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A Data Cache Invalidation Strategy for Internet Vehicular Ad hoc Network on Highway

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ABSTRACT **- Internet vehicular Ad hoc network (IVANET) is a combination of wired Internet and Vehicular Ad hoc Network (VANET) through roadside infrastructure for universal communication among vehicles. A key optimization technique in IVANET is to cache frequently accessed data items in local storage of vehicles. A critical design issue is how to keep cache copies valid or invalidate them when original data item changed. This is important in IVANET where vehicles move very fast. Only 40% data updating is needed in city while 60% data updating is needed on highway. In this paper we have improved the data cache invalidation scheme on highway. This scheme shows better performance in handover and reduces the cache invalidation data drop in vehicles.**

Keywords-**IVANET, Cache Invalidation, Invalidation Report**

1. INTRODUCTION

A VANET is a technology that establishes communication among high speed mobile vehicles [1]. It facilitates vehicle to vehicle or vehicle to roadside infrastructure communication through a multi hop message relay without the assistance of any fixed infrastructure. Most of the concern of interest to MANET (Mobile Ad hoc Network) is interest in VANET but details differ. Rather than moving at random, vehicles move in organized way. The interactions with road side equipment can like wise characterize accurately and finally most vehicles are restricted in their range of motion for example by being constrained to follow paved highway.

In order to provide flexible connectivity, accessibility and a rich set of services, it is imperative to consider the integration of VANET with wireless infrastructure, such as wireless local area network and wireless wide area network. It is envisaged that IVANET will become a ubiquitous infrastructure in coming days.

A key optimization technique improving the communication performance of IVANET is to cache the frequently access data item in local storage. In an IVANET, it is less of problem to determine which data items to cache because memory in vehicle is not critically limited. When a data item in server is updated, it is necessary to invalidate cached copies of data item by broadcast invalidation report (IR). However, due to fast roaming vehicle, cache invalidation scheme develop for cellular network and mobile ad hoc network may not work well. Unlike these networks, energy conservation is not an issue in IVANET because vehicle is supported by vehicle power battery. Rather, our concerns are query delay in IVANET.

The following observations in IVANET characterize in IVANETs in the context of cache invalidation scheme: (1) High speed mobile vehicles can not reside in an area for long time. Therefore when data server broadcast IR, it is very difficult to recognize which coverage area should be target. Since multiple coverage areas are involved in a broadcast operation. (2) It is wasteful to broadcast same invalidation report to different vehicles, since most of content may not be relevant to them. (3) A web proxy caching may reduce network traffic [3] but it does not reduce network traffic in wireless links. In order to support a scalable caching operation with minimized invalidation report traffics in both data server and wireless network. It is necessary to co ordinate with network agent of location management.

To address these problems, we propose a scheme in which we try to effectively deal with cache invalidation of fast moving vehicles without incurring significant overhead. We contribute following work:

(a) We reserve a channel of next regional network for cache invalidation.

(b) This scheme facilitates invalidation without data drop in handover of invalidation report.

(c) In the last, this technique is efficient on highway due to fast mobility.

2. CACHE INVALIDATION SCHEMES

In this section we analyze single cell and multi cell cache invalidation scheme.

Single cell cache invalidation scheme is based on time stamp (TS) where base station broadcast invalidation report in regular interval time. Since IR is periodically broadcasted, there is unavoidable delay before answering question. This scheme can not be implemented in IVANETs because time stamp does not consider mobility of vehicles. For example when vehicles generate a query and wait for answer, they may miss IR if they moved to adjacent cell. Multi-cell cache invalidation scheme has reduced the limits of single cell cache invalidation scheme. Its design extended from asynchronous state full (AS) scheme [2]. In this scheme Mobile Switching Centre (MSC) located in higher network hierarchy than a Base Station (BS) execute cache invalidation operation. In VANET, vehicles exist in a coverage area for short period of time and travel along the large number of cells and thus, it is wasteful to examine cache invalidation with server on every hand off. Also, server's pro-active IR transmission to multiple cells is not an efficient solution, if updated data item is not queried.

2.1 Related Work

In this section we explore Cooperative Cache Invalidation scheme (CCI), Enhanced Cooperative Cache Invalidation scheme (ECCI)[4] and on cache invalidation scheme by Sunho Lim[5]. In [4], data server maintains list of data items and access history by vehicles. This server does not blindly broadcast IR to vehicles, it sends IR to home agent and HA judiciously forward data through appropriate Gateway Foreign Agent (GFA). In this strategy GFAs do not proactively broadcast IR to individual vehicles, but reply the queries of vehicles on demand basis. CCI is a state-aware cooperative approach where data server and location management agents coordinate for data cache invalidation. In [5], authors demonstrated triangular routing based system on mobile IP. Here cache invalidation scheme is integrated with mobile IP location management system. Server asynchronously sends IR to HA rather than blindly broadcast to vehicles. Then HA judiciously refines data and distributes the IR to appropriate GFA based on triangular method based on mobile computing. Vehicles mobility is very high in VANET. When vehicle moves in to new coverage area within same regional network, it sends location update message to GFA. When vehicle moves in to different regional network, however, it sends location update message to HA through GFA and Access Point (AP). In both the schemes, IR data drop probability is high if next AP does not have channel in cache invalidation. We have tried to improve this deficiency in our scheme.

3. PROPOSED SCHEME

Our scheme uses direction of vehicles in invalidation of cache data. Unlike cellular network and mobile ad hoc network (MANET), vehicles mobility uses fix direction from source to destination. Similar to CCI, server maintains list of data item d_x is accessed by which vehicles V_x in registry. Whenever vehicle moves for source to destination, it sends information P_x to HA. If data is updated, server sends IR to HA along with data id d_x, vehicle id V_x and current time stamp T_x. Now HA has information of $<d_x,V_x,P_x,T_x,GFA_x>$, it generates new IR(R_n) and send to GFA(where vehicle is moving).this R_n contains $<d_x,T_x,P_x>$.if GFA finds ,data can not be transmitted in single AP1 coverage area then it sends an informative message to next AP2 $<I_x>$ for channel reservation. This information has high priority that's why AP2 perform forced handoff in its coverage area on those vehicles which are near to AP3 and reserve a channel for coming vehicle.

PROBLEM AND SOLUTION

There is a possibility of hand off during invalidation of cache data due to high mobility. In this situation new FA does not know, how many new vehicles are coming in its coverage area.

Our scheme enables GFA so that it can send information to next FA about vehicle which is in the process of cache invalidation scheme. FA makes this information to high priority and facilitates vehicle with appropriate channel.

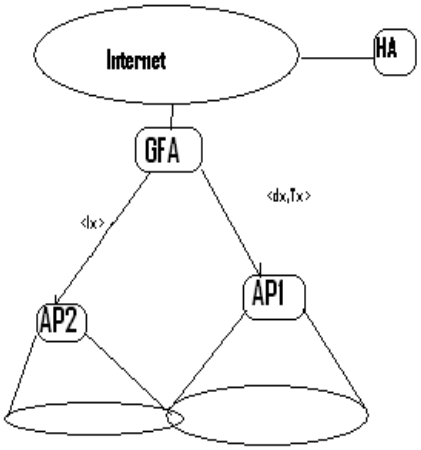

Fig 1 System model of proposed scheme

When vehicle(V_x) initially connect to server, it sends all the ids of cached data items (d_x) and current time stamp(T_{curr}) then server update its registry. Whenever server receives a request packet for validation of cache data or accessing data, it also updates its registry. When vehicle handoff to coverage area which is under different GFA, then HA updates its registry and generate new IR (Rn) for new GFA.

Let's examine proposed cache invalidation scheme in detail. First when vehicle V_x generates a query for data item (d_x) which is not cached, it sends request packet for accessing data item to server. The packet contains care of address(COA) of vehicle , id of request data item (dx),path for destination (P_x) and a single bit flag F for representing whether the queried data item is cached or not,$[CoA_x,V_x,Id(d_x),P_x,F]$, it is sent to AP. As the packet is forwarded to server through AP and GFA, care of address of AP and GFA is appended in the packet header $[COA_{gfa}, [COA_{ap}, [COA_x, d_x, P_x, F]]]$ to keep the route information. Upon receiving request packet, server attaches the queried data item to acknowledgement (ack) packet with the route information. The ack packet is replied back to AP via GFA. Now AP uncast packet to corresponding vehicle.

When query is generated which is answered by cached copy of data item, the vehicle sends a request packet to GFA for checking validity through nearest AP. The GFA compares the id of queried data item with the Rn and reply with ack packet, if the cached copy is valid. If the cached copy is not valid, GFA forward data item to server. Server receives packet and verify it and check the status of queried data.

When queried data item is large and data transmission can not be completed in single AP. GFA sends an informative message to next AP for channel reservation and appropriate handoff. Selection of next AP is easy here because IVANET path is pre decided.

In summary, our scheme is based on the direction or path of vehicle in cached data invalidation that's why decision of next GFA and AP is easy.

4. NUMERICAL RESULT

In order to evaluate performance of proposed scheme, we calculate cost of cache invalidation on the probability of available channel for invalidation.

Let us assume C is a cost of cache invalidation when probability of available channel in next access point or GFA is one. Channels are limited in vehicular ad hoc network while demands of services are increased. It is not easy to keep free channel for new vehicles. Probabilities of free channels are decreased that's why cache invalidation cost is increased. Following table demonstrate relation between probability of available channel and cost:

Table 1

Probability of available channel	cost
1	C
0.5	C+D
0	C+C

When probability of available channel in next regional network is zero, cost of cache invalidation scheme is double in CCI. Here D is extra cost in invalidation when probabilities decrease.

Our proposed scheme sends information to next regional network. Next regional network reserve channel for cache invalidation and stop less priority services or perform forcible handover in its network. This scheme has maintained the probability of available channel in next AP is one that's why our proposed scheme does not need extra cost in cache invalidation

5. CONCLUSION

In this paper, we evaluate the hand off cost in cache data invalidation. This IVANET scheme has used the path of vehicles. This path selection has helped in finding next AP and next GFA. This cache invalidation scheme has reduced the cost of data invalidation when data item size is large. Large data needs more number of APs and more hand off for cache invalidation. Our proposed scheme efficiently decreased the cost of cache invalidation in Internet Vehicular Ad hoc Network.

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