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A Novel Approach using LoRaWRP for Emergency Vehicle Traffic Management

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ABSTRACT

The road traffic was increasing at an alarming rate for the past few years due to the vast number of vehicles on the road. It resulted in traffic chaos, high fuel consumption, wastage of valuable time on road and increase in air pollution. Traditional traffic system works based on fixed green light sequences, therefore it does not consider emergency vehicles in account. Due to this, emergency vehicles are getting delayed in traffic signals and resulted in chaos. This paper recommends a novel approach using LoRaWRP that provide congestion free route to the destination. The algorithm was framed in such a manner that it could be effective in maintaining traffic through communication among vehicles and vehicles (OBUs) to the Roadside Unit (RSU). The RSUs will generate possible routes and control the traffic signals within the accessible limit, if any emergency situation occurs. In proposed system, the RSUs will track active location of emergency vehicles and manages the traffic signals accordingly to provide hassle free movements at traffic junctions.

Keywords: VANET, LoRa, LRWAN, Emergency vehicles, vehicle tracking.

1. INTRODUCTION

In recent years road traffic has increased drastically due to the massive number of vehicle production on the globe. By providing a better communication system among the V2V and V2I, congestions, traffic delays, parking related issues etc can be solved. The VANET which is an extensional version of MANET gives the freedom for each vehicle to leave and enter the required network [1]. In VANET the communication information was transmitted among different vehicle that are in motion i.e., dynamically changing the network topology. The information that one vehicle (node) contained would be transferred to all other vehicle and vice versa [2].

The VANET is a group of vehicles that establish a communication link among them for the exchange of information without the help of any central station. The deployment of a VANET was challenging task due to various factors like quality of service, designing optimal routing algorithms, robustness, scalability of network, establishing communication among vehicles and provide network security [3]. There are many VANET variations to minimize the above mentioned challenges. In the present paper, a VANET protocol was proposed with a novel approach using LoRaWRP (Long Range WAN Routing Protocol) for a congestion free motion of emergency vehicle. It is anticipated that around thirty billion IoT based devices / M2M based devices will be connected through internet using LRWAN technology [4]. The advantage of LoRaWan is that it consumes very less energy and can transmit signals to a long range.

In the proposed model the VANET would communicate the information that includes vehicle parameter, distance etc among the vehicles and also to the roadside unit (RSU). The system provides priority to the emergency vehicles to go pass the traffic signal junction by turning the signal into green instantly by the communication from the vehicle to RSU and then to the traffic signal.

2. LITERATURE REVIEW

LRWAN based protocols can be effectively used for many IoT based applications. It is widely acceptable now due to its low cost of establishment, wide range for the signal support and the most important thing is it consumes very less energy. This LRWAN uses spectrum technique with a large band. LoRa uses entire bandwidth of the channel for communication their by reduces channel noise, Doppler Effect and fading of signals [5]. A novel Vehicle Assisted Data Delivery technique (VADD) was introduced with the idea of creating the helper node in which the vehicle in motion carried the packet until the new one enters into the area. This helper node technique had enhanced the performance of the VANET regarding the privacy, throughput, packet delay[17] and loss of data [6]. A secure communication must be established among the vehicles and between the RSU and vehicles with in the VANET. Another important thing that need serious consideration is to establish shortest possible distance through the traffic to the users. The different routing strategy for highway and urban networks was considered and that remains to be accomplished [7-9].

A scheduling approach for emergency vehicles in traffic is presented. It measures the distance between emergency vehicle and intersection using video sensing techniques. Euclidean distance, Manhattan distance and Canberra distance techniques are used and were compared with each other. From the result it is found that the Euclidean distance performs well compared to other techniques. It provides an insight for the design of urban congestion management system, effective for managing emergency vehicles [10].

The Dynamic Source Routing and Ad hoc On-Demand, two routing protocols in VANET were implemented among the highway police cars. The outcome showed that the AODV protocols were better in providing communication among the police cars in the highway in real time. The DSR protocols performance deteriorates with increase in the density of the node and the duration of call among the police cars [11]. The co-operating positioning of the particles in the GPS-assisted[18] VANETs was implemented to reduce the quantity of the CAM payloads with no degradation in accuracy. It continually provided location service with very high-precision during the congestion of the channel and reducing the computation load and communication when it was free [12].

The performance of the VANET system was analyzed regarding the packet delivery ratio (PDR) and message overheads from the various protocols that include AODV, GPSR, CBR and DSR. The outcome of the work deliberated that the CBR was the superior related to all other protocols as they undergo the deprovement of the curve with an increase in simulation time [13]. The performance of the VANET was evaluated over the usage of the DSDV, AODV and DSR routing protocols. The PDR, packet loss percentage and end-end delay parameters were embraced to evaluate those routing protocols in a planned area [14].

The implementation of the RFID within the RSU would count the number of vehicle on the road if the number increased beyond the threshold the RFID would deliver the information regarding the traffic congestion. This method also provides the option for the ambulance to inform about emergency by which the roads would be cleared for free movement [15].

3. LORAWRP METHODOLOGY

VANET was the developed to generate and transfer the communication among the vehicles on the road, but it could not be constrained within that as they were competent of communicating with the RSU. It helps transmit the information about the traffic through the clouding units so that the information was widespread on the networks. Hence the VANET has the two primary forms of communication as V2V and V2R communication [16]. Fig 1 shows the framework for LoRaWAN VANET model. First a network was formed with some id for different nodes (vehicles) v1, v2, v3,…Vn. A network topology is formed through a collection of nodes or systems.

Each vehicles are equipped with LoRa supported GPS units, through which the exact GPS locations can be found. The vital information’s including the location of emergency vehicles can be transferred across vehicles to reach RSU and the control information from RSU will be transferred back through the vehicles to reach the signal junctions. The RSU will identify the emergency vehicle based on the vehicle attributes stored on the server. After identifying the emergency vehicle, its current position and distance to signal junction will be find out. Finally based on these details the traffic signal clearance will be enabled once it reaches the coverage area of signal unit.

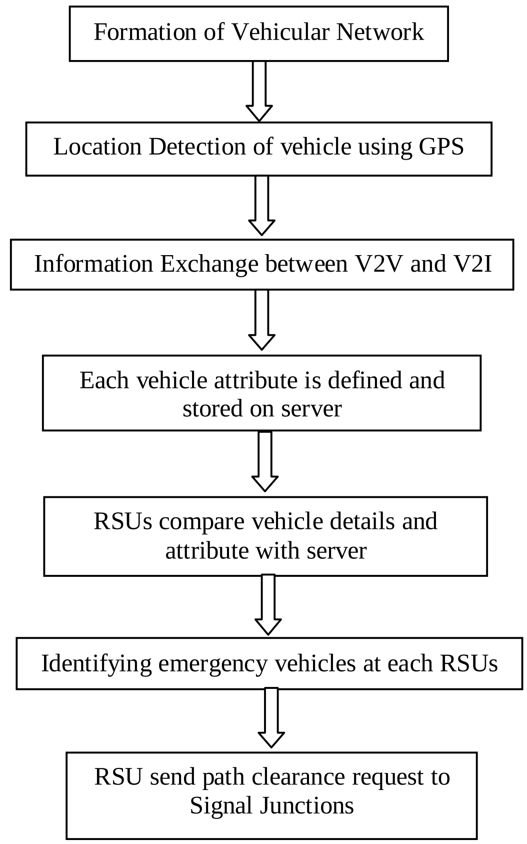

Figure 1: Framework activity for LoRaWRP Protocol

4. LORAWRP ALGORITHM

The first step of the algorithm was to provide the input on the set of the vehicle that can pass through the installed signal over the period and the maximum number of nodes or vehicles (n) that the system has been designed. The next step was framed to detect whether the number of nodes (i) was less than the maximum (n) within the limit of the setup. If i was less than the n, then the distance between the nodes was calculated, and the position of the nodes was estimated in x and y directions. Then the value of i was incremented.

The third step was to detect whether the v[i] was less than the maximum range, if it satisfies then the RSU would generate the information that was communicated to the vehicle through the OBU in them. The next step was to determine whether there were any emergency vehicles in the limit by checking the attributes of the vehicles with the server. If the

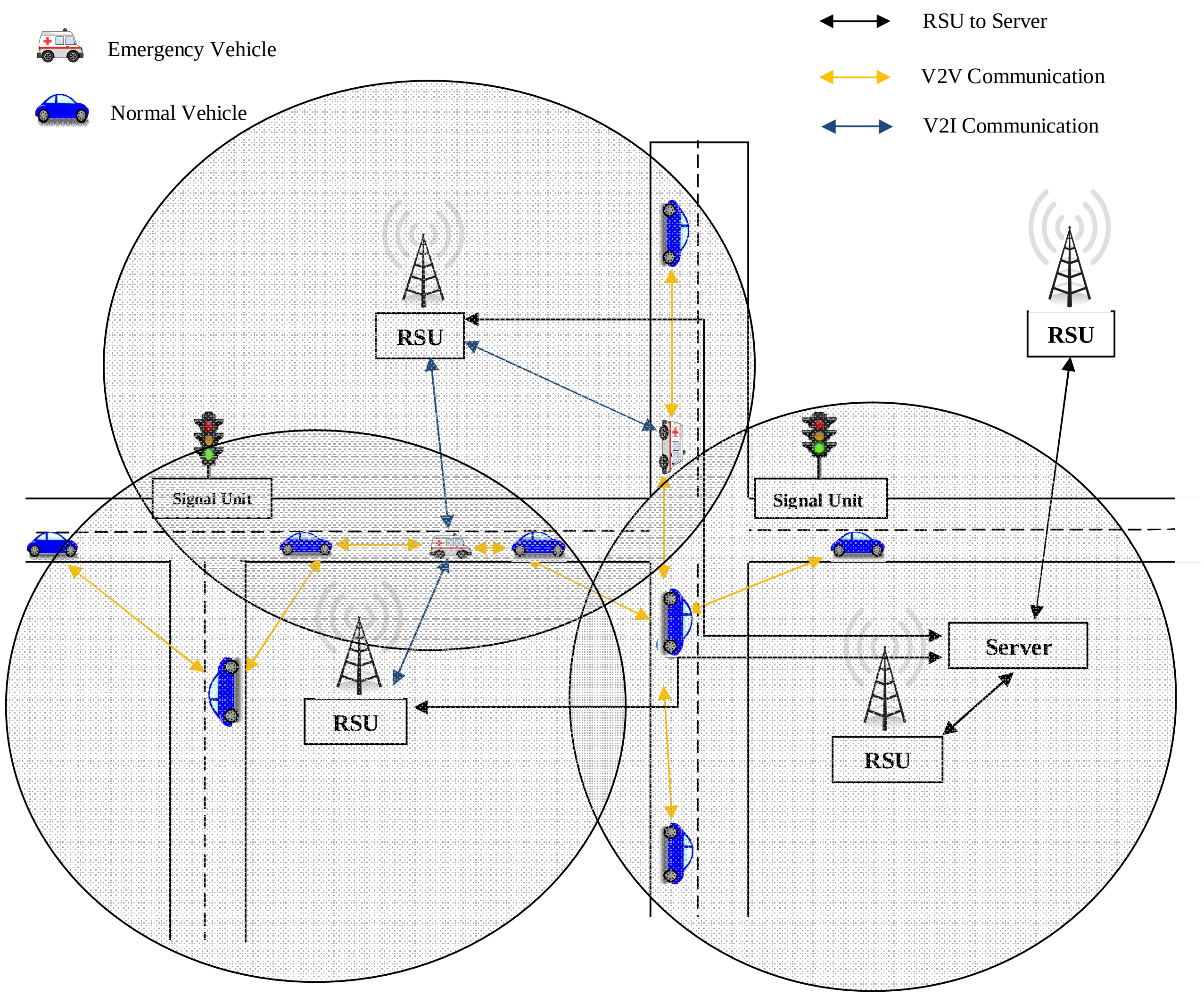

Figure 2: LoRaWRP Communication Network

attributes matched the emergency vehicle, the signal of the roads would be turned green for the time to aid the movement of it through the traffic. All other vehicles would be informed about it from the RSU. The condition would remain unaltered if there were no emergency vehicle.

LORAWRP Algorithm

```
Begin
Step:1
        input→ set of vehicle v [i];
        i=n;            // n number of vehicle in the network
        Initialize the vehicle v[1]= 1;
                        // considering the 1st vehicle
Step: 2
        while (i< n)
         {
            Distance= getDistance (v[i]);
             D= (vx [i], vy [i]);
                        // finding the GPS location of each vehicle
            increment i;
         }
Step: 3
        if (v[i] <= Maximum Range)
         {
            Broadcasting message from RSU to the vehicle
                through OBU (On-board unit) ;
            Detect location (v[i]) ;     //for all vehicles
            Vehicle details are monitor by the server;
         }
        else
         {
            Message transmit from vehicle to vehicle via OBU
               with route discover & Maintain;
         }
Step: 4
    Checking Emergency Vehicle
    Vehicle attributes→ alarm, symbol, shape, id;
    for (i=0; i<=n; i++)
```

```
    {
      Match of vehicle = detect (vehicle attributes of v[i]);
        if (match of vehicle! = emergency vehicle
                                          properties)
            {
                No emergency vehicle detected;
            }
        else
            {
                Emergency vehicle detected;
                Signal will be changed using
                            LoRaWAN sensors;
            }
        Vehicle traffic act as normal;
    }
End
```

5. CONCLUSION

The hybrid Vehicular network which is well connected by vehicles, RSU and cellular towers were developed with the novel LoRaWRP protocol as the routing protocol. The LoRaWAN sensors were incorporated into the architecture of the RSU by which the details of the vehicles can be fetched with reference to the server. With the help of the incorporated GPS and the advance LRWAN sensors, the location of emergency vehicles can be tracked. Since it uses LoRaWAN technology, the power consumed by each unit will be very less; also the range of transmission of signals will be high when comparing with other similar technologies like zigbee, RFID tags etc. The present system works well in the urban regions where the number of connected vehicles, traffic signal junctions etc are high than in the remote region or highways. In the future, this algorithm can be enhanced for stolen vehicle detection and for finding the optimal path to the vehicle drivers.

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