AN ANALYTICAL STUDY OF GPSR PROTOCOL FOR DIFFERENT REAL TIME CONFIGURATION IN VANET

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Abstract*—Vehicle network is the complex network form because of integrated dynasim and hybridization. The routing in this network a critical challenge that affects because of network scenario, architecture and communication. In this paper, an analytical study on the performance behavior of three different network configurations is provided for highway scenery. The configuration constraints are defined based on the traffic strength. The observations are taken against the GPSR protocols. The ration of network traffic, and integrated RSUs is provided to evaluate the network performance. The simulation of work is done in NS2 environments. The analysis is provided in terms of throughput, communication delay and communication loss parameters. The implementation is applied on four different scenarios. The observation shows that the increased in density increased the communication loss and communication delay, whereas the increase in infrastructure devices has improved the communication throughput.

***Index Terms*—VANET, Infrastructure Driven, Highway Scenario, GPSR**

I. INTRODUCTION (HEADING 1)

Vehicular network is the real time network that provides the solution to the GPS tracking of vehicle nodes in wider network area. It is considered as the sub-class of Mobile network, but contains the features of both sensor network and mobile network. The hybridization at different level increases the network criticality and its integration to real environment present it as an emerged research area. For a vehicular network, nothing can be static or fix in terms of architecture, protocol, environment or the scenario. This dynamic nature and different communication forms relative to various scenarios and requirements increases the network criticality. Even in a traditional vehicular network, the hybridization of infrastructure specific and infrastructure less communication exist. According to the parties involve in the network and the requirement, the network provides three types of core communications called V2V (Vehicle to Vehicle), V2I(Vehicle to Infrastructure) and I2I (Infrastructure to Infrastructure). The infrastructure are the fix controller devices placed on road side to monitor the region traffic. The basic architecture of Vehicular communication is shown here in figure 1.

Each of the communication form is having its own requirements and advantages. The most common communication form is V2I communication. As a vehicle enters to the coverage of particular RSU, RSU captures the vehicle detail using RFID code of vehicle. This code information includes the information like vehicle type, brand, maximum speed, registration location, driver detail etc. After registraction, any request for location search such as hotels, hospital etc is also communicated via infrastrucure device. The information message communication and the communication control within region is provided via RSUs. The alert message for any accident or traffic jamis also provided by the RSUs. RSUs are also responsible to locate the short and reliable alternative route within the network.

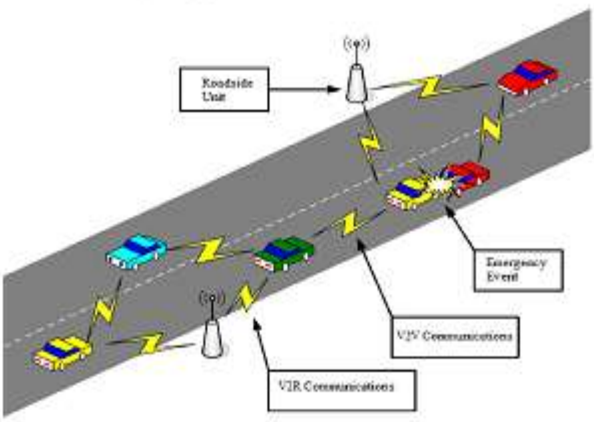

Figure 1 : VANET Architecture

V2V communication is the adhoc and infrastructure less communication performed between the vehicles. To obtain some location update or the accidental information can be shared among the vehicle directly. This kind of communication is generally short distance and broadcasted to all the neighbor nodes. The dynamic hop selection within the coverage can be performed to share such critical information. I2I communication is generally performed on vehicle request to generate the effective route. The jam preventive and traffic preventive and shortest distance route can be identified by the current RSU by sharing the vehicle destination requirement with all neighbors RSUs. The possible paths with distance and traffic load parameters can be observed to estimate the most effective vehicle route.

Each of these communication types requires to be controlled under constraint specifications defined under the routing protocol as well as environmental setup. In this paper, GPSR implementation for different network configurations is provided. The key strength for any network is routing method applied to deliver the message. Different routing methods for vehicular network are listed in figure 2.

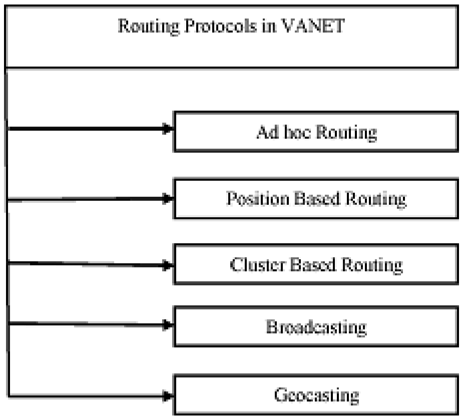

Figure 2 : Routing Froms in VANET

Each of communication type described earlier in this section follow one or more routing forms controlled under the relative protocols. The adhoc routing is the infrastructure free routing which is generated by electing the effective neighbor node from the list of available nodes. V2V and I2I communication follows the Adhoc routing for information sharing. As the vehicular adhoc network is dynamic and frequently changes the node position and the coverage region. Because of this, the network requires to track the nodes positions. The position adaptive routing is required to track position, direction and speed of vehicle nodes. While performing the real time streaming such as video communication, the regular tracking is the main requirement. In such case, the position based routing is required.

Vehicular network is a densed network form. To optimize the network communication, the network is divided in smaller dynamic regions called clusters. Each cluster is controlled by a controller node. The cluster based routing is also defined in the network to reduce the load of infrastructure devices. The broadcasting the message distribution form in which all the vehicles in a region are flooded by same message. In vehicular network, the broadcasting is common to share the information about the accidents, traffic jams or the road blockage. As the vehicles enters to the particular RSU region, the geocast routing is performed to capture the positional information of the vehicle. The vehicle tracking and the communication within the region can be performed via Geocast routing.

In this paper, GPSR protocol is defined for highway network with infrastructure specification. The network is here generated with V2V and V2I communication. Different configurations are defined at architecture level under the specification of traffic density. In this section, the communication type and routing constraints for vehicular network is defined. In section II, the work defined by earlier researchers on GPSR protocol and for different environmental configuration is provided. In section III, the detailed description of GPSR protocol and its functioning is provided. In section IV, the simulaton results of GPSR under three network scenarios is presented. In section V, the conclusion of work is presented.

II. RELATED WORK

GPSR is the most common protocol considered for the communication in vehicular network. The protocol is adpative to the geographical position as well as able to handle larger geographical constraints. GPSR also suffers from various challenges and limitations. A study work, analytical observation and the improvements over this protocol is suggested by different researchers. Some of the work already provided by the researchers on GPSR protocol is described in this section.

Due to the versatality exist in the vehicular network at different levels, analytical study is required to explore the features of particular network configuration and characterization. This versatality exist in terms of protocols, network behaviour, architecture and the events occurs in the network. Such an analytical study on video communication in vehicular network was provided by Xu et. al.[3]. Video data is the real time stream communication that captures the scene videos for vehicles or the controllers. Author also observe the performance relative to the vehicle mobility, network traffic and against different routing methods. The network condition specific constraint analysis was also provided by the author. Another study work was provided by Yu et. al.[4] for different network configuration in terms of architectural setup and vehicle density. Author applied the GPSR protocol for urban environment with different density networks. The link connectivity and communication deficiencies were identified by the author. Another analytical work on performance observation for different scenarios was provided by Bala et. al.[7] using AODV and GPSR protocols. Author applied the work for urban vehicular network with different vehicle density, speed variation, different protocol and packet specifications. Author traffic adaptive observation identified the significance of routing protocols in the real scenarios. A comparative performance analysis for GRP and GPSR protcols for densed vehicular network was provided by Setiabudi et. al.[8]. Author setup the protocol configuration as well as architectural constraints to identify the performance of each protocol. Author identified that the performance of ZRP is more reliable than GPSR in densed network, but the GPSR provided lesser delay with higher throughput.

Some of the researchers improved the GPSR protocol in different real time scenarios by adjusting the network parameters, routing constraints and the situational characterization. Lee et. al.[1] has proposed a new protocol called GPCR by resolving the problem of obstacles and non-uniform distribution of vehicle. The new protocol is the parameter specific improvement over GPSR protocl by considering the junction nodes in the network. Author implied the work in dynamic urban environment and provided the safe and reliable communication. An improvement to the geographical routing was provided by Wang et. al.[6]. Author integrated the GPS based location tracking with greedy adaptive distance measure to improve the routing for GPSR protocol. The interaction analysis with route recovery was provided by the author by extracting the accurate position of vehicles. An improvement to the GPSR protocol was provided by Ning et. al.[9]. Author defined a greedy formula to identify the cost of each of neighbor in sparse and dense environment. The location and traffic specific mathemtical evaluation was provided by the author to optimize the communication route. A work on motion vector evaluation for vehicular network and its integration with GPSR protocol was provided by Tu et. al.[10] as new GPSR-MV protocol. The forwarding node selection rules were defined by the author under motion, direction and position analysis. The schematic formulation had improved the communication throughput with lesser delay. Another environment constaint and vehicle characterization specific improvement to GPSR protocol was provided by Hu et. al.[11]. Author defined a new functionality driven measure for neighbor identification for next hop. The priority specific hop selection was provided by the author under range transmission. Arzil et. al.[12] also improved the routing method for GPSR protocol by applying more intelligent analysis on inter-vehicle communication. The policy driven analysis with network partitioning was provided by the author. The quality path was discovered by applying the flooding on neighboring nodes. The parametric analysis was applied to identify the most effective neighbor. Brahmi et. al.[13] has considered the mobility as the major communication constraint and applied a safety analysis approach to generate the effective communication path. The V2V and V2I communication for the network was improved by the author. Author applied the data routing with significant relative measurement to reduce the latency and communication loss for the network. Hu et. al.[14] has improvement the functioning of GPSR protocol in more critical and congested environment. The buffering and the memory consideration for network nodes was identified by the author. A planner graph based greedy routing method with cache size consideration was applied to generate the optimized and restricted path. Load Consideration[15] is always the critical challenge for vehicular network. Author defined the GPSR with load, location and communication observation. The node specific route estimation was provided by the author in the form of determistic metric. This metric is based on distance, speed, direction and the load vector. All parameters are combined mathematically to generate the optimized routing path. A two pahse routing method with incorporated information was provided by Wang et. al.[16]. Author procssed the overlay path with infrastructure and scenario specification. The static and dynamic constraints were observed with architctural configuration and behaviour analysis. The node and the network tracing was applied to generate the effective route for the network. The access phase routing with greedy approach was provided to generate the effective communication route. Chen et. al.[17] used the regular updation at positional aspect so that the accurate prediction of mobility and direction will be obtained. Based on these positional aspects, the route formulation and the traffic pattern analysis will be done. The mobility parameter specific validation was defined in realistic environment to generate the effective routing path. Author also applied the periodic transmission and reception to improve the communication in real time network.

The network scenario specification, network deployment and RSU placement can be improved to achieve the effective benefit from existing GPSR protocol. The architectural configuration can be applied to gain the maximum utilization of available resources. Wang et. al.[2] has adopt the clustering method to reduce the network communication by setting up the dynamic controllers. The conventional GPSR protocol is used as the group adpative or the cluster adpative GPSR to achive more optimal communication solution. The method is effective and less exhaustive than traditional communication methods. Luo et. al.[5] also defined a network architecture with mobile infrastructure for Urban Vehicular network. The seperate modules were defined by the author to setup and register the mobile infrastructure and later on applied the routing via this mobile infrastructure. The new scenario was deployed and tested with GPSR protcol which identified that the architectural improvement has doubled the commuication throughput.

III. GPSR Protocol

GPSR is the position tracked routing protocol defined specifically for Vehicular network. The key strength of the protocol is to provide the node tracking and integrating the V2V and V2I communication interactively. The key functioning of this protocol is based on the concept of greedy forwarding method that provides the distance adpative routing solution with worst case complexity $O(d^2)$. The protocol is based on the positional analysis in which the neighbor informationis collected with destination specification. The method to lookup the neighbor nodes within geographical region is called greedy forwarding. The selection of the most effective neighbor is based on the positional analysis on neighbor node and the destination nodes. The position knowledge analysis is defined to take the decision relative to the interference analysis applied with topology information. The complete process of GPSR is divided in two phenomenon called Greedy Forwarding and Parameter Forwarding. The basic work characterization of GPSR is shown in figure 3

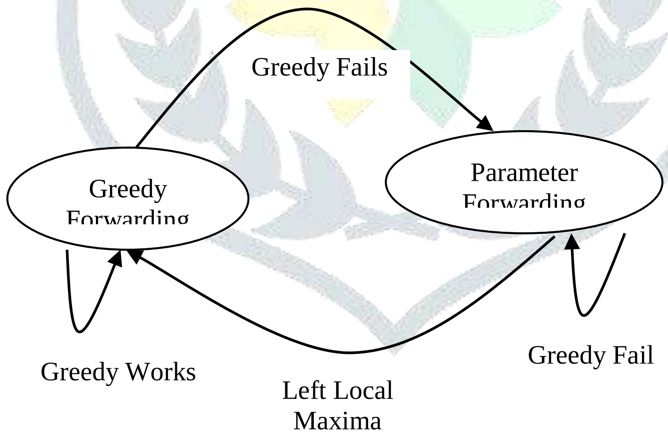

Figure 3: GPSR Work Characterization

From figure 3, the integration of two major work stages to GPSR is shown i.e. Greedy Forwarding and Parameter Forwarding. The first adaptation is performed based on the greedy forwarding. But if the solution path is not obtained, the parameter forwarding is applied to identify the neighbor. If the parameter warding not obtained the effective positional observation, a recheck on greedy forwarding can be applied.

The routing decision by this protocol in vehicular network is performed by extracting the neighbor information. The location table analysis along with forwarding decision is applied and forwarded in the form of integrated packet information. The forwarding information includes

- An identity flag to decide whether the packet is in Greedy forwarding or parimeter forwarding.
- Destination node based physical address processing
- GPSR packet header processing with location information analysis
- The packet address analysis with edge cross obvervation at the information transition
- GPSR rejects the packet that forwarded repeated if not occur in range.

These characteristics collectivity applied with distance and parameter observation towards the destination specification. The parameter mode observation with the same link specification can be defined. The geographical location based analysis and the usage of routing state is also applied to generate the dynamic route. The process flow of GPSR protocol is shown here in figure 4.

A) Greedy Forwarding

Greedy forwarding adopts the method for packet forwarding based on the physical position of the nodes. As the communication initialize, the source node is having the positional information about the source and the destination nodes. As the process begins, the neighbor nodes physical information is collected and the election of effective neighbor is considered as a next intermediate node. The process on intermediate nodes will be repeated till the destination node will not arrive. The physical position of neighbor nodes will be extracted and processed under beaconing algorithms. The neighbor forwarding based closed region analysis is defined to generate the path under positional information. The location table is generated and updated to generate the path. The radio range analysis is defined to identify the neighbors and the effective neighbor selection is done to generate the path.

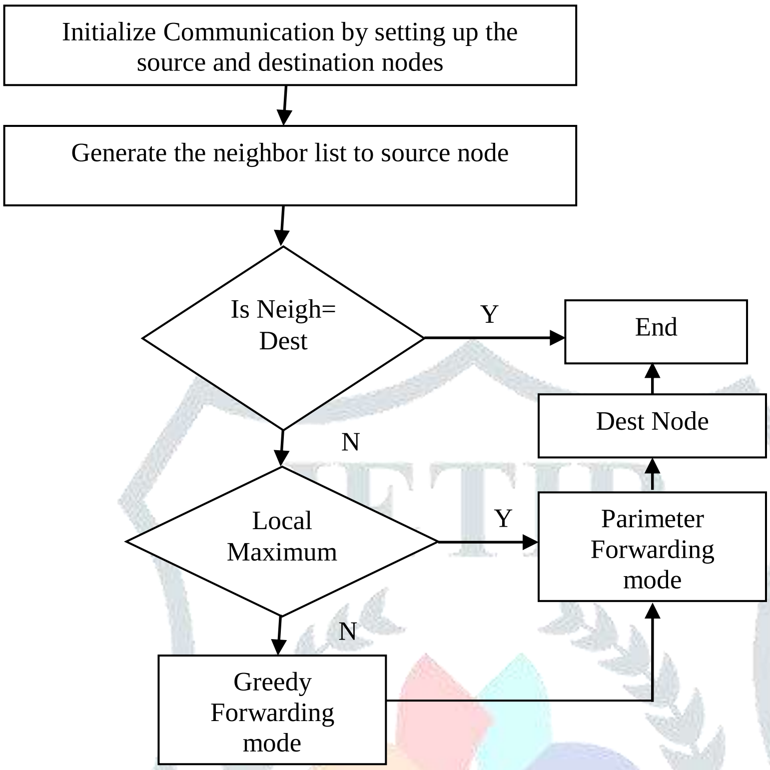

Figure 4: Working of GPSR

In this process of greedy forwarding, the local maximum analysis is defined to switch the perimeter based path. The route formation with parameters based packet forwarding is defined to generate the local maximum region in clockwise direction. The suitable neighbor based packet forwarding is defined to evaluate the local maximum. The node level recovery with situational estimation is defined. The packet buffering is defined to apply the periodical check along with data packet forwarding within the buffer limit of packet. The packet cannot be forwarded through the junction sequence. The forward packet based greedy method is defined to generate the communication route. The evaluation of the path is done, which requires to recomputed because of the dynamic nature of nodes. Because of this, the route formation under greedy forwarding is always a challenge. When the greedy forwarding fails, the parameter forwarding is applied to generate the path.

B) Perimeter Forwarding

Perimeter forwarding is generally applied when the greedy forwarding fails. It means, the next hop based closest neighbor processing and the destination processing can be applied to generate the effective perimeter forwarding. The region based analysis can be applied to identify the effective neighbor on which forwarding can be applied. The region specific analysis within the region can be done in counter-clockwise direction to identify the destination. The direction specific observation can be applied to constraint mapping to identify the effective region node. The edge level traversing within the region is considered as the perimeter. The edge cross perimeter is defined to apply the heuristic mapping so that the maximum ability to the destination node arrival will be obtained. This edge based mapping is able to identify the effective routing solution where the greedy forwarding fails.

IV. RESULTS AND EVALUATION

In this work, the analytical observation of GPSR protocol is done in different network environments under highway scenario. The environment variation is here done in terms of number of infrastructure devices, node speed and the network density. To evaluate the network characteristics, the implementation of the work is done for four different scenarios. These scenarios with different parameter is shown here in table 1. The evaluation of these scenarios is done under communication throughput, packet lossrate and communication delay parameters.

Table 1 : Different Scenario Configurations

Sceanrios	Parameter	Values
Scenario 1	Number of Infrastructure Devices	4
	Network Density	100
	Speed	20 to 40
Scenario 2	Number of Infrastructure Devices	4
	Network Density	200

	Speed	20 to 80
Scenario 3	Number of Infrastructure Devices	8
	Network Density	100
	Speed	20 to 40
Scenario 4	Number of Infrastructure Devices	8
	Network Density	200
	Speed	20 to 80

Table 1 has shows that the variation in the scenarios are applied for highway environment with different infrastructure, vehicle node density and speed parameters. The first evaluation in terms of throughput parameter is shown in figure 5.

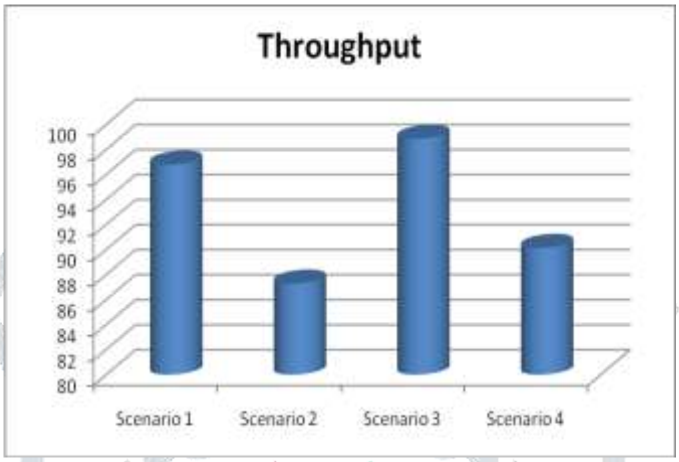

Figure 5: Communication Throughput Analysis

Figure 5 shows the communication throughput analysis of different network configuration. The result shows that as the network density increases, the communication throughput decreased. As the number of infrastructure within the region is increased, the network throughput is improved as the communication balancing is improved. The speed variation of the vehicle also affects the network throughput.

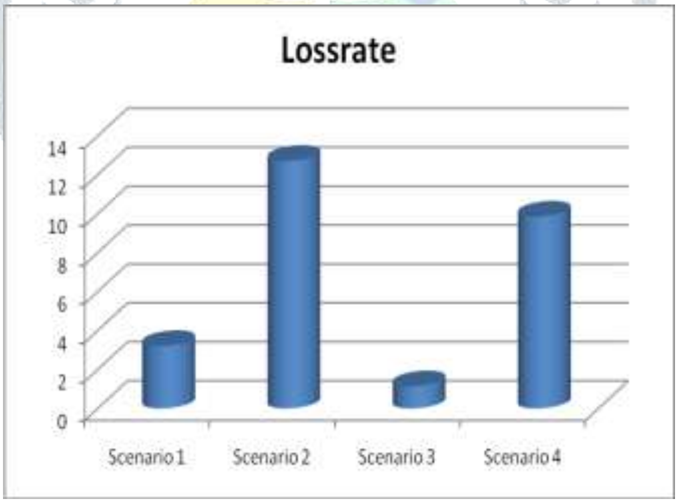

Figure 6: Lossrate Analysis

Here figure 6 is showing the loss rate analysis obtained for four different scenarios. The observations shows that as the number of infrastructure devices in the network increases, the communication loss decreases. In same way, as the network density increases, the load on the infrastructure devices increases that increases the communication loss. Higher the speed variation also affected the communication loss over the network.

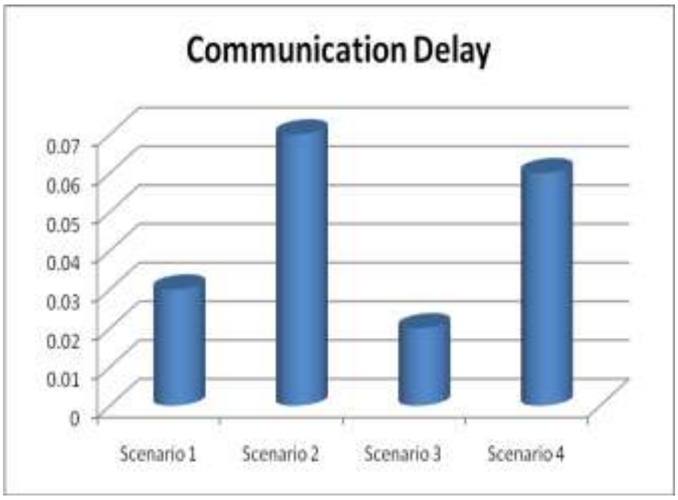

Figure 7: Communication Delay Analysis

Figure 7 shows the communication delay analysis for four different scenarios. The observations show that the scenarios with lesser density and infrastructure devices given lesser delay. But as the density increases in the network, the load on the devices is increased and unequal because of which the communication delay is increased.

V. CONCLUSION

In this paper, an analytical analysis on GPSR protocol is provided for different configuration in highway scneario. The paper has explored the algorithmic processing of GPSR protocol and applied it in four different scenario configurations. The secnearios are defined with differnet density, infrastructure devices and vehicle speed parametes. The observations shows that the density increase has increased the communication loss and communication delay. Whereas the increase in the infrastructure devices improved the communication throughput.

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