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A Study on Service Procedure in Clustered Vehicular Communication

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Abstract **:** Vehicular ad-hoc network is a new technology to achieve intelligent inter-vehicular communications. Vehicular ad-hoc network is highly dynamic due to the high speed of the vehicles, building and trees in the city areas that causes frequent changes in the network topology. Therefore it requires an efficient routing protocol and service architecture. This paper focuses a new cluster based highway model with 802.11p technology in which the service request and service update procedure for various protocols are studied and their performances have been analyzed and the results are presented in this paper. Here a new service request and service response procedure is introduced in the cluster based highway model that increases the performance of the service reply time and broadcasting time of warning messages.

Keywords: VANET, MANET, DSDV, AODV, DSR, OBU, GPS

I. INTRODUCTION

The speed and path define the dynamic topology of VANET. If two vehicles are moving away from each other with a speed of 30 m/sec and the transmission range is assumed to be 300 m, then the link between these two vehicles will last for every 5 seconds. This causes a very high dynamic topology and every node needed another link with nearby vehicle to maintain connectivity for every 5 seconds. So a frequent disconnection of network connectivity will occur especially for low vehicle density areas. For this reasons a cluster concept is introduced in the vehicular environment to reduce such a failure. To maintain the connectivity of the vehicles the network needed the knowledge about the position of the vehicle, speed, pattern and direction of movement of each vehicle [1]. These features are based on the traffic model, road condition and density of the vehicles. The above mentioned parameters are important for the construction of efficient network design. The mobility model of the vehicular environment varies from high way model to city Environment. So network design, routing algorithm and mobility pattern also need to adapt for these changes [2]. The highway mobility model is almost one dimensional model. Their direction, position, and the speed of the vehicle in a particular range can be easily predicted. But for city model road structure, the density of the vehicles is different; buildings and trees in the city model behave as obstacles, so the communication becomes complex. Because of the low speed of vehicles in the city area an effective communication is possible in this cluster concept model [3]. While using the cluster concepts in the city environment, the cluster head life time is long due to low speed vehicle movements in the city model. But it is not possible in high way scenarios. Due to the high speed vehicle movements, the high way model requires a special type of technology called 802.11p for regular VANET communication [4][5].

II. CLUSTER BASED VANET APPROACH

In the cluster-based vehicular model each graphical area is divided into a number of clusters. The head election algorithm elects a suitable vehicle as a cluster head. The data communication between vehicle and vehicle is carried out by the use of cluster head [6][7]. The inter communication among different vehicles in the VANET area is carried through the cluster heads, where as the intra-vehicular communication within each cluster is made through direct link. The cluster approach is more suitable for MANET [8]. Due to the high speed of the vehicle and unpredictable variation of mobility, the continuity of the link in the cluster often breaks. For this reason, a research can be made to modify the cluster algorithm that fulfills the needs of the VANET environment.

III. ROUTING PROTOCOLS

VANET is a main component of MANET. So the operations of these two ad-hoc networks are the same. Though most of the MANET routing protocols are applicable to vehicular communication, there are differences in their characteristics such as high dynamic, mobility constrains and high speed of the vehicles [9]. So the vehicular communication requires suitable modification in the predefined protocols. The VANET does not have the limitation of less power constraints and limited battery. Therefore these factors provide the researchers to develop a suitable routing protocol for vehicular communication. This paper presents the performance analysis of various services using Destination Sequence Distance Vector Protocol (DSDV), Dynamic Source Routing Protocol (DSR) and Ad-hoc On-demand Distance Vector Protocol (AODV) [10].

IV. Sysem Model

Each vehicle in a highway is equipped with a communication device, known as On Board Unit (OBU). Using this device, the vehicle can communicate with each other. In the present work each vehicle acts as a router to communicate with other vehicles. The efficient routing scheme needs the position of each vehicle in the network area. Therefore each vehicle is equipped with a Global Positioning System (GPS) device to identify the correct location of the other vehicle. It is also assumed that each vehicle has the knowledge about its moving velocity and the direction of the movement. On the basis of above mentioned assumption, a NS-2 simulation area has been designed. The vehicle position and their movements in a simulation can be created by the use of screen scenario generator mentioned in the figure 1. the VANET simulation scenario for 100 nodes is shown in the figure 2.

```
$node_(95)set Z_ 0.0000000
$node_(95)set Y_ 361.54
$node_(95)set X_ 1186.8
$node_(96)set Z_ 0.0000000
$node_(96)set Y_ 401.67
$node_(96)set X_ 1222.8

$ns_ at 2.5 "$node_(95) setdest 1250 179 10
$ns_ at 2.5 "$node_(96) setdest 1250 235.3 10
```

Figure 1: Screen scenario generator

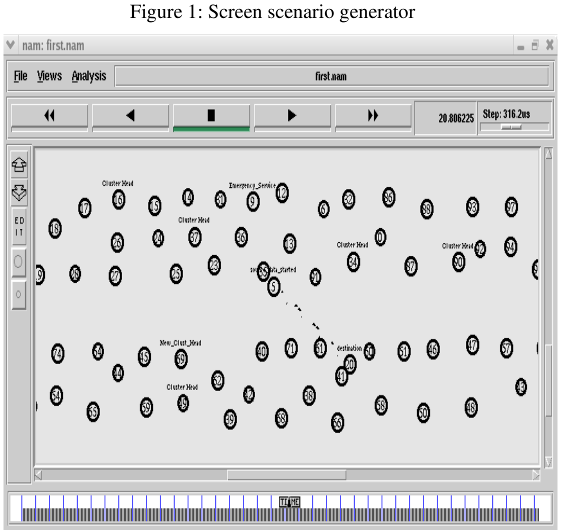

Figure2. : Simple Highway Mobility Model -NS2 NAM file

V. Previous Work

In the earlier model the communication is done through the Road Side Unit (RSU) [11]. This type of network model is valid only inside the city area where the vehicles move slowly and a more number of fixed base stations are available. But in the highway model, the vehicles moves with very high velocity and only a few roadside units or no road side units are available in the vehicular model outside the city. Because of the limited infrastructure, a new model for efficient data communication in vehicular environment is required. Most of the previous papers discuss the data communication with the use of 802.11 standards [12]. But this paper focuses a new highway model in which an efficient cluster creation method, cluster head election procedure and cluster head switching algorithm are introduced [13]. This paper presents the service request procedure and service response procedure for the nodes which receive service request messages and also broadcast warning messages. This paper also compares the performance of these services for various routing protocols and IEEE standards 802.11 & 802.11p [14][15]

VI. Service Request And Service Response

The VANET supports two types of data traffics. One is information service based on unicast traffic approach. The other is multi casting traffic application like the distribution of warning messages. If a vehicle in the cluster requests a service then it initiates the service request procedure. Each intermediate vehicle in the network must maintain the description of the service supplied by it and keep the track of services provided by other nodes in the cluster. When ever a new service is availed by any vehicle it must be informed to its local cluster head. This information is periodically updated with all other cluster heads. It ensures that all cluster heads have the same information. The service request and response procedure can be brought under three phases.

Phases1: When a node requests a service message to its local cluster head, the head first checks the flag bit of the message. It the flag bit is '0' then the head decides that the received message is a service request message. Now the head checks the requested service information in its own database and it responds to the client if the service is available.

Phase 2: If the flag bit is 0 and the requested service is not available in its local cluster head then the service synchronization process is activated. Then it updates the latest information with all the cluster heads. It makes another search for the service and replies the service information with the details of the necessary service provider to the requested vehicle. If not, it informs the client that the service is not available.

Phase 3: If the flag bit is 1 then the corresponding head thinks that the received message is a warning message and not a service request message. The head immediately calls the emergency service procedure to alert all the cluster heads. When the cluster head receives a warning message, it immediately transfers this information to the nearby heads and also transmits to the vehicles which are directly connected to this head.

The service process of vehicular network is shown in figure 3 and 4 describes the efficient service request and service response architecture in the proposed cluster-based highway model.

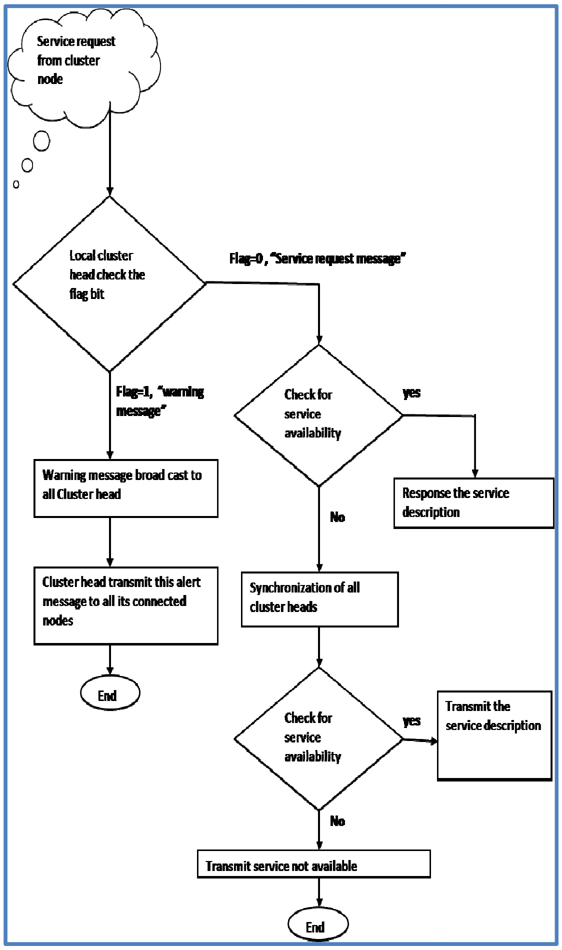

Figure 3: Service process in Vehicular communication

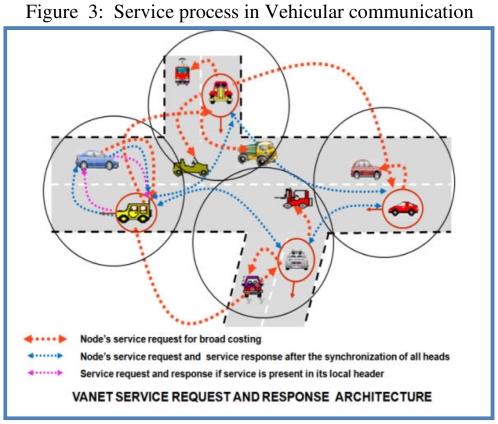

Figure 4: Service request/response and warning message VANET architecture

VII. SIMULATION PROCESS

The service request and response time is estimated using NS2.34 simulator. The following NS2 parameters are assumed to execute this simulation work. The VANET area is assumed as 1400 * 1400 meters of highway with bidirectional movement of vehicles. The Number of nodes varies between 25 and 150 and the number of clusters varies from 2 to 20 in steps of 2. The speed of the vehicles is assumed to be constant in each scenario and the experiment can be repeated for different speeds from 5m/sec to 25 m/sec. The well suited vehicular technology known as 802.11p is used in this process. To enable accuracy and reliability, the average of 50 samples are taken in to consideration.

VIII. EXPERIMENTAL RESULT

This simulation is done with 50 nodes,70 nodes and 100 nodes where services like Fuel station information, Fire service information and Hospital information are stored in any one of the nodes of the three clusters. Whenever a new service is introduced in the node then this information is periodically synchronized with all the cluster heads. If a node requests the petrol information in its local cluster head, then it checks the service in its data base and replies if it is available. These experimental results are listed below.

A. Service reply time before synchronization with speed 5 m/sec and 25 m/sec

The Figures 5 and 6 show the service request and response time before synchronization process for speed 5 m/sec and speed 25 m/sec with routing protocol AODV. From this graph it is noticed that better reply time is received for node 75. The service response time increases when the speed of the vehicle increases. For speed 5m/sec, the reply time before synchronization is less than the reply time for speed 25.

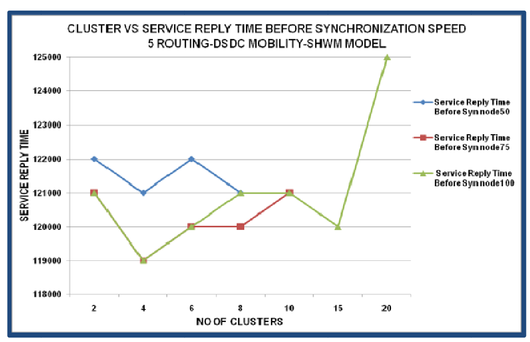

Figure 5: Service reply time before synchronization with speed 5

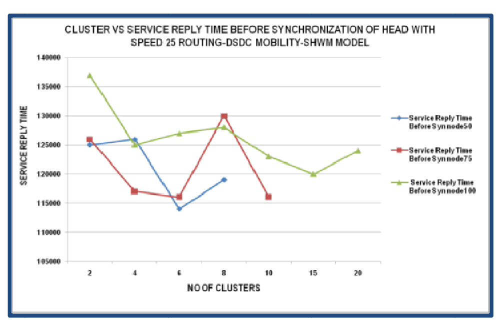

Figure 6: Service reply time before synchronization with speed 2**5**

B. Service reply time after synchronization with speed 5 m/sec and speed 25 m/sec

From Figure 7 and Figure 8, it is noted that the service reply time after synchronization process with speed 25 m/sec yields better performance than the reply time with speed 5 m/sec. It is also observed that for nodes 75, the performance of the service reply time is higher than the nodes 50 and nodes 100 for both speeds.

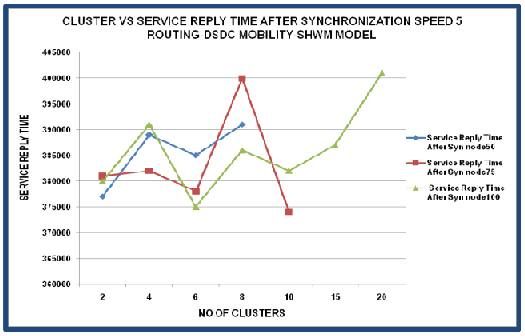

Figure7 : Service reply time after synchronization with speed 5

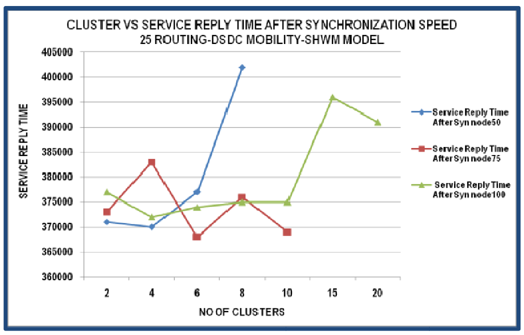

Figure 8: Service reply time after synchronization with speed 25

C. Service reply time for service not available with speed 5 m/sec and 25 m/sec

In the case of service not available, the service reply time increases when the number of node increases. In Figure 9 and Figure 10, it is observed that the reply time is high for nodes 100 and it is low for node 50 and 75. In speed 5 and speed 25 it is noticed that the service response time for nodes 50 and nodes 75 yields almost constant value which is shown in the graph.

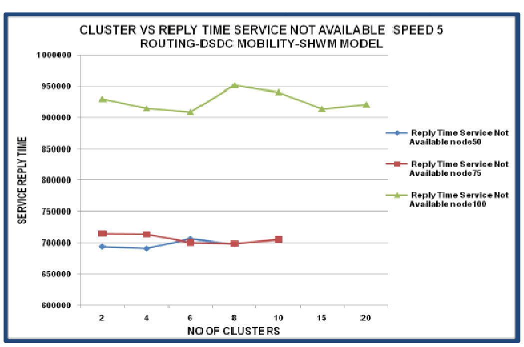

Figure 9: Service reply time service not available with Speed 5

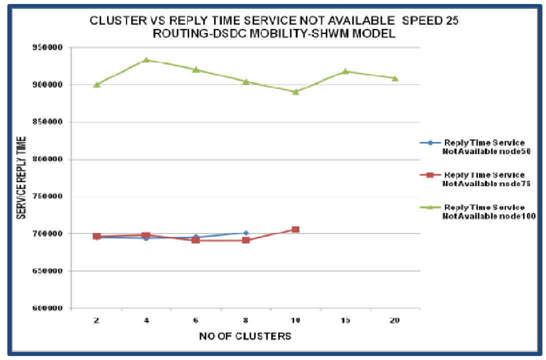

Figure 10: Service reply time service not available with speed 25

D. Figure 11: DSR- DSDV-AODV Service response time with speed 10

The Figures 11,12 and 13 show the performance of cluster Vs service request and response time for DSR, DSDV and AODV protocols with speed 10. The IEEE standard 802.11p is introduced in this research work. From these graphs, it is observed that the response time before synchronization is low for various routing protocols. The service reply time after the synchronization process is higher than the before synchronization process and less than the service response time if the service is not available.

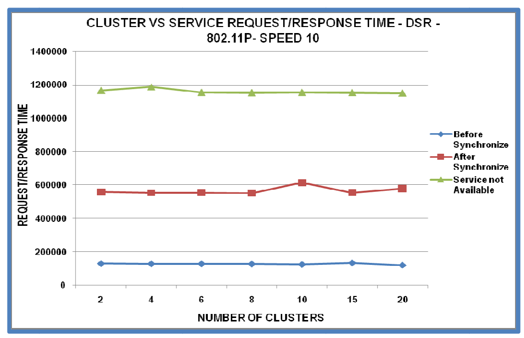

Figure 11 : DSR- Service response time with speed 10

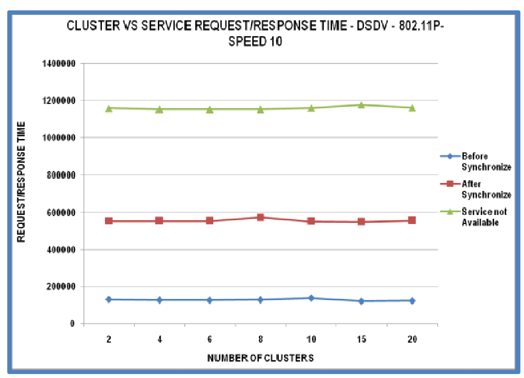

Figure 12 : DSDV- Service response time with speed 10

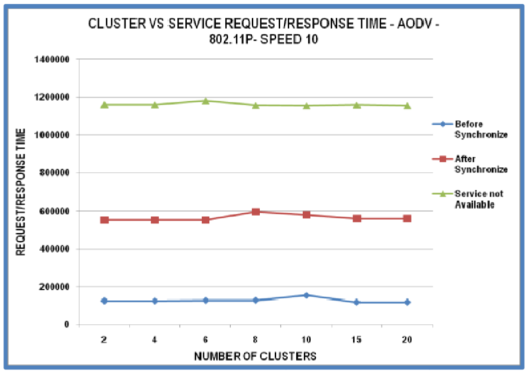

Figure 13 : AODV - Service response time with speed 10

E. Comparison of various protocols before synchronization service reply time

The service request/response time of before synchronization for various routing protocol is compared in Figure 14. Here DSDV protocol gives minimum reply time than other two protocols. It is also noticed that the number of clusters is between 15 and 20, the reply time reaches to minimum value for all these three protocols.

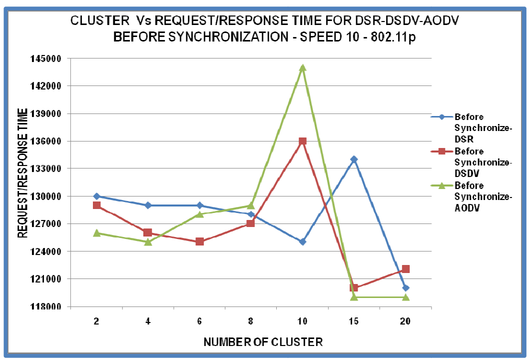

Figure 14 : DSR-DSDV-AODV response time before synchronization

F. Comparison of performance analysis for DSR-DSDV-AODV protocol's response time after synchronization

The Figure 12 shows the performance characteristic of service reply time after the execution of the synchronization phase. It is noticed that minimum value is observed when DSDV protocol is used. Here it is also noticed that these three protocols yield minimum value for clusters between 2 and 6. When the number of clusters increases above 6, the performance of the DSR and AODV protocols is less than DSDV protocol.

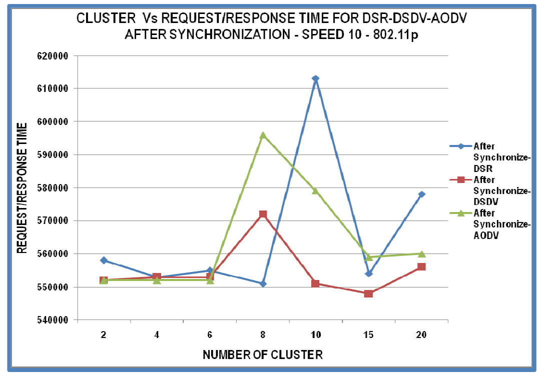

Figure 15 : DSR-DSDV-AODV response time after synchronization

G. Comparison of DSR-DSDV-AODV response time when the service is not available

The Figure 16 presents the response time for the service request in which the service is not available. This graph represents the comparison charts of various protocols with the number of clusters varying from 2 to 20 insteps of 2. From this graph it is observed that the low reply time is obtained for DSDV protocol when the number of cluster is less than 8. Above 8 clusters, the DSR and AODV yield minimum reply time.

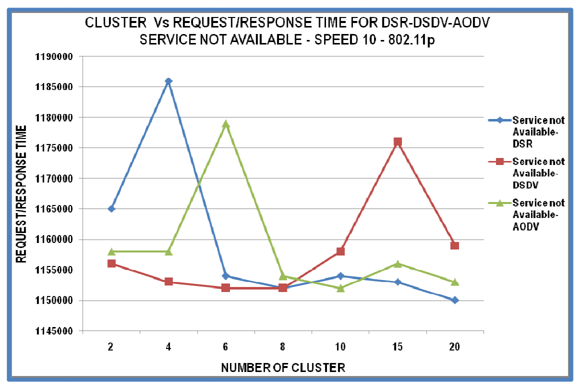

Figure 16 : DSR-DSDV-AODV response time service not available

H. DSR service reply time for before and after synchronization with 802.11& 802.11p

Figures 15, 16 and 17 compare the performance of service reply time for before synchronization and after synchronization under service not available condition with standard 802.11 and 802.11p. For the given scenarios and the position of the service provider nodes, the 802.11 technology emerges a better response time which is shown in Figure 14. The service reply time after synchronization for 802.11 and 802.11p is shown in Figure 15. Better reply time is studied for the clusters varying between 2 and 8. When the number of clusters increases above 8, both the technologies yield a low performance.

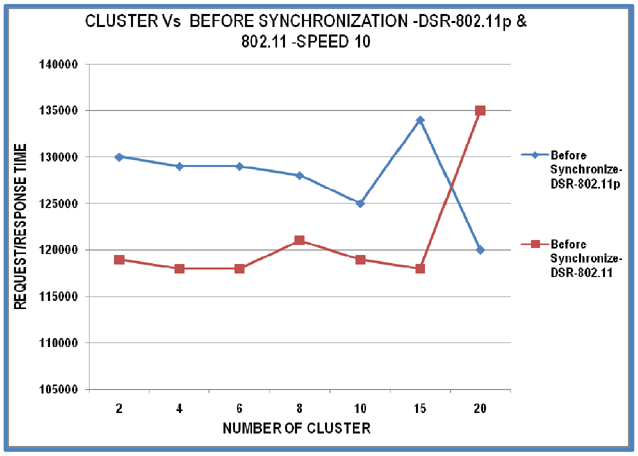

Figure 17 : DSR response time before update -802.11&802.11p

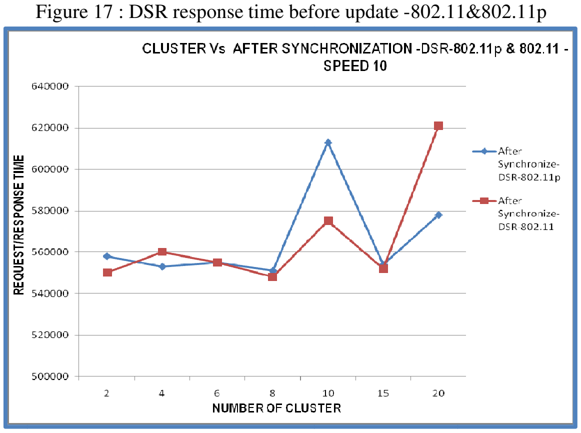

Figure 18 : DSR response time after update -802.11&802.11p

Figure 19, if the service is not present, the reply time is higher for lower number of clusters and the performance increases when the number of clusters also increases.

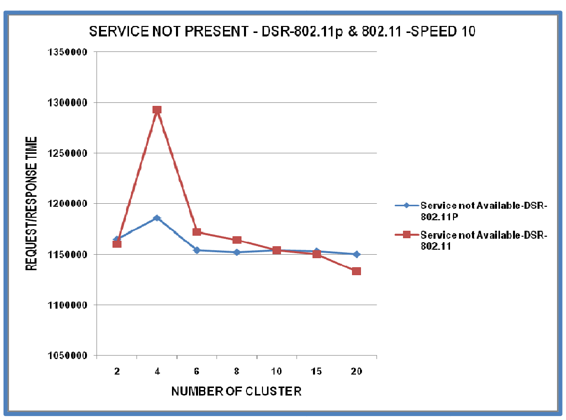

Figure 19: DSR response time service not present -802.11&802.11p

I. DSR-DSDV-AODV response time before synchronization, after synchronization and service not available with 802.11p & 802.11

Figures 20, 21 and 22 represent the comparative analysis of various protocols with various technologies. From the graph it is noticed that 802.11p technology is well suited for both reply time after synchronization and service reply time if the service in not available.

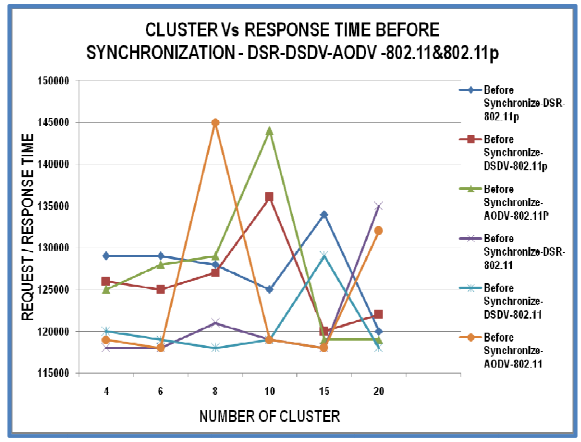

Figure 20 : DSR-DSDV-AODV response time before synchronization With 802.11p & 802.11

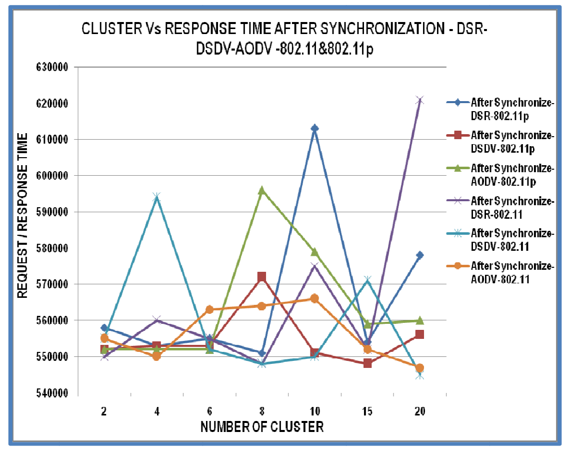

Figure 21 : DSR-DSDV-AODV response time after synchronization With 802.11p & 802.11

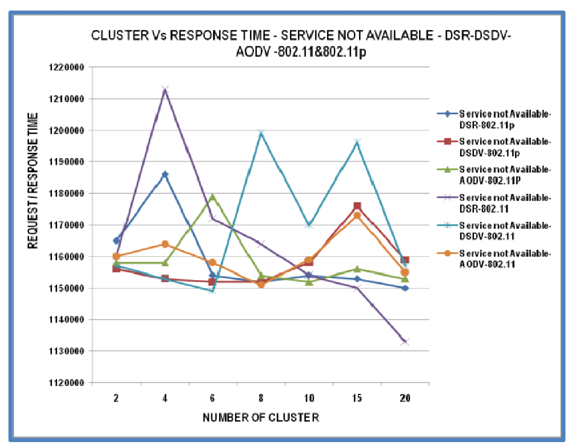

Figure 22 : DSR-DSDV-AODV response time service not present with 802.11p & 802.11

J. Emergency broadcasting using 802.11p

The Broadcasting time of packets to all cluster head is estimated for various clusters. When the number of clusters increases, the broadcasting time slightly decreases as shown in Figure 24. It is noticed that better broadcasting time is measured when the number of node is 125. Figure 17 represents the simulation output of emergency broadcasting to all cluster heads.

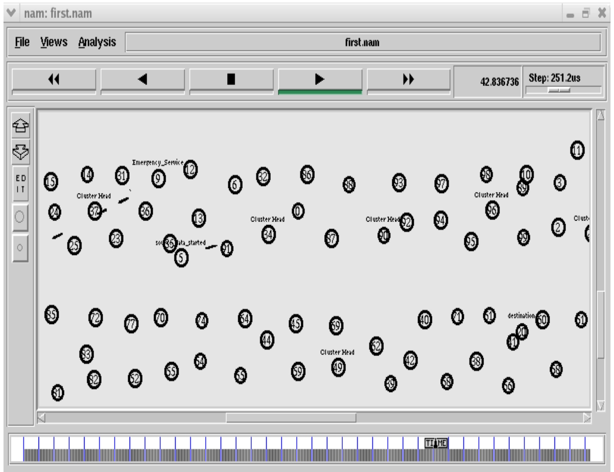

Figure 23: Broadcasting to all cluster heads

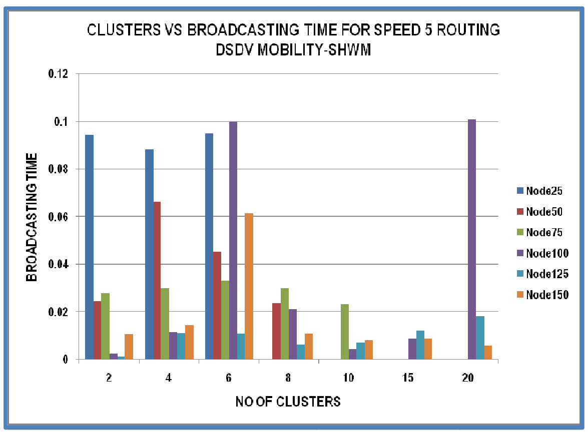

Figure 24: Analysis of broadcasting time

IX . Conclusion

This paper focuses on the study of performance analysis of service procedure in vehicular environments. The methods used in this work increase the performance of the service response time requested by the nodes in the VANET area. The two main concepts introduced in this paper are handling the services requested by the clients and the warning messages to all the heads in this network. The head in turn communicates this alert signal to all its clients. In the proposed work a new procedure has been developed for the given simple cluster based highway model. The performance analysis of service reply time before synchronization process and after synchronization process is presented in this paper. The aim of this work is to process the clients request quickly and broadcast the emergency warning alert message like accident information, traffic information to all the cluster based VANET nodes.

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