Framework for Enhancing Connectivity in Hybrid Manets

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***Abstract* -** The increasing demand for enabling MANET nodes to connect to IP based fixed infrastructure wired networks and use their services and applications requires cooperation of MANET routing protocols and IP mobility protocol. Integration of MANETs to the fixed infrastructure IP access networks is useful in many scenarios. MANET users can access the wired network and Internet and access a range of services and applications. In this paper, we have proposed a framework which provide connectivity to MANET node to the wired network using Mobile IP enabled gateway nodes. We implement Mobile IP with DSDV protocol to provide connectivity between hybrid MANETs. The proposed framework is simulated in ns2 simulator and the performance of proposed framework is evaluated on the basis of packet delivery ratio, average end to end delay and throughput under different scenarios.

Keywords: Hybrid MANETs, Gateway node, Routing Protocols, Mobile IP

I. INTRODUCTION

MANET is a wireless network architecture which consist of mobile nodes which can communicate with each other, without the need of network infrastructure or centralized administration [1]. MANETs have some limitations which includes dynamic topology, limited battery power of mobile nodes, limited bandwidth, limited wireless coverage &limited number of services and applications [2]. The lack of

Connectivity to the wired infrastructure enables simple management and deployment of MANETs, but it limits the applicability of MANETs to scenario which requires connectivity to the outside network. Nodes in the MANET can be connected to other networks such as internet resulting in Hybrid MANETs [3]. Hybrid MANETs enables the mobile node to access internet services and is achieved through gateway which act as a bridge between MANET and the Internet [4]. The Hybrid MANETs architecture consist of MANETs connected with the wired network with the help of gateways. The gateway node act as a bridge between the MANET and the outside world. All communication to the outside world passes though the gateway i.e. mobile node can get data from the correspondent node CN through the gateway node and vice versa.

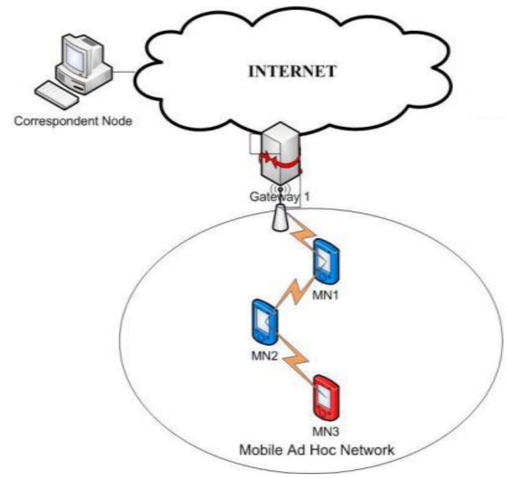

Fig.1**.** Hybrid MANET architecture

The rest of the paper is organized as follows. Section 2 presents the overview of MANET routing protocols and Mobile IP. Section 3 discuss the proposed framework. Section IV simulates the proposed framework and performance evaluation is done under different scenarios. Section V provides conclusion of the paper.

II. LITERATURE REVIEW

2.1 MANET routing protocols

Routing protocols have a significant role in enabling communication in wireless ad hoc networks. Routing protocols can be classified as proactive, reactive and hybrid protocols [5]. Proactive or Table driven routing protocols keep up-to-date routing information in a routing table which is exchanged periodically or when network topology changes. Optimized link state routing (OLSR) [6] and destination sequenced distance vector (DSDV) [7] are well known proactive routing protocols. Reactive or on demand routing protocols creates route to the destination only when required. Examples of on demand routing protocols includes AODV [8], DSR [9]. Hybrid routing protocols provides the benefits of proactive and reactive routing protocols.

2.1.1 DSDV

Destination Sequence Distance Vector (DSDV) routing protocol [7] allows a set of mobile node to exchange data along changing and arbitrary paths. Every mobile node stores routing table it. Every routing table list all available destinations and no. of hops to each. Each route table entry is tagged with a sequence number which is originated by destination node.

Routing information is advertised by broadcasting. Updates are sent periodically and when significant new information is available. DSDV protocol requires each mobile node to advertise its routing table to each of its neighbors. At all instants DSDV protocol guarantees loop free paths to each destination by the use of sequence numbers.

2.2 Mobile IP

Mobile IP allows transparent routing of IP packets to mobile nodes in Internet [10]. Each mobile node (MN) is identified by its home address regardless of its current point of attachment to the internet. Correspondent Node (CN) is the host that communicates with the mobile node. The Mobile IP protocol has two types of Mobility Agents. These are Home Agent (HA) and Foreign Agent (FA). The home agent resides at the home network of the mobile node. Packets from the CN to the MN are routed using the home address. The HA intercept the packets and tunnels them to the current location of the MN. To tunnel packet to MN, the HA must be aware of the current location of the MN. The MN acquires a Care-of-Address (CoA) from the network it is visiting. Every time the MN moves, the current CoA is registered to the HA. A foreign resides in the visited network. It offers routing services for the registered mobile nodes. The FA provides the MN with CoA and detunnels and delivers datagrams to the MN that are tunneled by the HA. The FA can also serve as a default router for the registered MNs. MN sends packets to the CN, it uses the home address as a source address. Packets can be routed directly to CN or tunneled via HA.

2.3 RELATED WORK

In the literature, many solutions have been proposed for integrating MANET with the Internet using IP Mobility protocols [11]. According to the gateway discovery procedure these integrated routing protocols can be classified as proactive solutions, reactive solutions and hybrid solutions [12]. In the proactive solutions, agent advertisement messages are broadcast by gateway nodes and forwarded to whole ad hoc network. The agent advertisement message is used for gateway discovery, creating default route, movement detection and handoff decision based on number of hops. In [13], MEWLANA, Mobile IP Enriched Wireless Local Area Network, MEWLANA-TD and MEWLANA-RD are proposed. Three types of domains are considered namely, Internet domain, the FA domain and the ad hoc domain. MEWLANA-TD uses DSDV routing protocol to route packets between the FA and Mobile ad hoc nodes. In MEWLANA-RD, table based bidirectional routing (TBBR) is used to route packets between the ad hoc mobile nodes to the FA. In [14], EDSDV is proposed to solve link break problem due to high mobility. It also propose bidirectional connectivity for ad hoc networks.

In [15], an ad hoc networking mechanism is designed and implemented, which enables mobile computers to communicate with each other and access the internet. The proposal makes FA to serve a mobile node which is out of communication range. A modified RIP (Routing Information Protocol) I sued to handle the routing inside the ad hoc network. In [16], MIPMANET – Mobile IP for Mobile Ad Hoc Networks, uses FA as an access point to the Internet. AODV routing protocol is used to route packets between the FA and ad hoc nodes. When a node wants to access the internet, it registers with FA using its home address. The mobile node in the ad hoc network tunnel the packet s to the FA in order to send them to the Internet. Routing of packet inside the ad hoc network is based on ad hoc routing protocol used i. e. AODV.

In [17], the authors proposes a method to enable MANET to obtain Internet connectivity. The proposed method integrate Mobile IPv4 and AODV, such that a mobile node outside the FA transmission range and get a CoA and connect with Internet through other hops in the MANET. It can roam to another MANET subnet without disconnection using Mobile IP. In [18], authors combine the mobile IP and AODV such that the mobile node in the ad hoc network can obtain Internet connectivity and roam to another subnet. In [19], Integration of a MANET with the Internet is proposed. In this integration, one hop wireless networks are extended to multiple MANETs. Every MANET is served by an FA (access point) and it represent a subnet of Internet. The proposed architecture consist of multiple MANETs connected to the Internet using different access points called Gateways.

II. PROPOSED FRAMEWORK

Our proposed framework consist of multiple MANETs attached to the backbone Internet through gateway nodes. A Gateway is the host that connects MANET to the Internet. Each Gateway is connected with the internet through wired link and with MANET through wireless links. Gateway forward data packets from the Mobile node to the Correspondent node and vice versa. Gateway nodes works as a home agent for local nodes and foreign agent for the visitor nodes. DSDV protocol is used for routing for the communication of the nodes which want to communicate with each other inside the MANET. To communicate with the wired domain, the mobile node send the packet to gateway node which in turn forward the packet to the correspondent node. Similarly, packets from the correspondent node reached to the mobile node through gateway node.

3.1 Proposed protocol stack

MANET Node

Application	
TCP	
IP	DSDV
LLC 802.11 MAC	
802.11 PHY	

Gateway Node

Application		Application
TCP		TCP
IP	DSDV	MIP
LLC 802.11 MAC		Data Link
802.11 PHY		Physical

Internet Host

Application
TCP
IP
Data Link
Physical

Fig.2: Proposed protocol stack for MANET node, Gateway node and Internet Host

3.2 Proposed Network Model

In the proposed network model, there is one correspondent node CN which is connected with router R which in turn is connected to two gateway nodes G1 and G2 which are providing connectivity to two different Manets. Also G2 is assigned the responsibility of Foreign Agent which servers the mobile nodes which comes to its are

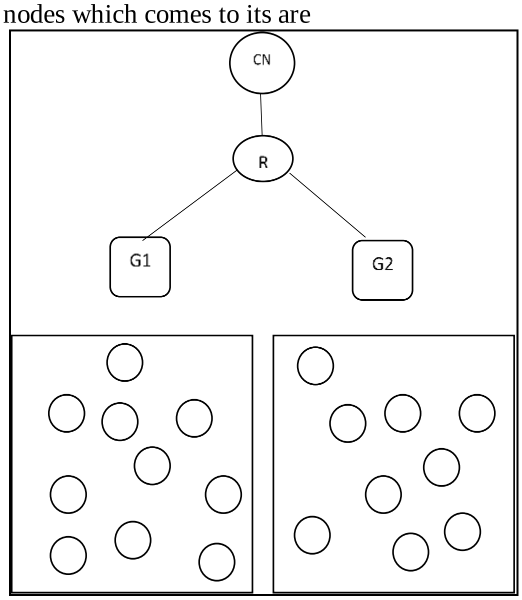

Fig.3: Proposed Network Model

3.3 Proposed Scheme

We have proposed the new scheme which consist of three different parts.

Part 1: When a mobile node want to communicate with another node inside the same MANET

To communicate with another host in the MANET, the ad hoc node checks its routing table. If the destination is inside the ad hoc network, it will find routing entry in the routing table and packets will be forwarded to next hop in the routing table according the DSDV protocol.

Part 2: When ad hoc host want to communicate with CN on Internet

To communicate with CN on the internet, the ad hoc host check its routing table, if no routing information to the CN is found, the ad hoc host forward the packet to the base station (Home Agent) of the area, which forward the packet to CN by using Internet IP routing protocol.

Part 3: When CN on the internet wants to communicate with ad hoc host

If a CN wants to send packets to an ad hoc host, the packets will be delivered to HA of the ad hoc host. If the ad hoc host is roaming away from its HA, HA maintains the ad hoc host's current location via FA registration. Using the COA of FA, HA forwards the packet to the FA visited by the destination ad hoc host. The FA checks its routing table and delivers the packets to the requested destination ad hoc host via DSDV routing protocol.

IV. SIMULATION MODEL

We have used simulation model based on network simulator NS2 [20]. We have taken two simulation scenarios. One has the area of 500 x 500 meters and other has area of 750 x 750 meters. No. of Wired nodes are 2. One is the correspondent node CN and other is a router which are connected with each other with wired link and two gateway nodes G1 and G2 which are connected with the wired link with the router R. The distributed coordination function (DCF) of IEEE 802.11 for wireless LAN is used as MAC layer. For routing in MANET, DSDV protocol is used. Simulation runs for 250 seconds. Two ray ground propagation is used. Onmi-directional antenna is used for simulation purpose. No of mobile nodes are 20. Initially all the nodes are under the gateway node G1 and then they are moved to the area under the gateway node G2 which is also serving as the Foreign Agent.

Table 1. Simulation Parameters

Parameter	Value
Simulation Area	500 x 500 m 750 x 750 m
Channel Type	Wireless
Simulation Time	250 Seconds
MAC Type	802.11
Antenna Model	Omni
Radio Propagation Model	Two Ray Ground
Traffic Type	FTP
Interface Queue Length	50
Interface Queue Type	DropTail/ Priqueue
Max. No. of Nodes	20
Max No. of FTP Connections	20

V. PERFORMANCE EVALUATION AND RESULT ANALYSIS

We have taken packet delivery ratio, average end to end delay and throughput as the performance parameters.

5.1. Packet delivery ratio

It is calculated by dividing the no. of data packets delivered to the destination by the no. of packets generated by the FTP sources.

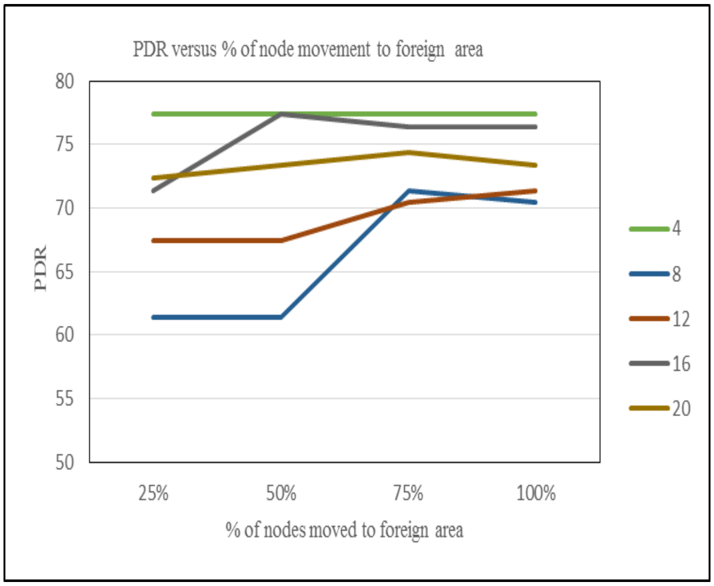

Fig.4: PDR versus % of nodes movement to foreign area with varying no. of connections in 500 x 500 m scenario.

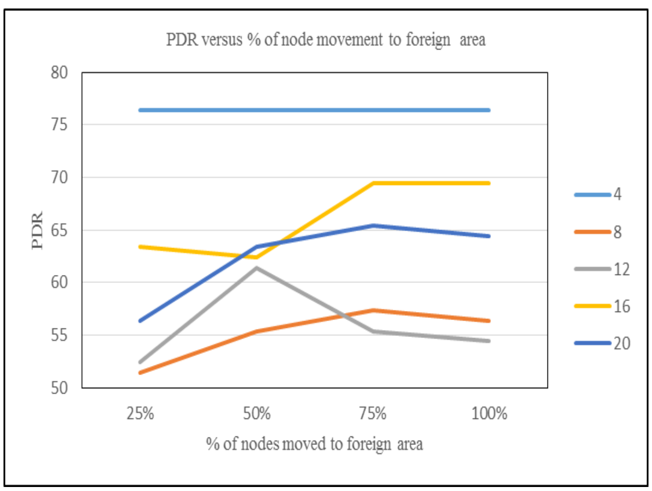

Fig.5: PDR versus % of nodes movement to foreign area with varying no. of connections in 750 x 750 m scenario.

Figure 4 shows the packet delivery ratio versus % of nodes movement to foreign area with varying no. of connections in 500 x 500 m scenario. Figure 5 shows the PDR versus % of nodes movement to foreign area with varying no. of connections in 750 x 750 m scenario. In our proposed framework, PDR is not much affected by the node movement.

5.2. Average end to end delay

It is the total time taken by each packet to reach the destination. It includes all delays such as buffering during route discovery, queuing at the interface queue, retransmision delay at the MAC layer, propagation and transfer time.

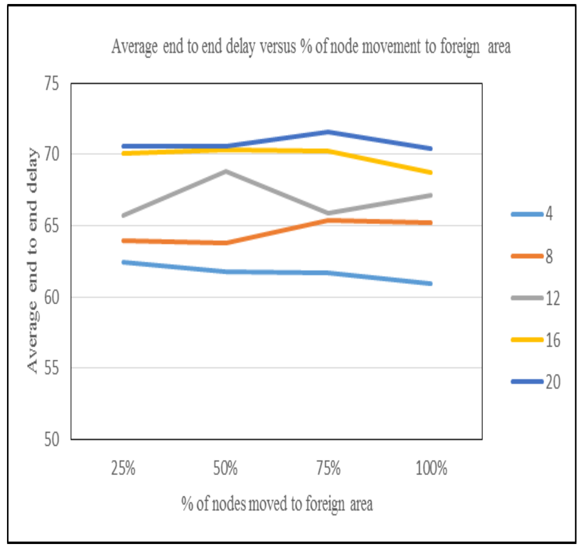

Fig.6: Average end to end delay versus % of nodes movement to foreign area with varying no. of connections in 500 x 500 m scenario

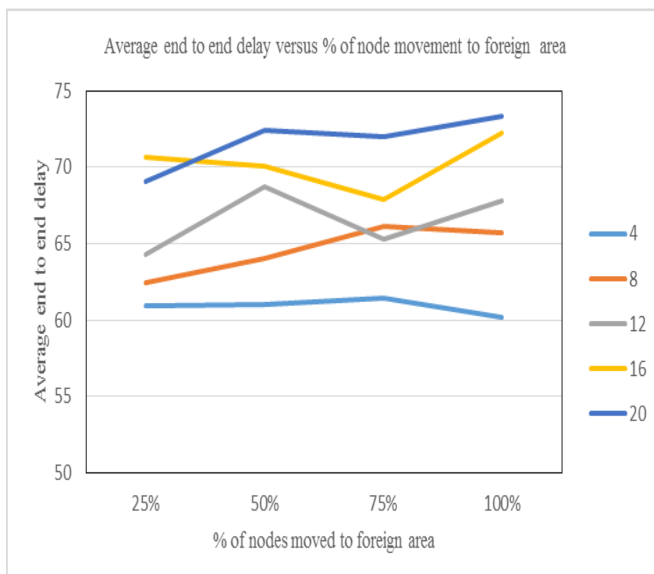

Fig.7: Average end to end delay versus % of nodes movement to foreign area with varying no. of connections in 750 x 750 m scenario.

Figure 6 shows the average end to end delay versus % of nodes movement to foreign area with varying no. of connections in 500 x 500 m scenario. Figure 7 shows the average end to end delay versus % of nodes movement to foreign area with varying no. of connections in 750 x 750 m scenario. Average end to end delay increases as % of node movement increases from 25% to 100%.

5.3. Throughput

Throughput is the average rate of successful message delivery over a communication channel. The throughput is measured in bits per second.

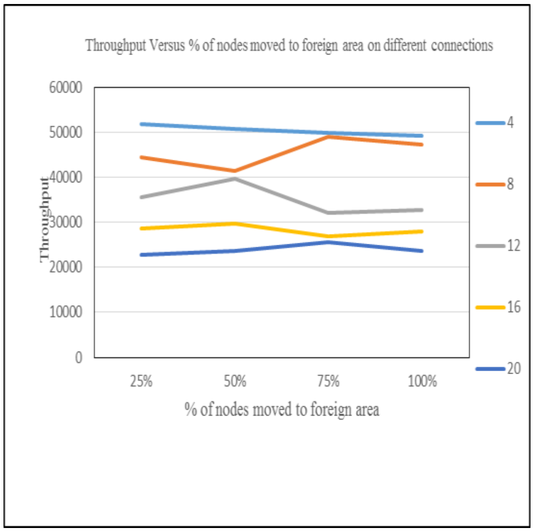

Fig.8: Throughput versus % of nodes movement to foreign area with varying no. of connections in 500 x 500 m scenario.

Fig.9: Throughput versus % of nodes movement to foreign area with varying no. of connections in 750 x 750 m scenario.

Figure 8 shows the throughput versus % of nodes movement to foreign area with varying no. of connections in 500 x 500 m scenario. Figure 9 shows the throughput versus % of nodes movement to foreign area with varying no. of connections in 750 x 750 m scenario. There is a little change in the throughput when the node movement is increased from 25% to 100% in our proposed framework.

VI. CONCLUSION

Integration of MANETs to the IP based fixed infrastructure wired networks networks is useful in many scenarios. It enables the mobile nodes to move in different MANETs without losing the connection. In this paper, we have proposed a framework which enable a MANET node to connect to IP based fixed infrastructure wired networks using Mobile IP enabled gateway nodes. We implement Mobile IP with DSDV protocol for hybrid MANETs. The proposed framework for hybrid MANETs is simulated in ns2 simulator. We have considered two network scenarios with 500m x 500m and 750m x 750m network area. This research paper evaluates the performance of the proposed framework under different scenarios 25% nodes leaves the base station area, 50 % nodes leaves the base station area, 75 % nodes leaves the base station area and visiting foreign area and 100 % nodes leaves the base station area and visiting the foreign area with respect to different parameters including packet delivery ratio, average end to end delay and throughput. The proposed framework is able to provide high packet delivery ratio and throughput irrespective to the node mobility.

VII. REFERENCES

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