CLUSTER BASED HANDOFF MANAGEMENT TECHNIQUE IN VANET USING BACKUP NODE

Nimra Mazhar, Khalid Awan & Peer Azmat Shah

Department of Computer Science, COMSATS Institute of IT, Attock, Pakistan

ABSTRACT

Handoff in Vehicular Adhoc Networks (VANET) is a process in which one vehicle disconnected from one network and join to another network. In VANET, handover is a big challenge for a vehicle due to high mobility and the process of handover occurs frequently. This mobility of a vehicle creates a lot of issues. Many solutions have been proposed to resolve these problems and some of them became standardized like MIPv6, HMIPv6, PMIPv6, and NEMO BS. In this research, we have addressed issues that lie in such network, when a vehicle performs the handover procedure. The challenges that a vehicle faces in handover procedure have been discussed and compared. Also, a methodology Cluster Based Handoff using Backup node (CBHBCK) is proposed to achieve the continuity in the network named as cluster based handoff using backup node, in which a backup node that is responsible for handoff is introduced. Using this backup node overhead on cluster head and disconnectivity during handoff procedure will be reduced. At the end, results are compared with the NEMO and Cluster Based technology by simulation using NS2 simulator. Simulation result proves that the proposed technique has better ability to achieve the continuity in communication during handoff procedure.

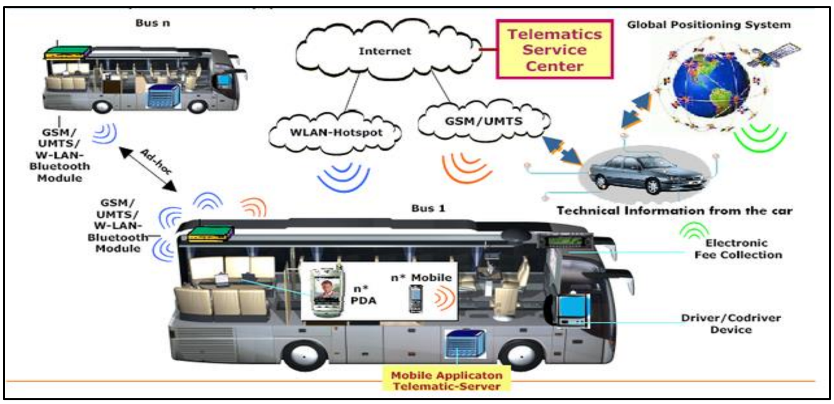
Keywords*: MIPv6, HMIPv6, PMIPv6, NEMO, mobile router, handoff, MANET, VANET*

INTRODUCTION

VANET has gained a lot of popularity over the past decade in academic research and industry. VANET is the sub category of MANET. In MANET nodes directly connected with each other without any infrastructure while in VANET there is a need of roadside infrastructure called as Base Station (BS). The nodes i.e. vehicles are highly dynamic in VANET. Mobility of vehicle is predictable and the broadcast is used in VANET for Sending and delivering of message instead of using unicasting (Singh, Kumar, Rishi & Madan, 2011). There are two types of communications in VANET; Vehicle to Vehicle (V2V) and Vehicle to Infrastructure (V2I). In V2V the communication is direct and multi-hop as well. This is efficient and cost effective due to short range bandwidth between the vehicles. V2V is based on dedicated short range communications (DSRC). While in V2I the communication is between vehicles and roadside units also and it uses GPRS, Wi-Fi or WiMAX for transmission(Hartenstein & Laberteaux, 2008). VANET has the advantage over the MANET in case of low cast communication between the vehicles. There are two types of application in VANET.

- Internet connectivity based is which multimedia, hypermedia, web browsing is included.
- Safety based in which collision alert, emergency warning and weather condition warning is included.

Figure 1. VANET Applications



In these applications, there is a need of continuous internet connectivity as shown in Fig 1. To achieve such a continuous connectivity the handoff procedure should be seamless and the assignment of IP address to the device must be assigned and reassigned frequently. This frequent assignment and reassignment make us able to achieve continuous connectivity to internet. After that mobile internet protocol version 4 was proposed in 2002 (Perkins, 2002) but still it has issues in triangular routing, weak security mechanisms and short range of communication. To overcome issues in MIPV4, the MIPV6 was introduced. It has a better security mechanism and efficient as compared with MIPV4 but still node mobility is very high, so MIPV6 (Nada, 2007) also not satisfied the requirement of connectivity continuity in VANET. To overcome the problems in MIPV6 a new protocol that works on handoff was introduced known as hierarchical mobile internet protocol (HMIPv6) (Soliman, Bellier & Malki, 2005). In this protocol, many new things were introduced such as Mobile Anchor Point (MAP), on-link Care of Address (LCoA) and Regional Care of Address (RCoA). It uses MAP to manage the user location.

For managing the location, it uses two types of management techniques; micro mobility and macro mobility. The mobile host (MH) using micro mobility management technique will create an LCoA and send binding message to MAP while MH using macro mobility management technique will create RCoA and sends binding message to its Home Agent

(HA). All these mechanisms discussed above only works on terminal mobility, none of them was considered. In terminal mobility, the ability of a terminal, while in motion, to access telecommunication services from different locations, and the capability of the network to identify and locate that terminal is included and all above mentioned techniques considered this type of mobility. So there was a need to work on the network mobility in which the mobility of the entire network is considered either it is a node or a BS. For this network mobility (NEMO) (Boukerche, Zhang & Fei, 2011) based protocol was introduced to handle the mobility of the network. In this protocol the base was mobile Router (MR) and user was not allowed to communicate directly to BS. Each MR has its own address known as home address (HA). When an MR moves to communication range of new Access router it will acquire a care-of-address (CoA) from the visited network. After this, it will send a binding update message to HA which will forward all the data packets.

Many protocols (Márquez, Calafate, Cano & Manzoni, 2011) have been introduced as discussed above but VANET handoff have issues due to highly dynamic environment a vehicle creates frequent handoff, which causes packet delay and packet losses. The term handoff refers to process of transferring network traffic from ongoing channel to another channel that is connected to the network due the shorter range of the channel. In this process the continuity of the services provided by the network is disturbed. To achieve the maximum services of the network the handoff procedure should be done in such a way that the user should not disturbed and handoff should also have done. Handoff is classified in many ways (Lee, Yu, Yoo & Choi, 2008). Horizontal and Vertical Handoff: In vertical handoff (Kumari, 2013) node have two interfaces of network and according to its facility the node will choose one of the networks for communication. For example, a laptop has two interfaces a Wi-Fi and a wired interface it will choose the wired interface when Wi-Fi interface is unavailable. While in horizontal handoff procedure the node switches between different BS and APs lies within same network access such as 4G and WiMAX. The process of handoff is different as compared to MANET (Hossain et al., 2010; Hui, 2005).

LITERATURE REVIEW

This section contains some important techniques that show how handoff latency in VANET are discussed and the challenges are highlighted that still need to address.

Two Antenna Approach

In this technique, each vehicle equipped with two wireless network interface cards. Each card has an antenna that is why is called as two antenna approach (Tian, Li, Huang, Shi & Zhou, 2012). These antennas cooperate each other in such a way that their responsibilities are distributed. The antenna that is responsible for the handoff will check the signal strength of the BS and register to that BS. In this case the front antenna will not be disturbed; it will continue its transmission except time period in which handoff procedure will be performed. After the time period is over the front antenna will be replaced with new one completely. By using this technique packet loss and handoff time is reduced (Amoroso, Marfia, Roccetti & Pau, 2012).

IP Passing

In this technique the IP address of the vehicle that is entering in the communication range of another BS it exchanges the IP address from the vehicle at opposite direction that is also performing handoff (Chen, Hsu & Yi, 2012). The exchange between IP addresses occur when these vehicles pass each other. After doing this a vehicle assists the vehicle behind of it to perform pre-handoff procedure. DHCP is a protocol in which a vehicle gets its IP address when it is entering in the boundary of another BS. Each device will get different type of IP address each time when it enters in the network (Jin, Rim, Kim & Wei, 2012).

Network Mobility (NEMO) Based

In this type of handoff technique, the groups of vehicles are made. In this technique multi-hop relay concept is used (Taha & Shen, 2013). NEMO uses Mobile Router (MR) for communication with the BS. Its concept is just like a real bus that has two MRs one at the front called as front MR and another is at end called as rear MR. Front MR is responsible for handoff and rear MR is responsible for the services provided to the network. All the hosts in bus are connected to MRs using Wi-Fi and MRs are connected to internet using WiMAX (Lee, Kim & Lee, 2014). In NEMO based technique a virtual bus is created that have a group of vehicles in it. First vehicle have front MR and the last vehicle in this virtual bus is equipped with rear MR. The front MR performs pre-handoff for the rear MR that is equipped in the last car in virtual bus (Yang, Li & Huang, 2013).

Vehicular Fast handoff Scheme (VFHS)

It is also known as cross layer handoff scheme (Chiu, Hwang & Chen, 2011). There are three vehicles types participating in this technique; RV (Relay Vehicle), OSV (Oncoming Side Vehicle) and BV (Broken Vehicle). An RV is a vehicle whose size is bigger than others so that it has the ability of relay and managing the MMR (Mobile Multi-hop Relay) WiMAX network to neighboring vehicles (Li, Chai, Hu & Chen, 2012). In this technique the OSV uses a predefined frequency channel for broadcasting Network Topology Message (NTM) to BVs (Sehlabaka & Kogeda, 2013). In this technique, the Preferred Access Points (PAP) and early handoff are used. Each AP prepares a list of PAP and this prior knowledge makes able the vehicle to perform handoff from ongoing AP by sending the details of PAP to the vehicle before dis-connectivity from it(Gupta & Dave, 2013). Each AP must have the physical knowledge of the system, and the next PAP based on the direction of the (MU). This is the mechanism used by the Early Handoff technique.

Cluster Based Handoff

In cluster based the vehicles on the highway makes group in such a way there is a cluster head, which communicates directly to the BS while other vehicles in cluster communicate only with the cluster head, i.e. the intermediate communication of clusters is not be allowed (Zhang, Boukerche & Pazzi, 2011). The cluster head is choosing by base station (BS) and the vehicle that acts as cluster head is always stronger when compared to other vehicles. As the cluster head has all the responsibilities for maintaining the whole network so it should be chosen by following basic metrics such storage capacity, communication range, energy etc. In this way the cluster head is responsible for all the communications as well as for the handoff procedure (Benslimane, Taleb & Sivaraj, 2011). As cluster head has all responsibilities for maintaining whole network so it should be chosen by following basic metrics such storage capacity, communication range, energy etc. In this way the cluster head is responsible for all the communications as well as for the handoff procedure (Cooper, Franklin, Ros, Safaei & Abolhasan, 2016; Ucar, Ergen & Ozkasap, 2016).

Table1: Comparison of Existing Methodologies

Approach	**Pros**	**Cons**
Two Antenna Approach (Silva, Nogueira, Kim, Cerqueira, & Santos, 2016)	It is very fast and packet loss rate is less. The traffic on one antenna is less which reduces network overhead.	It is expensive. Implementation in real world scenario is difficult.
IP Passing	It is very fast as is do not used DHCP. It is not expensive. It do not need any extra hardware to perform handoff.	Another vehicle is required in to perform handoff. If there is no vehicle in opposite direction it will use traditional DHCP procedure. (Midya, Roy, Majumder, De & Phadikar, 2017)
Network Mobility (NEMO) based	The handoff latency is reduced. Reduces overhead on individual vehicle as well.	If any vehicle that has higher speed over takes front MR than this process will be failed (Sangari & Baskaran, 2016). Same for the rear MR, it must be slowest one.
Vehicular fast handoff scheme(VFHS)	By making communication over RV reduces the handoff latency. Packet loss rate is minimized.	It is complex and time consuming. For making decision of handoff, GPS information is required (Mathew & Xavier, 2014)
Early Handoff mechanism (Hashimi & Hussein, 2015)	The period of dis-connectivity is reduced to few milliseconds. The vehicle should be connected to many APs at all the time that make vehicle capable of achieving continuity in providing services to hosts.	Each vehicle has to connect many APs at all time creates overhead on a single node. This reduces the energy of the node by scanning the network after a specified time period.
Cluster based handoff	Overhead on vehicle is reduced. The disturbance of disconnectivity network is reduced.	The overhead on the cluster head is increased. The disconnectivity of cluster head means the entire cluster will be disconnected (Malik & Sunkari, 2014)

Existing methodologies that are discussed above in Table 1 shows different drawback and hand off issue with respect to different techniques exists. Two main issues disconnectivity and load on cluster head are discussed in c comparison.

RESEARCH METHODOLOGY

In the previous section, we have discussed some techniques that have been applied to achieve the network continuity to user when a node or group of node is performing handoff. All techniques discussed are more and less suitable in different scenarios. The technique we proposed is discussed below. Our proposed scheme based on cluster of vehicles. A cluster is group of vehicles that moves together and shares the information with each other via any wireless network connection. In our proposed model, there are two nodes that keep track of handoff procedure. Let we assume that there is a network which has distributed its nodes into the clusters. We assume that cluster head and backup (assistant to cluster head) node is already chosen. This backup node keeps the track of location and performs the location updates to prepare handoff while cluster head is only responsible for the physical handoff and communication with other nodes and BS. In this technique, the overhead on the cluster head and the packet loss rate is reduced.

In our proposed solution, we will be able to achieve

- The continuity of communication while performing handoff.
- Overhead on cluster head will be reduced.
- Network performance will be increased.
- Network disconnectivity will be reduced.

Algorithm

Algorithm for handoff using backup node.

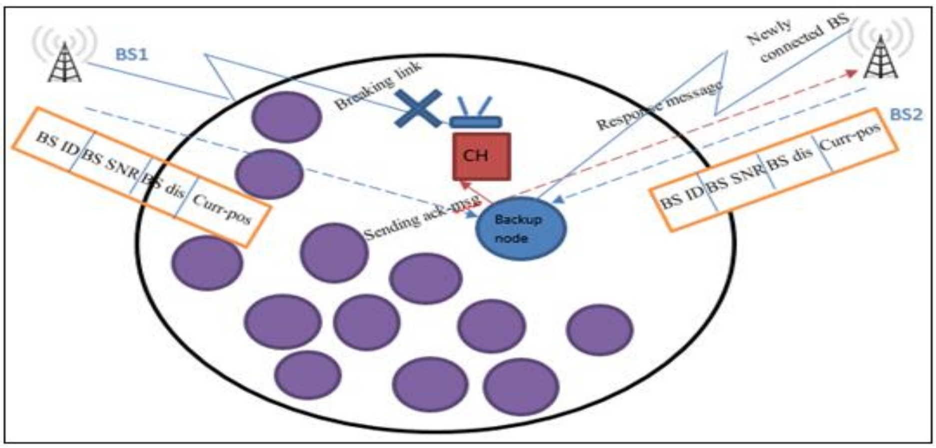
```
Handoff (h, n, bck, t, BS)
if (h_status[i]==false && t >1min) //handoff is not performing time setting for location update
{i =bck                    // backup node will update location
 B==BS[ i++]  // update and count  the number of base stations near by
Calculate DistanceSort(B[i-n-1]) // calling distance sort function for distance sorting.
Save B[i0-n-1]     // save the list of BSs according to distance nearest to farther
Else  if ( h_status[i] == true  && dis >=30metrs)
{search B[i0-n-1] // search BS list
BS= B[i0]        // select the BS from list B i.e. i0 the nearest BS
B[i0]→h        // inform the new BS to cluster head for physical handoff}
                         else
                         continue communication
                         End
```

Working of Algorithm

Step by step execution of algorithm.

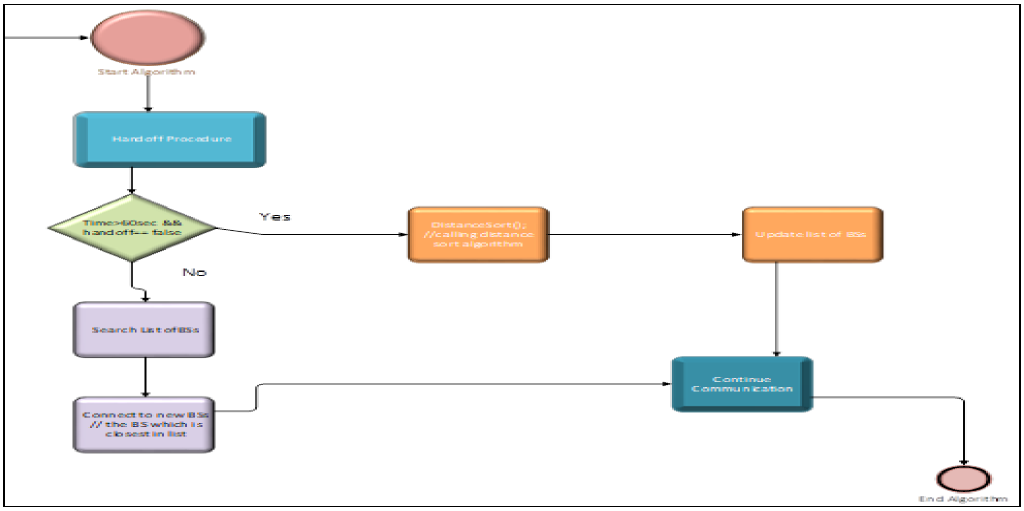
STEP 1: When handoff is not accruing & backup node sending hello messages after 1 min
STEP 2: Location updating and maintaining list of BS.
STEP 3: Connecting with new BS, BS2 that is nearest to the cluster head
STEP 4: Sending Physical byline to Cluster head for physical handoff by backup node
STEP 5: Disconnecting from BS1 as is farther BS and connecting with BS3 as it is nearest.
STEP6: Connecting to new BS physically & backup node will start updating list of nodes.

Figure 2. Algorithm execution for backup node selection



In the above Fig 2 different step of proposed algorithm are shown when handoff is not performing and backup node is updating the location by sending hello messages within the 30 meters (the range of the cluster head) range Base stations. In Step 2 the backup node will send route request (RREQ) messages to nearby BSs, and will get the route reply (RREP) messages. In Step 3 backup node will calculate the distance of available BSs and save them in its list from. Then select new BS which comes first in that list. Backup node will prepare the pre-handoff procedure. In Step 4 the backup node will send acknowledgement to Cluster head to perform the physical handoff as new BS is nearest and have much stronger signal capacity, which lessen the packet loss ratio. In Step 5 the cluster head will break its link from old BS meanwhile the backup node will communicate with the devices to achieve continuity. This will reduce the packet loss rate and handoff disturbance will minimize. In Step 6 the cluster head will connect to the new BS and backup node will again start to update the location and search the BSs to its maintain the list so whenever signal strength is less it should connect to another BS that is nearest per list. Flow chart of proposed methodology is shown in Fig 3.

Figure 3. Flowchart of Proposed Methodology



SIMULATION AND RESULTS

During the experiment phase the algorithm is tested using NS-2 simulator. The simulation is run for 200sec and the average results are plotted for evaluating the performance of the system. The simulation parameters are shown in Table 2.

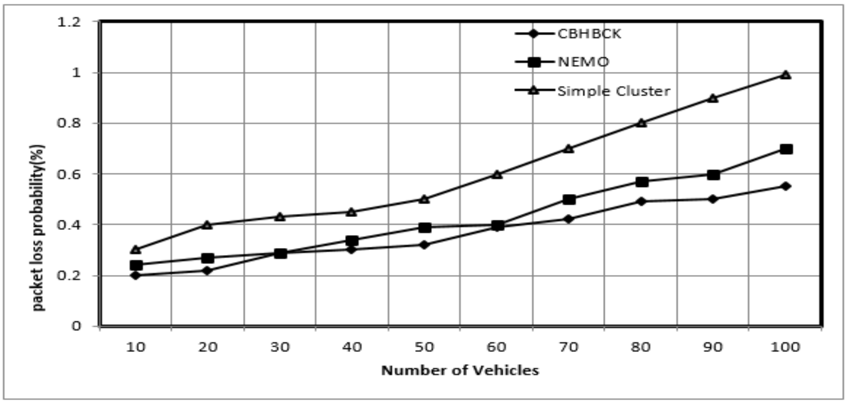
Table 2. Parameters Used During Simulation

1.	Network size	1000m×1000m
2.	Maximum Number of vehicles in cluster	100
3.	Speed of vehicle	0-100km/h
4.	Size of Packet	300bytes
5.	Time of Simulation	200s
6.	Rate of packets	90 packets/s
7.	Transmission range of WIFI	300m
8.	Transmission range of 3G or LTE	1000m

The performance metrics of interest are:

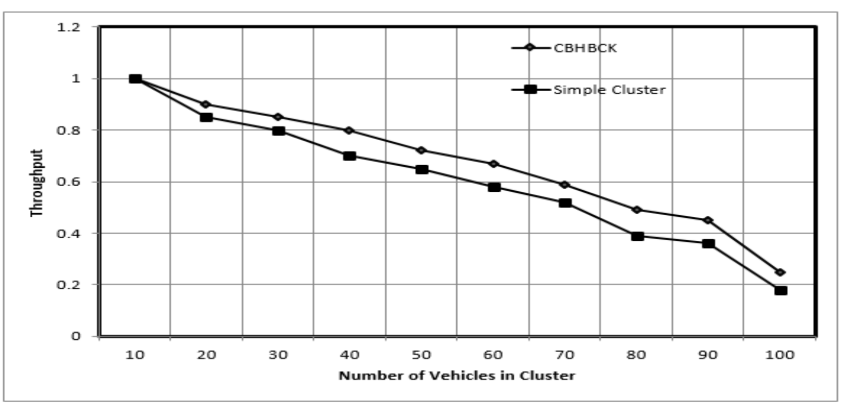
- Load on cluster head: It refers to the traffic load on cluster head during communication
- Packet loss: This metrics means the number of lost packets during handover procedure.
- Throughput: This means the average rate of successful message delivery to destinations. We will compare our methodology using these metrics to check how our technology performs.

Figure 4. Packets loss probability VS Number of vehicles in cluster



Comparison of proposed work with the existing methodology NEMO and cluster based. The results shows that Cluster based handoff with back up node works better in case of packet loss as the number of vehicles are increased. Fig.4 shows when there are 30 and 60 vehicles the packet loss rate is equal in both NEMO and CBHBK. As number of vehicles increased we can see (70, 80, 90, 100) the packet loss probability increases in NEMO and cluster based. It is due to the overhead on cluster head, as backup node assists the cluster head for seamless handoff.

Figure 5. Throughput VS Number of Vehicles in Cluster



Cluster head will continue to communicate with other nodes will reduce the packet loss rate even hundreds of vehicles in the cluster. In figure 5, the result of Cluster based and CBHBCK are simulated. As it can be seen above in the start when there are 10 vehicles in a cluster the throughput is probably same. As cluster expands and more vehicles are now part of cluster the throughput decreases. But in cluster based technology throughput is gradually decreasing while in CBHBCK the throughput is not decreasing as much as cluster based.

CONCLUSION

We have compared these technologies in terms of network disconnectivity, throughput and packet loss rate. Our proposed methodology is based on cluster handoff. We enhance the existing cluster based technology by adding a backup node that assist the cluster head to perform its duties. The burden on the cluster head is reduced in such a way that it is responsible for communication and physical handoff while the backup node will update the location and base stations list as the cluster moves. Backup node will send the HELLO message to BS to whom, the cluster will be connected. This technique will reduce the overhead on cluster head, increase throughput and decrease packet loss rate.

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