

Rapid Emergency Message Dissemination Routing In Delay Tolerant Network

G. Santhana Devi, M. Germanus Alex



Abstract: In VANET, vehicles are move very fast as a consequence intermittent connectivity occurs frequently. In this delay-tolerant situation, the emergency rescue message broadcast is an extremely challenging task. The proposed routing protocol REMD give a solution to the problem. REMD follow the store carry forward method and flooding based message forwarding method. This paper expresses rapid emergency message dissemination routing in delay tolerant network called REMD Protocol. In this protocol, the source vehicle broadcast emergency message to the presented all neighbour vehicles in its communication range. The sender vehicle allocates message replicas and message time to live to the neighbour vehicles based on the corresponding vehicles credence value. Each vehicle credence value is calculated from their Visited Level Estimation (VLE) and Destination Reaches Level Estimation (DLE) values.

Keyword: Delay-tolerant network, credence value, emergency message, message dissemination, routing protocol

I. INTRODUCTION

Generally, vehicle density is very low in rural areas as well as night time in urban areas thus end to end connection from the source to the destination is not possible majority of the time. In the highway, vehicles are moving very speedy thus intermittent connectivity such as delay tolerant network occurs on the road. As the emergency event is occurring in the intermittent connectivity areas, the message communication problem is occurring. In this situation, vehicles preserve and carry the emergency message until it will meet the other vehicle in its communication range [1]. In the DTN, default message copies and message TTL is not suitable for emergency message communication. Hence, the proposed REMD routing protocol allocates different number of message replicas and different duration of message TTL for each vehicle based on their credence value. Each vehicle credence value is calculated from the corresponding vehicle Visited Level Estimation (VLE) value, it is calculated based on the number of nodes previously visited by the node and Destination Reaches Level Estimation (DLE) value, it is calculated based on the number of times the node successfully delivered the message to the destination. The delay-tolerant routing protocols are well suited for disconnected and delay tolerant network which provides the connectivity and reduce the message latency and increases the message delivery ratio. In this routing, each node employs store and carry forward method.

In the DTN, vehicle density is very low those time the source node store and carry the message until it meets the suitable forwarder then forwards the message. Thus, the proposed REMD routing protocol follows the store-carry and forward method. In addition, it pursues flooding message forwarding approach [8] is used to improve the message delivery ratio and throughput. Some of the Delay routing protocols are described below.

The epidemic protocol [2] is a simple and basic DTN protocol. This protocol use flooding based strategy in message communication. It achieves fast and probably delivers the message to its destination. The MaxProp protocol [3] is to follow the flooding based strategy and openly clears the delivered bundle copies in the buffer. The authors [4] are presented DAWN protocol chooses the data forwarding method with the use of how many numbers of vehicles available in the roads such as density-based data forwarding method is selected for message communication. The authors [5] are proposed DARCC protocol assume all vehicles have a GPS which is used to calculate the motion vector based on a vehicle moving speed and direction.

The authors ASCF [6] are present ASCF protocol. This protocol is developed for reducing the outage time of vehicles. Such as the vehicle positioned in the uncovered area it provide the relay node communication to the vehicles thus out of coverage time is decreases. The authors [7] present GeoSpray protocol. This protocol combines the advantage of the GeoOpps and Spraywait protocols. At the beginning, GeoSpray uses the multiple copy scheme, which flood the limited message copies to all directions subsequently it uses the single copy scheme. This protocol deletes the delivered message from vehicles storage buffer with the use of disseminating the delivery information. The authors [9] presented GeoOpps is a single copy routing protocol. In [10] authors proposed VADD choose the forwarder based on a vehicle moving direction and positioned near the destination. In [11] authors developed PBRS solves the RSU coverage problem in communication. The main aim of the REMD routing protocol is to enhance the probability of emergency message delivery ratio and throughput.

The contribution of the REMD routing protocol is given below

- In the REMD routing protocol, each vehicle follows the store and carry technique.
- The sender node allocates the message replicas and message TTL to all neighbour vehicles based on their credence value.
- Providing the diverse number of message replicas and message TTL will improve the message delivery ratio.

Manuscript published on 30 August 2019.

*Correspondence Author(s)

G. Santhana Devi, Research scholar, Research & Development Center, Bharathiyar University, Coimbatore-641 046, Tamilnadu

M. Germanus Alex, Prof & Head, Government Arts and Science College, Nagercoil, Tamilnadu

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- As the message reaches the destination, the intermediate vehicles have the corresponding message will be clear.
- The proposed REMD routing protocol endeavour improving the message delivery ratio and throughput through the optimized forwarder in the network.

II. METHODOLOGY OF REMDR

This section, provide the main concept of the REMD routing protocol and present detail explanation for the REMD routing protocol.

In the emergency situation, if the vehicle present in sparse networks, the connectivity problem will occur. This suffers the emergency message transfers in the instant of time reasoning that no available neighbour nodes. So, route breakages and message losses will occur. The proposed REMD routing protocol solves this problem.

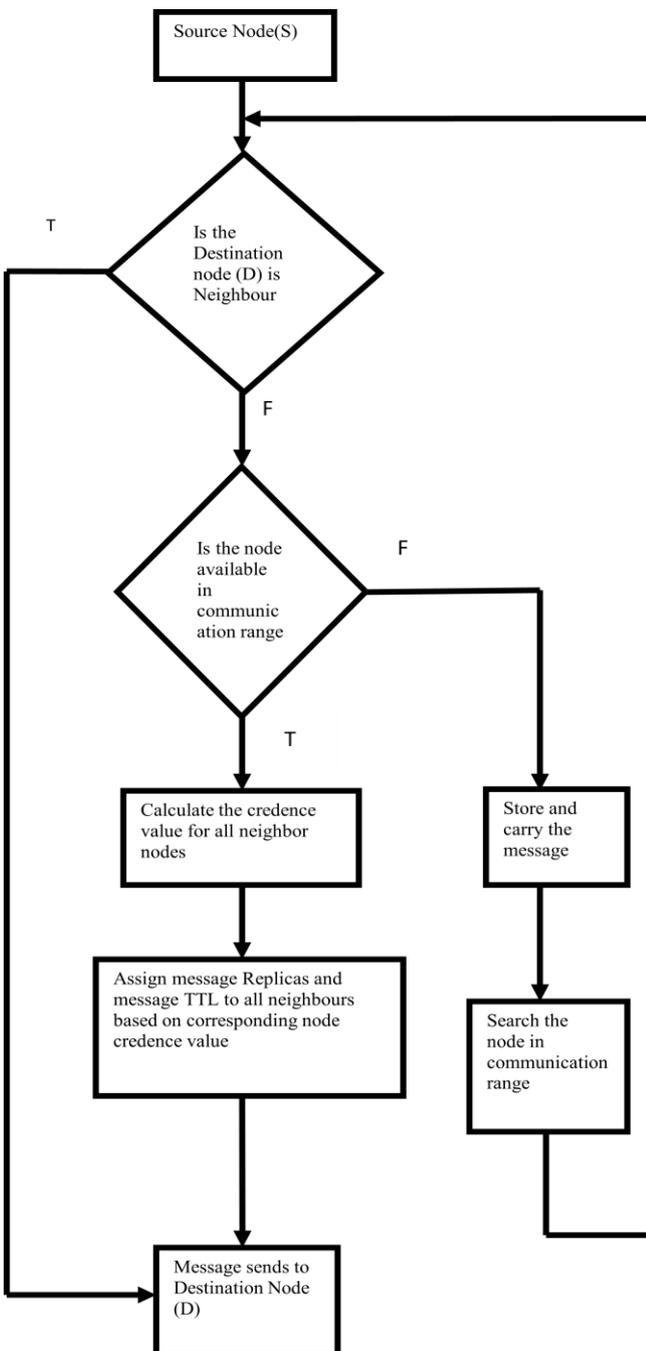


Fig 1: The process of REMD Routing Protocol

In the REMD routing protocol, primarily the sender vehicle verify, the destination node is existing in its communication range. If the destination node is offered here then it will directly send the message to the destination. Otherwise, it forwards the message with the help of the intermediate vehicles. Sometimes the sender vehicle does not have any neighbour vehicles in its communication range, that time it will save and carry the message until it will meet the neighbours, which is called store-carry forward method.

The process of REMD Routing Protocol is shown in Fig.1

In the REMD routing protocol, the sender node concurrently compute the visited level and Destination Reaches Level estimation for each neighbouring vehicle and then calculate the credence value for that vehicle. The sender vehicle allocates message replicas and message TTL to the neighbour vehicles depending upon their credence value. The vehicle has greater credence value; high message copies and long message TTL are provided to that vehicle.

REMD routing protocol Algorithm:

- Step: 1**
Source vehicle calculate the visited level estimation value to its neighbor vehicles.
- Step: 2**
Source vehicle calculate the destination reaches level estimation value to its neighbor vehicles.
- Step: 3**
Source vehicle calculate the credence value to its neighbor vehicles.
- Step: 4**
Source vehicle assign the message replicas and message TTL to its neighbor vehicles based on credence value.
- Each neighbor vehicle repeats this process 1 to 4 until the emergency message to reaches the destinations.

Fig. 2. The REMD Routing Protocol algorithm

Credence value range is 0 to1. The vehicle has a credence value is the high range, the sender vehicle provides a high number of message copies and long message TTL to that vehicle or else the number of message copies and message TTL duration is based on vehicle credence value.

The REMD Routing Protocol presumes that all vehicles frequently update and store their visited level (VL) values and Destination Reaches Level (DL) values in its buffer. The vehicles send that values to its neighbours at beacon message broadcast time. The REMD Routing Protocol algorithm is given in Fig: 2.

Step: 1

In the REMD routing protocol, the source vehicle first calculate the visited level estimation value for its neighbours. Vehicle_i visited level [vehicle_i (VL)] means the amount of vehicle visited by the vehicle_i within the specific time period. Each vehicle has different visited level depending on it has neighbours. Generally, during the beacon time each vehicle collects the visited level VL from its neighbours. The source vehicle S, select the highest visited level such as [MAX VL] from its neighbour node's Visited Level collection.

$$MAX_{VL} = MAX (vehicle_i (VL)) \quad i=1,2,...,n$$

Where n is the number of neighbour vehicles for source vehicle S. After that, source vehicle S calculates the Visited level estimation value (VLE) for each neighbour vehicle using the following equation.

$$\text{vehicle}_i (\text{VLE}) = \text{vehicle}_i (\text{VL}) / \text{MAX}_{\text{VL}} \quad i=1,2,\dots,n$$

Where n is the number of neighbour vehicles for source vehicle S.

Step: 2

In the REMD routing protocol, after the VLE calculation, the source vehicle S calculate the Destination reaches level estimation value(DLE) for its neighbours.

Vehicle_i Destination reaches level [vehicle_i (DL)] means the amount of time that vehicle disseminate the message successfully to the destination. Each vehicle has different destination reaches level depending on its moving the path and its neighbours.

Procedure for assigns the message replicas and message TTL	
If [Node _i (S _{credence}) < 0.1] then	Set Message replicas is 0 Set Message TTL is 0
Elseif [Node _i (S _{credence}) > 0.1 and Node _i (S _{credence}) ≤ 0.3] then	Set Message replicas is 3 Set Message TTL is 3
Elseif [Node _i (S _{credence}) > 0.3 and Node _i (S _{credence}) ≤ 0.5] then	Set Message replicas is 6 Set Message TTL is 5
Elseif [Node _i (S _{credence}) > 0.5 and Node _i (S _{credence}) ≤ 0.7] then	Set Message replicas is 8 Set Message TTL is 7
Elseif [Node _i (S _{credence}) > 0.7 and Node _i (S _{credence}) ≤ 1.0] then	Set Message replicas is 10 Set Message TTL is 10
EndIf	

Fig: 3 Procedure for assigns the message replicas and message TTL

Generally, during the beacon time each vehicle collect the destination reaches level DL from its neighbours. The source vehicle S, select the highest destination reaches level such as [MAX_{DL}] from its neighbour node's Destination reaches Level collection.

$$\text{MAX}_{\text{DL}} = \text{MAX} (\text{vehicle}_i (\text{DL})) \quad i=1,2,\dots,n$$

Where n is the number of neighbour vehicles for source vehicle S.

Subsequently, source vehicle S computes the Destination reaches level estimation value (DLE) for each neighbour vehicle using the following equation.

$$\text{vehicle}_i (\text{DLE}) = \text{vehicle}_i (\text{DL}) / \text{MAX}_{\text{DL}} \quad i=1,2,\dots,n$$

Where n is the number of neighbour vehicles for source vehicle S.

Step: 3

In the REMD routing protocol, after the VLE and DLE values calculation, the source vehicle S calculate the Credence value for its neighbour vehicles.

Vehicle_i credence value is calculated from visited level estimation value and destination reaches level estimation value. In the credence value calculation, two weight factors w1 and w2 are used.

In the credence value calculation, visited level estimation and destination reaches level estimation both are

most important. Thus, two weight factor w1 and w2 have equal value is 0.5.

The sum of w1 percentage of Vehicle_i visited level estimation value vehicle_i (VLE) and w2 percentage of Vehicle_i destination reaches level estimation value vehicle_i (DLE) is called the Vehicle_i credence value [vehicle_i (Credence)].

$$\text{Node}_i (\text{Credence}) = w1 * \text{Node}_i (\text{VLE}) + w2 * \text{Node}_i (\text{DLE})$$

Where, w1 is weight factor1, w2 is a weight factor 2 w1, w2 = 0.5

The Node_i (Credence) value is 0 to 1

Step: 4

In the delay tolerant network, vehicle counting is very low hence, connectivity problem will occur frequently. The REMD solve the connectivity problem with the use of message copies and message TTL allocation. In the REMD, the sender vehicle allocates message replicas and message TTL to its neighbours based on their credence value. While vehicle credence value is high, it has high opportunity to inspection the destination or it has the maximum chance to visit the more neighbour nodes.

The sender vehicle assigns the message replicas and message TTL to its neighbours based on the credence values as the procedure is given in Fig: 3.

In the DTN environment, the proposed REMD Routing protocol sends the message to its neighbours with various numbers of message copies and various messages TTL based on their credence value. Thus, confidently any one node must deliver an emergency message to the destination.

III. IMPLEMENTATION AND RESULT ANALYSIS

Generally, the main aspire of the delay-tolerant network routing protocol is to deliver the emergency message with the instant of time. In addition, in the DTN message delivery is a challenging task. Thus, the proposed protocol performance metrics message delivery ratio is analyzed with various DTN protocols. Afterward, the message delivery ratio of REMD is compared in different network connectivity condition.

The simulation parameters of REMD routing protocol is given in Table: 1. In the NS2 simulator, this parameter values are and run the simulator to assess the performance value. In this evaluation originate that the proposed REMD routing protocol is superior to existing schemes. The obtained results are shown in the following figures.

Table 1: Simulation Parameters to REMDR Protocols

Parameters	Values
Network Area	3000mX 3000m
Node Density	125,150,175
No of RSU	3
MAC Protocol	IEEE 802_15.4
Beacon Interval	500 Sec
Average Vehicle Speed	25 m/s
Message Size	200 Bytes
Encrypted Message Size	302 bytes
Buffer Size	150 MB
Time To Live	800 c



A. Comparisons of message delivery ratio

In this section, the message delivery ratio of the proposed REMD routing protocol is evaluated and compares with other existing DTN protocols Epidemic [2], MaxProp [3].

The network connectivity means the number of vehicles connected in the network. The Message TTL means the amount of time the message should protect in vehicles storage buffer earlier to being discarded. In the 60% network connectivity, the message TTL changing between 0, 30, 50, 100 to 800 seconds in the simulation, attain the message delivery ratio of various protocols is illustrated in Fig: 4.

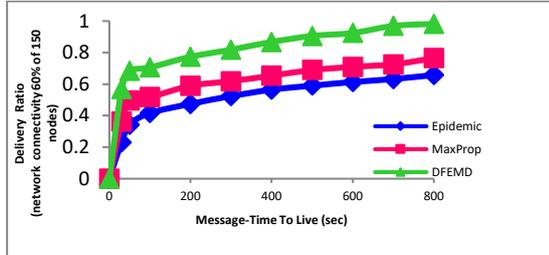


Fig: 4 Comparisons of Message Delivery Ratio

Fig 4 shows REMD protocol is better as compared with Epidemic and MaxProp protocols in terms of message delivery ratio. While the Message TTL equivalent to 800 seconds the message delivery ratio of REMD is increasing as compared to the epidemic 32.47% and compared to MaxProp 21.80%. Among these three protocols, the message delivery ratio of proposed REMD protocol is superior, the Epidemic protocol message delivery ratio is low and the MaxProp protocol message delivery ratio is moderate.

In Fig 4, we observe that the message TTL increases, the message delivery ratio also increases. As the TTL is 700 seconds, the proposed REMD protocol message delivery ratio is gradually reach 97%. Because in the DTN the message TTL is increased, the vehicle has an opportunity to visit more vehicles in their communication range hence; it delivers the message effectively to its destination. In this figure, observe that the REMD routing protocol has the higher delivery ratio as compared to other protocols.

B. Message delivery ratio in different network connectivity

The message delivery ratio is obtained in different network connectivity such as 50%, 60% and 70 %. This simulation result is shown in Fig: 5.

In this simulation, 50% network connectivity means 125 vehicles available in the network, 60% network connectivity means 150 vehicles available in the network and 70% network connectivity means 175 vehicles available in the network. In DTNs, the vehicles not available in communication range it follow the store and carry approach for message communication. Based on vehicle density the message store and carry time is varies.

In this Fig :5, the highest message TTL such as 800 seconds is needed to deliver all messages in 50% network connectivity as well as 700 seconds is needed to deliver all messages in 70% network connectivity. As increasing network connectivity in DTN, it will change the partially connected network to fully connected network hence, the smallest message TTL is needed to deliver all message to the destination.

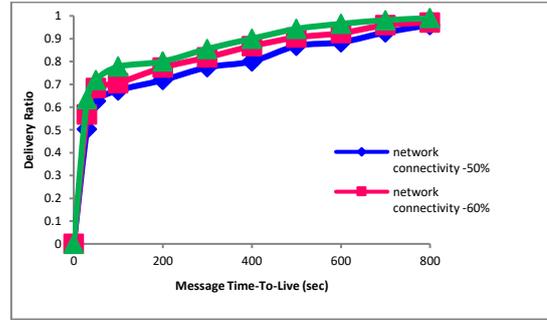


Fig: 5 Message Delivery Ratios in Different Network Connectivity

C. Comparison of throughput with various protocols

This section analyzes the performance parameter throughput among the proposed REMD routing protocol with existing Epidemic and MaxProp protocols.

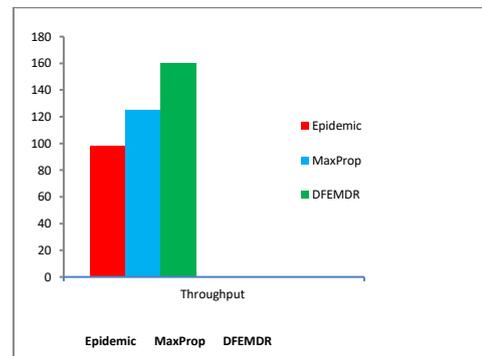


Fig: 6 Throughput with various protocols

Fig 6 shows the throughput of the three protocols in the 60% network connectivity. According to the graph illustrate the throughput of the proposed REMD protocol is extremely high as compared with the Epidemic and MaxProp protocols. In the delay-tolerant environment, vehicle density is very low hence, the proposed REMD routing protocol is initiated more message copies and extend the message TTL thus the message delivery ratio will be increased in the protocol.

IV. CONCLUSIONS

The proposed protocol REMD is developed for emergency message dissemination in the delay-tolerant network. Before forwarding the emergency message the sender vehicle calculates the credence value of each neighbour vehicles based on the corresponding vehicle visited level estimation value and Destination Reaches Level estimation value. After that, the sender vehicle allocates the message copies and message living time such as message TTL to all available neighbours based on their credence value. The sender vehicle set the various numbers of message copies and various message TTL to each forwarder. The vehicle has high credence value it has the maximum chance to deliver the message to the destination hence, sender vehicle allocates more message copies and long message TTL to that vehicles.

As increasing the message TTL the message delivery ratio will be increased. However, this routing protocol provides connectivity for emergency rescue message dissemination in the vehicular ad-hoc network.

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AUTHORS PROFILE



G.Santhana devi is currently pursuing the research in the Department of Computer Science, Bharathiar University Coimbatore, Tamilnadu and also working as a Lecturer in Kamarajar Government Arts College Surandai, Tamilnadu. She has completed her Mphil degree in Computer Science from Prist University, Thanjavur, Tamilnadu. She has completed her M.C.A degree in Computer Science from Annamalai University, Chidambaram, Tamilnadu. Her

research interest in the field of image processing and ad-hoc networking.



Dr.M.Germanux Alex is currently working as a Professor & Head in the Department of Computer Science, Government Arts and Science College, Nagercoil, Tamilnadu. He received his M.Sc - Computer Science in St. Joseph's College, Tiruchirapalli affiliated to Bharadhidhasan University. M.Phil- Computer Science in Manonmaniam Sundaranar University, Tirunelveli, Tamilnadu. He

received his Doctorate in Computer Science, Manonmaniam Sundaranar University, Tirunelveli, Tamilnadu. He has published papers in many National and International level Journals and Conferences. His Research interests are in the field of Digital Image Processing, Data Mining, Computer Networks, Neural Network.