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# Comparative Analysis of Multi-hop Dissemination Schemes for Broadcast Storm Problem in Vanets

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**Abstract:- The main aim of Vehicular Adhoc Network (Vanet) is to incorporate drivers with ease and safety while driving on roads. Now-a-days many technologies are introduced which include different entertainments and improve protection against drivers for road safety by using many useful traffic services. One of the most important solutions is by sending alert messages to nearby vehicles regarding any emergency issues. The main goal of different dissemination schemes is to reduce the latency of message delivery as soon as any emergency situation occurs. As many dissemination schemes are available, it is very difficult to find an appropriate dissemination scheme for a particular scenario. In this paper, we have provided a comparative study on different multi-hop dissemination schemes under different view. This helps the researcher to narrow down their research work and provide an in-depth study in their area of interest.**

***Keywords:-*** *VANET, Dissemination, Rebroadcast, Mitigate, Relay, Protocol, Topology.*

## I. INTRODUCTION

Now-a-days all the vehicles are manufactured with On-Board Units (OBU) for many purposes. The main purpose is to find an occurrence of accident depending upon the information gathered from accelerometers and sensors present in the vehicle [1]. Once accident detected, an emergency message is send to the neighbours and also rebroadcast by the receiving vehicles to other vehicles which guide them to take an alternate and safe route to the destination as a prevention of risk. This vehicle-to-vehicle communication is provided by the network called Vehicular Adhoc Network (Vanet). Vanet consists of groups of moving or stationary vehicles connected by a wireless network. The main use of Vanet is to provide safety and comfort to drivers in vehicular environment. It is the branch of Adhoc Network and one of the most challenging and popular research area. Generally Vanet offers three types of communication modes namely, Vehicle-to-Vehicle (V2V), Vehicle-to-infrastructure (V2I) and Inter Infrastructure communication [2]. This network provides different services for efficient driving, smart vehicles, passenger's comfort, infotainment etc. Generally applications are divided into two types namely *Safety* and *Comfort* applications. The safety application provides space that is free from harm or danger. The comfort application helps to improve traffic performance and increase passengers comfort. Examples of safety applications are automatic accident notification, collision avoidance, tracking of stolen vehicles etc. Examples of comfort applications are traffic notification system, petrol station, nearby hospitals, hotels etc. Similarly there are two types of communication such as *Forward* and *Backward* message transmission. All the vehicles are equipped with Global Positioning Systems (GPS) and sensors to gather information of that vehicle in terms of position, speed, direction and acceleration. These information are broadcasted to its neighbours for safety and secure driving to get away from risks. So finally it is clear that selection of appropriate Dissemination schemes must be given utmost care and importance. Basically Vanet protocols are grouped by types of Vanet applications, types of environments and scenarios and infrastructure support. The main technical issues in Vanet are difficult to achieve rapid network changes, restoration is inefficient etc. Vanet features are listed based on scenario namely density, speed, location, highway, one direction and no obstacles.

The issues in Vanet are *Security* from different threads and attacks, *routing* of message transmission over network, mobility, bandwidth constraint, resource constraint, error prone shared broadcast radio channel, hidden and exposed terminal problems etc. Under routing, one of the main problem is message dissemination, which causes Broadcast Storm Problem [3]. It is an abnormally broadcasting high number of packets within a short period of time. A broadcast storm can overwhelm switches and endpoints as they struggle to keep up with processing the flood of packets. When this happens, network performance degrades. Actually it is a result of collision and contention in MAC layer. This situation arises when any emergency event occurs in high traffic areas. Some of the Broadcast storm problems are many redundant rebroadcast, heavy channel contention, long-lasting message collision, causes plently of obstacles, creating blind areas etc. In order to reduce BSP and to increase efficiency, adapt dissemination policy by taking into account of vehicle density and vehicle location. Moreover the BSP can be quantified using message delay, packet loss rate and conventional metrics like message reachability and message overhead.

Basically protocols are classified as *Beaconing, Handshaking* and *Instant Broadcasting*. GPS are used to gather all details about a particular vehicle and its neighbours. But it does not work on Tunnels, shadowed areas, urban areas with skyscraper etc. So many researchers suggest using GPS with random noise to obtain accurate results. Dissemination Schemes are categorized as *one-hop* and *multi-hop*. In one-hop, each vehicle will stores the received broadcast message on its OBU instead of flooding throughout the network. Whereas in multi-hop, the relay vehicle perform the rebroadcast decision in a distributed manner towards a zero of relevance. Again the multi-hop is divided into five classes namely *counter-based, distance-based, location-based, cluster-based* and *stochastic*. The threshold based techniques are counter-based, distance-based and location-based. Many researchers suggest using fuzzy logic instead of having threshold value. Some protocols are based on propagation function having the following information such as structure road network and traffic condition. Whereas the probabilistic schemes are suitable for Adhoc with low overhead and good scalability. Finally the store-and-forward schemes obtain good message delivery in sparse network. Before reaching the target zone it is suggested to go for broadcasting and exactly at the target zone it is recommended for flooding of safety alert messages. Basically dissemination is affected by signal attenuation, effect of obstacles and instantaneous vehicle density. The selection of relay node for rebroadcast is may be the farthest node from the sender, node with best like quality, endangers nodes, nodes with high probability or the head of cluster node. Many dissemination schemes are available so the choice is based upon two parameters namely vehicle density and vehicle location. The low vehicle density conditions are found in areas such as residential, rural, highway and outskirts or suburban areas with less than 25 vehicle/km$^2$. The problem with low density vehicle is frequent network partition which may cause message loss and misinformation. So the goal is to inform as many vehicles as possible in short period of time. The high density conditions are found in areas such as urban, traffic jam in large cities with more than 300 vehicle/km$^2$. Whereas the problem with high vehicle density causes message collision and channel contention which lead to broadcast storm problem. So the goal is to reduce the number of messages sent to the neighbor vehicles. Simple broadcasting of messages causes two problems, one is producing lot of redundant rebroadcast message and another is high probability.

## II. SURVEY ON DIFFERENT BROADCAST PROTOCOLS IN VANETs

Sze-Yao Ni et al [4] proposed *Counter Dissemination Scheme* to mitigate BSP in Vanet. This scheme uses a counter which holds the redundancy of received message. The rebroadcast is allowed only when the counter value c is less than some counter threshold C value. The main aim of this scheme is to stop any unwanted rebroadcast message transmission.

Sze-Yao Ni et al [4] suggested the *Distance Dissemination Scheme* to solve BSP. In this scheme, the

Value of $d_{min}$ and additional coverage will determine whether to rebroadcast the transmission message or not. The comparison is made between the $d_{min}$ value and some distance threshold D value.

Wisitpongphan N et al [5] designed three probabilistic schemes namely *weighted p-persistence, slotted 1-persistence and slotted p-persistence* to mitigate BSP in Vanet. The main aim of these schemes is to reduce 70% of broadcast redundancy with end-to-end delay. The reason of using probability-1 is because of low complexity and high packet penetration rate.

Kanitsom Suriyapaiboonwattana et al [6] proposed *The Last One* (TLO) to reduce BSP and end-to-end delay. In TLO, the vehicle selected as last node in transmission range will only rebroadcast the safety alert message whereas other vehicles wait for a threshold time interval. In this scheme, Vincentry formula is used to calculate the distance between accident vehicle and received vehicle to find out the farthest node within the transmission range.

Kanitsom Suriyapaiboonwattana et al [7] recommended *Adaptive Probability Alert Protocol* (APAL) to solve BSP and alert message problem in Vanet. This APAL does not depend on local information and is based on p-persistence which makes use of adaptive wait-windows and adaptive probability. The main objective of APAL is to improve the success rate of safety alert message with lowest collision and delay.

Michael Slavik et al [8] developed *Stochastic Broadcast* (SBS) to solve BSP in Vanet. This SBS uses retransmit probability function to transmit received messages which is obtained from the distance between received node and last hop neighbour. The privacy of node identification is maintained private this implies more security in this scheme. When the density threshold value is approximately 4.5 yields high reachability and minimum bandwidth utilization. So some adjustments are made for retransmit probability according to the density of network to reach the appropriate value.

Manuel Fogue et al [9] proposed *enhanced Street Broadcast reduction* (eSBR) to reduce BSP in urban scenarios. This scheme does not show much complexity and calculations. The overall output shows how the blind nodes are reduced by half and how the number of packets received is increased slightly.

Manuel Fogue et al [10] developed *enhanced Message Dissemination based on Roadmaps* (eMDR) to solve BSP in realistic urban scenario. The main goal of this scheme is to increase the percentage of informed vehicles, reduce notification time and minimize reception overhead. All information are gathered through GPS and maps. The overall result of this scheme states that generating greater amount of messages and selection of more appropriate forwarding nodes.

Francisco J Ros et al [11] recommended *Connected Dominating Set* (CDS) to solve BSP in Vanet. This scheme supports wide range of scenarios and traffic condition. All the information is gathered through Beacon Messages. It addresses the issue of non-continuous and process high reliability, redundant transmission, lower overhead and reduces number of transmission per transmitting node.

Sommer C et al [12] proposed *Adaptive Traffic Beacon* (ATB) for solving BSP in Vanet. This ATB can adapt to highly dynamic network conditions ie proactive or reactive. The main aim of this scheme is updating the beacon frequently and producing a congestion-free network.

Yuanguo Bi et al [13] designed *Cross Layer Broadcast Protocol* (CLBP) to solve BSP in Vanet. The main goal in selection of message forwarding vehicle is based on geographical location, channel condition and relative velocity. This is applicable for highway scenario using BRTS and BCTS frame with handshake mechanism. Finally it improves the transmission reliability and minimizes message redundancy.

Julio A Sanguesa et al [14] recommended *Nearest Junction Located* [NJL] to solve BSP in Vanet for high density environment. This scheme performs rebroadcast only when there is any nearest vehicle in geographical coordinates based on topology information. This informs highest possible number of vehicles in short period of time and reduces the percentage of received vehicle by half.

Julio A Sanguesa et al [15] developed *Junction Store and Forward* [JSF] to solve BSP in Vanet for low density environment. First all received message are stored and rebroadcast only when optimal situation ie vehicle at junction is obtained. This increases the percentage of vehicle by reducing the warning notification time.

Julio A Sanguesa et al [16] suggested Neighbour Store and Forward (NSF) to solve BSP in Vanet. This protocol mainly focuses on sparse urban environment which rely only on neighbor information. It improves the performance using store-carry-forward mechanism by reducing the warning notification time and informs more number of vehicles with small amount of overhead.

Sok-Ian Son et al [17] proposed *Store-Carry-Broadcast* (SCB) for solving BSP in Vanet. This is applied for both highway and urban road scenarios. Compared to other protocols, this protocol disseminate safety message in opposite vehicle instead of forwarding in same lane. This consumes less bandwidth, reduces overhead and delivery delay.

Ozan K Tongue et al [18] suggested *Distributed Vehicular broadcast* [DV-CAST] to solve both BSP and disconnected network problem. It is mainly suitable for highway scenario. By using mechanism such as Neighbour Detection and Store-carry-forward produces 100% reachability and reduces the amount of overhead three times than blind flooding.

Wantanee Viriyasitavat et al [19] developed an *Urban Vehicular broadcast* (UV-CAST) for solving both BSP and Disconnected network problem. This protocol is applied for urban scenario and supports both well connected and disconnected network regimes. The intersection based broadstorm suppression mechanisms used is most effective because more number of vehicles forward messages and more than once.

Davide Sormani et al [20] proposed *Function Driven Probability Diffusion* (FDPD) for solving BSP in Vanet. This protocol is a probabilistic message dissemination which uses propagation function to select the most suitable vehicle to forward the message.

Julio A Sanguesa et al [21] suggested *Real-Time Adaptive Dissemination* (RTAD) for solving BSP in Vanet. This protocol in mainly suitable for high density and robust. It reduces the number of messages received by half and informs more number of vehicles in less time by avoiding the channel contention.

## III. COMPARATIVE STUDY

This section presents the reasonable analysis of the above mentioned multi-hop dissemination schemes in three tables. Table 1 gives the overall characteristics of different simulation environment by different protocols. Table 2 specifies the classification, scenario and achievement of different schemes. Table 3 represents when the rebroadcast of emergency message will be performed in various schemes with its performance metrics.

**Table 1: Overall characteristics of different dissemination schemes in multi-hop**

| Dissemination Schemes | Topology | Radio Propagation Model | Maximum Transmission Range | Network Density (Min – Max) | Communication Standard | Mobility Model | Simulator |
|---|---|---|---|---|---|---|---|
| **Counter [4]** | 0.25-25Km2 field | Free Space | 500m | 10-100 | 801.11 | RWP | Custom C++ |
| **Distance [4]** | 0.25-25Km2 field | Free Space | 500m | 10-100 | 801.11 | RWP | Custom C++ |
| **Persistence [5]** | Single & Multilane | Free Space | 1000m | 10-100 | 802.11a | - | OPNET |
| **TLO [6]** | 4 Lane Street | - | 300m | 10-100 | 802.11 | Uniform Speed | GrooveNET |
| **APAL [7]** | 4 Lane Street | - | 200m | 10-100 | 802.11b | Uniform Speed | GrooveNET |
| **SBS [8]** | 1 Km2 field | - | 10m | 10-100 | - | Random | Constant |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | | Way Point | JAVA |
| **eSBR [9]** | 4Km2 | RAV | 400m | 100-400 | 802.11p | Krauss | ns-2 |
| **eMDR [10]** | 4Km2 | RAV | 400m | 100-400 | 802.11p | Krauss | ns-2 |
| **CDS [11]** | 4Km2 | TRG | 250m | 5-75 | 802.11p | Constant Speed | ns-2 |
| **ATB [12]** | 4Km2 | OMNeT++ INET | 180m | 14-170 | 802.11b | Random Way Point | Veins |
| **CLBP [13]** | Two-lane Highway | TRG | 250m | 20-50 | 802.11e | Constant Speed | ns-2 |
| **NJL [14]** | 4Km2 Urban | RAV | 400m | 25-250 | 802.11p | Krauss | ns-2 |
| **JSF [15]** | 4Km2 Urban | RAV | 400m | 10-500 | 802.11p | Krauss | ns-2 |
| **NSF [16]** | 1Km2 | RAV | 400m | 10-500 | 802.11p | Krauss | ns-2 |
| **SCB [17]** | 5Km | DSRC | 250m | 10-100 | 802.11p | - | C++ |
| **DV-CAST [18]** | Circular Highway | Ricean | 5000m | 20-400 | 802.11a | Uniform Speed | ns-2 |
| **UV-CAST [19]** | 2.3Km2 Urban | LOS & NLOS | 140-250m | 20-400 | 802.11p | CA-based | ns-2 |
| **FDPD [20]** | 4Km2 Manhattan | TRG | 200m | 50-200 | 802.11 | Manhattan | Java |
| **RTAD [21]** | 4Km2 Urban | RAV | 400m | 25-250 | 802.11p | Krauss | ns-2 |

**Table 2: Classification of different multi-hop dissemination schemes with its achievement**

| Dissemination Schemes | Classification of Dissemination Schemes | Purpose Improve Dissemination Scheme (IDS)/BSP | Scenarios | Vehicle Density | Information Gathering | Goal | Transmission Delay |
|---|---|---|---|---|---|---|---|
| **Counter [4]** | Flooding | IDS | Highway | Low | Radio Propagation | Eliminate Redundancy | Yes |
| **Distance [4]** | Distance | IDS | Urban | High | Radio Propagation | Better Message Reachability | Yes |
| **Persistence [5]** | Probability | IDS | Highway & Urban | Low, High | GPS | Better Message Reachability, reduce redundancy & Overhead | No |
| **TLO [6]** | Distance | BSP, End-to-end delay and Avoid Alert message problem | Highway | Low | GPS | Low Collision | No |
| **APAL [7]** | Probability | IDS | Highway | Low | GPS | Lowest collision, Highest Success Rate | No |
| **SBS [8]** | Distance, Probability | IDS | Urban | High | Topology | High Reachability, Min Bandwidth Utilization, no message overhead, Anonymity, Scalability | No |
| **eSBR [9]** | Topology, Distance | BSP, reduce Blind nodes and warning message | Highway | Low | GPS | Reduce Complexity, calculation no. of received packets increased | No |
| **eMDR [10]** | Topology, Distance | BSP | Urban | High | GPS | Increase message delivery, reduce | No |

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| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | | notification time, reception overhead and number of broadcast message | |
| **CDS [11]** | Beacon | IDS | Highway & Urban | Low & High | Beacon | High Reliability, reduce redundancy, low overhead. | No |
| **ATB [12]** | Beacon | IDS | Highway | Low | Beacon | High Penetration ratio, Incr. channel Quality and message utility and congestion free. | No |
| **CLBP [13]** | Topology | IDS | Highway | Low | GPS | Transmission reliability, min message redundancy, PER relay selection delay, EM access delay | No |
| **NJL [14]** | Topology | BSP | Urban | High | Topology | Better reliability, channel contention and frequency of collision, reduce number of message received. | No |
| **JSF [15]** | Topology, Store & Forward | IDS | Highway | Low | Beacon | Max. message delivery, min channel overhead, reduce warning notification time, min. number of message received. | No |
| **NSF [16]** | Store & Forward, Beacon | IDS | Urban | High | Topology | Highest percentage of vehicle informed, max. S&F performance, small amount of overhead. | No |
| **SCB [17]** | Store & Forward | IDS | Highway, Urban | Low, High | Beacon | Scalability, reduce overhead & delivery delay, bandwidth consumption. | No |
| **DV-CAST [18]** | Topology, Store & Forward, Beacon | BSP,IDS, Disconnected network problem | Highway | Low | Topology | Reduce redundancy, packet loss ratio, 100% reachability, robustness, reliability, efficiency scalability. | Yes |
| **UV-CAST [19]** | Store & Forward | BSP, IDS, Disconnected Network problem | Urban | High | GPS | Good Network reachability, less network overhead | Yes |
| **FDPD [20]** | Distance, Probability | BSP | Highway, Urban | Low, High | GPS | Good Delivery Ratio, efficiency in network traffic, improve selectivity, limit message propagation neighbours. | Yes |
| **RTAD [21]** | Topology, | IDS,BSP | Urban | High | Topology | Avoid channel | No |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Beacon | | | | | contention, Maximize message delivery, min number of message received, incr. more vehicle. | | |

**Table 3: Routing of alert message transmission with performance metric in different dissemination schemes.**

| Dissemination Schemes | Performance Metric | Rebroadcast | Direction | Network Regime |
|---|---|---|---|---|
| **Counter [4]** | 1. Reachability<br>2. Saved Rebroadcast<br>3. Average Latency | When c < C Threshold value | One | Connected |
| **Distance [4]** | 1. Reachability<br>2. Saved Rebroadcast<br>3. Average Latency | Low Additional coverage | One | Connected |
| **Persistence [5]** | 1. Packet Loss Ratio<br>2. Latency | High Priority Vehicle | All | Well-connected |
| **TLO [6]** | 1. Time<br>2. Collision | Selecting Farthest Vehicle | One | Connected |
| **APAL [7]** | 1. No. of Collisions<br>2. Success rate<br>3. Time delay | Selecting Farthest Vehicle | One | Connected |
| **SBS [8]** | 1. Reachability<br>2. Bandwidth Utilization | Maintain Network density =4.5 Threshold value | One | Well-connected |
| **eSBR [9]** | 1. Percentage of vehicles informed<br>2. Warning Notification Time<br>3. No. of Packets Received/Vehicle<br>4. Reception Overhead | Additional coverage value is very large or very low in difference road | One | Delay-Tolerant |
| **eMDR [10]** | 1. Percentage of vehicles informed<br>2. Warning Notification Time | Vehicle in each junction | One | Connected and Delay-Tolerant |
| **CDS [11]** | 1. Percentage of vehicles informed<br>2. Warning Notification Time | Augmented with the received acknowledgements | Both | Well-connected, Sparsely connected and totally connected |
| **ATB [12]** | 1. Channel quality<br>2. Message utility | Based on Beacon Message | One | Highly dynamic ie. Proactive and Reactive |
| **CLBP [13]** | 1. Packet Error Rate<br>2. Relay Selection Delay<br>3. Message Access Delay | Based on a novel relaying metric | Both | Well-connected |
| **NJL [14]** | 1. Percentage of Informed Vehicle<br>2. Percentage of Received Vehicle | Nearest to geographical coordinates | One | Dense and Well-connected |
| **JSF [15]** | 1. Percentage of informed vehicle<br>2. Number of message received/vehicle<br>3. Warning Notification Time | When optimal solution is obtained | One | Sparse and Disconnected |
| **NSF [16]** | 1. Percentage of vehicles informed<br>2. Warning Notification Time<br>3. Warning Notification | When it finds a new neighbour | One | Sparse |

| | | | | |
|---|---|---|---|---|
| | Time | | | |
| **SCB [17]** | 1. Broadcast Overhead<br>2. Average Delivery Delay | An opposite vehicle is selected | Reverse | Sparse |
| **DV-CAST [18]** | 1. Reliability<br>2. Efficiency<br>3. Scalability | Determined from local topology information | Both | Well-connected & Sparse |
| **UV-CAST [19]** | 1. Network Reachability<br>2. Received Distance<br>3. Transmission Overhead<br>4. Reception Overhead | Based on Beacon Message | 360° | Well-connected & Disconnected |
| **FDPD [20]** | 1. Message Delivery<br>2. Network Traffic | Calculate Propagation function for vehicle selection | One | Sparse and Disconnected |
| **RTAD [21]** | 1. Message Delivery<br>2.Message Received/Vehicle | Based on Propagation Function | One | Sparse and Dense |

## IV. CONCLUSION

This paper presents a complete survey on various multi-hop dissemination schemes specially designed for Vanet. The Table 1 specifies all the characteristics of simulation environment such as its Topology, Radio Propagation model, maximum transmission range, range of network density, Communication standard, mobility model and the name of the simulator used. The Table 2 presents the classification of dissemination schemes, its purpose, various scenarios, category of vehicle density, how information is gathered, its goal or achievement and transmission latency. Finally the Table 3 represents the list of performance metrics, when rebroadcast occurs, its direction and different network regimes it support. From this we conclude that different protocols are suitable and unique for different environment and prove their efficiency. So we ensure that selection of a particular dissemination scheme is depends upon the scenario.

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