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AN INSIGHT OVERVIEW OF ISSUES AND CHALLENGES IN VEHICULAR ADHOC NETWORK

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Abstract: Vehicular Ad hoc Networks is a kind of special wireless ad hoc network, which has the characteristics of high node mobility and fast topology changes. The Vehicular Networks can provide wide variety of services, range from safety-related warning systems to improved navigation mechanisms as well as information and entertainment applications. These additional features make the routing and other services more challenging and cause vulnerability in network services. These problems include network architecture, vanet protocols, routing algorithms, as well as security issues. In this paper, we provide a review for the researches related to Vehicular Ad Hoc Networks and also try to propose solution for related issues and challenges.

Keywords*:* Vehicular adhoc Network (VANET), Vulnerabilities, Congestion.

INTRODUCTION

For people living in developed countries the sheer volume of road traffic can be a daily nuisance. In addition, the road traffic conditions affect the safety of the population since 1.2 million people worldwide are estimated to be killed each year on the roads [1]. For this reason, nowadays the automotive industry and governments invest many resources to increase road safety and traffic efficiency, as well as to reduce the impact of transportation on the environment.

With the development of manufacturing technologies, automobiles have been a killer application. When Karl Benz built the first vehicle to use an internal combustion engine in 1885 there were less than 1000 petrol-driven cars. In 2007, there were about 806 million cars and light trucks on the road around the world. According to the Organisation Internationale des Constructers d' Automobiles (OICA) [2], more than 77 million vehicles had been manufactured in 2010, and now about two vehicles are manufactured each second.

Figure.1 A car after crash

Figure.2 A typical traffic congestion scenario

VANET

VANET is the technology of building a robust Ad-Hoc network between mobile vehicles and each other, besides, between mobile vehicles and roadside units.

VANETs are start-of-the-art technology integrating ad hoc network, wireless LAN (WLAN) and cellular technology to achieve intelligent Inter-Vehicle Communications (IVC) and Roadside-to-Vehicle Communications (RVC). VANETs share some common characteristics with general Mobile Ad Hoc Network (MANET). Both VANET and MANET are characterized by the movement and self-organization of the nodes. But they are different in some ways. Because of the high nodes mobility and unreliable channel conditions [3], VANETs have unique characteristics which pose many challenging research issues, such as data dissemination, data sharing, and security issues.

VANETs have turned into an important research area over the last few years. VANETs are distinguished from MANET by their hybrid network architectures, node movement characteristics, and new application scenarios.

Characteristics:

Drive behaviour, constraints on mobility, and high speeds create unique Characteristics in VANETs. These characteristics distinguish them from other mobile ad hoc networks, and the major characteristics are as follows:

High mobility and Rapid changing topology: Vehicles move very fast especially on highways. Thus, they stay in the communication range of each other just for several seconds, and links are established and broken fast. When the vehicle density is low or existing routes break before constructing new routes, it has higher probability that the vehicular networks are disconnected. So, the previous routing protocols in MANET are not suitable for VANETs.

Geographic position available: Vehicles can be equipped with accurate positioning systems integrated by electronic maps. For example, GPS receivers are very popular in cars which help to provide location information for routing purposes.

Mobility modelling and prediction: Vehicular nodes are usually constrained by prebuilt highways, roads and streets, so given the speed and the street map, the future position of the vehicle can be predicated. Vehicles move along pre-defined paths, this provides an opportunity to predict how long routes would last compared to arbitrary motion patterns like the random waypoint model [4].

Hard delay constraints: In VANETs applications, such as the collision warning or Pre-Crash Sensing, the network does not require high data rates but has hard delay constraints, and the maximum delay will be crucial.

No power constraint: Since nodes are cars instead of small handheld devices, power constraint can be neglected thanks to always recharging batteries.

System Architectures:

System architectures can be divided into different forms according different perspective in VANETs. From the vehicular communication perspective speaking, it can be categorized into road-vehicle communication (RVC, also called C2I) systems and inter-vehicle communication (IVC, also called C2C) systems [4]. But in C2C-CC, three distinct domains are comprised as shown in Figure 1[5]. But from the point of view of network architecture, the VANETs system architecture is divided into five layers: Physical Layer, MAC Layer, Network Layer, Transport Layer, and Application Layer.

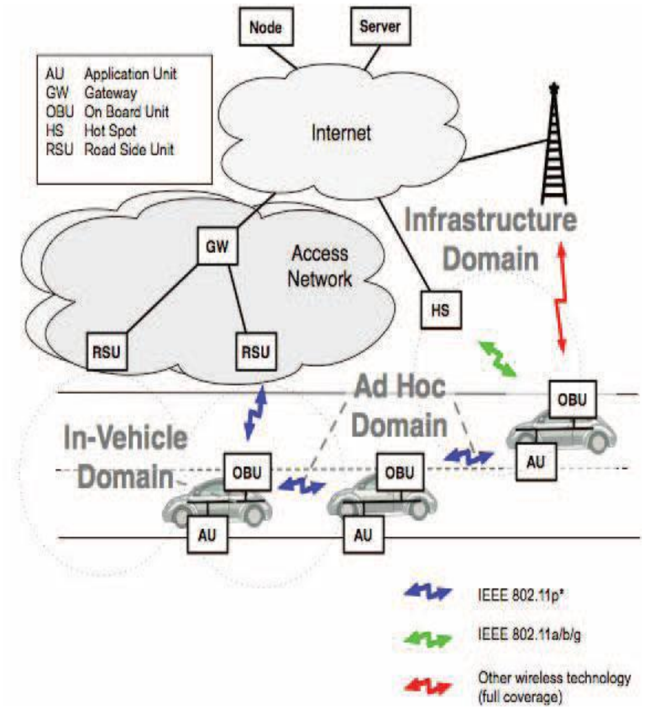

Figure 3.C2C-CC draft reference architecture

Application Service:

VANETs indicate its potential with regard to safety, traffic efficiency, and comfort. The prospective applications of VANETs are categorized into two groups as comfort and safety applications [6]:

Safety service:

This group of research focuses on enabling the delivery of messages and files in a vehicular network to the target receivers with acceptable performance. A group of applications, such as accident and road construction warning systems, require the network protocols to forward messages from a sender to only relevant receivers based on the location and driving direction. Also, safety applications are time sensitive and should be given priority over non-safety applications.

Comfort service:

Another kind of applications focuses on connecting the vehicles to the Internet using roadside beacons and inter-vehicles communications. Authors in [7] envision a future vehicular communication scenario in which the vehicles can communicate to roadside Internet gateway via the adhoc network as shown in fig 4:

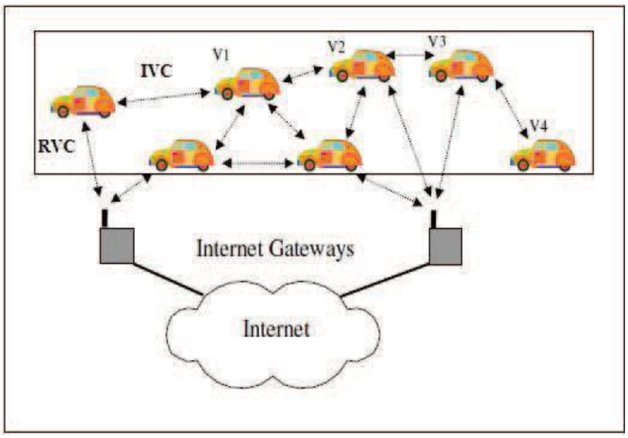

Figure 4: Future vehicular communication scenario

VANET ROUTING PROTOCOLS

The most important networking operations include efficient routing and adequate network management. In VANET, the routing protocols are classified into five categories: Topology based routing protocol, Position based routing protocol, Cluster based routing protocol, and Geo cast routing protocol and Broadcast routing protocol. These protocols are characterized on the basis of area / application where they are most suitable [8].

Topology Based Routing Protocols:

These routing protocols use links information that exists in the network to perform packet forwarding. They are further divided into Proactive, Reactive & Hybrid Protocols.

Proactive routing protocols: The proactive routing means that the routing information, like next forwarding hop is maintained in the background irrespective of communication requests. The advantage of proactive routing protocol is that there is no route discovery since the destination route is stored in the background, but the disadvantage of this protocol is that it provides low latency for real time application. The various types of proactive routing protocols are: FSR, DSDV, OLSR, CGSR, WRP, and TBRPF.

Reactive/Ad hoc based routing: Reactive routing opens the route only when it is necessary for a node to communicate with each other. Reactive routing consists of route discovery phase in which the query packets are flooded into the network for the path search and this phase completes when route is found. The various types of reactive routing protocols are AODV, PGB, DSR, TORA, and JARR.

Hybrid Protocols: The hybrid protocols are introduced to reduce the control overhead of proactive routing protocols and decrease the initial route discovery delay in reactive routing protocols.

Position Based Routing Protocols:

Position based routing consists of class of routing algorithm. They share the property of using geographic positioning information in order to select the next forwarding hops. Position based routing is broadly divided in two types: Position based greedy V2V protocols, Delay Tolerant Protocols.

Cluster Based Routing Protocols:

Cluster based routing is preferred in clusters. A group of nodes identifies themselves to be a part of cluster and a node is designated as cluster head will broadcast the packet to cluster. Good scalability can be provided for large networks but network delays and overhead are incurred when forming clusters in highly mobile VANET. The various Clusters based routing protocols are COIN, LORA-CBF, TIBCRPH, and CBDRP.

Geo Cast Routing Protocols:

Geo cast routing is basically a location based multicast routing. Its objective is to deliver the packet from source node to all other nodes within a specified geographical region (Zone of Relevance ZOR). The various Geo cast routing protocols are IVG, DG-CASTOR and DRG.

Broadcast Based Routing Protocols:

Broadcast routing is frequently used in VANET for sharing, traffic, weather and emergency, road conditions among vehicles and delivering advertisements and announcements. The various Broadcast routing protocols are BROADCOMM, UMB, V-TRADE, and DV-CAST.

All of these existing routing strategies are responsible for following metrics: Minimizing end-to-end delay, Maximizing end-to-end throughput, adaptable to dynamic topology and Packets are always routed through optimal path.

VULNERABILITIES AND PROBABLE SOLUTIONS TO ISSUES AND CHALLENGES IN VEHICULAR ADHOC NETWORKS (VANETS)

Scalability:

Inter-vehicle communication (IVC) and its diverse application possibilities are experiencing growing interest both in research and industry. One of the main challenges inherent to the deployment of VANETs is operability, both in very sparse and in highly overloaded networks. This scalability problem is not comprehensively addressed by existing approaches, as they only focus on parts of the problem. We consider a VANET to be scalable if information is disseminated through the network in sparse as well as dense network scenarios, while optimally leveraging the available bandwidth. Therefore, methods for defining and evaluating the benefit of certain information become important to determine the optimal network usage [9].

Solution*:* The Relevance-based approach provides a comprehensive concept that operates efficiently both in dense and sparse networks and manages to deliver information to where it is needed, independent of the current network load. With the help of a measure called message relevance, both an in-vehicle and inter-vehicle message prioritization is realized, which is inevitable in the context of limited network resources. The relevance value of one specific message is determined by estimating the benefit that the receiving node will be provided on the basis of several parameters concerning current vehicle context, message content, and network situation.

By implementing a methodology applying controlled unfairness in scheduling the broadcast of data packets, bandwidth can be used optimally and the benefit provided to all the vehicles participating in a VANET is optimized at the same time.

Privacy:

Vehicular *ad hoc* networks (VANETs) can be expected to improve traffic safety and transportation management in the near future. This is realized by letting vehicles exchange their sensed traffic environment changes with other vehicles. Such exchanges also create privacy concerns since the vehicle-generated reports contain much private information on the vehicle and its driver.

Solution*:* Vehicles in pseudonym based approaches can anonymously authenticate their own vehicular reports. This approach is conceptually simple and it is supported by the DSRC standard [9]. However a major shortcoming is that each vehicle needs to pre-load a huge pool of anonymous certificates to achieve privacy, and a trusted authority also needs to maintain and manage them, which implies a heavy burden of pseudonym management. To circumvent the intricate pseudonym management, some proposals suggest using group signatures to anonymously authenticate traffic reports. In this approach [10], each vehicle registers to the transportation administration office and obtains a secret token. With this token, the vehicle can authenticate any message and the authenticated message can be verified by any vehicle getting it.

Bandwidth limitation:

Unlike the wired counterparts the networking scenario is far more distributed in nature in vehicular ad hoc wireless network, which adds a substantial responsibility upon the nodes. In such environment the optimal utilization of the bandwidth among nodes is not expectedly supported. Thus the limited capacity of radio band to offer data rates becomes a challenge in mobile ad hoc networks.

Solution*:* Adaptive protocols. To countermeasure the effects caused by the bandwidth constrained ad hoc network, an adaptive scheme must be deployed. Forwarded data packet is embedded with some information regarding the bandwidth it requires for its relaying and processing. The intermediate/destination nodes check this requirement and then take an action accordingly.

Traffic congestion:

Traffic congestion has been plaguing motorists for years, and it progressively continues to get worse as the population continues to increase, resulting in an increase in the number of vehicles on the road [11]. Congestion can occur either naturally due to external factors such as road maintenance, rush hours etc., or indirectly created due to bad driving behaviour and not following the rules of the road.

Solution: Integrate Vehicular Ad-hoc Network (VANET) with artificial intelligence to create a driver aid that helps in combating traffic congestion as well as embedding safety awareness by dynamically rerouting traffic depending on road conditions.

Network Congestion and Overhead:

Unlike MANETs, VANETs nodes are moving very fast. It becomes quite challenging to maintain a stable path for broadcasting Emergency and Warning (E/ W) messages from a risk zone. So routing takes an important role in VANETs. Reducing network overhead, avoiding network congestion, traffic congestion and increasing packet delivery ratio are the major issues of routing in VANETs.

Solution: Broadcast the risk notification (RN) messages such as accident and injury prevention messages, congestion control messages, road condition and other emergency/ warning messages in time to the rear vehicles. The node which receives the emergency message will intimate to all the other members of its cluster. By doing this the rear cluster can change its current path before reaching the risk zone. Due to this, the network congestion and traffic congestion will be highly reduced.

Safety:

Accidents currently account for 42 000 fatalities annually [12], and an estimated 18% of the health care expenditure in the U.S. technologies to enhance vehicular and passenger safety are of great interest. The automation of driving tasks is increasing, evidenced by several advanced driver assistance systems that have come to the market over the last decade Collision avoidance technologies are currently largely vehicle-based systems that are offered by original equipment manufacturers as autonomous packages that broadly serve the following two functions: 1) collision warning and 2) driver assistance. . It is necessary to improve road traffic safety to reduce the number of daily accidents so that human lives can be saved.

Solution: The automation of driving tasks is of increasing interest for highway traffic management [13].The emerging technologies of global positioning and inter-vehicular wireless communications combined with in-vehicle computation and sensing capabilities, can potentially provide remarkable improvements in safety and efficiency. Intelligent intersections that are representative of class of complex hybrid systems also provide improved efficiency.

CONCLUSION

This paper represents an overview and tutorial of various issues and challenges in vehicular adhoc network. Various types of challenges in vehicular network has been identified and addressed. The above proposed solutions for certain vulnerabilities have to cope with a challenging environment including high mobility and hard delay constraints in sparse and dense connected network. These solutions only cover a subset of all the vulnerabilities and are far from providing a comprehensive answer to the routing and security problems in VANETs. There are still a number of unaddressed challenges to be solved for these solutions to be practically deployable.

REFERENCES

[1]. M.C. Schut et al," SOTRIP: A self organizing protocol for traffic information", IWCMC, pp. 21-24, 2009.

[2]. http://www.car-accidents.com/2008-wreck-pages/2-18-08-neon-1.html.

[3]. G. M. T. Abdalla, M. A. Abu-Rgheff, and S. M. Senouci. "Current Trends in Vehicular Ad Hoc Networks," IEEE Global Information Infrastructure Symposium, Morocco July2007.

[4]. T. Kosch. "Local Danger Warning based on Vehicle Ad-hoc Networks: Prototype and Simulation," 1st International Workshop on Intelligent Transportation (WIT 2004), Hamburg, Germany, and March, 2004.

[5]. C2C-CC: CAR 2 CAR Communication Consortium. http://www.car-to-car.org.

[6]. S. Yousefi, M. S. Mousavi, M. Fathy. "Vehicular ad hoc networks (VANETs) challenges and perspectives," in proc. of 6th IEEE international conference on ITS telecommunications proceedings, June 2006, pp. 761-766.

[7]. M. Bechler, L. Wolf, O. Storz, and W. Franz. "Efficient Discovery of Internet Gateways in Future Vehicular Communication Systems," the 57th IEEE Semi-annual Vehicular Technology Conference. April 2003.

[8]. Uma Nagaraj,Dr.M.U.Kharat,Poonam Dhamal"Study of various routing protocols in Vanet" IJCST Vol. 2, Issue 4, Oct . - Dec. 2011.

[9]. Timo Kosch, Christian J. Adler, Stephan Eichler, Christoph Schroth, and Markus Strassberger"The scalability problem of vehicular adhoc network and how to solve it."

[10]. Josep Domingo-Ferrer and Qianhong Wu. "Preserving Privacy in Vehicular *ad hoc* Networks".

[11]. Ali Ghazy, Tarik Ozkul," Design and simulation of an artificially intelligent vanet for solving traffic congestion". Masaum journal of basic and applied sciences vol.1, no.2 September 2009.

[12]. A. R. Girard, J. B. de Sousa, J. A. Misener, and J. K. Hedrick, "A control architecture for integrated cooperative cruise control and collision warning systems," in *Proc. 40th IEEE Conf. Decision Control*, 2001,pp.1491-1496.

[13]. Hemant Kowshik et al, "Provable system wide safety in intelligent intersections", IEEE transactions on vehicular technology, vol. 60, no. 3 march 2011.

