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Effective Cluster Head Election Method for Mobile Ad-hoc Networks

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Abstract–**Mobile ad-hoc network device has different properties in terms of transmission area, power consumption and battery backup. These diverse properties cause several issues in the data communication such as efficient routing, efficient utilization of finite resource constraints and QoS provisioning. Among of them, efficient routing takes major concerns for the mobile ad-hoc networks. Therefore, routing require to perform its procedure with focus of diverse properties of device. In this paper, initially routing procedure, design issues and alternative solutions were presented. Later, clustering and different cluster head election methods are also discussed. Along with this, efficient cluster head election method with the concentrating of heterogeneous constraints of deviceis also proposed. To evaluate the performance of proposed method, an experimental environment is considered which presents simulation of proposed method using network simulator (NS-2). The performance of proposed method is evaluated on the basis of throughput, network lifetime and routing overhead.**

Keywords:Ad-hoc Network, Heterogeneous MANET, Heterogeneity Issues Clustering, Cluster head election.

I. INTRODUCTION

When wireless network does not have central coordinator and configure itself then it is referred as ad-hoc wireless network [1]. Bluetooth is an example of wireless ad-hoc networks. Such kind of network is comprises of devices which are portable in nature which have limited resource constrained. As mentioned, ad-hoc network is self configuring network where devices are themselves responsible for managing network topology and routing process. In this, every device may act different roles such as relay or forwarder, source, router, and sink. A situation, where devices do not changes the location during the transmission then it known as static ad-hoc network. When devices change their locations frequently then it is known as mobile ad-hoc network. In this research, mobile ad-hoc network is considered for data communications.

Further, a scenario of ad-hoc network is considered that shows in figure 1. In a network, four devices are illustrated which labeled a to d. Here device a may communicate with device b or c or d and vice versa because they all are in range of each other.

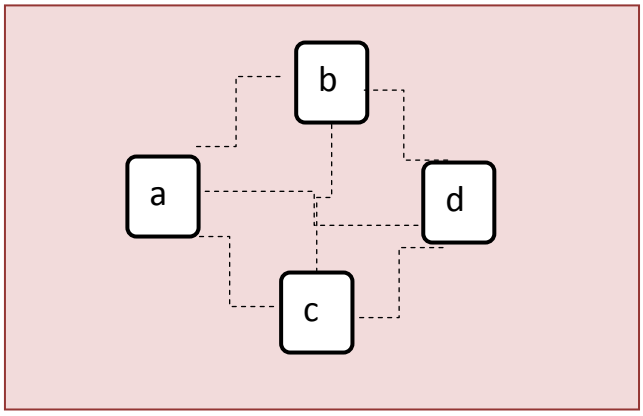

Fig. 1Ad-hoc network

A. Ad-hoc Network Categories

With the mobility characteristics, ad-hoc network devices are flexible to update their position according to user convenience. Mobility expands application area such as smart transportation as well as military and emergency areas. Inversely, mobility cause several issues such as route breaks, dropping of data, topology changes and many more. On the basis of diverse properties of devices, mobile ad-hoc network is categorized as homogenous and heterogeneous network. Homogenous network has devices with similar characteristics but heterogeneous network has devices with different characteristics. Fig. 2 shows the categories of mobile ad-hoc networks.

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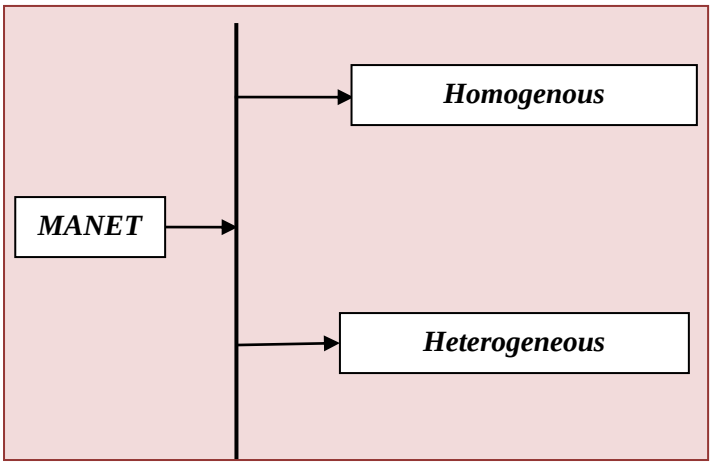

Fig. 2 Mobile Ad-hoc Network Categories

- **Heterogeneous Network**

Heterogeneous network deals with heterogeneous characteristics of devices which are defined in form of different transmission coverage, power consumption and battery backup. Fig. 3 illustrates the scenario of heterogeneous mobile ad-hoc network with different transmission coverage, mobility factor and battery backup.

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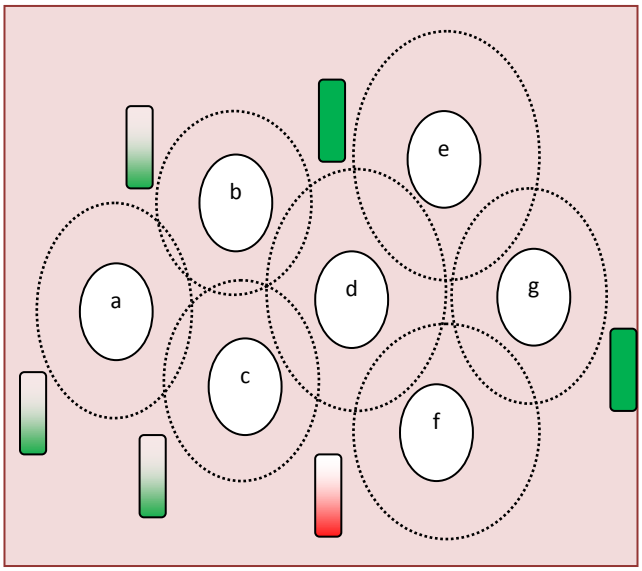

Fig. 3 Heterogeneous Network

B. Heterogeneity Issues

Heterogeneous property affects efficiency of routing procedure, performance and optimization of device resources and so on. Few among of them presented here.

- *Routing Issue- Most of current routing protocols assume homogeneous network conditions where all nodes have the same capabilities and resources [10].*
- *Network Lifetime- In the network, nodes may participate in communication with different battery power that leads link, nodes and service failure.*
- *MAC Layer Issues- Nodes play role of relay which deal with the incoming and outgoing traffics.*

II. RELATED WORK

In past few years, sufficient research work done in domain of mobile ad-hoc network considering routing, QoS , security and efficient utilization of resource constraints. In this section, several contributions on routing including clustering methods have been presented

Location based clustering and optimum gateway selection method [2] was approved. It was tried to improve routing performance for mobile ad-hoc networks.
Adaptive clustering method [3] was suggested to focus on inter domain routing. *In current scenario inter domain networking rely on gateway for inter domain route update, protocol translation.*
A new protocol [4] for cluster head and gateway election in wireless sensor network by making use of clustering was proposed. To improve location based clustering, I-GIDR method [5] was proposed with considering knowledge of neighbors. Further, mobility based cluster head elections method[6] was suggested. *Seung-Hoon Lee, et al [7] proposed a scheme for election of gateways in which many attributes of the border nodes have been considered for selecting them as gateways.*Another, NEMO [8] based on mobility was proposed which was focus clustering method.
On the basis of network performance, broadcast based clustering method was proposed for wireless ad-hoc network. *In this, control message exchange has been reduced by using a novel traffic isolation method.*Additionally, mobility parameter based MCFA [11] method was proposed. *A mechanism is proposed for intra and inters cluster routing in different cases [12]. The motive of the approach was to benefited features of on-demand and proactive routing protocols.* Moreover, energy efficient clustering method [13] was proposed. *It worked on the basis of determine the value of energy consumed of the network.* AMQR [14] clustering method based on different criteria such as scalability, competence was proposed. *Recently a stable loose clustering algorithm was present which consider intricate characteristics of nodes to elects cluster heads [15].*

III. PROPOSED METHOD

To enable clustering method for electing efficient cluster head, a cluster head election method is proposed. Proposed method initiates cluster head election procedure considering different characteristics of network devices. In election procedure, device transmission coverage and mobility factors are considered to take decision of a device is nominated as

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cluster head. The decision for cluster head is depends on the grade of device that computed by coverage, mobility factors. The decision made on the basis of high coverage and less velocity of device in the network. The whole process of cluster head election methods represented in form of algorithm that defined below.

A. Algorithm

The step by step process of cluster head election method represented through algorithmic form. Algorithm define number of nodes and their characteristics as input, perform cluster formation and cluster head election as process and return efficient cluster head as result or output. The complete step of algorithm shows below.

```
Algorithm ClusterHead (Node[], N)
{
DECLARE i, j, NB[],GN[],CL[],CH[],M, cov, CHead[] ;
 Repeat i=1 to N            //Cluster formation
  {
    If (reciveHello(Node [i],Node[i+1]))
    {
     CL[j++]=Node[i+1]
    }
   }
 Repeat j to M              //Cluster Head nominations
    {
    CH[j]=CluserHead (NB[j],NB[j+1])
    }
  Repeat j to M                  // Creation cluster head List and
select suitable cluster head
    {
    If (belongs (NB[j], CH[j]))
    CH[j]= NB[j];
    cov++
    }
    Repeat j to M                      // select suitable one
    {
    If          (CH[j].velocity<CH[j+1].velocity          &&
CH[j].cov>CH[j+1].cov)
    CHead[j]= GN[j];
    }
}
```

IV. SIMULATION & RESULT ANALYSIS

To evaluate the performance of proposed method, an experimental environment is considered. In this, a network is simulated using simulation software that named as NS-2 with considering different physical characteristic of network devices such as number of devices, coverage area, routing protocol and so on.

A.Network Characteristics

. The list of characteristics mentioned in table 1 that included in simulation work.

Table 1 Network Characteristics and their value

Network Characteristics	*Value*
Number of devices (mobile in nature)	*25,50,75,100*
Simulation area	*1000×1100*
Simulation time (seconds)	*100*
Device Coverage (meters)	*75,100,150*
Propagation Model	*Two Ray Ground*
Traffic class	*CBR*
Data size (bytes)	*512*
Routing Protocol	*AODV*
Connection Type	*TCP*

B.Network Simulation Scenario

Simulation scenario of network in NS-2 is created that define number of mobile devices, their transmission coverage and routing procedure. In this context, TCP traffic is created and AODV routing protocol is used to simulate proposed method. Fig.4illustrate simulation scenario for mobile ad-hoc networks.

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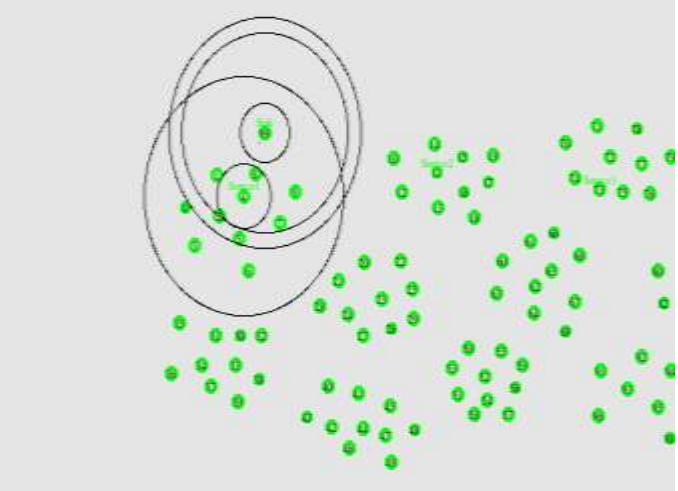

Fig. 4 Simulation Scenario

C. Result Analysis

Proposed methodis evaluated on the basis of different network performance criteria such as throughput, routing overhead and residual power of devices. The comparative results of proposed method show below.

Throughput-When number of bits or bytes or packets received at receivers in per unit time then it is known as throughput. The comparative method shows in figure 5.

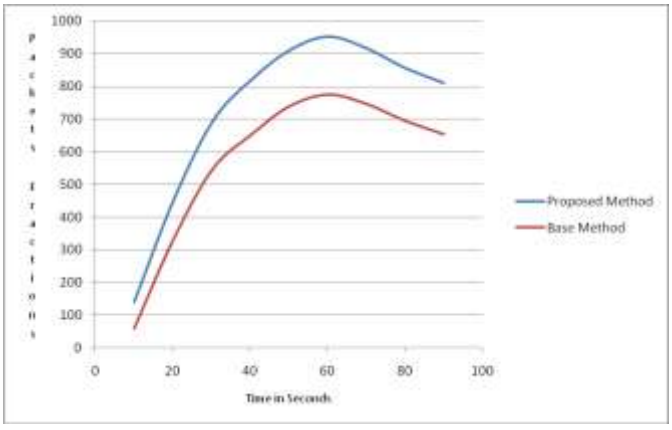

Fig. 5Throughput analysis

Residual power-In the network each device has limited battery power that consume some amount of it during an event in the network. Residual power indicate remaining battery of each device after the accomplish task. Fig. 6 depicts residual power analysis of network devices.

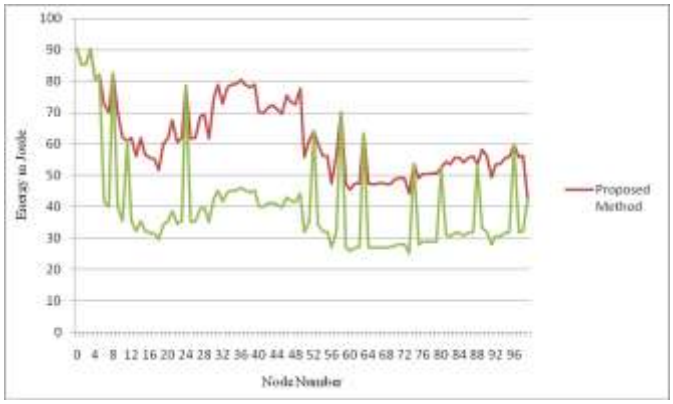

Fig. 6Residual power analysis

Routing Overhead-During the routing, certain number of control packets are exchanged to find route between source and destinations. Though, number of controls packets are transmitted during the route discovery indicates routing overhead. Fig. 7illustrates routing overhead analysis.

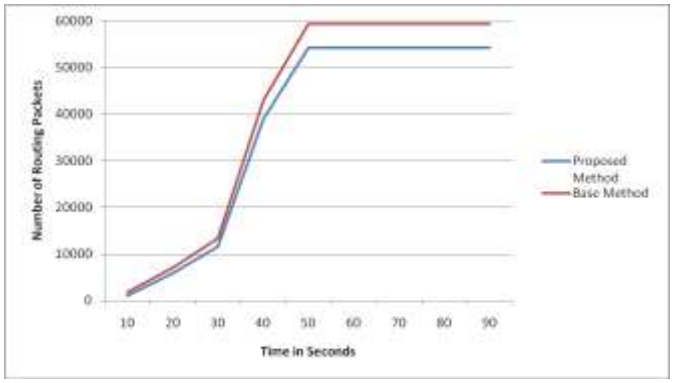

Fig. 7Routing overhead analysis

V. CONCLUSION

Efficient routing is key challenges for mobile ad-hoc network when devices have different characteristics. The performance of routing algorithm depends on the several constraints such as mobility, battery power of devices because they are finite in nature. Therefore, to improve the efficiency of routing algorithm the concepts of clustering is adapted. Clustering make efficient utilizations of finite resource by reducing flooding of control packets through conceptual partitioning of networks into clusters. But clustering method also face challenges during cluster head elections. Therefore, to enable clustering for electing effective cluster head in diverse network, a method was proposed. Proposed method was simulated in NS-2 and evaluated using different network criteria. Further, proposed method may be extended in the

aspects of different network constraints such as routing protocol and other device characteristics.

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