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Two Hop Clustering Scheme for Pseudolinear Mobile Ad Hoc Network (THPM)

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Abstract: One hop clustering scheme in Mobile Ad hoc Network (MANET) adopts the shorter path technique for packet transmission. However, its maintenance overhead is significant compared to others. This study presents a Two Hop Clustering Scheme for Pseudolinear Mobile Ad hoc Network (THPM) which uses the node connectivity and node mobility jointly to form a cluster which will be able to improve scalability. In this scheme, node mobility has been taken into account in terms of the average clusterhead lifetime of holding nodes to increase the network stability. Simulation results show that the clusters created by THPM retain more uniform cluster size, clusterhead lifetime and average number of nodes in each cluster up to 45~50% than the existing scheme.

Key words: Multi hop clustering, pseudolinear mobile ad hoc network, doppler value, network scalability, uniform, node scheme

INTRODUCTION

The lack of a fixed infrastructure in Mobile Ad hoc Network (MANET) implies that any computation on the network needs to be carried out in a decentralized manner. Thus, many of the important problems in ad hoc networking can be formulated as problems in distributed computing. If the network has a flat topology that is all nodes are treated equally; the size of the routing table is proportional to the number of nodes in the entire network. Further, as the network size increases, communication costs may consume a larger proportion of the bandwidth. Moreover, as the rate of the network topology change increases the exchange of routing tables between neighboring nodes must be more frequent to keep the routing information up to date. Other network parameters such as network node density and traffic load can also impair network scalability.

To get commercial success in MANET, it is necessary to solve the scalability problem. One promising approach is to build hierarchies among the nodes such that the network topology can be abstracted. This process is commonly referred to as clustering (Pan and Xiao, 2006). A cluster-based MANET has many important issues to examine such as cluster structure stability, 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 clusterheads A clusterhead normally serves as a local coordinator for its cluster, performing intra-cluster transmission arrangement data forwarding and so on (Yu and Chong, 2003, 2005) for a mobile node.

The number of hops of the mobile nodes in the network is an important issue in cluster based MANET. Most researches on Pseudolinear Highly Mobile Ad hoc network (PHMANET) Sakhaee and Jamalipour (2008) have focused on single hop clustering which allows simple local management within each cluster. However, with increased network size and a greater number of mobile nodes, one hop clustering creates many small clusters because of the small coverage area of each. These clusters are likely to be broken when mobile nodes move out of their cluster's coverage. PHMANET is one of the prominent one hop cluster formation techniques in MANET. In this technique node moves in a linear path without frequently changing its direction and motion parameters. It focuses on a clustering technique for the nodes with slow changes of node's moving direction and speed. If mobile nodes change its mobility pattern frequently, the performance of this clustering scheme may degrade. This clustering technique consider only single hop cluster which causes frequently change of clusterhead and the diameter of each cluster is also small for considering one hop clustering technique.

Compared to one hop (Sakhaee and Jamalipour, 2008), two hop clustering is more scalable for large scale PHMANET as it groups all nodes in the network with a small number of clusterheads. To form a stable cluster network this study proposes a two hop clustering scheme

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for PHMANET named as THPM, considering the number of mobile nodes and the average number of clusters in the network to form a stable cluster. Moveover, it is not restricted on speed and direction. In THPM, nodes move toward a random destination at their own random speed of movement. It uses stability metric, Doppler Value (DV) for clustering. DV is based on the relative velocity between nodes obtained from the Doppler shift of control packets exchanged between nodes during the clustering process. The smaller DV of a node means lower mobility and hence, higher stability than its neighbors and this node has the quality of being the clusterhead in THPM. Although, there are many topology control algorithms for MANET (Kadivar *et al*., 2009), THPM develops an efficient equation for calculating two hop neighbors for forming a two hop cluster in the network. It develops the equation based on euclidean distance by ignoring direct link between two nodes and excluding the self node.

The observation from the performance analysis states that the proposed clustering method performs >45~50% better than the existing method in terms of the average number of cluster heads, average cluster head lifetime of holding nodes and average number of nodes in each cluster. In case of average clusterhead lifetime of holding nodes, it shows that when the number of nodes increases, the lifetime of each cluster also increases. Because, if the network becomes dense, there is more possibility to stable as a clusterhead. The average number of nodes in each cluster in THPM is almost twice than PHMANET as it considers two hop and the existing method considers one hop.

LITERATURE REVIEW

With the help of clustering it is possible to improve the system performance of MANET such as throughput and delay in the presence of both mobility and a large number of mobile terminals (Yu and Chong, 2003, 2005). A large variety of different approaches for ad hoc clustering have been proposed based on one hop and multi hop clustering schemes.

Least Cluster Change (LCC) is a one hop clustering scheme which limits re-clustering situations and reduces clustering control overhead (Chiang *et al*., 1997). The 3-Hop Between Adjacent Clusterheads (3hBAC) (Yu and Chong, 2003, 2005) is also a one hop clustering algorithm that limits re-clustering situations, reducing clustering control overhead and eliminating ripple effect of re-clustering ripple effect of re-clustering indicates that the re-election of one clusterhead may affect the structure of many clusters and arouse the clusterhead re-election over the network. This produces non-overlapping cluster structure by eliminating unnecessary small clusters. Lin's (Yu and Chong, 2003, 2005) algorithm is an adaptive clustering scheme to form a non-overlapping cluster architecture. It also limits re-clustering situations and reduces clustering control overhead by eliminating clusterheads in cluster maintenance to avoid overloaded nodes. Passive Clustering (PC) (Kwon *et al*., 2003) is another one hop clustering algorithm which eliminates explicit control message for clustering and forming and maintaining a cluster structure only when some mobile nodes have packets to send; suppressing the number of gateways to achieve flooding efficiency.

A Mobility Based Metric for Clustering (MOBIC): It is a one hop clustering algorithm that minimizes the influence of mobile nodes' movement based on their explicit relative speed and tightening the connection between the nodes residing in the same clusters (Basu *et al*., 2001). It is effective for MANETs with group mobility behavior where a group of mobile nodes move in the same speed and direction.

Distributed Dynamic Clustering Algorithm (DDCA) (McDonald and Znati 2001) is a multihop clustering algorithm. It reduces the influence of mobile nodes' movement by adjusting the dominant routing mechanisms based on the network's mobility behavior. It works well compared to MOBIC in a dynamic environment where mobile nodes are continuously moving. An Adaptive Multihop Clustering (AMC) (Ohta *et al*., 2003) is a multihop clustering scheme which balances the traffic load in each cluster by limiting the number of mobile nodes that a cluster can handle within a predefined range. Degree-Load-Balancing Clustering (DLBC) (Amis *et al*., 2000) is another clustering scheme which uses two hop clusters for simulation. It also balances the workload of each cluster by limiting the number of mobile nodes around an optimal value in a cluster. AMC has no limits on the hop distance between neighboring clusterheads but DLBC requires that neighboring clusterheads should be at least three hops away.

Clustering schemes of MANET can provide stability among vehicles and other mobile nodes for the purpose of communication and data sharing. The mobile nodes which move in a relatively linear path without frequently changing its direction and motion parameters for example, aircraft, ships, trains and cars on highways are called pseudo linear mobile entity. And the communication among the pseudo linear mobile entities is known as Pseudolinear Highly Mobile Ad hoc Network (PHMANET) (Sakhaee and Jamalipour, 2008).

Two new stability-driven clustering algorithms, one is Dubbed dynamic Doppler Velocity Clustering (DDVC) and another is Dynamic Link Duration Clustering (DLDC) applicable in PHMANET have been proposed by (Sakhaee and Jamalipour, 2008). The aim of the proposed clustering algorithms is to form stable clusters considering the mobility and position parameters of the nodes. Both clustering schemes consider two phases, one is cluster formation (initial clustering) and the other is cluster maintenance. Both algorithms dynamically elect clusterheads and add members to newly formed clusters and produce one hop clusters (Lin and Gerla, 1997; Basu *et al*., 2001; Xu and Gerla, 2002; Shang and Cheng, 2005; Chiang *et al*., 1997; Venkateswaran *et al*., 2005).

DDVC is suitable where positions and velocity of pseudolinear mobile nodes are not directly available or easily obtained. It uses a new stability metric, Doppler Value (DV). DV is obtained from the Doppler shift of control packets exchanged between nodes during the initial phase of clustering. The second algorithm DLDC is aimed at scenarios where nodes are equipped with the Global Positioning System (GPS) that is position information of nodes is assumed to available. It is based on the estimated Link Expiration Time (LET) which more accurately estimates the link duration based on the position and velocity parameters of nodes during the initial clustering phase.

Besides this there are also some topology control algorithms for MANET. Such an example is Distributed Topology Control Algorithm Based on One and Two Hop Neighbors' Information for Ad Hoc Networks (DTCA) proposed by Kadivar *et al.* (2009). This algorithm adopts its topology to network changes by considering the weights of each node.

The algorithms presented by Sakhaee and Jamalipour (2008) are suited for the possibility of reliable data sharing and communication between highly mobile vehicles, depending on the amount of reliable mobility information available in the targeted system. It can form stable clusters containing members that remain within their associated clusters for a longer period of time, despite the targeted system having node speeds exceeding normal MANET scenarios. In these algorithms stability is defined in terms of cluster membership rather than changes to the clusterhead such as clusterhead reelection and ripple effects due to the re-clustering. Although, the proposed clustering algorithm (Sakhaee and Jamalipour, 2008) ensures that no two clusterheads are within the range of each other in the initial cluster formation, this does not prevent two clusterheads from coming into each other's locality and thus may cause cluster contentions.

PROPOSED THPM METHOD COMPARED TO EXISTING SYSTEM

This study is proposing a two hop clustering scheme for PHMANET, named as THPM which is an expansion of PHMANET (Sakhaee and Jamalipour, 2008). For calculating two hop neighbor this study also takes the help of another existing research DTCA which is proposed by Kadivar *et al.* (2009).

Existing algorithm PHMANET: As mentioned in the study, a one hop clustering scheme for PHMANET has been used for the initial clustering formation. It is assumed that all participating nodes in the network are initially in the NULL state which means the role the role of the nodes may be as clusterhead or clustermember of the nodes yet to be defined. The Doppler Value (DV) of the Hello messages of each node is calculated by first measuring the Doppler shift of the Hello messages. The relative velocity of two mobile nodes related to the Doppler shift is as follows:

$$V = C\,[(F/F0)-1] \qquad (1)$$

Where:

- V = Relative velocity between two communicating nodes
- C = Speed of light
- F = Expected frequency of the signal/packet and
- F_0 = Observed frequency of the signal/packet

DV is related to the relative velocity of two nodes while taking into account the effect of approaching and receding nodes. DV has been calculated by the following equations: For approaching nodes:

$$\text{if } (F/F0) < 1 \text{ then } DV = C\,|\,V\,| \qquad (2)$$

For receding nodes:

$$\text{if } (F/F0) > 1 \text{ then } DV = 2C\,|\,V\,| \qquad (3)$$

For approaching nodes, the observed frequency turns out to be smaller than the expected frequency. For receding nodes however, the observed frequency is greater than the expected frequency. Receding nodes are considered half as stable as approaching nodes as nodes that are approaching are generally be within communication range of each other for twice as long as nodes that are receding from each other.

The DVs of all the received Hello messages are stored at each node. These are then used to calculate the Sum of the DVs (DVS). The DVS reflects the relative stability of the node with respect to its neighbors as it defines the relative mobility based on the DV of the nodes. A smaller DVS will result in lower mobility and hence, higher stability of a node with respect to its neighbors. The attributes and steps of the existing algorithm are given:

Algorithm 1: Initial Cluster Formation

Algorithm for one hop neighbor in phmanet
Data

State:	NULL
Node identifier:	nodeID
1Hop neighbor:	OHN
Doppler value:	DV
Sum of doppler values:	DVS
Own DVS:	O_DVS
Receiving DVS:	R_DVS
Message type (packet):	HELLO, DVS,

Cluster head claim, Join request, Join accept, Cluster member

Step 1: [Each node]
Broadcasts hELLO (nodeID, NULL)
Step 2: [HELLOs receiving nodes]
Calculate DVS of hELLOs
Broadcast DVS (nodeID, DVS) to their OHNs
Step 3: [DVS receiving nodes] Compare R_DVS with O_DVS If O_DVS<R_DVS
Broadcasts Cluster head claim (clusterID) to their OHNs
Step 4: [Cluster head claim receiving nodes]
Can wishes to join the cluster sends join request (clusterID, nodeID)
Step 5: [Clusterhead]
Sends Join accept (clusterID, nodeID)
Step 6: [Request accepted nodes]
Join the cluster and periodically broadcasts cluster member (clusterID, nodeID)

Proposed algorithm THPM: Compared to one hop clustering, multi hop clustering is more scalable for large networks. The goal of effectiveness is achieved by grouping all nodes in the networks with a small number of clusterheads which leads to a simple and stable cluster backbone. This study is proposing a clustering algorithm THPM for two hop neighboring information in a network. For calculating the two hop neighbor, this study uses the concept from DTCA which is another existing solution of topology control based on one and two hop neighbors' information for MANETs but in a modified way. The mechanism for calculating the two hop neighbor has been described below: Let, each node in the Fig. 1 knows its one hop neighbor information (based on Euclidean distance). Then, the One Hop Neighbor (OHN) lists of each node are:

OHN (A) = {B, F, G}
OHN (B) = {A, C}
OHN (C) = {B, D, G}
OHN (D) = {E, C, G}
OHN (E) = {D, F, G}
OHN (F) = {E, A, G}
OHN (G) = {A, C, E, F, D}

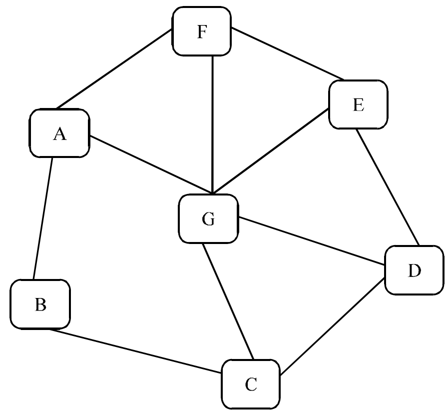

Fig. 1: Two hop neighbor calculation

Now Two Hop Neighbor (THN) of node A will be:

THN (A) = [OHN (B) - OHN (A)] U [OHN (F) - OHN (A)] U [OHN (G) - OHN (A)]
= [{A, C} - {B, F, G}] U [{E, A, G} - {B, F, G}] U [{A, C, E, F, D} - {B, F, G}]
= [{A, C} U {E, A} U {A, C, E, D}]
= {A, C, E, D}

By excluding the self node:

THN (A) = {C, E, D}

In the same way, Two Hop Neighbor (THN) of node E will be:

THN (E) = [OHN (D)-OHN (E)] U [OHN (F)-OHN (E)] U [OHN (G)-OHN (E)
= [{E, C, G}-{D, F, G}] U [{E, A, G}-{D, F, G}] U [{A, C, E, F, D}-{D, F, G}]
= [{E, C} U {E, A} U {A, C, E, D}]
= {A, C, E, D} (4)

By excluding the self node and by ignoring the direct link between the nodes:

THN (E) = {A, C}

Now, the general equation for calculating the two hop neighbor can be written like the following: Let, set of nodes:

$$(U) = \{U_1, U_2, \ldots, U_n\}$$
$$\text{OHN } (U_n) \text{ list} = \{V_1, V_2, \ldots V_n\}$$

Then:

$$THN(U_n) = [OHN(V_1) - OHN(U_n)] \cup [OHN(V_2) - OHN(U_n)] \cup ... [OHN(V_n) - OHN(U_n)] \quad (5)$$

where, $U_n \neq V_n$ and no direct link between U_n and V_n. Finally, applying the above equation this study develops the algorithm THPM. This proposed algorithm of clustering scheme considers two phases:

Initial cluster formation: The initial cluster formation only initiates among NULL nodes which means that its roles are yet to be defined. For the clustering schemes, the main types of roles of the nodes in a cluster are clusterhead, clustermember (a clustermember is usually called an ordinary node which is a non-clusterhead node without any inter-cluster links) and clustergateway (a clustergateway is a non-clusterhead node with inter-cluster links, so it can access neighboring clusters to forward information between clusters). The attributes and steps for initial cluster formation of THPM are described in Algorithm 2.

Algorithm 2: Initial cluster formation algorithm (THPM) for two hop neighbor

Data
State: NULL
Node identifier: nodeID
1Hop neighbor: OHN
2Hop neighbor: THN
Set of nodes (U): $U_1, U_2, \ldots U_n$ OHN
(U_n) list: $V_1, V_2, \ldots V_n$
Sum of Doppler values: DVS
Own DVS: O_DVS
Receiving DVS: R_DVS
Message type (Packet): HELLO, DVS
Cluster head claim, Join request, Join accept, Cluster member

Step 1: [Each node]
Broadcast HELLO (nodeID, NULL) to its THNs using (5)
$THN(U_n) = OHN(V_1)-OHN(U_n) \cup OHN(V_2) -OHN(U_n) \cup \ldots OHN(V_n)- OHN(U_n)$
Step 2: [HELLOs receiving nodes] Calculate DVS of HELLOs
Broadcast DVS (nodeID, DVS) to their THNs
Step 3: [DVS Receiving nodes] Compare R_DVS with O_DVS
If O_DVS<R_DVS
Broadcast cluster head claim (clusterID, O_DVS) to their THNs; containing smallest O_DVS node will be the cluster head
Step 4: [Cluster head claim receiving nodes] can wishes to join the cluster
Send join request (clusterID, nodeID)
Step 5: [Cluster head]
Sends join accept (clusterID, nodeID)
Step 6: [request accepted nodes]
Join the cluster and periodically broadcasts
Cluster member (clusterID, nodeID)

In step 1 of Algorithm 2, each node broadcasts a HELLO message to its THNs indicating its existence in the network. HELLO receiving nodes calculate the DVS and broadcasts to its THNs in step 2. In step 3, the DVS receiving nodes compare the receiving DVS with its own DVS and if its own DVS is less than the receiving DVS, it broadcasts Cluster head claim (clusterID, O_DVS) to its THNs. Containing smallest O_DVS node will be the cluster head and here cluster ID is equal to the node ID of the cluster head claiming node. Upon reception of the cluster head claim packet, a node may choose to join the cluster. Once a node wishes to join a cluster, it sends a Join request (clusterID, nodeID) message and the cluster head then sends a Join accept (clusterID, nodeID) message to the requesting nodes which are stated in step 4 and step 5. Finally, in step 6, the accepted nodes by the clusterhead joins the cluster and periodically broadcasts a Cluster member (clusterID, nodeID) notifying its state, and its associated cluster of its presence.

Progressive cluster maintenance: In ad hoc network, nodes already in a cluster may leave its cluster and clusterheads may come into range or may be destroyed. When a node is connected or disconnected from its neighboring nodes, the cluster structure may change. The frequent change of cluster may degrade the performance. It affects on the network performance and also consumes bandwidth. Cluster maintenance remedies these types of events proceeding after the initial cluster formation which is very important to keep a stable cluster structure. THPM has an effective mechanism for node activation and deactivation.

Node activation: The primary objective of node activation is to detect an adjacent node and to join a cluster. Every mobile node in the network monitors its neighboring node through Hello packets. When a non member node comes close to its cluster or switches on its power inside the cluster, it becomes activated. On receiving Hello packets from a new neighboring node, the non member node tries to join within a two hop range cluster.

Node deactivation: When the node leaves from its cluster or switched off its power at that time deactivation occurs. A member node that does not receive periodic broadcast from a cluster head will dissociate itself from that cluster. Likewise, the clusterhead also removes the member from its list of members if it does not receive the periodic cluster member broadcasts. If a node is not part of any cluster, loses the path for connecting the original cluster head or the distance between the cluster head is far enough to join the cluster, it begins broadcasting periodic join request message to find a new cluster to join. In this case, the node selects a new clusterhead which is able to connect the two hop cluster members.

SIMULATION AND PERFORMANCE ANALYSIS

This study compares the performance of the proposed THPM Method with the existing method PHMANET with respect to the parameters of the average number of cluster heads, average clusterhead lifetime of holding nodes and average number of nodes in each cluster. Before representing the results of the simulation, its environment and methodology has been explained and this is used to carrying out the results.

Simulation environment: To simulate the proposed clustering algorithm and to compare its performance with existing PHMANET, Network Simulator Version 2.34 (NS2) has been used. The reason for choosing NS2 is that it supports a multi hop wireless ad hoc network which is the requirement of this research.

To modify the working of existing algorithm and to implement the proposed method both runs at the network layer along with a preferred routing algorithm that is Ad hoc on Demand Distance Vector (AODV). For this purpose, the algorithms have been implemented extending the base class Agent of NS2.

Simulation methodology: This study describes the simulation methodology which has been used in both existing and proposed methods. The following subsections provide descriptions of the various simulation parameters.

Simulation topography: The network simulation carried out in flat grid topography for tracking the movement of mobile nodes within an area of 1000×1000 m which is convenient for calculation. Both proposed and existing method has been measured in the same topography. The number of nodes is between 10-40.

Mobility pattern and movement scenarios: The Random Way point Model (RWM) has been chosen as the mobility model for the simulation in accordance with THPM where a node randomly chooses a destination and moves toward a randomly selected velocity from a uniform distribution. NS2 has General Operation Direction (GOD) which used to store the total number of mobile nodes and a table of shortest number of hops required to reach from one node to another. Another utility or API of NS2 is setdest which has been used to generate random mobility. This API is used to change direction as well as the speed of movement of the mobile nodes. AODV routing protocol has been chosen for route-discovery, route-maintenance and hop-by-hop routing. It helps to detect clusterhead in terms of the number of hops and velocity. The 802.11 MAC protocol has been used for simulation. It uses a RTS/CTS/DATA/ACK pattern for all unicast packets and sends out data for broadcast packets. The Radio Propagation Model is used to predict the received signal power of each packet. It is convenient for short range communication.

A common set-up values for the simulation has been shown in Table 1. At the start of the simulation, all the nodes are laid out randomly on the rectangular topography and start moving towards random destination at their own random speed of movement. The sample of each node's random speed is shown in Table 2. Whenever a node comes within the transmission range of another node, it starts to transfer packets if it is active.

Traffic model: A source node selects its destination randomly and sends Constant Bit Rate (CBR) traffic through UDP with a rate of 50 packets per second. The default packet size of UDP agent is 1024 bytes. The same traffic model is used for both existing and proposed method.

Performance metrics: To evaluate the performance of the new clustering algorithm with the existing, three parameters have been chosen. These parameters are given.

Number of clusters: This parameter calculates the average number of clusters with respect to the total number of nodes in the network. Because the less clusters

Table 1: A common set up values for simulation

Property	Values
MAC	802.11
Radio Propagation Model	Free Space Model
Routing protocol	AODV
Traffic pattern	CBR
Maximum packet	50
Packet carrying bytes	1024

Table 2: Velocity of 10 nodes

Nodes	Velocity
0	192.68149402583089
1	346.76353346871377
2	396.74633666721468
3	155.53847241938976
4	125.63125399203565
5	461.25816877989945
6	242.55015502802567
7	262.38720596879125
8	419.52515622578801
9	375.11132558580084

in the network causes less clusterhead which is an advantage to reduce the need for retransmission, less topology change and dimension reduction.

Clusterhead lifetime: The cluster scalability and stability are substantially enhanced with the longer clusterhead duration. The node with a large value of lifetime of holding nodes is able to maintain longer connection with neighboring nodes. More likely such a node is selected as a clusterhead than the node which has a short lifetime of holding nodes. That is why, the average clusterhead lifetime of holding nodes has been considered to calculate.

Number of nodes in each cluster: As many nodes are connected within the cluster, the probability of having non member nodes reduces. This redundant cluster structure can tolerate failed route and balance traffic load. For this reason, the average number of nodes in each cluster has been taken into account for evaluation.

The average number of clusters: The average number of clusters with respect to the total number of nodes in the network has been shown in Fig. 2. As the number of nodes increase, the possibility of forming clusters also increases in both cases. From Fig. 2, it shows that in the proposed method, average number of cluster is about 45~50% less than the existing technique, no matter what the node velocity is. This is because the proposed method selects the most unique node as a clusterhead in the terms of node ID, remaining battery, degree and holding time of each node where as existing technique uses the node ID and node degree. By considering hop two in proposed solution, the size of the cluster increases and for that the possibility of forming the clusterhead decreases.

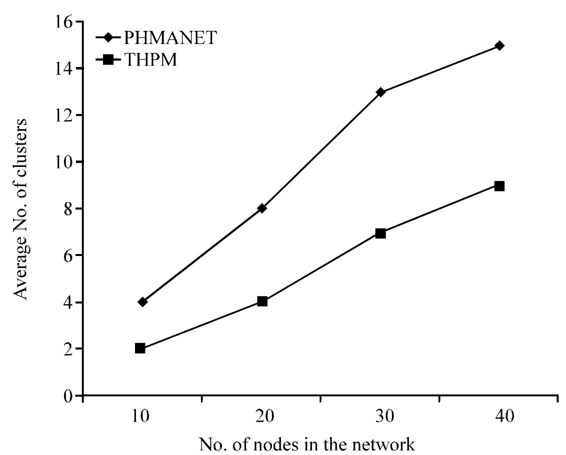

Fig. 2: The average number of clusters

The average clusterhead lifetime of holding nodes: Cluster stability is defined by the lifetime of the clusterhead which stays in the head status without any interruption. The cluster life time starts when the clusterhead is selected and ends when it is switched off or exited from its cluster. Figure 3 shows that when the number of nodes are smaller, the average clusterhead lifetime is similar for two techniques whenever the number of node increases the average clusterhead lifetime is higher than the existing. In proposed THPM, holding time of each node is considered as a parameter. Considering the density of the network, the more it is dense the more possibility to stable as a clusterhead.

The average number of nodes in each cluster: Figure 4 shows the scalability issue in the proposed THPM Method by considering the average number of nodes in each cluster as a parameter. As the number of nodes increases in each network, the degree of nodes also increases. Figure 4 shows that average number of nodes in each cluster in proposed solution is almost twice than existing method as the proposed solution considers two hop and the existing method considers one hop.

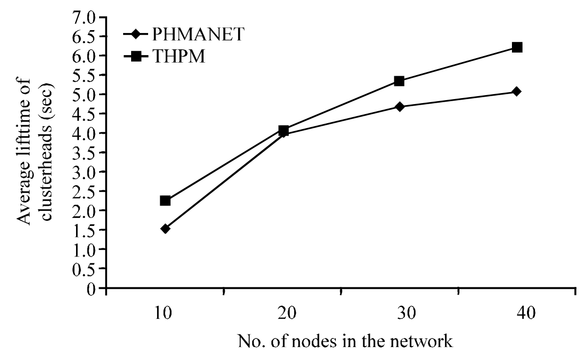

Fig. 3: The average clusterhead lifetime of holding nodes

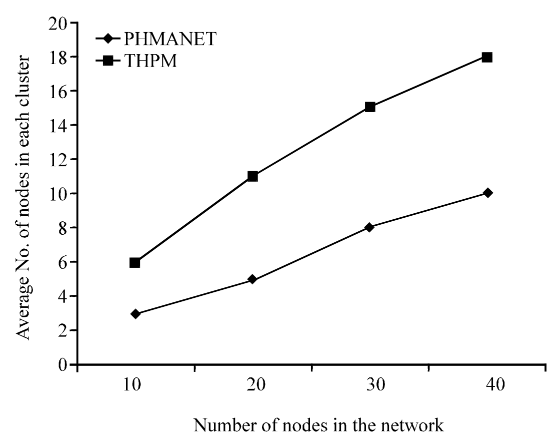

Fig. 4: The average number of nodes in each cluster

DISCUSSION

This study summarizes the achievement of the proposed THPM Method. It presents the problem in the existing technique including result discussion with respect to the proposed technique. And it also gives some ideas for future research.

PHMANET is one of the prominent cluster formation techniques in MANET. The method uses one hop clustering scheme for Pseudolinear Mobile Ad hoc Network in which node moves in a linear path without frequently changing its direction and motion parameters. It focuses on a clustering technique for the nodes with slow changes of node's moving direction and speed. If mobile nodes change its mobility pattern frequently, the performance of this clustering scheme may degrade. This clustering technique considers only single hop cluster which causes frequent change of clusterheads and the diameter of each cluster is also small for considering one hop clustering technique.

The primary goal of this study is to propose a clustering technique for wireless MANET especially based on PHMANET that ensures the longevity of cluster to manage two hop ad hoc network in an efficient and scalable way. Three important parameters have been considered to evaluate the result with the existing method. The first parameter is the average number of clusters. Less number of clusters in the network causes less clusterhead which is an advantage to reduce the need for re-affiliation, less topology change and dimension reduction. The second parameter represents the average clusterhead lifetime of holding nodes. The node with a large value of lifetime of holding nodes is able to maintain longer connection with neighboring nodes. Such a node more likely is selected as a clusterhead than the node which has a short lifetime of holding nodes. And finally, the the proposed THPM proves that it is more scalable than the existing by considering the average number of nodes in each cluster as a parameter.

The total performance result is shown in Table 3. It shows that the diameter of cluster increases with the increases of hop count. Furthermore, it is not restricted on speed and direction. In proposed method, two hop is considered to improve the performance of cluster which has longer clusterhead duration and less control overhead, indicating that cluster stability and scalability are enhanced substantially.

Table 3: Performance results at a glance

Node No.	Avg. no. of clusters		Avg. cluster head lifetime of holding nodes		Avg. no. of nodes in each cluster	
	PHMANET	THPM	PHMANET	THPM	PHMANET	THPM
10	4	2	1.531475	2.2503	3	6
20	8	4	3.980000	4.0800	5	11
30	13	7	4.680000	5.3800	8	13
40	15	9	5.080000	6.2300	10	18

In MANET, nodes communicate with each other without any fixed infrastructure. Due to various constraints like scarcity of resources, excessive routing overhead etc., the clustering scheme in MANET becomes less reliable. MANETs are usually composed of battery constraint devices which make energy conservation a vital concern of its design. Reducing energy consumption has been addressed through different aspects till now. Energy conservation in PHMANET can be considered.

In most of the mobility models such as the random waypoint nodes move independently one of each other. However, in many realistic scenarios, nodes move in groups which exchange messages with the purpose of rapidly propagating information about traffic conditions. Thus, the impact of group mobility on topology control should be carefully investigated.

CONCLUSION

The proposed clustering technique does not deal with k-hop clusters. Energy power of each node has not taken into account as a parameter to improve the performance of clusterhead. In near future this research work will try to make an enhancement to remove these limitations to get a more stable and scalable clustering scheme.

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