

## Performance Evaluation of Group Mobility in Mobile Ad hoc Networks

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**Abstract.** Mobility of nodes is an important issue in mobile adhoc networks (MANET). Nodes in MANET move from one network to another individually and in the form of group. In single node mobility scheme every node performs registration individually in new MANET whereas in group mobility scheme only one node in a group i.e group representative (GR) performs registration on behalf of all other nodes in the group and is assigned Care of Address (CoA). Internet protocol (IP) of all other nodes in the group remains same. Our simulated results prove that group mobility scheme reduces number of messages and consumes less time for registration of nodes as compared to single node mobility scheme. Thus network load is reduced in group mobility scheme. This research paper evaluates the performance of group mobility with single node mobility scheme. Test bed for this evaluation is based on Network Simulator 2 (NS-2) environment.

**Keywords:** Mobile Adhoc network, Group Registration, Group Representative, Care of Address

### 1 Introduction

The application of mobile adhoc network is increasing in the modern age. It is a network that is developed on the run without any prior infrastructure [1]. Every node in the network acts as a router or relay station to forward data to the designated node. In mobile adhoc network (MANET) the nodes are mobile that constantly changes their location from one MANET to another.

MANET is developed without any prior infrastructure so security is a big issue in it [2]. Nodes in MANET roam from one network to another. In roaming between different networks the main aim is to receive data in its new location without any delay and disruption. For this purpose mobile IP functionality is used to allow

roaming of nodes [3]. Mobile IP allows a node to acquire a virtual IP address called Care of Address (CoA) in the new network.

In mobile IP scenario [4] when a mobile node (MN) is in its original location, that network is known as home network. When it moves to a new network that network acts as a foreign network. When a mobile node moves from its home network to foreign network, it sends registration request to foreign agent. The foreign agent sends registration request to home network of the mobile node. The home agent sends registration reply to the foreign agent. The foreign agent send registration reply to mobile node and it is assigned a Care of Address in the foreign network.

A group registration with group mobility scheme is proposed [6]. In this scheme nodes moves in the form of a group. Groups are established on the basis of similar interests like army soldiers can form infantry, artillery or armored group. Groups can be identified as business or educational groups. There is a fixed node in the network which is the overall controller of MANET. This fixed gateway keeps the mobility location of all nodes in the network. Every group has a group representative (GR) which is controller of the group. When nodes move in the form of a group, this GR performs registration on behalf of all other nodes in the group. Only GR is assigned an individual CoA. IP of all other nodes in the group remains same.

The rest of this paper is organized as; section 2 describes the related work. The mathematical function is described in section 3. In section 4 simulation results are described. Section 5 concludes the contribution of this paper. At the end of this paper references are given.

## 2 Related Work

There are various schemes for mobility in MANET. Mobile IP routers are used to support mobility [7]. This router has two interfaces. One interface is connected to MANET and other is connected to outside world. A scheme is proposed by Zhao [8] for adhoc network connection to the internet. In this scheme dynamic gateways are used that uses mobile IP functionality. Mobile nodes in adhoc network use these dynamic gateways to connect to the internet. The dynamic gateway architecture has several advantages, like it eliminates the need of fixed gateways, reduces system complexity, improves reliability and lowers the cost.

Mobile IP functionality is used in mobile adhoc network [5]. All the nodes in the network are mobile except one node that is fixed. This fixed node acts as a gateway. This concept allows single node mobility. When a node moves, it asks for registration request and it is assigned a Care of Address (CoA). All the nodes are assigned an individual CoA in the new network. A scheme explained internet based mobile ad hoc networking [9]. Each node in a mobile adhoc network (MANET) logically consists of a router with possibly multiple IP addressable hosts. End devices in MANET are mobile.

### 3 Mathematical Analysis

In this section we have performed mathematical analysis of group mobility scheme with single node mobility scheme [6].

The mathematical function shows the relationship of number of nodes with number of messages for single node mobility scheme.

$$f(n) = m * n \quad \text{for all } n \geq 1$$

m = no. of messages which is constant i.e 5

n =no. of nodes

If n=1  $f(1) = 5 * 1 = 5$

If n=2  $f(2) = 5 * 2 = 10$

If n=3  $f(3) = 5 * 3 = 15$

If n=4  $f(4) = 5 * 4 = 20$

If n=5  $f(5) = 5 * 5 = 25$

The relationship of number of nodes with number of messages in group mobility scheme is

$$f(n) = m \quad \text{for all } n \geq 1$$

If n =1  $f(1) = 5$

If n =2  $f(2) = 5$

If n =3  $f(3) = 5$

If n =4  $f(4) = 5$

If n =5  $f(5) = 5$

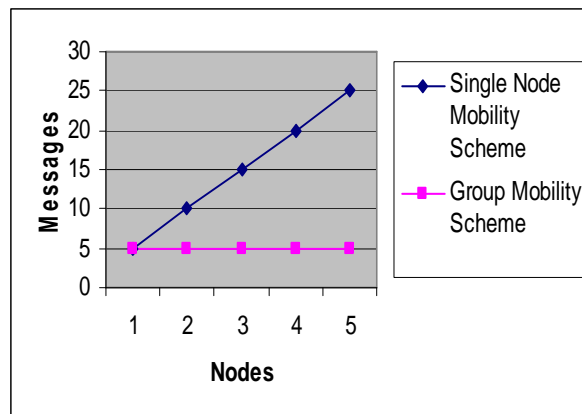
In single node mobility scheme as no. of nodes increases in the MANET, no of messages increases. In group registration concept as the number of nodes increases, the no. of messages to register node in the new group remains same because in this scheme only one node i.e GR performs registration on behalf of all other nodes in the group.

**Table 1.** Comparison of messages between single & group mobility scheme

SCHEMES	NUMBER OF NODES				
	1	2	3	4	5

	NUMBER OF MESSAGES				
SINGLE NODE MOBILITY SCHEME	05	10	15	20	25
GROUP MOBILITY SCHEME	05	05	05	05	05

In Fig. 1 the number of messages is shown at horizontal axis while the vertical axis shows the number of nodes. In single mobility scheme the number of messages tends to grow with the increasing number of nodes. While in group mobility scheme the number of messages remains constant with the increasing number of nodes as compared to single node mobility scheme.



**Fig. 1** Comparison of message consumption for registration between single and group mobility schemes

## 4 Simulations

In this section we have discussed the simulations environment, simulation detail and its results. We have performed our simulation results on NS-2.

### 4.1 Message Size

The architecture consists of 5 mobile nodes in a group, 5 in other group and one node that is fixed in group mobility scheme. In this scheme when a group moves, GR of

group sends 5 messages to register itself in new group. Each message is of 128 bits in length. So total size of messages for registration of GR is 640 bits in length.

In single node mobility scheme there are 5 mobile nodes in a MANET and 5 nodes in other MANET. One node in each MANET is fixed that acts as a gateway. In this scheme every node sends individual registration request message. The message size is 128 bits in length and one node sends 5 messages for registration so it takes 640 bits for registration of one node, so total size of message for registration of 5 nodes is 3200 bits length.

#### 4.2 Registration Time

In group registration scheme when a group moves, GR of group only send registration request message. This registration process of whole group is completed in 4.30 ms. In this scheme only GR sends registration request as it does registration on behalf of all other nodes in the group. So registration of whole group is completed in this time.

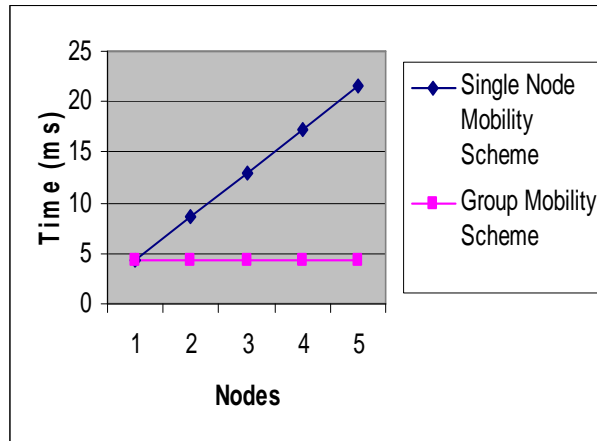
In single node mobility scheme when 1<sup>st</sup> node moves to a new MANET, it completes registration process in 4.30 ms. Second node completes its registration process in 8.60 ms. Third node completes this process in 12.90 ms. Fourth node completes this process in 17.20 ms. Fifth node completes this process in 21.50 ms.

**Table 2.** Registration Time for Nodes

SCHEMES	NUMBER OF NODES				
	1	2	3	4	5
	TIME FOR REGISTRATION (ms)				
<b>SINGLE NODE MOBILITY SCHEME</b>	4.3	8.6	12.9	17.2	21.5
<b>GROUP MOBILITY SCHEME</b>	4.3	4.3	4.3	4.3	4.3

In Fig. 2 the time in milliseconds has been shown at horizontal axis while the vertical axis shows the number of nodes. In single mobility scheme the registration

time tends to grow with the increasing number of nodes. While in group mobility scheme the registration time remains constant with the increasing number of nodes as compared to single node mobility scheme.



**Fig. 2.** Registration time for nodes

### 4.3 Network Load

Network load is reduced in group mobility scheme as compared to single mobility scheme. In group mobility scheme network load for registration of a group is 0.625 Kbps. The network load in single node mobility scheme for registration of nodes in MANET is 3.125 Kbps.

**Table 3.** Network load for Single & Group mobility scheme

NETWORK LOAD	Kbps
SINGLE NODE MOBILITY SCHEME	3.125
GROUP MOBILITY SCHEME	0.625

## 5 Conclusion

In this research paper we have simulated the results of group mobility and single node mobility schemes in MANET. We have discussed the simulation scenarios, mathematical functions and simulation results which validate the efficiency of group mobility scheme. The validated result shows that group mobility scheme not only

reduces the number of messages, it also reduces the network load and time for registration of nodes.

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