VANET-based Protocols for Intelligent Transport Systems

Tsvetan Marinov, Maria Nenova, Georgi Iliev
Faculty of Telecommunications at Technical University of Sofia
8 Kl. Ohridski Blvd, Sofia 1756
Bulgaria
{ts_marinov@abv.bg} {mariamnenova@gmail.com} {gli@tu-sofia.bg}

ABSTRACT: *In wireless communication networks, the Vehicular Ad Hoc Networks (VANET) play a vital role. Basically, the VANETs are the part of the Mobile Adhoc Networks (MANET) which is mainly deployed for Intelligent Transport System. To use the Intelligent Transport Systems effectively, it is essential to deploy various VANET based protocols. In this paper we have introduced the protocols that can sense the adverse weather conditions. This algorithms and protocols work based on temperature measurements and in this paper we have presented algorithms block diagrams.*

Keywords: VANET, Protocols, Dangerous Weather, Vehicle to Vehicle Communication (V2V), Vehicle to Infrastructure Communication (V2I), ITS

Received: 18 October 2020, Revised 17 February 2021, Accepted 27 February 2021

DOI: 10.6025/jisr/2021/12/2/33-39

1. Introduction

Nowadays the number of wireless communications devices is constantly increasing. Important problems are incidents with vehicle, congestions and so on. Every year numbers of dead cases increase resulting in 1.3 million people died all over the word. By developing the technology this number can be decreased. One possible solution is an intelligent transport system (ITS). Transport systems help us to increase security, decrease congestions and harmful air emission. This way we can make transport more effective, secure and stable.

Mobile ad-hoc network (MANET) is consists from devices, which can self-configuration in individual networks. With development of technology in near future we can see “smart vehicle”. Vehicle ad-hoc network Vanet is developed on Manet network. The idea on Vanet is communication vehicle to vehicle (V2V), vehicle to infrastructure (V2I) and vehicle to broadband (V2B). When nodes are moving and if we have information for them, we can predict the future position on the road. This information could enable us to compute the traffic and decrease congestions, accidents and harmful air emissions.

Although Vehicular Ad-hoc Network (VANET) is not a new topic, it continues to provide new research challenges and and problems. The main objective of VANET is to help a group of vehicles to set up and maintain a communication network among them without using any central base station or any controller. One of the major applications of VANET is in the critical medical emergency situations where there is no infrastructure while it is critical to pass on the information for saving human lives. However, along with these useful applications of VANET, emerge new challenges and problems. Lack of infrastructure in VANET puts additional responsibilities on vehicles [1].

2. Network Architecture

In principle, there is no fixed architecture or topology that a VANET must follow. However, a general VANET consists of moving vehicles communicating with each other as well as with some nearby road side unit (RSU). A VANET is different than a MANET in the sense that vehicles do not move randomly as nodes do in MANETs, rather moving vehicles follow some fixed paths such as urban roads and highways. While it is easy to consider VANETs as a part of MANETs, it is also important to think of VANETs as an individual research field, especially when it comes to designing of network architecture. In VANET architecture, an on board unit (OBU) in a vehicle consists of wireless transmitter and receiver [1].

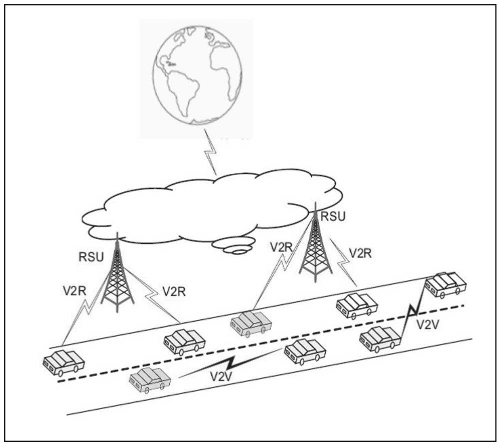

Figure 1. Network Architecture in VANET

In a broad sense, we can loosely define three possible communication scenarios for vehicles. One possibility is that all vehicles communicate with each other through some RSU. This architecture may resemble wireless local area networks(WLAN). Second possibility is where vehicles directly communicate with each other and there is no need of any RSU. This can be classified as Ad-hoc architecture. In third possibility, some of the vehicles can communicate with each other directly while others may need some RSU to communicate. This can be referred as hybrid scenario. Fig. 1 shows these three possibilities.

Communication types in VANETs can be categorized into free types. The category is closely related to VANETs components as described above.

In-vehicle communication, which is more and more necessary and important in VANETs research, refers to the in vehicle domain. In-vehicle communication system can detect a vehicle's performance and especially driver's fatigue and drowsiness, which is critical for driver and public safety.

Vehicle-to-vehicle (V2V) communication can provide a data exchange platform for the drivers to share information and warning messages, so as to expand driver assistance.

Vehicle-to-road infrastructure (V2I) communication is another useful research field in VANETs. V2I communication enables real-time traffic/weather updates for drivers and provides environmental sensing and monitoring.

Vehicle-to-broadband cloud (V2B) communication means that vehicles may communicate via wireless broadband mechanisms such as 3G/4G. As the broad band cloud may include more traffic information and monitoring data as well as infotainment, this type of communication will be useful for active driver assistance and vehicle tracking [2].

3. Protocols in VANET

In VANET, the routing protocols are classified into five categories: Topology based routing protocol, Position based routing protocol, Cluster based routing protocol, Geo cast routing protocol and Broadcast routing protocol. These protocols are characterized on the basis of area / application where they are most suitable [1].

One of the major challenges in the design of vehicular adhoc network is the development of a dynamic routing protocol that can help disseminate the information from one node (vehicle) to another. Routing in VANET is different to the traditional MANET routing because of highly dynamic and ever changing topologies in the former. Few protocols that were earlier designed for MANET environment have been tested on VANET. The challenge however remains as how to reduce delay associated with passing the information from one node to another.

Most of the routing protocols in VANET are closely linked with the topology being used in the network architecture and the performance deviates whenever there is a change in network topology. Routing in VANET can be classified into five major categories namely as:

- Ad-hoc or Topology Driven Protocols
- Location Based Routing Protocols
- Cluster Based Protocols
- Broadcast Protocols
- Geocast Protocols

3.1. Ad-hoc or Topology Driven Routing

In general, VANETs are infrastructure-less networks and many routing protocols devised for prior ad-hoc network such as MANET based on different network topologies may be applied to VANETs with certain modifications. Topology driven protocols are sub-classified into three categories such as proactive, reactive and hybrid. A number of such protocols were designed to cater the needs of VANET environment [3]- [9], In a proactive protocol, nodes continuously update their routing table with information regarding new routes within the network. This information is passed around to all nodes by sending periodic HELLO packets. This approach, however, creates substantial control overheads. This restricts the use of limited wireless resource such as available bandwidth.

3.2. Location Based Routing

Another category of protocols that have been shown interest among the researchers are Location or Position Based Routing protocols. In this scheme of protocols information regarding geographic location of vehicles is obtained from different sources like maps, Global Positioning System (GPRS) or even traces of traffic models to help disseminate the information. Quite a few researches like [10]-[13] and have presented a thorough comparison of well known topology based protocols like AODV and DSR in conjunction with Position Based algorithm and the results have shown better and improved performance as compared to using plain topological approach.

3.3. Cluster Based Routing

In order to reduce the network traffic and routing overheads in VANET, a routing paradigm namely Cluster Based Routing (CBR) is introduced in [14]. The main idea behind CBR is to create a network architecture based on small groups of vehicles called as clusters. In a cluster, one of the vehicles plays the role of a cluster-head as shown in Figure 5. The size of the cluster depends on the design of the routing algorithm which may be based on the number of vehicles in a cluster or the geographical position of the vehicles.

3.4. Broadcast Routing

Broadcast Routing was one of the traditional routing techniques used in VANET. Primarily broadcast approach is used when the message is needed to be sent to the vehicle that is outside the range. Packets are transmitted using flooding techniques. This ensures delivery of information, but uses extensive resources of bandwidth. As briefed previously, this sort of technique is utilised in many well established routing protocols, especially in the stage of discovering of route to the destination. BROADCOMM and the Nth-Powered Persistent Broadcast protocol (NPPB) are such well known protocols designed using the broadcasting concept.

3.5. Geocast Routing

Geocast routing is the classification of routing that deals with dissemination of information in specific area of relevance. Since the early induction of VANET, quite a few approaches of Geocast routing were presented [15]-[20]. Many VANET applications require position dependent multicasting e.g. disseminating hazar dous traffic information to vehicles approaching in the same direction. The key idea behind the Geocast routing is to narrow down the search for next hop to a specific Zone Of Relevance (ZOR). Imagine the possibility of having a mechanis m in which if a car gets involved in an accident, it will automatically report the accident to the approaching vehicles within that zone.

4. Dangerous Weather Warning Algorithm

The following paragraph presents the dangerous weather warning algorithm that warns drivers for unsafe road conditions. The algorithm monitors the temperature and rainfall. There are four cases, which are shown in figure 2. Case one is for icy road. Case two is for wet road. The third and fourth cases are for light icy and dry road. If $Temp<0C^o$ and rainfall are less then v(constant) we have a light icy road. If $Temp<0C^o$ and rainfall are more than v (constant) we have icy road. Analogously if $Temp>0C^o$ and rainfall are more than v(constant) have wet road, and for - $Temp>0C^o$ and no rainfall, we have safe road. These cases are presented in Figure 2.

Symbols	Significance
previousstate	First state for comparative
presentstate	Value from temperature and rainfall
reportstate	State for report
Term	Time for stop notifications
T	Time need to stay in a state before starting sending notifications
Rainfall	Rainfall
Temp	Measured temperature

Table 1. Notations

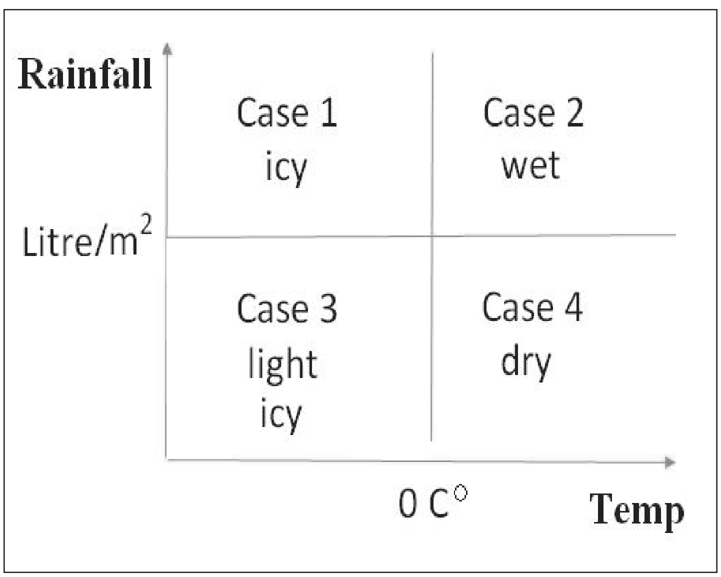

Figure 2. Cases for notification

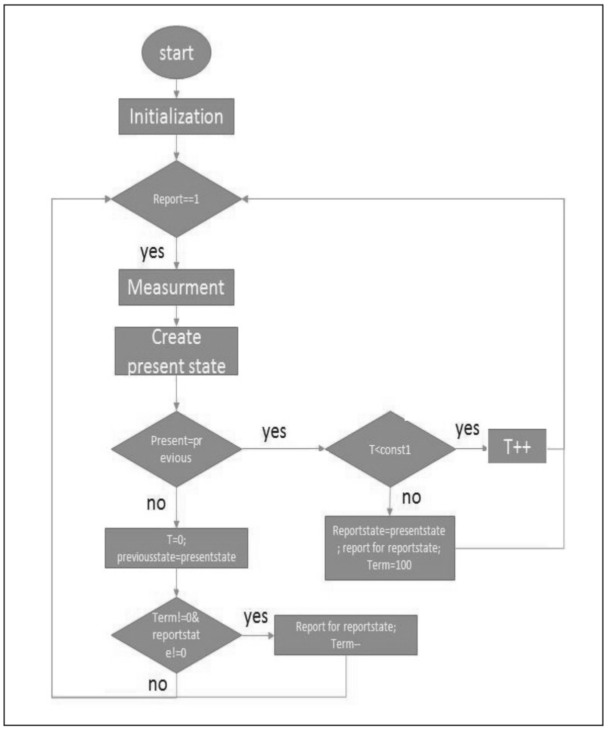

Figure 3. Block diagram

We give value to Term and T++. The algorithm works as follows.

Algorithm following temperature and rainfall

```
Start
Initialization (T=0; Term=0; previousstate=0;
presentstate=0; reportstate=0; report=1)
While(report==1)
{
Measurment;
Create presentstate from "Temp" and "Rainfall"
If(previousstate==presentstate)
        {
        if (T<const1) {T++}
        else { reportstate=presenstate; report info for reportstate; Term=100}
        }
        else
        {
        T=0; previousstate= presentstate;
        if (Term!=0 & reportstate!=0) { report info for reportstate; Term—;}
}
}
```

5. Conclusion

The paper presented VANET network and protocols. Furthermore it considered different types of communications like vehicle to vehicle (V2V), vehicle to infrastructure (V2I) and vehicle to broadband (V2B). We have proposed an algorithm for dangerous weather in VANET. As a result - it improves road safety. Table one reviewed the cases for notification. Figure three shows us the logic of the algorithm with a block diagram. Further research will be necessary. We should consider other algorithms for accidents, road repair and congestions.

References

[1] ur Rehman, S., Arif Khan, M., Zia, T. A., Zheng, L. (2013). Vehicular Ad-Hoc Networks (VANETs) - An Overview and Challenges, *Journal of Wireless Networking and Communications*, 3 (3) 29-38.

[2] Faezipour, M., Nourani, M., Saeed, A., Addepalli, S. (2012). Progress and Challenges in Intelligent Vehicle Area Networks, *Communications of the ACM*, 55 (2) 90- 100.

[3] Soares, R. B., Loureiro, A. A. F. (2012). VCARP: Vehicular Ad-hoc Networks Context-aware Routing Protocol, 2012 *IEEE Symposium on Computers and Communications (ISCC)*, 442-447.

[4] Perkins, C. E., Royer, E. M. (1999). Ad-hoc On-Demand Distance Vector Routing, *Second IEEE Workshop on Mobile Computing Systems and Applications*, 1999, p. 90–100.

[5] Haerri, J., Filali, F., Bonnet, C. (2006). Performance Comparison of AODV and OLSR in VANETs Urban Environments Under Realistic Mobility Patterns, *Med-Hoc-Net* 2006*, 5th Annual Mediterranean Ad Hoc Networking Workshop*, (June).

[6] Li, B., Liu, Y., Chu, G. (2010). Improved AODV Routing Protocol for Vehicular Ad hoc Networks, 2010 3rd *International* Conference on Advanced Computer Theory and Engineering *(ICACTE)*, vol. 4, p. V4–337–V4–340.

[7] Eichler, S., Dtzer, F., Schwingenschlgl, C., Javier, F., Caro, F., Eberspcher, J. (2004). Secure Routing in a Vehicular Ad hoc Network, *Proceedings of the* 2004 *IEEE* 60*th Vehicular Technology Conference*.

[8] Johnson, D. B., Maltz, D. A. (1996). Dynamic Source Routing in Ad Hoc Wireless Networks, *Mobile Computing*, ch. 5.

[9] Zhang, M., Wolff, R. S. (2010). A Border Node Based Routing Protocol for Partially Connected Vehicular Ad Hoc Networks, *Journal of Communications*, 5 (2) 130-143 (February).

[10] Watfa, M. (2010). *Advances in Vehicular Ad-Hoc Networks: Developments and Challenges*, ser. Intelligent Transport Systems. IGI Global.

[11] Lochert, C., Hartenstein, H., Tian, J., Fussler, H., Hermann, D., Mauve, M. (2003). A Routing Strategy for Vehicular Ad hoc Networks in City Environments, *Intelligent Vehicles Symposium*, 2003 Proceedings IEEE, p. 156-161.

[12] Fonseca, A., Vazo, T. (2013). Applicability of Position-Based Routing for {VANET} in Highways and Urban Environment, *Journal of Network and Computer Applications*, 36 (3) 961-973.

[13] Liu, G., Lee, B.S., Seet, B.C., Foh, H., Wong, K. J., Lee, K. K. (2004). A Routing Strategy for Metropolis Vehicular Communications, *International Conference on Information Networking (ICOIN)*, p. 134-143.

[14] Lin, C., Gerla, M. (1997). Adaptive Clustering for Mobile Wireless Networks, *IEEE Journal on Selected Areas in Communications*, 15 (7) 1265-1275.

[15] Kihl, M., Sichitiu, M. L., Joshi, H. P. (2007). Design and Evaluation of two Geocast Protocols for Vehicular Ad-hoc Networks, *Swedish Governmental Agency for Innovation Systems (Vinnova)*.

[16] Rahbar, H., Naik, K., Nayak, A. (2010). DTSG: Dynamic Timestable Geocast Routing in Vehicular Ad hoc Networks”, 2010 The 9th IFIP Annual Mediterranean Ad Hoc Networking *Workshop (Med-Hoc-Net)*, p. 1-7.

[17] Ko, Y. B., Vaidya, N. H. (2000). Location-Aided Routing (LAR) in Mobile Ad hoc Networks, *ACM journal of Wireless Networks*, 6, p 307-321, 2000.

[18] Akhtar Husain, A. D., and Kumar, B. (2010). A Study of Location Aided Routing (LAR) Protocol for Vehicular Ad hoc Networks in Highway Scenario, *International Journal of Information Technology and Web Engineering*, 2 (2) 118-124.

[19] Dhurandher, S. K., Obaidat, M. S., Bhardwaj, D., Garg, A. (2012). GROOV: A Geographic Routing Over Vanets and Its Performance Evaluation, 2012 *IEEE Global Communications Conference (GLOBECOM)*, p. 1670-1675.

[20] Wang, Y. -B., Wu, T. -Y., Lee, W. -T., Ke, C. -H. (2010). A Novel Geographic Routing Strategy over VANET, *2010 IEEE 24*th International Conference on Advanced Information Networking *and Applications Workshops* (*WAINA*), p. 873-879, 20-23 (April).

[21] Sivasakthi, M., Suresh, S. (2013). Research on Vehicular Ad hoc Networks (VANETs): An Overview, *Journal of Applied Sciences and Engineering Research*, 2 (1) 23-27.