

# Carry and Forwarding Based Routing Protocol for Urban Geographic Vehicle Networks

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**Abstract:** Some of the existing Researchers vehicular communication applications will involve pre defined path construction based multicast and broadcast based communications where all vehicles in a definite region of interest are the planned recipients of particular messages. The existing system take more computation time for path plan construction .The proposed system focus on carry and forwarding based vanet routing protocol to improve the packet reliability of broadcast VANET communications and also reduce communication cost. The new improved routing carry and forward technique to disseminate emergency data, after a car crash, within a group of vehicles. Here consider a route based data dissemination technique to perform broadcast flooding task optimization, and compare it with a existing flooding scheme. For the evaluation, The warning message dissemination based protocol is used to calculate the Performance of the proposed store-carry-forward protocol is evaluated in terms of network reach ability, received distance, and network overhead in ideal different topology scenarios as well as in real cities. The overall performance of store-carry-forward is excellent.

**Index Term** – VANETs, dissemination, trajectory-based broadcasting, flooding, performance evaluation.

## 1. INTRODUCTION

In VANETs, there are three types of techniques of communications Inter-vehicle communication, vehicle-to-roadside communication, and routing-based communication. In inter-vehicle communication, there are two types of message forwarding mechanism naive broadcasting where vehicles periodically broadcast messages and ignore the message from at the back. It ensures all the vehicles moving in forward direction can receive the broadcast message. Intellectual broadcasting where the number of message broadcast for an event is imperfect. If the event detecting vehicles receives same messages from the vehicles from behind, it is assumed that at least one vehicle from at the back received the message and stop broadcasting. The vehicle from behind is responsible for moving the message forward. Vehicle to roadside based communication is the communication between the road-side unit and the vehicles. The roadside unit will periodically broadcast certain information such as speed limit to all the vehicles within its range.

Dedicated Short-Range Communications (DSRC) is a promising wireless technology which operates in the 5.9 GHz range with 75 MHz of spectrum. It is a standard wireless protocol still under expansion which is designed to support vehicle-to-vehicle and vehicle-to-infrastructure communication. Its primary reason is to support serious safety applications which will decrease the number of accidents on the road and as a result will reduce the number of live lost and its minor purpose is to improve traffic flood, although sideways from these two, confidential services will also be allowable.

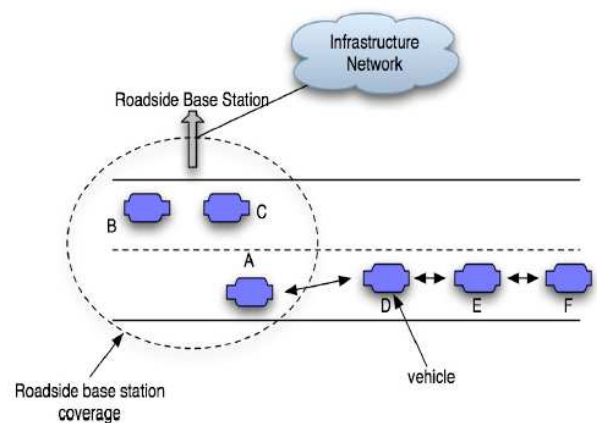


Fig. 1. Vehicular network architecture

In vehicular networks, it is expected that there will be limited access to an infrastructure network that will be supported by roadside base stations. Such access is limited in its nature for two reasons. First, the deployment of the infrastructure is expected to be slow and incremental leading to wide areas where there is no access to the infrastructure. Second, a complete deployment is expected to be sparse because of cost. The coverage provide by a roadside base station may be on the order of 200-300m while roadside base stations may be placed every km or so. Consequently, not all vehicles will be connected to the infrastructure at all times. To obtain access to safety or other types of information, it becomes necessary to rely on vehicle-to-vehicle communications.

The rest of the paper is organized as follows. Section I, gives an overview of related work. Section III presents proposed approach. In Section IV, deal with some topologies to validate proposed approach. Conclusion is presented in Section V.

## **2. RELATED WORK**

The Existing system has been shown that routing protocols, designed for highway VANETs [2], cannot be directly mapped or applied to urban VANETs [1], [7] as they do not work well in this new two dimensional topology environment. Due to space limit, only routing protocols for urban scenarios will be discussed.

Urban Multi-hop Broadcast (UMB) protocol proposed by Korkmaz et al. is a MAC layer solution for disseminating messages to all vehicles [3]. In this protocol, each vehicle contend for the channel by transmitting a variable-length black-burst; the vehicles with the longest burst end up forwarding the message. Vehicles (or repeaters) at intersections also create additional directional message broadcasts to other road directions. Yi et al. have proposed the Street Cast protocol in [8] which is also a MAC layer protocol that comprises three components: i) relay-node selection (RSUs at intersections choose the optimal relay vehicles); ii) Multicast Request-To-Send (MRTS) handshaking which is used to avoid collisions and hidden terminal problem; and iii) adaptive beacon control which is used to avoid the broadcast storm problem caused by hello messages at a crowded intersection. However, both UMB and StreetCast protocols assume that the network is always well-connected; no solutions for disconnected networks have been reported.

Costa et al. propose in [9] a Direction-aware Function-Driven Feedback augmented Store and Forward Diffusion (DFD-FSFD) scheme. Each vehicle, upon receiving the message, computes a forwarding probability based on the proposed message propagation function that encodes information about target areas and preferred routes. In the case where the network is disconnected, vehicles store and periodically rebroadcast the message. AckPBSM, an Acknowledged Parameter less Broadcast in Static to highly Mobile protocol, is proposed by F. J. Ros et al. in [1]. This protocol uses the Connecting Dominating Set (CDS) concept for broadcasting in well-connected networks. Message reception acknowledgement, piggybacked in periodic hello messages, is used for relaying the message in a disconnected network. In this scheme, vehicles, upon receiving the messages, have to wait for the new hello message in order to compute their wait time. Hence, the message latency depends on the hello message interval which might cause additional delay when the hello interval is large. Both [1] and [9] are evaluated in ideal Manhattan-like urban scenarios.

In this paper, we propose a fully distributed, lightweight, and zero-infrastructure support broadcast protocol that can support both well-connected and disconnected network regimes for broadcast applications in urban areas. The proposed protocol utilizes both direct relays through multi-hop transmissions (i.e., spatial relay) and indirect packet relays through the “store-carry-forward” mechanism (i.e., temporal relay). The protocol has been evaluated extensively both in ideal Manhattan-like and real city scenarios.

## **3. PROPOSED APPROACH**

The successful dissemination of latency sensitive messages is a much more challenging requirement to meet in two-dimensional urban areas than in one-dimensional highway scenarios. Such complications arise from the additional dimension of the urban network topology and existence of intersections. Some of the key routing issues/problems that distinguish the protocol design for urban scenarios from the design for highway scenarios are:

### **3.1. Region of Interest**

In order to determine the appropriate ROI for a VANET application, one has to consider whether all the vehicles in a particular geographical location that travel in a particular direction would be interested in the broadcast message. This implies that the ROI of a particular application should be determined not only by the geographical area but also by the route schedule of individual vehicles.

### **3.2. Direction change**

Due to the possible direction changes of vehicles at intersections, it is not obvious which vehicles should be responsible for storing, carrying and forwarding the message. dissimilar highway scenarios, where the sequential relay node is always the utmost vehicle traveling in the direction opposite to the message direction (such a vehicle has the smallest re-healing time, i.e., time to encounter new vehicles), the same method may not work in urban scenarios; i.e., only the utmost vehicle decisive factor might be insufficient, as it will relay the message only to a sub region of a city. Hence, the traditional store-carry-forward (SCF) mechanism (i.e., the selection of SCF-agent vehicles) used in one-dimensional highway protocols might not be an appropriate solution for urban areas.

### **3.3. Multiple ROI**

While there is only one “entry” and one “exit” locations in the ROI of highway scenarios (as indicated with green and blue arrows, respectively), the ROI in urban scenarios typically has several locations where vehicles can enter and exit from. Because of the multiple “entry” points, it is no longer realistic to assume that if the message reaches the end of the relevant area, the complete section of the road has already been covered. Vehicles that enter into the already-covered area may not receive the message if they arrive at a later time, after the time the message passes through the full topology area.

### **3.4. Vehicle location based Connectivity**

It is clear that the transmission coverage of vehicles in urban areas differs depending on their geographical locations. The transmission coverage of the intersection vehicles may cover more “road area” than that of vehicles between intersections (i.e., non-intersection vehicles).

Hence, the intersection vehicles are more likely to have better connectivity, i.e., they have a higher number of neighbors. The proposed urban routing protocol should utilize this non-uniform transmission coverage feature which is unique to the urban environment.

### 3.5 Routing store-carry-forward

Due to the omni (or multi) directionality of message direction and the ROI, if there is only one vehicle responsible for the SCF task, the message will be temporally relayed to the region through which such vehicle passes before it leaves the ROI (i.e., only a sub region of a given ROI will be covered). Therefore, in order to relay messages in many directions, SCF task should be assigned to more than one vehicle. This mechanism is crucial, especially during the initial deployment phase of DSRC where only a small fraction of vehicles will be DSRC-equipped.

Due to the possible changes in vehicles' direction and the fact that the ROI in urban areas has several entry and exit points, it is clear that a vehicle will encounter uninformed neighbors again and again (at different points in time). Thus, vehicles assigned as "agents" for SCF should continue to carry and forward the message even though they have already relayed their messages to the new neighbors. However, such modification may cause a lot of rebroadcasts; some of which will clearly be redundant. In order to avoid such unnecessary rebroadcasts, the routing protocol should restrict the message rebroadcasts as opposed to blindly rebroadcasting the message whenever SCF-agent vehicles meet new neighbors.

One solution to avoid redundant rebroadcast is to use message acknowledgment in periodic hello messages. For example, an additional 4-byte field (called message id field) should be added to the message header which stores id of messages that a vehicle has recently received. With this acknowledgment mechanism, an SCF-assigned vehicle can decide whether it should rebroadcast the message upon receiving hello messages from its neighbors.

Intersection vehicles naturally have more neighbors than non intersection vehicles, particularly in a network with high traffic density. Warning message rebroadcasts from the intersection vehicles thus are likely to reach additional vehicles within a shorter time, as compared to the case where the same number of messages is rebroadcasted from the non intersection vehicles. Intersection based broadcast storm suppression scheme is therefore expected to be more effective and efficient than other non-intersection-based schemes.

### 3.6 Protocol Implementation

#### 3.6.1 Selection of Store-carry-forward

In our implementation, store-carry-forward (SCF) task is assigned to vehicles that have small expected re-healing

time (i.e., time before they see new neighbors). However, due to two-dimensional road topology and possible changes of vehicles' directions at intersections, it is impractical to compute the re curative time of a vehicle in urban areas based only on its location and direction. Hence, we assign the SCF task to vehicles on the boundary of the connected component since they, with high probability, have a smaller re-healing time as compared to the non border vehicles. Vehicles in the in the shade region belong to the connected component. Thus, it is obvious that the boundary vehicles, as indicated with blue color, are more likely to meet other uninformed vehicles (e.g., outside the connected component) before the non-boundary vehicles (as depicted by red vehicles) do. Therefore, such boundary vehicles are the primary candidates for the SCF task.

#### Efficient Algorithm for SCF agent Vehicles Selection

**Step1:**  $\angle(A, S, i) \Leftarrow$  angle between a vector from Vehicle A to Vehicle S and another vector from Vehicle A to Vehicle i where  $\angle(A, S, i) \in [-\pi, \pi]$   
**Step2:**  $Nbr(A) \Leftarrow$  set of all neighboring vehicles of Vehicle A  
**Step3:** When A receives the message for the first time from Vehicle S  
**Step4:** for all  $i \in Nbr(A) \setminus \{S\}$  do  
 $\theta_i \Leftarrow \angle(A, S, i)$   
 End for  
**Step5:** neighbors of all nodes  
 $\theta_- \Leftarrow \min(\min_i(\theta_i), 0)$   
 $\theta_+ \Leftarrow \max(\max_i(\theta_i), 0)$   
**Step6:** if  $|\theta_+| + |\theta_-| < \pi$  then  
 $A \Leftarrow SCF\ task$   
 End if

However, it is worth mentioning that since the distributed version is only an approximation of the centralized gift wrapping algorithm (which assumes global knowledge about the network topology), the algorithm might over-select the SCF agent vehicles; i.e., since all boundary vehicles are SCF agent vehicles but not vice versa, a set of SCF-agent vehicles selected by the proposed distributed gift-wrapping algorithm is always a subset of a set that contains all boundary vehicles.

#### 3.6.2 Wait time calculation

This mechanism corresponds to the shaded rectangular box. Upon receiving a new message from Vehicle j, Vehicle i computes its wait time  $\tau_i$  as follows:

$$\tau_i = \begin{cases} \frac{1}{2} \left( 1 - \frac{d_{ij}}{R} \right) \tau_{\max} & \text{if } i \text{ is at an intersection} \\ \frac{1}{2} \left( 2 - \frac{d_{ij}}{R} \right) \tau_{\max} & \text{otherwise} \end{cases} \quad (1)$$

Where  $d_{ij}$  is the distance between Vehicles  $i$  and Vehicle  $j$ ,  $R$  is the maximum transmission range, and  $\tau_{max}$  is the maximum waiting time. Once the timer expires and Vehicle  $i$  does not receive any duplicate message, Vehicle  $i$  rebroadcasts. Or else, Vehicle  $i$  suppresses its rebroadcast. Reminder that the value of maximum waiting time  $\tau_{max}$  needs to be carefully chosen. If the value of  $\tau_{max}$  is too low, most vehicles rebroadcast before they could receive duplicate messages from their neighbors (in which case, they should instead suppress their rebroadcasts). On the other hand, if  $\tau_{max}$  is in adding high, then redundant rebroadcasts can be avoid at the cost of an increase in delay. It should be mentioned that the wait time can be computed in dissimilar ways and the exact method presented in Equation (1) is only an clarifying. Sensitivity implementation on the wait time calculation is an important subject.

#### 4. EXPERIMENTAL RESULTS

In the simulations, we assume a 1 km X 1 km network topology with 8 evenly-spaced horizontal and vertical streets; each street has two lanes, so the traffic can travel in both directions. All road junctions are equipped with pre-timed signals and the underlying mobility model that governs vehicle movement.

##### 4.1 Performance Metrics

The following four metrics are used to evaluate the performance of the proposed SCF protocol. While reach ability and received distance metrics determine the protocol reliability and effectiveness, transmission and reception overhead metrics quantify the efficiency of the protocol.

**Network reach ability:** Measures the fraction of vehicles in the region of interest that receive the message. A good protocol must ensure that most, if not all, vehicles intended to receive the message do receive the message before they arrive at the accident scene.

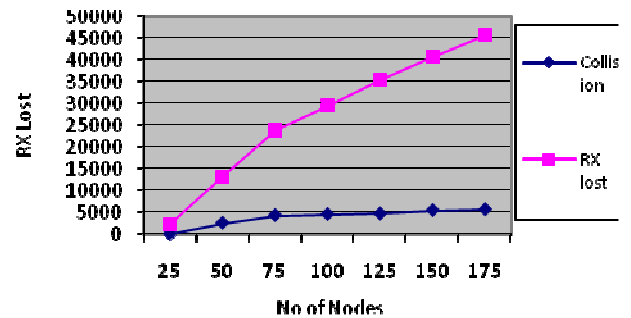
**Received distance:** is the closest Euclidean distance to the accident scene from the arc on the trajectory of a vehicle which was at a point (say A) when the message was broadcast but later receives the message at point B. Note that if a vehicle immediately receives the message at the time the message was broadcast, then the points A and B are identical.

**Transmission Overhead:** measures the total number of messages transmitted into the network by all vehicles. This metric is important as it indicates whether or not the message transmission generated by the proposed protocol overwhelms the network; in other words, whether it uses excessive amount of bandwidth.

**Reception Overhead:** measures the average number of duplicate messages received at a vehicle. This metric determines whether the protocol can effectively solve or mitigate the broadcast storm problem.

**Table 1:** SCF broadcast performance with Optimized Algorithm

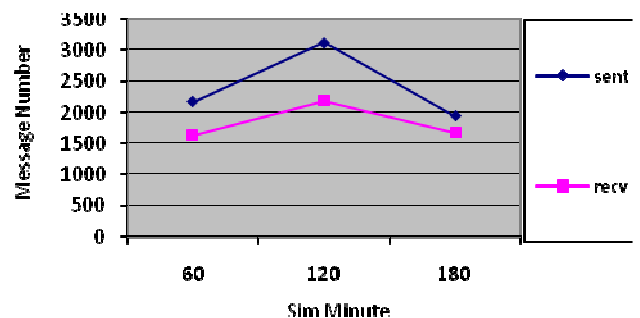
Sim. minute	1	2	3	4	5	6	7
No of cars	25	50	75	100	125	150	175
Collisi on	0	249	428	452	465	545	564
RX lost	7	46	23	12	23	53	32



**Fig. 2** broadcast performance Vs proposed algorithm

**Table 2:** Emergency Message Received and Send

sim minute	60	120	180
Sent	2169	3122	1938
rcv	1632	2184	1673



**Fig. 3** Total message broadcast

**Table 3:** SCF Received Packets and Lost

Sim minute	1	2	3	4	5	6	7
No of cars	45	55	75	95	115	105	100
Corrupted	0	121	55	354	63	8	69
Weak	12	23	71	12	58	63	8

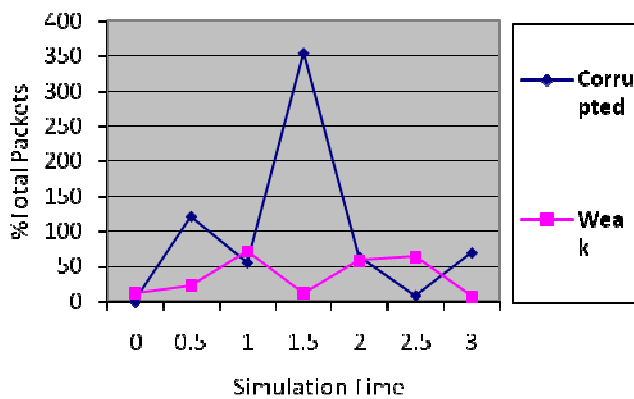


Fig. 4 Simulation with 802.11 physical

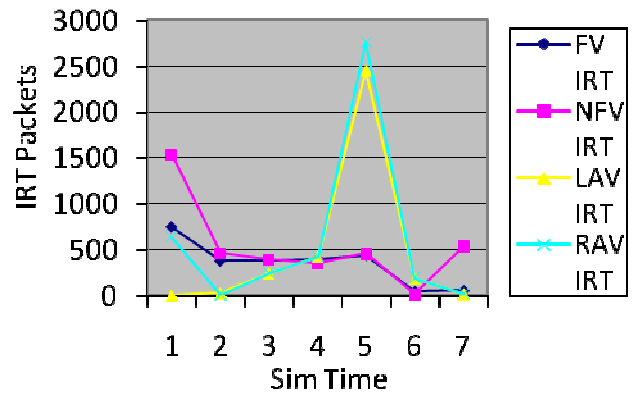


Fig. 6 inter frame reception time without the two mechanisms

Table 5: Received Packets by transmitter

Sim minute	1	2	3	4	5	6	7
FV received	63 2	583 4	943 2	967 3	1104 3	1175 3	1265 4
NFV received	53	183 4	385 3	267 5	4672	3935	4724
LAV received	2	46	53	58	41	49	21
RAV received	0	25	47	46	31	34	24

Table 7: Received Packets Lost/Ok

Sim minute	1	2	3	4	5	6	7
weak	63 4	835	2543	2756	3328	2523	2453
corrupted	0	174 5	4327	5341	6453	6643	6342
lost per	83 6	274 3	1035 3	1384 7	1673 4	1437 3	1247 6

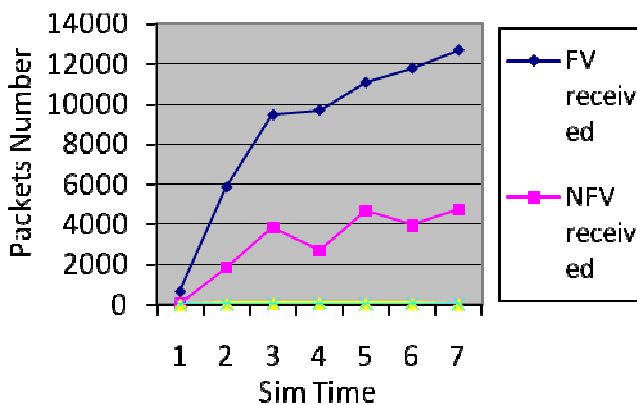


Fig. 5 received packets without the two mechanisms

Table 6: IRT by transmitter

Sim minute	1	2	3	4	5	6	7
FV IRT	743	374	385	396	436	43	53
NFV IRT	1532	463	385	354	453	14	534
LAV IRT	1	27	241	421	2452	185	18
RAV IRT	634	7	243	423	2753	193	15

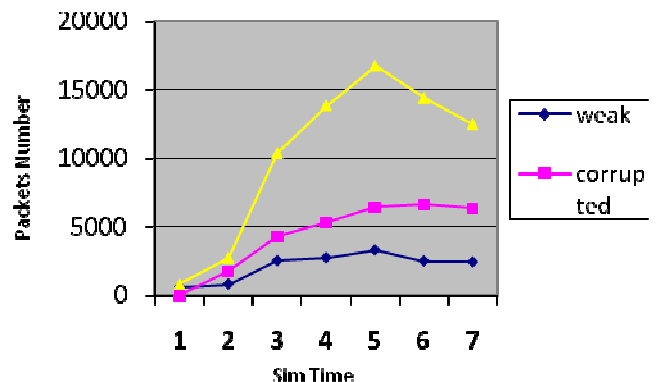


Fig. 7 SCF broadcast performance with Two Ray Ground

Table 8: Comparison of existing Algorithm

Algorithm	Path cost	Min link stability	Avg. link stability	Eto E link stability	Hop Count	Transmission Delay	
L L A	Avg. Value	36.0	0.25	0.55	0.009	5.61	15.36
	Length of 95% conf. Interval	6.56	0.002	0.03	0.01	0.28	0.08
S C F	Avg. Value	23.43	0.18	0.74	0.043	8.23	23.75
	Length of 95% conf. Interval	4.32	0.02	0.03	0.01	0.35	0.09

However, due to omitting links characterized by low stability indices, primary paths found by SCF approach were about 21% longer on average (which implied a small increase of the average message transmission delay of about 2.6 ms).

## 5. CONCLUSION AND FUTURE WORK

The proposed new broadcast routing protocols, SCF for urban VANETs which assume zero infrastructure support. SCF is a completely distributed broadcast protocol and it can be implemented by using only the local information available to each vehicle in an urban VANET. The protocol is considered by attractive into explanation the two dimensional road topology in urban area settings. In contrast to one-dimensional highway scenarios, routing protocol design in urban areas is a much more challenging task for many reasons: i) direction of vehicles in urban areas may change at intersections while direction of vehicles on highways do not change until they leave the highway; ii) while a message in highway scenarios is disseminated in only one direction, message dissemination direction in urban areas may encompass 360 degrees. Thus, the existing broadcast protocols designed for highway VANETs cannot be applied to urban settings.

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