Performance Analysis of GreedLea Routing Protocol in Internet of Vehicle (IoV) Network

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Abstract. The Internet of Vehicles (IoV) network transforms smart life on the wheels through several connections between vehicles, highways, people and networks, providing a safer, more effective and more energy-efficient driving experience. In a specific field, the reliable arrival of independent vehicles and the typical enhancement of traffic safety change through a fast and consistent distribution of messages. It is important to disseminate messages between vehicles that make up the IoV network and to be exploit of the quick and effective transmission of multi-hop communication for the information broadcasting. This study introduces the standardization method and summarizes the primary technologies of IoV network. This study provides a set of traditional research developments, analyses key innovations to date and, eventually, proposes solutions to common use cases that could provide valuable references for the development and implementation of potential IoVs network. The simulation has been done using OMNET++ platform to evaluate the GreedLea routing protocol with the standard Greedy Perimeter Stateless Routing (GPSR) and Ad-hoc On-demand Distance Vector (AODV) routing protocol in IoV network scenario. In the performance analysis varied parameters for example direction, node and speed has been take into account. This study also proposed to evaluate GreedLea in a crowded city situation and in a highway situation to provide further realistic simulations. From the simulation results, it shown that the GreedLea presented better performance compared to the traditional GPSR and AODV in term of end-to-end latency, packet loss rate and path loss.

1. Introduction

In line to improve driving safety and efficiency, aside from to facilitate self-directed driving and deliver various other connectivity-based facilities, IoV is the main technology [1]–[7]. In this context, the distribution of messages between the vehicles cause IoV become most important and required the establishment of the fast and effective transmission for multi-hop communication to transmit information. The main objective is to introduce a message distribution approach capable of decreasing the message transmission latency whereas maintaining high delivery rate and reliability. Unfortunately, due to their heterogeneity and dynamicity, vehicular scenarios are quite demanding. Vehicle density can vary greatly reliant on the location, in addition to the interruption produced by continuing broadcasts. Moreover, vehicles can drive on various road types: highways, country roads, city roads, etc. This intends that some vehicle might be under various networking conditions (mobility, topology, interference, density, etc.) when operating the similar application for traffic safety. IoV operations are experiencing disruptive changes as the scale of the automotive industry continues to grow. IoV is the organic implementation of various advanced technologies, deriving several value-
added facilities, such as positioning, sensor technologies, telecommunications and the internet. In this case, the use of IoV communication technologies is increasingly. Vehicle-to-Everything (V2X) organically connects variables such as pedestrians, vehicles, roads and clouds to transport participation, which is conducive to decreasing accident rates, improving traffic quality, reducing congestion, and helping to develop a smart transport system. With the introduction of the smart city concept plus the growing requirements representing a variety of vehicles, the IoV obtains a great deal of interest in offering several advantages, counting the rise of vehicles, incidents, emission levels, and traffic congestion. In addition, by merging vehicular ad hoc networks (VANET) and the Internet of Things (IoT) into smart cities, IoV offers various services. However, since the critical message is broadcast through an uncertain channel in the IoV-based smart city climate, communication between vehicles is inclined to several safety hazards. In order to make sure different amenities for IoV in a smart city network, a safe message authentication protocol is therefore necessary.

2. Previous Work
Associated to the conventional IoV around suburban or motorways zones, preserving network accessibility and reliability is a significant task for IoV in city environment among complex road conditions. In [8], authors evaluate end-to-end connectivity in a particular node dissemination model and disclose the association among entire node density and network connectivity. This paper introduces a notion of an IoV backbone net aimed at IoV in city area, called IoVB-net. The finding show that the theoretical benefit of the proposed model is compatible with the lower latency and higher delivery ratio can also be achieved by the proposed accessibility-based routing approach while enhanced routing and GPSR. In [9], authors offers a network of deep learning based vehicles, consisting of an in-vehicle telematics infotainment platform in addition to a web-based service platform, a cloud-based deep learning training server, and collision detection sensors. The offered framework incorporates techniques to predict traffic accident report based on deep learning and deliver associated emergency notification. When a traffic crash incident is reported, relevant information will be submitted to a cloud-based response network for emergency notification and associated method. By way of an outcome, the investigational outcome presented that it is possible to achieve up to 96 percent of the precision of average response time and traffic accident collision detection for associated emergency notification is around 7 seconds. Authors [10] discuss the influence of traffic lights on the development of routing protocols for ad hoc networks. Authors focused on intersection-based routing protocols developed aimed at vehicle network for city scenario. Authors notice that the traffic lights have a significant effect on city routing, but this topic has not been handled well in current routing protocols. For VANETs with traffic light issues, authors suggest a novel method, known as Shortest Path Based Traffic Light Aware Routing (STAR). Aimed at STAR, the indications from the traffic lights by the side of the intersection, along with the traffic designs and decide the way of packets being forwarded. The findings show that STAR performs higher TCP throughput, higher delivery ratio and shorter average latency for city VANET communications compared to current routing protocols. In order to deliver high-link connectivity, authors [11] stimulate efficient cooperation among user equipment (UEs) and offer a social-aware community forming system to efficiently assign resource blocks (RBs) subsequent an in-band NB-IoT solution. Authors develop a new experimental as well as a relay selection and comprehensive power control consideration, because there is a high computational density to the created optimization problem. Performance analyses according to synthetic and actual trace simulations show that the proposed method might substantially improve network communication, energy efficiency, network throughput, and link ability compared to the current methods. IoV network has gained various awareness by specifying many advantages, comprising the incensement of vehicles, levels of pollution, traffic congestion and collisions among the implementation of the smart city model besides enhancing demand for a variety of vehicles. In addition, IoV network delivers different services by integrating VANET with IoT in smart cities. To resolve the security alerts of the analysed framework, authors [12] are developing an efficient and secure message authentication protocol for IoV called IoV-SMAP. The offered IoV-SMAP, as well as mutual authentication, can withstand security drawbacks and provide user privacy. Authors prove the safety of IoV-SMAP by presenting informal
and organized analyses. Furthermore, authors evaluate IoV-SMAP efficiency with current rival authentication systems related to it. Authors prove that IoV-SMAP delivers improved security and effectiveness compared to correlated competing systems as well as appropriate for the IoV-based smart city climate. In [13], authors offer an attracting process to calculate the future location of a vehicle by using the principle of confidence zone according to a recognised real-time object detection method. This method uses the idea of trust area to predict the future vehicular location. By using the power of dynamics, authors might obtain diverse future confidence areas, correspondingly. To automatically find the most acceptable eligible model, authors expect to design separate comparative methods for future work by means of simply analysing a slight previous experience and challenging the estimation of a beyond future.

3. IoV: Background and Concept

Technological improvements throughout vehicular communication technology are changing transportation systems rapidly and have produced many chances for the locals in the IoV network arena. The IoV is known in the role of a vehicle-connected network according to a vehicle information system. This technique has been introduced in different forms throughout countries yet meanwhile the idea of IoV turn out to be well-liked. IoV technology has been made good use of by Europeans and Japanese [14]–[16]. IoV is a technology that can link various individuals and cars together. Figure 1 demonstrates an overall IoV network architecture which contains of infrastructure, pedestrian, network and vehicles.

![Figure 1. Communication in IoV.][1]

3.1. Vehicles in IoV

Automotive awareness has been one of the areas of study where many researches have been made to improve it. A connected vehicle can be said to be a vehicle which employs the internet and wireless network connectivity to exchange data across multiple devices. The virtual platform generated in this manner is referred to as the IoV network. In reality, IoV become highly significant features of intelligent transport. Almost all highways vehicles are already fitted with smart applications, and the number of cars linked to vehicular network is projected to soon reach 380 million by 2030. By establishing intelligent regulation among people, vehicles, roads and vehicles, IoV enhances road conditions and travel safety. In addition, IoV network produces advanced information services and smart decision-making systems which might be employed to resolve drawbacks also manage traffic information. Eventually, IoV network might be seen by way of vehicles delivering advanced sensors, controls, actuators as well as other devices which combine network technology and modern
technology to get a comprehensive vehicle environment. In accordance with this definition, IoV vehicles might drive more safely and save money.

3.2. IoV Connections

Vehicle-to-Road (V2R) communication and Vehicle-to-Vehicle (V2V) communication, furthermore known as Vehicle-to-Infrastructure (V2I), are two distinct types of wireless connections. V2V contact is used directly to exchange information between vehicles. Employing the IEEE 802.11p standard, V2V wireless connections link vehicles inward an ad-hoc system to create a VANET network. The sharing of information among vehicles is done through communication with V2R. The relationship of roadside vehicles and units is enabled by V2R. Through the use of V2V and V2I communications, information sharing between Internet, road-side facilities, and vehicles might be accomplished among IoV network. As a result, IoV network can be supported by different applications, for example Internet services and ITS.

4. IoV Features and Challenges

4.1. IoV Features

The networks of IoVs are usually comprised of vehicle nodes. In terms of behaviour, such networks vary from other wireless nodes. Different activities of such networks will influence IoV technologies and trigger problems for these networks. A few of the features of VANET networks employing IoV technology such as cross-layer, highly dynamic topology, large-scale network, geographical exchange, irregular network density, expected mobility, various communication scenario and sufficient energy and storage.

4.2. IoV Challenges

In addition to being a facility network for V2V communication, IoV is furthermore a dynamic method aimed at synchronization of the human-vehicle situation. Vehicles must also be able to link the IoV architecture to heterogeneous networks and computers. The flexibility of such a procedure has contributed to a great difference from another networks, because it requires specific criteria to be established. Current IoV network issues need to be overcome are irregular network density, bad network connectivity and stability, hard delay constraints, service sustainability, high scalability constraints, privacy and security and high reliability constraints.

5. GreedLea Routing Protocol

To process the routing profile for IoV network, GreedLea implements the aforementioned methods. The profile process is the last part of the creation and it take place in the car side. Each car in the network selects its host as the closest neighbour, and therefore obtains its routing profile by sending its’ host a profile request message (Profile REQ). GreedLea selects the host based on the physical distance. Once a host accepts a profile request from a car, it responds in a reply message with the newest routing profile (Profile REP). Two forms of notification (neighbours’ table update and Profile REP) are obtained by GreedLea on the car side. The table update from Neighbours is a notification sent by the beaconing process. To detect a link shift in the network scenario, this indication is used. By searching for its host, the car responded to this notification. If the current host selected is new, car sends Profile REQ to the new selected host to obtain its new routing profile. Profile REP is a message with an optimized routing profile sent by host. It tests the freshness of the profile once car receives this profile. If the received profile is new and has a valid ID, the car will replace the current profile with the new one, otherwise it will be ignored. On the host side, GreedLea is responsible for either initiating the optimization process to measure and store the routing profile, or reacting by sending Profile REP to the car profile request. Figure 2 show the overall process for the development of GreedLea routing protocol. RouteSel Process is the process of link selection. RouteBea Process is the message beaconing process while MobMod Process is the process of developing MOVE mobility model for GreedLea routing protocol.
6. IoV Simulation Scenario
The IoV network applied in this study are created on city and highway traffic and roads conditions. For the ideas of testing the GreedLea in a merged situation, the geographical location of the highway that crosses the city is considered. The dimensions of the city canvas are 1000 m in width and 1000 m in length. In the range of 30-60 Km/h, vehicles drive into the city and follow the trajectory of the internal roads. Although the number of vehicles for various tests has varied. Host has been mounted on the tops of buildings and has been simulated to determine their location on the map with the static mobility module. 50m in width and 2000m in length are the dimensions of the highway canvas. In the speed range of 90-110 Km/h, vehicles are traveling in a linear direction towards the ends of the highway. Hosts with a fixed distance of 200 to 300 m between them has been put on the side of the lane. For a separate experiment, there are a variety of cars. The main simulation parameters for GreedLea routing protocol are shown in table 1.

Table 1. GreedLea Routing Protocol Simulation Parameters.

| Parameter                | City            | Highway      |
|--------------------------|-----------------|-------------|
| Simulation area          | 1000m x 1000m   | 50m x 2000m |
| Number of Vehicles       | 30 ~ 60         | 20 ~ 40     |
| Vehicle’s Speed          | 40 ~ 60km/h     | 80 ~ 110km/h|
| Simulation time          | NILL            | NILL        |
| Data packet size         | 512 ~ 1024 bytes| 512 ~ 1024 bytes |
| Vehicle Mobility Module  | Road trajectory | Linear      |

7. Discussion and Conclusion
An IoV routing protocol has been built in this study to adapt network conditions via integrative real-time vehicle traffic information and road stability within geographic forwarding and road-based path. To discover paths, hybrid routing protocols has been built. This map is then distributed to all network nodes and used to determine the shortest paths to destinations. It was possible to uniformly compare parameters for example packet delivery ratio, routing overhead, delay variance, average packet latency, average number of hops, average buffer sizes and connection reliability. Figure 3 shows the
average path loss with respect to the car number under the routing protocol of AODV, GPSR and GreedLea respectively. It is shown here that path loss is a bit high for all AODV, GPSR and GreedLea on lower car density. In addition, the output begins to degrade at higher car density due to routing overhead induced by higher car numbers. Due to the availability of more intermediate cars, the path loss value continues to decrease as the number of cars increases. From the result it shows that GreedLea provide average of 20dB path loss compared to AODV results in 43dB and GPSR having 33dB of path loss.

![Path Loss vs Car](image1)

**Figure 3. Path loss vs number of car**

Figure 4 display PDR with respect to the car number under the routing protocol of AODV, GPSR and GreedLea respectively. It is shown here that PDR is a bit poor for all AODV and GPSR on lower car density. Due to the lack of relaying cars, the lower PDR using AODV, most of the packets are drop and do not arrive the destination, however as the car density increases, efficiency also improves in PDR terms. In addition, the output begins to degrade at higher car density due to routing overhead induced by higher car numbers. In the case of GreedLea, due to the greater probability of network splitting and a greater number of void regions, PDR is maintained for all number of car setting. Due to the availability of more intermediate cars, the PDR value continues to increase as the number of cars increases. From the result it shows that GreedLea provide 100% of average PDR which is the loss of the packet is 0%.

![PDR vs Car](image2)

**Figure 4. PDR vs number of car**
Figure 5 display average delay vs. number of cars under the routing protocol of AODV, GPSR and GreedLea. The findings indicate that the average latency for AODV is much greater with a lower number of cars on the network. This is because connections are often broken at lower density and greater speed, and much of the time is spent on re-establishing new routes. There is a boost in efficiency as the number of car increases, the delay is decreased. However, with an advance rise in car density, due to the routing overheads incurred, the average latency continues to increase. On the other hand, in the case of GreedLea, the shift in average delays is mild. In GreedLea, a slight increase in average delay is due to overhead due to hello beacons. GreedLea exceeds GPSR and AODV since the shortest path is chosen on a packet-by-packet basis in GPSR and can distribute at lower delays. From the result it shows that GreedLea routing protocol having 4.79µs of delay compared to GPSR which is having 4.12µs of delay and AODV having 0.14ms of delay.

8. Conclusion

Considering the erratic actions of IoVs network, choosing the subsequent relay node has shown to be an extremely difficult job. Consequently, in sequence to preserve fair network performance, the routing algorithm requests to be precisely developed to respond to the rapid changes in the network. In order to develop successful communication between vehicles, routing is the main aspect that must be explored. The goal of this study is to explore the performance of routing protocols for GreedLea, GPSR and AODV in an IoV network scenario under diverse traffic situations in various scenarios among regard to the path loss, Packet Delivery Ratio (PDR) and the average delay. AODV has been discovered to perform improved the delay by means of regard to PDR. Furthermore, all routing protocols and traffic types differ in performance from one situation to another. There might also be another motivation why packets might be sent in the reverse direction or versatility might cause loops. The GPSR procedure is an extensively used for IoVs. GreedLea address the GPSR limitations, which contains further extension tables in the Neighbors' Table to choose the greatest route and avoid the nodes that have distributed those foregoing packets in recovery mode. Furthermore, GreedLea has remove loops for packet routing, preventing the same packet from being sent to the same neighboring node. For instance, in dead-end roads or road collisions, these GreedLea properties might assist to solve link-breakage. The simulation has been done using OMNET++ platform to evaluate the GreedLea routing protocol with the standard GPSR and AODV routing protocol. The results display that the GreedLea presented better performance compared to the traditional GPSR and AODV in term of end-to-end latency, packet loss rate and path loss. This study takes into account varied parameters for such as direction, node and density speed. This study also proposed to evaluate GreedLea in a crowded city situation and in a highway situation to provide further realistic simulations.
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