Modeling and Simulation of Efficient Cluster Based Manhattan Mobility Model for Vehicular Communication

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Abstract — **Pattern design plays a vital role in establishing network communication in Ad-hoc network scenario. The real challenge to the researchers is designing the communication architecture to vehicular network. Vehicular network architecture design is difficult, since the movement of the vehicle speed is high. The existing vehicular network architecture forms the network communication but the communication is not reliable and the message transmission time is high. However a new architecture design is required to establish fair network communication among vehicles. This paper presents a novel cluster based vehicular network architecture for Manhattan Mobility Model and the proposed model is analyzed with various routing protocols. The result and analysis of the proposed model show clearly that the Cluster based Manhattan Mobility Model produces reliable communication. The proposed Cluster scheme reduces the message transmission time obviously.**

Index Terms —**MANET, VANET, RSU, DSDV, AODV, DSR.**

I. Introduction

The present lifestyle of people throughout the world made many people use vehicles to travel from one area to another area [1]. VANET is a new class of MANET, where vehicles are considered as nodes to establish the network communication [2]. This special kind of MANET known as VANET supports high mobility speed network communication [3, 4, 5, 6, 7]. Vehicular ad hoc network allows exchanging of messages among vehicles Road Side Unit (RSU) [2]. VANET communication is mainly used in many applications such as sharing files, and real time traffic information [8]. Vehicles that move on the roads are connected with other vehicles or with Road Side Units. This makes all the vehicles that are connected within the network area to pass the communication message to other vehicles.

The mobility pattern of MANET is at random, whereas the mobility pattern of VANET is restricted within the given topology (Road) [9]. Memory and processing capabilities of VANET nodes are so high, that these factors must be considered while designing the protocol for VANET communication [9]. The fundamental aim of vehicular network communication is to increase the comfort of passengers and drivers [10]. Vehicles act as the communication node to exchange messages such as road condition, accident warning, traffic information, breakdown, fuel services and so on with other vehicles. Every vehicle is manufactured with a special unit known as On Board Unit (OBU), which is used to send and receive the messages from one vehicle to another vehicle [11, 12, 22]. Communication is possible with some protocols, which is used to transmit and receive the messages in VANET [13, 14]. However this sort of wireless network communication must be reliable and its performance should be high. This paper proposes a new model VANET architecture communication, which produces better performance and reliable network communication.

II. Related Work

Traffic control system is very important in guiding the vehicles moving on the road [15]. The existing traffic control patterns are static, which makes the car wait for a long time at the intersection points [15]. Obviously a dynamic pattern design is needed according to the demand of the vehicle that reduces the vehicle waiting

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time at the intersection points using car-to-car communication to adjust the timing pattern of the traffic control system [15]. Owing to the high mobility of vehicle nodes, Routing is the real task in vehicular communication [16]. Vehicular safety is another issue in VANET architecture. Various research attempts have been made to increase the safety of the passengers and drivers of the vehicle.

Observations of the previous research work in this area state that most of the existing work in VANET communication is established on the basis of vehicle to infrastructure model. In this model On Board Unit (OBU) is embedded in each vehicle to transmit the position of the vehicle to the trusted server periodically [17]. The transmitted location from the On Board Unit is tested with the Road Side Unit (RSU) to verify its trust worthiness [17]. Only a few research works have been carried out in vehicle to vehicle communication. For an efficient V2V communication cluster based VANET (CBVANET) architecture is presented [18]. In this work, the communication area is divided into a number of cluster ranges based on the movement of the vehicles [18]. One vehicle is chosen as the cluster head within the cluster ranges and all the other vehicles within the cluster area are connected to the cluster head [18].

The standards used in VANET communication are 802.11 and 802.11p [19]. These two standards with various routing protocols such as DSDV, AODV, and DSR are tested in highway mobility model [19]. Among the protocols, AODV protocol yields better performance in highway environment [20]. The above mentioned standards and protocols are tested in Cluster based Manhattan Mobility Model and its performances are evaluated in this paper.

III. Architecture

A. Manhattan Mobility Model

Vehicular Ad-hoc network communication is formed with various mobility models. However, all the mobility models provide the necessary information to the drivers and passengers for safety travel. One such mobility model is Manhattan Mobility model. This model uses the map file to control the vehicle movement properly and it is highly suitable for urban area. The path defined in this model is well-organized and predefined.

The map contains a number of horizontal and vertical streets as the root guide to the drivers. The structure of the road in Manhattan Mobility Model composed of two lanes for each direction. The vertical street contains the north and south and the other horizontal street consists of east and west direction roads. The vehicle is allowed to move on the predefined lanes either horizontal or vertical as indicated in the map of the Manhattan Mobility Model. Vehicle can move left, right, straight with certain probability within the prescribed grid lanes of the map.

The Mobility Generator tool is used to generate the Manhattan Mobility scenarios. The performances of the protocols, standards, Cluster and Sans Cluster concept are evaluated in these Manhattan Mobility scenarios. The trace files generated by these tools are compatible with the format required by Network Simulator. The generated trace file is given as input directly to the Network Simulator NS-2.34 and executes the simulation. Any number of scenarios can be created by modifying the appropriate parameters.

B. Cluster Based Manhattan Mobility Model

Mobility model in city environment depends on the road structure and density of the vehicles. The trees, towers and buildings act as the obstacles for the network communication in city environment. Hence, the network communication in city environment is quite complex. The movement and speed of the vehicle in the urban area is slow, which promotes effective communication.

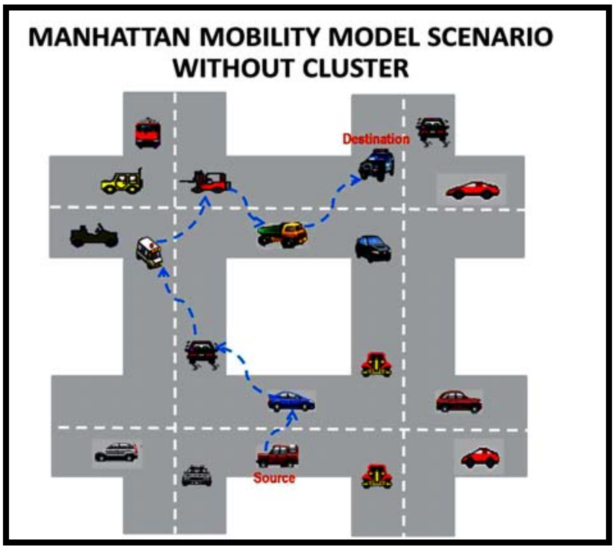

Figure 1a. Sans Cluster Manhattan Model

Existing research work in the field of VANET communication was established with the help of Road Side Unit (RSU). RSU is expensive and more number of RSU is needed to make fair and effective Vehicular network communication. In order to avoid such expensive RSUs, the author proposed a novel VANET architecture [21]. The proposed model replaces the Road Side Unit and makes vehicle to vehicle communication as shown in the Figure 1a.

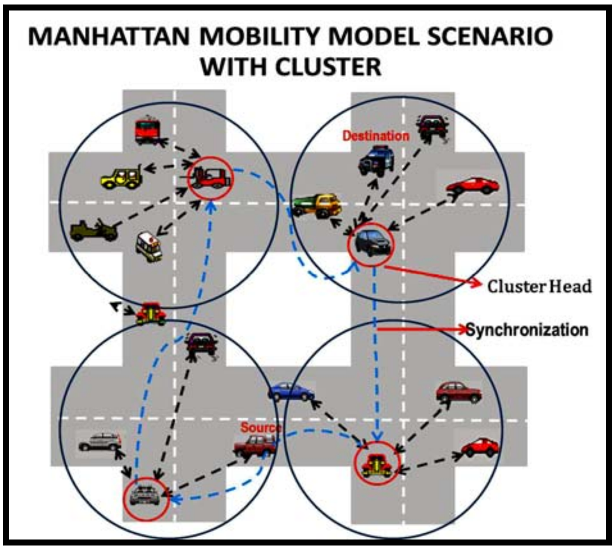

Figure 1b Cluster based Manhattan Model

However, V2V communication could not lead to effective communication because its message transmission time is high and it is unable to provide all the services requested by the vehicle. This paper proposes a novel cluster based Manhattan Mobility Model to increase the efficiency of the service discovery procedure as shown in Figure 1b.

C. *Cluster Creation Process in Manhattan Model*

All the vehicles moving in the Manhattan Mobility Model are grouped together to form a cluster. The Algorithm 1 tracks the position of each node and identifies the speed of each vehicle. Cluster size will become smaller, when the average speed of the node is slow. Similarly, whenever the average speed of the vehicle is high, the algorithm creates a bigger size cluster.

```
Cluster (N)
{
   N = Number of Nodes;
   Track the position of N;
   Calculate the speed of each node
   from N;
If (Average speed of node is slow)
   Form the cluster size smaller;
Else
   Make the cluster size bigger;
}
```

Algorithm 1: Cluster Creation Process

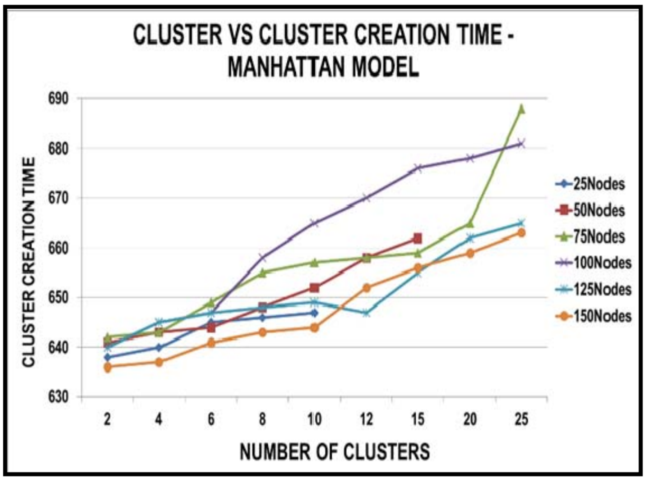

Figure 2a Cluster Creation Time

The cluster creation time of the Manhattan Mobility Model is presented for various cluster sizes in Figure 2a. When the number of clusters is low Manhattan Mobility Model provides low cluster creation time, and with the increase of the clusters, the cluster creation time increases proportionally.

D. *Cluster Head Election & Cluster Head Switching Procedure*

Algorithm 2 represents the working principle of head election and head switching procedure among the nodes within the cluster range. Based on the parameters described in Algorithm 2, the long life node is elected as the cluster head. Here the key note is, once the cluster head moves away from the cluster boundary, a new cluster head should be elected automatically. Following are the key points which should be considered in the election of cluster head.

- Count the number of available nodes within the cluster range.
- Track the position of node at time Tx using GPS.
- Track the position of node at time Tx+10 using GPS.
- Track the direction of the node.
- Calculate the velocity of nodes using two positions Tx and Tx+10;
- Identify the node that has less velocity and elect it as cluster head.

Once cluster head is chosen, all the other nodes within the cluster range are connected to the cluster head. All the cluster heads are interconnected to form the VANET network. Whenever a node gets new information, the message is passed to the cluster head. The cluster head routes the message to all the other cluster heads. Whenever a cluster head reaches its cluster boundary the algorithm elects a new cluster head. As soon as a new cluster head is elected, the database of the old cluster head is transferred to the new cluster head.

```
Cluster_Head ()
{
        Total = Count the total number of nodes within the cluster area;
        Int distance=0, Speed;
        Distance_High_Node;
        For(i=0;i<total;i++)
        {
                Track the position of node at time Tx;
                Track the position of node at time Tx+10;
                Track the direction of the node;
                Calculate the velocity of the total number of nodes;
                Calculate the distance of each node from cluster boundary;
        For(i=0;i<total;i++)
        {
                If(node[i]>distance)
                {
                        Distance_high_Node = node[i];
                }
        }
        Speed= Distance_High_node[velocity];
        For (i=0;i<total;i++)
        {
                If (Distance_High_Node[velocity] < node[velocity] )
                {
                        Distance_High_Node is elected as Cluster Head;
                }
                If ( Distance_High_Node[velocity]> node[velocity]
                {
                        Time= node[distance] / node[velocity];
                        Node[long_Time] to reach boundary is elected as cluster
    head;
                }
        }
        }

        If (cluster head position = cluster boundary – Threshold value)
            {
                Cluster_Head(); # Elect new cluster head
                Transfer the content of old cluster head to new cluster head;
            }
}
```

Algorithm 2: Cluster Head Election & Cluster Head Switching Procedure

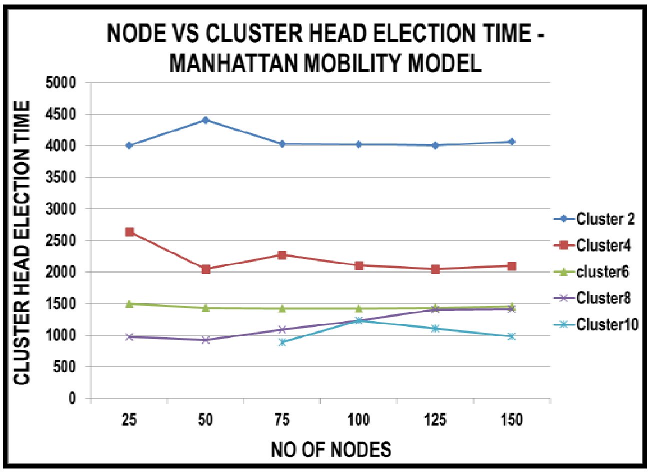

Figure 2b Cluster Head Election Time

Figure 2b shows the cluster election time which is estimated for different cluster sizes by varying the number of nodes. From the graph, it is noticed that when the number of clusters is low it yields high head election time. In the case of Manhattan Mobility Model better head election time is achieved, when the optimal number of clusters in the VANET network area is between 8 and 12.

E. Synchronization Procedure Call in Manhattan Model

Once synchronization procedure is called, it ensures that all the cluster heads should have the same data. This synchronization procedure call is executed at the predefined periodical time. However, it may be necessary to execute the synchronization procedure call by the cluster head at any time depending upon the service required by the node.

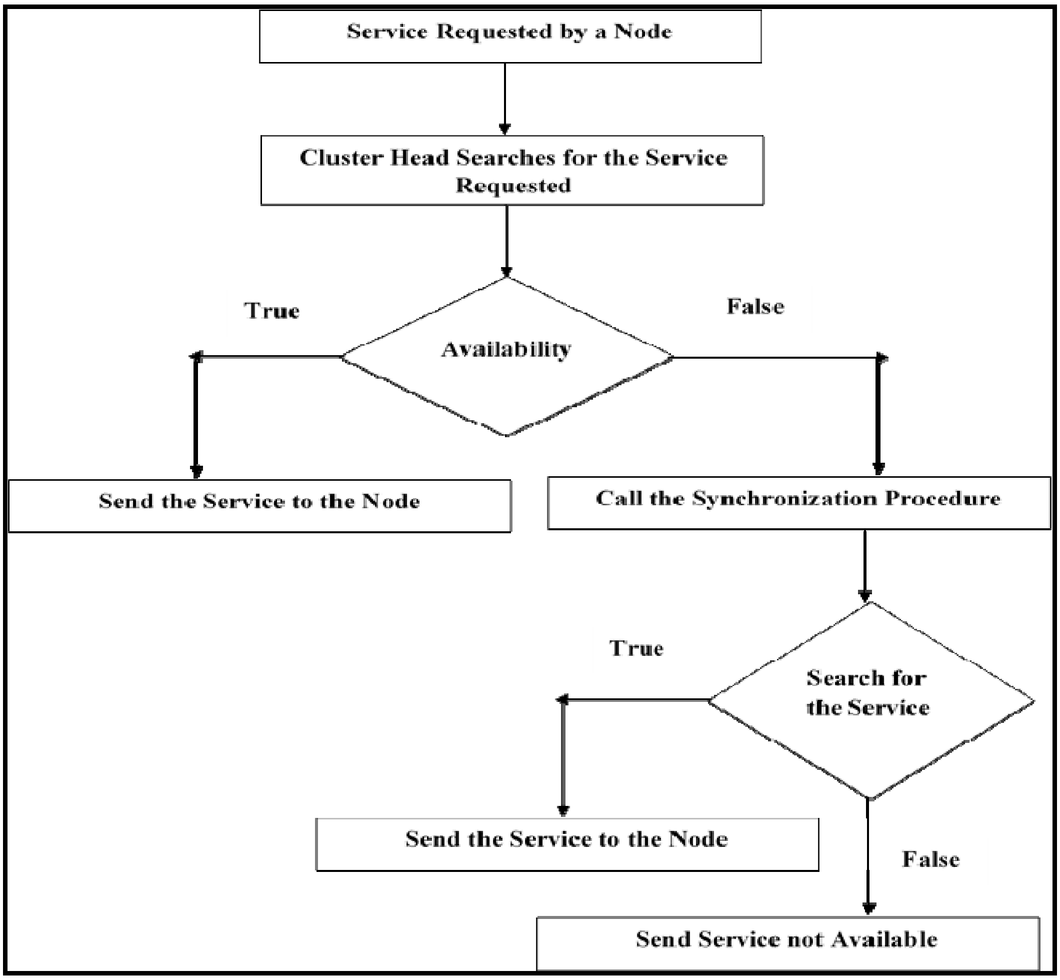

Figure 3 Synchronization Procedure Call Data Flow Chart

As represented in Figure 3 when a node makes a request for a service, the cluster head makes a search for the service. If the service is available, it sends the service information to the node. If the service is not available, the cluster head executes the synchronization procedure, which makes all the cluster heads are updated with the recently received information from one another. After the execution of synchronization procedure call, the cluster head again searches for the service requested by the node. If the service is available then the requested service is sent to the node; otherwise service not available information is sent to the node.

IV. EXPERIMENTAL ANALYSIS

A. Simulation Parameter

NS2.34 comprises the standards 802.11 and 802.11p. The NS2.34 is used to implement and test the performance of the proposed Cluster based Manhattan Mobility Model. Execution of VANET simulation in Manhattan Mobility Model could be done with the following parameters.

TABLE 1

SIMULATION PARAMETER

Network Area	-	1500 x 1500 m
Channel Type	-	Wireless
Propagation Model	-	Two Way Ground
Traffic Type	-	CBR
Visualization Tools	-	NAM, Tracing
MAC Layer	-	IEEE 802.11p, 802.11
Mobility	-	Manhattan Mobility Model
Protocol	-	AODV, DSR, DSDV
No. of Nodes	-	25, 50, 75, 100, 125, and 150
Node Speed	-	5m/s and 10m/s

B. Packet Receiving Time for Manhattan Model

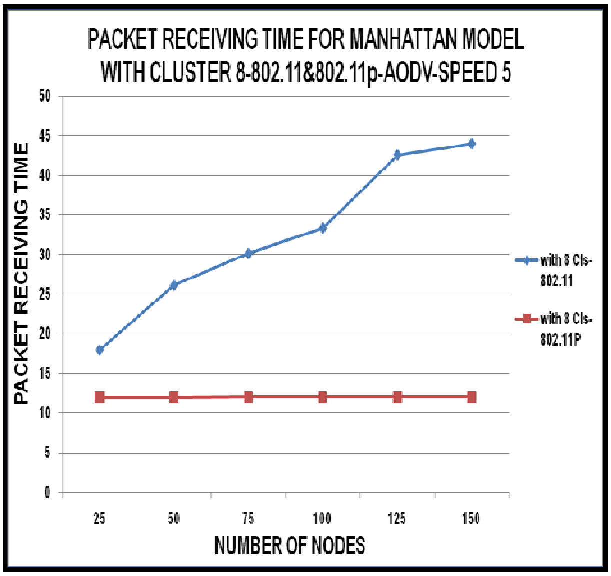

Figure 4a Packet Receiving Time with Cluster

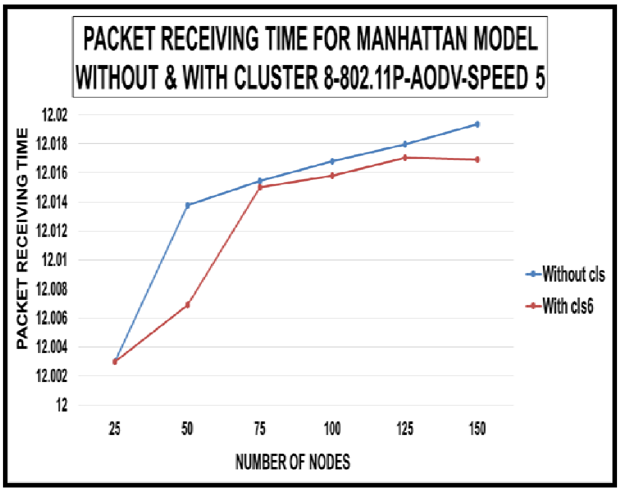

Figure 4b Packet Receiving Time with &Sans Cluster

The Figures 4a and 4b illustrate the performance of packet receiving time for cluster 8 with varying nodes between 25 and 150 and the speed of the node is 5 m/s. From the Figure 4a it has been noticed that the VANET MAC layer standard 802.11p yields better packet receiving time than 802.11. Figure 4b shows the comparative study of packet receiving time for cluster and sans cluster based Manhattan Mobility Model. From the graph it is crystal clear that cluster based concept consumes less packet receiving time than non-cluster based approach.

C. Packet Delay Time and Throughput Ratio

Effectiveness of network communication could be determined by the packet delay time and throughput ratio parameters. The performance of the packet delay time can be measured by the standards 802.11 and 802.11p for various clusters ranges from 2 to 15, as shown in Figure 5a. The dedicated short range communication (DSRC) at 5.9 GHz band allotted for intelligent transport system uses the IEEE 802.11p base. The frequency parameter Phy/WirelessPhyExt set freq_5.9e+9 or 5.85 GHz used in NS2.34 represents the operation on DSRC band. The transmission power of each vehicle is set to Phy/WirelessPhyExt set Pt_ 5.0e-2. The range of the communication is approximately 350 meters. The packet delay time of 802.11 and 802.11p are analyzed. Here the observation depicts that 802.11p has better performance because of the amendment of the above mentioned frequency and power parameters. It is also noted that AODV protocol consumes less packet delay time. Observations obtained from Figure 5b demonstrate that AODV protocol yields high packet throughput ratio using the standard 802.11p.

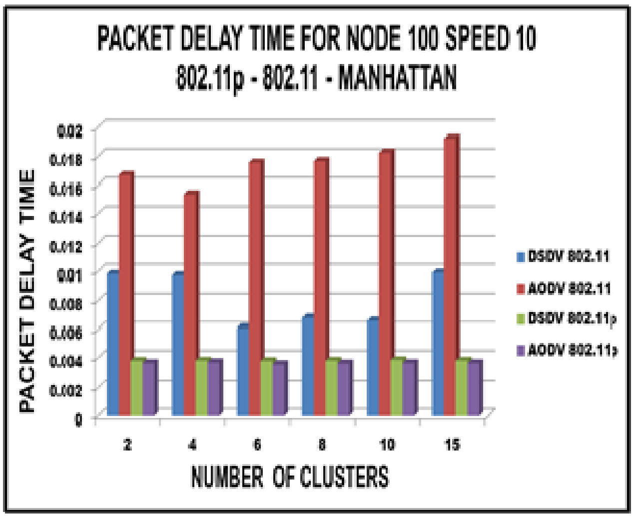

Figure 5a Packet Delay Time

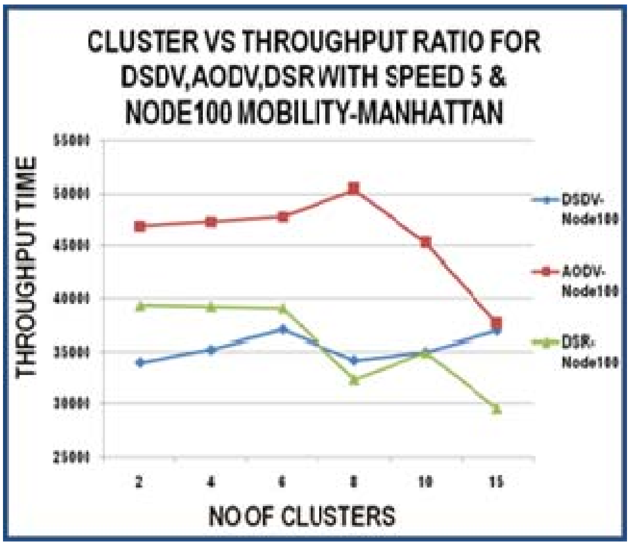

Figure 5b Throughput Ratio

D. Normalized Routing Load and Delivery Ratio

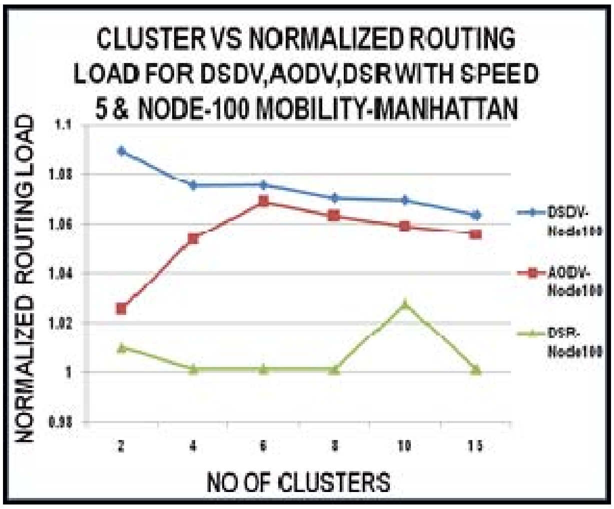

Figure 6a Normalized Routing Load

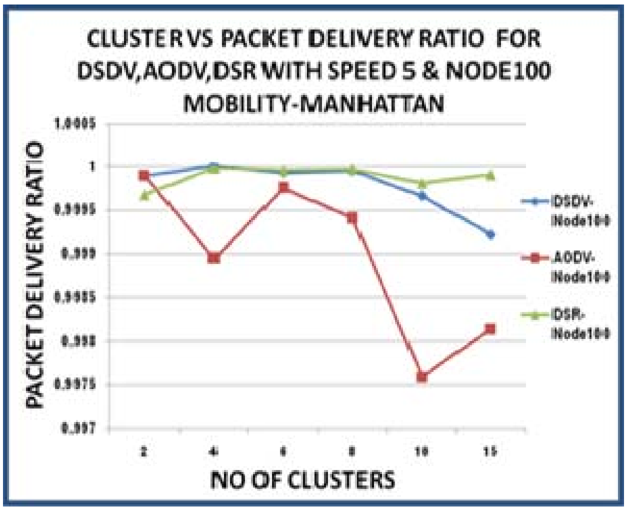

Figure 6b Packet Delivery Ratio

The experimental result of Manhattan Mobility Model with DSR routing protocol is shown in the Figure 6a and 6b respectively. The performance of DSR is evaluated with other routing protocols and identified that DSR provides better normalized routing load and packet delivery ratio.

E. NAM output of Manhattan Mobility Model

NAM file output of cluster based and sans cluster based Manhattan Mobility Model is shown in Figure 7a and 7b respectively.

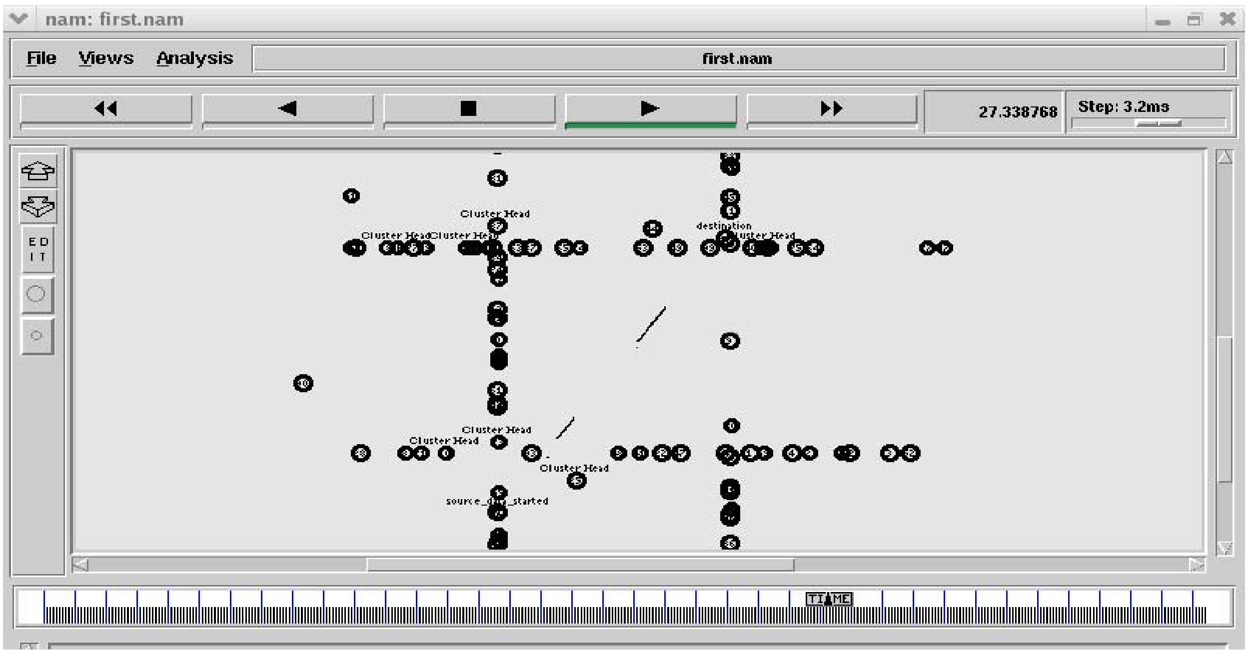

Figure 7a NAM output for Cluster based Manhattan Mobility Model

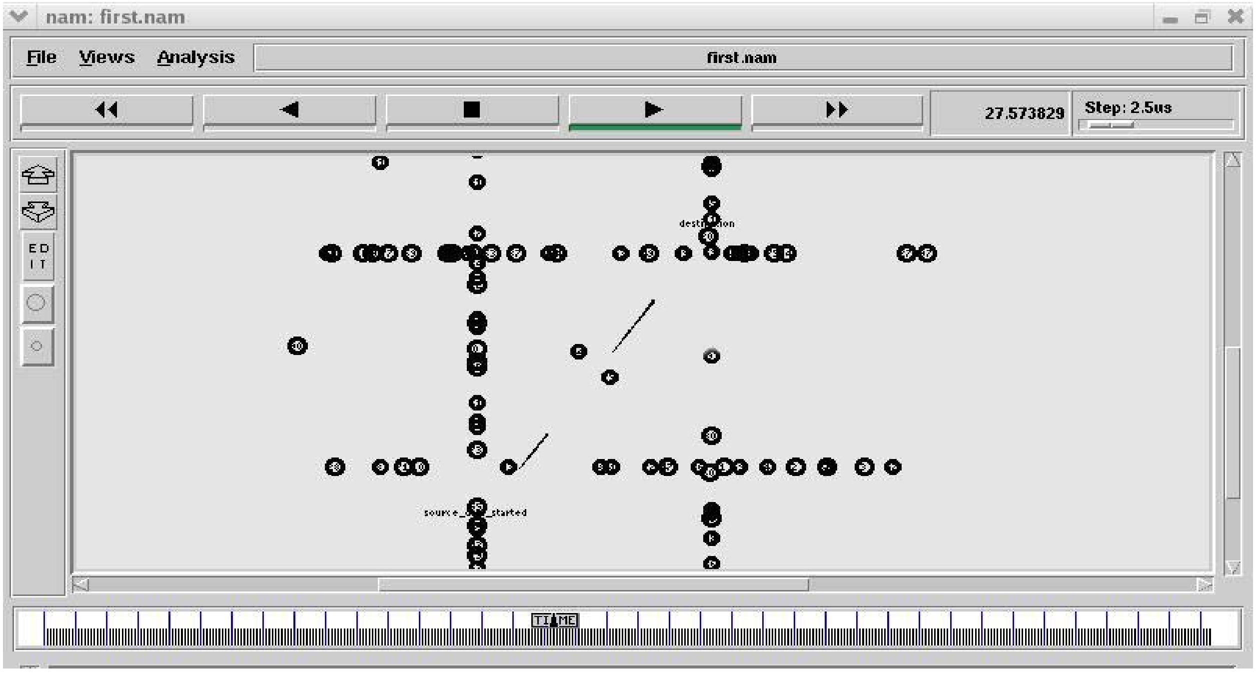

Figure 7b NAM output for Sans Cluster based Manhattan Mobility Model

Note 1: In this research work the Proactive protocol DSDV and Reactive protocol AODV and DSR are used to analyses the performance of the Manhattan Mobility Model. Experimental results depict that AODV protocol yields better performance compared to the DSDV and DSR protocols. Research analyses prove that the reactive protocol such as AODV and DSR are well suited for Vehicular Network communication.

Note 2: In this paper, the standards 802.11 and 802.11p are used to compare the performance of Cluster based Manhattan Mobility Model and the routing protocols. The mobility of nodes in VANET is high; hence the standard 802.11p is highly suitable for Vehicular network than the standard 802.11. The Performance is tested for various parameters such as packet receiving time, packet delivery time, packet delay time, throughput, normalized routing load.

Note 3: In the cluster based NAM output, the cluster creation algorithm elects various cluster heads and the data communication is established from source to destination through various cluster heads, whereas in the case of sans cluster model source to destination communication can be established through the intermediate nodes only.

CONCLUSION

The characteristics of Manhattan Mobility vehicular network Model is completely studied in this paper. The ultimate challenge is designing the network architecture, since the movement of vehicles speed is high. The study of previous research work notifies clearly that the network communication in VANET is not reliable and its message communication time is very high. The message transmission time in Manhattan Mobility Model is the biggest task. The drawback can be overridden by applying novel cluster based network architecture in Manhattan mobility model. In this approach the service request by the nodes is efficiently handled by the cluster heads. The experimental results clearly show that the cluster based Manhattan Mobility Model with 802.11p increases the efficiency of the network parameters.

REFERENCES

[1] Saif Al-Sultan, MoathM.Al-Doori,AliH.Al-Bayatti,HussienZedan, “A comprehensive survey on vehicular Ad Hoc network”, Journal of Network and Computer Applications (Article in Press).

[2] Hu Xiong, Zhong Chen, Fagen Li, “Efficient and multi-level privacy-preserving communication protocol for VANET”, Computers and Electrical Engineering 38 (2012) 573–58.

[3] Omar Abdel Wahab, Hadi Otrok, Azzam Mourad, “VANET QoS-OLSR: QoS-based clustering protocol for Vehicular Ad hoc Networks”, Computer Communications 36 (2013) 1422–1435.

[4] Y. Hongseok, K. Dongkyun Kim, Repetition-based cooperative broadcasting for vehicular ad-hoc networks, Computer Communications 34 (15) (2011) 1870–1882.

[5] J.-T. Isaac, J.-S. Camara, S. Zeadally, J.-T. Marquez, A Secure vehicle-to-roadside communication payment protocol in vehicular ad hoc networks, Computer Communications 31 (10) (2012) 2478–2484.

[6] S. Yousefi, E. Altman, R. El-Azouzi, M. Fathy, Improving connectivity in vehicular ad hoc networks: an analytical study, Computer Communications 31(9) (2008) 1653–1659.

[7] S. Lim, C. Yu, C.-R. Das, Cache invalidation strategies for internet-based vehicular ad hoc networks, Computer Communications 35 (3) (2012) 380–391.

[8] Manuel Fogue, Piedad Garrido, Francisco J. Martinez, Juan-Carlos Cano, Carlos T. Calafate, Pietro Manzoni, “Evaluating the impact of a novel message dissemination

scheme for vehicular networks using real maps”, Transportation Research Part C 25 (2012) 61–80.
[9] Victor Sandonis, Maria Calderon, Ignacio Soto, Carlos J. Bernardos, “Design and performance evaluation of a PMIPv6 solution for geonetworking-based VANETs”, Ad Hoc Networks 11 (2013) 2069–2082.
[10] Salim Bitam, AbdelhamidMellouk,” Bee life-based multi constraints multicast routing optimization for vehicular ad hoc networks”, Journal of Network and Computer Applications 36 (2013) 981–991.
[11] Wern-Yarng Shieh Wei-Hsun Lee Shen, ”Analysis of the Optimum Configuration of Roadside Units and Onboard Units in Dedicated Short-Range Communication Systems”, Intelligent Transportation Systems, IEEE Transactions on Issue Date : Dec. 2006 Volume :7 , Issue:4 On page(s): 565 – 571.
[12] M. Milton Joe, R.S. Shaji, R. Thulasi, “Modeling Network Communication in VANET using Bluetooth Technology”, International Journal of Advanced and Innovative Research, Vol 2 No 3, PP. 643-651, March - 2013.
[13] Tuteja, Asma Gujral, Rajneesh Thalia, Sunil,” Comparative Performance Analysis of DSDV, AODV and DSR Routing Protocols in MANET Using NS2”, ACE, International Conference on 2010, page(s): 330 – 333.
[14] M. Milton Joe,R.S. Shaji,K. Ashok Kumar,"Establishing Inter Vehicle Wireless Communication in Vanet and Preventing It from Hackers ", IJCNIS, vol.5, no.8, pp.55-61,2013. DOI: 10.5815/ijcnis.2013.08.07.
[15] Nitin Maslekar, JosephMouzna, MounirBoussedjra, HoudaLabiod,” CATS: An adaptive traffic signal system based on car-to-car communication “, Journal of Network and Computer Applications 36 (2013) 1308–1315.
[16] Sardar MuhammadBilal, CarlosJesusBernardos,CarmenGuerrero , “Position-based routing in vehicular networks: A survey”, Journal of Network and Computer Applications 36 (2013) 685–697.
[17] T.W. Chim, S.M. Yiu, Lucas C.K. Hui, Victor O.K. Li, “VANET-based secure taxi service”, Ad Hoc Networks 11 (2013) 2381–2390.
[18] B. Ramakrishnan, Dr. R.S. Rajesh, R.S. Shaji, “CBVANET: A Cluster Based Vehicular Adhoc Network Model for Simple Highway Communication”, International Journal of Advanced Networking and Applications – Volume: 02, Issue: 04, Pages: 755-761 (2011).
[19] B. Ramakrishnan, Dr. R.S. Rajesh, R.S. Shaji, “Performance Analysis of 802.11 and 802.11p in Cluster Based Simple Highway Model”, International Journal of Computer Science and Information Technologies, Vol. 1 (5), 2010, 420-426.
[20] B. Ramakrishnan, “Performance Analysis of AODV Routing Protocol in Vehicular Ad-hoc Network Service Discovery Architecture”, ARPN Journal of Systems and Software- VOL. 2, NO. 2, February 2012, Pages: 65-72.
[21] Dr. B. Ramakrishnan Ph.D, “Analysis of Manhattan mobility model without RSUs” IOSR Journal of Computer Engineering (IOSR-JCE), e-ISSN: 2278-0661, p- ISSN: 2278-8727 Volume 9, Issue 5 (Mar. - Apr. 2013), PP 82-90.
[22] M. Milton Joe, B. Ramakrishnan, R. S. Shaji,"Modeling GSM Based Network Communication in Vehicular Network", IJCNIS, vol.6, no.3, pp.37-43, 2014. DOI: 10.5815/ijcnis.2014.03.05

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