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Review of Manet on Different Clustering Approaches

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Abstract: A new era is dawning for wireless mobile ad hoc networks where communication will be done using a group of mobile devices called cluster, hence clustered network. In a clustered network, protocols used by these mobile devices are different from those used in a wired network; which helps to save computation time and resources efficiently. A mobile ad hoc network (MANET) is a network in which data is transmitted from the sender to the receiver without the need for any infrastructure. In this network, the connected nodes may be in the form of laptops, mobile phones, personal digital assistant (PDA), and so on, and any node can work as a router that receives and sends packets [1]. In an ad hoc network, the delay of route traffic can be minimized by the clustering technique, and network performance, as well as data transfer control, can be improved by the selection of the routing protocol type [2]. This survey investigates the effect of using the clustering technique in ad hoc networks and how this technique can increase resource savings and decrease time delay. It also describes clustering, cluster structure, cluster linking type, and the different types of clustering algorithms used in cluster head selection and their effects on MANETs.

Keywords: MANET, WSN, Optimization, Clustering.

INTRODUCTION

A wireless mobile ad-hoc network is a group of mobile devices that forms a network which does not require the usage of wires or cables for communication. Mobile nodes in this network are able to detect the presence of nodes that are in close proximity. Due to the limited transmission range of wireless network interfaces, multiple networks “hops” may be needed for one node to exchange data with another across the network. Wireless ad-hoc networks have some properties such as the dynamic network topology, limited bandwidth, and energy constraint in the network. A mobile ad hoc network (MANET) consists of a number of mobile nodes that jointly function as a router. A MANET can be created dynamically without any infrastructure. In this network type, the use of the clustering technique significantly reduces the routing traffic that occurs during the routing process. Clustering is used to divide an ad hoc network into small sets of nodes, with each cluster consisting of a cluster head, ordinary nodes, and gateway nodes. Clustering can be used for the effective utilization of resources for large ad hoc networks. This survey explores the main clustering mechanisms for selecting cluster heads in ad hoc networks. The mechanisms include the lowest degree ID algorithm (LDID), highest degree ID algorithm (HDID), dynamic mobile adaptive clustering (DMAC), and weighted clustering algorithm (WCA). Different types of routing protocols are used to evaluate the performance of this network type with and without clustering. According to [4,5], sensor nodes are dynamic in nature also and are limited in the communication range and computing power. The energy of sensor nodes gets reduced while communicating with other nodes or the base station. These nodes get converted into dead nodes from the alive nodes, which can make the network less energy efficient. Making clusters of the sensors is one of the possible solutions to deal with this issue as this can make the network more scalable and energy efficient. In cluster based routing, a network is divided into a number of clusters and within each cluster, a cluster head is elected based on some pre-decided parameter. Cluster Head nodes in clusters have more energy as compared to non-clusterhead nodes. So, to balance energy level of the network, we propose Flower Pollination Algorithm (FPA) which gives more energy efficient network as compared to existing approaches.

Fig.1 shows all the nodes connected in the ad hoc network without clustering, and Fig.2 shows the same network with clustering.

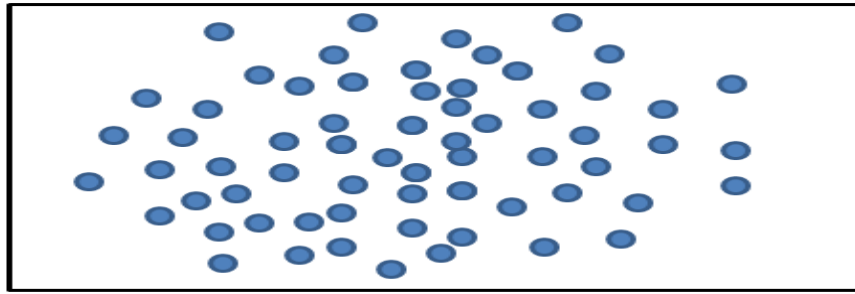


Figure.1: Ad hoc network without cluster

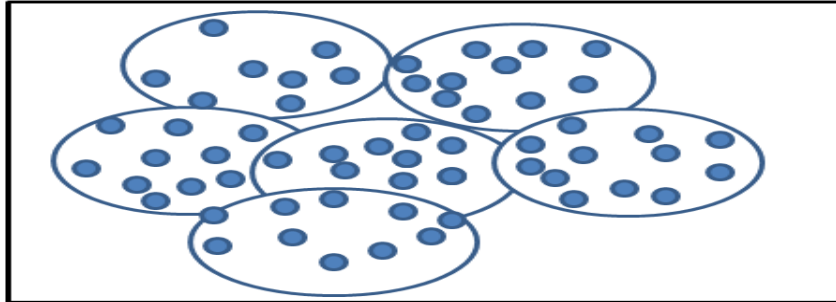


Fig.2. Ad-hoc network with cluster

CLUSTERING

Clustering is one of the most popular techniques used to reduce traffic in routes and minimize energy consumption in large wireless networks by collecting the nodes into groups called clusters. In the clustering algorithm, the agent node of each cluster is called the (cluster head), which is responsible for finding a suitable route for any node in his cluster; the other node that serves as an intermediary for any communication in the cluster is called the gateway. The remaining nodes in the network are called ordinary nodes [9],

As shown in Fig. 3.

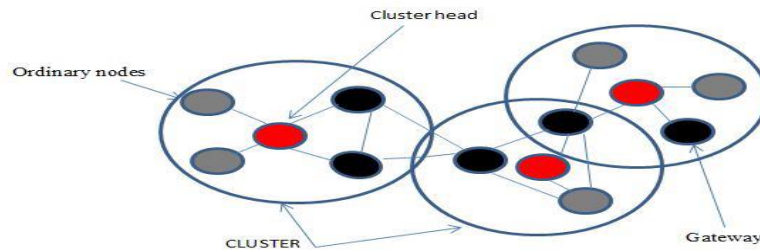


Figure 3: Clustering in MANET

The choice of cluster head depends on different algorithms. To satisfy the requirements of MANETs, any cluster must be verified using the following properties:

1. Any ordinary node must be a neighbor to at least one cluster head.
2. Any ordinary node must be a neighbour to the cluster head with the bigger weight.
3. No two cluster heads can be neighbours [10].

CLUSTER STRUCTURE

Two methods can be used to arrange the cluster structure.

A- Connectivity-based method: network cluster is arranged based on the number of connectivity for each node in the network. The node with the highest number of neighbour nodes is selected as the cluster head. In this case, if the cluster head loses a neighbour node, its connectivity decreases, and other nodes can be selected as a cluster head.

B- Identifier-based method: this method depends on the ID of each node. If a node has the lowest/highest ID in its group, it is automatically selected as the cluster head [11].

CLUSTER LINKING TYPES

Cluster links are classified into two types based on the nature of connectivity, As shown in Fig. 4.

A- Bidirectional link: a cluster link is bidirectional if a two-directional link exists between two nodes of neighbour clusters or if two opposite unidirectional links are found between two different nodes of two different clusters.

B- Unidirectional link: a cluster link is unidirectional if only one unidirectional link exists between two nodes.

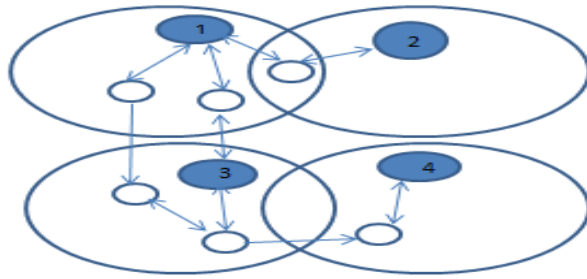


Fig. 4. Bidirectionally linked clusters 1, 2 and 1, 3, Unidirectional linked clusters 3, 4

APPROACHES FOR CLUSTER HEAD SELECTION

Several clustering approaches are used to select cluster heads in ad hoc networks. The cluster head is responsible for keeping the routing information and managing the network nodes. Existing approaches elect the cluster head based either on the IDs of the network nodes or on the location information of the nodes. As shown in Fig.5, the existing approaches for cluster head selection are the LDID, HDID, DMAC, and WCA. Each approach comprises properties and steps for cluster head selection.

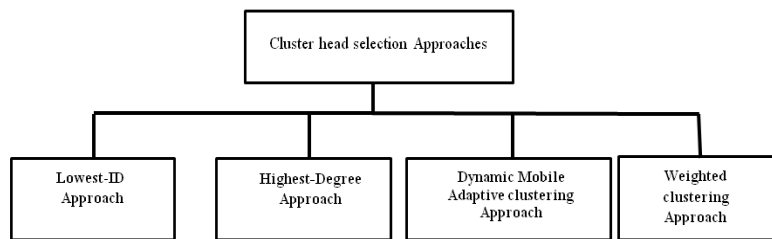


Figure 5: Cluster Head Selection Approaches

A-Lowest ID Approach (LDID): LDID clustering is one of the most commonly used clustering schemes in ad hoc networks. The main idea of this algorithm is that the node with the lowest ID in its group is selected to be the cluster head of this group. The selected cluster head manages all communications and maintains all routes of the nodes. As shown in Flowchart 1, the main steps of the LDID process are as follows [12].

B-Highest Degree Approach (HDID): The HDID approach is known as connectivity clustering. The HDID is one of the oldest clustering algorithms used for MANETs. It involves three types of nodes: cluster head, gateway, and ordinary node. The main function of a cluster head is to manage the connectivity traffic of the nodes in the cluster.

C. Dynamic Mobile Adaptive clustering (DMAC): DMAC is a modified version of the dynamic clustering algorithm (DCA), which is used professionally when the movement of nodes is slow [15]. However, DMAC is better than DCA because it can achieve a high performance even for ad hoc networks with high-speed movement.

D. Weighted Clustering Approach (WCA): This approach considers many factors, such as the power of transmission, the degree of each node, and battery power for each node. All of these factors must be used in cluster head selection. The WCA always uses a specific threshold to identify the number of nodes in a cluster and consequently ensure the successful operation of the medium access control (MAC) protocol

ROUTING PROTOCOLS

Routing is the act of carrying a piece of information from a source to a destination in an internetwork. An encounter of a minimum of one intermediate node inside the Internet occurs in this process. Given that routing has already been employed in networks since the 1970s, this concept is no longer a novelty in the field of computer science. However, the concept of routing has slowly been gaining popularity since the mid-1980s. Despite being less complicated and functional in homogeneous environments, high-end and large-scale internetworking shows the most updated development. Fundamentally, the routing concept deals with two activities: making sure that routing paths are optimal and moving the information groups, specifically referred to as packets, along and across an internetwork. The latter is called packet switching, which is easy to understand; by contrast, path determination can become complicated. Routing protocols adopt several metrics for calculating the best path before the packets are sent to their intended destination. These metrics are standard measurements using a number of hops, which are normally used by the routing algorithm to decide on the optimal path that should be used by the packet to reach its destination. The path determination process suggests that routing algorithms kick-start and retains the routing tables, which contain the entire packet route information that varies across routing algorithms. Routing tables contain a wide range of information generated by routing algorithms. The most common entries in the routing table come in the form of IP address prefixes and the next hops. Routing table destination or next hop associations suggest to the router that a destination can be reached in an optimal manner by sending the packet to a router while representing the "next hop" on its way to the final destination. The IP address prefix searches for a set of destinations for which the routing entry is valid. Switching is relatively simpler than path determination, in which a host is determined to send some packets to another server. The host is needed by the router address and sends the packet addressed specifically to the writers of the MAC address; the packet

comes with the protocol address of the host to the given destination. The protocol address is then analysed by the router and verified in terms of whether such address knows how the data will reach the destination. If the answer is positive, then the packet is forwarded to its destination; if the answer is negative, then packet would be dropped. Routing is subcategorized into static routing and dynamic routing. Static routing indicates the routing strategy stated through a static and manual manner in the router. This kind of routing keeps intact a routing table that is typically written by a network administrator, and it does not rely on network status or on whether the destination is found active or otherwise. Dynamic routing is the routing strategy that is learned by either the interior or the exterior routing protocol. This strategy largely depends on the state of the network, which means that the routing table is affected by the destination in an active manner. One great flaw of static routing is that when a new router is introduced or extracted from the network, the administrator is tasked to revise the changes in the routing tables. However, such is not the case with dynamic routing, in which each router is confirmed to be present through the flooding of the information packet into the network; every router within the network is subsequently propelled to learn about the “new visitor” and its entries [19].

ROUTING PROTOCOL CLASSIFICATION

Many types of multi-path routing protocols are used for ad hoc networks [20]. These routing protocols are either table driven routing protocols (proactive routing protocols) or on-demand routing protocols (reactive routing protocols). Many routing protocols are hybrid and contain combined attributes of both proactive and reactive routing protocols. Proactive routing protocols update their routing tables periodically when a request is made to forward a message through the routes available in the routing table. In reactive routing, when a request for a route is received, the searching process is performed to find a route. In the route search process, the reactive routing protocols find multiple paths for the same source and destination pair. One out of these multiple routes is then selected to forward messages to the destination node.

Figure 6 shows the classification of routing protocols.

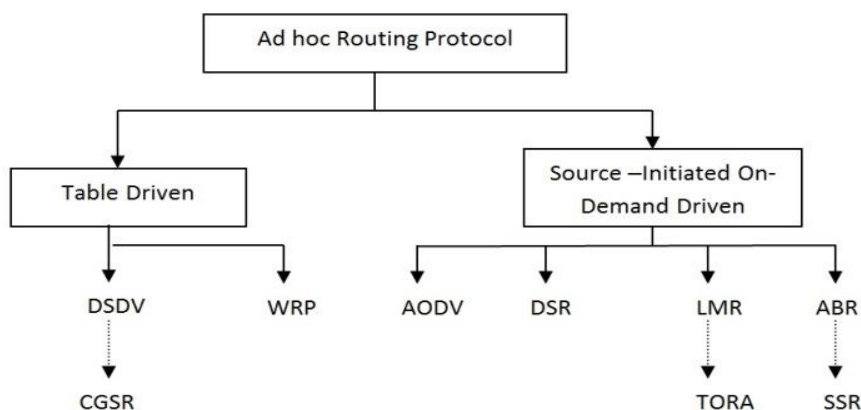


Fig. 6 Classification of ad hoc routing protocols

A-Cluster-based Routing Protocol (CBRP):

The cluster-based routing protocol (CBRP) was first presented in 1999 by Jiang. In this type of routing protocol, wireless network nodes are divided into a number of disjoint and overlapping clusters. Each cluster selects one of its nodes to be a cluster head. This type of node is responsible for the routing process. The cluster heads are capable of communicating with one another using gateway nodes. Another type of cluster node is a gateway, which is defined as a node with two or more cluster heads as its neighbours. The clustered technique leads to little traffic because any route request is passed between cluster heads only and passing through the entire network is not necessary [21].

B- Ad hoc On-demand Distance Vector (AODV):

AODV is one type of demand routing protocol. In AODV, routes are established only when needed to reduce traffic overhead. AODV can efficiently repair link failures. The AODV algorithm allows multi-hop routing between system nodes, which are necessary to establish an ad hoc network. AODV also allows mobile nodes to quickly find routes that are available in active communication for any destination node. In AODV, each node has an equal distance to every other node in the network. Thus, every node maintains a routing table with all known nodes. When a node in an active communication circle loses its communication with the other nodes, it can either repair the route locally by sending a route request to find a new route to the destination node or send a route error, which indicates that the destination node is unreachable. However, the main problem of AODV is the “count to infinity” phenomenon.

C- Dynamic Source Routing (DSR): is an on-demand routing protocol. In this protocol, the sequence of nodes that are needed for packets to be transmitted is calculated and processed in the packet header. When packets are sent, the route cache within the specific node is compared with the actual route. If the result is positive, then the packets are forwarded. Otherwise, the route discovery process is initiated again. In other words, the source node specifies the entire route to be followed by a packet and not only the next hop. When the source node does not have a route, it sends a route request to any node that has a path to the specific destination or a route reply to the source node when it can reach such destination. This reply contains the full path embedded in the route request packet. The main advantage of DSR is that private mechanisms are not necessary to reduce loops. Route caching, which is used in

DSR, can be used to eliminate the overhead of route discovery. However, DSR also has several disadvantages, such as collisions between numerous route requests made by neighbour nodes [19].

D- Destination-Sequenced Distance Vector (DSDV): is a table-driven routing protocol that adds a sequence number to distance-vector routing and keeps all short duration changes. In this protocol, each node transfers its own routing table updates, important link status changes, and its sequence numbers to other nodes periodically. When two routes to a destination node are received from two different nodes, the one with the highest destination sequence number is selected. However, if the two numbers are equal, the one with the smaller hop count is selected. DSDV always reduces the overhead of control through the incremental update and settling time. In DSDV, the routes are maintained by periodic exchanges with the routing table. The settling time and incremental dumps are also used to reduce the overhead of DSDV control. DSDV maintains only the best path instead of maintaining multiple paths to every destination. Therefore, the amount of space in the routing table is reduced, and the table can be used to avoid extra traffic with incremental updates instead of full dump updates. The count-to-infinity problem is also reduced in DSDV [22].

MANET Features

Autonomous terminal. In MANET, each mobile terminal is an autonomous node, which may function as both a host and a router. In other words, besides the basic processing ability as a host, the mobile nodes can also perform switching functions as a router. So usually endpoints and switches are indistinguishable in MANET.

- **Distributed operation.** Since there is no background network for the central control of the network operations, the control and management of the network are distributed among the terminals. The nodes involved in a MANET should collaborate amongst themselves and each node acts as a relay as needed, to implement functions e.g. security and routing.
- **Multihop routing.** Basic types of ad hoc routing algorithms can be single-hop and multihop, based on different link layer attributes and routing protocols. Single-hop MANET is simpler than multihop in terms of structure and implementation, with the cost of lesser functionality and applicability. When delivering data packets from a source to its destination out of the direct wireless transmission range, the packets should be forwarded via one or more intermediate nodes.
- **Dynamic network topology.** Since the nodes are mobile, the network topology may change rapidly and unpredictably and the connectivity among the terminals may vary with time. MANET should adapt to the traffic and propagation conditions as well as the mobility patterns of the mobile network nodes. The mobile nodes in the network dynamically establish routing among themselves as they move about, forming their own network on the fly. Moreover, a user in the MANET may not only operate within the ad hoc network but may require access to a public fixed network (e.g. Internet).
- **Fluctuating link capacity.** The nature of high bit-error rates of wireless connection might be more profound in a MANET. One end-to-end path can be shared by several sessions. The channel over which the terminals communicate is subject to noise, fading, and interference, and has less bandwidth than a wired network. In some scenarios, the path between any pair of users can traverse multiple wireless links and the link themselves can be heterogeneous.
- **Light-weight terminals.** In most cases, the MANET nodes are mobile devices with less CPU processing capability, small memory size, and low power storage. Such devices need optimized algorithms and mechanisms that implement the computing and communicating functions

MANET Challenges

Regardless of the attractive applications, the features of MANET introduce several challenges that must be studied carefully before a wide commercial deployment can be expected. These include:

- **Routing.** Since the topology of the network is constantly changing, the issue of routing packets between any pair of nodes becomes a challenging task. Most protocols should be based on reactive routing instead of proactive. Multicast routing is another challenge because the multicast tree is no longer static due to the random movement of nodes within the network. Routes between nodes may potentially contain multiple hops, which is more complex than the single hop communication.
- **Security and Reliability.** In addition to the common vulnerabilities of wireless connection, an ad hoc network has its particular security problems due to e.g. nasty neighbor relaying packets. The feature of distributed operation requires different schemes of authentication and key management. Further, wireless link characteristics introduce also reliability problems, because of the limited wireless transmission range, the broadcast nature of the wireless medium (e.g. hidden terminal problem), mobility-induced packet losses, and data transmission errors.
- **The quality of Service (QoS).** Providing different quality of service levels in a constantly changing environment will be a challenge. The inherent stochastic feature of communications quality in a MANET makes it difficult to offer fixed guarantees on the services offered by a device. An adaptive QoS must be implemented over the traditional resource reservation to support the multimedia services.
- **Internetworking.** In addition to the communication within an ad hoc network, internetworking between MANET and fixed networks (mainly IP-based) is often expected in many cases. The coexistence of routing protocols in such a mobile device is a challenge for the harmonious mobility management.
- **Power Consumption.** For most of the light-weight mobile terminals, the communication-related functions should be optimized for lean power consumption. Conservation of power and power-aware routing must be taken into consideration.

LITERATURE SURVEY

Edwin Prem Kumar Gilbert [2004]: ad hoc wireless Networks (WSN) are used in a diversity of fields which involves military, healthcare, environmental, biological, home and other commercial uses. With the massive progression in the field of set computer

and sensor technology, ad hoc wireless Networks (WSN), which consist of various thousands of sensor nodes which are efficient of sensing, activating, and transmitting the collected information, have made extraordinary influence everywhere. This paper presents a summary of the several research problems in WSN based applications [1].

Peter Corke et al [2003]: This paper is apprehensive with the use of ad hoc wireless network (WSN) technology to long-duration and large-scale environmental monitoring. The holy grail is a structure that can be employed and functioned by domain specialists not engineers, but this residue some distance into the future. They present our views as to why this field has advanced less quickly than many anticipate it would more than ten years ago. They use real examples taken from our own work in this field to suggest the technological complexities and limitations that are required in meeting end-user needs for information collect systems. Security and capacity are main concerns and impact the design choices for structure hardware and software. They concluded with a consideration of long-term limitation for WSN technology in environmental observing and framework their view point of the future[5].

RanjanaThalore et al [2005]: Energy competent protocol design for ad hoc wireless Networks (WSNs) is a very demanding task for the reason that of inadequate battery ability of nodes. This need for energy efficient procedure of a WSN has provoked the expansion of new protocols in all layers of the communication stack. Layer wise deployment of densely deployed nodes to efficiently lengthen the overall network life is presented in this paper. Simulation is done in QualNet 6.1 network simulator. A successful number of layers as well as effective node density over a ground is also investigated to attain energy proficient design. Layering helps the network to work for a long time as only one layer in the network is in action at a time, rest layers are completely sleeping. Also, sensor nodes in ML-MAC (Multi-Layer MAC) have a very short listening time that minimizes the energy utilization throughout the communication. The outcome is used to create a parameter estimator through MATLAB[7].

Mohammad Daneshzand et al [2001]: Most uses dealing with ad hoc wireless networks require an approach to minimize energy use. A single node in ad hoc wireless network has a definite amount of battery, in which in some applications is important for a scheme to have stable nodes with the capability of working properly. One of the current algorithm to have an energy well-organized topology is to use human's cells regeneration procedure as an inspiration of a ad hoc wireless network models. Here we proposed a new energy efficient topology based on how human's brain cells (neurons) will participate in doing a task while a group of these cells might be deactivated. There are approximately 10 billion neurons that can be measured as nodes of a very huge ad hoc wireless network. How these neurons or nodes work jointly to carry out a task although they know brain uses a small quantity of energy, is an appealing motivation used in their anticipated energy competent ad hoc wireless network.]: ad hoc wireless networks (WSN) are existing receiving important attention because of their immense perspective. Hence, it is still very early in the lifetime of such systems and many research limitations exist. In this brief paper concentrate on six key research limitations for ad hoc wireless networks. Author conclude with a precisely indicate a number of other research limitation that must be met before WSN become prevalent [8].

SukhchandanRandhawa [2009]: Ad hoc wireless network (WSN) has significant uses alike remote environmental supervising and target tracking. This has been authorized by the possibility, specifically in current years, of sensors that are smaller, cheaper, and intelligent. These sensors are supplied with wireless interfaces with which they can communicate with one another to form a network. The design of a WSN relied more importantly on the application, and it must recommend factors alike the environment, the application's design goals, cost, hardware, and system challenges. The main motive of the survey is to present a inclusive review of the current literature in ad hoc wireless network. This paper reviews the major advancement and new research limitation in this research area[9].

EikoYoneki, Jean Bacon [2007]: Author reports current trends in ad hoc wireless network study involving a summary of the several classifications of WSN, a research of WSN technologies and a discussion of current research prototypes and industry uses. They focal point is on middleware technology and explains brief of some recent research prototypes, then address limitations and future approaches on the middleware. This research highlights that middleware requires delivering a common interface for several operational elements of WSN: identification and data collection, signal processing, data aggregation, and notification [10].

Mohammad Rakibul Islam [2006]: Energy organized data transfer is one of the main factors for energy competent ad hoc wireless network (WSN). In this paper, an energy well-organized supportive method is proposed for a WSN where preferred numbers of sensors at the transmit end are used to form a MIMO formation wirelessly related with selected number of sensors at the receiving end. The selection of nodes in the transmitting end is based on a selection work which is a grouping of channel condition, exceptional energy; inter-sensor distance in a cluster and geographical location while the selection in receiving side is performed on the basis of channel condition. Energy models are evaluated for associated circumstances. Experimental outcome prove that the selected MIMO configuration surpass the unselected MIMO in terms of total energy utilization and therefore in energy efficiency[12].

Mohammad Daneshzand et al [2001]: Most users dealing with ad hoc wireless networks require an approach to minimize energy use. A single node in ad hoc wireless network has a definite amount of battery, in which in some applications is important for a scheme to have stable nodes with the capability of working properly. One of the current algorithm to have an energy well-organized topology is to use human's cells regeneration procedure as an inspiration of a ad hoc wireless network models. Here we proposed a new energy efficient topology based on how human's brain cells (neurons) will participate in doing a task while a group of these cells might be deactivated. There are approximately 10 billion neurons that can be measured as nodes of a very huge ad hoc wireless

network. How these neurons or nodes work jointly to carry out a task although they know brain uses a small quantity of energy is an appealing motivation used in their anticipated energy competent adhoc wireless network [14].

CONCLUSION

The future of ad-hoc networks is really appealing, giving the vision of “anywhere, anytime” and cheap communication. This survey shows that the clustering algorithm can be used to reduce routing traffic by dividing the network into a number of clusters. The results of this study prove that the CBRP has a moderate packet delivery ratio and has the best throughput, even when the network size is increased. The rapid developments in the field of ad hoc networking allow the nodes to form a self-creating, self-organizing and self-administering wireless network. Its intrinsic flexibility, lack of infrastructure, ease of deployment, auto configuration, low cost and potential applications makes it an essential part of future pervasive computing environments. This review aims to discover ad hoc network architecture, application, features and also mentions about various challenging issues and provides the feasible solution based on new technology. Considering all findings, we conclude that if we use optimization techniques in cluster head selection process then network becomes more stable which enhance the performance of ad hoc networks.

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