Route Beaconing (RouteBea) Process in GreedLea Routing Protocol for Internet of Vehicle (IoV) Network Environment

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Abstract. Practically, vehicles tend to travel in long distances. As a result, a vehicle might attach to different network scenarios and topologies. This unique behavior in IoV brings the attention for a robust routing protocol design. For example, a vehicle that runs the same routing protocol, while it moves from one geographical area to another, it experiences different network topology requirements, and thus, the performance of the routing protocol contrasts. Consequently, the performances of the network drop. Considering a huge number of vehicles join in these networks with their high mobility, there are still having problem due to the viability of applications via different network topology. Traffic management problems come up as number of vehicle has been growing at an exponential rate. In order to make life easier, emergency response to road accidents, speed limits, and pollution checks should be considered to be observed. The common applied to this problem are observing of vehicle’s speed via CCTV cameras, speed trackers and periodic pollution checks. However, these approaches be inclined to fail as a large number of vehicles need to be observed. Therefore, GreedLea routing protocol has been develop to overcome the problem of monitoring the traffic condition and traffic congestion. In GreedLea routing protocol, path interval is provided by the host to other vehicle to update the condition of traffic and routes in certain area. The details about GreedLea routing protocol has been described in following section. The performance of the GreedLea routing in different speed and distance has been analyze and presented in result and discussion section. In the result, it shows that the performance of GreedLea increase in the packet delivery ratio (PDR) which is packet loss is less than 0.1% and reducing protocol overhead by approximately 20-60% as the vehicle’s speed increase for beaconing intervals in the range of 1-3 seconds.

Keywords: IoV, V2V, V2I, V2X, GreedLea, GPSR, RL, VANET

1. INTRODUCTION
Scientific literature provides a wide range of routing algorithms for Ad Hoc networks; yet, none of them has still found the right trade-off between control traffic overhead, convergence speed, and reliability of the algorithm. Several protocol families proposed including proactive protocols, reactive protocols, position driven protocols, etc. Unfortunately, none of the current protocols are able to fully cope with the high node mobility and typical urban propagation scenarios in vehicular networks. Despite the impact of IoV applications in improving the quality of humans’ transportation systems, there are still obvious challenges...
and development issues that faced by its deployment in various real-time applications. Major Quality-of-Service (QoS) aspects for example reliability, connectivity, delay and packet delivery ratio still remain as open research issues. For example, providing continuous connection to a vehicle node imposes challenges as a result of mobility, the variations in network topology and frequent change of traffic conditions which create different network performances. This deviation may deteriorate the network performances.

2. **IOV STANDARD**

IoV is a network protocol for information interchange among vehicle and human, vehicle to vehicle, vehicle to road, vehicle to internet. As an integrated network, IoV able to realize intelligent dynamic information service and intelligent vehicle and traffic control. Based on the above concepts, IoV can be summarized as overall perception, multi-way interaction and comprehensive application. IoV architecture can be classified as three layer, as described below:

a. **Perceptual execution layer**

The purpose of this layer is to collect attribute and related information of physical world objects as well as enabling the vehicle to have the abilities of addressing and network identification and take action according to the instruction of its own or upper layer.

b. **Network transmission control layer**

Provide a uniform interface to perceptual layer. It is compatible to different network technique and provides route and error control to information transmission to ensure complete and reliable transmission of data.

c. **Integrated application layer**

Such layer centers on data collection, computation, monitoring, scheduling, management and application of the vehicle, so it needs mass memory, real-time communication, security certification, and cloud computing. It can be divided into four sub-layers further:

i. **Data layer**: form cluster of perception and interactive information according to a certain mode, sort out and store the data, and form data base of system

ii. **Support layer**: process different data, provide intelligent information processing method to the upper layer of applications and provide data service to different objects

iii. **Application layer**: to face the user’s demand, provide corresponding service according to different applications

iv. **Display layer**: present different types of information comprehensively

Nowadays, vehicle is developing toward intelligence. Vehicle itself has become complete information system. From system architecture, it can be seen that IoV technology and IoT technology is premised on information perception, based on communication network technology and centered on application innovation. The relationship between information perception and system application is not only the relationship between source and stream, but also interactive process, supplemented each other.

3. **BENEFITS OF IOV**

The IoV can be described as a platform which allowed the information exchange among the vehicles with the environment among various communication channels. IoV known as an integrated network aimed to support various functions in the different network environment [1]. IoV is combination of three important modules which are vehicular mobile Internet, intra vehicular network and inter vehicular network. IoV permits vehicles constantly attached with the internet, establishing the vehicles’ interconnected set which be able to deliver traffic information such as road safety, infotainment and traffic management. IoV allows the information exchange between drivers, passengers, vehicles, electric actuators, sensors, road infrastructures and internet via communication standards and protocols for example Vehicular Cooperative Media Access Control (VC-MAC), Directional Medium Access Control (DMAC), Dynamic Source Routing (DSR), Ad hoc On Demand Distance Vector (AODV), General Packet Radio Services (GPRS) and IEEE 802.11p [2]. IoV is unlike Intelligent Transportation System (ITS) for the reason that IoV focus on communication among surrounding road infrastructures, human and vehicles. It is in excess of 7 million
people are injured and almost 1.3 million people die over 8 million traffic accidents every year. Citizens wasting in excess of 80 billion hours due to traffic condition such as accidents and traffic jams [3].

4. PREVIOUS WORK

In this section describe a summary of previous work on routing protocol for different network environment. Each proposed method has their own benefits and drawback which need some improvement in future. Table 1 shows the summary of the previous work.

Table 1. Summary of previous work.

| Proposed Model                                              | Method / Aims                  | Network Scenario       | Conclusion                                                                 |
|-------------------------------------------------------------|-------------------------------|------------------------|---------------------------------------------------------------------------|
| Vehicle Routing Problem (VRP) [4]                           | reinforcement learning        | City                   | fairly requesting because the simply condition is a verifier to select possible solutions and a reward signal to show in what way the technique is functioning |
| Improved Directional LAR routing protocol (ID-LAR) [5]      | select the best next hop forwarder | City                   | ID-LAR is appropriate for position based routing protocol to establish the forward area to handover packets data in the network |
| Infrastructure based connectivity aware routing protocol known (iCAR-II) [6] | multi hop vehicle applications, | global network topology | the road sections delivering reliable and efficient routes’ data that applied to create a routing path with small delivery delay to the destination |
| Optimized and reliable routing strategy in VANET scenario [7] | Boolean Expression           | Smart City             | haven’t upgrade the message exchange process to decrease routing overhead enhanced PDR and decrease delay |
| Comprehensive Real-Time Traffic Map (CRT Map), [8]          | Crowd sensing                 | real-time traffic      |                                                                           |
| CRT Map Based Routing (CBR) [8]                            | consecutive roads in routing decisions | real-time traffic |                                                                           |
| SafeRNet [9]                                                | analyze streaming traffic data | IoV, cloud computing and |                                                                           |
Adaptive reinforcement learning agent (ARLA) [10] Reinforcement Learning (RL) advanced artificial intelligence micro topology street increase PDR and decrease average end-to-end delay compared to Greedy Stateless Routing Protocol (GPSR) and Improved Greedy Traffic Aware Routing (GyTAR) routing in a driverless vehicle

Street-centric routing protocol based on MT (SRPMT) [15] GreedLEA ROUTING PROTOCOL

Routing Scheme for Urban Scenarios (RSUS) [16] grouping strategy City urban ideal performance with a low network overhead ratio and increase PDR should to be enhanced to analyze and manage the mobility of UAVs

UAV-Assisted VANET Routing Protocol (UVAR) [14] traffic density streets enhances performance as compared to AODV, Greedy Stateless Routing (GSR), and POVRP only in urban vehicular scenarios

improved distance-based VANET routing protocol in urban traffic environments [17] multi-hop broadcast urban traffic environments

In previous work some feature haven’t highlighted such as multi scenario. Nowadays, vehicle tent to travel in long distance which required vehicle to attach with different network scenario.

5. GREEDLEA ROUTING PROTOCOL

GPSR uses a greedy forwarding algorithm to calculate a path, the strategy depends on sent a packet from the sender to the receiver using the most efficient route. Each node knows its direct neighborhood, it chooses a neighbor that is nearer to the receiver than itself and forwards the packet. The neighbor that is nearer to the receiver selected if there are multiple neighbors accomplish the norm. The greedy forwarding considered fails in scenario is when the receiver node is closer to the sender note than any of sources from the other neighbors where located outside the sender node parameter. The forwarding will be used which routes around the perimeter of the region. If a node needs to forward a packet, simply has no convenient neighbors, and there exists an unoccupied topological between one node and the purpose receiver. In such cases, GPSR switches to perimeter mode that used the relative neighborhood graph (RNG) as an undirected graph defined on a circle of nodes in the network topology by connecting two nodes by an edge whenever there does not exist a third node that is closer to two nodes than they are to each other. RNG remove link crossovers, and the packet is forwarded using the right-hand rule until the unoccupied topological is traversed and the packet can be returned to greedy mode [30]. The right-hand rule is used to overpass a graph without routing loops by thoroughly visiting every node in a specific way. The next node chooses...
depends on choosing a node located at the smallest angle counter-clockwise from the angle of entry. In [30], authors explained GPSR override DSR in MANET scenario, the GPSR increase in the packet delivery ratio about 1-2% while reducing protocol overhead by approximately 50-80% for beaconing intervals in the range of 1-3 seconds.

GPSR have many problems that define its work effectiveness in VANETs. Firstly, GPSR designed to provides works best with the slow movement without obstruction. Secondly, perimeter forwarding can increase in end to end delay and hop count, since the packets forwarded to nearest neighbor instead of the most optimal neighbor. Finally, GPSR has not the capacity to fix the position of the goal receiver node, it using the greedy forwarding and perimeter forwarding with the assumption are known the receiver node. GPSR used the Grid Location Service (GLS) permits the development of ad hoc networks that go up to a large number of vehicles and specify the receiver node location.

This part elaborate on the development GreedLea routing protocol. The GreedLea routing protocol is a combination between RL method and GPSR routing protocol aims to cope with a network fragmentation and network topology change. GreedLea routing protocol is developed with geographical information to cope with time constraints applications, various network scenario such as city and highways and highly dynamic topology. This followed by mobility model which developed with actual mobility traces and detailed synthetic in high mobility and large obstacle environment.

5.1 Selection of Routing Protocol’s Parameter

Three inner parameters are selected for GreedLea routing protocol aimed for required result in the network performances. Therefore the selected inner-parameters are:

i. MAX_JITTER is an acceptable maximum time for jittering. Jittering is a randomly particular time to decrease transmission collision applied in the routing protocol to manage traffic transmission [31]. The impact of transmission collision and its mitigation in VANET is a hot issue in the literature [32]–[36].

ii. BEACON_INTERVAL: Beacon are used by GreedLea to update the closest neighbors with vehicles’ information by sending a beacon message. Network bandwidth is used in this process. Therefore, as beacon message is sending repeatedly, it will cause of protocol’s overhead increase, and by minimizing its frequency possibly will cause the vehicle to be removed, and push the vehicle to determine a new route request.

iii. NVTime is the maximum time to hold a vehicle in the routing table before being deleted. Holding a vehicle route information for a longer time decreases the demand for establishing a different route request. But, if the neighbor is not connected, it may cause of loss of information and thus reduces the network performances. However, holding vehicle information reduced the possibility of requesting new route where may result in unrequested protocol overhead if the vehicle is still connected.

5.2 Route Beaconing Process

The other mode of message applied by GreedLea Routing protocol known as Route beaconing (RouteBea) process. In GreedLea routing protocol, beacon message is utilized in the beaconing process. GreedLea routing protocol demands each vehicle to regularly broadcast a beacon message consists of location and nodes identification to the closest neighbors. Beaconing process is applied by GreedLea routing protocol to create and to update the neighbor’s table. In this RouteBea process, when the beacon message is obtained, the accepting beacon initially verified whether the vehicle is in its listing table or not. If the vehicle is in the table, the vehicle updates the table with beacon received’s time, but the accepting beacon will add the vehicle to its table if the vehicle is not in the table. This phase is proceed with network planar graph’s recalculation. Besides that, if no beacon message is obtained from that vehicle in a specified period of time called Neighbor Validity Time (NVTime), beaconing process deletes the vehicle from the table. Figure 1 shows the flowchart for RouteBea process.
6. DATA SOURCE AND DATA COLLECTION TECHNIQUE
The GreedLea routing protocol has been implemented, evaluated and analyzed in a simulation framework. The discrete event simulator OMNET++ 5.0 and the INET 3.5 framework has been utilized for the development of GreedLea routing protocol. GreedLea routing protocol has been implemented and integrated with INET 3.5 protocols’ stack and has been analyzed and verified in Highway and City scenario in IoV network. IoV nodes (road side unit (RSU) and Onboard Unit (OBU)) has been implemented with INET3.5 protocols stack for wireless node module (WN). By applying the mobility modules, vehicles mobility has been achieved.
7. SIMULATION SCENARIOS
IoV network environment has been applied in this paper is design according to the traffic and roads in highway and city scenarios. The city canvas dimensions are 1000 m in width and 1000 m in length. Vehicles are moving into the city within the speed range 30-60 Km/h, and follows the trajectory of the internal roads. While the number of vehicles has varied for different experiments. RSU will be placed on the tops of buildings and will be simulated with the static mobility module to specify their placement on the map. While, the highway canvas dimensions are 50m in width and 2000m in length. Vehicles are moving in linear trajectory toward the ends of the highway within the speed range of 90-110 Km/h. RSU will be placed on the road side with a fix distance of 200 to 300 m between them. A number of vehicles is varied for a different experiment. The combined scenario is a mix of city and highway scenarios mentioned above.

8. RESULTS AND DISCUSSIONS
The objective of analyzing is to determine the success of the GreedLea routing protocol performances in the IoV network environment. To complete this objective, three performance metrics has been analyzed (path loss, PDR and delay) in different vehicle’s speed and distance.

8.1 100m
PDR determines the ability of the network to deliver information effectively as the relation between the total number of received packets and total number of sent packets. Besides, the inverse PDR used to evaluate the packet loss ratio in the network. Figure 2 shows the comparison of PDR result for GreedLea routing protocol for different speeds of car or vehicles for the distance of 100m. It shows that the average PDR for the speed of 50mps is 100% while for the speed of 200mps, the average PDR is 99.95%. As the conclusion, the average PDR for all speed setting is 99.96% which is can be consider as better compared to other existing routing protocol since the packet loss is less the 0.1%.

![Figure 2. PDR vs Car.](image)

Delay is the sum of time needed by this system to provide an information packet to its destination. Delay is measure in second. Figure 3 shows the comparison of average delay result for GreedLea routing protocol for different speeds of car or vehicles for the distance of 100m. It shows that average delay for 50mps is 2.09x10^{-4}s and average delay for 200mps is 1.41x10^{-4}s. Thus, the average delay for all speed setting is 1.66x10^{-4}s.
Path loss is the decrease in power density. In this paper, we describe the linear path loss as the ratio of transmit power to receiver power. Figure 4 shows the comparison of path loss result GreedLea routing protocol for different speeds of car or vehicles for the distance of 100m. It shows that in the speed of 50mps, the average of path loss is 39.76dB while for the speed of 200mps, the average path loss is 36.41dB which is 3.35% better compared to 50mps.

Figure 5 shows the comparison of PDR result for GreedLea routing protocol for different speeds of car or vehicles for the distance of 1000m. It shows that the average PDR for the speed of 50mps is 100% while for the speed of 200mps, the average PDR is 99.99%. As the conclusion, the average PDR for all speed setting is 99.99% which is can be consider as better compared to other existing routing protocol since the packet loss is less the 0.1%.

8.2 1000m
Figure 5 shows the comparison of PDR result for GreedLea routing protocol for different speeds of car or vehicles for the distance of 1000m. It shows that the average PDR for the speed of 50mps is 100% while for the speed of 200mps, the average PDR is 99.99%. As the conclusion, the average PDR for all speed setting is 99.99% which is can be consider as better compared to other existing routing protocol since the packet loss is less the 0.1%.
Figure 5. PDR vs Car.

Figure 6 shows the comparison of average delay result for GreedLea routing protocol for different speeds of car or vehicles for the distance of 1000m. It shows that average delay for 50mps is $1.75 \times 10^{-4}$s and average delay for 200mps is $1.51 \times 10^{-4}$s. Thus, the average delay for all speed setting is $1.61 \times 10^{-4}$s.

Figure 6. Delay vs Car.

Figure 7 shows the comparison of path loss result GreedLea routing protocol for different speeds of car or vehicles for the distance of 1000m. It shows that in the speed of 50mps, the average of path loss is 45.73dB while for the speed of 200mps, the average path loss is 40.53dB which is 5.2% better compared to 50mps.
9. CONCLUSION

GreedLea routing protocol should be effectively cope with a fragmented network and fast topology changing. However, existing ad hoc routing protocols decline to fulfill these particular requirement. Nevertheless, the stateless character of geographic forwarding in these protocols avoids them from expecting topology holes (network fragmentation) in routes direction. This paper studies on the problem of the dynamic network topology and the problem of developing robust routing protocols which to be employed in IoV. The features of IoV, such as network partitioning, high mobility and intermittent connectivity comprise routing protocol become a challenging task. For example, providing continuous connection to a vehicle node imposes challenges as a result of mobility, the variations in network topology and frequent change of traffic conditions which create different network performances. This deviation may deteriorate the network performances. Moreover, achieving a stable level performances in term of high-throughput, less packet loss and less link failure in IoV is a challenging problem. GreedLea routing protocol has been develop to overcome the problem of monitoring the traffic condition and traffic congestion. From the results, GreedLea routing protocol has delivered greater performance compared to existing routing protocol in term of average delay, packet loss and path loss compared to existing GPSR routing protocol. The network performance has been analyze based on difference vehicle’s speed and distance. From the result it shown that as the vehicle speed increase, average delay decrease. Performance of GreedLea increase in the PDR which is packet loss is less than 0.1% and reducing protocol overhead by approximately 20-60% as the vehicle’s speed increase for beaconing intervals in the range of 1-3 seconds.

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