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An Effective Routing Algorithm for Cooperative Video Streaming Over VANETs

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***Abstract*— Vehicular Ad Hoc Networks are the promising approach to provide a wide scope of real time multimedia services, mobile distributed applications and file sharing. In VANETs, there are two possible usages of video streams are in infotainment applications like internet access and in the safety applications like vehicle collision warning. Due to high mobility and dynamic changing topology, it is necessary to have an efficient routing algorithm to keep a stable and reliable communication among vehicles. Concerning the multimedia streaming services, a vehicle may not have sufficient bandwidth to receive good quality video using a single 3G/3.5G cellular interface. This work proposes a Temporally Ordered Routing Algorithm based on Link Reversal Routing for cooperative video streaming over VANETs. This work consists of CVS scenario having a fleet of vehicles share their network resources during their trip. The performance of this work can be evaluated in terms of successive rate, data transmission rate, delay, energy level and bandwidth rate. Finally, we utilize network simulator (NS2) for this proposed work.**

Index terms* -Cooperative video streaming, Temporally Ordered Routing Algorithm (TORA) , vehicular ad-hoc network (VANET), dedicated short-range communication(DSRC).

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I. INTRODUCTION

People are getting use to transferring information also when they are mobile. Usually transmission requires the help of a network with some fixed network elements. Intelligent transportation system (ITS) enhances the performance of the future transportation system with the integration of the modern communication and electronic technologies. Vehicular Ad Hoc Networks (VANETs) are created by applying the principles of mobile ad hoc networks(MANETs) - the spontaneous creation of a wireless network for data exchange - to the domain of vehicles. They are a key component of intelligent transportation systems (ITS).More specifically, a VANET consists of on-board-units (OBUs) installed on the vehicles facilitate V2V communication and road-side units (RSUs) installed along sides of the urban roads/highways through which vehicles communicate constitute vehicle-to-infrastructure (V2I) communications [1]. Intelligent transportation systems for vehicular ad-hoc networks have stimulated a wide variety of interesting applications, such as vehicle collision warning, lane changing, driver assistance, co-operative driving, internet access, automatic parking, driverless vehicles etc. The on-board buffer storage, positioning system, and intelligent antenna further facilitate efficient video forwarding and collaborative downloading from internet server and communication takes place among vehicles.

The ad hoc routing protocols can be divided into two groups. Proactive, i.e. table-driven routing protocols in which node in the network maintain a routing table for the delivery of the data packets and they desire to establish a connection to other nodes in the network. These nodes keep track for all the presented destinations, hop count required to arrive at each destination in the routing table. The routing entry is designate with a sequence number which is created by the destination node [2]. To retain the stability, each station broadcasts and modifies its routing table from time to time. On the other hand, Reactive, i.e. on-demand driven routing protocol which lower communication overhead since routes are determined on demand basis. The protocol comprises of two main functions of Route Discovery and Route Maintenance. Route Discovery function is responsible for the discovery of new route, when one is needed and Route Maintenance function is responsible for the detection of link breaks and repair of an existing route.

A. THE COOPERATIVE STREAMING SCENARIO IN VEHICULAR NETWORKS

When a group of persons, it may be family members or group of friends decided to go for a trip together, they can form a fleet based vehicle network and they can share their network resources during their trip. If a user in a vehicle wants to get a video streaming service during the trip, the requested video data can be downloaded from the Internet using his 3G/3.5G cellular link. However, the band width of the 3G/3.5G link may not be sufficient to achieve high quality of service (QoS). Even if the vehicle downloads the video data using a 4G or Wi-Fi link, the bandwidth provided by this link may not be good for the following concerns [3]. The requester ask the other members of the same fleet to download the video data cooperatively and the other members belonging to same fleet download parts of video data and forwarded to the requester hop by hop through DSRC ad-hoc network.

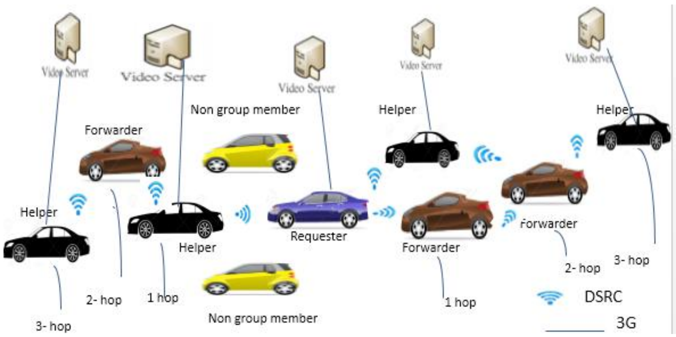

Fig 1. The cooperative streaming scenario in vehicular networks

The scenario consists of requester, forwarder and helper. Those who are in need of the video streaming service is the requester, the forwarders are those who forward the pieces of video data hop by hop through DSRC based ad-hoc network [3].The helpers are those who not only forward the pieces of video data but also use their cellular interface to download the data. The main aim of this paper deals with better utilization of bandwidth by bandwidth sharing mechanism for neighboring peers in VANETs In the previous works whenever a forwarder wants to send a packet, it just picks the nearest one as helper with the smaller hop count distance from its neighbors and intends to select helpers as the next forwarder first. They did not not select an optimized routing path for downloading and forwarding.

In our research, we specify an efficient routing algorithm Temporally Ordered Routing Algorithm (TORA), which is highly adaptive, proficient and scalable distributed routing algorithm based on Link Reversal Routing (LRR) protocol[4]. By this TORA, we can create the route to particular destination, maintain the route in case of link failure and erase the route whether there are invalid routes. We propose this algorithm to overcome the limitations of previous works like throughput, energy level, end to end delay, packet delivery rate and bandwidth rate. We use NS2 as a simulator to perform the current method. Part II explain the background information about the cooperative streaming over VANETs, part III discuss about the 9proposed method. Finally simulation and results are discussed in part IV.

II .Related Work

In this section, we survey existing research issues in the cooperative video streaming over VANETs including Wireless Access in Vehicular Environment (WAVE) technology is a layered architecture for devices employing IEEE 802.11.The IEEE 802.11p WAVE standardization process originates from the allocation of the Dedicated Short Range Communications (DSRC) spectrum band in the United States and the effort to define the technology for usage in the DSRC band [5]. Fast and efficient discovery of neighbor nodes is very important for the utilization of wireless ad-hoc networks. Random access discovery schemes like birthday protocols [6], neighbor discovery using directional antennas which requires nodes to be randomly in a “transmitting” or “listening” state in each time slot so that each node gets a chance to hear every neighbor for at least once in a sufficient amount of time[7].For this a large number of time slots are required for efficient neighbor node discovery. In order to overcome this problem a CDMA like on-off signaling is proposed[8] ,in which each node is assigned a signature and nodes transmit the signatures simultaneously when they receive the beacon from the center node.

A cohesive car fleet maintenance scheme[9] by employing a swarming model which can be complemented by a small world phenomenon and self-driven robotic car fleets are studied in simulations in order to measure the cohesive performance of scheme. Based on Distributed cohesive car fleet scheme(DCFS)[9], a car fleet management system can be implemented as a networked application over Android mobile devices which are equipped with 3.5G and Wi-Fi interfaces which includes the services like enrollment management, location management, cohesion management, V2V communication, and emergency broadcast. In case of routing, the existing routing protocols in MANETs cannot be effectively applied to VANETs. The Predictable Routing Protocol [10] is used to predict a link breakage prior to its occurrence. VADD protocol [11] adopted the idea of carry-and-forward for data delivery in which the moving vehicle carries the packet and forward the packet until a new vehicle move into vicinity.

Peer-Peer networking is an effective method for data delivery especially for streaming. Swarming is a peer-peer content delivery mechanism that share resources among a mesh of cooperating peers. SPAWN protocol [12] consists of peer discovery, peer & content selection, content discovery & delivery. A protocol termed as Collaborative Streaming among Mobiles (COSMOS)[13] is used to distribute multimedia content to mobile in a peer -peer manner. A new video streaming system in which mobile devices receive video streams broadcast in a WMAN and share the received data over WLAN[14].This system uses time slicing mechanism to save energy. In bandwidth aggregation scheme, in order to help the requester to use the greedy approach the members will first of all analyze its available band width and then select suitable helpers from these members accordingly. To achieve the maximal throughput in the CVS scenario [15], Greedy Approach is used to select suitable members as helpers.

The H.264 SVC (Scalable Video Coding) is a video compression algorithm that enables effectual and cost effective transmission of video files over low bandwidth networks. An extension to the H.264 codec standard, H.264 SVC performs multi-platform distribution and adaptive streaming from a single file. So, essentially, SVC video stream is constructed with a minimum base layer and additional (multiple) enhancement layers [16]. According to the H.264/SVC standard, the encoded video bit stream is composed of multiple network abstract layer (NAL) units, form natural entities for packetization [16].Base layer is the lower layer which is downloaded by the requester and enhancement layer which may enhance the temporal resolution, (frame rate), spatial resolution or quality of video represent by lower layers can be downloaded by helpers.

III .Proposed Work

We proposed an efficient, scalable and highly adaptive distributed on demand, source initiated routing algorithm, Temporally Ordered Routing Algorithm (TORA) based on the concept of Link Reversal Routing (LRR) protocols. There are three LRR algorithms: Gafni-Bertsekas (GB), Lightweight Mobile Routing (LMR) and Temporally Ordered Routing Algorithm (TORA).TORA is a merger of the ideas from the GB algorithm and the LMR algorithm. It uses the QRY-RPY mechanism of the LMR algorithm as well as the partial link reversal mechanism of the GB algorithm. However, both of these mechanisms are modified in TORA. The key feature of TORA is its reaction to link failures. It erases invalid routes, searches for new routes and builds new routes in a single-pass of the distributed algorithm. The main objective of TORA is to limit control message propagation in the highly dynamic mobile computing environment. It provides multiple routes to same destination and establishes routes quickly. It minimize communication overhead by localizing algorithmic reaction to topological changes when possible.

TORA essentially performs three tasks: Creation of a route from a source to a destination, maintenance of the route and erasure of the route when the route is no longer valid. TORA attempts to build what is known as a directed acyclic graph (DAG) which is rooted at the destination. TORA uses three kinds of messages

- The QRY message for creating a route.
- The UPD message for both creating and maintaining routes.
- The CLR message for erasing a route

The height value of a node consists of five components, (τ, *oid*, *r*, δ, *i*). The first three of them are related to the reference level used. τ is the time when the reference level was created. The nodes are expected to be synchronized. All nodes are assumed to have a unique id. *Oid* is the id of the node, which set the new reference level. The reference level can be divided into two sublevels by using *r*, which is only one bit value. The remaining two components describe the height values related to the reference level. δ describes the height value respect to the reference level. Finally *i* makes sure that the nodes can always be ordered lexicographically. *i* is a unique identifier of the node. In addition to its own value, the node also keeps a list of the height values of its neighbors. The direction of a directed link is from the higher node to the lower. The height of the destination is always zero (0, 0, 0, 0, dest_id). In the beginning the height of all the other nodes is NULL (-, -, -, -, id), which describes the value of infinity, and the links are undirected.

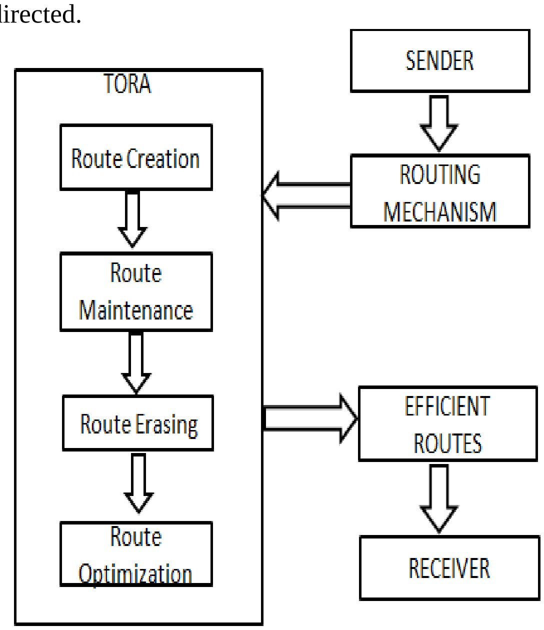

Fig 2. Block Diagram

Sender send request to other nodes in network and the proposed algorithm processed. Proposed routing mechanism receives the senders request from sender. Then proposed TORA algorithm accessed in routing mechanism. TORA having four types of process for efficient routing in network. First one, Route creation in this process creates routes in network. Second one, Route maintenance this process used to maintain the routes without malicious nodes and attacks. Third one, Route erasing it used to erase unwanted or malicious routes. Last one, Route optimization it is used to optimize routes in network. These all process done in proposed algorithm. And then achieve efficient routes in network we used that routes for quality data transmission, efficient transmission, less delay, less energy consumption and high throughput for our process. At the last receiver receives data in above qualities.

A. Route creation

A node with undirected links wants to get a route to another node. It broadcasts a QRY packet to its neighbors. All nodes have a route-required flag, which is set to 1 when sending a QRY. If the receiving node does not have a route to the destination and if its route-required flag is not set, the node

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forwards the query and sets its flag. If the node has no route but the flag is set, it discards the packet. In case the receiving node has a route (i.e. it has at least one downstream node) and its height is NULL, it sets its reference height according to the reference height value of its downstream neighbor, which has the minimum non-NULL height value, but increases the δ value by one compared to the value of the neighbor. The node also broadcasts a UPD packet If its own height is not NULL, the node compares the transmission time of the last UPD and the time when the link, through which the QRY was transmitted, became active. If the time of the UPD packet transmission is later, the QRY packet is discarded; otherwise new update is sent.

When a node gets a UPD packet, it first updates the list containing its neighbors' heights. Then if the node has a set route-required flag, it updates its height according to the minimum non-NULL value of its neighbours, updates the states of its links, unsets the flag, and broadcasts UPD. If the flag is not set, only the states of the links are updated.

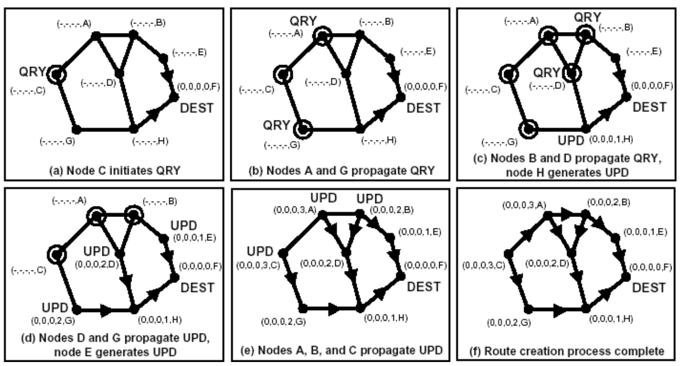

Fig 3. Route Creation

B. Route Maintenanace

Consider the link (B,E) fails, if we remove the link every node has a downstream link so that routing will keep on routing packet without updating.

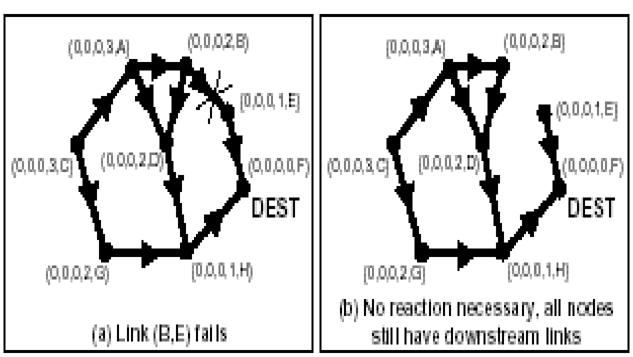

Fig.4 Link Reaction without failure

Nodes that have height NULL are not considered when defining the height values and no height maintenance is performed for them either. There are five reactions to the situation when a node *i* does not have a downstream link. In the first case the node does not have downstream links because of a link failure:

1. The node defines a new reference level and becomes a global maximum. It has been assumed here that the node has upstream neighbors. If that is not the case, the height is just set to NULL.
   $(\tau_i, oid_i, r_i) = (t, i, 0)$, where t is the time of the failure
   $(\delta, i) = (0, i)$
   If the node loses a link that is not its last downstream link, information related to the link and the neighbor is just removed from the node's lists.

Other cases occur when the node loses its last downstream link when it receives a UPD packet and reverses its links. The UPD packet causes the states of the links and the heights of the neighbors to be updated. The neighbor of the node *i* is here. The four possible reactions are:

2. The reference levels of all the neighbors are not the same. The node chooses the maximum reference level and select a height lower than all the other heights of that reference level.
   $(\tau_i, oid_i, r_i) = \max\{(\tau_j, oid_j, r_j)$ of all neighbors$\}$
   $(\delta, i) = (\delta_m-1, i)$, where δ_m is the minimum height value related to the reference value.
3. The reference level is same for all neighbors so that the value of *r* is 0. *r* divides the reference levels into two sublevels: the original reference level and the higher reflected reference level associated to the original reference level. The node "reflects" back the higher reference level (higher because r is 1, not 0) towards the node that created the reference level. If the reflected level is propagated back to its origin from all of its neighbors, no route to the destination can be found.
   $(\tau_i, oid_i, r_i) = (\tau_j, oid_j, 1)$
   $(\delta, i) = (0, i)$
4. The reference levels of the neighbors are the same and r = 1. Also the reference level is defined by the node *i* itself. Thus, the reflected level has reach the origin and no route could be found. The node must initiate the route erasing.
   $(\tau_i, oid_i, r_i) = (-, -, -)$
   $(\delta, i) = (-, i)$
5. The reference levels are the same with r = 1 and the originator of the reference level is not *i*. This does not yet necessarily mean that partitioning has happened. However, the node has experienced a link error (no reaction was required for it) at time t. The node defines a new reference level.
   $(\tau_i, oid_i, r_i) = (t, i, 0)$
   $(\delta, i) = (0, i)$

In cases 1, 2, 3 and 5 the node updates the states of its links and sends a UPD packet to its neighbors.

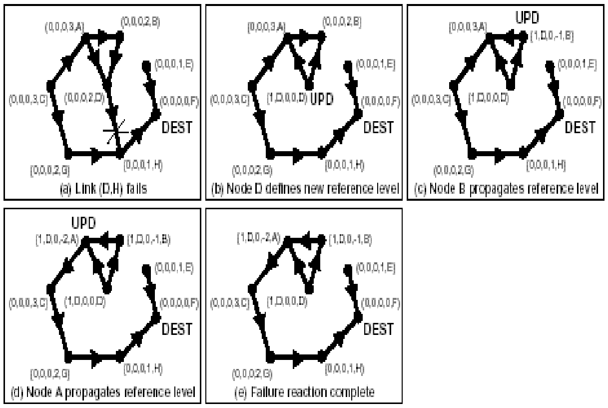

Fig 5. Route maintenance Phase

3. Route destruction

When the reflected reference level propagates back to its originator (case 4) and thus the originator knows that the networks has been partitioned, invalid routes must be destroyed. The node sets its own and its neighbors' height to NULL, updates the link states and broadcasts a CLR packet. The CLR packet includes information about the reference level. When a node receives the packet, it checks if the receiving node uses the same reference level than the node that sent the CLR packet. If the level is the same, the node clears its own and its neighbors' height values, updates link states and forwards the CLR packet. If the reference level in the CLR packet is different from the level of the receiving node, the node sets the heights of all the neighbors with the same reference level than the packet to NULL and updates the link states. If this makes the node to lose its last downstream link, it reacts as in case 1 of the maintenance phase.

IV. RESULTS AND DISCUSSION

We use Network simulator version-2 (NS2) to show the performance of our proposed scheme. The Cooperative Video streaming Scenario (CVS) consists of 40 mobile nodes are randomly deployed over a square region of 2000 ×1500 m2 used in this simulation. The size of the data packet is 512bytes. Ad hoc on Demand Routing (AODV)protocol and TORA is used. In the simulation we have random selection of requester from the set of 40 nodes. As compared to existing scheme, our proposed scheme has better performance in terms of energy efficiency, packet delivery rate, through put. The end to end delay and bandwidth rate can be minimized. The following section shows the simulation parameters, results and comparison performance of the proposed system. Table 1 shows the simulation parameters for the proposed method.

Table 1
Simulation Parameters

Parameter	Value
Field size	2000 × 1500
Number of mobile nodes	40
Propagation Type	Two ray ground
Routing Protocol	AODV and TORA
Channel	Wireless channel
Simulation time	35 sec

Performance Results

In this section, the performance of our protocol is compared with the existing method in terms of throughput, energy level, packet delivery ratio, end to end delay, and bandwidth rate.

Throughput

Throughput is the rate of successful message delivery over a communication channel. The data these messages belong to may be delivered over a physical or logical link, or it can pass through a certain network node. Throughput is usually measured in bits per second (bit/s or bps), and sometimes in data packets per second (p/s or pps) or data packets per time slot. Below graph shows the comparison of existing and proposed routing scheme in terms of throughput. In case of cooperative video streaming the video quality can be improved by efficient routing i.e, the proposed scheme as compared to existing paper.

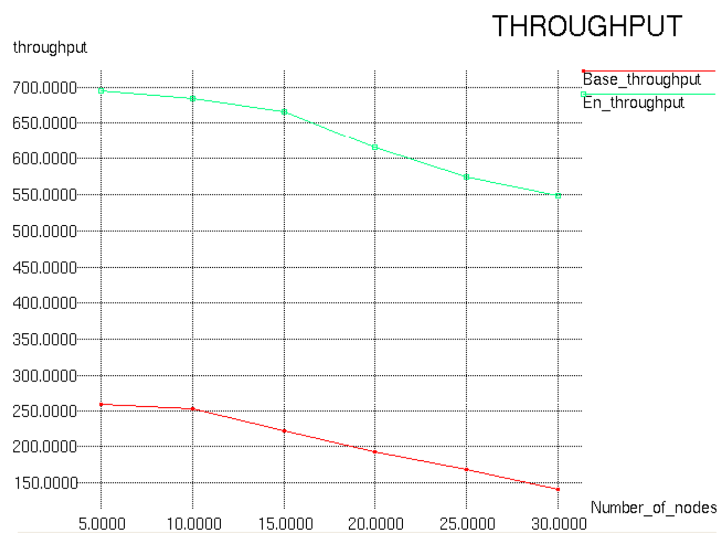

Fig.6 Throughput

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Energy Efficiency Ratio

Below graph shows the comparison of existing and proposed in terms of energy efficiency. The energy capability of nodes in proposed scheme is efficient than existing system.

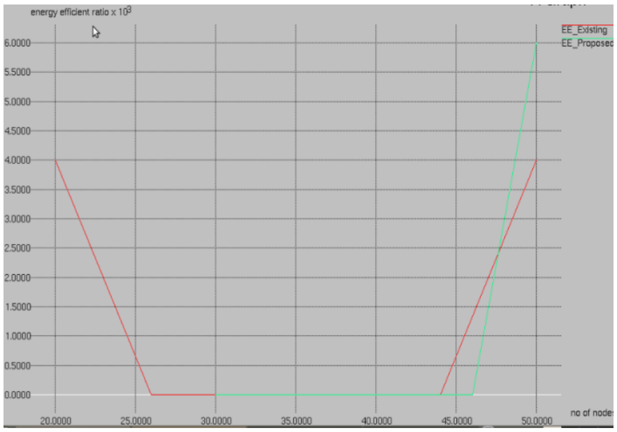

Fig.7 Energy Efficient Ratio

Packet Delivery Ratio

Below graph shows the comparison of existing and proposed routing scheme in terms of packet delivery ratio (PDR). The whole ratio of the number of packets being delivered from the source to the destination is found to be increased as compared with the existing work.

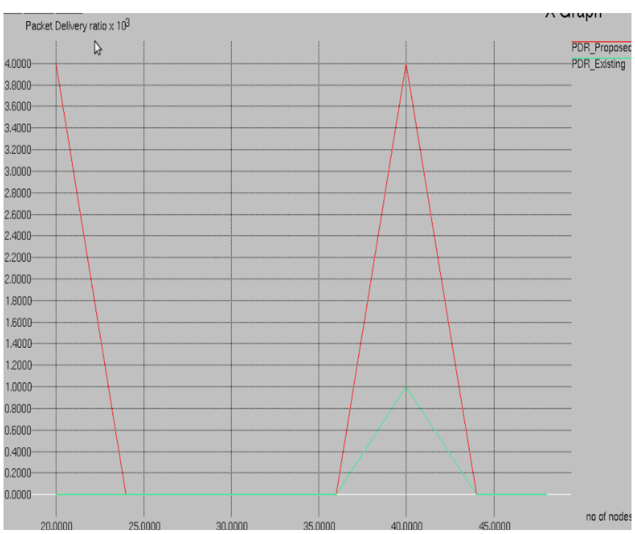

Fig 8.Packet Delivery Ratio

End to End Delay

Below graph shows the comparison of previous technique and proposed routing framework in terms of end to end delay. In this figure, the average time delay caused by a data packet to reach at the destination is found to be low as compared with the previous system.

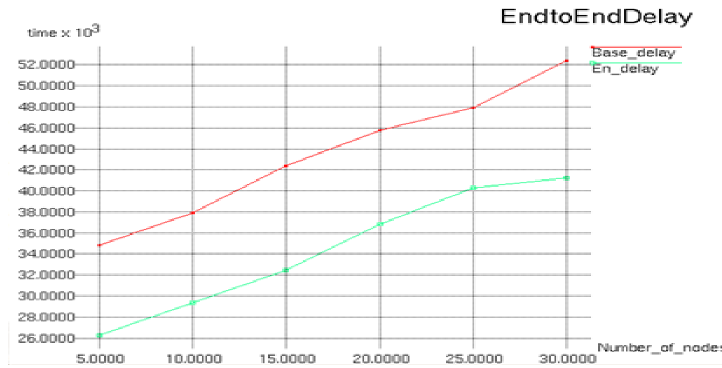

Fig.9 End to end Delay

Bandwidth Ratio

Below graph shows the comparison of previous technique and proposed routing framework in terms of bandwidth utilization. In this figure, by effective routing the bandwidth can be utilized among neighbouring peers compared to the previous scheme.

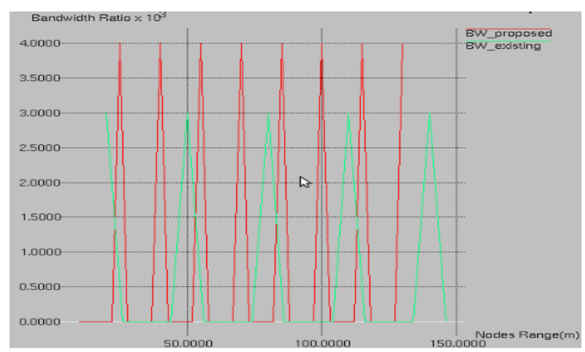

Fig .10 Bandwidth ratio

V.CONCLUSION

Due to the increased demand of people to be connected and used to transfer information when they are mobile. Cooperative video streaming over VANETs provide better bandwidth utilization among neighboring peers. Temporally-Ordered Routing Algorithm (TORA) for Video Streaming

Protocol in Hybrid Vehicular Networks provide an optimized routing path for achieving better performance in video streaming. TORA is an on-demand routing protocol which can be used effectively in a congested network. It establish shortest path and provide multiple routes quickly to minimize the delay at the time of packet forwarding .It can avoid packet loss and provide better throughput compared to existing method. The proposed method provide an efficient path to achieve sufficient helper section so that communication overhead can be minimized. By this TORA, we can create the route to particular destination, maintain the route in case of link failure and erase the route whether there are invalid routes. We propose this algorithm to overcome the limitations of previous works like throughput, energy level, end to end delay, packet delivery rate and bandwidth rate.

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