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Performance and Execution Evaluation of VANETs Routing Protocols in different Scenarios

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Abstract

VANETs an application of MANETs, a fast growing, promising and emerging technology provides basis for ITS following IEEE 802.11p standard based on DSRC designed for WAVE. VANETs enable communication among vehicles (V2V) and road side infrastructure (V2I), disseminating alert messages regarding road conditions and any other critical situation to ensure safety and avoid losses of precious lives and property. Due to high velocity of moving vehicles and dynamic speedy topology change ultimate optimum routing protocols is still a challenging task in VANETs. It is cleared from the proposed results that there is no such protocol that is best for all kind of evaluation criteria. Infact, each routing algorithm conduct differently in sense of performance metrics. In VANETs timely arrival of data is much important to handle the security threats or any emergency efficiently. In this paper we focused and inspected various routing protocols including AODV, DSR and DSDV for the purpose to find out protocols best suited for all scenarios. The comparison and evaluation of various routing protocols is done on the basis of different performance metric criteria like data throughput, PDR, end to end delay or latency and network stability etc.

Keywords: MANETs, VANETs, Throughput, End-to-End Delay, Routing Protocols.

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1. Introduction

Information And Communication Technology (ICT) plays a vital role in making the cities smarter in future through Inter Vehicle Communication (IVC), using an infrastructure of Car4ICT using IEEE 802.11p based on Dedicated Short Rang Communication (DSRC) protocol. Car4ICT infrastructure is future technology which facilitate user by easily accessing different applications like routing, uploading and downloading data. It also provides data processing and storage facilities for the users. Such services are complex and require detail knowledge to constitute it in big cities [1]. IEEE 802.11 is an accumulation of physical layer (PHY) specifications and media access control (MAC) for implementing WLAN in the 2.4, 3.6, 5 and 60 GHz frequency bands, maintained by the IEEE 802 LAN Standards Committee in 1997 In VANETs possible communication among Infrastructure to Vehicle (I2V), or Vehicle to Infrastructure (V2I), and Vehicle to Vehicle (V2V) take place, depending upon the scenarios i.e., urban or rural [2], [3]. In VANETs nodes/vehicles are highly mobile, so it is difficult to predict the location/position of the nodes because nodes continuously changing their position and in result network topology also altering in VANETs. In VANETs Vehicles are free to move and interchanging information with no restrictions when they are in radio

communications range. Power is not constrain in VANETs because vehicles have enough battery power for information interchange between nodes/infrastructure. In VANETs time factor is obligatory for information interchange between V2V and V2I and response is mandatory in the specified time interval [3]. Possible integration of internet of things [24] and cognitive radio networks [25-26] can be performed in future vanets. VANETs system provides security to lives and property and improve Quality of Service (QoS), in since of congestion, road block, traffic jam conditions, weather information, and secure information interchange among vehicles. Further to reduce latency in packet delivery and to avoid packet drop and error possibility. VANETs basic structure is shown in figure 1. Rest of the paper is further divided into sub sections which are describe as follows. Section II provides some existing works. Proposed routing protocol for VANETs and results are presented in Sections III, and finally the paper is concluded in section IV.

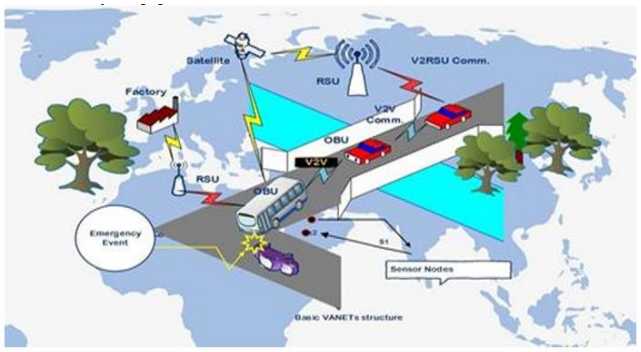

Fig. 1. Basic VANETs Structure

2 Related Work

Various researchers have proposed variety of protocols and algorithms to enhance performance and establish a reliable communication. Few of them are summarized and discussed below.

In paper [4], authors had studied geo-cast for VANETs scenarios, which frequently scatter information in a zone for definite intervals. They have studied a demarcation between already existing scheme and their design protocols. In case of conventional broadcast techniques, during each cycle the broadcast should be done in multi hope way for all the entire destination area, resulting substantial network overhead. Also, in fixed broadcast cycle change of network topology cannot be matched, which leads inefficient transmissions. Moreover, reliability was not ensure in case of poor link quality. Authors proposed technique of, Abiding Geo-cast protocol based on Carrier Sets (AG-CS) fully based on stability estimation index. Abiding messages can be received via one hope delivery. In paper [9], authors described the operation of multichannel Medium Access Control (MAC) technique through using revised analytical model as well as simulation results. Authors designed a navel technique on the bases of theoretical results, which enhanced the data rate and packets delay. Authors found that with increase of retry limit, the data rate increases and delay in service packet decreases. For enhanced throughput, Systems Successful Transmission Interval (SSTI) was kept minimal. In authors proposed algorithm single packet delay was enhanced, but end to end single packet delay is reduced due to minimal retransmissions. Similarly, some good work on mobile ad hoc and vehicular networks can be found in [10-14].

Table 1. Summary of Related Work on VANETs

Scheme	Technique	Area of Applications	Parameters Addressed	Deficiencies
Carrier set [4]	Abiding Geo-cast Based on carrier set (AG-CS)	VANETs	Avoid overhead, enhance probability of reception, reliability enhancement	One dimensional problem
Connectivity probability model [5]	Minimum safety distance (S_d)	VANETs	Improved network connectivity, propagation of safety messages	Network connectivity
Scheme	Technique	Area of Applications	Parameters Addressed	Deficiencies
Fast and Reliable Warning Message Dissemination (FRWD) [6]	Sender oriented broadcast method	VANETs	Low latency and high reliability	Sender oriented multi-hope broad casting, Time sensitive, Specific area
Low Delay Forwarding with Multiple Candidates (LDMC) [7]	Geographic routing protocol	VANETs	High packet delivery, best for delay sensitive, improvement in forwarding delay	Destination position, location service, prefer nodes close to intersection
Hybrid device to device (D2D) and IEEE 802.11p [8]	Cellular base station	VANETs	Improved delay performance, removed contention delay, support longer distance	Interference, link selection and channel assignment
Multi-channel Medium Access Control (MAC) [9]	Revised analytical model with limited retry	VANETs	Improved throughput and packet delay, less retransmission	Limited retry best up-to 7, longer single packet delay

According to the literature survey, majority of the researchers [15] .Put their efforts to make the VANETs system reliable, efficient and secure for data dissemination among the participating vehicles, to ensure data safety and also thwart intruder's misbehavior attempts. The VANETs a worthy type, subclass, and an application of MANETs. Both had infrastructure less and self-organized scenarios, while in VANETs the vehicles move with high velocity, due to high mobility specific and ultimate techniques for reliable, efficient and quick data dissemination were still a challenging task, however power was no more a constrain in VANETs. To reduce the information vulnerabilities in VANETs system, researchers in [15] fixed few security requirements and find out probable attacks in VANETs. The security requirements listed by researchers were 1. Authentication, 2. Availability, 3. Non-repudiation, 4. Privacy, 5. Data Check and 6. Data Integrity. These were essential

requirements for VANETs deployment to achieve flawless communication among vehicles. These attacks were, attack on availability, authentication, confidentiality, integrity, non-repudiation, impersonation, identity revealing, location tracking, Sybil and DOS attack and many more were investigated. Researchers put a verity of solution/techniques and algorithms (cryptographic techniques, digital signatures and many other) to reduce the attacks frequency or even to eliminate its occurrences, (like authentication avoid impersonation and Sybil attacks) but still full pledge security model for VANETs system was a challenging task. In [16], authors compared the performances of various routing protocols on the bases of different performance metrics. The aim was to present the best routing protocols for VANETs system to ensure efficient communication among the participating vehicles. In order to reduce the limitation in the discussion above we did comparison of various routing protocols for VANETs. In VANETs, the performance was increased by taking care of PDR, data throughput, jitters, packet drop and end-end-delay or latency in packet delivery.

3 Protocol under Comparison

OLSR [17]: Authors evaluated Ad hoc on Demand Distance Vector Routing (AODV), Optimized Link State Routing (OLSR) and Greedy Perimeter Stateless Routing (GPSR), which were respectively reactive, proactive and position aware routing protocols for VANETs utilized in urban scenario. Their performance comparison were done on the basis of Drop Burst Length (DBL), Delay and Packet Delivery Ratio (PDR). From results, authors suggested that a network under small load OLSR is best in comparison to AODV and GPSR in term of low DBL and strong PDR. In case of huge and moderate network load GPSR shows stable PDR for networks. GPSR is best for delay sensitive networks because packets delivery take place with minimal latency. EAODV [18]: Researchers enhanced, modified and enrich AODV routing protocols for VANETs with establishing an acknowledgment technique among source and destination entities to ensure on time reception of data packets, and reduce loss of data packets. AODV was a reactive routing protocol, so when it needs to transmit data among nodes, it launched route discovery algorithm procedure. In which source forward Route Request Message (RREQ) and destination respond with Route Reply Message (RREP). In case of broken links Route Error Message (RERR) were propagated to inform all other nodes about the path failure to avoid latency and achieve better PDR with improved QoS in smart cities scenarios. OLSR [19]: Authors presented proactive routing protocol named Optimized Link State Routing (OLSR). In OLSR each node had its own routing table which keeping routing information. OLSR properly cut down traffic in the network through control packets flooding mechanism and minimized unnecessary control packets. OLSR using Multi Point Relays (MPR) algorithm, also OLSR consist of stationary and mobile nodes. In OLSR mobile nodes were avoided to be selected as an MPR node, such procedure leads minimal overhead of control packet, also packet loss ratio were significantly reduced, and in result a long network lifespan were achieved. PA-FSR [20]: Researchers proposed an efficiently utilizing power routing algorithm named Power Aware Fisheye State Routing (PA-FSR) solving the power constrain issue up to certain limit in MANETs. In PA-FSR algorithms two groups of nodes were chosen. One group consisted of nodes had maximum energy or power capacity and the other had limited power capacity. The transmission of data packets among sender and receiver were based on power capacities of the nodes in the groups, which provides proper utilization of energy. Authors also had made a comparison between Power Aware Fisheye State Routing (PA-FSR) and FSR in term of power consumption and distribution among nodes. FSR was a link state routing protocol. The obtained results showed that the performance of PA-FSR was better than that of FSR, in further comparison authors had also included jitters, end to end delay and data throughput. RLT-AOD [21]: Researchers designed a new routing protocols for VANETs scenario, by adding a mechanism called Route Life Time (RLT) with conventional routing protocols AODV. Later they also added the same technique with DSR routing protocols too. The modified routing protocols were known as RLT-AODV and RLTDSR. Authors evaluated RLT-AODV and RLT-DSR in term of performance metrics like throughput, Round Trip Time (RTT), Transmission Over Head (TOH) and Successful PDR (SPDR). Authors compared results obtained from RLT-AODV with conventional AODV and concluded that RLT-AODV provides stable throughput, reduced TOH up to 81% and an enhanced SPDR up to 13%. Same procedure was also repeated for RLT-DSR, which showed high data throughput as compared to conventional DSR. Further authors also investigated that in term of throughput RLTDSR had better results than that of RLT-AODV. STORA [22]: Authors presented a modified version of MANETs Temporally Ordered Routing Algorithm (TORA) called Secure-TORA (STORA). The authors designed technique had the capacity to detect the DoS attack like black hole attack etc. Authors claimed that in the presence of black hole attack some of misbehaving nodes discontinued data packets from moving ahead or cease data delivery to destination. To eliminate DoS attack (black hole attack) authors had implemented digital signature procedure in STORA protocols. So from the results of STORA authors concluded that STORA well performed than that of the ordinary TORA in presence and absence of attacks. ZRP [23]: Researchers studied a MANETs routing protocol known as Zone Routing Protocol (ZRP) facing an issue of forwarding unnecessary control data packets, which results into an enhanced network load and consequently worst network operation was recorded. To achieve better results authors had modified ZRP into IntErzone Routing Protocol (IERP). IERP using bloom filter and topology information of nodes in its neighbor to enhanced ZRP

operation. IERP avoid useless control packets, and also minimized route query packets via bloom filter and hence enhanced the conventional ZRP operation. Results showed that IERP well performed in comparison to ZRP protocols and obtained its feasibility for MANETs. The summary of protocols under comparison are shown in table 2

Table 2. Comparison of VANETs Routing Protocols

References, Proposed by Author, Year.	Technique/ Protocols	Parameter Addressed	Type	Routing	Dig. Map	Overhead
[12] A. K. Ali, *et al.* 2016	AODV, OLSR, GPSR	Drop Burst Length (DBL), PDR, and Packet Delay	Topology	Reactive, Proactive and Position aware	No	Path State
[13] A.Bouroumine, *et al.* 2016	Enhanced AODV	PDR with Acknowledgement, QoS	Topology	Proactive	No	Path State
[14] Y. Mustafaei, *et al.* 2016	OLSR	Reduced Packet Loss Ratio and Control Packets, Enhanced Lifespan of Network, no Change in Delay	Topology	Proactive	No	Link State
[15] B. Devika, *et al.* 2016	Power-Aware Fish -eye State (PA-FSR)	Reduced Power Consumption, PDR, Delay, Jitter, Data-rate	Topology	Proactive	No	Link State
References, Proposed by Author, Year.	Technique/ Protocols	Parameter Addressed	Type	Routing	Dig. Map	Overhead
[16] I. Lengliz, *et al.* 2016	RLT-AODV, RLT-DSR	Round Trip Time (RTT), Throughput, Successful-PDR (SPDR), Transmission Over Head (TOH)	Topology	Reactive	No	Multi hop
[17] N. Venkatadri, *et al.* 2106	Secure TORA (STORA)	Detection and Elimination of Black Hole Attack Through Dig. Signature using Twofish Algorithm	Topology	Reactive	No	Multi hop
[18] Y. Oigawa, *et al.* 2016	Enhanced IntErzone Routing Protocol (IERP) using Bloom Filter	Number of Control Packets are Reduced, Over all Network Performance Improved	Topology	Hybrid	No	Multi hop

4.Conclusion and Future Work:

Abundant of research work has done on VANETs that focus different parameters like; PDR, topology, throughput, QoS, end-to-end delay, stability period, PLR and security of information/data. Researchers designed different routing protocols for the purpose to improve the performance of VANETs by considering the above discussed parameters. VANETs is an essential key technology for ITS applications. However, Due to the rapid changing topology and high speed of moving vehicles, in VANETs specific and ultimate routing protocols are still required much research, still plenty of challenging issues are open and requires more vital research to resolve. Routing of collision avoidance or emergency related alert messages in VANETs required efficient on time delivery mechanisms to avoid critical tragedies. In case of failure of alert message to the corresponding destinations can result into road crashes and loss of lives and property. In our research work we have studied variety of routing protocols including AODV, DSR, and DSDV. We studied that different routing protocols are implanted in different simulator like different vehicular driving environments: downtown, residential, and suburban areas. Each produced area is characterized by different driving environment parameters: different road obstacles, road lanes, and/or traffic light. From the collected results it is cleared that different routing protocols perform differently at different collection of transmission accesses, densities, and velocities of vehicles in VANETs. On average, the network load sharing and efficiency of AODV protocol showed an improved performance in comparison to DSR and DSDV protocols. However, DSR protocol exhibited good performance, at definite values of simulation parameters, than AODV and DSDV protocols. In our research we showed that some protocols has better stability period, minimum end-to-delay or latency, enhanced throughput over others, but there is no single routing protocol that has all these qualities individually. In future much research work is still possible to collect much qualities in a single routing protocol.

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