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Efficient Mechanism to Exchange Relevant Messages in Vehicular Ad Hoc Networks

***Abstract**. Broadcast is the commonly used technique for data dissemination in VANETs .It requires unicast and multicast protocols for connectivity and maintenance of path. Broadcast has the problem of surplus data. In order to resolve it, we modify the" Hello" packet of Optimized Link State Routing Protocol (OLSR) and add a new parameter called preference list. It contains the interest of the vehicle and data which current vehicle has. Due to mobility, there is very short time available for data exchange and limited messages are only communicated according to neighbour preference. We evaluate the modified OLSR with the help of Network Simulator in VANETs scenario. So in this way, surplus data and network load is reduced.*

***Streszczenie.** W artykule przedstawiono zmodyfikowany protokół transmisji danych OLSR z dodatkiem tzw. listy preferencji, który wykorzystywano w sieci typu VANET. W związku z mobilnością elementów, możliwa jest tylko krótkoterminowa wymiana danych w ograniczony sposób, wysyłanie wiadomości. Proponowane rozwiązanie pozwala na redukcję danych nadwyżkowych i obciążenia sieci. (**Sieć typu VANET – wydajny system wymiany informacji**).*

Keywords: Sensor network, Inter-Vehicle Communication (IVC), Vehicular Ad hoc Networks (VANETs), Broadcast, DSDV (Destination-Sequenced Distance Vector).
Słowa kluczowe: sieć czujników, komunikacja IVC, VANETs, nadawanie, DSDV.

Introduction

In Vehicular Ad-Hoc Networks [1] [2], vehicles contact each other during their journey and do not require router and base station for communication [3]. They communicate directly and also through intermediate vehicles. Vehicular Ad-Hoc Networks (VANETs) are a unique form of Mobile ad Hoc Networks (MANETs) [4]. VANETs like MANETs [5] [6] are self-organizing and distributed communication networks, that do not need any infrastructure [7]. Fast speed, mobility, traffic pattern, security issues and no battery constraints make VANETS different from other adhoc networks [8].

Normally in VANETs, vehicles require same kind of data e.g. data related to safety, traffic jam, parking and weather forecast [9]. Broadcast is the commonly used technique for data dissemination in VANETs [10] [11]. It is mechanism through which a vehicle in VANETS sends message to all its neighbor vehicles in the same VANETs. Sharing safety, weather, and road information, advertisements and announcements are through on broadcast [12]. Communication in VANETs needs various multicast and unicast protocols to establish and maintain their route [13]. Dynamic Source Routing (DSR) [14], Ad Hoc On Demand Distance Vector (AODV) [15], Zone Routing Protocol (ZRP) [16], and Location Aided Routing (LAR) [17] are such examples of it.

In this paper we enhance the OLSR protocol and add new parameter called Preference list in hello message. It contains the interest and stored data of vehicle. With help of this modification, Surplus data and Network load of broadcast techniques is reduced.

Reactive Protocols

The Reactive protocols are on-demand protocols, which find a path only on request. Ad hoc On Demand Distance Vector (AODV) protocol and Dynamic Source Routing (DSR) protocol are the examples of reactive protocols. These protocols used simple flooding to establish a route. There is no predate present when we receive route request. But the delay of finding the route is reasonable [18].

AODV is a reactive routing protocol and consists of two procedures, i.e. route discovery and route maintenance. To find the path of vehicle, route request and route reply are used. Source vehicle send a route request to its neighbour. The neighbours send to its own neighbours until reaching the destination. When destination vehicle receive the first request, it send the route reply. It answers only the first request in order to maintain shortest path [19].

AODV is dynamic in nature because it locates the path only when it wants to share the information [20].Sequence number and next hop information are presented in routing table in order to check the message age. The neighbor information is also stored for back up purposes [21].It does not create routing loops due to sequence number and decreases bandwidth overhead with the help of intermediate nodes [22]. AODV reduces the broadcast packets by making routes on demand [23]. It is mainly designed for mobile ad hoc network [24].

DSR is reactive routing protocol which constructs route when information is available for sharing. It also has two mechanisms i.e. route discovery and route maintenance [25].Performance of network is not affected by DSR as it does not generate control message [26].To determine the path of vehicle, route request is initiated in broadcast manner by source vehicle. Whenever a destination vehicle receives it, it usually replies unicast message to source vehicle through intermediate vehicles [27].

Proactive Protocols

Table driven proactive protocols calculate the route before the message transmission [28]. The related examples include Destination-Sequenced Distance Vector (DSDV) protocol [29], Wireless Routing Protocol (WRP), Temporally-Ordered Routing Algorithm (TORA) [30], and Lightweight Mobile Routing (LMR) protocol. Implementations of proactive protocol are easy as compare to reactive protocol and it is more stable than reactive protocols. A large number of control messages needed to control the network topology in VANETs scenario. So they generate collision and contention of packets and waste network resources [31].

RFC3626 [32] explains the Optimized Link State Routing Protocol (OLSR). It is designed especially for mobile ad hoc networks. It regularly shares topology information with neighbour vehicles using hello packet.

OLSR protocol reduces the size of control packet and minimizes flooding by allowing only selected nodes called multipoint relays (MPR) to forward packets in the network [33]. MPR reduces the broadcast messages but the problem of reliability is still there because of wireless medium. Hidden node problem, frame errors and MAC layer issues affect the reliability of message delivery [34].

Proposed Solution

We modify the hello packet of OLSR protocol. Now it contains the preference list of user. Each vehicle has its own preference list. This list stores two types of information i.e. interest and buffered data of vehicle. With the help of this list, redundant information is discarded and only useful messages are disseminated. If vehicle wants parking information, why he receives messages about fuel station and weather. Preference List of different vehicles is shown in below Table 1.

Table 1. Preference List of Vehicles

Vehicles	Contained Data	Interest
V1	Traffic Jam, Accident	Traffic Jam, Accident
V2	Accident	Accident
V3	Accident	Traffic Jam, Accident
V4	Traffic Jam	Traffic Jam
V5	Traffic Jam, Accident	Accident

By modifying the OLSR protocol and inserting a preference list in hello packet, the number of surplus and redundant messages can be reduced as shown in figure 1. We utilize the four bits of reserved bits for preference list. The first two bits of reserved bits represent the containing data of vehicle called buffered Date (B) and next two bits called Vehicle Interest (I) which gives information about vehicle interest. Now we discuss the different scenarios and their simulation, which shows that the proposed approach gives better results than the existing one.

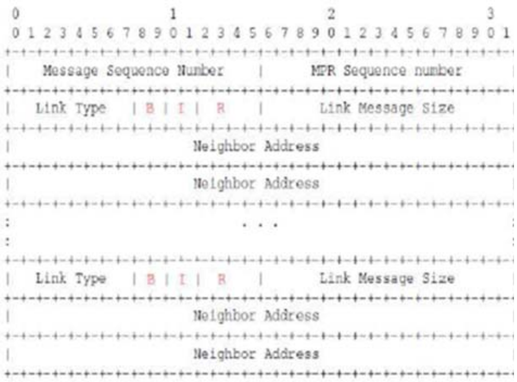

Fig. 1. Modified OLSR

Scenario 1

In scenario 1 we have four vehicles V1, V2, V3, and V4 as shown in figure 2. These vehicles form a temporary vehicular adhoc network for information sharing. With the help of hello messages, they come to know the interest of their neighbours and store this information in preference table for future communication.

Scenario 2 and Scenario 3

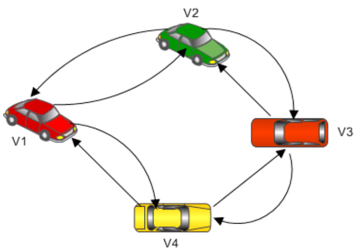

Fig. 2. Basic Scenario of VANETs

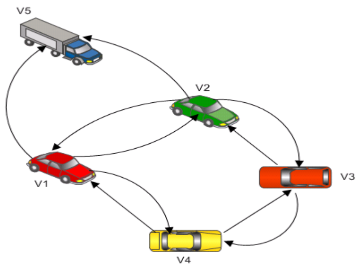

Fig. 3. New Vehicle joins VANETs

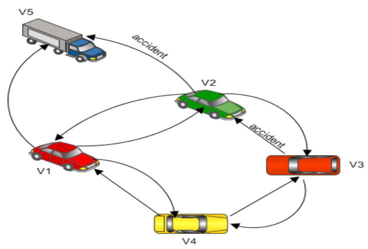

Fig. 4. V3 detected an accident

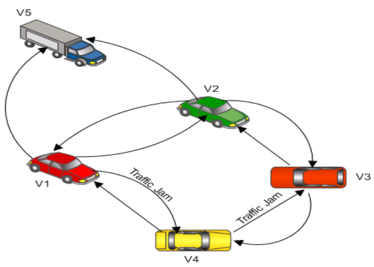

Fig. 5 V1 detected an Traffic Jam

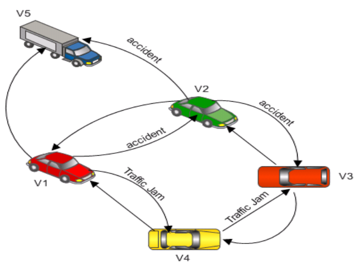

Fig. 6. V1 detected traffic and accident info

In Scenario 2, a new vehicle V5 joins the VANETs as shown in figure 3. V1 and V2 share hello message with V5 to get the preference of it and also to tell their interest of data.

In scenario 3, Suddenly V3 detects an accident.V2 and V4 are neighbours of it, as shown in figure 4. So he has to forward data to its neighbours, but he send information to V2 and does not send any information about accident to V4. Now the broadcast is done by using preference list. Only the nodes who mention their interest in particular type of data in their preference list will receive the respective data. As in preference table, V2 mentioned that he needs accident information and V4 says that he does not need any accident information. Similarly, V2 sends accident information only to V5 and no data to V1.

Scenario 4 and Scenario 5

Suddenly V1 detects traffic jam as shown in figure 5. V4 and V5 are neighbours of it. Therefore he has to forward data to its neighbor, but he send information to V4 only and does not send any information about accident to V5. Because in preference table, V4 mentioned that he needs

Traffic Jam information and V5 says that he does not need any traffic jam information. Similarly V4 send traffic information to V3 and V3 does not send it to V2.

In scenario 5, V1 detects an accident and traffic Jam as shown in figure 6. So it checks its preference table for broadcast. He forwarded accident information to V2 and traffic information to V4. Similarly, V2 sent accident information to V5, V3, and V4 sends traffic information to V3 and V3 does not forward it to any neighbor because he has no entry for traffic jam.

Simulation Results

In order to validate our proposed scheme, we implement the above scenarios with increasing the number of vehicles to get better and real environment. We used NS-2 [35], a network simulator, to simulate the existing behavior of OLSR under different scenarios. Mobility is generated using Rice Mobility generator and mobility trace file are available at [36] with 1188 number of roads and 383 number of intersections. The simulation is performed by using Network Simulator (NS-2) and parameter used for scenarios are shown in Table 2.

Table 2. Simulation Parameters

Parameters	Values
Channel	Wireless
Antenna Type	Omni directional
MAC protocol	802.11
Radio Propagation Model	Two-Ray Ground
Routing Protocol	OLSR

We consider an area of 3000m x3000m with vehicles moving at a speed of 40Km/hr to 70 Km/hr. User specifies their preference and we measure the performance of different types of messages exchanged by vehicles.

Figure 7 shows that vehicles number 0, 2, 4, 6, 8,…..48 are interested in accident information as mentioned in their preference list. Weather and traffic jam information is surplus data for these vehicles as they have no interest in that information. In figure 8, different vehicles ranges from 0, 3, 6, 9, 12,…..48 have shown their interest in traffic jam information and we measure their performance.

In figure 9, vehicle 0, 5, 10, 15,…..49 are interested in fuel station information. Accident and traffic jam information is surplus data for these vehicles as they have no interest in that information. In figure 10, vehicle 0,10, 20,..49 are interested in parking data. We measure the throughput of vehicles according to their interest. Figure 11 shows that four different types of messages are shared between different nodes. The number of relevant accident messages that the vehicle received for which they have been subscribed for. Vehicles number 0, 2, 4, 6, 8,…..48 needs accident information. Vehicles ranges from 0, 3, 6, 9, 12….48 has showed their interest in traffic jam information and vehicle 0, 5, 10, 15…49 needs fuel station information. Vehicles ranges from 0, 10, 20, and 49 need parking information. We measure their throughput according to their interest. In figure 11, we measure the performance of all the vehicles according to their interest.

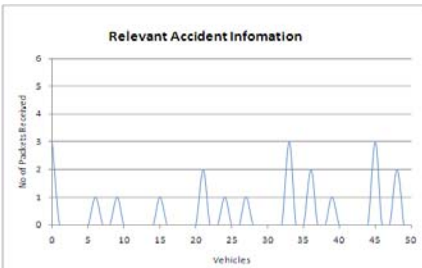

Fig 7: Relevant accident Information

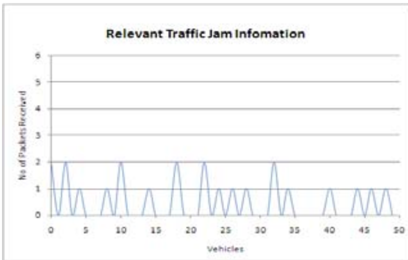

Fig 8: Relevant Traffic Jam Info Sharing

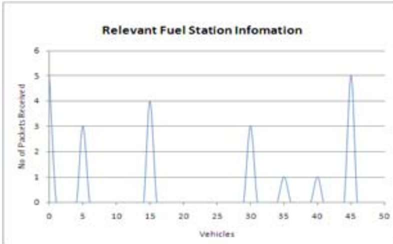

Fig 9: Relevant Fuel Station Information

Fig 10: Relevant Parking Information Sharing

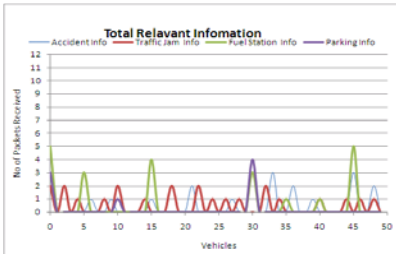

Fig 11: Total Relevant Information Sharing

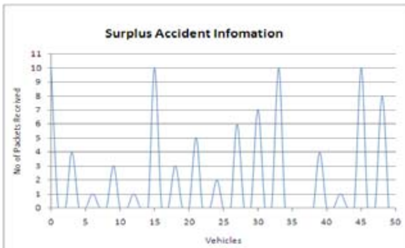

Fig 12: Surplus Accident Information

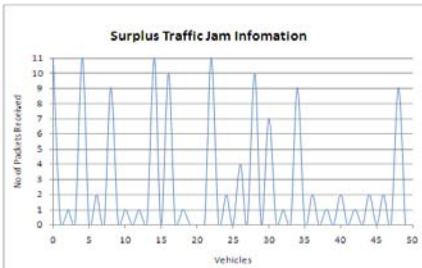

Fig 13: Surplus Traffic Jam Information

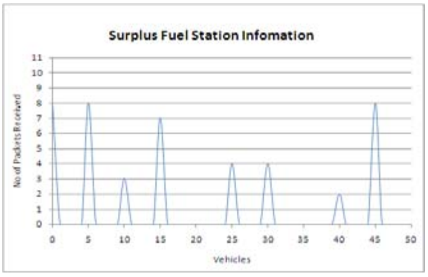

Fig 14: Surplus Fuel Station Information

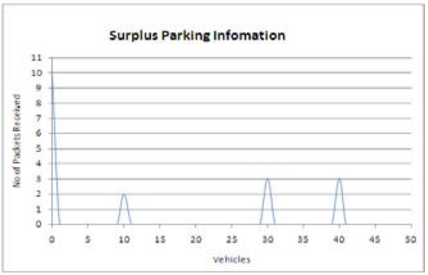

Fig 15: Surplus Parking Information

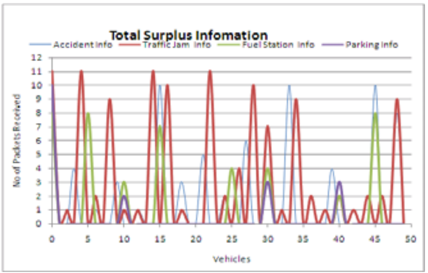

Fig 16: Total Surplus Information Sharing

Now we consider that we don't have preference list in OLSR protocol. Figure 12 shows the number of surplus accident messages that vehicles received for which they have not subscribed. In figure 13, different vehicles ranges from 0, 2, 4, 6, 8,…..48 receive traffic jam information. These vehicles have no interest in traffic jam information

In figure 14 shows the performance of vehicle interested in accident and traffic jam information but they got surplus fuel station information. Figure 15 shows the surplus parking information. Vehicles need fuel information but they are getting parking information. Figure 16 shows that four different types of messages (accident, traffic jam, fuel station parking) are shared among different nodes. Vehicles receive a lot of information which they don't need.

Conclusion

Broadcast is a commonly used technique for communication. Many data dissemination schemes use OLSR protocol to get network information of each vehicle. Main problem of broadcast is surplus data. So we modify the OLSR protocol and insert a preference list in hello packet, in order to reduce the number of Surplus and redundant messages. Simulation results show that performance of network improves and discards redundant data with help of preference list.

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