical:
• More reliability and survivability.
- No single point of failure.
- Alternative routes in the network.
• More "optimal routing".
• Better coverage, i.e. reduced use of the wireless resources.
• Route diversity, i.e. better load balancing property.
• All nodes have one type of equipment.

The *no single point of failure* means that if one node goes down, the rest of the network will still function. In the hierarchical if one of the cluster heads goes down, that section of the network won't be able to send or receive messages to other sections for the duration of the downtime of the cluster head.

The flat routing algorithm doesn't have a good scalability. When the network becomes larger the routing overhead will increase rapidly.

The hierarchical architecture has the following advantages over the flat:

• Easier mobility management procedures (just ask the cluster head).

• Better manageability.

XII. UNICAST VS. MULTICAST

In multicast routing a single packet is sent simultaneously to multiple receivers. In unicast routing a single packet is only sent to one recipient every transmission. Thus the multicast method is very efficient and a useful way to support group communication when bandwidth is limited and energy is constrained.

Due to the broadcast characteristics of the multicast protocol it is better suited for MANET then the unicast protocol.

XIII. UNIPATH VS. MULTIPATH

In a multipath routing protocol the packets can be sent via multiple paths between the source and destination. This increases the packet delivery ratio with regard to unipath. This also means that there is no necessity of finding new routes, decreasing the route discovery traffic.

XIV. QUALITY OF SERVICE (QOS)

Quality of service can be used as a measurement of how good the routes in the network are. The routes should guarantee a set of pre specified service attributes, such as delivery, bandwidth and delay variance (jitter). It also involves the specification of latency, loss, availability etc... For a protocol to provide good QoS it must determine new routes rapidly and with minimal bandwidth consumption. There are several metrics that directly affect the QoS of every protocol, for example: Packet delivery ratio, control packet overhead (packets and total bytes), average hop count, end-to-end latency and power consumption to mention a few. Using a protocol that provides good quality of service will greatly affect the MANETs performance.

XV. A NEW ROUTING PROTOCOL FOR MANET INTRODUCTION

The routing protocol for MANETs described is a hybrid and a hierarchical routing protocol. The nodes which move slowly or have high traffic will work (or will try to work) in proactive mode, joining a proactive area. The others will work in reactive mode. Since there are many typical routing protocols proposed, this protocol uses two existing protocols directly. For proactive areas, OLSR is utilized because it is very popular and performs well compared with other proactive routing protocols. Reactive nodes run AODV for no additional overhead introduced with the network growing. Besides, when the mobility is very high, AODV has impresive resilience.

XVI. PROTOCOL DESCRIPTION

The description of the routing protocol is quite easy. Each node checks its velocity and its traffic periodically. If the velocity is smaller than a threshold X, or the traffic is higher than a threshold Z, then the node will try to join or to create a proactive area. Within this area, the features to use are the same that in the OLSR. If not, the node will work in reactive mode, using the same features that AODV. The proactive areas have a limited size in number of nodes. The number of nodes within an area can not be greater than a threshold Y. If a node that wants to join an area does not find an area with less than Y nodes, it has to create a new area or it can not work in proactive mode.

But not all the nodes inside the area work like pure OLSR. There are some nodes that have to work as gateways to communicate the area with the outside. Similarly, not all the nodes outside the area work in the same way that AODV. Some of them have special features to allow the communication between reactive and proactive nodes.

XVII. HOW A NODE DECIDES ITS FEATURES

PROTOCOL PARAMETERS

First of all, there are some parameters that have to be described to understand the operation of the protocol.

V=velocity

Periodically, the node checks its velocity to know if topology changes can happen. The velocity to have into account to switch from an operation mode to another is the average velocity. That is, the node checks with GPS (Global Positioning System) its position periodically. The average velocity necessary to change from the last position to the current position is the V.

X= threshold velocity=3.5 m/s

If we review different performance studies as, we can see that AODV is better than OLSR in all the range of mobility since the point of view of the throughput, the total amount of generated network traffic, and the resilience. However, when the nodes are semi-static (at very low velocities) the OLSR can perform better in terms of delay end-to-end. This is because in a network with not many topology changes OLSR can almost always give the shortest path available. As mentioned, AODV usually performs better than OLSR in every mobility environment, but at less than 3.5 m/s it can be interesting to use OLSR since the network is more similar to a static network than to a Mobile Ad-hoc network. When the network has no topology changes, the throughput and the resilience to topology changes are similar (there are not topology changes). Therefore, we can compromise the control traffic load to achieve a better delay end-to-end using the proactive routing protocol.

N=number of nodes in the area

N is the number of nodes working in the same area using the proactive features.

Y= threshold number of nodes in an area = 90

The proactive area works in the same way that OLSR. OLSR reduces the number of "superfluous" forwarding, reduces the size of LS updates, and reduces the table size. However, while the number of nodes into an OLSR area increases, the number of control packets increase.

A good threshold to the number of nodes in an OLSR network could be 90. OLSR allows choosing a big value for the number of nodes in a network, but when this value exceeds 100 the performance of the protocol may decrease. With the number of 90, there is a margin of 10 nodes to reach this critical point.

T= Traffic

T is the traffic that a node manages. This traffic is just data traffic (with no control traffic), and can be both the traffic generated by the node and the traffic routed by the node and generated in others nodes.

Z= threshold value of traffic= 300 kbps

As explained before, when the traffic in the network is high, the nodes need to know the route to the destination as fast as possible. In this case a proactive routing protocol outperforms the reactive one because it already has the route when necessary. However, it is quite difficult to define a threshold value for the traffic of a fixed node.

A SINGLE NODE

If we have a node implementing the routing protocol, this one must know its velocity (for example, using GPS) and its traffic. If the velocity V, is ≤ than a threshold velocity X or the traffic T is > than a threshold Z, then the node knows that it is better to use the proactive features since the nodes with low mobility and high traffic always perform better with a proactive protocol than with a reactive one. Hence, the node will try to join an area with other nodes in the same situation.

If none of both conditions mentioned before happens, then the node knows that it is better to use the reactive features. If the V is not very small, the topology is changing fast and is not efficient to change the routing information periodically all the time (even when these routes are not being used). Also, if the T is not very high it is not efficient to maintain routes constantly because these are not being used very often.

A NODE OPERATION

A node working with the protocol will work using different features depending on its velocity, traffic and environment. It defines 6 different states for a node: Initial, R1 (Reactive 1), R2 (Reactive 2), R3 (Reactive 3), P1 (Proactive 1), P2 (Proactive 2) and P3 (Proactive 3) states. Figure illustrates a diagram state describing the behaviour of a node. Hereafter, each state is described:

• Initial state: When a node is reset it begins in an initial state. In this state the node must check its velocity and its traffic to decide in which mode it has to work. We define "condition 1" as: "(V<=X) OR (T>Z)". If condition 1 doesn't happen then it will work in the reactive mode (Reactive 1), but if condition 1 happens, then it will try to work in the proactive mode. Hence, the node will pass to the Reactive 3 state.

• Reactive 1: In this state, the node works using the AODV features. While condition 1 is not fulfilled and the node does not have connectivity with an area it will remain in the same mode of operation. In the case that the node discovers a node or more working in the Proactive 1 or Proactive 2 modes then it will work in the Reactive 2 mode. If condition 1 is fulfilled, then it will try to work in proactive mode (Reactive 3).

• Reactive 2: In this state, the node works using the AODV features, but also must process the control messages coming from the proactive zone. This is because it needs these messages to have, in its routing table, the proactive destinations. While there is no condition 1 and while the connectivity with any node working in the Proactive 1 or Proactive 2 modes continues the node will remain in the same state. If condition 1 is not fulfilled but the router looses the connectivity with the mentioned routers, then it will come back to the Reactive 1 state. If condition 1 occurs then it will try to work in proactive mode (Reactive 3 state).

• Reactive 3: This state exists for the reason that when a node decides that to work in proactive mode is better, firstly it must join or create an area. In this state the node still works using the AODV features, but also has to generate and to process the proactive control messages. If there is no condition 1 happening the node will come back to the Reactive 1 state. But while condition 1 happens, the node will try to join or to create an area. If it listens another node working in Reactive 3, Proactive 1 or Proactive 2 modes, then it will join the area unless in the area the number of nodes N is > Y. If N>Y the node remains in the same state waiting to listen to other area with less number of nodes.

• Proactive 1: In this state the router works using the OLSR features. If condition 1 is not fulfilled, the node will go to the Reactive 1 state. But when condition 1 is fulfilled, the node will continue working in this state unless it discovers a node working in the Reactive 1 or Reactive 2 states. Then it will go to the Proactive 2 state.

• Proactive 2 (Area Border Router): In this state the node works using the OLSR features but it has to understand the reactive routing messages (RREQ, RREP and RERR) because it needs to have in its routing table all the reactive 2 nodes connected with it. When an ABR (Area Border Router) receives a reactive routing message (RREQ, RREP or RERR) it must look for the destination. If the destination is inside its own area, then it answers to that message reactively. If not, it forwards them to all the others ABRs of its area. The intermediate nodes are purely reactive, but they know what they have to do with those packets looking at the two flags attached in all the packet. These exit ABRs will change the flags again.

If condition 1 is not fulfilled the node will go to the Reactive 1 state. But while condition 1 occurs the node will continue working in this state unless it lost all the connectivity with the nodes working in the Reactive 1 or Reactive 2 states. In this case it will go to Proactive 1 mode.

A node goes to Initial State from every state when it is reset.

XVIII. PROACTIVE 1 STATE: SAME WORKING AS OLSR

INTRODUCTION

OLSR is an improvement of the pure link state protocol. Since it is a proactive routing protocol, the routes are always available. The route discovery process is based in the broadcast of the HELLO and TC (Topology Control) messages. Besides, the OLSR is based in the MPR (Multipoint Relay) concept.

OLSR is considered as a good protocol for dense and big mobile networks, thanks to the optimization of the MPR nodes. It is also a hop to hop routing protocol. Thus, each node uses its local information to forward the packets to the destination.

XIX. REACTIVE 1 STATE: SAME WORKING AS AODV

INTRODUCTION

AODV presents the following characteristics:

• *Low control signalization:* There are no periodic updates with information about the routing, since it is reactive.

• *Loop prevention:* There is a mechanism to solve the loops.

• *Only works with bidirectional links.*

REACTIVE 2 STATE

All the nodes within an area must work in proactive mode, understanding the control messages necessary to get the routing tables (as TC and Hello messages). But also the nodes outside the area with connectivity with an area border router (that have connectivity with an area) need to understand these messages. These nodes are working in the Reactive 2 mode.

REACTIVE 3 STATE

In this state the node has decided to work in proactive mode, but it knows no areas yet. It makes no sense to have an area with just one node. Due to this, this node continues working using the AODV features while it is sending the OLSR control messages searching for another router in the same situation, or an area to join. When the node working in the Reactive 3 state listens to the proactive control messages it will work in the Proactive 1 state, becoming part of the area (if N<Y). As we can see, the minimum number of nodes in an area is two.

If the node working in reactive 3 state listens to the proactive control messages of an area, it must check how many nodes there are in that area. If N<Y, then our node will join the area and will work in the Proactive 1 state. But if N≥Y, then the node must continue to search another area that it can join.

XX. PROACTIVE 2 STATE

The nodes working in this mode are the area border routers (ABRs), that is, the nodes that have connectivity with any router outside the area. All the nodes outside the area must understand the reactive routing protocol messages (RREQ and RREP), but also the area border routers must do so.

When an ABR receives a RREQ, it first determines whether it has a path to the requested node (can be a known AODV node, or an OLSR node that is in its routing table because it is in the same proactive area) or whether it has to forward the RREQ to other AODV nodes crossing the area. If it has a path to the destination node, it will send a RREP to the sender. If the destination in the RREQ is a pure OLSR node, the ABR will have to keep track of the destination sequence number on behalf of the OLSR node, to ensure correct operation of the AODV protocol. If the ABR does not have a path to the destination, it will have to rebroadcast the RREQ to other AODV nodes and unicast the RREQ to other ABRs, enabling it to traverse OLSR networks. When an ABR receives a RREP, it will create a forward route to the source of the RREP, and forward the RREP to the next hop of the reverse route. Similarly, the broadcasting of RERR messages will have to be modified. In AODV networks, RERR messages are unicast if there is only one predecessor or broadcast if there is more than one. However, if the node is an ABR, RERR messages will be unicast to every predecessor node that is an ABR.

An ABR receiving an AODV routing message (RREQ, RREP or RERR) that has to pass through the proactive area sets the flags to the correspondent value. The exit ABRs will change the flags's value again. Then, these ABRs must broadcast the routing messages to all the routers with connectivity to them.

PROCESSING OF DATA PACKETS

For a data packet received for a Proactive 2 node via its Reactive 2 node which is connected to from a Reactive 1, Reactive 2 or Reactive 3 node, and the destination is not found, a RERR will be sent back to the sender. For a data packet received by a Reactive 2 node via its Proactive 2 node which is connected to an OLSR node, and the destination is not found, it will buffer the data packets and send a RREQ to initiate a route discovery process on behalf of the OLSR node. If no RREP is received after RREQ_RETRIES, then it will send an ICMP (Internet Control Message Protocol) Destination Unreachable message back to the OLSR node.

XXI. CONCLUSION

In this, a qualitative analysis has been provided for AODV, OLSR and New Protocol. The quantative analysis was not possible to be done for the new protocol, but it was necessary at least to show one for the rest of protocols. In this section, the conclusions of the study realized are explained.

The AODV will perform better in the networks with static traffic and with a number of source and destination pairs relatively small for each host. In this case, AODV use fewer resources than OLSR, because the control overhead is small. Also, they require less bandwidth to maintain the routes. Besides, the routing table is kept small reducing the computational complexity. The reactive protocol can be used in resource critical environments.

The OLSR protocol is more efficient in networks with high density and highly sporadic traffic. The quality metrics are easy to expand to the current protocol. Hence, it is possible for OLSR to offer QoS. However, OLSR requires that it continuously have some bandwidth in order to receive the topology updates messages.

The scalability of both classes of protocols is restricted due to their proactive or reactive characteristics. For reactive protocols, it is the flooding overhead in the high mobility and large networks. For OLSR protocol, it is the size of the routing table and topological updates messages.

XXII. SUMMARY

In this, there has been a description of what MANETs are and why they are so interesting. Because of its characteristics, the tradicional routing protocols for wired networks are not advisable for them. A specific routing protocol for MANETs is necessary. In this thesis the main groups of these protocols have been explained and some of the most commonly used of them were studied. We saw that each protocol is better in a specific environment. None of them are perfect for all the ranges of nodes mobility, traffic, number of nodes, etc.

The two main groups of protocols studied are the proactive and the reactive ones. The main characteristic of the proactive is that each node maintains a route to every node in the network. Besides, it periodically updates this information. No matter if there is communication between the nodes or not. As representative examples of proactive protocols, OLSR is described here. On the other hand, in the reactive ones the nodes only calculate the routes between those nodes that want to communicate. This kind of protocols perform in a more efficient usage of the bandwith (which is very limited in the MANETs medium) and the resources of the nodes. However, as a drawback, when the route is not available yet, the delay to achieve it can be great. The reactive protocols choosen here to be studied is AODV.

XXIII. FUTURE WORK

This report has proposed a routing protocol for MANETs. The greatest part of the work during the four months of duration of the master thesis was to read papers and RFCs to understand what MANETs are, why they are so important, and which kind of routing protocols they use. Once the different existing routing protocols as well as their advantages and disadvantages were understood, the objective was to design a new protocol more suitable for networks with nodes moving freely. These networks should be able to be both large and small. Also the traffic pattern was taken into acount to decide the features of each node. Since there was no time to make a quantitative study by means of simulation, only a qualitative analysis was done. Therefore, as future work, should be programed for example in NS-2 to carry out a performance study in comparison with the other protocols already implemented.

REFERENCES

[1] M. Abolhasan, T. A. Wysocki, and E. Dutkiewicz, "A Review of Routing Protocols for Mobile Ad hoc Networks", In Elsevier Journal of Ad hoc Networks, 2, 1-22.

[2] C. E. Perkins, "Ad Hoc Networking", Addison-Wesley, Boston.

[3] C. Perkins, E.Belding-Royer, S. Das, "Ad hoc On-Demand Distance Vector (AODV) Routing", IETF RFC 3561.

[4] "Ad hoc On-Demand Distance Vector (AODV) Routing". November 2002 <draft-ietf-manet-aodv-12.txt>

[5] Benzaid M., Minet P., Al A. K. "Analysis and simulation offast-OLSR". The 57th IEEE Semiannual Vehicular Technology Conference. 3. 1788 – 1792 pp

[6] Benzaid M., Minet P., Al A. K. "Integrating fast Mobility in the OLSR routing protocol". Proceedings of the 4th IEEE Conference on Mobile and Wireless Communications Networks, Stockholm, Sweden.

[7] "Comparative Study of Routing Protocols for Mobile Ad-hoc NETworks". Thomas Heide Clausen, Philippe Jacquet and Laurent Viennot.

[8] C-k Toh, "Ad Hoc Mobile Wireless Networks", Prentice Hall.

[9] I. Chalamtac, M. Conti and J. Liu, "Mobile Ad hoc Networking. Imperatives and Challenges", Ad Hoc Network Journal, Vol. 1 N. 1, January-Feburary- March.

[10] S. Basagni, M. Conti, S. Giordando, and I. Stojmenovic, "Mobile Ad Hoc Networking", IEEE Press & Wiley Inter-Science.

[11] S. Corson, J. Macker, "Mobile Ad hoc Networking (MANET): Routing Protocol Performance Issues and Evaluation Considerations", IETF RFC 2501, January.

[12] "Scenario-oriented *ad* hoc networks simulation with mobility models" Kevin M. McNeill, Yun Zhao, Natalia Gaviria Ralph Martinez & John Deal. MILCOM IEEE Military Communications Conference

[13] hilippe Jacquet et altres. Multicast Optimized Link State Routing. draftietf-manet-olsr-molsr-01.txt, april.

[14] "MPLS implementation in mobile ad-hoc networks (manets)" Sasan Adibi. ECE dept, university of Waterloo

[15] C. Mantelis, "Multicasting in Ad Hoc Networks", Unpublished document. Columbia University, USA. [Electronic] Available: < http://comet.ctr.columbia.edu/~jaekwon/E6768/HarryMantelis-E6768Final.pdf >.

[16] [NS_2] The Network Simulator ns2. http://www.isi.edu/nsnam/ns/

AUTHORS

First Author – Pawan Bhadana, Associate Professor, Department of Computer Engineering, B.S.A. Institute of Technology & Management, Faridabad, India

Second Author – Ritu Khurana, Associate Professor, Department of Computer Engineering, B.S.A. Institute of Technology & Management, Faridabad, India

Third Author – Chanchal, Computer Science & Engineering, B.S.A. Institute of Technology & Management, Faridabad, India

Fourth Author – Manisha, Computer Science & Engineering, B.S.A. Institute of Technology & Management, Faridabad, India