CBRP: A Network clustering model in vehicular ad-hoc networks

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Abstract : Inter-vehicle communication is a major part of the Intelligent Transportation Systems (ITS). Vehicular Ad-Hoc Network (VANET) is one of the most promising applications of Mobile Ad-Hoc Network (MANET) which was primarily developed to improve safety and comfort for vehicles, passengers and drivers. There are many challenges in VANET which must be improved to provide a reliable service. These challenges include network architecture, routing algorithms, and security. Because of high mobility and changeable infrastructure, stable and reliable routing in VANET is one of the major issues. Existing routing algorithms for VANET are divided into five major classes: AdHoc, position-based, broadcast, Geocast and cluster-based. Among them, cluster-based algorithms have received more attention by researchers because such algorithms try to keep the network performance in an acceptable level even though the network may consist of many mobile nodes. In this paper a cluster-based routing algorithm will be proposed which is scalable, efficient and distributed. In the algorithm that will be proposed, when selecting the cluster head the speed deviation of vehicles as well as the remaining time to destination will be taken into account. Simulation results will be used to show that the proposed algorithm will have lower End-to-End delay compared with CBLR algorithm.

***IndexTerms* – VANET, Routing, Clustering, CRRP, CRLR, Speed Deviation**

I. Introduction

The main aim of the Intelligent Transport Systems (ITS) is decreasing traffic and increasing passengers and drivers safety. To achieve this aim, every vehicle must equip with proper communication devices and control systems. Vehicular Ad-Hoc Network (VANET) represents a particularly new class of wireless AdHoc networks that enables vehicles to communicate with each other and/or with roadside infrastructure. Vehicular communications are divided into two types: Vehicle-to-Vehicle (V2V) and Vehicle to Roadside (V2R). V2V-based VANETs have several advantages over V2Rbased V ANETs. First, the V2V -based V ANET is more flexible and more independent of the roadside conditions, which is particularly attractive for most developing countries and remote areas where the proper roadside infrastructures are unavailable.

Second, the V2V -based VANET is less expensive than V2R-based V ANET since it does not need expensive equipment. Third, V2V -based V ANET can avoid fast fading, short connectivity time and high frequent hand-offs caused by high relative-speed difference between fast-moving vehicles and road-side stations. Finally, the V2V -based V ANET is more appropriate for vehicle-related applications in which neighboring vehicles exchange messages. One of the most important issues in V ANETs is routing because of the dynamic nature of mobile nodes in the network [1]. This paper focuses on the V2V-based VANETs and proposes a cluster-based algorithm which imposes a low End-to-End delay.

II. VANET

In 1999, the Federal Communication Commission allocated a frequency spectrum for vehicle-vehicle and vehicle-roadside wireless communications. The Commission then established the service and license rules for Dedicated Short Range Communications (DSRC) service in 2003. DSRC is a communication service that uses for public safety and private applications. The allocated frequency and developed services enable vehicles and roadside beacons to form V ANET in which the nodes can communicate wirelessly with each other without central access point. In contrary, nodes in V ANET are rechargeable and can be constrained by the road and traffic patterns [2-4]. V ANET has the following characteristics:

Rapid topology changes: The speed and choice of path defines the dynamic topology of VA NET.
Frequent fragmentation: The dynamic topology requires every vehicle to establish a new link with nearby vehicles in a short time to maintain seamless connectivity.
Small effective network diameter: High mobility causes paths to be disconnected before they can be used.
Variant network congestion: Network density depends on vehicular density.

Changing network topology: Since drivers react to the messages differently their behavior may change the network topology.
Very fluid and dynamic network: Because of the nature of travelling vehicles and traffic condition, such networks have a dynamic nature and require dynamic routing schemes. [5-11]. VANET applications are divided into three categories.
- Safety
- Intelligent transport
- Comfort

III. Literature Survey

I. G. Shayeb, A H. Hussein, and A B. Nasoura, "A Survey of Clustering Schemes for Mobile Ad-Hoc Network (MANET)," 2011. Cognitive Radio Network (CRN) has an important role in next generation wireless networks; it can potentially provide higher performance of wireless communication networks in terms of reliability, scalability, stability and spectrum efficiency. Cognitive radio networks are on the basis of radio nodes equipped with a cognitive engine (CE); it can manage spectrum and change transmission parameters using artificial intelligence methods in particular bio-inspired optimization methods. This study investigates spectrum management problem in cognitive ad hoc network in particular mobile ad hoc network with cognitive nodes. The spectrum management problem can be summarized as channel allocation and cluster formation problems that are both multi-objective combinatorial optimization problems, which can be addressed with bio-inspired optimization algorithms, i.e., genetic algorithms and swarm intelligence methods. In this thesis the focus are on the convergence characteristics and multi-objective functions.

Y. Luo, W. Zhang, and Y. Hu, "A New Cluster Based Routing Protocol for VANET," 2010. VANET is a subset of MANET. VANET is a self-organized information system composed of vehicles (and possibly additional infrastructure) capable of short-range communication through the device called On Board Unit (OBU). There is a wide range of possible application areas of VANETs, including warning systems, collision avoidance/notification, autonomous vehicles, and traffic optimization. VANETs rely heavily on broadcast transmission. When a vehicle rebroadcasts a message, it is highly likely that the neighboring vehicles have already received it, and these results in a large number of redundant messages. This affects inter-vehicle communications, since redundant rebroadcasts, contention and collisions can be largely increased as the number of vehicles increases. Broadcasting packets may lead to frequent contention and collisions in transmission among neighboring vehicles this problem is referred as the broadcast storm problem. The main goal of Selective Reliable Broadcast protocol (SRB), is intended to limit the number of packet transmissions. Through an opportunistic vehicle selection, packets are retransmitted towards a next hop, in order to strongly reduce the number of forwarder vehicles, while preserving an acceptable level of QoS. SRB belongs to the class of broadcast protocols, as well as cluster-based approaches. It exploits the partitioning behavior, as typical from vehicular ad hoc networks, in order to automatically detect vehicular clusters, intended as "zones of interest". Packets will be then forwarded only to selected vehicles, opportunistically elected as cluster-heads. SRB performances have been assessed in different vehicular scenarios, mostly realistic environments, such as highway scenarios.

Y. Luo, W. Zhang, and Y. Hu, "A New Cluster Based Routing Protocol for VANET," 2010. In this paper, the problem of determining faulty readings in a wireless sensor network without compromising detection of important events is studied. By exploring correlations between readings of sensors, a correlation network is built based on similarity between readings of two sensors. By exploring Markov Chain in the network, a mechanism for rating sensors in terms of the correlation, called Sensor Rank, is developed. In light of Sensor Rank, an efficient in-network voting algorithm, called Trust Voting, is proposed to determine faulty sensor readings.

M. KumarI, R. Rishi2, and D. K. Madan3, "Comparative Analysis of CBRP, DSR, AODV Routing Protocol in MANET," 2010. Vehicular communication is an important and emerging area of research in the field of vehicular technology. The development of software and hardware in communication systems leads to the generation of new networks. In this paper cluster based routing is used to enhance the performance of information in vehicular Ad-hoc networks. Clustering in VANET is one of the control schemes used to make VANET global topology. This cluster based routing is presented with Adaptive transmission power control in VANET. In this work the transmission power is adapted. This adaptation is based on the distance between vehicles and cluster head. Therefore, VANET cluster schemes should take into consideration and parameters to produce relatively stable clustering structure.

T. W. G. Wang, "TIBCRPH Traffic Infrastructure Based Cluster Routing Protocol with Handoff in V ANET," 2010. In a vehicular sensor network (VSN), the key design issue is how to organize vehicles effectively, such that the local network topology can be stabilized quickly. In this work, each vehicle with on-board sensors can be considered as a local controller associated with a group of communication members. In order to balance the load among the nodes and govern the local topology change, a group formation scheme using localized criteria is implemented. The proposed distributed topology control method focuses on reducing the rate of group member change and avoiding the unnecessary information exchange. Two major phases are sequentially applied to choose the group members of each vehicle using hybrid angle/distance information.

IV.Problem Definetion

One of the most important issues in VANETs is routing because of the dynamic nature of mobile nodes in the network and high mobility and changeable infrastructure. Stable and reliable routing in VANET is major issue.

Routing Protocols for VANET

Routing protocols for V ANET are classified into five categories: ad-hoc, position-based, cluster-based, broadcast, and geocast routing.

Ad-Hoc Routing

Some of the ad-hoc routing protocols such as AODV and DSR can be modified and applied to VANET as well. For example, PR-AODV is a modified version of AODV for V ANET in which, opposed to AODV, a new link is created only when an existing one is disconnected. In PRAOVD-M which itself is a modified version of PRAODV, the path with maximum estimated life time is selected. This is while in both PR-AODV and AODV the shortest path is selected.

Position-Based Routing

Position-based routing techniques rely on vehicles information about the position of their nearby vehicles. In geographical routing each node knows its own location by using the Global Positioning System (GPS) or other localization techniques. When a source wants to send a packet to a destination, it uses the destination's location to fmd the closest neighbor to the destination which is also closer than itself to the destination, and then forwards the packet to that neighbor. Greedy Perimeter Stateless Routing (GPSR)[16], which is one of the best known position-based routing techniques, combines both greed forwarding and face routing.

Geographic Source Routing

(GSR) is another position based routing algorithm which uses a Reactive Location Service (RLS) to get the destination node position [5]. This algorithm gets the city topology through a static street map. The sender uses the Dijkstra algorithm to determine the junctions through which packets must travel. Forwarding between junctions is then done in a position-based fashion. By combining the geographic routing and topological knowledge from street maps, GSR proposes a promising routing strategy for V ANETs in city environments. Anchor-based Street and Traffic Aware Routing (ASTAR) [17] is a positioned-based routing scheme designed for inter-vehicular communication in a city environment. This algorithm tries to identify anchor paths with high connectivity for packet delivery using the information of city bus routes.

Broadcast-Based Routing

Broadcast-based routing is the most popular routing protocol for V ANET especially when a message must be delivered to all vehicles (e.g. safety related messages). The simplest form of broadcasting is flooding in which each node rebroadcasts the message to other nodes. Although flooding ensures the message is delivered to all targets, it suffers from a big overhead especially when there are many nodes in the network. In a dense network, number of messages grows exponentially which may cause collision, high bandwidth consumption and a fall in overall performance. Several selective forwarding schemes such as BROADCOMM[18], Urban Multi-hop Broadcast Protocol (UMB)[19] Vector-based Tracking Detection (VTRADE)[20], and History Enhanced V-TRADE (HVTRADE)[20] have been proposed to overcome the aforementioned issues.

Cluster-Based Routing

In a clustering scheme for V ANET, the adjacent mobile nodes are virtually grouped in a cluster. Each node in a cluster may get one of the following roles: cluster head, cluster-gateway, or cluster-member. Normally, a cluster head serves as a local coordinator for its cluster, performing intra-cluster transmission arrangement, data forwarding, and so on. A cluster-gateway is a non-cluster head node with inter-cluster links to establish a connection between the cluster and neighboring clusters. A cluster-member is usually called an ordinary node with no inter-cluster link. Cluster-based routing protocols have several advantages over flat routing protocols (i.e. those without any hierarchy) which include lower overhead, higher scalability and throughput, and better usage of the system capacity because of better performance in the MAC layer.

At the network layer, clustering reduces the size of routing table and decreases transmission overhead resulted from updating routing tables after topological changes. Although each node stores only a fraction of the total network routing information, clustering is able to achieve topology information by aggregating current nodes information. Consequently, clustering may be considered to create more scalable and stable communication schemes. There are many cluster-based algorithms for V ANET, of which, we briefly introduce the most famous ones in the following sections. Clustering algorithms for V ANET are divided into two categories: position-based and speed-based.

Speed-Based Clustering

Speed-based clustering algorithms use the information about vehicles' speed for routing. Data Propagation Protocol (DPP) enables message propagation in VANET without the use of fixed infrastructure such as access points or satellite communication. The algorithm is inherently distributed and does not require a global naming function. This algorithm can be used for any traffic condition. The cost of message exchange is deterministic and is a function of speed of vehicle, speed of message propagation, and the traffic conditions.

In [34] an efficient protocol named Traffic Infrastructure Based Cluster Routing Protocol with Handoff (TIBCRPH) has been introduced which uses the handoff idea of cellular networks to fmd the new cluster head of the vehicles when they move across the overlapped region. Clustering Fonnation for Inter-Vehicle Communication protocol (CF-IVC) [35] makes a hierarchy of vehicles based on their speeds. By assigning different codes to clusters, it guarantees a collision-free data exchange among the nodes in the intra-cluster or inter-cluster communication through multi-hop cluster sequence.

V. Proposed Implementation Procedure

The proposed algorithm is a cluster-based routing algorithm which is based on CBRP. The algorithm divides the nodes into a number of overlapping or disjoint 2- hopdiameter clusters in a distributed manner. Because of the following advantages, we chose CBRP as the base clustering method in the proposed algorithm:

• It is fully distributed.
• There is low flooding traffic during the dynamic route discovery process.
• Broken routes can be repaired locally without performing rediscovery.
• It shortens the route by excluding the redundant nodes from the route. Before explaining the proposed algorithm, let us review some of the assumptions.
• Link's status: Links can be unidirectional or bidirectional.
• Node's ID: We use a string as a unique identifier for each node.
• Node's status: Based on their membership to clusters, nodes may get one of the following roles: undecided, cluster head, gateway or member. Undecided means that the node is not a member of any cluster. A node which is a member of at least two clusters is a gateway. Such nodes facilitate inter cluster communications.
• Host cluster: If node x has a bidirectional link to a cluster head, that cluster is the host cluster for node x.

Data Structures

Data structures used in the proposed algorithm are as follows.

Neighbor Table

The neighbor table is a data structure used for cluster formation in which the information of neighbors is stored for each node. Each entry of the table contains: the ID of the neighbor, the role of the neighbor and the status of the link between them (bidirectional or unidirectional).

Cluster Adjacency Table (CAT)

The cluster adjacency table keeps information about neighbor clusters. Each entry contains the ID of the neighboring cluster head, the gateway node through which the host cluster head communicates with the neighboring cluster head, and the status of the link between the gateway and the neighboring cluster head.

Two-hop Topology Database

In the proposed algorithm, each node broadcasts its neighbor table information periodically via hello packets. Therefore, by examining the neighbor table of its neighbors, a node is able to get information about the nodes located at most two-hops away from itself and store such information in two-hop topology database.

Cluster Head Selection

CBRP uses a variation of the lowest-ID algorithm, which is an identifier-based algorithm [38] to choose the cluster head. High mobility is a characteristic of V ANET, which means there is a rapid variation in nodes' speed. This makes the minimum ID algorithm inefficient for V ANET.

Therefore, in the proposed algorithm we select the cluster head using the following formula:

$$E_i = exp(-\frac{d}{t}) \qquad T \in (0, T_{max}) \qquad (1)$$

Where T is the estimated travel time and d is the speed deviation. Tmax is the maximum travel time. T and dare measured in second and meter/second, respectively. If a vehicle has a long travel time and a small speed deviation (i.e. when Ej is high), its chance is high for being selected as a cluster head.

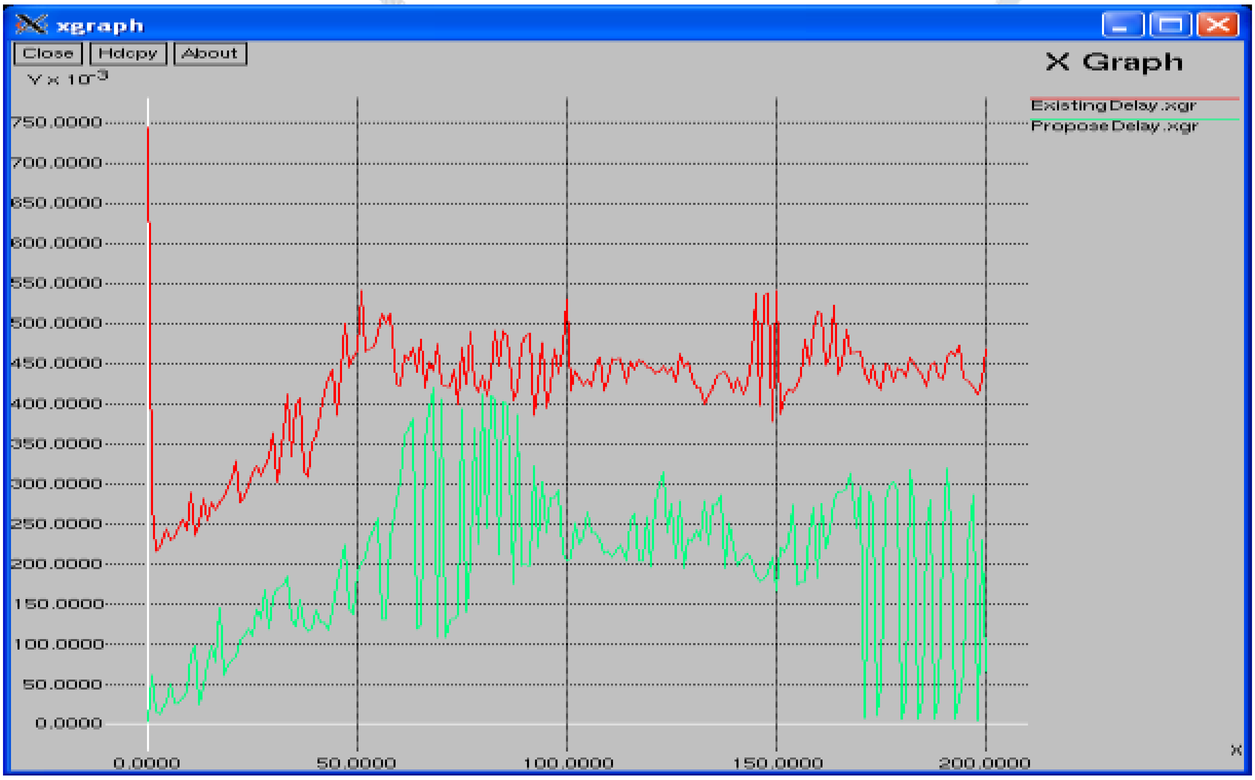
CBRP Procedures

Cluster Based Routing protocol to establish communication between vehicle to vehicle. In propose work nodes will belong to one cluster if one node hello messages receive by other node and then replied back. Cluster head will be form if a node hear message from all other nodes in a cluster. Cluster gateway will form if two cluster have a common node. If a node not hear hello message from any other node then it will be called as Undecided node.

To implement this concept we will use CBRP protocol for ns2.35. If CBRP not work then we will modify AODV to support cluster formation by using paper concept. In this simulation we will input total no of nodes and then place all those nodes randomly. After placement we will form clusters by using nodes distance and hello messages. Similarly will form gateway and cluster head. After running simulation will try to run delay metrics between propose and existing cluster protocols.

VI. Simulation Results

The proposed algorithm has been simulated in NS2.29 on a system running ubuntu in a computer with 4 Gigabyte Ram. We used Average End-to-End delay metric for evaluating the proposed algorithm.



VII. Conclusion

In this paper we proposed a cluster-based routing algorithm. In the proposed algorithm a cluster head is selected for each cluster to maintain cluster membership information. To address high mobility and speed variation of nodes, we give the node with high estimated travel time and low speed deviation a high chance to become a cluster head. The proposed algorithm is compared with CBLR in term of end-to-end delay. The simulation result shows that proposed algorithm is better than the CBLR.

References

[I] X. Zhang and H. Su, "Cluster-Based Multi-Channel Communication Protocols in Vehicle Ad-Hoc Netwok," presented at the Vehicular Technology, IEEE, 2007.

[2] "Federal Communications Commission," in FCC 03-324. FCC Report and Order, ed, February 2004.

[3] "Standard Specification for Telecommunication and Information Exchange between Roadside and Vehicle Systems -5GHZ Band Dedicated Short Range Communication (DSRC) Medium Access Control (MAC) and physical Layer (PHY) specification," vol. E2213-03, ed: ASTM int'!, July 2003.
[4] S. Yousefi, M. Siadat, and M. Fathi, "Vehicular Ad hoc Networks (VANETs): Challenges and perspectives," in 6th international conference on iTS Telecommunication proceedings, 2006.
[5] C. Lochert, A Barthels, A Cervantes, M. Mauve, and M. Caliskan, "Multiple Simulator Interlinking Environment for IVC," in Proceedings of 2nd ACM International Workshop on Vehicular Ad Hoc Networks (VANET 2005),2005, pp. 87 - 88
[6] S. Y. Wang, "On the Intermittence of Routing Paths in VehicleFormed Mobile Ad Hoc Networks on Highways," in Proceedings of 7th IEEE intelligent Transportation Systems Conference, 2004, pp. 803 - 809.
[7] S. Y. Wang, "Predicting the Lifetime of Repairable Unicast Routing Paths in Vehicle-Formed Mobile AdHoc Networks on Highways," in Proceedings of 15th iEEE International Symposium on Personal, indoor, and Mobile Radio Communications (IEEE PlMRC), 2004, pp. 2815-2819.
[8] J. J. Blum, A Eskandarian, and L. J. Hoffman, "Challenges of Intervehicle Ad Hoc Networks," presented at the IEEE Transactions on Intelligent Transportation Systems, December 2004.
[9] J. Haerri and C. Bonnet, "A Lower Bound for Vehicles' Trajectory Duration," in Proceedings of 62nd iEEE Semiannual Vehicular Technology Conference (VTC-Fal/), 2005, pp. 2273 - 2277.
[10] D. R. Choffues and F. E. Bustamante, "An Integrated Mobility and Traffic Model for Vehicular Wireless Networks," in Proceedings of 2nd ACM international Workshop on Vehicular Ad Hoc Networks (VANET2005), 2005, pp. 69 - 78.
[11] M. M. Artimy, W. Robertson, and W. Phillip, "Connectivity in InterVehicle Ad Hoc Networks," in iEEE Proceedings of Canadian Conference on Electrical and Computer Engineering, 2004, pp. 293 - 298.
[12] R. Kumar and M. Dave, "A Comparative Study of Various Routing Protocols in V ANET," lJCSI international Journal of Computer Science issues, vol. 8, 20 II.
[13] C. E. Perkins and E. M.Royer, "Ad-hoc on Demand Distance Vector Routing," iEEE Workshop on Mobile Computing Systems and APPlications, 1999.
[14] D. B. Johnson and D. A Maltz, "Dynamic Source Routing in Ad hoc Wireless Networks," in mobile computing, ed, 1996.
[15] V. Namboodiri, M. Agarwal, and L. Gao, "A Study on the Feasibility of Mobile Gateways for Vehicular Ad-hoc Networks," presented at the First International Workshop on Vehicular Ad Hoc Networks, 2004.
[16] B. Karp and H. T. Kung, "GPSR: greedy perimeter stateless routing for wireless networks," in 6th annual international conference on Mobile computing and networking 2000, pp. 243-254
[17] G. Liu, B.-S. Lee, B. C. Seet, C. H. Foh, K. J. Wong, and K. K. Lee, "A Routing Strategy for Metropolis Vehicular Communications," presented at the International Conference on Information Networking (ICOIN),2004.
[18] M. Durresi, A Durresi, and L. Barolli, "Emergency Broadcast Protocol for Intervehicle Communications," presented at the 11th International Conference on Parallel and Distributed Systems, 2005.
[19] E. E. G. Korkmaz, F. Ozguner and D. Ozguner, "Urban Multi-Hop Broadcast Protocol for Inter-Vehicle Communication Systems," presented at the ACM International Workshop on Vehicular Ad Hoc Networks, 2004.
[20] M. Sun, W. Feng, T. H. Lai, K. Yamada, H. Okada, and K. Fujimura, "GPS-Based Message Broadcasting for Inter-Vehicle Communication," in international Conference on Parallel Processing, 2000.
[21] C. C. Ooi and N. Fisal, "Implementation of Geocast-Enhanced AODV-Bis Routing Protocol in MANET," in iEEE Region 10 Conference,2004,pp. 660-663.
[22] A Bachir and A. Benslimane, "A multicast protocol in ad hoc networks inter-vehicle geocast," in 57th iEEE Semiannual Vehicular Technology Conference (VTC 2003-Spring), 2003, pp. 2456-2460.