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An Intelligent Routing Protocol for MANETs with Efficient Weighted Clustering and Twin-cluster Heads

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Abstract: Mobile Ad hoc Networks (MANET) consisting multiple number of nodes having the feature of wireless communication and networking capability. These nodes are able to communicate with each node irrespective of its frequency range. Being the self-organizing nature, these networks can be formed as well as deformed easily and quickly without installing any centralized infrastructure. These networks have the highest mobility and routes to be updated frequently to ensure that the connections are newer one. The best performance guaranteeing routing protocol is Cluster Based Routing Protocol (CBRP). However, the CBRP has been suffering to sustain its performance due to poor responses from the cluster heads. To overcome this challenge, it is proposed an Intelligent Cluster Based Routing Protocol(ICBRP) having the feature of dualcluster heads which ensures the firmness of clusters and a novel technique for clusterhead selection employing enhanced weighted clustering process. Also, the dualcluster heads are optimized and allowed to work together with better understanding regarding increasing the performance level of clusters, solidity and extension of network lifetime.

Keywords: Mobile Ad hoc Networks, CBRP, Clustering, clusterhead, Routing, Intelligent, Stability

1 Introduction

Everyone prefer networks such as Mobile Ad hoc Networks since which do not require any base station for basic communication and data transmission and can be established quickly [1]. The nodes in Mobile Ad hoc Networks are performing both host and routing functions such as packet generation and forwarding the packet through appropriate routes. Since there is no wired or wireless communication infrastructure, Mobile Ad hoc Networks do not depend on any specific routers for route discovery and routing. Therefore, the nodes have cooperative nature in establishing the connections on the fly [2,3]. It capable of finding the routes, forwarding the packets and better manages the network traffic in distributed fashion over dynamic and multi-hop connections.

In such networks having the feature of decentralized communication and rapid deployment it better suits for battlefield, disaster rescue operations, and military applications involving voice as well as video communication to share maps and data during battle. At the same time have considerable commercial applications due to development of low cost and power mobile devices and people want to be in touch all the time. The importance of Mobile Ad hoc Networks have been increasing as there are many wireless communication standards developed such as Bluetooth and HomeRF etc. This enables Mobile Ad hoc Networks have become the main platform for ubiquitous computing. The communication between any mobile nodes involves smaller to longer path and may pass through multiple hops. Due to mobility of intermediate nodes there is a chance of frequent disconnection among nodes and lead to a fresh route discovery process and updating of route information in the memory. Some nodes are intelligent enough to carry the local repairing of the routes [4,5].

In this situation, Mobile Ad hoc Networks are expected to come out of the problem with low latency and better accuracy in finding the new and stable routes otherwise the Quality of Service(QoS) of the networks would be lost which is very critical in realtime applications or delay sensitive applications [6]. When the network size increases, the flat routing protocols are not able to scale better with respect to its performance. An arrangement of flat routing such as Dynamic Source

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Routing (DSR) protocol works on the principle of flooding route request by source nodes on its own and intended destination nodes give routes reply in the reverse path. Dynamic Source Routing (DSR) protocol performance is consistent for the smaller networks but for the large networks, the performance is degraded due to more population of nodes, longer routes among the nodes, less utilization of bandwidth and more delay [7]. The topology is using clustered architecture is better in scalability when compared to the traditional flat routing schemes since it has overflowing traffic under control.

Mobile Ad hoc networks are popular and have been widely used in the field of medical, industrial, battle-field and hotspot etc. This network has the advantage working without any infrastructure. The nodes are self-organizing and start working on its own. One of the main challenging issue in designing a Mobile Ad hoc Network is finding a right path for communication when node movements are normal and high. When frequent movement of the nodes takes place, there is a break in the connections and establishing new connections involves considerable amount of time, energy and bandwidth [8,9,10]. The ideal choice for routing in a Mobile Ad hoc network is cluster based routing protocol. This uses the principle of cluster formation, clusterhead selection and maintenance of clusters. Its clusterhead selection process plays a vital role in delivering the performance. The requirements for clusterhead selection are mobility nature of the nodes, energy of the nodes and density of node connections. Due to mobility characteristics of Mobile Ad hoc Networks, frequent connection losses, route discovery and quick draining of clusterhead energy leading for a new election of clusterhead. This leads to considerable amount of delay and throughput degradation till bringing the network to a stable state [11,12,13]. Distributed weighted clustering is mostly employed technique in clusterhead selection.

The proposed work of enhanced weighted clustering algorithm reduces the energy requirement and improves the network lifetime to a significant level because of incorporating dualcluster heads. The main idea of introducing the dualcluster heads to share the communication loads appropriately and extend the network lifetime, increase the utilization of network resources and guarantee the QoS. Our proposed Intelligent Cluster Based Routing Protocol is evaluated through the measurement of performance parameters such as delay, throughput, network lifetime and average energy with the help of simulation. The related work, intelligent and improved algorithm, dual clusters, performance metrics measurement and clustering comparison through simulation and conclusion are discussed in sections 2, 3, 4, 5 and 6 respectively.

2 Related Works

Most of the wired network is designed by considering the performance parameter such as throughput and it is maintained at maximum value while keeping other performance parameter delay at minimum value. It is not the case when it comes to Mobile Ad hoc Networks, which is a kind of wireless networks having self-organizing, able to communicating and routing even when it is having high movement of nodes. These features of Mobile Ad hoc Networks lead to frequent break of connections, repairing a connection and making a new connection, which involves significant amount of energy spent[14]. There may be a situation that there is no energy available for basic communication. This issue in Mobile Ad hoc Networks is motivated many researchers to do research by keeping an energy and interference is one of the major constraints when it comes to advanced applications which have high number of nodes with mobility characteristics [15].

The enhancement of energy efficiency in Mobile Ad hoc Networks is tried by implementing efficient communication layer mechanism at various levels. But many researchers have chosen hardware component of communication process as the key to improve the energy efficiency. For example introducing an advanced VLSI communication processor, it consumes less power, involves less power losses and power aware modulation supported apart from having the feature of versatile power saving modes. Further the scope of increasing the power efficiency can be achieved in terms of enhancing node architecture and its suitable selection of software components such as firmware, operating systems and type of applications. It is automatically suggested that there is a tremendous scope for researchers to enhance the power efficiency in specializing over network layer protocols [16]. Another emerging routing technique in Mobile Ad hoc Networks is considering energy as major metrics for route selection because of much advancement in wireless node design in terms of size, various energy requirements and communication capabilities.

The major overhead in mobile Ad hoc routing is maintenance of routing table since frequent movement of nodes leads to break in connections and need to establish fresh connections through route discoveries and its new route information to be updated in the routing table while deleting the stale routes. Now the network designers are keen to include routing technique which is highly stable. A stability is nothing but guaranteeing the reliability of the connections and life of the connections are quite longer [17]. To support stable routing, the intelligence of power management is required such that the adequate power is available with the nodes and are performing the communication for longest time with the specific range and connections. This kind of routing has not been taking account of important metrics of the network like the proposed protocol. A comparison between direct routing protocols which has the ability to communicate with the gateway nodes freely and less energy spending routing protocol which manages the power of transmission very well is analyzed. The performance of direct routing protocol is much better than the less energy spending

routing protocols [18]. It proposed work is also aligned to direct routing protocol by means of considering the energy which may be required for data collection, processing and efficient routing management.

The comparison of three power aware routing protocol is performed. In this protocol the maximum power efficiency is achieved by considering remaining battery power, stability of the links and the power of transmission appropriately [19,20]. The routing load of the network is uniformly distributed among various connections such that the network lifetime are getting increased. In our proposed work in addition to extending the network lifetime, the latency and throughput is enhanced considerably. We compare the performance of position based routing protocols which has the feature of having stronger network connections, it is not only that we select route which is energy efficient but also considers other important metrics such as position [21]. In cluster based approach of routing, the selection of cluster member, gateway nodes and defining its hierarchy have complexity. However, if try to adopt a better scheme in managing the cluster members, selection of cluster heads and gateway leads to simpler [22]. This can guarantee the support of scalability.

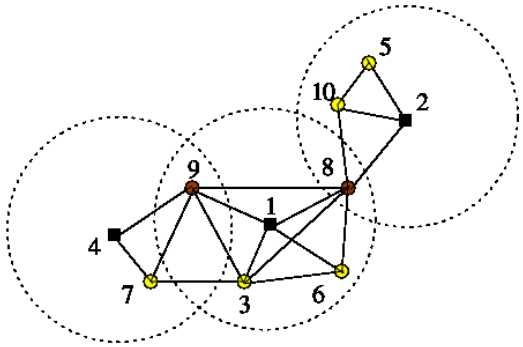

Fig. 1: Lowest ID clustering algorithm

The cluster based protocols with hierarchical routing is employed since long time. It may have the feature of distributed and connected cluster architecture with flexibility of networks. Due to more mobile nodes, having multi-hop connections and supporting multimedia applications, it is presently called as Mobile Ad hoc Networks or multimedia wireless networks [23]. The lowest ID clustering is a very famous clustering method which is used in the past and present, where the nodes are grouped as clusters, the two hop connections are considered and the one have the lowest ID would be selected as the clusterhead of the group. This clusterhead has the responsibility of communicating with the other cluster heads through the gateway nodes and also maintain the connections among cluster member nodes regularly.

The Lowest-ID algorithm continues as tracks and consequences in the cluster creation, using maximum of two hops in a diameter.

- –The node with specific ID is regularly used to broadcast the details of its own and neighbors.
- –In case any node receives ID value which is higher than its own then it is decided as “clusterhead” (CH)
- –If wanted any node with the lowest ID can give up the role of a cluster head, other node with lower ID will be given an opportunity.
- –The only node which hears two or higher cluster heads will be designated as ‘’gateway”
- –The nodes other than cluster heads and gateways are normal or ordinary nodes.

Fig. 1 shows that the identification of cluster is carried out by the clusterhead, once the lowest ID clustering algorithm engine runs, the cluster members are named, gateways are included and clusterhead selection is performed based on the principle of the lowest ID connections which are shown in different color nodes in the diagram. The other algorithm namely maximum connections having four were compared, in this comparison we confirmed that the performance of maximum connections algorithms is much lower than the Lowest ID algorithms while considering the stability of the cluster mainly. The cluster stability of the network may be measured as the average number changes of the cluster head with respect to time.

The procedures mainly involved in Distributed Mobility Adaptive Clustering algorithm (DMAC) and Distributed Clustering Algorithm (DCA), all the nodes are assigned with real numbers considering its reliability level. The node is having the highest would be selected as the clusterhead. In case if there is no adequate number nodes with higher weights, automatically the nodes that having the least weights get an opportunity to become a cluster head. The only condition to be followed for distributed clustering algorithms is that the network connections are static or in other words the nodes are not moving from the positions. The Distributed Clustering Algorithm (DCA) is suitable only for the network that the nodes are not moving or it may be moving in very slow speed. Therefore, the algorithm DCA fails to deliver the performance when network topology is highly dynamic. On the other hand the Distributed Mobility Adaptive Algorithm (DMAC) performs better even when the nodes moving in higher speed by means of adapting the dynamic situation. It also assumes that all nodes receiving the data within the specific time period and every node aware each node IDs and corresponding weights [24,25].

The performance analysis reports that the node weights are allowed to modify with linear variation and the results confirm that the exact requirement of new route information needed is smaller than the lowermost as well as highest ID heuristics. In every simulation phase the node weights are not constant and different from every value. Therefore, calculation of cluster heads are working

out costly plus no optimization on important performance metrics such as power control and throughput. All these heuristics algorithms are unsuccessful to produce optimal selection of cluster heads because includes only subdivision of metrics that may introduce a bottleneck on the system. Hence, these methods can be used to only some specific applications rather than wide applications.

That is, the Highest-Degree Heuristic conditions that the node having the biggest number of nearby nodes must be chosen as a clusterhead. However, a clusterhead would not be possible to service more number of nodes because of resource constraints when these nodes are even closer and places comfortably over its communication range. For instance, Bluetooth works on the principle of Master-Slave approach in which the clusterhead is the master and handles maximum number slaves limited to seven. Therefore, the load treatment volume of the clusterhead places a higher limit on degree of nodes. It can be explained it another way that more considerations of nodes within the area, leads to more burden for the cluster heads. Numerous cluster heads leads to an expensive system in terms of computation. While, this may produce better throughput. The packets of data go through numerous number of connection. Therefore, suggesting more delay. Likewise, the cluster head is selected by seeing and comparing its ID heuristics with different nodes, whichever the node has the lowest ID heuristics that is given top priority than other nodes. With this conditions the nodes having lesser ids gets a fair chance to become a cluster head compared to the nodes with bigger ids. Therefore, some nodes are disposed to drainage of power because of acting as cluster heads for longer time.

The suitability of the nodes to behave as a clusterhead is built on its weights, whichever the nodes having higher weights will be preferred as cluster head. Each node decides itself on its own to develop a clusterhead or work as a normal node. The heuristic procedure does not told anything about the maximum time it has to wait for getting responses from nearby nodes. The objective this work has three fold. Firstly, the total number of nodes which can be handled by a clusterhead is ideally bounded by a value. Secondly, the node degree of every node is calculated so that the cluster heads never ever overloaded. Finally the stability of a node is tested and considered. The proposed work of ours focuses on improving the arrangement of nodes in Mobile Ad hoc Networks only with single clusterhead by incorporating additional backup cluster which can overcome the limitations of frequent re-clustering, more delay and reduced network lifetime present in the single cluster setup. Hence, the Intelligent Cluster Based Routing Protocols is more efficient than cluster based proto-col without additional clusterhead for support and balancing the network load during high traffic. By referring the works of author [26, 27, 28], determined to fix the shortcomings of choosing the value for maximum count of members preferred per cluster and calculating the angle of node.

The Weighted Clustering Algorithm (WCA) has the election of clusterhead is taking place only when there is shortage in cluster membership, high load and the clusterhead is out of reach. The cluster also uses different power operating modes such as low power as well as high power and it reduces the control overhead. In an Enhanced Weighted Clustering Algorithm, the metrics considered for clusterhead selection includes area of coverage, power of battery, energy and transmitting power. However, there is no automatic selection of clusterhead. To overcome these three issues, proposing an Intelligent Cluster Based Routing Protocol in which flexibility in adding number of associate nodes as per the network conditions. At the same time clusterhead election running as and when needed. There are two phases included in this algorithm, during first phase the formation of clusters and in second phase clusterhead election carried out. The proposed framework of design takes care of conditions such as nodes are highly moving, having variety of node connection and poor responses from nodes.

3 Intelligent Clusterhead Algorithm

The cluster based routing protocol (CBRP) employs a hierarchical connection approach, not like other proactive routing schemes that use uniform network topologies. The diagram for Cluster Based Routing Protocol is shown in Fig. 2 . CBRP arranges nodes in the form of clusters, having co-ordination between the members and clusterhead. The clusterhead is chosen enthusiastically by employing clusterhead algorithm. The Cluster Based Routing Protocols arranges the nodes with two hop diameter in a distributed way. The cluster is subjected to clusterhead election and the cluster connects to other cluster heads through gate-way nodes. The gateway node area has minimum of one clusterhead or higher numbers, cluster heads collects the membership details of nearby nodes and finds the routes within the cluster based on membership information. It is very similar to DSR (Dynamic Source Routing), which is a source routing has the combination of inter cluster and intra cluster routing. The route request messages are flooded to find the routes when it is performing Inter cluster routing.

The flat routing protocols is not able to deliver the performance since it has only single level of hierarchy and also suffers from overload conditions and it increases when the network scales up. The cluster based routing protocol uses the hello messages to inform the connection with the neighbor nodes, each node IDs are received and tabled. The nodes which are having the minimum ID is selected as the clusterhead. Each nodes having a full duplex connection among the nodes. The clusterhead is responsible for identifying the clusters, it is very much essential that clusterhead does not lose its position as clusterhead frequently. Usually the non-clusterhead is not challenging the job of present clusterhead. Because,

CBRP is able to deliver consistent performance even when network size increases. Therefore, CBRP is ideally suitable for Mobile Ad hoc Networks which are highly dynamic in nature.

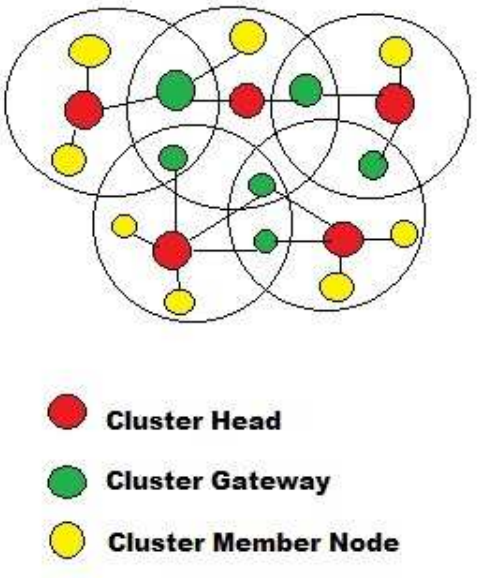

Fig. 2: Cluster based routing protocol

When any main cluster head expires from its life period, in case of the intelligent Cluster Based Routing necessary preventive and recovery steps are taken on the fly with help of a second clusterhead. Also, second cluster head informs to all the cluster nodes about the role of new cluster and its procedure of co-ordination among member nodes not only in the present cluster, also with far off clusters through the gateway nodes. In case the main cluster head completes life, automatically the secondary cluster head will take over the responsibility of the main cluster head and also informs the members that it is performing the role of main cluster head. In the proposed work, the cluster based routing protocol is enhanced without introducing any fresh cluster formation and cluster head selection process in case, the main cluster head life expires with the introduction of bringing a second cluster head to take over the jobs of main cluster head. However, once the second cluster head life completes, re-clustering process will start after receiving the messages from the member nodes.

The following metrics mainly considered in our proposed framework for selecting both main cluster head as well as second cluster head are energy, density of connections, mobility and utilization of memory resources.

a.The energy:The remaining energy available with the nodes. Which has to be sufficient to cater different messaging and data services. The energy parameter is highly important in designing a cluster based routing protocol for Mobile Ad hoc networks because the mobile nodes are operated with battery and has the main role of extending the network lifetime. If the energy is drained it is difficult to communicate with the member nodes and perform the basic operations. It is advised to have check regularly on the power of transmission as well as reception.

b. Route Sequence Number: Guarantees fresh routes if the sequence number is lowest.

c. Density of Connections: It is the number of connections with a specific node.

d. Utilization of Buffer Level:It is the amount of buffer used by the nodes when shared memory communication encouraged.

e. Mobility Characteristics:It is one of the important metrics which decides about the frequency of clusterhead election when a current clusterhead life expires. In case if the frequency of clusterhead election is less, there is going to be significant saving in energy and bandwidth requirement. Less mobility characteristics of nodes ensure the stability of a network. The network topology in Mobile Ad hoc Network is highly dynamic because of nodes movement and it leads to frequent path breaks, seriously affecting the current session of communication. The distraction happens due to the movements of intermediate nodes or end nodes. Similar situation is not arising in wired networks because the connections are reliable due to nodes are static in nature. Even though the wired networks able to provide alternative paths but the convergence is very slow. Considering the mobility parameter while choosing a clusterhead assures the efficient and effective mobility management.

f. The Degree of Nodes: This is nothing about the percentage of connections with the node which will be entitled to compete for clusterhead. Usually the preferred percentage of connections is 30. The balanced percentage of connections among clusterhead always produces the best result in terms of lesser delay.

Weighted clustering algorithm 3.1.

The intelligent weighted clustering algorithm runs in the following method. The weights for each and every node in the proposed intelligent cluster based routing

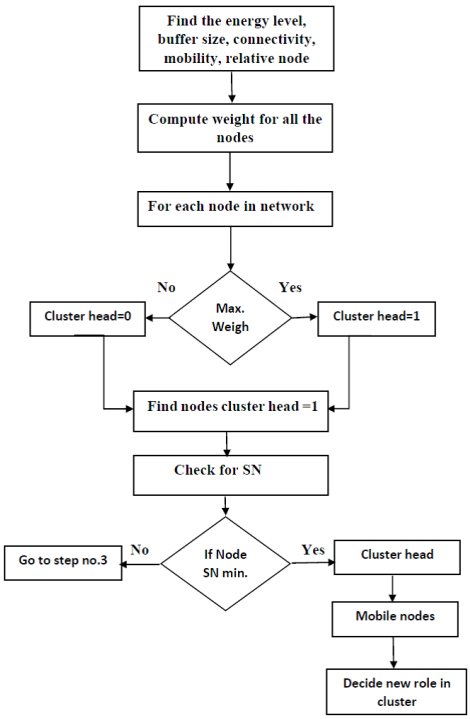

Fig. 3: clusterhead selection

protocol is computed by using the following mathematical expression.

$$W = w1 * k + w2 * e + w3 * M + w4 * \Phi \quad (1)$$

Where k is number of neighbor nodes
e is the remaining battery level
M is Mobility of nodes given by the following equation
$M = 1/T \sum_{t=1}^{T} \sqrt{(xt - xt_{-1})^2 - (yt - yt_{-1})^2}$
Φ is the relative node degree
w1,w2,w3 and w4 are weighting factors

$$w1 + w2 + w3 + w4 = 1 \quad (2)$$

The intelligent weighted clustering algorithm have two phases. During the first phase and second phase respectively, the calculation of weighted clustering algorithm and clusterhead selection algorithm and displayed in Fig. 3. Initially the algorithm thoroughly performs the measurement of remaining energy available, buffer space available, density of connections and node degree for all the nodes. Once the measurement is successfully completed, the corresponding values are given as the input for the weight calculation engine. Subsequently, the weights are checked for error and taken for a comparison with each and every nodes of the network. During the phase of weight comparison, whichever the nodes having the highest weight compared to other will be processed first to the next stage of checking the sequence number. The sequence number of the highest weight having node will be allowed to check its value is minimum. If the sequence number is found to be minimum, the node will be chosen as clusterhead. The clusterhead starts initializing the communication among cluster members and performing the preliminary collection of resource information and application requirements. The clusterhead understands the kind of application running such as real time and non-real time over the member nodes. At the same time other node which has the second uppermost weight would be processed, provided it meets out the similar requirement like first clusterhead. This second clusterhead acts as a backup cluster, once the energy level of first clusterhead is depleted to minimum. The clusterhead and backup clusterhead cycle repeated when clusterhead life expires.

4 clusterhead pairs

The main challenge that every researcher faces in the cluster based routing protocol is that how well it manages the clusterhead and continuing the performance in case the clusterhead fails. We have introduced the feature of secondary clusterhead which will take over the main cluster in case if any sudden failure of the clusterhead or expires the life. This will enhance the performance of intelligent cluster based routing protocol to a significant level.

Most of the clustering algorithms are designed for Mobile Ad hoc Networks, considering mainly the major objectives such as maintenance of connections and efficient packet forwarding in the shortest route. These algorithms apart from performing network maintenance and routing, take care of increasing the network lifetime to a significant level. Even though the performance of single cluster based protocols delivers performance much better than flat routing protocols such as DSDV, AODV and DSR. However, a single cluster has more jobs such as collecting nodes information, packet forwarding and maintaining communication with inter as well as intra cluster through gateway nodes. These tasks are always keeps clusterhead very busy and starts spending the energy, at one stage it reaches a power level at which the life of node ends. This situation leads to a degraded performance in terms of keeping delay at check, lower throughput and reduced network lifetime. At this juncture the only option left is going for a fresh clusterhead discovery and selection process which introduce additional delay to the networks and nodes require more energy. The proposed work considerably reduces a fresh clusterhead discovery and selection, delay since having the combinations two cluster heads which complements each other when the tasks are assigned, may be one node takes the role of clusterhead which is common in every cluster based routing protocol, the other clusterhead performs the basic jobs such as sending inquiries and receiving responses and collecting node details. After

Table 1: Simulation setup

Number of Nodes	300 to 1000
Node Speed	2m/s to 15m/s
Area Size	550 X 550m
Mac	IEEE 802.11
Propagation model	two-way ground
Transmission Range	225m
Simulation Time	60 Sec
Traffic Source	CBR
Number of CBR connections	30
Packet Size	250
Rate	15KB
Initial Energy	25 Joules
Transmission Power	0.650

successful selection of dual clusters, the one which has higher is permitted to perform all the major activities such as route finding, data collection and message passing among the cluster nodes. During the working of first clusterhead, second clusterhead monitors the activity intelligently and has check on remaining power availability. Once the remaining power of the main cluster reaches its threshold percentage of seventy, second one takes over main cluster position and performs the operations. The previous clusterhead involves in less energy requiring activities. This feature ensures the lifetime of the network has been extended for the considerable period while reducing the delay, frequency of clusterhead election and improving the bandwidth utilization.

5 Simulation and analysis

The network setup and configuration for the intelligent cluster based routing protocol employing enhanced weighted clustering algorithm with dual cluster is given in Table 1 when simulating it using NS-2. The major performance metrics has been considered during simulation are average network energy, delay, clusterhead lifetime, network lifetime, packet delivery ratio and throughput. Definition of network lifetime is that the time between active and dead conditions of mobile nodes. The graph for percentage of active nodes in both protocols such as Cluster Based Routing protocol and the proposed intelligent and improved cluster based routing protocol is shown in Fig. 4 . Quite evident that the percentage of actives nodes present in Intelligent Cluster Based routing protocol is higher than the traditional cluster based routing.

This is possible because of maintaining load balancing between nodes due to the introduction of AggregatorHead instead of a single cluster setup. The Fig. 4 plot confirms that the network lifetime has been improved because of clusterhead stability due to enhanced weighted clustering algorithm with dual cluster heads.

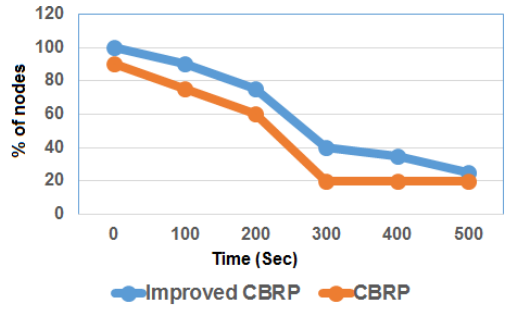

Fig. 4: Network lifetime

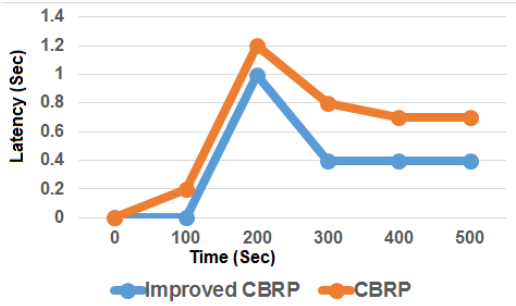

Fig. 5: End to end delay

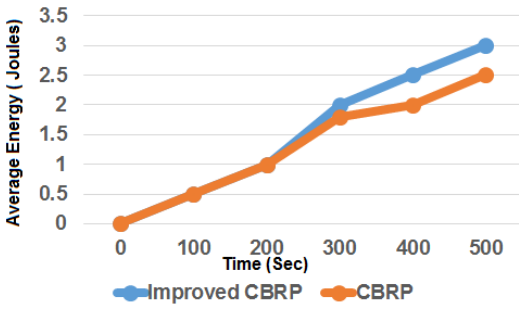

Fig. 6: Average energy

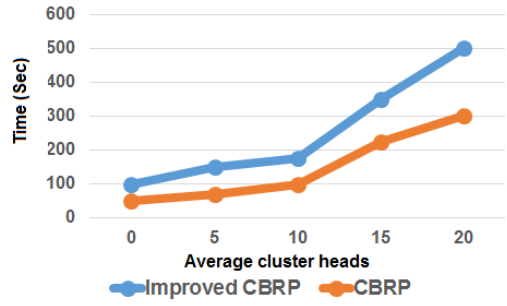

Fig. 7: clusterhead life

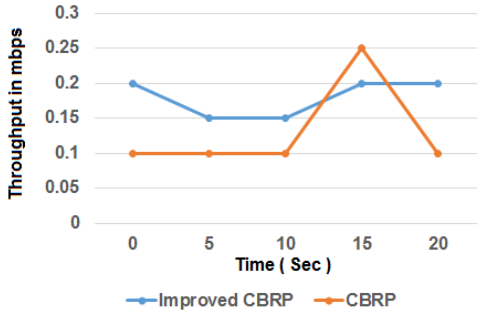

Fig. 8: Throuhput

Fig. 5 shows that the measurement of delay which is lesser because of balanced data traffic among dual cluster heads. The life of the clusterhead is extended better than single clusterhead based protocol and the same is shown in Fig. 7, it is because of the introduction of second clusterhead. Definition of average energy is the ratio between the energy taken by each node and total number of nodes. The average node energy measurement variation with different time is shown in Fig. 6 .

The intelligent cluster based routing protocol assures that the energy spending is lower than traditional cluster based routing protocol because of having double cluster heads sharing the tasks well. Hence, a fresh clusterhead discovery and selection needed frequently, this demands some energy. Fig. 6 confirms that the average energy available has been enhanced and it leads to improvement of clusterhead life as shown in Fig. 7. Fig. 8 shows that the throughput has been consistently improving which is the prime performance metrics of Mobile Ad hoc Networks.

6 Conclusion and Future Work

The enhancement of performance when using the proposed algorithm has been evaluated by using NS-2 simulation tool. The measurement of various evaluation parameters by simulation and its comparison confirms that longer clusterhead lifetime, less delay, high throughput and longer network lifetime. An enhanced weighted clustering algorithm along with its refined performance metrics such as relative node degree, remaining battery, mobility, density of nodes and buffer space has led to the overall improvement of the network. In addition, the feature of clusterhead pair selection and balanced working of dual cluster as and when needed. The idea of working is the main clusterhead does the major communication intelligently in normal condition. However, when the measurement of power for the main clusterhead is meadured, in case if it drains to below seventy percent of its power, the second clusterhead takes over the first clusterhead automatically. At the same time the first clusterhead performs less power communication such as collecting the route information and updating it. This cycle of activity is performed with every cluster pairs. This feature provides a saving in terms of bandwidth and energy. The future work may be incorporating a strong set of security features over Intelligent Cluster Based Routing Protocols. Since the present applications employing Mobile Ad hoc Networks are heavily prone to security threats and challenges.

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