Proceedings of the International MultiConference of Engineers and Computer Scientists 2010 Vol II,
IMECS 2010, March 17 - 19, 2010, Hong Kong

Inter-Vehicle Communication Protocols for Multimedia Transmission

Kayhan Zrar Ghafoor and Kamalrulnizam Abu Bakar

***Abstract*—Vehicular Ad Hoc Network (VANETs) could achieve flexible communication among vehicles and with infrastructure. VANET provides multi-hop transmission to cover all intended receivers. This multi-hop capability has the potential to increase safety, efficiency and convenience of transportation system. Multi-hop transmission enhances a range of applications including traffic safety and comfort of every day road travel. In most of the envisioned applications, information to all or specific group vehicles inside a certain region is needed to be delivered. These applications rely on unicast, broadcast and geocast approaches. This study presents a review of recent routing protocols for both text and video data transmission. In particular, this paper focuses on quality based comparison of routing protocols for video data streaming over VANET. Some of routing challenges for video streaming and text dissemination over VANET are also discussed.**

***Index Terms*—multi-hop transmission, routing protocols, Vehicular Ad-Hoc Network (VANET), video streaming**

I. INTRODUCTION

The continuous increase in the number of vehicles in the transportation system calls for an improvement of traffic safety and efficiency of the overall transportation infrastructure. To achieve this demand, the vehicular communications have been considered to enable various road traffic applications ranging from traffic safety to pleasant driving applications. Effective implementation of vehicular communication could also improve traffic management system. This effectiveness could be achieved by designing efficient vehicular network protocols. Therefore, vehicular communication networks not only could provide scalable connectivity between vehicles on the road but also can establish better coordination between road mobile users. This will also ensure an efficient vehicular communications, which could enable the Intelligent Transportation Systems (ITS). Many automobile manufacturers around the world are in different stages of integrating wireless communication devices in their production. This technology could improve traffic safety, driving assistance, entertainment, and mobile commerce. In the near future, the number of vehicles equipped with communication device is going to increase; this allows the scalable VANET to be materialised. A number of research projects around the world, e.g. [1] in Europe, [2] in US and [3] in Japan are engaged in researching and developing the infrastructure of VANET and ITS.

The routing protocols in VANET are quite different from routing in mobile ad hoc network (MANET) due to several reasons including high mobility, frequent topology fragmentation, frequent disconnection, ample power requirements, etc. Therefore, routing protocols designed for VANET must be highly scalable, robust and easy to deploy. In addition, the frequent arrival and departure of vehicles brings many challenges in routing research. VANET vehicles movement is restricted as it is bidirectional at the highway or urban area. Furthermore, vehicles require ample power for process computation and storage [4].

Thus, analysing the existing VANET protocol designs and describing the effect of these designs on communication potency have become integral in the global transportation system. Even though there is an extensive amount of recent work on VANET applications and routing protocols for VANETs, few surveys exist in VANET about routing protocols of simple text propagation while none of them looks into the video streaming. Issues that have been investigated regarding VANET include mostly routing protocols for video streaming and simple text transmission, security problems, and suitable applications.

In this paper, the broadcast, geocast, and unicast routing approaches in VANET are reviewed in terms of simple text data and video data transmission. In particular, it focuses on quality based comparison of routing protocols for video data streaming over VANET. Therefore, the Section II of this paper describes the IVC routing protocols for text propagation. This is followed with a discussion on the video communication over VANET in section III. A comparison of IVC protocols for video transmission is discussed and a number of routing challenges are highlighted in section IV. Finally, this paper ends with a conclusion of the study in section V.

II. IVC PROTOCOLS FOR TEXT DISSEMINATION

Taking into consideration all the above mentioned unique characteristics, a different type of routing method is required in order to cope with the VANET environment. Each of the existing protocols found in the literature has different architectural design, regarding to the data link, network, and transport layers of OSI model. Hence, a good design decision has a positive effect on multidimensional aspects of VANET communication services. In addition to that, there is a trade-off between metrics for instance, increasing delay for higher throughput which need to be tackled during the designing process. Figure 1 shows a tree structure of classified IVC protocols used for unicasting, geocasting and broadcasting information.

Manuscript received October 9, 2009.
Kayhan Zrar Koyee and Kamalrulnizam Abu Bakar are with the Faculty of Computer Science & Information Systems, Universiti Teknologi Malaysia, 81310 UTM Skudai, Johor D. T, Malaysia (phone: 0127792943;e-mail: mrkayhanz@gmail.com; kamarul@fsksm.utm.my)

ISBN: 978-988-18210-4-1
ISSN: 2078-0958 (Print); ISSN: 2078-0966 (Online)

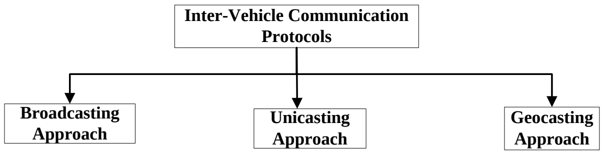

Fig.1. Taxonomy of Inter-Vehicle Communication protocols.

In the following sections the types of IVC protocols are discussed.

A. Broadcast Protocols

The objective of broadcasting in VANET is to disseminate information from one source to many destinations. In the other words, broadcasting is a method of information dissemination which is frequently used in VANET. Several applications that rely on broadcast include emergency data dissemination, road traffic data sharing among vehicles, and delivering advertisement and announcement [5]. Broadcasting in the mobile wireless networks of (n) nodes costs (n) transmissions. Therefore, it offers more overhead and bandwidth utilisation for improved reliability. Some authors [6] have proposed the method for restricting the rebroadcasting nodes while maintaining radio coverage. The Urban Multi-hop Broadcast protocol (UMB) in [5] introduces a new request-to-send and clear-to-send handshake for IEEE 802.11 that enables the farthest node from a transmitter to retransmit packets. However, the potential relay nodes wait for the longest time before retransmitting. This mechanism may lead to long latency, especially for high node densities. Some authors [7] have proposed a solution of UMB by designing a position–aware routing protocol, named Smart Broadcast, for fast and reliable message propagation in VANET. It makes use of position information provided by a GPS-like system to speed up the message propagation along the network, by allowing farthest nodes to attempt transmission first.

In addition, the high velocity and limited communication range of the vehicles incur frequent link disconnection and even network partition. It takes time for vehicle to catch up with other vehicles ahead and reconnect the network. This amount of time is called as catch-up delay [8]. During the catch-up phase, the routing protocol uses the store-and-forward scheme to buffer the packet and send it in the next chance [9]. Some authors in [10] have designed Directional Propagation Protocol (DPP) for data dissemination in VANET using opportunistic forwarding. Figure 2 illustrates the formation of clusters and how Directional Propagation Protocol (DPP) can provide communication between vehicles whenever clusters are fully connected. Thus, in VANET, the opportunistic flooding is used for packet dissemination over intermittent connectivity. This type of packet dissemination often leads to a higher proportion of delivered messages and lowers transmissions, but message propagation may be relatively slow. A vehicle may use GPS to decide whether a rebroadcast will advance stored messages following a period of motion. Authors in [11] have presented a broadcast routing protocol. This broadcast approach adapts with different vehicular traffic conditions. The protocol could achieve less number of transmissions while maximising reliability.

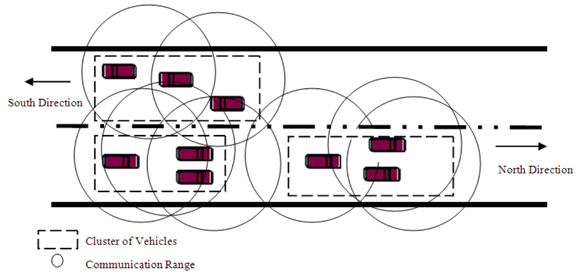

Fig. 2. Illustration of multi-hop routing between clusters.

In the given scenario illustrated in Figure 3, vehicle A is a source of broadcast message which is received by B, C, and D. After that receivers set up a defer time which is shorter if the vehicles belong to the computed Connected Dominating Set (CDS). If D belongs in the CDS, it retransmits first. As a result, D covers all neighbours causing B and C to cancel their transmission. All covered intended receivers will then acknowledge the reception of the message.The lack of acknowledgment means the receivers are not fully covered. Some authors [12] have proposed reliable and efficient multi-hop broadcast protocol RB-MP for VANET. Firstly, the protocol divides the neighbours in the base of their direction. Then the rebroadcast node is selected by using the position and velocity information.

The mobility-centric data dissemination (MDDV) protocol [13] uses opportunistic forwarding to propagate a message along a trajectory and deliver it to geographical destination region by a deadline. Opportunistic forwarding targets networks in an end-to-end path cannot be assumed to exist. Messages are stored and forwarded to another node; a copy may remain with the original and be forwarded again later to improve reliability. Figure 4 shows the concept of opportunistic forwarding in MDDV.

B. Geocast Protocols

Efficient message deliveries in VANET to a group of intended receivers are achieved by using group communication. The deliveries to the group of intended receivers could be more effective if it is designed as narrowly as possible. In order to maximise the performance of the protocol and preserve the network resources, the set of intended receivers can be identified by geographical coordinates. The objective of using geographic coordinates is to constrain the scope of message forwarding to a set of receivers; this technique is called geocast [14]. Many VANET applications will benefit from geocast routing. For example, a source vehicle wants to disseminate information such as emergency warning messages, advertisement or important information to a set of intended receivers within the relevance zone. The authors [15] have proposed an Inter-Vehicles Geocast protocol, called IVG, to broadcast an alarm message to all the vehicles if being in risk area.

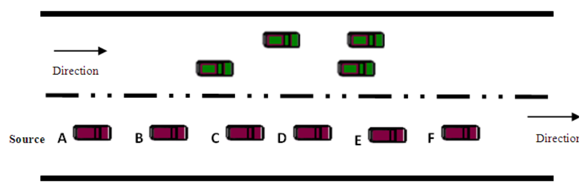

Fig. 3 Common vehicular scenario.

ISBN: 978-988-18210-4-1
ISSN: 2078-0958 (Print); ISSN: 2078-0966 (Online)

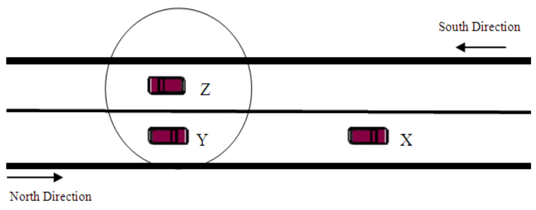

Fig. 4. Opportunistic forwarding: vehicle Z stores transmitted message from vehicle X to vehicle Y.

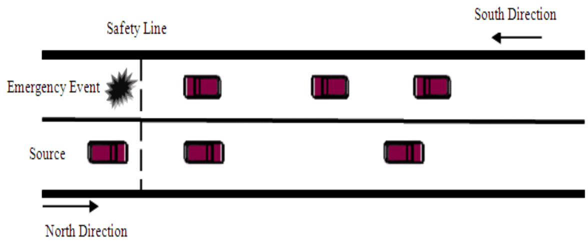

Fig. 5. Emergency message dissemination.

The node which receives an alarm message or warning should not rebroadcast it immediately but has to wait for some time, called defer time, to take a decision about rebroadcast. When this defer time expires and if it does not receive the same alarm message from another node behind it, it deduces that there is no relay node behind it. Thus, it has to designate itself as a relay and broadcasting alarm messages to inform the vehicles which might be behind it. Hence, a broadcast storm is avoided and the forwarding is optimised around the initiating vehicle.

Besides, in classical geocast routing, recently, abiding geocast is introduced to disseminate information to a group of nodes in an area for specific time interval as discussed in [16]. When a vehicle enters such an area, the virtual warning sign displayed for the driver; it employs periodic flooding or epidemic dissemination. The authors [17] have proposed a system of abiding geocast for disseminating warning messages in VANETs. Two strategies are used to improve the efficiency of disseminating i.e. vehicles travelling in opposite direction are used as preferred relays to overcome fragmentation and reduce broadcasting. Figure 5 shows the illustration of abiding geocast, in which the vehicle in the problem area inform all vehicles moving left before they pass the safety line during the life time of the event, at the same time vehicles broadcast as few messages as possible.

C. *Unicast Protocols*

Geographic unicast provides information delivery between two nodes via multiple wireless hops. Unicast communication between vehicles is more complicated due to frequent topology fragmentation and bipolar traffic conditions: sparse and dense scenarios. Some research has been done to enhance the unicast routing protocols which are designed for MANET such as [16]. Authors in [18] have proposed Velocity-Headed based Routing Protocol (VHRP). This method uses GPS information to predict the path disconnection and take pre-emptive action.

In VANET, geographical routing has been known as more promising routing paradigm. A position based routing consists of some components such as beaconing, location service, and forwarding scheme. Beaconing is utilised to get topology information of the network whereas the location service is used to obtain the location of the receivers. Furthermore, a forwarding scheme selects the next hop based on geographical information of the current node. The routing discovery strategy of position based forwarding algorithms based on location information. For instance, Greedy Perimeter Stateless Routing (GPSR) selects the node that is geographically closest to the destination [19]. It combines greedy routing with perimeter backtracking. The perimeter backtracking is used to get out of the local optimum where greedy routing fails. Also the graph which is used in GPSR position based routing must be planar. Thus, some authors in [20] proposed Greedy Perimeter Coordinator Routing (GPCR). It utilises the concept of junction nodes to control the next road segments that packet should follow. However, in mobile urban environment, the concept of junction nodes is an issue and hard to maintain. Some authors in [21] have proposed Gpsrj+. The enhancement is based on a prediction method to select a road segment on which its neighbouring junction node will forward the packet to. In addition, to address the issue of high mobile and route breakage, authors in [22] proposed Vehicle Assisted Data Delivery (VADD). The idea of carrying and forwarding approaches with vehicle mobility prediction is adopted. Furthermore, authors in [23] have proposed a distributed protocol for multi-hop data dissemination. The protocol achieves maximum packet delivery under a wide range of network conditions in vehicular networks.

III. VIDEO COMMUNICATION OVER VANET

Real-time communication across wireless automobile networks provides more comprehensive information via multimedia such as video which can help drivers to make more suitable decision within disaster area.

The provision of video streaming to driving vehicles can achieve very attractive applications. For instance, in highway safety system, the transmitted emergency message allows responders better understanding of the nature of the problem about the disaster area. In this type of application the video source can be a vehicle or a base station (access point) with appropriate capability while the video receivers are vehicles that are travelling in the vicinity zone. Thus, there are two approaches for video streaming in VANET: (1) infrastructure based approach which relies on deployed access points; and (2) infrastructure-free approach which forwards video file to vehicles in vicinity zone. The first approach costs too much due to high base station deployment and maintenance services. Furthermore, in vehicle to vehicle communications approach it totally relies on the infrastructure-less vehicular network and it supports video applications over vehicle to vehicle communication. This is a more challenging task due to the lack of a pre-installed infrastructure to provide centralised control for the entire networks. On the other hand, the advancement of wireless technology and video compression techniques gives a practical solution for video streaming through VANET. Vehicles have embedded with large storage power and provide high computation capability. Therefore, vehicles have an efficient capability to forward continuous video data to other vehicles by using the IEEE 802.11 standard which supports up to 54Mbps transmission rate.

ISBN: 978-988-18210-4-1
ISSN: 2078-0958 (Print); ISSN: 2078-0966 (Online)

IV. IVC PROTOCOLS FOR VIDEO COMMUNICATION: A COMPARISON & DISCUSSION

The existing advancement of wireless local area network LAN technology (IEEE 802.11) and the emerging research interests improve the VANET for the first responders who are involved in emergency services for the disaster recovery. However, the accomplishment of these real time applications is not easy due to high mobility of vehicles and lack of pre-existing infrastructure. On the other hand, video applications have rigid requirements of bandwidth, delay, and jitter. There is few literature on video streaming applications in VANET and more generally in ad hoc networks. The authors [24] have investigated architecture for video streaming over VANET whereas no real video data are used in their simulation, and only the delay is reported in the experimental test bed study. Some authors [25] have discussed two routing protocols: Source Based Forwarding and Receiver Based Forwarding. The real video data are used to simulate video streaming over VANET. In addition to that, different traffic conditions and data forwarding are studied to evaluate video streaming between platoons of vehicles. Authors [25] have changed the traffic density from sparse to dense. As a result, the quality of transmitted video is changed from bad to excellent as shown in Table 1. However, the Source Based Method requires the maintenance of neighbours set by all the vehicles. In other words, each node periodically broadcasts its location, velocity and driving direction information. The maintenance of this list would generate a significant overload in the network that could increase packet delay and packet loss during transmission of the multimedia information. Thus, the performance of Receiver Based Forwarding is better than the Source Based Forwarding. In addition, the challenge of video streaming over VANET can be interpreted by the high dynamics of the vehicles. The high velocity and limited communication range of the vehicles incur frequent link disconnection and uneven network partition. Authors in [27] have combined data mulling technique with three strategies, network coding [26], erasure coding, and repetition coding. Specially, vehicles in the opposite direction are exploited as data mules to relay multimedia data to other vehicles to overcome intermittent connectivity in sparse vehicular ad hoc network. However, the analysis of the delay for relaying multimedia data is based on the theoretical mathematical model (real video data are not used). Figure 6 demonstrates the proposed scenario for delay analysis.

Some authors [28] have proposed an adaptive Forward Error Correction (FEC) with interleaving technique to reduce the length of burst loss and retrieve from packet loss in VANET. The adaptive based technique can transmit optimised multimedia sequences over VANET. Moreover, it was based on the Forward Error Correction (FEC) and interleaving between packets. This method has used the Real Time Control Protocol (RTCP) to adaptively monitor the channel condition of the wireless network environment.

The adjustment of the amount of FEC is based on the reported packet loss which was known by RTCP. The combined FEC with packet interleaving improves the value of Peak Signal to Noise Ratio (PSNR is a metrics to assess the application level quality of service of video transmissions).

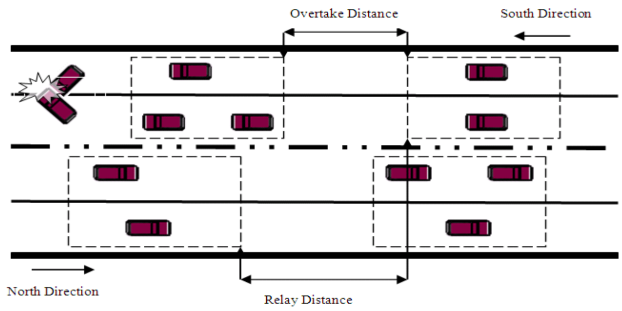

Fig. 6. Highway relay model scenario.

However, this method has extra overhead due to several aspects: (1) the bandwidth redundancy created by the FEC; and (2) the feedback of RTCP for monitoring the packet loss. In addition to this, the authors in [29] have investigated the emergency warning video dissemination to a platoon of vehicles following an accident area. The network coding algorithm was applied for the video dissemination. The evaluation performance reveals the fact that network coding is more beneficial for video dissemination over VANET especially in high mobility and high channel loss. In addition, authors analytically have shown that network coding reduces delay in delivery across platoons via data mulling.

The review results as summarised in Table 1 could offer suggestions in the future research area:

1) The design of robust and reliable protocol for video transmission over VANET needs to be explored.
2) Changing the FEC from the source to adapt with packet loss in the high erasure channel and mobility environment should be looked into as suggested by authors in [28].
3) It is essential for multimedia application to know the error characteristics of wireless channel for an environment that change dynamically with time and speed. Thus, in order to find a suitable FEC rate at the source node, a model is needed to be explored to determine an adequate level of FEC.
4) Network coding has emerged as an alternative to traditional routing algorithms in communication systems. In this technique, network nodes can combine the packets they receive before forwarding them to downstream nodes. This technique can be used to increase throughput for video streaming in wireless environment. However, it introduces a decoding delay. Therefore, investigation into the tradeoffs between throughput and decoding delay still is an open research issue.

V. CONCLUSION

In this paper, a comprehensive comparison of recent routing protocols has been discussed for video and text transmission over VANET. In addition to this, some of routing challenges for video streaming and text dissemination over VANET are proposed. Furthermore, the comparison results conclude that for multimedia applications, this critical environment could negatively affect the performance of the network. In this situation, the major concern is to design and develop an efficient routing protocol for multimedia communication in such harsh environment which has very rapid changes. All these changes must be synchronised with the software and hardware environment for the efficient

ISBN: 978-988-18210-4-1
ISSN: 2078-0958 (Print); ISSN: 2078-0966 (Online)

control and improvement.

TABLE 1. COMPARISON OF EXISTING PROTOCOLS FOR VIDEO STREAMING

Methods for Video Streaming	Comparison Parameters						
	Network Coding Technique	PSNR (dB)	Packet Delivery Ratio	Delay	Packet Loss Rate	Overhead	Real Video Data
Without Joint FEC/Interleaving Schemes[28]	No	Fair	Non	Non	Higher	No	Yes
With Fixed Joint FEC/Interleaving Schemes[28]	No	Fair	Non	Non	High	A bit Higher	Yes
With Adaptive Joint FEC/Interleaving Schemes [28]	No	Good	Non	Non	Low	High	Yes
With Source based Forwarding[25]	No	Bad to Excellent	Non	Non	Non	Non	Yes
With Receiver based Forwarding (RBF) [25]	No	Bad to Excellent	Non	Non	Non	Non	Yes
Delay Analysis [27]	Yes	Non	Non	Low	Non	Non	Non
Emergency Video Streaming (NCDD) [29]	Yes	Non	High	Non	Non	Low	Yes

ACKNOWLEDGMENT

The authors would like to thank to the administration of FSKSM and UTM for encouragement and generous support.

REFERENCES

[1] "Car-to-Car communication," [Online]. Available: http://www.car-to-car.org.[Accessed : 15 November,2009].
[2] "US department of transportation: Intelligent transportation systems," [Online]. Available: http://www.its.dot.gov.[Accessed: 10 November,2009].
[3] "Ahsra: Advance cruise-assist highway system research association," [Online]. Available: http://www.ahsra.or.jp. .[Accessed : 15 November,2009].
[4] L. Fan, and W. YU, "Routing in vehicular ad hoc networks: a survey," IEEE Vehicular Technology Magazine, pp. 12-22, 2007.
[5] G. Korkmaz et al., "Urban Multi-hop Broadcast protocol for intervehicle Communication systems, " in 1st ACM International Workshop on Vehicular Ad Hoc Networks, Philadelphia, PA, USA, 2004, pp. 76-85.
[6] X. Yang et al., "A vehicle-to-vehicle communication protocol for cooperative collision warning," in 1st Annu. Int. Conf. Mobile Ubiquitous Syst.: Netw. Services, 2004, pp. 114-123.
[7] E. Fasolo, R. Furiato and A. Zanella, "Smart Broadcast for inter–vehicular communications," in Proc. of WPMC05, Sep.2005, Alborg Denmark.
[8] X. Zhang, F. Xie, W. Wang, and M. Chatterjee, "TCP throughput for Vehicle-to-Vehicle Communications," in Proceedings of the 1st International Conference on Communications and Networking in China (ChinaCOM) 2006, pp. 1-5. Oct. 2006.
[9] Z. Chen, H. Kung and D. Vlah, "Ad hoc relay wireless networks over moving vehicles on highways," in Proceedings of Mobihoc 2001, pp. 247– 250.
[10] T.D.C. Little and A. Agarwal, "An information propagation scheme for VANETs," In Proceedings 8th International IEEE Conference on Intelligent Transportation Systems (ITSC 2005), 2005, pp. 155-160.
[11] R. Francisco J., R., Pedro M., and S. Ivan, "Reliable and efficient broadcasting in vehicular ad hoc networks" In IEEE 69th Vehicular Technology Conferenc, Barcelona, Spain, 2009.
[12] L. Peiyuan, W. Xinhong, L. Ning, and L. Fuqiang, "A reliable broadcast routing scheme based on mobility prediction for VANET" in Proceedings of the 2009 International Conference on Intillegent Vehicles, p.p 1083-1087, 2009.
[13] H. Wu et al., "MDDV: a mobility-centric data dissemination algorithm for vehicular networks," in 1st ACM International Workshop on Vehicular Ad Hoc Networks (VANET'04), Philadelphia, PA, USA, 2004, pp. 47-56.
[14] C. Maihöfer, "A survey of geocast routing protocols," IEEE Commun. Surveys Tutorials, vol. 6, pp. 32-42, 2004.
[15] A. Bachir,Abderrahim Benslimane, "A multicast protocol in ad hoc networks intervehicle geocast," in Proceedings of the 57th IEEE Semiannual Vehicular Technology Conference, vol. 4, pp. 2456–2460, 2003.
[16] C. Maihöfer, T. Leinmüller, and E. Schoch, "Abiding geocast: time–stable geocast for ad hoc networks," in Proceedings of the 2nd ACM international workshop on Vehicular ad hoc networks (VANET '05), pp. 20–29, 2005.
[17] Y. Qiangyuan, H. Geert, "Abiding geocast for warning message dissemination in vehicular ad hoc networks," Proc.IEEE International Conference on Communications, Beijing, China, pp. 400-404,2008.
[18] T. Taleb, M. Ochi, N. Kato, and Y. Nemoto, "An efficient vehicle-heading based routing protocol for VANET networks," in Proc. IEEE Wireless Communications and Networking Conference, WCNC 2006.
[19] B. Karp and H.T. Kung, ''GPSR: Greedy perimeter stateless routing for wireless networks,'' in Proceedings of the ACM/IEEE International Conference on Mobile Computing and Networking (MobiCom), 2000.
[20] C. Lochert, M. Mauve, H. Füßler, and H. Hartenstein"Geographic routing in city scenarios," In ACM SIGMOBILE Mobile Computing and Communications Review (MC2R), vol. 9, no. 1, pp. 69–72, January 2005.
[21] K. C. Lee, J. Haerri, U Lee, and M. Gerla, " Enahanced perimeter routing for geographic routing protocols in urban vehicular scenarios," In IEEE Autonet workshop,2007.
[22] J. Zhao and G. Cao, " VADD: Vehicle-assisted data delivery in vehicular ad hoc networks," in Proc of IEEE Infocom,2006.
[23] K. R. Guha, and W. Chen, "Achieving High-Rate Multi-hop Data Delivery in Vehicular Networks," In Proceedings IEEE 69th Vehicular Technology Conference,2009.
[24] M. Gao, M.H. Ammar, E.W. Zegura, "V3: a Vehicle-to-Vehicle Live Video Streaming Architecture," Proc. 3rd IEEE International Conference on Pervasive Computing and Communications, Kauai, HI, Mar 2005.
[25] F. Xie, K. A. Hua, W. Wang, and Y. H. Ho, "Performance study of live video streaming over highway vehicular Ad hoc networks," In international IEEE Vehicular Technology Conference,USA, 2007,pp. 2121-2125.
[26] R. Ahlswede, N. Cai, S.-Y.R. Li, and R.W. Yeung, "Network information flow," IEEE Trans. Inf. Theory, vol.46, no.4, pp.1204–1216, July 2000.
[27] J. Park,U. Lee, S. Oh, M. Gerla, "Delay analysis of car-to-car reliable data delivery strategies based on data mulling with network coding," The IEICE TRANS. INF. & SYST., Vol.E91–D, No.10, pp.2524-2527,October 2008.
[28] M. Pasin, M. Petracca, P. Bucciol, A. Servetti, J. De Martin, "Error resilient real-time multimedia streaming over vehicular networks," In-Vehicle Systems and Safety, Dallas, TX, USA, 2009.
[29] P. Joon Sang, L. Uichin , O. Soon Y., G. Mario, L. Desmond S., "Emergency related video streaming in VANET using network coding," In Third ACM International Workshop on Vehicular Ad Hoc Networks,USA,2006.