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Integration of Internet with Mobile Ad-Hoc Network: By Extended AODV

Mrs. Nidhi Jain
(Asst. Professor of ECE Department)

Abstract: *Mobile Ad-hoc Networks are autonomously self-organized networks without infrastructure support. To provide communication within the network a routing protocol is used to discover routes between nodes. The main aim of the routing protocol is to have an efficient route establishment between a pair of nodes, so that messages can be delivered in a timely manner. Routing in the MANETs is a challenging task which has led to development of many different routing protocols for MANETs. The recent years have witnessed a tremendous growth in the number of mobile internet users and the need for mobility support is indispensable for seamless internet connectivity.* ***Mobile IP*** *is a mobility support protocol that supports roaming across multiple Access Points without having to re-establish the end to end connection. After investigate the several challenges that Mobile IP faces it would turn out to be the protocol for supporting mobility in the future is known as Extended AODV or enhanced AODV or AODV+. This paper has been made to implement, the integration of internet with mobile ad-hoc network, using routing protocol extended AODV for two performance matrices Packet Delivery Ratio and End to End Delay. Simulation tool is Network Simulator-2. To provide the connectivity between wired and wireless network, we made the scenario in this way that it provide large Packet Delivery Ratio and less average End to End delay.*

I. Introduction

MANET (Mobile Ad-Hoc Network) is Infrastructure less, Dynamic in nature wireless network in which all the devices are independent to move from one place to another. These networks are extremely flexible, self configurable, and do not require the deployment of any infrastructure for communication among mobile devices. MANET is a multi-hop wireless network which forms a temporary infrastructure less network and communicates with each other and support decentralized administration. In MANET each node (Device) can move independently thus each node acts as a Router and Forward packets. Because of High mobility of nodes, network topology changes frequently. That's why Routing in Ad-Hoc network becomes a more Challenging task. Therefore routing in MANET becomes recent research area. Every node has its own transmission range and every node acts as a router used for data transmission of all nodes with data of itself. The principle behind ad hoc networking is multi-hop relaying

1.1 Cellular and Ad Hoc Wireless Networks

Fig 1.1 shows the major Difference between ad hoc and cellular networks. In this figure one side is cellular network in which the mobile nodes communicate to each other via. base station. On the other side is ad hoc wireless network in which the mobile nodes can communicate to each other only by multi hop relying not by the base station. Because of their self creating, self-organizing and self administering capabilities, ad hoc networks can be rapidly deployed with minimum user intervention. There is no need for detailed planning of base station installation or wiring. Also, ad hoc networks do not need to operate in a stand-alone fashion, but can be attached to the Internet, thereby integrating many different devices and making their services available to other users

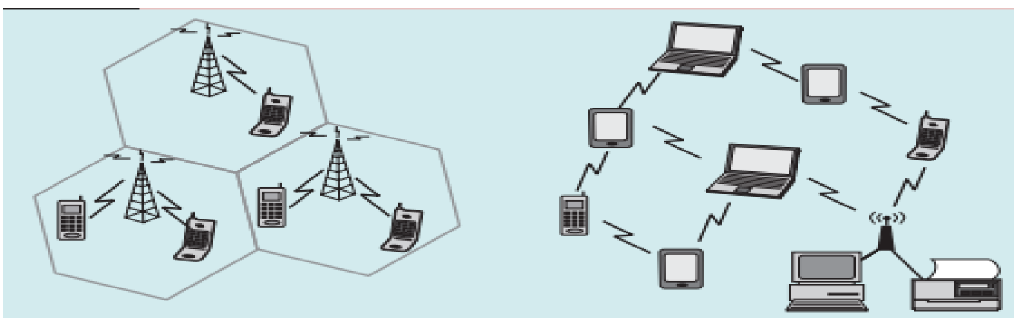


Fig 1.1 Cellular and Ad hoc Network

1.2Applications of Ad Hoc Wireless Networks
The major applications of Ad Hoc wireless networks include

1.2.1Military Applications

Ad hoc wireless networks can be very useful in establishing communication among a group of soldiers for tactical operations. Setting up a fixed infrastructure for communication among a group of soldiers in enemy territories or in inhospitable terrains may not be possible. In such environments, ad hoc wireless networks provide the required communication mechanism quickly. Another application in this area can be the coordination of military objects moving at high speeds such as fleets of airplanes or warships.

1.2.2 Emergency Applications

Ad Hoc wireless networks are very useful in emergency operations such as search and rescue, crowd control, and commando operations. The major factors that favor ad hoc wireless networks for such tasks are self configuration of the system with minimal overhead, independent of fixed or centralized infrastructure, the nature of the terrain of such applications, the freedom and flexibility of mobility, and the unavailability of conventional infrastructure based communication facilities are destroyed due to a war or due to natural climates such as earthquakes, immediate deployment of ad-hoc wireless networks would be a good solution for coordinating rescue activities.

1.2.3Wireless Sensor Network Applications

Wireless Sensor Networks are a special category of ad hoc networks that are used to provide a wireless communication infrastructure among the sensors deployed in a specific application domain. A sensor network is a collection of a large number of sensor nodes that are deployed in a particular region.

1.3 Issues in Ad hoc Wireless Networks

The major issues and challenges that are need to be considered when an ad hoc wireless system is to be designed. The major issues that affect the design, deployment, and performance of an ad hoc wireless system are as follows.

1.3.1 Media Access Scheme

The major issues to be considered in designing a MAC protocol for ad hoc wireless networks are as follows:

Distributed operation**:** The Ad Hoc wireless networks need to operate in environments where no centralized coordination is possible**.**

Synchronization**:** The MAC protocol design should take into account the requirement of time synchronization. Synchronization is required in TDMA-based systems.

Hidden terminals: Hidden terminals are nodes hidden from a sender of a data transmission session, but are reachable to the receiver of the session. The hidden terminal can cause collisions at the receiver node. The presence of hidden terminals can significantly reduce the throughput of a MAC protocol used in Ad Hoc network

Exposed terminals: Exposed Terminals, the nodes that are in the transmission range of the sender of an outgoing session, are prevented from making a transmission. In order to improve the efficiency of the MAC protocol, the exposed nodes should be allowed to transmit in a controlled fashion without causing collision to the on-going data transfer.

1.3.2 Routing

The major challenges that a routing protocol faces are as follows.

Mobility: The mobility of nodes results in frequent path breaks, packet collisions, transient's loops, stale routing information, and difficulty in resource reservation. A good routing protocol should be able to efficiently solve all the issues.

Bandwidth constraint: Channel is shared by all nodes in the broadcast region, the bandwidth available per wireless link depends on the number of nodes and the traffic they handle.

1.3.3 Security

The major security threats that exist in ad hoc wireless network are as follows.

Denial of Service: The attacks effected by making the network resource unavailable for service to other nodes either by consuming the bandwidth or by overloading the system is known as denial of service.

Resource consumption**:** The scarce availability of resources in ad hoc wireless network makes it an easy target for internal attacks, particularly aiming at consuming resources available in the network.

II. Routing Protocols

2.1 Overview of routing protocols

Compared to wired networks, mobile networks have unique characteristics. In mobile networks, node mobility may cause frequent network topology changes, which are rare in wired networks. Because of the importance of routing protocols in dynamic multi hop networks, a lot of mobile ad hoc network routing protocols have been pro-posed in the last few years. The broadcast nature of the wireless medium introduces the hidden terminal and exposed terminal problems. Additionally, mobile nodes have restricted power, computing, and bandwidth resources and require effective routing schemes. As promising network types in future mobile applications, mobile ad hoc networks are attracting more and more researchers.

2.2 Classification of Routing Protocols

The existing routing protocols in MANETs can be classified into three categories.
Table Driven or Proactive
Source on Demand
Hybrid.

2.2.1 Table Driven or Proactive Routing Protocol

Using a proactive routing protocol, nodes in a mobile ad hoc network continuously evaluate routes to all reachable nodes and attempt to maintain consistent, up-to-date routing information. Therefore, a source node can get a routing path immediately if it needs one. In proactive routing protocols, all nodes need to maintain a consistent view of the network topology. When a network topology change occurs, respective updates must be propagated throughout the network to notify the change. Most proactive routing protocols proposed for mobile ad hoc networks have inherited properties from algorithms used in wired networks. In this category DSDV routing protocol is used.

DSDV (Destination Sequenced Distance Vector Routing Protocol)

DSDV is Destination Based Routing protocol and it is Proactive (Table Driven). The characteristics of DSDV are as follows. Each node maintains routing information for all known destinations and Routing information must be updated periodically. It makes immediate route advertisement on significant changes in routing.

2.2.2 Source on Demand

Source on demand routing protocol is also known as reactive routing protocols for mobile ad hoc networks. In a reactive routing protocol, routing paths are searched only when needed. A route discovery operation invokes a route determination procedure. The discovery procedure terminates when either a route has been found or no route is available after examination for all route permutations. In a mobile ad hoc network, active routes may be disconnected due to node mobility. Therefore, route maintenance is an important operation of reactive routing protocols. Compared to the proactive routing protocols for mobile ad hoc networks, less control overhead is a distinct advantage of the reactive routing protocols. Thus, reactive routing protocols have better scalability than proactive routing protocols in mobile ad hoc networks**.** Ad Hoc On-Demand Distance Vector (AODV) Routing Protocol and the Dynamic Source Routing (DSR) Protocol are examples of reactive routing protocols for mobile ad hoc networks.

AODV (Ad Hoc On-Demand Distance Vector)

Reactive protocols discover routes only as needed. When a node wishes to communicate with another node, it checks with its existing information for a valid route to the destination. If one exists, the node uses that route for communication with the destination node. If not, the source node initiates a route request procedure, to which either the destination node or one of the intermediate nodes sends a reply back to the source node with a valid route.

AODV Route Requests (RREQs)

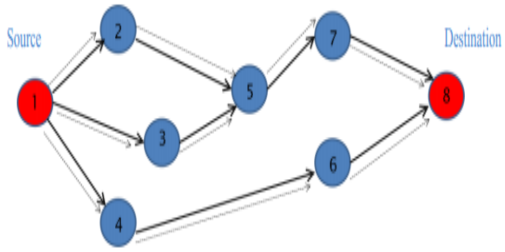


Fig. 2.1 AODV route request

Each neighboring node will pass this RREQ message to other its neighboring node until the destination will find.
Route Reply (RREPs)

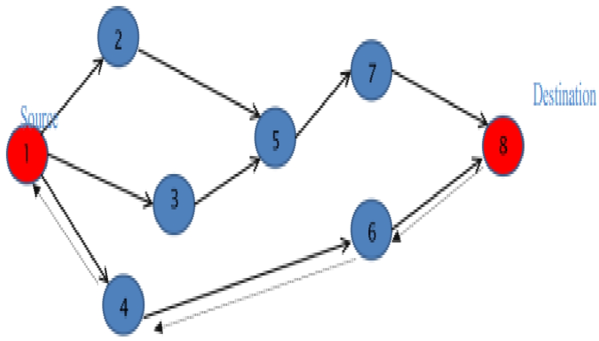


Fig. 2.2 AODV route reply

If a node has some data to send, it will broadcast a route request message to its neighbors. Intermediate nodes received the RREQ message and store the address of the source node in the routing table so that if duplicate RREQ is received in future may be discarded. If any node has a current route to the destination lies send a response to the source in the form of RREP message. The node may be the destination node.During the reverse movement of RREP, nodes in this path will store the forward route entries for setting up of forward route to the destination.

III. Extended Aodv

The interworking between mobile ad hoc networks and the Internet is described in this section.

3.1 Motivation

Although an autonomous, stand-alone mobile ad hoc network is useful in many cases, a mobile ad hoc network connected to the Internet is much more desirable. So far, most of the research concerning mobile ad hoc networking has been done on protocols for autonomous mobile ad hoc networks. To achieve this network interconnection, gateways that understand the protocols of both the mobile ad hoc network stack and the TCP/IP suite are needed. All communication between a mobile ad hoc network and the Internet must pass through the gateways. The Internet draft "Global Connectivity for IPv6 Mobile Ad Hoc Networks" describes how to provide Internet connectivity to mobile ad hoc networks. In particular, it explains how a mobile node and a gateway should operate. Further, it proposes and illustrates how to apply a method for discovering gateways. In the case for reactive routing protocols, the idea is to extend the route discovery messaging, so that it can be used for discovering not only mobile nodes but also gateways

3.2 The Extended Route Request

The extended RREQ message contains exactly the same fields with the same functions as the ordinary RREQ message, except for a flag. This flag is called Internet-Global Address Resolution Flag and is referred to as the I-flag. Hence, the RREQ message extended with the I-flag is referred to as the RREQ_I message throughout this text**.**

Frame Format of Extended RREQ_I

TABLE 3.1 Frame Format of Extended RREQ_I

Flag I(Internet Global Address Resolution Flag)
RREQ ID
Destination IP address
Destination sequence no.
Originator IP Address
Originator sequence no.

3.2 The Extended Route Reply

The extended RREP message contains exactly the same fields with the same functions as the ordinary RREP message, except for a flag. This flag is the same flag that has extended the RREQ message to the RREQ_I message, namely the Internet-Global Ad-dress Resolution Flag (or the I-flag). Hence, the RREP message extended with the I-flag is referred to as the RREP_I message throughout this text.
Frame Format of Extended RREP_I

TABLE 3.1 Frame Format of Extended RREP_I

Flag I(Internet Global Address Resolution Flag)
Destination IP address
Destination sequence no.
Originator IP Address
Life Time

IV. Network Simulator-2

Network Simulator (NS) is an object-oriented, discrete event simulator for networking research. NS provides substantial support for simulation of TCP , routing and multicast protocols over wired and wireless networks. The simulator is a result of an on-going effort of research and development. Even though there is a considerable confidence in NS, it is not a polished and finished product yet and bugs are being discovered and corrected continuously .NS is written in C++, with an OTcl interpreter as a command and configuration interface. The C++ part, which is fast to run but slower to change, is used for detailed protocol implementation. The OTcl part, on the other hand, which runs much slower but can be changed very quickly, is used for simulation configuration. One of the advantages of this split-language programming approach is that it allows for fast generation of large scenarios. To simply use the simulator, it is sufficient to know OTcl.

Basic Architecture of NS

NS2 consists of two key languages: C++ and Object oriented Tool Command Language (OTcl). While the C++ defines the internal mechanism (i.e. a backend) of the simulation objects, the OTcl sets up simulation by assembling and configuring the objects as well as scheduling discrete events.

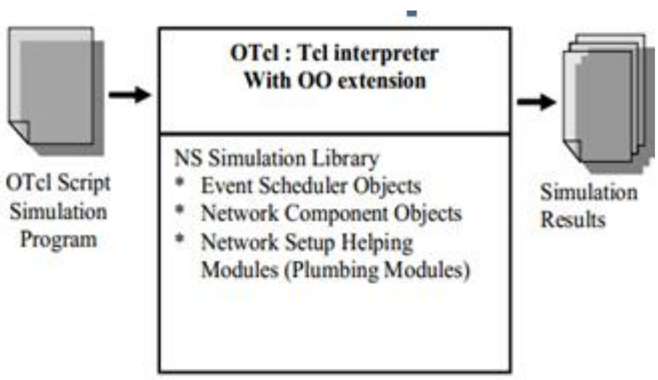


Fig. 3.1NS-2 structure

V. Simulation

5.1 Internet access for wired-cum-wireless Network using ADOV+

To provide connectivity between these two environments we have a concept of extended AODV. Extended AODV is a solution to provide connectivity for mobile nodes if any node move from one type of network to another network.

Simulation Setup: This section describes the simulation scenario, Simulation model to provide the connectivity between MANET and wired network with the help of Mobile IP concept.

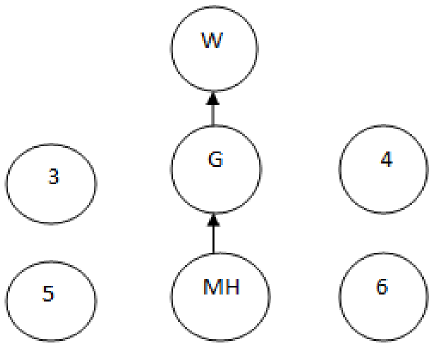
Simulation Scenario: The simulation is done under NS 2. The basic configuration is that in a 1000mt*1000mt Square area with variable no. of mobile nodes. The traffic Sources are CBR (Constant Bit Rate), 512 byte as data packets. The maximum speed of mobile nodes is 20mt/sec and simulation time is 250Sec. To use CBR is for a fair comparison purpose, since bit rate vary will make the data packets traffic load unpredictable, which situation we do not want it happen. Transmission range is 250mt. and routing protocol is Extended AODV.

In this simulation we have Two Domain

1. Wired domain(fixed network)
2. Wireless Domain(MANET)

In wireless domain Node 1 is Gateway node(G)

Scenario 1 Data travel from MH (mobile host node 2) to Wired node (W) via Gateway



Scenario 2 Data travel from MH to W via node 3 e.g. (1 hop)

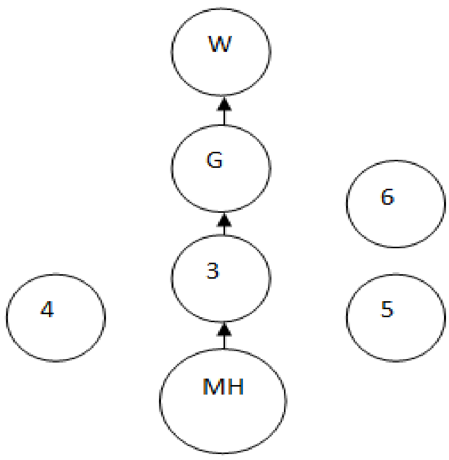


Fig. 5.2 data travel from wireless to wired node via 1 hop

Scenario 3 Data travel from MH to W via Gateway, MH, node no. 3 and 4 (hop 2)

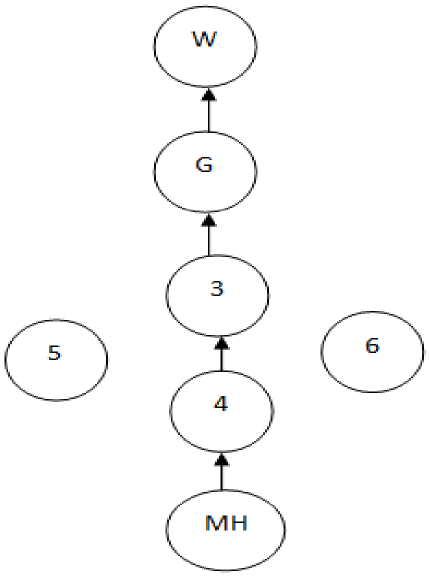


Fig. 5.3 data travel from wireless to wired node via 2 hop

Scenario 4. Data travel from MH to W via Gateway, MH, node no. 3,4,5(hop 3)

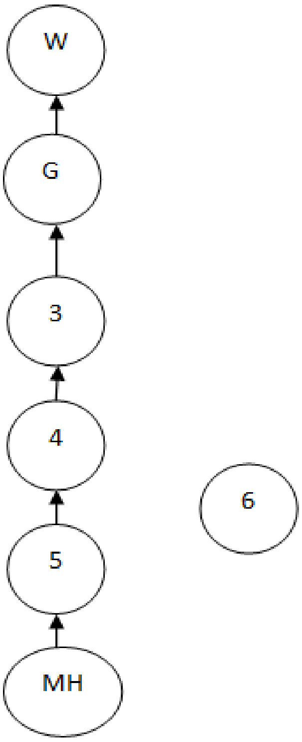


Fig. 5.4 data travel from wireless to wired node via 3 hop

Scenario 5 Data travel from MH to W via Gateway when MH moves from one network to another network.

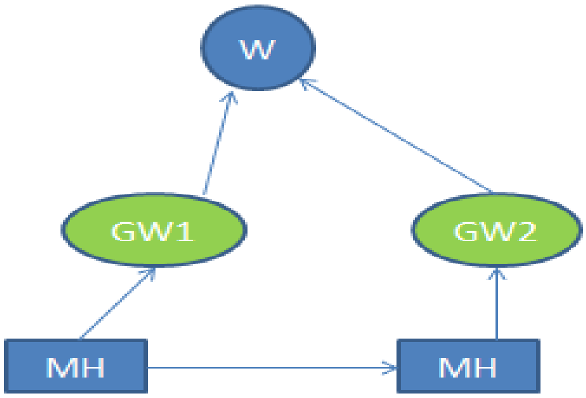


Fig. 5.5 data travel from wireless to wired node via Gateway 1 and Gateway 2

5.2 Simulation Parameters

TABLE 5.1Simulation Parameters

Parameters	Value
Simulator	NS-2
Routing Protocol	Extended AODV
MAC Layer	802.11 IEEE
Simulation Time	60 Secs
Simulation Area	1000m x1000m
Transmission Range	250m
Traffic Type	CBR
Data Payload	512bytes/packets
Speed of Node	20m/s

5.3 Performance Evaluation Metrics

Packet Delivery Ratio-The ratio of the data packets delivered to the destinations to those generated by the CBR sources. It is the fraction of packets sent by the application that are received by the receivers.

End-to-End Delay – End-to-End delay indicates how long it took for a packet to travel from the source to the application layer of the destination i.e. the total time taken by each packet to reach the destination.

5.4 Simulation Results:

Table 5.2 No. of Hopes, PDR and E2E delay

No. of Hopes	PDR(%)	Average End to End Delay
0	50%	0.00759633
1	49.623	0.0244597
2	48.990	0.0244603
3	49.897	0.0244723
4	49.7976	0.0270019
5	49.5253	0.0291146

This simulation result shows that if we increase the no. of hopes then PDR decrease and E2E delay increase. In this project we are trying to reduce the E2E delay and slowly reduce PDR. That means is nearly constant and E2E delay also has low variation.

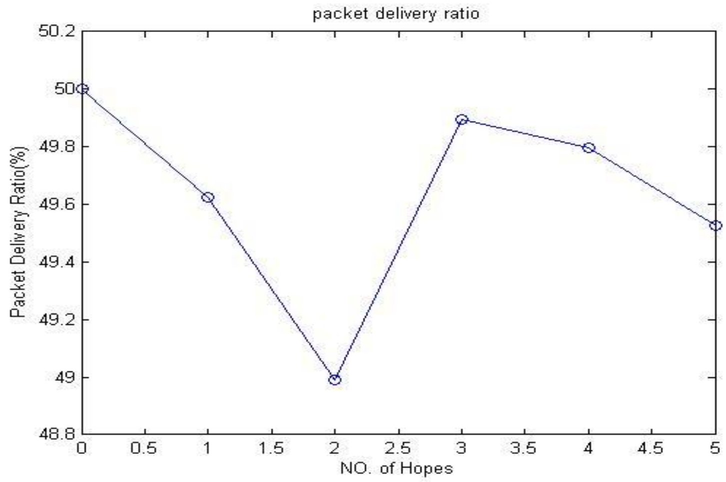


Fig. 5.6 Packet Delivery Ratio Vs No. of Hopes

Fig 5.6 shows that if we increase the no. of hopes then PDR will vary either increase or decrease depend on the position defined of the mobile nodes.

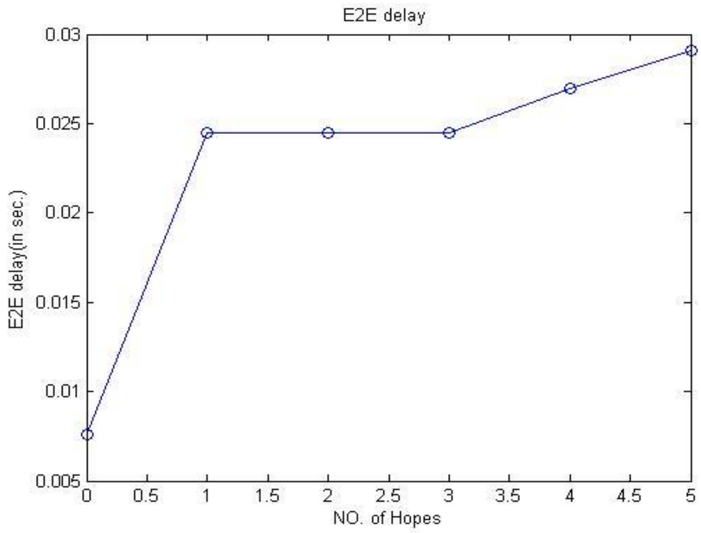


Fig. 5.7 End to End Delay Vs No. of Hopes

Fig 5.7 shows that if No. of Hopes increases then End to End Delay also increases.

VI. Conclusion

A fixed infrastructure network and MANET can be combined to make them work together in order to set up a multi hop path between MANET nodes and fixed infrastructure base stations, and allow MANET to obtain internet connectivity.If we increase the no. of hopes then the PDR decreases with respect to multi hop communication but if we arrange the mobile nodes in proper distance then we can maintain the PDR. If we increase the no of hopes end-to-end delay increases due to multi hop takes time.

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