

Intelligent Transportation System Avoids Collision by Disseminate the Warning Messages in Vehicular Ad Hoc Network

S. Karthikeyini^{1*}, G. Rajiv Suresh Kumar², R. Divya³

Abstract

Roads overload leftovers a critical issue while they are invariably increased so as to increase their capacity and enhance their effectiveness. This can be likely to cause many troubles specified ecologically, financially, and socially. The progress of urban traffic management systems, structure and development of roads are solutions to handle this problem and acquire better the performance of the road transmission, but these solutions are high-priced and need extra space for the establishment and lasting maintenance. A substitute would be to use the novel technologies within the field of communication for dispatch traffic information like dangerous road conditions and accident sites and vehicles leave warning messages to the emergency vehicles. In this paper, we present a VANET framework to avoid traffic congestion and other vehicles in the network are warned of moving emergency vehicles. The emergency vehicles receive detailed information about the emergency vehicle and additional route information. The driver will take possible right action timely by receiving detailed information. This type of application rescues lives and save precious time.

Keywords: ITS-AC, VANET, Traffic, warning message, maintenance, road congestion

INTRODUCTION

Transportation plays a significant role within financial and social development and might be an influential catalyst for expansion. Nevertheless, the large number of vehicles exceeding the size if the roads cause many problems, especially in terms of road safety, and contamination. One of the foremost

important problems is traffic congestion, and this acts as a critical handicap for the road transport system. Bottleneck on the road is the state in which the power of the infrastructure is inadequate to regulate the flow due to the increased number of users causing a sphere slowdown in road traffic. This spectacle is distinguished by the disintegration of the quality of service, waste of time, stress problems for users, downgraded productivity, extended energy consumption, and increased pollution. Still, land transportation is the most used means of transportation, which demonstrates the exponential development in the number of vehicles each year, particularly in town areas, which makes the road infrastructure and the methods of traffic management out of place. Construction and expansion of roads, traffic, and access organizing roundabouts are answers to deal with this problem of traffic congestion

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and develop the work of the transmission. But these solutions are costly and need extra space for improved and constant maintenance.

Emergency vehicles such as ambulances, fire-juggernaut and patrol cars are distinctive to react to an emergency condition. In this way, reaching their destination of emergency state as soon as possible is the significant concern. Assume an ambulance arrive at the place of an accident place so ambulance going to the hospital carrying an injured person who requires medical service. When the fire started, fire-juggernaut which arrives at the place on right time. A patrol car which needs to reach the place where a crime has just been announced. In all three scenarios, the right time needed to arrive their destination has created huge difference and protect human lives and time also. In concern to arrive their destination as possible, the emergency vehicles describe precedence over the usual vehicles on the road and are frequently allowed by law to break traditional road rules in order to arrive their destinations in the quickly workable time, like driving via a crossing when the traffic signal light is red, or over the speed limit, like in the European countries and America. In a literature survey various VANET routing protocols connect the mobile user for disseminating the message along the way for intelligent and safe transportation system. The challenging task of finding and maintaining the route and deliver the information in right time and right destination. In IEEE 802.11p protocol standard support communication vehicle to vehicle and vehicle to a server through the ITS band of 5.9GHz (5.85-5.925 GHz) [1], [2]. IEEE 802.11p MAC covers Carrier Sense Multiple Access/ Collision Avoidance (CSMA/CA), Time Division Multiple Access (TDMA), Frequency Division Multiple Access (FDMA). CSMA/CA which sense the channel is ideal it transmit otherwise it choose the random back-off time slot from Contention Window. The draw of CSMA/CA is an unpredictable delay of channel access and hidden terminal problem occurred without using of packet RTS/CTS, which leads to the high rate of packet collision. The Space Division Multiple Access (SDMA) divides the road into cells and assign the slot for each cell. During the low density it wastes the bandwidth, and it reduces the network utilization [3]. To avoid the issue another IEEE 802.11p MAC TDMA used to allocate the time slot each vehicle to transfer the packet. Assign the slot through the Roadside Unit (RSU) or Cluster Head (CH) which increase the maintenance of centralized unit and can occur the merge collision. In a decentralized way allocate the slot to each vehicle reduce the overhead of maintenance cost, but it increases the access collision [4]. Decentralized ADHOC MAC exchange the frame slot information to one-hop neighborhood. And new entry vehicle acquires the slot from available slot. The drawback of ADHOC MAC not suited for two-way traffic because it doesn't handle the collision avoidance scheme [5]. IEEE 1609.3 covers the topology-based routing protocol and position-based routing protocol. The position-based routing protocol gets the destination position information by GPS or exchange of a beacon message instead of maintaining the routing table. In Greedy Perimeter Stateless Routing (GPSR) protocol forward the packet from source to destination. First, it follows the greedy forward to choose the nearest neighbor of destination within the transmission range otherwise it follows the planner graph to forward the packet from source to destination. Dynamic Source Routing (DSR) protocol finds the shortest path by the Dijkstra algorithm between source to destination and a sequence of junction over the street map. In Greedy Perimeter Coordinator Routing (GPCR) has no need of street map information it need street and junction information and follow the restricted greedy to transfer the packet to node on the junction and not forward the Crossway of junction [6]. Vehicle position, speed, direction needed for the collision avoidance scheme and safety application. United States Department of Transportation (USDOT) supports event driven message which generated when any dangerous condition detected and a periodic message contain vehicle speed, position, direction which is used for safety application and collision prediction application [7, 8].

PROPOSED SYSTEM

Intelligent Transportation System (ITS) examines the information exchange and support Basic Safety Message for V2V various safety applications. It has different system such as Roadside Unit (RSU) may be a traffic signal controller, traffic management center and vehicle. The vehicle may be light vehicle, freight vehicle, transit vehicle and emergency vehicle which are illustrated in Figure 1.

In vehicle communication, initially in our model emergency vehicle transmission the alert message to all nearby vehicles. The broadcast message having the Prevalent State of Emergency Vehicle (PEV), Emergency Vehicle Specification SEV, Partial Route of an Emergency Vehicle (PEV) and length of the length of route varied from time to time. So, by using this time1 is the sufficient time to seize a suitable action by the driver. The optimal value for time1 has to be established by field tests and user studies. Relative velocity of Emergency Vehicle (REV) can be calculated maximum speed of vehicle M_s at a time.

$$M_s = \frac{\text{Distance}}{t} \quad (1)$$

A minimum S is defined by m min to make sure that REV is of effective length, even when the EV is halted or driving slow gradually. Presently we use $d_{\min} = 400m$. Broadcasting delay is expected to be insignificant in contrast to the additional parameters and is, thus, implicitly and road map material is modeled in every node.

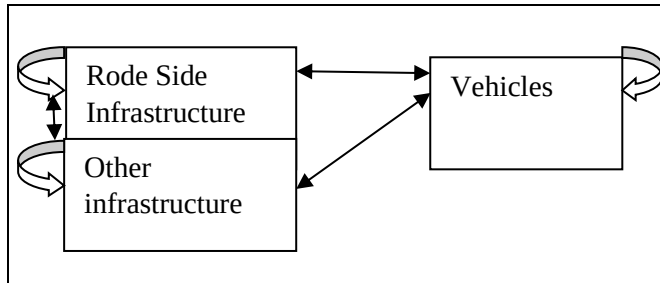


Figure 1. Intelligent transportation model for safety application.

Additionally, a 4-digit EV code is included in warning messages that provide information on the organizational type of the EV (e.g., patrol, ambulance, fire-juggernaut), the size of the EV (e.g., car, truck), and special properties (e.g., trailer) that enable other drivers to identify the emergency vehicle easier and react properly. This EV code provides more accurate warnings to identify the processes P for searching the nearest nodes,

$P = \{\text{Set of processes}\} P = \{P1, P2, P3, p4\}$

If (searching)

{

then

$P1 = \{e1, e2, e3, e4, e5\}$

}

Where

{

{e1= find the current position}

{e2= calculate speed}

{e3= find the route}

{e4= find the nearest nodes}

{e5= find the Distance between the nearest nodes}

}

$$EM = \sum_{BFD}^{FFD} \{\text{Broadcast the information}\} \quad (2)$$

FFD = Fix Forward Distance

BFD = Fix Backward Distance

Parameter Distance between two nodes $n1, n2$

Where to position of $n1 = p1(x1, y1)$ and position of $n2 = p2(x2, y2)$

The distance measurement between two vehicles is denoted in Equation (3).

$$\text{Distance} = \sqrt{(x1 - x2)^2 + (y1 - y2)^2} \quad (3)$$

Nearest neighbor can be calculated as distance < nearest neighbor threshold

Here, the emergency vehicle, sending a warning message between fix forward distance and backward forward distance. So, the other vehicle driver took the correct action. By using this technique, emergency vehicle to reach their destination as much early as possible

Skeleton of the Broadcast algorithm on the sender side:

```
# Generate a new message ID if needed
IF (distance (previous_location, current_location) >500)
{
OR (previous_time - current_time> 10)
OR (previous_road≠ current_road)
OR (previous_lane≠ current_lane)
}
THEN message_id← Generate_New_Message_ID()
END
IF
{# Prepare the packet
Packet← New_TC4EV_Packet (message_id, priority, current_location, current_velocity,
current_direction, current_road, current_lane, next_road_1, next_road_2, next_road_3) Send_Packet
(packet) }
```

ALGORITHM FOR EMERGENCY VEHICLE DECISION CONTROL

Begin Algorithm A source broadcasts Emergency message within the VANET.

When receiving Emergency message by a vehicle:

Cardist=dist(*carpath[0])

Ambudist=dist(*ambupath[0])

If (carseg== ambuseg)

{

then

Broadcast message (“ Ambulance in lane1, Change lane1 to lane2”)

Broadcast speed and distance information

}

Else

{

if (car-dist == ambu-dist) then

Broadcast message (“Change your oute, Follow the route 2”)

Broadcast speed and distance information

Broadcast message (“Change your lane Strictly”)

Broadcast speed and metric information vehicle

}

End if

End if

If(carseg!=ambu-seg && car-dist == ambu-dist)

{

then

Broadcast message (“Inform the driver to stay same lane, but slow down to let the ambulance go first”)

}

End
if End
Process p2 for forward the alternative path message to avoid the road congestion.
Process p2 = {e1,e2,e3}
{e1 = density of vehicle on the road}
{e2= speed of vehicle on the road}
{e3 = inter distance between the vehicle}

If an accident occurred, work in progress or the road is blocked, traffic congestion can occur. The congestion of road measured by the weighted parameter as speed of vehicle and distance of vehicles. Traffic management predicts the congestion and sends the alternate path message to avoid the congestion.

Number of vehicles on the road segment n_j . Average vehicle speed denoted in Equation (4).

$$V_s = (1/n_j \sum_{i=1}^{n_j} 1/v_i)^{-1} \quad (4)$$

The space between the vehicles V_{space} and S_{speed} is safety speed of vehicles on the road is denoted in Equation (5).

$$V_{space} = \frac{1}{n_j} \left(\sum_{i=1}^{n_j} length(vehicle\ i) + \sum_{i=1}^{n_j} \frac{speed(vehicle\ i)}{S_{speed}} \right) \quad (5)$$

The Density K of vehicle on the road segment and where V_{space} is an interspace between vehicles(6)

$$K = 1/V_{space} \quad (6)$$

The density K on the length L on the road segment at given time at t_1 is equal to the inverse of average space of n vehicle (7)

$$K(L, t_1) = \frac{n}{L} = \frac{1}{V_s(t_1)} \quad (7)$$

The number of vehicles Q passing in the road segment (8)

$Q = KV$ where K is the density and V is velocity

$$Q = 1/V_{space} \quad (8)$$

If Flow $Q < \text{Threshold}$ congestion occurred, it broadcasts the alternative path message along the road.

The flow and density relationship illustrated in Figure 2.

If Flow $Q (V_i) < \text{Threshold}$

Prepare the packet

Packet ← New_TC5CC_Packet (message_id, priority, current_location, current_velocity, current_direction, current_road) Send_Packet (packet)

ALGORITHM FOR CONGESTION DECISION CONTROL

Begin Algorithm B source broadcasts Congestion Control within the VANET.

When receiving Congestion Control by a vehicle V1

If Vehicle V1 within RSU range

Broadcast directly

Else

It finds the route from source V1 to destination RSU

RSU broadcast the alternative path decision along the road

P3= Lane changes warning of the microscopic model of the two- way lane traffic (Table 1).

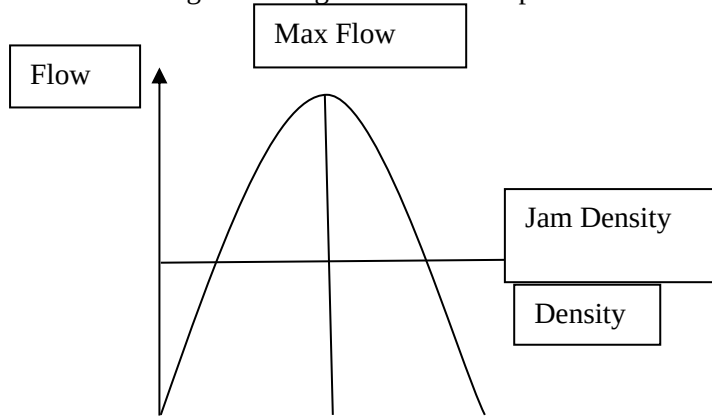


Figure 2. Relationship between density and flow of vehicle.

Table 1. Summary of symbols and their definition.

Symbol	Definition
Δt	Time step in [s]
Front distance	Expected inter-distance between I and j+1 after the lane change in [m]
Back distance	Expected inter-distance between I and j-1 After the lane change in[m]
Δx_i^{safe}	Safe distance at highway
$\Delta_{x_{j-1}}^{safe} (v_{j-1})$	Safe inter-distance between I and j-1 vehicle if on the same lane in[m]
$\Delta_{x_{j+1}}^{safe} (v_{j+1})$	Safe inter-distance between I and j+1 vehicle if on the same lane in[m]
V^{max}	Maximum velocity in [m/s]
V^{min}	Minimum velocity in [m/s]
V^{des}	Desired or targeted velocity in [m/s]
V^{safe}	Safe velocity in [m/s]

The combination of Global Navigation Satellite System (GNSS) and wireless communication support the safety application. Aim of safety application mitigates the vehicular collision and increase the traffic flow through the exchange of road condition information [9, 10]. The Lane Change Warning (LCW) application warns the driver who performs lane change when it is unsafe and predict the speed of remote vehicle. Vehicle I want to change the lane, it must find the maximum movement of following vehicles in the different lane[11, 12]. According to the Pipe's rule safe distance formulated in Equation (9)

$$\Delta x_i^{safe}(v_i) = L + T \cdot v_i + \phi \cdot v_i^2 \quad (9)$$

Where L is a Length of the vehicles, T is reaction time on the highway, ϕ is an adjusting parameter function on deceleration to maintain safe distance, $\phi \cdot v_i^2$ breaking distance.

When $\phi=0$ breaking distance between following and leading vehicle are equal.

It follows the inter-distance with the following vehicle j-1 at maximum speed at the next time stamp. The distance between inter vehicle follows condition which needs the current safe inter-distance with leading vehicle's safety, increased if it would reach the desired speed and the condition (10) and (11) explains inter-distance between vehicle and j+1, j-1 would not violate safety and avoid the accident on the same lane which is illustrated in Figure (3).

$$v_i^{des} > \Delta x_{i,i+1}$$

$$\Delta x_{i,j+1} \text{ or lead distance} > \Delta_{x_{j+1}}^{safe} (v_{j+1}) \quad (10)$$

$$\Delta x_{i,j-1} \text{ or follow distance} > \Delta_{x_{j-1}}^{safe} (v_{j-1}) \quad (11)$$

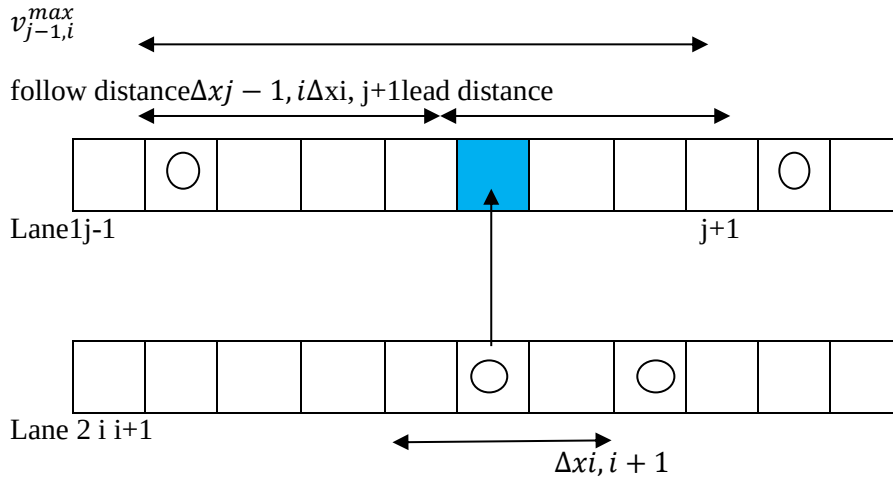


Figure 3. Safe Inter-Distance for Lane-change.

P4 = Broadcast Emergency Break Warning

Each car has a vehicle-to-vehicle communication devices such as ITRI WAVE/ DSRC(IWCW) is a radio communication system [13]. ITRI has an Advanced Driving Assistant system (ADAS) which integrate Lane Deviation Warning System (LDWS), Front Warning Collision System (FWCS) and Blind Spot Detection System (BSDS) are developed on System on Chip (SoC) [14, 15]. Each car can broadcast the Basic Safety Message (BSM) to warn the neighbor's car which is illustrated in Figure 4(a), (b), and (c).

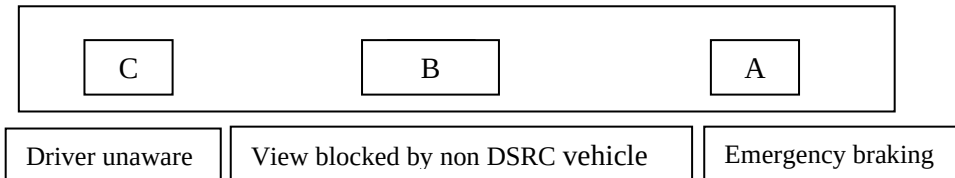


Figure 4. (a) Heavy break

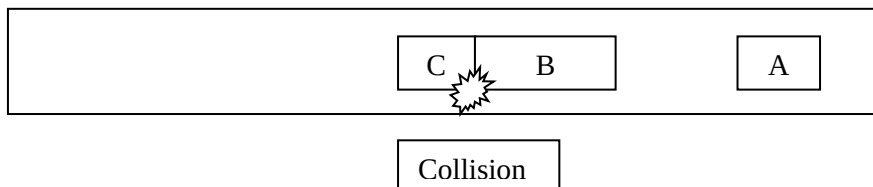


Figure 4. (b) Without EBW.

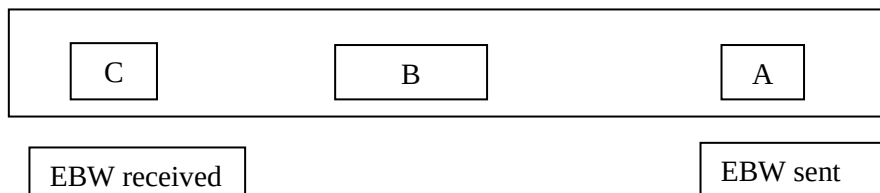


Figure 4. (c) With EBW.

Figure 4(a) brake lights are difficult to see if there is blocking the vehicle in between. (b) Without EBW vehicle C is not informed (c) With EBW, vehicle C is informed about the breaking information of vehicle A before the driver of vehicle B. A vehicle equipped with an IWCW system with consist of image detection, recognition module to collect the vehicle type, color and speed, GPS used to understand the car position information, User Interface (UI) responsible to display warning condition, which is connected with IWCW device with Wi-Fi, accelerometer (G-sensor) or On-Board Diagnostics -II used for detecting the emergency braking. An IWCW system broadcast vehicle type, color, speed, license plate information, vehicle list, current position and emergency message periodically broadcast nearby vehicle. The Licensed plate comparison technology is to collect information on vehicle type, color, and speed from camera to improve the position accuracy. The vehicle's list has the information about lane that are in same or adjacent. The vehicle's list construction module in the IWCW system which adds the license plate information of the front vehicle to BSM. The front vehicle's emergency brake warning information sent back to the car in the same lane not in the different lane which is illustrated in Figure 5.

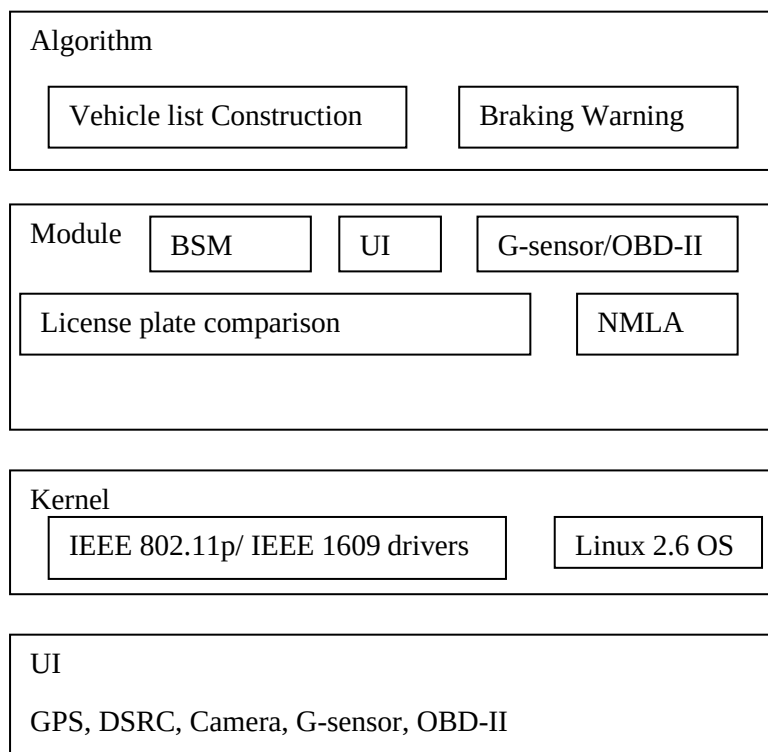


Figure 5. IWCW architecture.

Emergency Brake Warning Display:

1. IWCW broadcast BSM contain license plate of front vehicle, vehicle color, type, speed, current position, vehicle list
2. License plate comparison, continuously collect the information from camera and license plate of the front vehicle
3. Update vehicle list
4. If emergency braking signal arrived
5. Check signal source in vehicle list
6. If a signal source in the vehicle list
7. Determine the emergency level and display emergency brake warning in UI
8. Continue step 1.

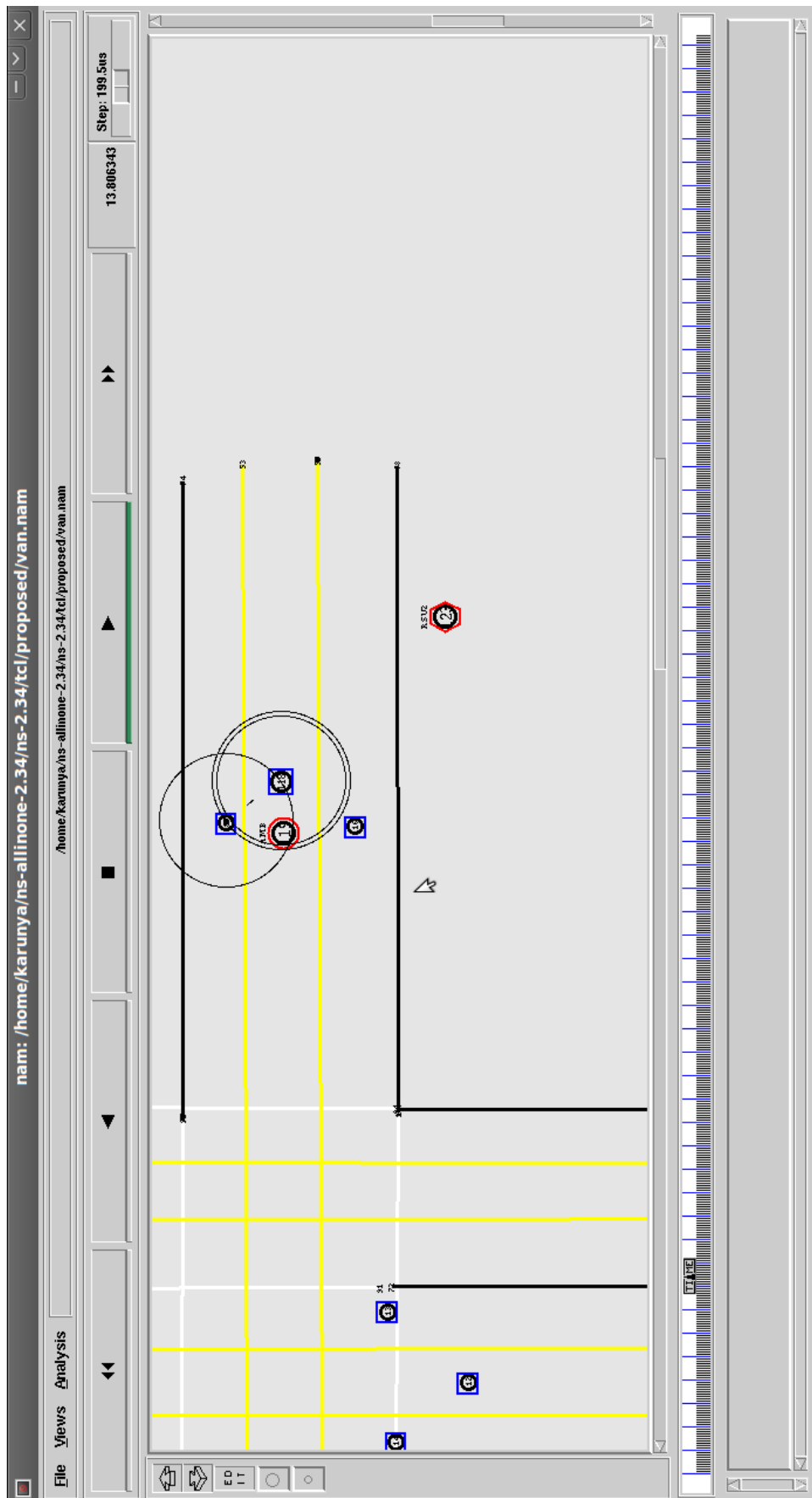


Figure 6. Transmission of Waring Message in Taffic Scenario.

SIMULATION RESULT

The Intelligent Transportation System (ITS) is an advanced application in which information, communication technologies and Artificial Intelligence (AI) are applied in the field of vehicles, drivers, and traffic management. To improve road safety and traffic efficiency on the road, it provides traffic information through safety applications such as route information, road curve warning, safe-overtake warning, speed limit warning, accident site information and emergency vehicle warning. Assume that an ambulance must carry an injured person from the accident site to the hospital for emergency treatment. In such a situation, the ambulance is allowed to break road norms like crossing the road when the traffic light is red or surpassing the speed limits so as to arrive at the destinations at the right time. The ambulance broadcasts this emergency message to its neighboring vehicle on the road to avoid mishaps and enable it to arrive at the destination at the earliest. Hence, the driver of the neighboring vehicle will take timely action by receiving emergency information. The simulation of traffic scenario is illustrated in Figure 6.

Table 2 shows the parameters used in the ITS-AC for reliable communication.

Table 2. Simulation parameters for ITS-CA.

Simulation Parameter	Value
Simulator	Ns-allinone-2.34
Topology size	1200 × 1200 m
Speed of vehicles	100m/s
Number of vehicles	100
Transmission range	250 m
Roadside Unit	6
Base Station	1
Packet size	512 bytes
Bandwidth	10MHz
Channel Data Rate	27Mbps
MAC type	802.11p

CONCLUSION

The vehicles in the network are responsible for communicating the warning information from source to destination for which it requires efficient nodes for improving effective communication. For effective communication, it is necessary to build the routing algorithm, which aims to improve the QoS in changing characteristics of the wireless channels over time and space in vehicular communication. The proposed work builds reliable routing protocol and maintains the consistent path when the speed of vehicles increases gradually in the network, resulting in low delay, controlled overhead, less packet loss, low energy consumption and high throughput compared to the existing protocol.

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