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ENERGY EFFICIENCY IN MOBILE AD -HOC NETWORKING USING CLUSTER HEAD ROUTING PROTOCOL

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1. INTRODUCTION

Mobile ad hoc networks (MANETs) are collection of mobile nodes that intercommunicate on shared wireless channels. The topology [3] of the network changes with time due to mobility of nodes. Nodes may also enter or leave the network. These nodes have routing capabilities which allow them to create multi hop paths connecting node which are not within radio range. The routing protocols can be roughly divided into three categories: proactive (table driven routing protocols), reactive (on-demand routing protocols), and hybrid. The primary goal of such an ad hoc network routing protocol is to provide correct and efficient route establishment between pair of nodes so that messages may be delivered in time. In proactive, each node maintains a routing table, containing routing information on reaching every other node in the network. In order to have this routing information available and update, routing information must be exchanged. Proactive routing protocol use periodic broadcast to establish routes and maintain them. This can cause substantial overhead (due to the “route message” traffic), affecting bandwidth utilization, and throughput as well as power usage. The advantage is that routes to any destination are always available without the overhead of a route discovery.

In reactive, when a node wishes to send packet to a particular destination, it initiates the route discovery process, in order to find the destination. Reactive routing protocol provides a cost-effective solution for packet routing. However, when routes are requested, nodes need to send out route query messages into a large part of the network, which could lead to the delay of route response and potentially [3] a large penalty in network resources. This situation causes throughput loss in high mobility scenarios, because the packets get dropped quickly due to unstable route selection.

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Security is a more sensitive issue in MANETs than any other networks due to lack of infrastructure and the broadcast nature of the network. While MANETs [3] can be quickly set up as needed, they also need secure routing protocols to add the security feature to normal routing protocols. The need for more effective security measures arises as many passive and active security attacks can be launched from the outside by malicious hosts or from the inside by compromised nodes. Key management is a fundamental part of secure routing protocols existence of an effective key management framework is also paramount for secure routing protocols. Several security protocols have been proposed for MANETs, there is no approach fitting all networks, because the nodes can vary between any devices.

However, it would be a difficult and challenging task to offer energy efficient and reliable multicast routing in MANETs. It might not be possible to recharge / replace a mobile node that is powered by batteries during a mission. The inadequate battery lifetime imposes a limitation on the network performance. To take full advantage of the lifetime of nodes, traffic should be routed in a way that energy consumption is minimized. In recent years, various energy efficient multicast routing protocols have been proposed. These protocols have unique attributes and utilize different recovery mechanisms on energy consumption. This project will provide a comprehensive understanding of these multicast routing protocols and better organize existing ideas and work to make it easy to design energy efficient routing in MANETs. The goal of this paper is to help researchers to gain a better understanding of energy-efficient and secure routing protocols available and assist them in the selection of the right protocol for their work. The rest of the paper is [5] organized as follows: this paper represents related work on comparisons and surveys of routing protocols for MANETs. This describes the energy-efficient routing protocols .Last section concludes the paper.

2. PROBLEM DESCRIPTION

MANET is a wireless network that is having no fixed infrastructure. It is a set of mobile devices that can communicate to each other without having cabled network. They also do not need help from network infrastructure for the purpose of communication. There are many real world applications that use [9] Mobile Ad Hoc Networks. Some of them include battlefield applications, rescue work applications, civilian applications like outdoor meeting, money transfers, and ad-hoc classrooms. There are many advantages of ad hoc networks.

However, they also throw security challenges. The security attacks might be internal or external attacks. The internal attacks are generally caused by the colluding nodes in the MANETs. Mobile ad hoc network is made up of nodes that are self-contained and having ability to connect to nearby wireless node and configure them without having dependency on any pre-defined [9] network infrastructure. Fraudulent activities are done by one or more colluding nodes that work together. The colluding nodes try to hide their activities in order to keep their misbehavior remain hidden. Thus the colluding nodes compromise one or more nodes in the network so as to perform fraudulent activities and cause problems in the networks with their internal attacks. The main internal attacks they cause include resource consumption attack, fabrication attack, replay attack and black hold attack. In MANETs, for resource management a cluster is formed that is a set of computers interlinked. These clusters are formed based on the radio range of nodes. In MANETs a cluster-based communication infrastructure is used for broadcasting. It also reduces collision in networking, energy consumption, and delay in packet transmission. It also improves throughput of the network performance of features such as limited bandwidth usage, virtual circuit support and power consumption. In case of pure ad hoc networks, trust management becomes very complicated by central authority and other nodes in the MANET [9] and their inter-dependency. It is very challenging to have trusts calculated from different levels.

Energy consumption is a crucial factor for the designing of energy efficient routing protocols. The basic objectives of MANET routing protocols are to maximize energy efficiency, maximize network throughput, maximize network lifetime and to minimize end-to-end delay in network.

Key challenges in Wireless Ad hoc networks are as follows:

· Limiting power supply

· Dynamically Changing Topology

· Limited Bandwidth

· Security

· Mobility-induced route change

· Battery constraints

Routing is the process of establishing path and forwarding packets from source node to destination node. It consists of two steps: first is route selection and second is delivery of packets to the correct destination. Energy is limited factor in case of Ad-hoc networks. Routing in wireless ad-hoc network has some unique characteristics:

1. Energy of nodes is crucial and depends [10] upon battery which has limited power supply.
2. Nodes can move in an uncontrolled manner so frequent route failure are possible.
3. Wireless channels have lower and more variable bandwidth compare to wired network.

Mostly algorithms are based on the some of the following criterion

· Keeping track of the residual [10] battery power.

· Keeping track of the previously used paths.

· Keeping back-up paths.

· Keeping track of the message overhead.

· On-demand calculation/update of routing tables.

· Sending data packets at a lower energy compared with the RREP/RREQ.

· Moving the nodes to sleep mode when they are not being used.

· Requiring a node to send packets with energy proportional to the distance rather than with fixed energy.

· Using a hierarchical routing technique.

· Using directional antennas.

· Transmitting the data packets by taking into consideration the actual amount of energy required to transmit.

3. LITERATURE REVIEW

In this section we present some of existing works on survey of clustering in MANETs Roberto Carlos Hincapi´e et al have presented [7] a survey on clustering techniques for MANET. They introduced some preliminary concepts that form the basis for the development of clustering algorithms. They also discussed the related clustering issues with the network topology, routing schemes, graph partitioning and mobility algorithms. They also described some of the most popular clustering techniques like Lowest-ID heuristic, Highest degree heuristic, DMAC (distributed mobility-adaptive clustering), WCA (weighted clustering algorithm).They also reviewed several clustering algorithms to organize mobile ad hoc networks in a [7] hierarchical manner and explained their advantages and disadvantages. Ratish Agarwal and

Dr. Mahesh Motwani have reviewed several clustering algorithms to organize mobile ad hoc networks in a hierarchical manner and presented their main characteristics. The survey examined the important issues related to cluster-based MANET, such as the cluster structure stability, the control overhead of cluster construction and maintenance, the energy consumption of mobile nodes with different cluster-related status, the traffic load distribution in clusters, and the fairness of serving as cluster heads for a mobile node.

4. SURVEY ON CLUSTER BASED ROUTING IN MAGNETS

1. Location Based Clustering

In the location-based routing protocol, the location information of mobile nodes are used to confine routing space into a smaller range .It reduces routing overhead [7] and broadcast storm. In Tzay-Farn Shih and Hsu Chun Yen have proposed a cluster-based routing protocol, named Core Location-Aided Cluster-based Routing protocol (CLACR).The characteristics of CLACR are stated as the entire network is partitioned into square clusters. In each cluster, the selection of cluster head is done by a cluster head election algorithm. The number of nodes responsible for routing and data transfer is decreased considerably by the usage of the cluster mechanism. It also diminished the routing overhead and increased the route lifetime massively. The path is computed using Dijkstra algorithm in a cluster-by-cluster basis by the CLACR.

In Biao Zhou et al proposed cluster-based inter-domain routing (CIDR) protocol. The clusters are formed by the affinity of geography, motion, or task. The cluster head acts as a local DNS for own cluster and its [7] neighbor cluster. The advertising protocol acts as the BG protocol. The proposed work routes the packets to remote nodes through cluster head advertised routes and to the local destinations using the local routing algorithm. The experiment results showed that the proposed inter-domain routing has achieved the scalability in large network, the robustness to mobility, and the independency of underlying intra-domain routing protocols.

In Hatem Hammed et al proposed a location enhanced routing protocol for clustered MANETs. In LECBRP, local position information is used to assist routing and to improve the performance of the basic protocol. Cluster formation, adjacency cluster discovery and routing are the three main components of the LECBRP. Cluster formation: A CH is elected by exchanging hello messages between the nodes which wake up in undecided state. When a

CH sends a Hello message to a new undecided node, it joins its cluster. In LECBRP, each node estimates its neighbor's locations and stores it in Location Table (LT).It also stores the relative locations of non-neighbor nodes. Adjacent cluster discovery: Every CH has a Cluster Adjacency Table (CAT) which records information about its entire neighboring CHs. Each node sends a Hello periodically. It contains a neighbor table (NT) and CAT. A CH discovers its adjacent CH using the Hello message alone. In LECBRP the control overhead is much smaller than CBRP, LEOD, and AODV. In Mangai .S and Tamilarasi .A proposed an Improved Location aided Cluster based Routing Protocol (ILCRP) for GPS enabled MANETs. The protocol has three phases namely, cluster formation followed by cluster maintenance and route discovery phase.

2. Mobility Based Clustering

In S. Muthuramalingam et al proposed a modified algorithm that uses Weighted Clustering Algorithm (WCA) for cluster formation and Mobility Prediction for cluster maintenance. In a MANET node management is done by Clustering.

3. Neighbor Based Clustering

In Hui -Yao a et al proposed a Cluster-Based Multipath Dynamic Source Routing in MANET (CMDSR). In this scheme, the hierarchy is used to perform Route Discovery and distributes traffic among diverse multiple paths.

4. Power Based Clustering

In Jehn-Ruey Jiang et al proposed a hybrid PS protocol for an IEEE 802.11-based MANET. The concept of dual-channel and dual-transmission-range clustering is used in the proposed protocol. In their proposed work all the hosts are divided into clusters. In each of the host one is selected as head and the other as the members. Individual clusters are operated using the synchronous PS protocol. Cluster heads are operated using QAPS protocols. The proposed protocol operates on the basis of neighborhood information so adapts to changes in network topology as quickly as possible.

Survey details

Many minimum energy (energy efficient) routing protocols have been proposed in recent years. However, very limited effort has been made in studying routing overhead issues associated with these protocols. Some of them that I referred are:

- http://web.engr.oregonstate.edu/~benl/Publications/Journals/WCMC03.pdf

- http://www.senouci.net/download/Publications/Conferences/Others/Senouci_ICC2004.pdf
- http://www.ee.sunysb.edu/~xwang/public/paper/cross.pdf
- http://scholarworks.sjsu.edu/cgi/viewcontent.cgi?article=1029&context=etd_projects&sei

5. METHODOLOGY + TOOL USED

A successful approach for dealing with the maintenance of mobile ad hoc networks is by partitioning the network into clusters. In this way [8] the network becomes more manageable. It must be clear though that a clustering technique is not a routing protocol. Clustering is a method which aggregates nodes into group's .These groups are contained by the network and they are known as clusters.

A cluster is basically a subset of nodes of the network that satisfies a certain properties. However, the cluster organization of an ad hoc network cannot be achieved offline as in fixed networks. Clustering presents several advantages for the medium access layer and the network layer in MANET. The implementation of clustering schemes allows a better performance of the protocols for the Medium Access Control (MAC) layer by improving spatial reuse, throughput, scalability and power consumption. The purpose of a clustering algorithm is to produce and maintain a connected cluster. In most clustering techniques nodes are selected to play different roles according to a certain criteria.

In general, three types of nodes are defined:

1) Ordinary nodes

Ordinary nodes are members of a cluster which do not have neighbors belonging to a different cluster.

2) Gateway nodes Gateway nodes are nodes in a non-cluster head state located at the periphery of a cluster. These types of nodes are called gateways because they are able to listen to transmissions from another node which is in a different cluster To accomplish this, a gateway node must have at least one neighbor that is a member of another cluster]

3) Cluster heads

Most clustering approaches for mobile ad hoc networks select a subset of nodes in order to form a network backbone that supports control functions. A set of the selected nodes are called cluster heads and each node in the network is associated with one. Cluster heads are

connected with one another directly or through gateway nodes. The union of gateway nodes and cluster heads form a connected backbone. This connected backbone helps simplify functions such as channel access, bandwidth allocation, routing power control and virtual circuit support Since cluster heads must perform extra work with respect to ordinary nodes they can easily become a single point of failure within a cluster. For this reason, the cluster head election process should consider for the cluster head role, those nodes with a higher degree of relative stability the main task of a cluster head is to calculate the routes for long-distance messages and to forward inter-cluster packets. A packet from any source node is first directed to its cluster head. If the destination is located in the same cluster, the cluster head just forwards the packet to the destination node. If the destination node is located in a different cluster, the cluster head of the sending node routes the packet within the substructure of the network, to the cluster head of the destination node. Then, this cluster head forwards the packet to its final destiny .Figure 1 shows different roles of nodes in a mobile ad hoc network organized by clusters.

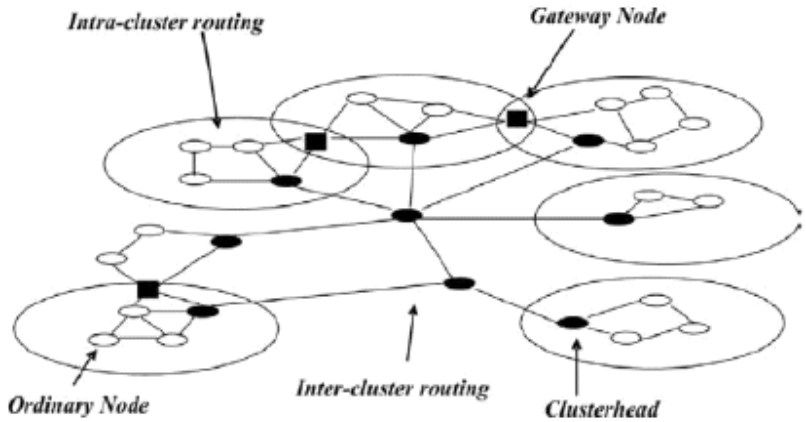
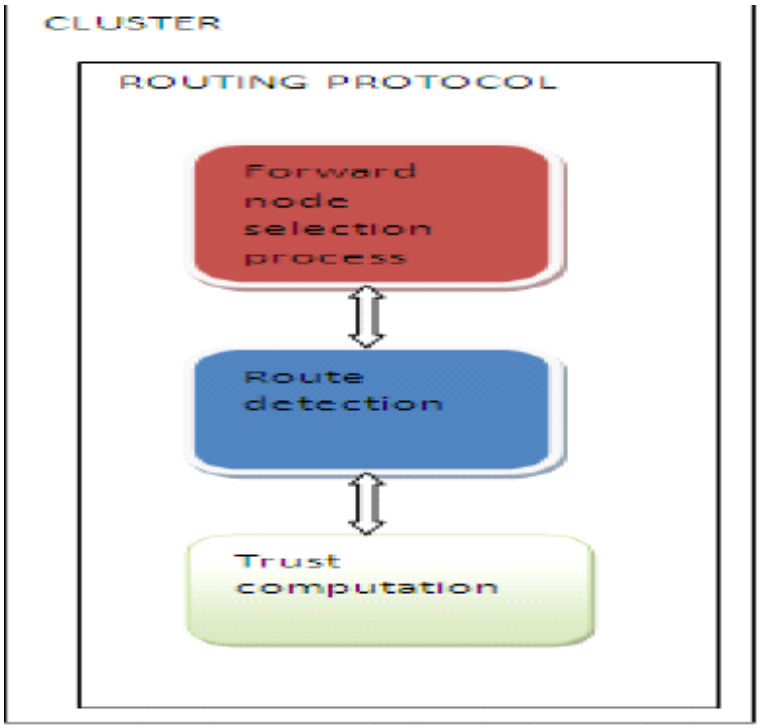


Fig 1. Cluster Configuration of an Ad hoc network and node roles

In summary, choosing an optimal number of cluster heads which will yield high throughput but incur as low latency as possible, is still an important problem. We could have a fully distributed system where all the nodes share the same responsibility and act as cluster heads. However, more cluster heads result extra number of hops for a packet when it gets routed from the source to the destination, since the packet has to go via larger number of cluster heads. Thus this solution leads to higher latency, more power consumption and more information processing per node. On the other hand, to maximize the resource utilization, we can choose to have the minimum number of cluster heads to cover the whole

geographical area over which the nodes are distributed. The whole area can be split up into zones, the size of which can be determined by the transmission range of the nodes. This can put a lower bound on the number of cluster heads required.

Clustering is involved in the architecture of the proposed system that enables trust computation, route [10] detection and forward node selection process.



Route detection component is responsible to choose a route that optimizes communication mechanism. The trust computation is responsible to calculate trust that is central to the proposed application to ensure security

Cluster Formation

The aim of proposed application is to minimize transmission delay, energy consumption, and increase overall throughput of the network . Apart from this the proposed mechanism facilitates the detection of colluding. Broadcasting is used in cluster approach for communication. The MANET described here is a collection independent nodes that are mobile in nature and thus the whole network strives to save the bandwidth and other resources .The cluster formation procedure is shown graphically in fig. 2

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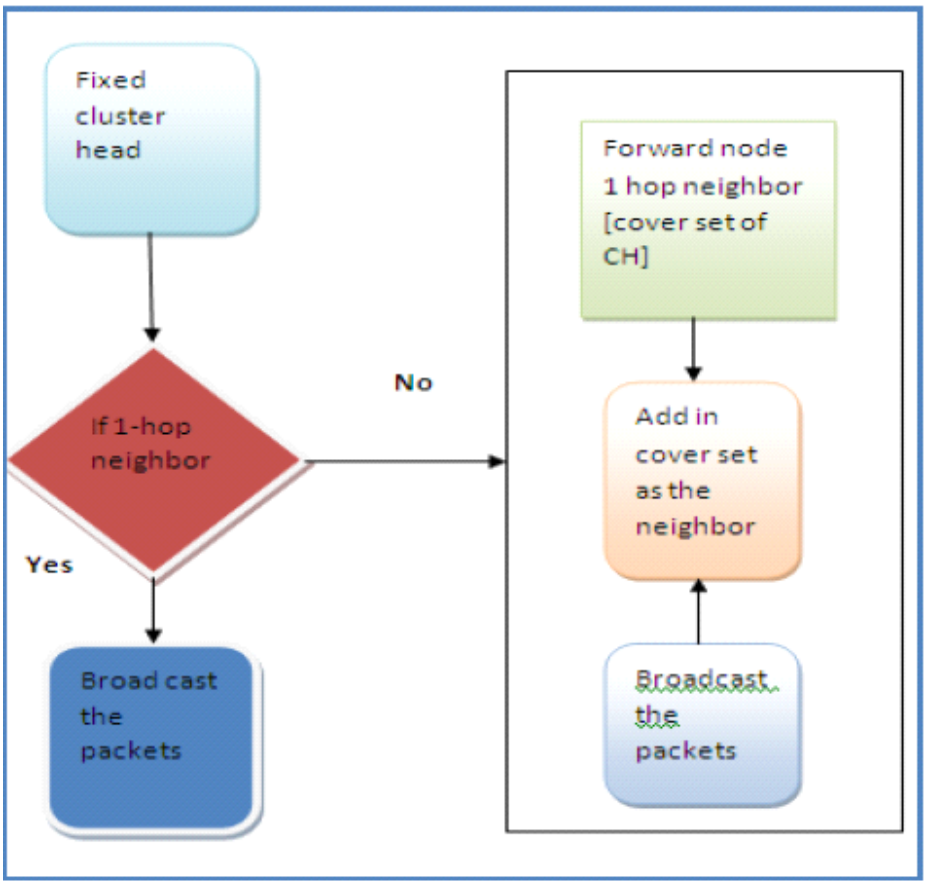

Fig. 2 – Procedure for cluster formation

Forward Node Selection

A node which is one hop neighbor of cluster head is known as forward node. For routing purposes within clusters the forward nodes are used. In order to route between the clusters Gateway nodes are used . Broadcasting of data is performed by cluster heads.

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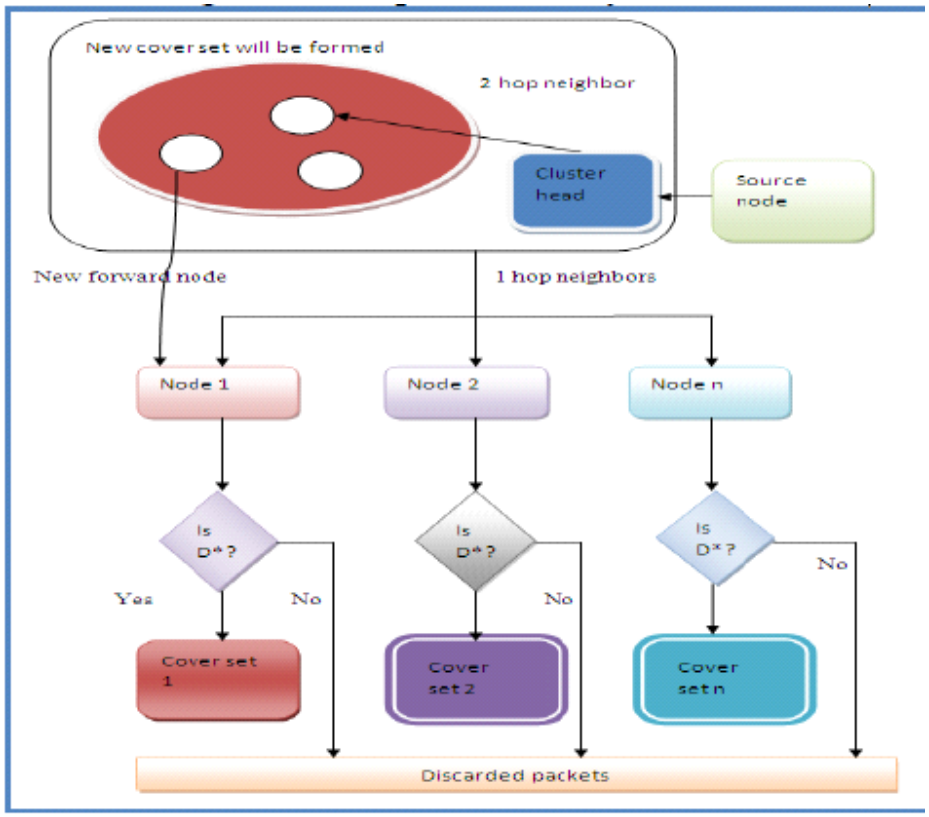

D*=Destination

Fig. 4 – Forward node procedure selection

As can be seen in fig. 4, as soon as a cluster head receives a packet, it forwards to one hop forward node after observing destination. Every forward node has two things known as cover set and neighbor set. One hop neighbors are known as cover sets while other forward nodes are known as neighbor set. When a node transmits a packet, first of all cluster receives packet and then the packet is broadcasted to forward nodes. The path is discarded when the destination id is not found in the cover set of a forward node. The routing information is retrieved by neighbor set and forward set from the cluster head and forwarding nodes.

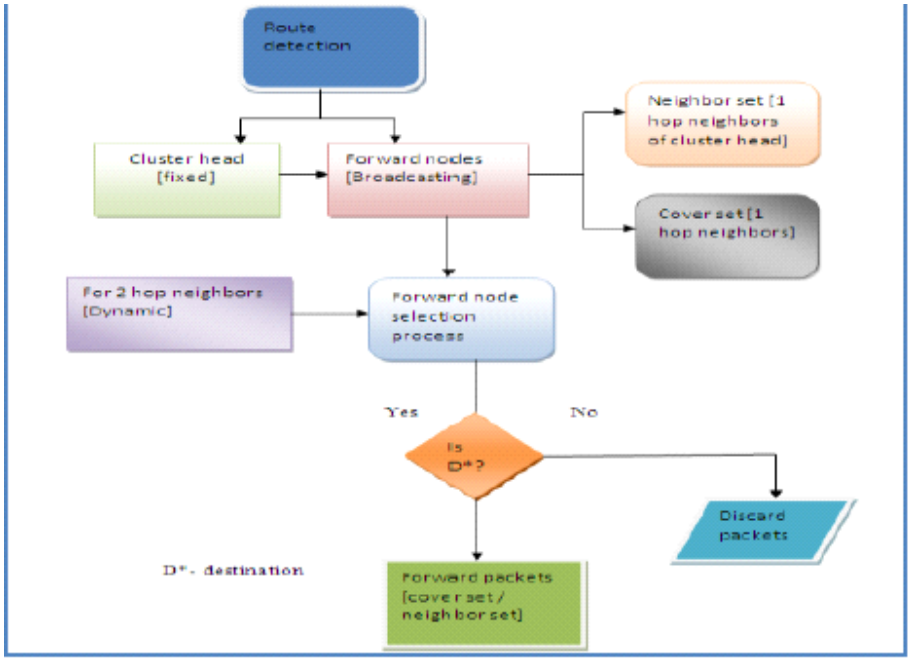

Fig. 5 – Route detection procedure

As can be seen in fig. 5, the route detection is one of the important tasks that are somehow related with trust value computation, energy efficiency and also the clustering mechanism.. The forwarding nodes and cluster head are involved in computation of trust. However, the approach following for hexagonal cluster

formation results in energy efficient way of activities such as route discovery, trust management and other communications involved.

6. TOOL USED

Tool we used to implement the cluster based routing algorithm: **MATLAB**

An energy model framework has developed and simulated in MATLAB with different application scenarios. The results show that the balanced load of the energy consumption and the reliable delivery of data packets achieve an extension of the network lifetime using proposed routing algorithm

MATLAB is a high-performance language for technical computing. It integrates Computation, visualization, and programming environment. Furthermore, MATLAB is a Modern programming language environment: it has sophisticated data structures, contains built-in editing and debugging tools, and supports object-oriented programming. These factors make MATLAB an excellent tool for teaching and research. MATLAB has many advantages

compared to conventional computer languages (e.g., C, FORTRAN) for solving technical problems. MATLAB is an interactive system whose basic data element is an array that does not require dimensioning. The software package has been commercially available since 1984 and is now considered as a standard tool at most universities and industries worldwide.

MATLAB (**mat**rix **lab**oratory) is a numerical computing environment and fourth-generation programming language. Developed by Math Works, MATLAB allows matrix manipulations, plotting of functions and data, implementation of algorithms, creation of user interfaces, and interfacing with programs written in other languages, including C, C++, Java, and Fortran.

Although MATLAB is intended primarily for numerical computing, an optional toolbox uses the symbolic engine, allowing access to symbolic computing capabilities. An additional package, Simulink, adds graphical multi-domain simulation and Model-Based Design for dynamic and embedded systems.

7. OBJECTIVE OF THE PROBLEM

Mobile ad hoc networks (MANETs) are collection of mobile nodes that intercommunicate on shared wireless channels. The topology [3] of the network changes with time due to mobility of nodes. Nodes may also enter or leave the network. These nodes have routing capabilities which allow them to create multihop paths connecting node which are not within radio range. The routing protocols can be roughly divided into three categories: proactive (table driven routing protocols), reactive (on-demand routing protocols), and hybrid. The primary goal of such an ad hoc network routing protocol is to provide correct and efficient route establishment between pair of nodes so that messages may be delivered in time.

We use clustering's structure for routing protocol. Clustering is a process that divides the network into interconnected substructures, called clusters. Each cluster has a cluster head (CH) as coordinator within the substructure. Each CH acts as a temporary base station within its zone or cluster and communicates with other CHs. In our protocol, there are four possible states for the node: NORMAL, ISOLATED, CLUSTERHEAD and GATEWAY. Initially all nodes are in the state of ISOLATED. Each node maintains the NEIGHBOR table wherein the information about the other neighbor nodes is stored CHs have another table (CHNEIGHBOR) wherein the information about the other neighbor CHs is stored. The primary step in clustering is the CH election.

Although establishing correct and efficient routes is an important design issue in mobile ad hoc networks (MANETs), a more challenging goal is to provide energy efficient routes because mobile nodes' operation time is the most critical limiting factor.

8. LIMITATION

LEACH protocol takes into a number of assumptions. This assumption can be considered as its limitation, as these assumptions may not be true for every proposed case.

A few of these assumptions are as follows:

- All nodes can transmit with enough power to reach the base station if needed.
- Each node has computational power to support different MAC protocols.
- Nodes always have data to send.
- Nodes located close to each other have correlated data.
- All nodes begin with the same amount of energy capacity in each election round, assuming that being a CH consumes approximately the same amount of energy for each node.

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