An Effect of Route Caching Scheme in DSR for Vehicular Adhoc Networks

Poonam kori, Dr. Sanjeev Sharma
School Of Information Technology, RGPV
BHOPAL, INDIA
E-mail: Poonam.kori@gmail.com

***Abstract* - Routing is one of the most significant challenges in Vehicular ad hoc networks and is critical for the basic network operations. Nodes (vehicles) in a Vehicular ad hoc network are allowed to move in an uncontrolled manner. Such node mobility results in a highly dynamic network with rapid topological changes. Caching the routing information can significantly improve the efficiency of routing mechanism in a wireless ad hoc network by reducing the access latency and bandwidth usage. Our work presents an analysis of the effects of route cache for this caching in on-demand routing protocols in Vehicular ad hoc networks. Our analysis is based on the Dynamic Source Routing protocol (DSR), which operates entirely on-demand. Using detailed simulations of Vehicular ad hoc networks, we studied a caching algorithm that utilize cache size as a design choice, and simulated each cache primarily over different movement scenarios drawn from various mobility models. We also evaluated a set of mobility metrics that allow accurate characterization of the relative difficulty that a given movement scenario presents to a Vehicular ad hoc network routing protocol, and we analyze each mobility metric's ability to predict the actual difficulty in terms of routing overhead and packet delivery ratio experienced by the routing protocol across the highway and city traffic scenarios in our study. Finally we have shown that caching the routing data is beneficial.**
Keywords- Vehicular Ad hoc network, route cache, cache size, DSR.

1. INTRODUCTION

Vehicular ad hoc networks (VANETs) are special case of mobile ad hoc networks (MANETs). High speed dynamically changing network topology is the main characteristics of vehicular networks. The transformation of information typically occurs via multihop routing. But the key hindrance in operation of VANET comes from the high speed and uncertain mobility [in contrast to MANET] of the mobile nodes (vehicles) along the paths. This suggested that the design of efficient routing protocol demands up-gradation of MANET architecture to accommodate the fast mobility of the VANET nodes in an efficient manner. This warranted various research challenges to design appropriate routing protocol.

An on-demand routing protocol[1] for Vehicular ad hoc networks is one that searches for and attempts to discover a route to some destination node only when a sending node originates a data packet addressed to that node. In order to avoid the need for such a route discovery to be performed before each data packet is sent, such routing protocols must cache routes previously discovered.

Route caching strategy is important in on-demand routing protocols in wireless ad hoc networks [1]. While high routing overhead usually has a significant performance impact in low bandwidth wireless networks, a good route caching strategy [2] can reduce routing overheads by making use of the available route information more efficiently.

2. BASIC OPERATION OF DSR PROTOCOL

We use the Dynamic Source Routing protocol (DSR) [6] in this paper to illustrate the effect of route caching strategy in on-demand routing protocols, since DSR operates *entirely* on-demand and thus clearly shows the caching behavior. DSR is composed of two mechanisms that work together to allow the discovery and maintenance of source routes in the ad hoc network.

Route Discovery is the mechanism by which a node **S** wishing to send a packet to a destination node **D** obtains a source route to **D**. Route Discovery is used only when **S** attempts to send a packet to **D** and does not already know a route to **D**.

Route Maintenance is the mechanism by which node **S**, while using a source route to **D**, is able to detect when the network topology has changed such that it can no longer use its route to **D** because a link along the route no longer works. When Route Maintenance indicates a source route is broken, **S** can attempt to use any other route it happens to know to **D**, or can invoke Route Discovery again to find a new route for subsequent packets that it sends. Route Maintenance is used only when **S** is actually sending packets to **D**.

This section describes the basic operation of Route Discovery and Route Maintenance.

To initiate a new Route Discovery for a node **D** (the target of the Route Discovery), **S** transmits a ROUTE REQUEST packet, which is received by other nodes located within direct wireless transmission range of **S**. Each node that receives the ROUTE REQUEST packet appends its own address to a record in the packet and rebroadcasts it to its neighbors, unless it has recently seen another copy of the ROUTE REQUEST for this Route Discovery or it finds that its address was already listed in the route record in the packet. The forwarding of the ROUTE REQUEST terminates when it reaches node **D**; this node then returns a ROUTE REPLY packet to **S**, giving a copy of the accumulated route record from the ROUTE REQUEST, indicating the path that the ROUTE REQUEST traveled to reach **D**. The forwarding of the ROUTE REQUEST also terminates when it reaches a node that has in its cache a route to **D**; this node then returns a ROUTE REPLY packet to **S**, giving the route as a concatenation of the accumulated route record from the ROUTE REQUEST together with this node's own cached route to **D**. The returned source route from the ROUTE REPLY is cached by **S** for use in sending subsequent data packets.

Route Maintenance is performed by each node that originates or forwards a data packet along a source route. Each such node is responsible for confirming that the packet has been received by the next hop along the source route given in the packet; the packet is retransmitted (up to a maximum number of attempts) until this confirmation of receipt is received. This confirmation may be provided at no cost to DSR, either as an existing standard part of the MAC protocol in use (such as the link-level acknowledgement frame defined by IEEE 802.11), or by a *passive acknowledgement*. If neither of these confirmation mechanisms is available, the node transmitting the packet may set a bit in the packet header to request a DSR-specific software acknowledgement be returned by the next hop. If this confirmation is not received after some maximum number of local retransmission attempts, this node returns to the original sender of the packet a ROUTE ERROR message, identifying the link over which the packet could not be successfully transmitted. When receiving the ROUTE ERROR, this original sending node removes this broken link from its cache. In addition to returning a ROUTE ERROR message, this node may also attempt to *salvage* the original packet, if it has a route to the intended destination of the packet in its own cache. If so, the node replaces the original source route on the packet with the route from its cache and forwards the packet along that route; otherwise, the node discards the packet since no correct route is available.

In response to a single Route Discovery, a node may learn and cache multiple routes to any destination. Nodes may also learn routing information from any packets that they forward or that they can overhear through optionally operating their network interface hardware in promiscuous mode; in particular, routing information may be learned from a ROUTE REQUEST, ROUTE REPLY, or ROUTE ERROR packet, or from the source route in the header of a data packet.

3. Proposed Scheme

We assume that all nodes wishing to communicate with other nodes within the ad hoc network are willing to participate fully in the protocols of the network and should also to forward packets for other nodes in the network.

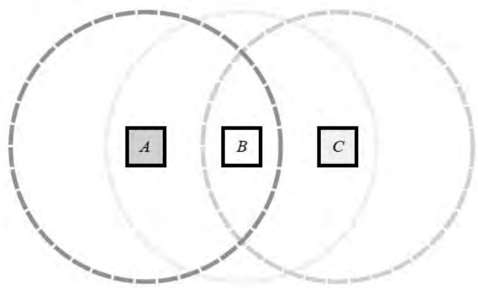

Fig 1 A simple ad hoc network of three wireless mobile hosts

We refer to the number of hops necessary for a packet to reach from any node located at one extreme edge of the network to another node located at the opposite extreme, as the diameter of the network. For example, the diameter of the ad hoc network depicted in Figure 1 is two. We assume that the diameter of an ad hoc network will be small but may often be greater than one. Nodes within the ad hoc network may move at any time without notice, but we assume that the speed with which nodes move is moderate with respect to the packet transmission latency and wireless transmission range of the particular underlying network hardware in use. In particular, we assume that nodes do not continuously move so rapidly as to make the flooding of every packet the only possible routing protocol. We assume that nodes can enable a promiscuous receive mode on their wireless network interface hardware, causing the hardware to deliver every received packet to the network driver software without filtering based on destination address.

Although we do not require this facility, it is common in current LAN hardware for broadcast media including wireless, and some of our optimizations take advantage of it. Use of promiscuous mode does increase the software overhead on the CPU, but we believe that wireless network speeds are more the inherent limiting factor to performance in current and future systems. We believe that portions of the protocol are also suitable for implementation directly in hardware or within a programmable network interface unit to avoid this overhead on the CPU.

4. MOBILITY MODELS STUDIED

In this section we discussed different mobility models used for this study.

High-way Traffic Model

- This model emulates the motion behavior of mobile nodes on a freeway for instance high-way. It can be used in exchanging traffic status or tracking a vehicle on a freeway.
- Freeway has lanes in both directions. Each mobile node is restricted to its lane on the freeway.
- The velocity of the following node cannot exceed the velocity of preceding node.

Manhattan City Traffic Model

- Movement pattern of mobile nodes on streets [7].
- Useful in modeling movement in an urban area where a computing service between portable devices are provided
- Each node is allowed to move along the grid of horizontal and vertical streets.
- Mobile node can turn left, right or go straight.
- Imposes geographic restrictions on node mobility.

5. METHODOLOGY

5.1. Simulator

We analyzed the effect of the route cache strategy through detailed simulations with different mobility models described in Section 4. The experiments were conducting using the *ns-2* network simulator [8], which support the simulation of wireless and mobile networks [5]. The simulator properly models signal strength, RF propagation, propagation delay, wireless medium contention, capture effect, interference, and arbitrary continuous node mobility. The radio model is based on the Lucent TechnologiesWaveLAN802.11 product, providing a 2Mbps transmission rate and a nominal transmission range of 250 m. The link layer modeled is the Distributed Coordination Function (DCF) of the IEEE 802.11 wireless LAN standard.

5.2. Communication Model Used

The communication model simulated in all scenarios was a script consisting of 20 Constant Bit Rate (CBR) data connections, each transmitting 4 packets per second; the size of each packet is 512 bytes. Each node was the source of at most 2 CBR connections.

5.3. DSR Performance Metrics

We evaluated the performance of DSR on each of the cache capacities according to two metrics:

- *Packet Delivery Ratio*: The fraction of packets sent by the “application layer” on a source node that are received by the “application layer” on the corresponding destination node.
- *Overhead*: The total number of packets transmitted by the routing protocol. This includes routing packets forwarded, but does not include data packets forwarded.

6. SIMULATION RESULTS

Here we investigated our work with three different application scenarios; however our work is fully concentrated on mobile ad hoc networks [3],[4],[5] only. Since the simulations performed successfully, we evaluated the performance parameters routing overhead and packet delivery ratio Vs variant cache sizes, and the results are shown in the form of graphs (**Fig 2 & 3**).

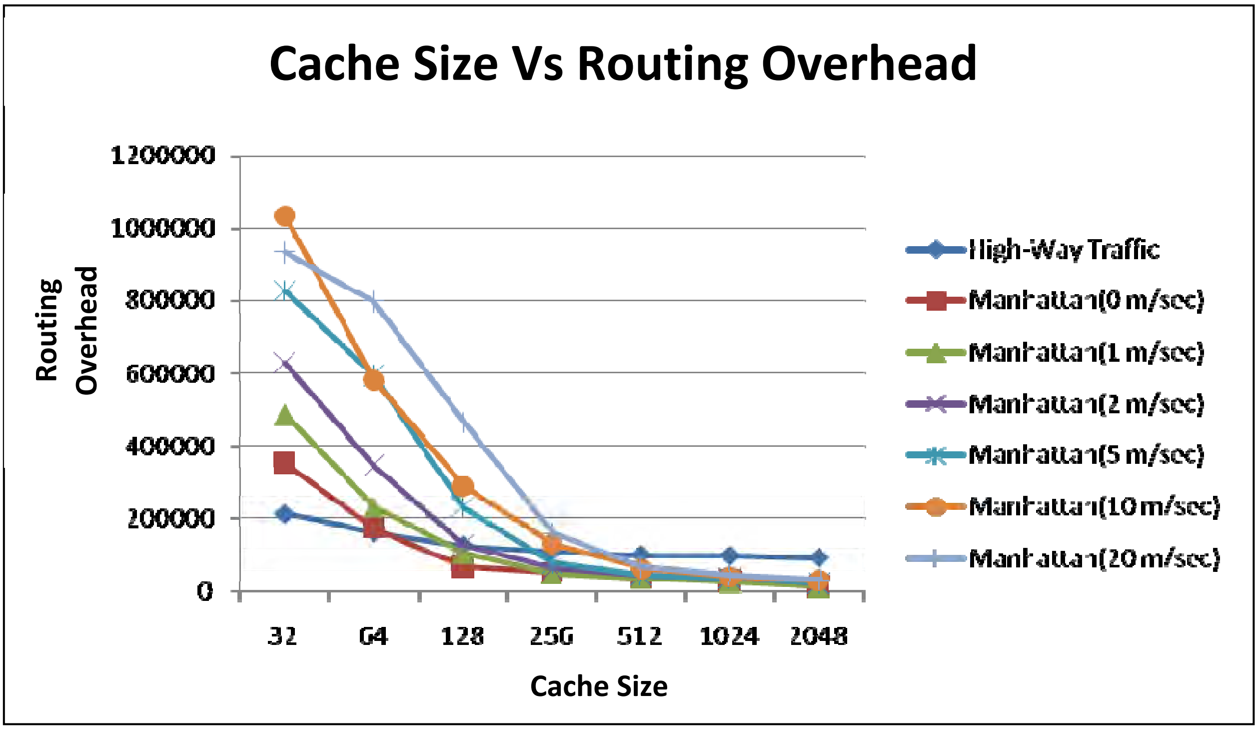

Fig 2 Comparing Cache Size Vs Routing Overhead for all Scenarios

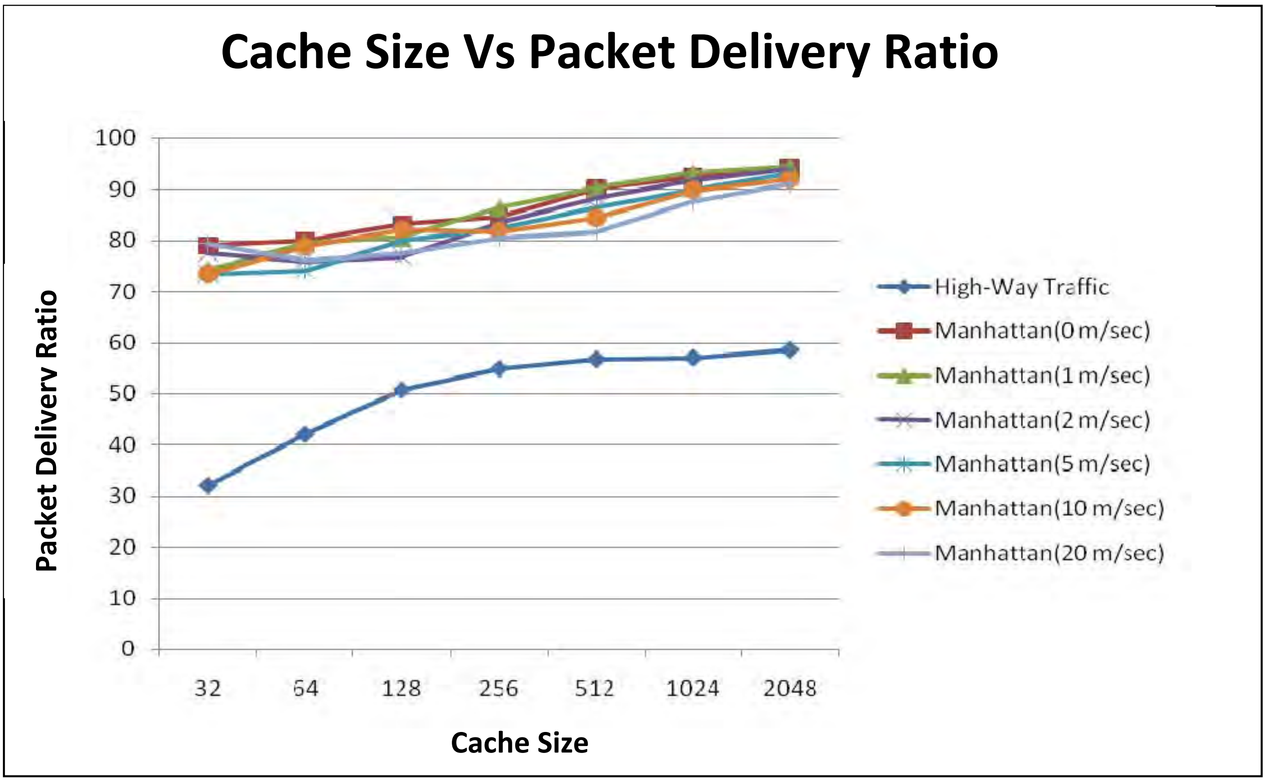

Fig 3 Comparing Cache Size Vs Packet Delivery Ratio for all Scenarios

From the above two graphs we made the following observations.
As we keep on increasing the cache size routing overhead can be drastically reduced, and considerable improvement can be achieved in Packet delivery ratio. One important factor that Routing overhead and Packet Delivery ratio depends is speed of the nodes in mobility model. Routing overhead is more in high-speed mobility models; this is due to the quick adaptation of changes in network.

Packet delivery ratio is somehow low in high-speed network. As we said when routing overhead is more the channel bandwidth consumption is more which in turn leads to decrement in packet delivery ratio.

Another important factor that affects the performance parameters is network size (no. of nodes) in conjunction with route cache. For large networks more route cache memory is required to handle lengthy paths, which could perform better. For small networks it is recommended to have small cache sizes. As we keep on increasing the cache size we found benefit in terms of routing overhead and packet delivery ratio. This benefit is getting decreased, so we stopped our simulations at cache size 2048 kb.

7. CONCLUSION

Dynamic Source Routing adapts quickly to routing changes when host movement is frequent yet requires little or no overhead during periods in which nodes move less frequently. It can be achieved by caching the routing information. Based on results from a packet-level simulation of mobile nodes operating in an ad hoc network, the protocol performs well over a variety of environmental conditions. By these simulation results we can conclude that implementing route cache technique will definitely yield good results almost in all kinds of mobile scenarios.

Through the extensive simulations it is possible to predict the required cache size at every node based on local and global traffic. As a future work proper algorithms can be designed so that we can restrict the usage of more cache when it is really not required even ample amount of cache memory is available for instance 2048 kilo bytes.

REFERENCES

[1] Caching Strategies in On-Demand Routing Protocols forWireless Ad Hoc Networks by Yih-Chun

[2] Benefit-Based Data Caching in Ad Hoc Networks by Bin Tang, Himanshu Gupta, and Samir R. Das, IEEE 2008 Published by the IEEE CS, CASS, ComSoc, IES, & SPS

[3] Supporting Cooperative Caching in Ad Hoc Networks by Liangzhong Yin and Guohong Cao, IEEE INFOCOM 2004

[4] Principles of Ad Hoc Networking by Michel Barbeau and Evangelos Kranakis Carleton University, Canada

[5] Ad hoc Networks Technologies and Protocols Edited by Prashant Mohapatra, Davis Srikanth, V. Krishnamurthy University of California.

[6] DSR: The Dynamic Source Routing Protocol for Multi-Hop Wireless Ad Hoc Networks by David B. Johnson David A. Maltz Josh Broch Computer Science Department Carnegie Mellon University

[7] Manhattan traffic congestion is a historic mistake West and East Village, Chelsea, Soho, Noho, Little Italy, Chinatown and Lower East Side, Since 1933 Volume 77, Number 9 | August 01 - 07, 2007

[8] The ns Manual, The VINT Project, May 9, 2010