Internet Connectivity using Vehicular Ad-Hoc Networks

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***Abstract*—Although a mobile Ad-Hoc network (MANET) can be used in many cases but the most preferable is a MANET connected to the internet. This is achieved by using gateways which act as bridges between a MANET and the internet. To communicate in-between, a mobile node needs to find a valid route to the gateway which requires gateway discovery mechanism. In this paper Ad hoc On-Demand Distance Vector (AODV) is altered to achieve the interconnection between a MANET and the Internet. Furthermore, the paper examines and compares three approaches for gateway discovery.**

1. Introduction

A Vehicular Ad-Hoc Network provides a communication medium between nearby vehicles and also between vehicles and nearby fixed equipment. The main goal of vehicular ad-hoc networks (VANET) is passenger's safety and comfort. For this purpose, an electronic device is placed inside each vehicle which provides Ad-Hoc Network connectivity for the passengers. This network does not require any infra-structure or legacy client and server communication to operate. Nodes in the Ad-Hoc network are the vehicles equipped with VANET device. These nodes can receive and relay others messages through the wireless network. The driver will be able to select the most suitable route through the necessary tools provided by collision warning, road sign alarms and in-place traffic view. Multimedia and internet connectivity facilities are also available for passengers within the wireless coverage of each car. Automatic payment for parking lots and toll

collection are other examples of possibilities inside VANET. Variety of wireless technologies is expected to be implemented using Vehicular Ad-Hoc Networks such as Dedicated Short Range Communications (DSRC). Vehicular Ad-Hoc Networks can be considered as component of the Intelligent Transportation Systems (ITS).

2. Mobility Model

There are various mobility models in VANET. The purpose of these mobility models is to provide the drivers of the vehicles a guide to choose the right path thus ensuring safety and comfort. One such mobility model is the Manhattan mobility model. The Manhattan mobility model uses a *grid road topology*. This mobility model was mainly proposed for the movement in urban area, where the streets are in an organized manner. In this mobility model, the movement of mobile nodes is in horizontal or vertical direction on an urban map. The Manhattan model employs a probabilistic approach in the selection of nodes movements, since, at each intersection, a vehicle chooses to keep moving in the same direction [1].

3. OVERVIEW OF MOBILE IP AND AODV

Overview of Mobile IP and AODV is as hereunder:

i. Mobile IP

Mobile IP is an Internet Engineering Task Force (IETF) standard communications protocol that is designed to allow mobile device users to vary from one network to another while maintaining a permanent IP address.

The Mobile IP protocol allows location-independent routing of IP datagrams on the Internet. Home address of the mobile node is used to identify each mobile node, irrespective of its current location in the Internet. The current location of the mobile node is identified by the *care-of*-address when away from its home network. Home address of a mobile node is associated with the local endpoint of a tunnel to its *home agent*. How a mobile node registers with its home agent and how the home agent routes datagrams to the mobile node through the tunnel is specified by Mobile IP [2].

Mobile IP provides an expeditious, ascendible mechanism for roaming within the Internet. Point-of-attachment to the internet of mobile nodes may be changed without updating their home IP address. This permits mobile nodes to sustain transport and higher-layer connections while roaming. Node mobility is agnised without the need to propagate host-specific routes throughout the Internet routing fabric.

A mobile node can have two addresses - a permanent home address and a care-of-address (CoA), which is consorted with the network, the mobile node is visiting. There are two types of entities in Mobile IP:

A *home agent* maintains information about mobile nodes current location, whose permanent home address is in the home agent's network.

A *foreign agent* stores information about mobile nodes visiting its network. Foreign agents also advertise care-of-addresses, which are used by Mobile IP. In Mobile Internet Protocol (Mobile IP), a foreign agent is a router serving as a mobility agent for a mobile node. A foreign agent works in conjunction with another type of mobility agent known as a home agent to support Internet traffic forwarding for a device connecting to the Internet from any location other than its home network.

a. AODV

- Allows quick response of mobile nodes to link breakages and changes in network topology. In case of link breakage, the affected sets of mobile nodes are notified by the AODV so that the routes using the broken links are invalidated. [3,4]
- A destination sequence number is created by the destination, for any route information, and is sent to requesting nodes. When multi-paths are available between routes to a destination, a requesting node always selects the one with the greatest sequence number.
- Message types:

  i. Route Request (RREQ): A broadcast RREQ is used by a node to find a route to the destination. A route can be delineated when the RREQ either itself reaches the destination, or through an intermediate node with a fresh enough route to the destination.

ii. Route Reply (RREP): Unicasting a RREP back to the source of the RREQ ensures the route availability. The RREP can be unicasted back from the destination to the source, as each node receiving the request caches a route back to the source of the request.

iii. The link status of next hops in active routes is monitored by mobile nodes. When a link breaks, an active route is detected. The loss of that link is notified to the mobile nodes through the RERR message, thus indicating unreachable destinations due to the link loss.

j. Care-of Address

A care-of-address (CoA) is a temporary IP address for a mobile device used in Internet routing. This permitts a home agent to forward messages to the mobile device. As the IP address that is used as host identification is topologically incorrect, a separate address is required to match the network of attachment. The care-of-address splits the dual nature of an IP address, that is, it is used to identify the host and the location within the global IP network [5].

k. Global Internet Connectivity

The Mobile IP and AODV networking protocols, when working together, manage to create multi-hop wireless routes between mobile nodes and foreign agents. The dead zones are decimated thus extending the covering range of the foreign agents. To ensure multi-hop Internet connectivity, AODV routing protocol is used for discovering and maintaining of routes within the Ad-Hoc network. Using the Mobile IP protocol, care-of-address may be acquired, thus ensuring Internet connectivity to a foreign agent through a multi-hop path [6].

4. Performance Evaluation

The protocol is evaluated using the following performance metrics:

- **Total Delay:** The time needed for a signal to traverse a network.
- **Packet Sent:** Number of packets delivered to the destination.
- **Packet Received:** Number of Packets received at the destination.
- **Overload**:

5. Experimental Setup

Research work of Ali Hamidian was set as a sample. All the three, Proactive, Hybrid and Reactive gateways are used.

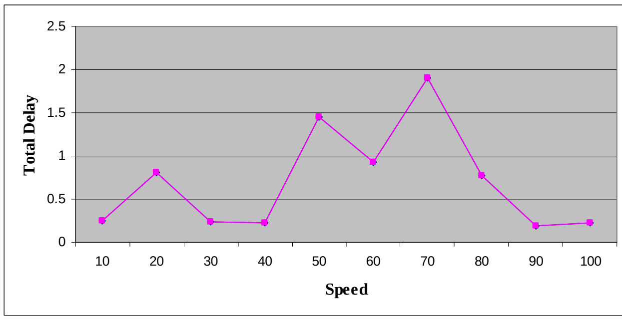
TABLE I. Simulation Paramenters

Parameters	***Default Value(s)***
Simulation Time	90.0 param
Routing Protocol	AODV
NS2 Version	ns 2.33
Transmission Range	
Number of Nodes	15
CBR Sources	
Mobility Models	
Topologies	2100 x 2100m Grid
Max. Wait Time	
Max. Node	

Parameters	***Default Value(s)***
Speed	
Accel./Decel. Rate	
Performance Metrics	

Figure 3. Overhead of proactive gateway discovery method

5. Results



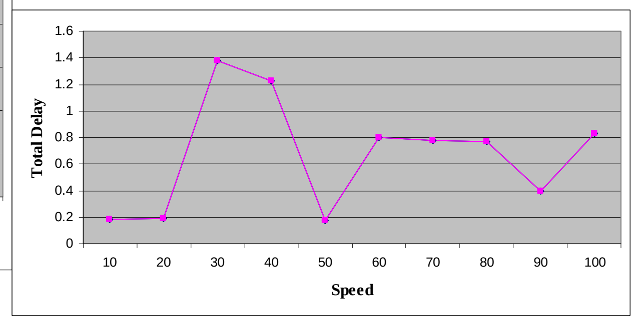


Figure 1. Delay of proactive gateway discovery method

Figure 4. Delay of hybrid gateway discovery method

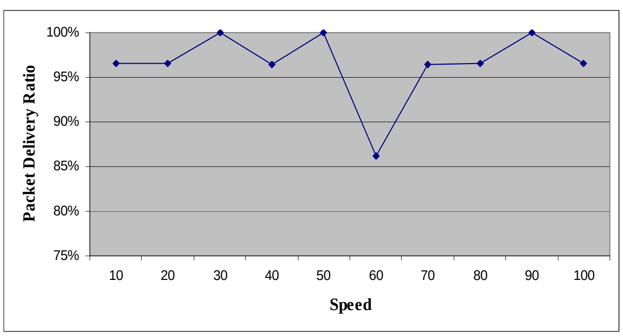
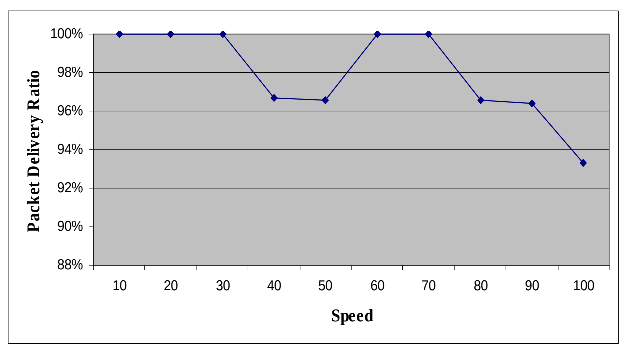
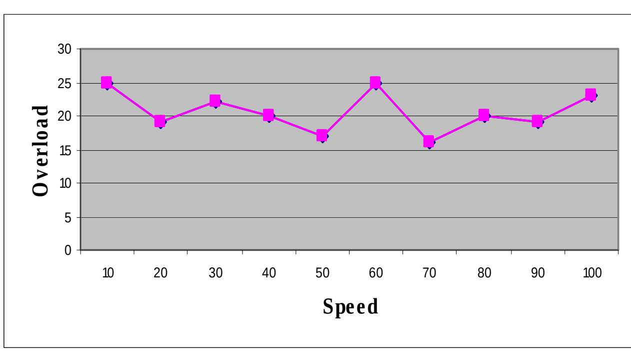


Figure 2. Throughput of proactive gateway discovery method



ure 5. Throughput of hybrid gateway discovery method



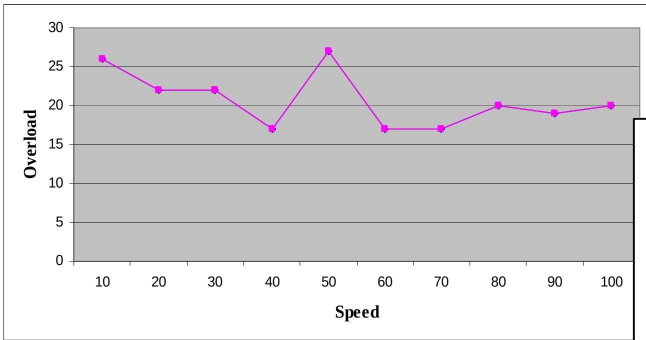


Figure 6. Overhead of hybrid gateway discovery method

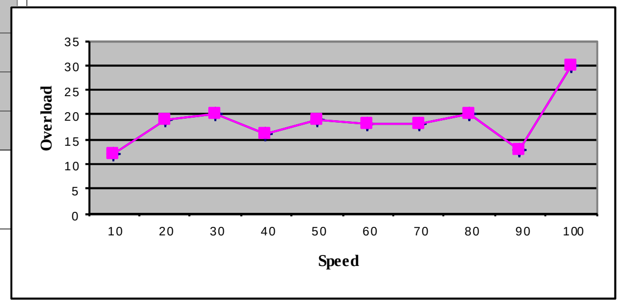


Figure 9. Overhead of reactive gateway discovery method

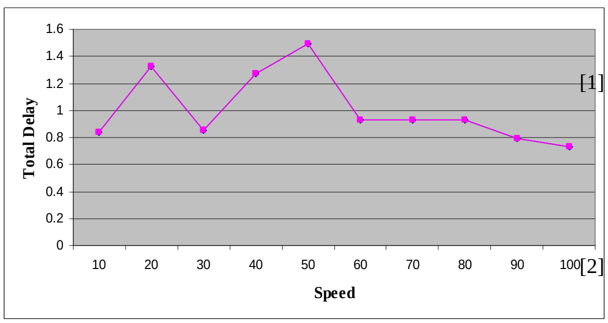


Figure 7. Delay of reactive gateway discovery method

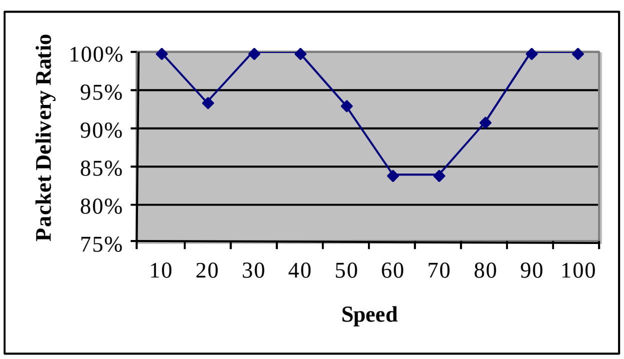


Figure 8. Throughput of reactive gateway discovery method

6. REFERENCES

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