Neighbor Position Verification Protocol for Non Line of Sight using Multiple Road Side Units in VANET

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Abstract: Vehicular Ad hoc Networks (VANETs) is a form of Mobile Ad-hoc Network (MANET), that provide communication and exchange of information among nearby vehicles, between vehicles and nearby fixed equipment, usually described as Road Side Unit (RSU). The information among vehicles is being exchanged through direct communication within each vehicle's radio communication range .In reality, the radio frequency signals are susceptible to interference and the direct communication may be restricted by certain topographic features, man- made structures and other moving vehicles that are of different sizes and shapes. VANET environment is not only concerned on fixed obstacles like trees and buildings but also on moving objects on the road that causes the signal block. Obstacles create a Non-Line of Sight (NLOS) state that could prevent a vehicle from receiving consistent updates and Location information from its neighbors. To overcome NLOS condition rather than relying on Tall Vehicles for the choosing them as next hop relay candidates, Neighbor Position Verification Protocol(NPVP) is used in cooperative neighboring vehicles to provide optimal solutions in all possible ways. In order to prevent the vehicles from NLOS state the Location of the vehicles are identified by considering many scenarios in the road environment using a Common vehicle or a Road Side Unit (RSU). It will help to maintain localization services integrity and reliability. It prevents traffic jam and provides accident control.

I INTRODUCTION

VANET is a widely discussed area of wireless communication at present. VANET is a subset of MANET where nodes represent vehicles moving at high pace and vehicle traffic determined regularity. This technology enables communication between vehicles and nearby road-side infrastructure and is made possible through a wireless sensing device installed in the vehicles. With the inception of VANET, new opportunities and related technologies like applications for traffic jam, accident control and weather updates have appeared. VANET performance can be tested in real situations but factors like cost, inaccurate results and protocol evaluation of complex environment may contribute towards a disappointing end. An automated tool called simulation can imitate the protocol and yield a similar result to that of the real world. VANET differs from MANET because in VANET the nodes strictly follow the traffic rules and their pattern of movement is very complex. To attain good results from VANET simulation, it is important to generate a realistic mobility model that is as realistic as real ad-hoc network communication.

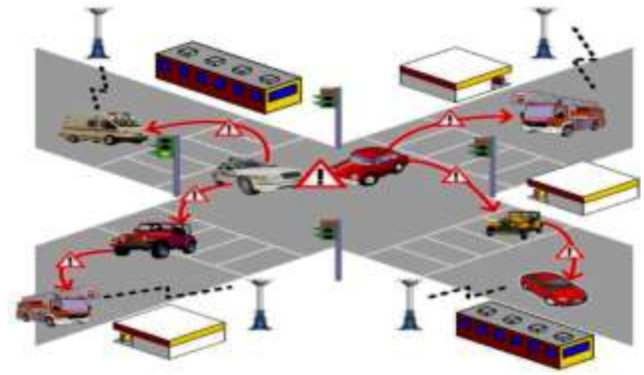

Fig. 1 Communication in Vehicular ad hoc Network

In fig. 1 shows how the communication takes place among nearby vehicles and between vehicles and nearby fixed equipments.

Communication Patterns

Applications for VANETs and network characteristics diverge largely. Moreover, the operation of applications is usually not detailed yet, i.e. it is open how data is collected, communicated and evaluated to implement the application. These recurring patterns with multiple, similar characteristics form the generic base for the design of VANET communication systems. The "communication patterns" classification is independent of the actual communication technology and assumes only the availability of a link layer broadcast and unicast mechanism. IEEE 802.11p is a good example of a suitable communication system that is likely to be deployed in VANETs.

The characteristics for each pattern,

Purpose: Describes the overall goal of this pattern.

Communication Mechanism: Describes generic communication mechanisms and presents examples of mechanisms conforming to this pattern.

Trigger: Describes the circumstances under which the communication is typically initiated.

Direction: Communication can be either unidirectional, bidirectional with response to the sender or without clear direction.

Data: Outlines typical communicated data.

Quality of Service: Describes typical capability and requirements of the communication patterns regarding metrics like message distribution success or latency.

II PROBLEM STATEMENT

Non-Line of Sight (NLOS) state that it could prevent a vehicle from receiving consistent updates and Location information from its neighbors.

In General, the radio frequency signals are susceptible to interference and the direct communication may be restricted by certain topographic features, man- made structures and other moving vehicles that are of different sizes and shapes. VANET environment is not only concerned on fixed obstacles like trees and buildings but also on moving objects on the road that causes the signal block.

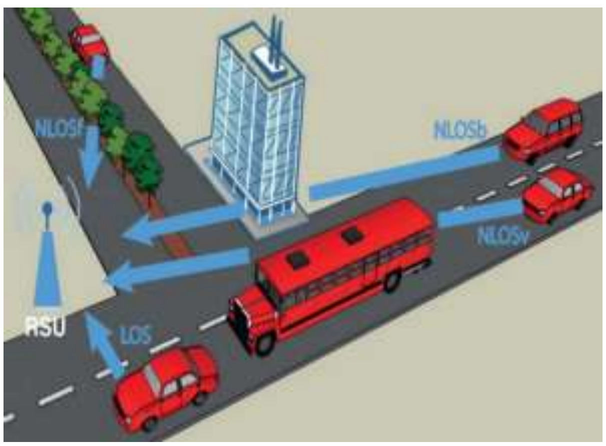

Fig 2 Non Line of Sight

III MULTIPLE ROADSIDE UNITS (MRSU)

The Roadside Units (RSU) is static devices that can be deployed independently on roadside or installed together with traffic lights and they are capable of large area sensing and communication. With RSUs such as 802.11 access points, vehicles can either access data stored in them or upload its own data. Each vehicle on the road can communicate with at least one RSU at any time. They could download information from RSUs and also upload information to them. The communication between Multiple Roadside Units also takes place.

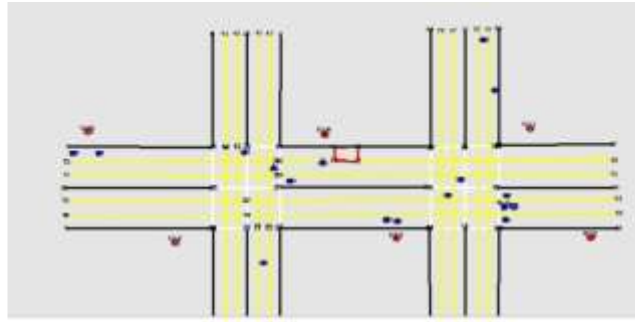

Fig 3 Multiple Rode Side Unit (MRSU)

Analysis

- Increase neighborhood awareness and vehicle's knowledge about surrounding nodes under NLOS conditions.
- Monitor localization information, detect data inconsistencies and validate data integrity.
- Ensure that a vehicle avoids total dependency on periodic incoming beacons and update messages.
- Maintain confidentiality and employ message or sender authentication.
- Validate processed information and eliminate false data before processing.
- Support availability in a large-scale environment

IV NEIGHBOR POSITION VERIFICATION PROTOCOL (NPVP)

In a VANET environment, consideration should be given not only to fixed obstacles and buildings but also to moving objects on the road that can cause signal block. Since vehicles come in different shapes and sizes, they can serve as obstacles between neighbors that are in the same communication range. Unlike with buildings and fixed structures for which interference and signal quality factors can be measured in the field and taken into consideration while traveling in a given area, moving obstacles with different shapes, speed, composition and density can create an NLOS state that changes on an unpredictable temporospatial basis and could prevent a vehicle from receiving consistent updates and location information from its neighbors.

The main objective is to overcome NLOS (Non Line of Sight) condition and secure the integrity of localization services in all possible aspects. Neighbor Position verification Protocol (NPVP) is applied when the obstacle is a vehicle or other physical objects.Event Location Information is passed to multiple Road Side Units when no vehicle is common. To provide road safety, traffic conditions and driver assistance applications that are beneficial to people.

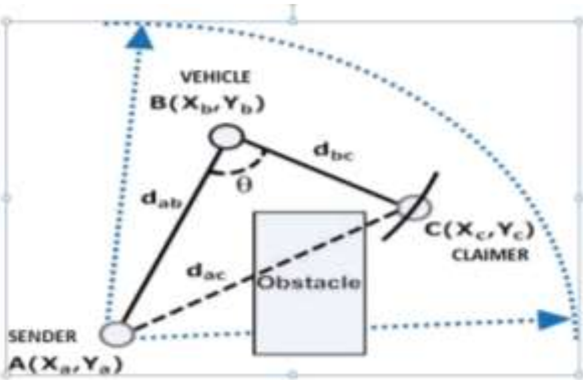

Fig 4 Triangulation Calculation

The position computation for the proposed protocol is based on triangulation calculations. Node A wants to verify node C's location; however, direct communication is not possible due to the existence of an obstacle. While node B can communicate directly with both A and C, each node knows its GPS position (x, y) in a two-dimensional plane. Node A sends a request to node B to verify location C with its announced position (x_c, y_c) and mobility vector. B can verify C's location by determining its distance using radio measurements, such as RSSI, and comparing the announced and measured values. If both values are a match, B will send a response back to A containing the distance d_{bc} and verifying the location of C.

A verifies d (using the radio measurement) and calculates the angle θ between BA and BC, where

$$\theta = \arccos(\vec{BA} \cdot \vec{BC})$$

A will then calculate its distance d_{ac} from C using the calculated values d_{bc} , d_{ab} , and θ as

$$d_{ac} = \sqrt{d^2{}_{bc} + d^2{}_{ab} - 2d_{bc}d_{ab}\cos\theta}$$

To make a fair comparison of both values, both distances d_{ac} and D_{ac}

$$x'_c = x_c + \Delta x$$
$$y'_c = y_c + \Delta y$$

The distance to C's new location with respect to both sources of data is then computed as

$$d'_{ac} = \sqrt{(x - x_c)^2 + (y - y_c)^2}$$
$$D'_{ac} = \sqrt{(x - x_c)^2 + (y - y_c)^2}$$

V NEIGHBOR POSITION VERIFICATION PROTOCOL (NPVP) ALGORITHM

I - Request for verification:

1. if data inconsistency detected
2. trigger vehicle (Sender A)
3. check nearby vehicles
4. if NLOS-> true
5. send(msg) to One Hop Neighbors

II- Receive request and compute position:

1. receive(msg)
2. if LOS(claimer C)->true
3. compute Position
4. verify announce position=actual position
5. send(msg) to sender
6. if NLOS(claimer C)->true
7. forward(msg) to other neighbors

III- Verify claimed Position

1. compute dist(sender A, vehicle B)
2. compute θ
3. calculate dist(sender A, claimer C) using RSS
4. compute changes dist(sender A, claimer C) and dist`(sender A, claimer C)
5. verify->original location
6. end

VI SIMULATIONS AND RESULT ANALYSIS

Through simulation communication of Multiple Road Side Units has been simulated and the analysis of Packet Delivery Ratio, End-to-End Delay, Energy and Throughput are obtained with the help of Xgraph.

6.1 Analysis of Packet Delivery Ratio

The ratio of number of delivered data packet to the destination. This illustrates the level of delivered data to the destination.
Packet Delivery Ratio = ∑ Number of packets received / = ∑ Number of packets sent The greater the value of packet delivery ratio means the better performance of the protocol .

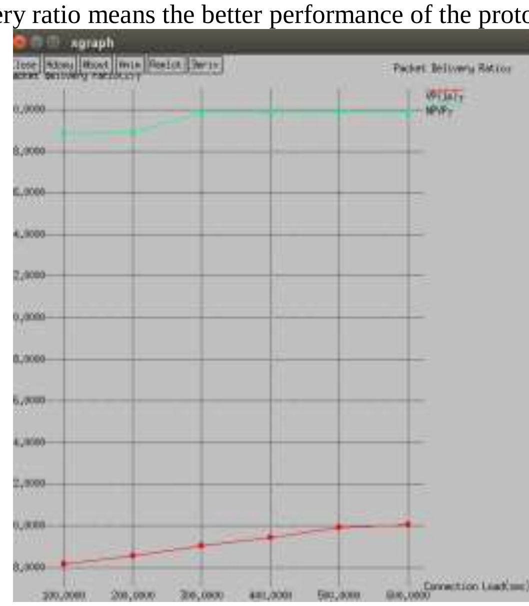

Fig 5 Packet Delivery Ratio

The graph in the Figure 5 shows the better Packet Delivery Ratio by using Neighbor Location Identification Protocol the comparison is made between the packet sending and packet receiving among two vehicles

6.2 Analysis of End-to-End Delay

The average time taken by a data packet to arrive in the destination. It also includes the delay caused by route discovery process and the queue in data packet transmission. Only the data packets that are successfully delivered to the destination is counted.
End-to-End Delay = ∑ (arrived time-sent time) / ∑ Number of connections.

The lower the value of end to end delay means the better performance of the protocol

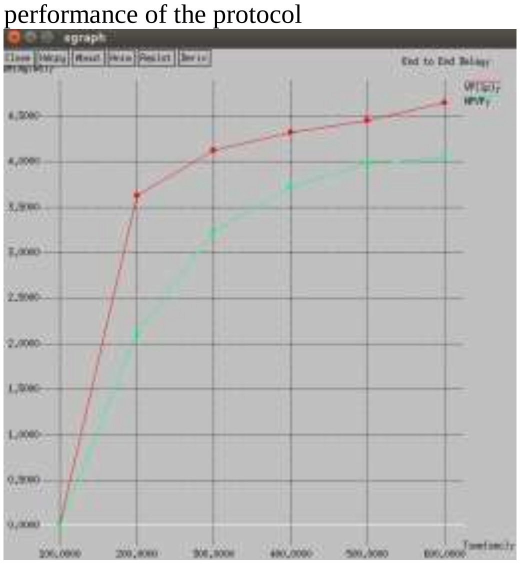

Fig 6 End to End Delay

The graph in Figure 6 shows the better end to end delay by using Neighbor Position Identification Protocol, the comparison is made between packet sending time and delay time.

6.3 Analysis of Energy

A communication between the vehicles takes greater consumption of energy when compared with monitoring and processing. For this reason, communication must occur with short distances, compelling that the packages of data are directed by means of routes with multiple jumps.

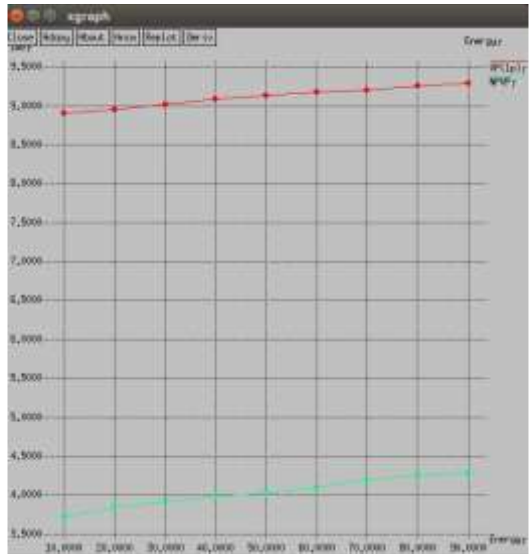

Fig 7 Energy

The graph in Figure 7 shows that Neighbor Identification Protocol consumes less energy and provides better performance for vehicle’s communication.

6.4 Throughput Analysis

Throughput refers to how much data can be transferred from one location to another in a given amount of time.

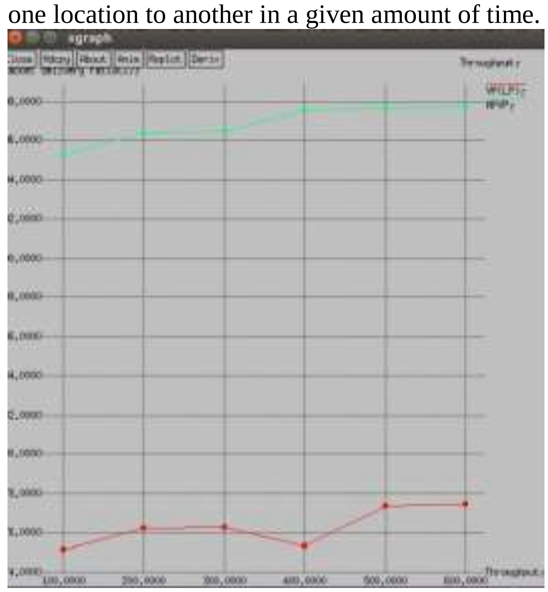

Fig 8 Throughput

The graph in Figure 8 shows the better Throughput analysis by using Neighbor Position Identification Protocol, the comparison is made between Packet Delivery Ratio and Delay time.

VII CONCLUSION

A state of NLOS among two vehicles restricts the communication between each vehicles respective radio communication range. Believing the neighborhood awareness is essential to supporting reliability and integrity in VANET applications. To overcome NLOS state and to increase the neighborhood awareness rather than increasing the size of antenna as suggested in TVR approach[1] , Neighbor Position Verification Protocol (NPVP) is used. It verifies an announced position when direct communication is blocked by an obstacle. And event location information is passed to multiple road side units. Those Road Side Units update the other road side unit's event location information to the vehicles under its coverage area, which is used to prevent the vehicles as a precaution from an NLOS state. The simulation result showed that the communication between Multiple Road Side Units has better performance and the solution proposed will help maintain Localization Service Integrity, reliability and provides accident control and traffic management.

Future Work

The security analysis and the scheduling algorithm for Multiple Road Side Units can be done to improve the performance of communication between Multiple Road Side Units.

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