ISSN: 2278 – 7798
International Journal of Science, Engineering and Technology Research (IJSETR)
Volume 2, Issue 5, May 2013

Streaming Urban Video in Vehicular Ad Hoc Networks

Divya Susan Mathew

***Abstract*— A Vehicular Ad hoc Network or VANET is a technology that uses moving cars as nodes in a network to create a mobile network. VANET turns every participating car into a wireless router or node, allowing cars approximately 100 to 300 metres of each other to connect and, in turn, create a network with a wide range. Vehicular Ad hoc Networks (VANETs) are ill-suited to support streaming media. Low bandwidth, volatile connectivity, and highly dynamic, unpredictable topology are the main limitations of VANET which does not support multimedia applications. Live multimedia streaming (LMS) services are important in VANETs since they provide comprehensive and user-friendly information. The fundamental challenges include achieving stable and high streaming rate for all the interested vehicles by using minimal bandwidth resources, especially under the dynamic topology of VANETs. JXTA is an open network computing platform designed for peer-to-peer (P2P) computing. Its goal is to develop basic building blocks and services to enable innovative applications for peer groups. This paper presents a solution for inter vehicular communications, called Streaming Video that is fully distributed and considers volatile topology, and leverages the characteristics of streaming applications to yield a highly efficient solution.**

***Index Terms*— Global positioning system (GPS), Inter Vehicular Communication (IVC), JXTA Protocol, Streaming Video.**

I. Introduction

Live multimedia streaming (LMS) is promising, because it consists of video, audio and can provide more comprehensive and user friendly information. A roadside access point (AP) continuously broadcasts the streaming video of the current road traffic conditions to vehicles driving towards it, which is useful in inclement weathers. The scenarios for LMS applications may include the following. When a police vehicle spots an accident, it provides LMS content of the accident to vehicles following several miles behind for early warning. Then advance preparation can be done based on the collected LMS content on their way to the accident scene. It plays a significant role in road safety. Vehicular ad hoc networks (VANET) using 802.11-based WLAN technology have recently received considerable attention. It uses moving vehicles as nodes. In such a network vehicles equipped with Wi-Fi hardware constitute the mobile nodes (hosts). A number of routing protocols for VANET have been proposed and evaluated. In such a network, each vehicle is equipped with a wireless communications technology and an on-board GPS device. Data forwarding is then performed collaboratively among vehicles in a multi-hop relaying manner. One of the most important applications for VANET is the distribution of active safety messages to improve driver safety, namely Safety-Critical Application (SCA), which requires timely and reliable message dissemination. The SCA information is exchanged to notify the drivers about the car accident and to perform control actions in coordinated systems. Inter-vehicular wireless networks are gaining much attention in the research community due to the number of applications that could improve the quality of everyday life. On one hand, such applications include vehicle-to-vehicle (V2V) communications, for delivering of safety information (state of the road after an accident, or fog, or snow, for instance). The challenge of successfully deploying VANET services is to ensure timely and reliable data delivery for mobile vehicles. Passengers in nearby vehicles can setup a video conversation by using the inter-vehicle streaming technology. Drivers could also enjoy watching live news or football match, while the video data is conveyed by other nearby vehicles. Streaming over vehicular ad hoc networks is applicable in reality. The car engine can provide sufficient power for complex data computation and communication. Vehicles can also equip large On-board storage. Thus the node in VANET is capable of forwarding continuous video data to other vehicles or roadside receivers [9]. The MAC protocols for radio channel access among vehicles are effective under less traffic. However, when the number of vehicles in the vicinity is large, the protocols may not be able to provide the desired service due to lack of radio resource, and cause a longer contention period to obtain it. The network characteristics and the variable bit rate (VBR) nature of the traffic along with the strict delay constraints, pose a different problem from the ones previously addressed in ad hoc networks [2], [3].

Streaming Video completely relies on inter vehicular communication: a video stream, generated at a roadside access point, is fed to the nodes and disseminated across the VANET which consists of mobile nodes. The nodes that belong to the distribution structure and forward the streaming video are the relay nodes. The distribution structure is assumed to be a grid, so as to minimize the number of relay nodes required to cover a network area while providing a good range of connectivity. Each relay node not only forwards the streaming traffic but also exploits a GPS and the received power level, to dynamically select its next-hop neighbours, so that the distribution structure approximates a grid as closely as possible [1]. The GPS signal is also used to synchronize all relay nodes to a TDMA transmission, as done

Manuscript received Apr 18, 2013.

***Divya Susan Mathew**, Department of Computer Science and Engineering, Noorul Islam University, Tamil Nadu, India, 9446744327*

in several other works, e.g., in [4]. In order to provide the described services, APs can be utilized to distribute the streaming media to nearby vehicles. Due to the high deployment cost of roadside APs and limited communication range, the entire road cannot be fully covered merely by APs. Therefore, the vehicles have to form a vehicular ad hoc network (VANET) and cooperatively propagate the streaming media when they are out of coverage of APs. Different from non-streaming services, such as content distribution [5], LMS services require not only high average streaming rate but also demand the stable streaming rate for the purpose of smooth playback. In the case of Vehicle-to-Roadside Communication (VRC), the delivering of live video streaming fails easily due to shadowing effect of signal translation, the long-length tunnel as well as the low base-station deployment. This affects the vision effect of the safety and non-safety applications. Moreover, for Inter-vehicle Communication (IVC), the traditional peer-to-peer approaches of delivering live video streaming cannot be employed on moving vehicles. There is a need for vehicular communication-adaptive solution to deliver live video streaming for VRC and IVC. Therefore, to solve this problem, the interest is in developing an efficient live video streaming solution for vehicles in motion on a highway scenario [8]. Due to collisions arising from improper grid selection, the scheduling algorithm may sometimes fail and result in bandwidth waste. Due to the time-varying network topology, the gateway can select different relays for each newly generated packet, and any relay node selects its next hop nodes according to the current status of its neighborhood. Streaming Video makes use of the traffic characteristics, and the leftover bandwidth at the MAC layer, to support best-effort traffic via a contention-based access, thus enhancing radio resource efficiency. Broadcasting in ad hoc networks has been widely studied. This work addresses these issues by offering a fully-distributed solution which spans several layers, from the application to the MAC layer.

II. NETWORK SCENARIO AND SYSTEM MODEL

Streaming Video can achieve a good performance even with spotty, dynamic vehicular connectivity. This work assumes that one or more gateway nodes, either fixed or mobile, provide streaming video to car passengers. Examples of streaming video include news, tourist information, commercial advertisements, football games, or music video clips. Distribution of multimedia data relies on inter vehicular communication and the vehicles may exchange best-effort data traffic in a peer-to-peer fashion: news summaries, public transportation timetables, traffic warnings, and so on. This paper describes the children selection criteria taking on the point of view of a generic relay node. This work refers to the node scheduling the tagged relay node and feeding traffic

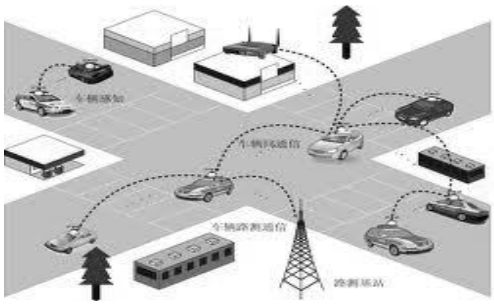

Figure 1: An Example for VANET

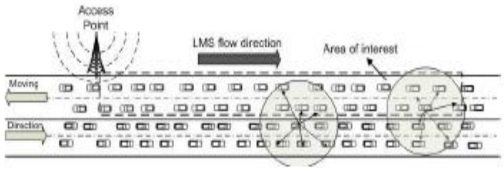

Figure 2: The LMS Architecture

to it as parent node, while it will refer to the relay nodes being scheduled and fed traffic by the tagged relay node as children nodes. The scheduling of children nodes by the relay node requires the identity of its parent, the position and the power level received from its 1-hop neighbors, and the slots already scheduled by its parent node. The no. of children nodes scheduled by the relay node changes with time; therefore, this process is periodically repeated. The length of the refresh period is taken as twice the GPS update period. The distribution topology formed by all relays has a grid-like structure [1], where each relay ideally sits in between four other relays. No explicit acknowledgment (ACK) is expected from children but a passive ACK is obtained at the relay node by monitoring transmissions in the slots where its children distribute the content. As shown in fig. 3, the data channel is divided into fixed length time frames of duration *TF*. Each time frame is further divided into *S* identical slots, where the value of *S*, and the subset of relay nodes that transmit in each time slot, is determined using the node coloring algorithm. This work considers the video to be encoded into three descriptors and each descriptor is composed of several video frames like *I*, *B*, or *P* of different size. The node protocol stack includes a Segmentation and Reassembly (SAR) layer. The SAR header also carries the video frame sequence number. At the receiver, the SAR layer reassembles different parts of the same video frame and send it to the upper layers. Every MAC packet to be transmitted in a time slot carries three video frames, each corresponding to a different descriptor. Fig. 2 shows the architecture for live multimedia streaming. This work highlights that due to the VBR nature of video traffic, *I* frames are very large, while *P* frames are small. This implies that when an *I* frame needs to be transmitted, one or more slots will be filled up but when *P* frames are sent, a large portion of the slot will remain free and can thus be reused.

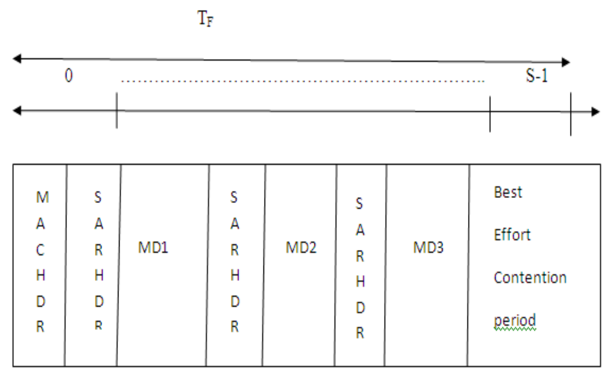

Figure 3: Data channel access: MD1, MD2 and MD3 are video descriptors

III. THE STREAMING VIDEO PROTOCOL

The tenets of the solution proposed are, the selection of relay nodes so as to maximize the coverage area, scheduling of relay nodes in TDMA fashion, scheduled access for streaming video, opportunistic access for streaming video and contention-based access for best-effort traffic.

Algorithm:-
Step 1: The distribution server is executed
Step 2: It checks the IP address and the password
Step 3: It can list the system files
Step 4: Enable the GPS
Step 5: Each of the peer groups are enabled
Step 6: They are given names and addresses
Step 7: Any peer node can send messages to other peer node
Step 8: The files can be shared by the nodes and saved
Step 9: These files can be searched
Step 10: The video file can be downloaded
Step 11: The details of distribution can be displayed

The distribution server provides a fully distributed solution called Streaming Video. IP address is checked to be valid or invalid. A video stream, generated in a point in space, is fed to the nodes and disseminated across the VANET through this server. It is associated with all the users in the VANET network. It also consists of the multimedia content. It is assumed to be a video sequence. The GPS minimizes the number of relay nodes required to cover a network area while providing a good level of connectivity. It is also used to synchronize all relay nodes to a structured TDMA transmission. All network nodes are supposed to be equipped with a positioning system, so that they are aware of their location and accurately synchronized in time. Each vehicle periodically broadcasts an in-band HELLO signaling message, which carries the sender's ID and GPS position. A vehicle can therefore keep an updated list of its 1-hop neighbors, i.e., the nodes from which it receives a HELLO with power level, and the position and the power level received from each of its 1-hop neighbors. The users can join or remove from the VANET group at any time. Basically these VANET groups contain very large number of users. So the group size is also the important factor for effective video streaming without any delay or data loss. The JXTA protocol is used to create a VANET. JXTA is an open source protocol and it is XML based. Basic settings are given. Service settings are given i.e., it can act as rendezvous, proxy or relay. TCP settings and HTTP settings are given. Incoming and outgoing connections are set. Multicast option is provided. Any peer can be selected and one peer can provide message to other. Local sharing of files take place. Searching of files can be done. Incoming message is displayed. Searched and selected files are seen. There are options for playing distributed video and viewing the distribution details. Messages like go straight, accident warning etc. can be seen. Two nodes can form group between them for secure communication. Similarly multiple members in VANET group form a binary tree structure to obtain common information for secure communication. The joined member is being viewed to all the groups those who are connected with the same VANET i.e., same port number. Streaming video and best-effort traffic are transmitted over a data channel, which is organized according to a TDMA structure. The data channel is structured in fixed length time frames of duration *TF*. Each time frame is further divided into *S* identical slots, where the value of *S*, as well as the subset of relay nodes that transmit in each time slot, is determined using the node coloring algorithm. The multimedia content is assumed to be a video sequence.

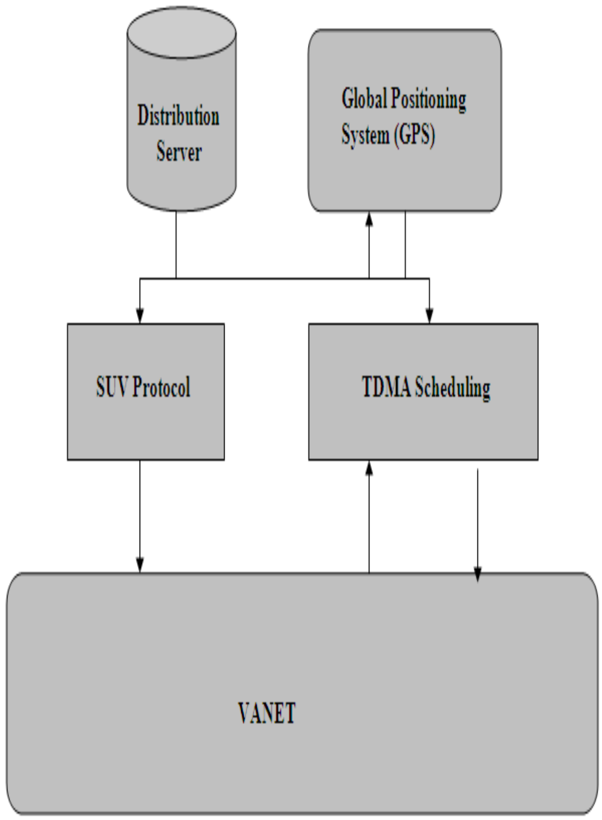

Figure 4: System Architecture

IV. THE JXTA PROTOCOL

JXTA is an open network computing platform designed for peer-to-peer (P2P) computing. Its goal is to develop basic building blocks and services to enable innovative applications for peer groups. It provides a common set of open protocols and an open source reference implementation for developing peer- to-peer applications. The JXTA protocols standardize the manner in which peers communicate. The JXTA network consists of a series of interconnected nodes, or peers. Peers can self-organize into peer groups, which provide a common set of services. JXTA peers advertise their services in XML documents called advertisements. Advertisements enable other peers on the network to learn how to connect to, and interact with, a peer's services. JXTA peers use pipes to send messages to one another. Pipes are an asynchronous and unidirectional message transfer mechanism used for service communication. Messages are simple XML documents whose envelope contains routing, digest, and credential information. Pipes are bound to specific endpoints, such as a TCP port and associated IP address. The steps to be performed are, obtaining the group services, building and publishing a module class advertisement, building pipe advertisement, building and publishing module specification advertisement and waiting for messages. The client peer will need to execute a few steps in order to use the pipe published by the sender peer. The steps are, the receiver peer will attempt to find the advertisement in the local cache, when the attempt fails the remote discovery request is sent by receiver peer using discovery service, module specification advertisement is obtained from remote discovery request, the receiver peer obtains pipe advertisement, pipe data and creates pipe advertisement, the receiver creates output pipe.

Algorithm:-
Step 1: The file manager is created
Step 2: The CMS class is designed
Step 3: The nodes can be added, advertisements can be given and files can be updated
Step 4: The peer nodes can share any file
Step 5: It can be removed
Step 6: The pipe messenger is created for sending and receiving messages
Step 7: Play video is designed for downloading video files and viewing it
Step 8: Search list is designed for getting files and other data
Step 9: The trust manager is created for checking the validity of data
Step 10: Start jxta function is used for creating peer nodes and for other services
Step 11: Messages can be sent and distribution details can be displayed

A. *Node Coloring*

This paper considers the fact that the network topology composed of relay nodes has a grid-like structure [1]. This first makes use of a regular grid topology, i.e., every node has two neighbors along each spatial dimension and that neighboring nodes are at the same distance *R* from each other. This formulates the scheduling problem and provides a solution that is optimal for all cases of practical interest. The obtained scheduling scheme is then applied to a realistic VANET, where, in general, the distance between relay nodes is shorter than *R* and relay nodes form an irregular grid.

Given an undirected graph *G = (V,E)* and a set of colors *C*, find a mapping $\emptyset : V \rightarrow C$, s.t.

$$max\emptyset \left\{ \min_{u,v \in V: \emptyset(u)=\emptyset(v)} d_{u,v} \right\} \quad (1)$$

where $d_{u,v}$ is the length of the shortest path connecting nodes *u* and *v*, in number of hops.
Given a set of colors, *C*, with cardinality $C \in N$ find integers *a, b, q ,r* s.t .

$$\max_{a,b \in Z_C} \left\{ \min_{q,r \in Z} (|q| + |r|) \right\}, \text{ with} \quad (2)$$

$$aq + br = 0 \quad (mod\ c) . \quad (3)$$

The number of colors will represent the number of slots, *S*, within a single time frame and the relay nodes assigned with the same color are scheduled for transmission in the same slot. The minimum number of colors needed to achieve such a separation is equal to eight. The number of packet transmissions is a linear function of the number of nodes in the network [10]. Let *Cu*, *Cv* be the colors of the nodes *u*, *v* respectively. The smallest time difference between the transmissions of node *u* and *v* is calculated as follows:

$$\Delta C = |(Cu - Cv) mod\ C| * T \quad (4)$$

where *T* is the time needed to traverse one hop.
It can be proved that, at least for the distances *k* of practical interest, the constant-step coloring optimally solves the distance-*k* coloring problem over a grid topology, that is, it finds the minimum number of colors needed to color the grid.

V. RESULTS

As shown in fig. 5, the number of packet transmissions increases linearly as the number of nodes.

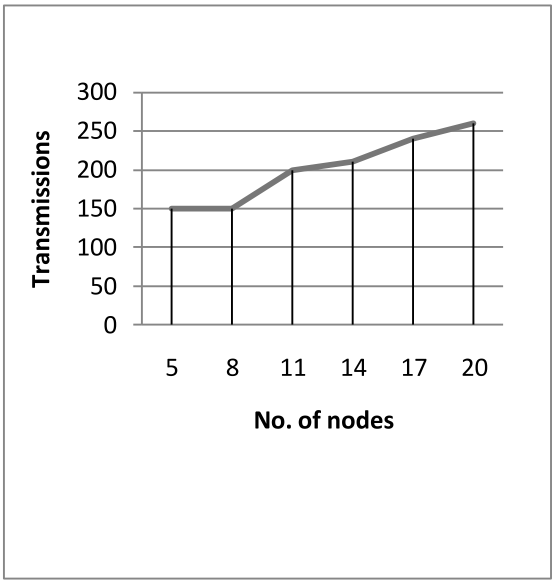

Figure 5: Packet Transmission

ISSN: 2278 – 7798
International Journal of Science, Engineering and Technology Research (IJSETR)
Volume 2, Issue 5, May 2013

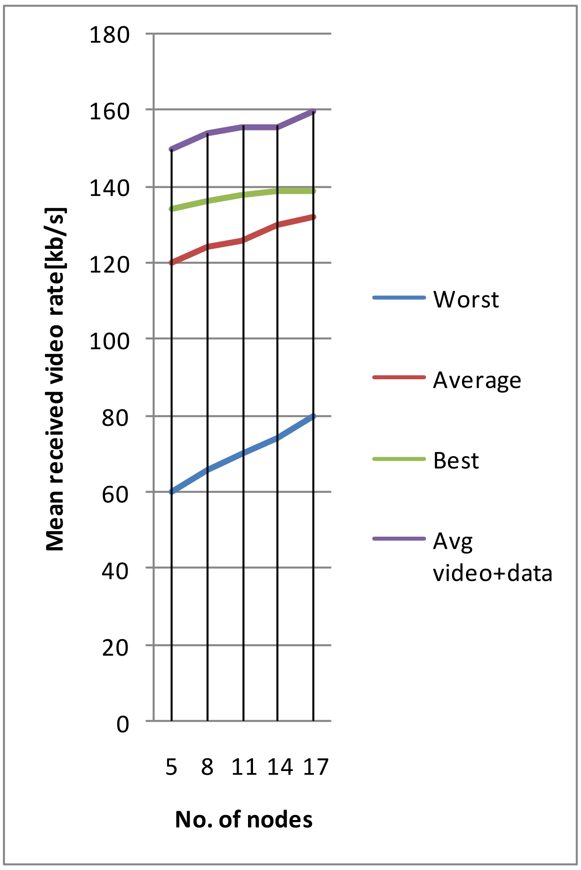

Figure 6: Mean Received Video Rate as a Function of the Number of Nodes in the Network

Table I: Best Effort Traffic Performance

No. of nodes	5	8	11	14
Efficiency	.80	.78	.76	.74

Fig. 6 plots the results obtained at the node experiencing the best and worst performance, as well as the performance averaged over all network nodes, as functions of the number of nodes. The plot also carries the average throughput for aggregate video and best-effort data traffic, and highlights the efficient bandwidth usage obtained through Streaming Video. Table 1 reports the access efficiency for what concerns the best effort traffic. It points out that Streaming Video allows best effort to pick up what is left by the streaming media and that every active node acts as a "hot spot." The access efficiency decreases with the increase of the number of network nodes.

VI. CONCLUSION

Streaming Video can achieve a good performance even with spotty, dynamic vehicular connectivity. It assumes that one or more gateway nodes, either fixed or mobile, provide streaming video to car passengers. This work has addressed the support of video streaming in VANETs by providing a fully-distributed solution, Streaming Video. The video distribution is achieved through a fully distributed, dynamic selection of forwarders. As the distance from the gateway node increases, so does the chance that neighboring nodes are chosen as children by different parents, thus increasing the number of collisions. A relay node in a dense topology can replace a collided video frame with one of its copies, broadcast at a later time in a neighboring sector. Losses are reduced here. Whenever a collision occurs, Streaming Video leverages the properties of video coding to design a collision-free mechanism. It also promotes best-effort traffic exchange in a VANET without any infrastructure support. As a future work, for broadcasting in a dense VANET, since there could be too many vehicles urgently demanding different portions of the LMS content, it can be extended to satisfy all their needs in a short time. By considering the time constraints of LMS applications, this can reduce frequent playback skips than in the case of sparse VANETs.

ACKNOWLEDGMENT

The author would like to thank the anonymous reviewers for their valuable reviews.

REFERENCES

[1] Fabio Soldo, Claudio Casetti, Caria-Fabiana Chiasserini, and Pedro Alonso Chaparro, "Video Streaming Distribution in VANETs," IEEE Transactions on Parallel and Distributed Systems, Vol. 22, No. 7, pp. 1085-1091, Jul. 2011.
[2] F.J. Ros, P.M. Ruiz, and I. Stojmenovic, "Reliable and Efficient Broadcasting in Vehicular Ad Hoc Networks," Proc. IEEE Vehicular Technology Conf. (VTC) Spring 2009, pp. 1-5, Apr. 2009.
[3] W. Chen, R.K. Guha, T.J. Kwon, J. Lee, and Y.-Y. H. Wirel, "A Survey and Challenges in Routing and Data Dissemination in Vehicular Ad Hoc Networks," Wireless Communications and Mobile Computing, Oct. 2009.
[4] R. Mangharam, R. Rajkumar, M. Hamilton, P. Mudalige, and F.Bai, "Bounded-Latency Alerts in Vehicular Networks," Proc. IEEE Mobile Networking for Vehicular Environments (MOVE Workshop), pp. 55-60, May 2007.
[5] M. Li, Z. Yang, and W. Lou, "Codeon: Cooperative popular content distribution for vehicular networks using symbol level network coding," Technical Report, ECE, WPI, 2010.
[6] F. Soldo, C. Casetti, and C.-F. Chiasserini, "Constant-Step Coloring," Technical report, Politecnico di Torino,available at http://www.telematica.polito.it/casetti/TechRep_Scheduling.pdf, Mar. 2010.
[7] F. Soldo, C. Casetti, C. F. Chiasserini, "Traffic scheduling in grid-based VANETs," Tech. Rep., Dec. 2007, http://www.telematica.polito.it/~carla/
[8] Y.-C. Chu and N.-F. Huang, "Delivering of Live Video Streaming for Vehicular Communication Using Peer-to-Peer Approach," Proc. IEEE Mobile Networking for Vehicular Environments (MOVE Workshop), pp. 1-6, 2008.
[9] Fei Xie, Kien A. Hua, Wenjing Wang, and Yao H. Ho, "Performance Study of Live Video Streaming over Highway Vehicular Ad hoc Networks," IEEE Vehicular Technology Conference(VTC-2007), pp. 2121- 2125, 2007.
[10] V. Naik, A. Arora, P. Sinha, and H. Zhang, "Sprinkler: A Reliable and Energy Efficient Data Dissemination Service for Extreme Scale Wireless Networks of Embedded Devices," IEEE Trans. Mobile Computing, vol. 6, no. 7, pp. 777-789, July 2007.

Divya Susan Mathew is an M.E student of the Department of Computer Science and Engineering, Noorul Islam University, Tamil Nadu. She completed her B.Tech in Computer Science and Engineering from University of Kerala in 2011. Her interest is in the area of Wireless Networks. She is a member of Computer Society of India.