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# Fructifying the Network performance of iVANET Rectified Associative Service Mechanism: An Architectural Proposal

Mohd Akbar
Dept. Computer Science
Integral University, Lucknow
*Email: akbar [AT] iul.ac.in*

Shish Ahmad
Dept. Computer Science.
Integral University, Lucknow

*Abstract* - **Internet based Vehicular(iVANET) ad-hoc networks are meticulously special case of normal VANET. It basically combines a wired Internet and vehicular ad hoc network for developing a new baby-boom of omnipresent and ubiquitous computing. The Internet connectivity is usually extended to V2I (vehicle to infrastructure) communication whilst ad-hoc networks are used in vehicle to vehicle (V2V) communication. The latency is one of the main matters of concern in VANET. By minimizing distance between data source and the remote vehicle through rectified caching technique along with redefined cache lookup mechanism, the latency can be shortened by a significant factor in iVANET environment. In this paper various cache invalidation schemes are studied and analyzed. Exploring the possibilities of caching schemes which can be hybridized or mutated, paper introduces an architectural proposal along with redefined services mechanism for cache lookup and invalidation. The proposed work is anticipated to fructify the network performance minimizing cost and bandwidth utilization during cache invalidation and hence guarantees improved quality of service(QoS).**

***Keyword-- Internet-based vehicular ad-hoc network, mobility, hybrid, mutate, cache invalidation, query latency, QoS , iVANE.***

## I. INTRODUCTION

Vehicular Adhoc Networks (VANETs) are an special form of Mobile Adhoc Networks (MANETs) which comprises of both wired and wireless technology. The communication occurs in two different ways firstly inter-vehicle-communication (V2V) and secondly vehicle to roadside unit (RSU) communication that is vehicle-to-Infrastructure (V2I) [3] communication. V2V communication relies on wireless technology for and the rest of communication process takes on wired technology. However the connection among the RSU is kept wired because the bandwidth of wired technology is still much higher when compared to that of wireless technology.

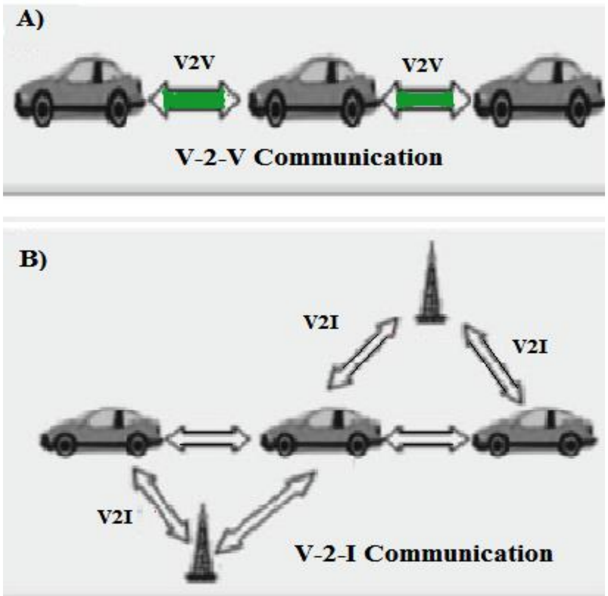


Fig-1: V2V & V2ICommunication

The communication equipments used for the vehicle are known as “OBU” ( On-Board Units). It is capable of computing the data received, sense the environment and adapt to the changes accordingly while providing the information related to current position of the vehicle. On-board unit uses DSRC channel (Dedicated Short Range Communication) for communication [4]. The roadside unit is also based on DSRC channel and interact with vehicles at particular fixed point by the road side. The roadside units are basically governed and maintained by the government or a private vending agency which devise their protocols and incorporate in into the network.
The roadside unit possesses components eg; access point(AP), foreign agent (FA), home agents (HA) and the data server (DS). Road-side infrastructure (RSI) has short range communication capacity by which it communicates with nearby vehicles. All road side units (RSUs) are deployed in proper place in a given region. Initially the region may be small, but as technology and economic conditions mature, those regions can be interconnected to form a

large region. Such an aggregation can convert districts to city or to a country and even to a global region eventually[1].

The roadside unit comprises of components namely access point (AP), foreign agent (FA), home agents (HA) and the data servers (DS). Access point acts as an interface between the vehicle and the server. In order to connect to the server, the vehicle has to first contact the access point. Home agent (HA) is a router on a mobile node's home network that maintains information about the vehicle's current location, as identified in its care-of address. A home agent (HA) may work in conjunction with a foreign agent (FA), which is a router on the visited network.

An access point (AP) is a device that allows wired communication devices to connect to a wireless network. Data server is meant to provide accessibility to the data stored locally at various local servers. The Access point is used as an interface between the vehicle and the server. The vehicle has to contact the access point every time it wishes to connect to the server. Other elements of networks like Data server, Home agent and Foreign agent are purposely used to provide accessibility to the data stored locally at different home agents (HA).

Like any other network, VANET has also been remain susceptible to many challenging issues namely, Routing, Security [2] and, Quality of Service issues like Query Latency time etc.

Routing plays an important role in VANETs applications but the high-speed mobility of vehicles and frequently changing topology results in conventional MANETs routing protocols which proves to be inadequate to efficiency and effectively deal with this unique vehicular environment as intermediate nodes cannot always be found between source and destination and end-to-end connectivity cannot always be established. This has led the researchers to find robust routing algorithms that are, good enough for the frequent path disruption caused by vehicle's random moments and quick mobility, new and novel approaches that can deliver improved throughput and better packet delivery ratio. Using the history based cache to store the movement information of inter-zone vehicles and location based information. There are many routing algorithms which support dynamic source routing for randomly moving mobile nodes in ad-hoc networks which lays a foundation for VANET routing.[5]

VANET security challenges are yet need to be addressed in the fields of authenticity, confidentiality, and availability. A lightweight, scalable authentication frameworks are needed that are capable enough to protect vehicular nodes from inside and/or outside attackers infiltrating the network using a false identity, identifying attacks that suppress, fabricate, alter or replay legitimate messages, revealing spoofed GPS signals, and prevent the introduction of misinformation into the vehicular network. As far as driver confidentiality is concerned, we need reliable and robust secure protocols that can protect message exchanges among nodes of a vehicular network from threats such as unauthorized collection of messages through eavesdropping or location information (through broadcast messages).

When it comes to improve the quality of service(QoS), reducing the query latency time appears to be the primary concern, and the "Cache Invalidation techniques" are the one which are considered to be the best to do with the latency reduction in the network. Caching frequently accessed data is an effective technique to improve the network performance because it reduces the network congestion, the query delay and the power consumption [6]. There are many traditional Cache invalidation techniques which can be applied only in MANETs at present. These techniques cannot be adopted for VANETs because of the mere reason that VANETs deploy high speed random mobility in their infrastructure. Moreover the techniques in MANETs are based on broadcast method[6].

There are many cache invalidation schemes for mobile ad-hoc networks and Vehicular ad-hoc network]7][8][9]. To take into consideration a few , following are the various cache invalidation techniques this paper includes in the survey.

## II. System Model

As shown in Fig. 2, an IVANET comprises of access points (APs), gateway foreign agents (GFAs), home agents (HAs), and server of data item source. Vehicles are equipped with communication services such as an IEEE 802.11-based dedicated short range communication(DSRC) transceiver[4]. Using this, they can either communicate with other vehicles or can get connected to the Internet based network. Since providing a location based capability in vehicles is becoming popular, it is assumed that vehicles are aware of its current location. Also vehicles have a built-in navigation system. A map is loaded using GPS system to show roads around current location and direction, the shortest path

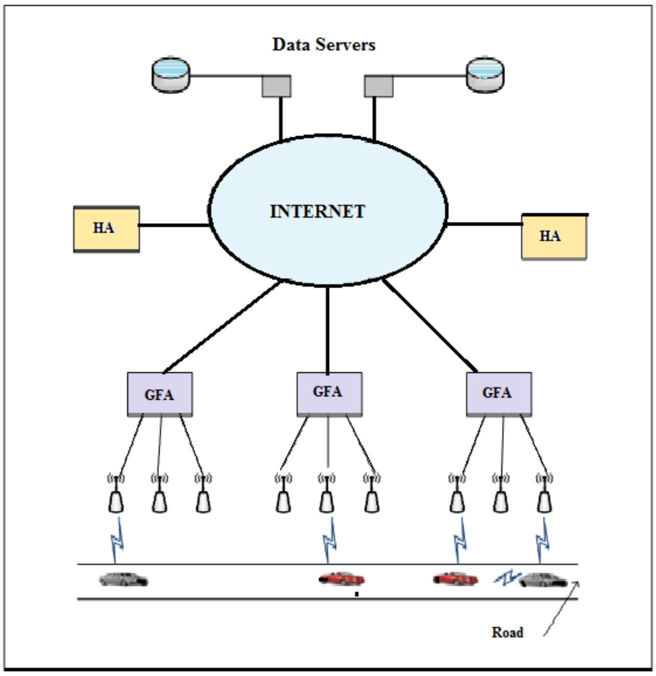


Fig: 2

to the destination, traffic conditions, location-dependent information, and so on. In addition, unlike cellular and MANET environments, where nodes move without restrictions, vehicles are bounded to the underlying fixed roads with speed limits and traffic lights in VANETS. Thus, it is quite simple to predict a likelihood movement of vehicles. For example, a vehicle is moving in the west direction along the road, while there is no exit or cross point for next several kilometers.

## III. Past Related Work

Having gone through numerous litrarture reviews and work done in the past it is fair to say that reveals that a good number of cache invalidation schemes have been proposed, implemented and validated in numerous literature, mostly were based on validation report eg; Invalidation Report(IR-based validation) [10][11][12][13][14].

In IR schemes, servers use to send intermittent IR broadcast, which include a list of updated and validated data items. Then moving nodes, which receive the IR, invalidate the cached data items.

In a scheme introduced by Sunho Lim et al[10] works on triangular routing system based on Mobile IP. They proposed cache invalidation scheme integrated with a mobile IP based location management. The server asynchronously sends an IR to a home agent (HA) rather than blindly broadcasts it to the vehicles. Then the HA judiciously refines and distributes the IR to appropriate gateway foreign agents (GPAs) based on triangular routing method similar to Mobile computing. When a vehicle moves into a coverage area within the same regional network, it sends the location update to the GFA.

When a vehicle moves into a different regional network, however, it sends the location update to the HA for correct forwarding the packets through the GFA and

AP. Both these schemes work take all the data as the same where as we classify the data into two categories and apply invalidation to both the data differently.

An author proposes, in a work, an Aggregate Cache based On Demand (ACOD) scheme for cache invalidation by altering two existing scheme modified timestamp (MTS) scheme and MTS with updated invalidation report (MTS + UIR) scheme, respectively.

ACOD scheme proved to efficient providing high throughput, low query latency, and low communication overhead in iMANET environment [10][15][16]. Meanwhile in this proposal the security governing privacy still remains an issue which could be addressed by Privacy Enhancing Communications Schemes [17].

In an another work 3 Caching strategies eg; **POD** (Pull on demand), **MOD**(Modified Amnesic Terminal) & **PAT**(Pull Based Amnesic Terminal) schemes were proposed [20][21][22] which inherits their own pros and cons on different parameters of concern.

**POD**: In this method query delay is a bit low but the cache hit ratio is compromised and also the cost of query message is high.[18]

**MAT:** It has shown a higher cache hit ratio and lower query message cost, but it faces increased query latency[19].

**PAT:** It is a pull-based strategy which only maintains delta-consistency of recent cached data [20].

The same was carried out along with a simple search (SS) algorithm ensures that a queried data is obtained from the closest AP or MP[23].

In a work of Sunho lim et al [24] an Aggregate Caching scheme has been proposed which puts together the local cache of every individual user (Mobile Terminal), like an unified cache, and tries to alleviate the limited data accessibility and longer access latency problems.

Few other approaches for cache invalidations were suggested by Sunho Lim, Chansu Yu† Chita R. Das[24][25[ where they proposed a novel caching scheme, and an extended asynchronous (EAS) scheme in line with these two schemes. Authors proposed a state-aware cooperative cache invalidation schemes along with hierarchical network model where network-server and network-agents use to coordinate the invalidation report operation.

The CCI (mobility impact on the performance is reduced) and ECCI schemes achieve better performance than the others in terms of query delay, cache hit rate, and communication cost overhead.

Continuing the analysis of various schemes , in a work, authors[26] have designed and proposed three schemes: CachePath, CacheData, and HybridCache.

In Cache-Data, intermediate nodes cache the data to serve future requests instead of fetching data from the data center.

The Cache-Path, mobile nodes cache the data path and use it to redirect future requests to the nearby node which has the data instead of the faraway data center [27].

Hybrid-Cache takes advantage of Cache-Data and Cache-Path while avoiding their weaknesses. Simulation results showed that the proposed schemes can significantly reduce the query delay when compared to Simple Cache and significantly reduce the message complexity when compared to Flood-Cache.

While having been studied above many schemes cache cooperation still have not achieved a remarkable improvement in the query latency reduction. Continuing this effort, Rajeev Tiwari et al [28] has proposed Cooperative Gateway Cache Invalidation Scheme for Internet-Based Vehicular Ad Hoc Networks. It The designed scheme introduces the concept of placing caches at gateways along with the vehic les cache.

In another work of the same Rajeev Tiwari et al [29] Doing so has an advantage of cooperation of Gateways in different regions along with the underlying location management scheme to reduce the number of broadcast operations, lesser Uplink requests, and query delay with an increase in the cache hit ratio.

The query arrival rate, object update rate, and cache size has been the parameters of concern under the simulated environment and proven to the effective in terms of reduced query delay and increased cache hit ration.

## IV. PROPOSED METHODOLOGY

When a vehicle ($V_y$) request data item ($d_x$) which is found in vehicle cache, then vehicle sends the requested packet which includes vehicle's id, data-id and vehicle home address to the GFA by AP, which checks for the cache validation. The GFA compares the id of query data with the vehicle registry (Rg.), if data is valid it sends the acknowledgement to vehicle, otherwise GFA sends this query packet to the server. Thus, the packet received by the server would have attributes namely vehicle's id, home network id, access point id and the GFA id. The server would also be able to recognize the overall path of the incoming data request

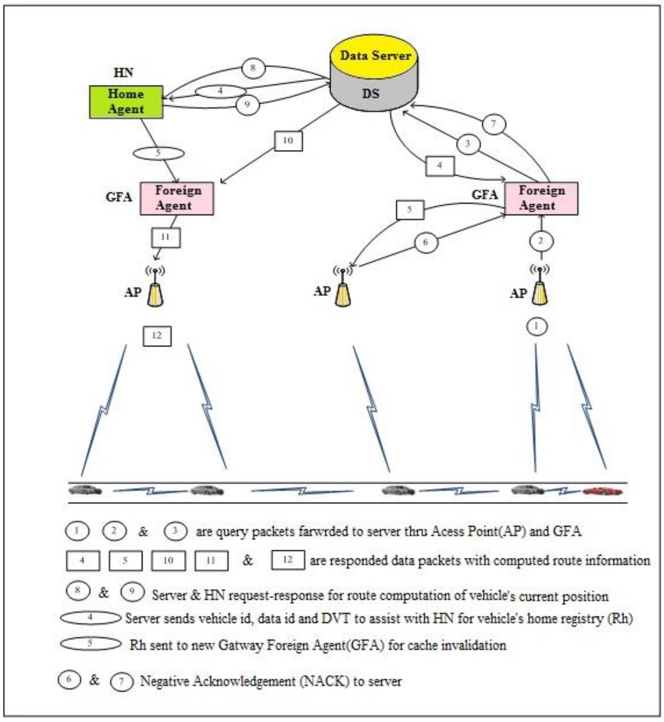


*Fig-3 Architectural Proposal along with Service Mechanism*

***4.1 Approach Overview:*** In normal VANET scenario while generating a query vehicle sends the query packet which includes the vehicle-id as well as the home network-id to the Access Point (AP). But in our case query packets includes additional piece of information. Since state-full servers are set free from location management task, the query pack needs to be well directed between source to destination. For this purpose every packet will include the current **speed(v)** of vehicle, **direction(d)** of movement and the **timestamp(t)**.

The access point includes its own id along with DVT (direction, velocity & Time) and passes on the query packet to the GFA. The GFA again adds its own id along with DVT into the packet and finally the complete packet is sent to the data server. In this way the packet would be consisting of information eg-vehicle id, home network id, access point id and the GFA id and DVT. Using DVT parameter, at any point of time, the linear location of vehicle can be calculated an approximated after elapsing time *'t'* and so is the likelihood of befalling GFA or HA of vehicle. The server would also get to know the overall path of the requested query along the way it has reached to the server. The server will search the requested data and send back to concerned GFA(likelihood approximation). This packet would be sent back to the GFA by the server. Also the server will be able to calculate and send the vehicle-id and the data id to the home network of the vehicle (a per calculation). HA maintains a record of the vehicles in its network range therefore after receiving the data-id which corresponds to the particular vehicle it will broadcast the packet and update the registry accordingly for that particular vehicle as long as it stays in HA's network range. The GFAs will also work in same way. If the vehicle still remains in the same network then there is no problem, however if the vehicle would have crept into another network then the respective GFA will get to broadcast the packed responded by data server.

Hence this approach mitigates two of the challenges as discussed in problem statement. Firstly it reduces the cost of additional cache on GFA's & optimizes bandwidth overhead be setting off location management task. Secondly it reduces the negative acknowledgements by guaranteed delivery of query response packet to the vehicle.

This scheme holds an assumption that the location management task on stateful server is freed and vehicle position is approximated by each hierarchical component in iVANET.

## V. CONCLUSION

As discussed in section 2, it is found that that, vehicular networks are being developed and are being improved by each passing day. Several new technologies and algorithms have been evolved and implemented which made VANET even more effective and enabled by this new kind of communication network.. he most important factor of data transmission in VANETs is latency. The latency is proportional to the distance between the data source and the remote vehicle and mechanism involved in accessing source memory. Proposed work would contribute to reduce the distance between data source and the remote vehicle by using location approximation of vehicles and cache lookup mechanism which subsequently reduces the latency. Also by observing the vehicle's movements and direction a guaranteed delivery of data to vehicle is made possible which ultimately reduces the NACK to server and resulting in a high throughput.

The design issue involved in caching for VANETs is to cache frequently accessed data items in the local storage of vehicles. The vehicles have their own re-chargeable battery so there is no power problem. The main concern is to support cache invalidation scheme and also query latency minimization in the context of mobility and communication cost. This proposal includes both vehicle to vehicle (V2V) and vehicle to infrastructure (V2I) communication and proposed architectural proposal along with associative service mechanism for spotting out the vehicles thru DVT approximation approach and hence improvise the cache invalidation problem and negative acknowledgement issue in iVANET.

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