Co-operative opportunistic routing in VANETS using PSR (Proactive Source Routing Protocol)

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Abstract— VANET (Vehicular Ad-hoc Network) is a new technology, which has taken enormous attention in the recent years. Due to rapid topology changing and frequent disconnection makes it difficult to design an efficient routing protocol for routing data among vehicles, called V2V or Vehicle to Vehicle communication and Vehicle to road side Infrastructure, called V2I. The existing routing protocols for VANET are not efficient to meet every traffic scenarios. Thus design of an efficient routing protocol has taken significant attention. In this paper, we propose a series of solutions to implement cooperative data forwarding in more general VANETs, which is called Cooperative opportunistic Routing in Vehicular Ad-hoc Networks (CORVAN). We propose a new Proactive Source Routing (PSR) protocol that has a very small communication overhead but provides nodes with more network structure information than distance-vector based protocols. PSR has higher TCP (Transmission Control Protocol) throughput, much shorter packet end-to-end delay and delay variance are the metrics used for performance analysis of the adhoc routing protocols.

Keywords - *Cooperative Communication, Proactive Source Routing (PSR), Ad-hoc On Demand Distance Vector (AODV), Vehicular Ad-Hoc Network (VANET), Cooperative data forwarding.*

1. INTRODUCTION

VANET is a special case of the general MANET to provide communications among nearby vehicles and between vehicles and nearby fixed roadside equipments. VANET networks, nodes are characterized by high dynamic and mobility, in addition to the high rate of topology changes and density variability .VANETs are a subset of MANETs (Mobile Ad-hoc NET works) in which communication nodes are mainly vehicles. As such, this kind of network should deal with a great number of highly mobile nodes, eventually dispersed in different roads. In VANETs, vehicles can communicate each other (V2V, Vehicle-to-Vehicle). They can connect to an infrastructure (V2I, Vehicle-to-Infrastructure) or Infrastructure to Vehicle (I2V) to get some service. This infrastructure is assumed to be located along the roads.

A VANET is a group of vehicles that are equipped with wireless communication devices, positioning systems, and digital maps. In VANETs vehicles may connect to roadside units (RSUs), which are connected to the Internet and may also be connected with each other via a high-capacity mesh network. VANETs routing is limited to vehicles few hops away. But, communicating data to far vehicles is also necessary.

The reason we are using RSUs to route packets is that RSUs are a fixed infrastructure. It is so easy to transmit a packet to a fixed target than to a remote moving target. Moreover, the delay of sending the packet through the fixed RSU network is much less than through the VANET.

As VANET is a subset of MANET, the technology and protocols for MANETs need to be evaluated carefully and then adapted in order to be used in VANET context. MANET and VANET, both are mobile networks but they mainly differs in terms of their mobility pattern of VANET nodes is such that they move on specific paths (roads) and hence not in random direction. In VANET the nodes are car having sufficient storage capacity and high processing power unlike MANET nodes lack in storage and processing power

The network architecture of VANET can be classified into three categories: pure cellular/WLAN, pure ad hoc, and hybrid. Due to new technology it has taken huge attention from government, academy & industry. Figure-1 shows a form of vehicular adhoc network. There are several VANET applications such as Vehicle collision warning, Security distance warning, Driver assistance, Cooperative driving, Cooperative cruise control, Dissemination of road information, Internet access, Map location, Automatic Parking Driverless Vehicles.

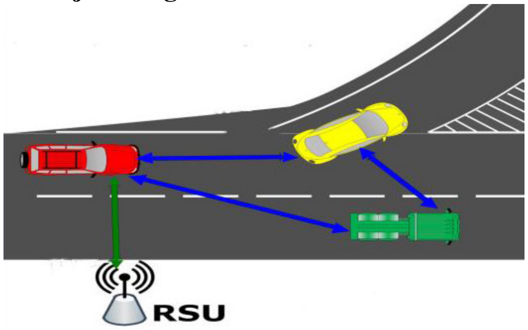

Fig. 1 Vehicular adhoc network

2. RELATED WORK

In these years have been proposed several protocols to route data within VANETs and we can group them in two main categories:

2.1 Topology-based routing divided in:

2.1.1 Table-Driven (or Proactive)

The nodes maintain a table of routes to every destination in the network, for this reason they periodically exchange messages. At all times the routes to all destinations are ready to use and as a consequence initial delays before sending data are small. Keeping routes to all destinations up-to-date, even if they are not used, is a disadvantage with regard to the usage of bandwidth and of network resources.

2.1.2 On-Demand (or Reactive)

These protocols were designed to overcome the wasted effort in maintaining unused routes. Routing information is acquired only when there is a need for it. The needed routes are calculated on demand. This saves the overhead of maintaining unused routes at each node, but on the other hand the latency for sending data packets will considerably increase.

2.1.3 Hybrid

This Protocol is a combination of the previous (proactive for near destinations and reactive for far destinations).

2.2. Position-based routing or geographic routing in which we need:

- A location service to find the destination. This unit is important because often IP addresses aren't enough to identify unambiguously all the nodes. In these cases it's preferable to use a hierarchic approach in which vehicles are recognized by geographic position and unique ID.
- Forwarding Strategies to send the packet to the destination reliably and as quick as possible. The path between source and destination is constructed step by step by each vehicle.

2.3 RSU idle periods and Suitable Conditions

The concept of RSU idle periods calculated with different traffic densities. Analysing the results obtained by placing the RSUs in different spots we identify the best conditions to perform our Carry and Forward (C&F) mechanism.

The vehicles can download information from fixed infrastructure or from RSUs located along roads. RSUs are connected via backbone and scattered among the topology but they don't cover the whole paths followed by vehicles. When a vehicle reaches the RSU coverage for the first time obtains identification (Node-ID) and then starts to periodically broadcast its direction, speed and ID. These beacons of information are forwarded to the server that gets a constantly updated overview of traffic under RSUs. So we only know status of vehicles under coverage but it's possible to obtain this information also when they travel in dark areas using historical paths.

Cooperation is achieved scheduling part of RSUs data among co-operators that have high probability to encounter receivers during their trip. In highway scenarios, in which vehicles follow the same direction for long periods, the server predicts without doubts which will be the next RSU on the path.

RSU terminology to refer properly to actors in the network:

- *Consumer* is a vehicle that downloads whenever the opportunity (from RSUs or other vehicles) has.
- *Receiver* is a consumer that is designed to receive data from co-operators. It is discovered by the C&F mechanism. Consumer usually becomes receiver only if has high probability to meet co-operators during its trip.
- *Co-operator* is a common vehicle that isn't interest in download files but can be used by RSUs to carry packets for receivers.
- *Idle period* is the time's slot in which the RSU has no consumers under coverage. RSU isn't really idle because it's busy to

manage cooperation between co-operators but for simplicity we continue to use this term.

3. SYSTEM ANALYSIS

3.1 Existing System

The Existing system is ExOR; it is an explorative cross layer opportunistic data forwarding technique in multi-hop wireless networks. In ExOR, data packets are prepended with an ExOR header, and they are further prepended with an 802.11 DATA frame header before being broadcasted. Path Finding Algorithm (PFA) [1] was developed based on the distance vector algorithm, which incorporates the predecessor of a destination in a routing update. The Link Vector (LV) algorithm [2] reduces the overhead of link-state algorithms to a great deal by only including links to be used in data forwarding in routing updates. The extreme case of LV where only one link is included per destination coincides with PFA.

3.2. Proposed Method:

CORVAN is a network layer solution to the opportunistic data transfer in mobile ad hoc networks. A flow of data packets are divided into batches. All packets in the same batch carry the same forwarder list when they leave the source node. To support CORVAN, we have an underlying routing protocol, Proactive Source Routing (PSR), which provides each node with the complete routing information to all other nodes in the network. Thus, the forwarder list contains the identities of the nodes on the path from the source node to the destination. As packets progress in the network, the nodes listed as forwarders can modify the forwarder list if any topology change has been observed in the network. This is referred to as large-scale live update in our work. In addition, we also allow some other nodes that are not listed as forwarders to retransmit data if this turns out to be helpful, referred to as small-scale retransmission.

- PSR runs in the background so that nodes periodically exchange network structure information. It converges after the number of iterations equal to the network diameter. At this point, each node has a spanning tree of the network indicating the shortest paths to all other nodes.
- Large-scale live update — when data packets are received by and stored at a forwarding node, the node may have a different view of how to forward them to the destination from the forwarder list carried by the packets. Since this node is closer to the destination than the source node, such discrepancy usually means that the forwarding node has more updated routing information. In this case, the forwarding node updates the part of the Forwarder list in the packets from this point on towards the destination according to its own knowledge.
- Small-scale retransmission — A short forwarder list forces packets to be forwarded over long and possibly weak links. To increase the reliability of data forwarding between two listed forwarders, CORVAN allows nodes that are not on the forwarder list but are situated between these two listed forwarders to retransmit data packets if the downstream forwarder has not received these packets successfully. In this module, the performance of CORVAN is analyzed on the basis of time with Packet loss and Packet Delivery ratio in the network.

4. NETWORK SIMULATOR

The Network Simulator is the Software using and Version 2.35. Network Simulator (NS2) is a discrete event driven simulator developed at UC Berkeley. It is part of the VINT project. The goal of NS2 is to support networking research and education. It is suitable for designing new protocols, comparing different protocols and traffic evaluations. NS2 is developed as a collaborative environment. It is distributed freely and open source. Versions are available for FreeBSD, Linux, Solaris, Windows and Mac OS X.

NS2 is built using object oriented methods in C++ and OTCL (object oriented variant of TCL).

TCL - Tool Command Language used for specifying scenarios and events.

Nam is a TCL/TK based animation tool for viewing network simulation traces and real world packet traces. It supports topology layout, packet level animation, and various data inspection tools.

5. RESULT ANALYSIS

This section gives the simulations that were performed to evaluate CORVAN using the network simulator ns2 software (version 2.35).The number of Vehicles is set to 12 and their speed set to 30m/s. Two RSUs deployed on map to have internet connection. The source vehicle can take data from RSU and it will transfer data to Destination Vehicle. To Analysis the performance of CORVAN we measure Packet Delivery Ratio, End-to-End Delay, and Throughput.

- Packet delivery ratio: the ratio of the number of delivered data packet to the destination. This illustrates the level of delivered data to the destination.

$$\text{PDR}=\frac{\sum \text{Number of packet receive}}{\sum \text{Number of packet send}}$$

- End-to-end Delay: the average time taken by a data packet to arrive in the destination. It also includes the delay caused by route discovery process and the queue in data packet transmission. Only the data packets that successfully delivered to destinations that counted.

$$\text{E2E}=\frac{\sum \text{arrive time} - \text{send time}}{\sum \text{Number of connections}}$$

- Throughput: It is defined as the amount of data delivered from source to destination in a given amount of time

The Fig. 2 Shows the NAM Result of CORVAN. We Deploy 16 nodes in network dimension. These nodes move following the random waypoint model with *v*max = 30 m/s. 2 RSU are distributed in the network. In these scenarios we test CORVAN capabilities in transporting CBR data flows between a randomly selected source-destination pair. The source node can access network from RSU and by Distance vector Algorithm first find the path to destination then it transmit the data by using neighbour node in a shortest distance.

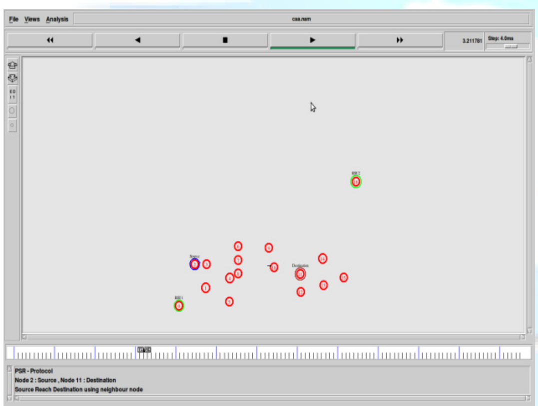

Fig. 2 Network Animator Result of CARVAN

5.1 Simulation Parameters

Parameters	Values
Simulator	NS 2.35
Protocol	AODV, DSDV
Traffic Source	TCP,UDP
Mobility Model	Random Way Point
Application agent	CBR
Number of Nodes	13
Maximum Simulation Time	100 sec
Antenna	Omni Antenna
Simulation Area	1000x1000

5.2 Performance Result Analysis of CORVAN

Generated Packet	880
Received Packet	629
Packet Delivery Ratio	71.47%
Total Dropped Packets	250
End to End Delay	35.288ms
Through put	213.27kbps

5.3 Performance Result Analysis of AODV

Generated Packet	1000
Received Packet	513
Packet Delivery Ratio	51.3%
Total Dropped Packets	486
End to End Delay	76.489ms
Throughput	173.38kbpd

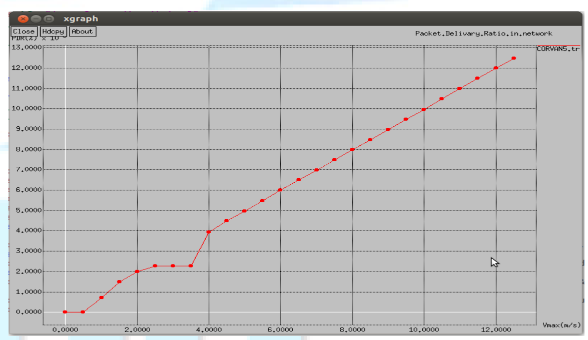

Fig. 3 Packet Delivery Ratio of CORVAN

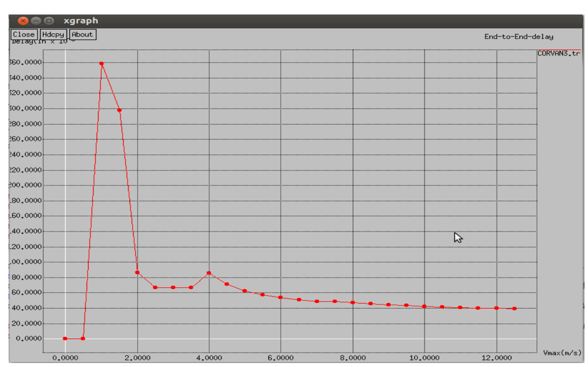

Fig. 4 End-to-End Delay of CORVAN

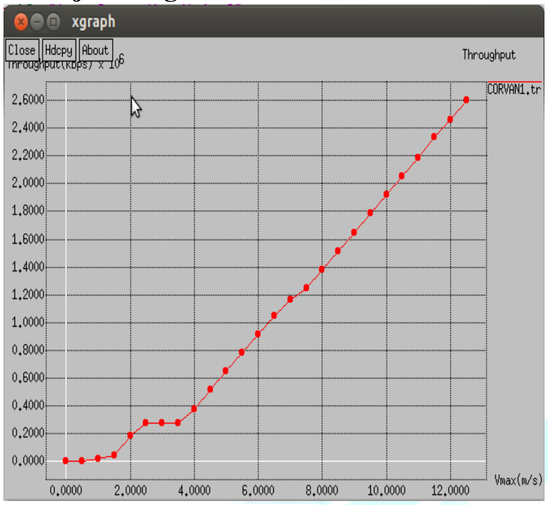

Fig.5 Throughput of CORVAN

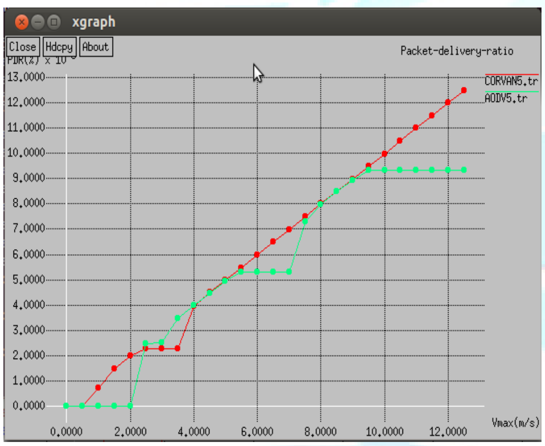

Fig. 6 Comparison of Packet Delivery Ratio of CORVAN and AODV

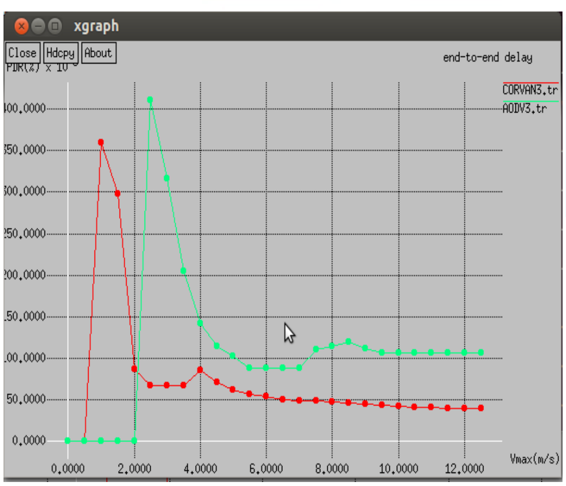

Fig. 7 Comparison of End-to-End Delay of CORVAN and AODV

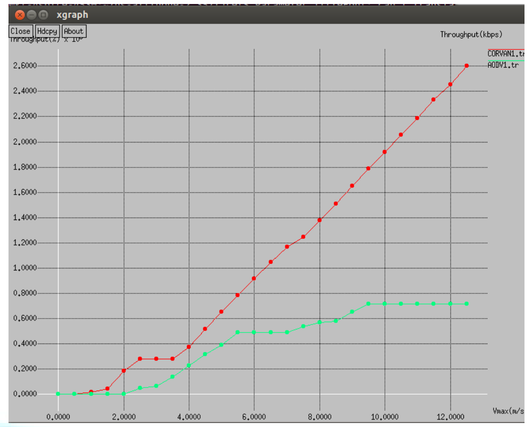

Fig. 8 Comparison of Throughput of CORVAN and AODV

The Fig3 shows Packet Delivery Ratio of CORVAN X-axis taken as Velocity, Vmax/sec and Y-axis is taken as PDR(%), according to CORVAN Performance PDR(%)=71.47. The Fig4 Shows End to End Delay of CORVAN X-axis taken as Velocity Vmax/sec and Y-axis taken as Delay (in m sec) ,according to CORVAN End to End Delay is 35.288ms.The Fig 5 Shows Throughput of CORVAN where X-axis taken Vmax/sec and Y-axis Throughput(kbps),according to CORVAN Performance Throughput is 213.27Kbps.

The Fig 6, Fig 7 and Fig 8 Shows the Performance Analysis of CORVAN with AODV with all the Three Matrices Packet Delivery Ratio, End to End Delay and Throughput. In Fig 6 Shows the PDR Comparison between CORVAN and AODV, X-axis Vmax/sec and Y-axis PDR (%).CORVAN PDR (%) is 71.477 and AODV PDR (%) is 51.3 Compare to AODV CORVAN provide better Packet Delivery ratio. In Fig 7 shows the End to End Delay Comparison X-axis Vmax/sec and Y-axis taken as Delay (m sec) CORVAN E2E Delay is 35.288ms and AODV E2E Delay is 76.489ms compare to AODV and CORVAN, AODV delay is more. In Fig 8 shows the Throughput Comparison X-axis taken as Vmax/sec and Y-axis taken as Throughput (kbps). The CORVAN Throughput is 213.27 Kbps and AODV Throughput is 173.38kbps.The Performance result Analysis shows that CORVAN gives better Performance compare to AODV.

6. Conclusion and Future Scope

This paper present CORVAN as a co-operative opportunistic routing scheme for VANET is composed of three components. 1)PSR—a proactive source routing protocol, 2) large-scale live update of forwarder list, and 3) small-scale retransmission of missing packets. All of these explicitly utilize the broadcasting nature of wireless channels and are achieved via efficient cooperation among participating nodes in the network. The evaluation of CORVAN confirmed its effectiveness when compare to other protocol. The future work focus on Nodes running CORVAN forward data packets in fragments. When the source and destination Vehicles are separated by many hops, it should allow vehicles at different segment of the route to operate simultaneously. That is, a pipeline of data transportation could be achieved by better spatial channel reuse. Nowadays Most VANETs works on using 3G or 4G in future we can implement to use of 5G.

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