Enhanced Relevance-Based Approach for Network Control

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Simple flooding, probabilistic approach, area-based scheme, knowledge-based approach and Multi hop Vehicular broadcast is not suitable for VANETs scenario because of its dynamic nature. Relevance scheme is proposed to disseminate the relevant message for sharing in VANETs and discards the redundant messages from the network and improves the over all performance of network. The relevance-based approach does not provide network control and it only broadcast user traffic. This paper presents an improvement in mathematical model to consider the network control. Simulations using NS-2 show that proposed mathematical model consider the network control and improve the global benefit.

Povzetek: Predstavljen je matematičen model izboljšanega nadzora in upravljanja z mrežo.

1 Introduction

Broadcast is the main building block of mobile applications and routing protocols in mobile adhoc networks [1]. Adhoc network is infrastructure less temporarily network, which is mainly used for disaster area and battle field. [2] Vehicular Ad-Hoc Networks is some how different from it in term of battery and mobility.

VANET is the collection of vehicles that communicate with each other from time to time and require no base station, no router for their communication. They can share information either directly or through intermediate nodes [3].

Mostly in VANETs, vehicles are interested in the same kind of information for example information about any accident, road block and weather situation of particular route [4]. So broadcast is the only best option for communication in VANETs.

In Mobile adhoc network a lot of work has been done for broadcast schemes but these existing techniques doses not perform well in VANETs. Simple flooding, probabilistic approach, area-based scheme, knowledge-based approach and Multi hop Vehicular broadcast are not suitable for VANETs scenario. As Collision, Contention and redundant messages [7] are the shortcoming of simple flooding. Probabilistic approach try to solve the redundant message and works fine in dense network but it performance degrades in sparse network. Area-based and knowledge-based approaches also not perform very well because of the dynamic nature of VANETs. Multi hop Vehicular broadcast [6] have Scalability problem. These schemes also ignore the relevance of information and inject the surplus information in network. Relevance approach is proposed to differentiate between high and low priority traffic and improve the performance of network by discarding the redundant messages from the network. The relevance-based approach also has one problem that it does not provide network control and it broadcast only user traffic.

This paper presents an enhancement in mathematical model of relevance-based approach to overcome this problem and global benefit of the network is enhance by adding the network control.

This paper is organized as follows: In section 2, previous work is described. In section 3, enhanced mathematical model is proposed. In section 4, simulation study and results are shown. Lastly in section 5 conclusions is given.

2 Related work

In this section, we will discuss the basic techniques for broadcast i.e. simple flooding, probabilistic approach, area-based scheme and knowledge-based approach. But these techniques can't work fine in VANETS because of dynamic nature of the network. After that we discuss the relevance-based approach that is designed specially for VANETs. We describe its properties, methodology and implementation.

2.1 Previous broadcast approaches

Simple flooding: approach to perform broadcast is by flooding. In this method, a vehicle sends a message to all of its neighbors and its neighbors in return send message to its neighbors. This process continues until all the vehicles get the same message.

Probabilistic scheme: the message is broadcast with some fixed probability. In dense network, due to share coverage only few nodes can do rebroadcast to save network resources. [9]

Area-based scheme: a node calculates the additional coverage area on bases of received redundant messages. If a node achieve sufficient additional coverage area with broadcast then it will rebroadcast else not. [9]

Neighbor knowledge: every node maintains neighbor node information. With help of this information a node decide to rebroadcast a massage or not. To get neighbor information each node has to exchange periodic Hello packets with its neighbor nodes. [10]

Existing broadcast techniques like simple flooding have shortcoming such as redundant rebroadcasts, collision, contention, and probabilistic approach works like simple flooding in spare network.

The performance of neighbor knowledge method depends upon the exchange of hello packet. If the nodes exchange hello message with short interval it will cause contention and collision. If the interval is large its performance degrades due to mobility.

2.2 Relevance-based approach

When two vehicles are in the same VANETs for only a short duration due to high mobility and both the vehicles have too much information in its buffer that they want to exchange with each other. So it is not possible to share all information. They select only important and relevant message for sharing by using relevance-based approach.

Properties

Altruism, application-oriented information differentiation and controlled unfairness are some basic characteristics of relevance-based approach [5] [6] [11]. Altruism means nodes are not selfish and malicious. They forward the information to increase the global benefit regardless of their own benefit. Application-oriented information differentiation means that existing techniques depend on packet specific data but now we get the application oriented data to remove the redundant and surplus information. Controlled unfairness means message are forwarded according to their priority rather than the time they spent in queue.

Methodology

The relevance-based approach is consisting of two steps. First is to calculate the importance of message using the information from three contexts (vehicle context (v), message context (m), information context (i)). Second is to forward the messages according to their relevance value [6].

Implementation

The cross layer design is used to implement the relevance-based approach. Relevance of each message is calculated at application layer and that value is attached to message header before passing it to link layer. Benefit-based extension change the functionality of interface queue and medium access control and forward messages according to their priority by getting information from application layer through interlayer communication [5] [6].

Relevance-based approach can also be implement through 802.11e protocol [8] but it is not suitable due following shortcoming. Firstly the four queues of 802.11e do not give internal resorting of the packets in a packet queue. Packets are inserted into one of the four different priority queues according to their relevance value but for dequeuing it ignore the relevance value and follow only FIFO principle. Secondly they are no mechanism to assign a priority to a given packet. Sort packets into four queues are harmful, because data packets of different relevance value are inserted into the same queue. Thirdly the performance of global benefit decreases because packets of less importance more often get the medium than the high relevance value due to no internal contention of four queues [5].

3 Proposed mathematical model for relevance-based approach

The mathematical model that relevance-based approach used to calculate Message Benefit is given below.

Message Benefit =

$$\frac{1}{\sum_{i=1}^{N} a_i} * \sum_{i=1}^{N} a_i * b_i(m, v, i) [6]$$

Message (m), Vehicle (v), and Information (i) context parameters are used to compute a message benefit for every message. Message context includes message age, last transmission, last reception etc. Vehicle context includes speed, road position and connectivity. Information context includes distance, impact and interest etc. Application dependent function bi is used to compute N parameters. The N parameters are then weighted with application dependent factors a_i. At the end all parameters are added and divided by the sum of all a_i. The message benefit value lies between 0 and 1.

Global Benefit = sum of local benefit of all vehicles

The mathematical model that relevance-based approach uses does not consider the network control it only consider user traffic. So its global benefit can be improved by improving the mathematical model by including network traffic as well.

First we will divide the network traffic into different categories. After that priority will be set for each type of traffic and new parameter will be introduce with the existing model that will represents the network traffic. The value of new parameter added will depend on type of traffic.

Basically we have two type of traffic i.e. user traffic and network traffic. User traffic is assign value 0 and network traffic is divided into three categories i.e. operational level, maintenance level and administrative level traffic. We assign the values to network traffic according to their importance e.g. Operational level traffic is assign a value one, then administrative level traffic has value two and lastly maintenance level traffic has three value. We assign values to user and network traffic from 0 to 3.So it is easy to handle them by using 802.11e protocols.

Enhanced Message Benefit =

$$\frac{1}{\sum_{i=1}^{N} a_i} * \sum_{i=1}^{N} a_i * b_i(m, v, i) + \sum_{i=1}^{N} p_i \quad (1)$$

a) $\sum_{i=1}^{N} Pi$ =0 if it is user traffic

Where as

$\sum_{i=1}^{N} Pi$ =1 for Operational level network problem

$\sum_{i=1}^{N} Pi$ =2 for Administrative level

$\sum_{i=1}^{N} Pi$ =3 for Maintenance level

b) Message Benefit = $\sum_{i=1}^{N} Pi$ (for Network Traffic only)

If $0 > \sum_{i=1}^{N} Pi \leq 3$ Then

$$\frac{1}{\sum_{i=1}^{N} a_i} * \sum_{i=1}^{N} a_i * b_i(m, v, i) = 0$$

802.11e protocol has four queues for data transmission at MAC layer and q0 has greater preference than q1 and q1 has greater preference than q2 and so on. We forward the user and network traffic in to queues according to their values. In existing message benefit calculation they are not considering the network control traffic and they have the range of 0 to 1 but in our proposed message benefit we have range from 0 to 3 is only to handle for 802.11e queues and the for the calculation of global benefit we divide enhance message benefit by three so that it values lies between 0 and 1.

4 Simulation study and results

In order to validate our proposed mathematical model, we compare its performance with existing relevance-based approach. We used NS-2, a network simulator, to simulate the behavior of broadcast schemes under VANETs scenarios.

We use Manhattan Mobility Model and traffic is generated by Generic Mobility Simulation Framework [12].We consider an area of 3000m x3000m with vehicles moving at a speed of 72Km/hr to 108 Km/hr.

4.1 Global benefit with relevance-based approach

Global Benefit (GB) is sum of all local benefits of vehicles during the simulation. Figure 1 shows the global benefit that can be achieved by using relevance-based approach. In existing mechanism there is no parameter for network traffic and no priority is assigned to network traffic so only user traffic getting more and more bandwidth than network traffic as its priority is set higher in existing mechanism.

Relevance-based approach consider only user traffic and ignore network traffic. So its global benefit can be improved by improving the mathematical model. We now evaluate the performance of relevance-based approach by adding the network control parameter in the existing formula. Figure 2 shows the global benefit with

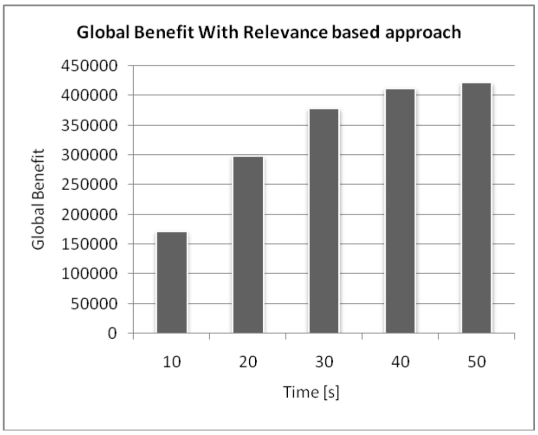

Figure 1: Relevance Approach.

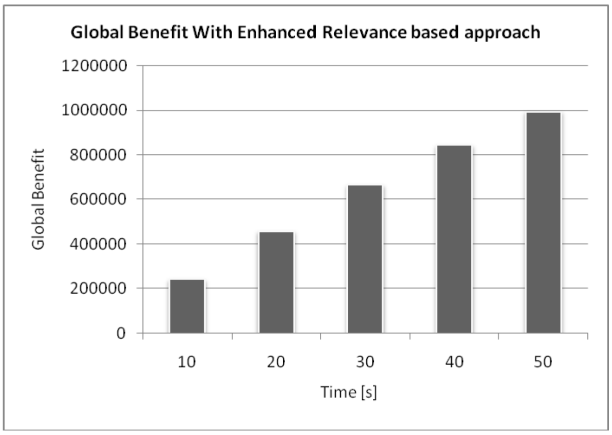

Figure 2: Enhanced Relevance Approach.

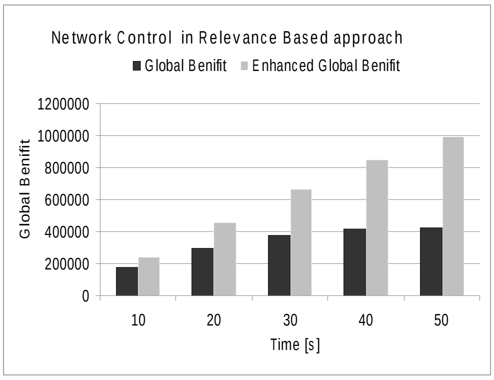

Figure 3: Comparison of GB and EGB

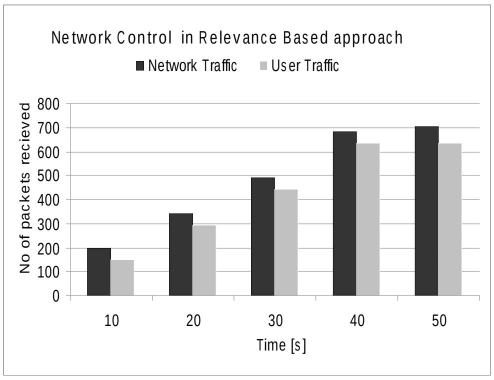

Figure 4: Network Control

enhanced relevance-based approach. It is clear from figure 1 and 2 that global benefit is improved by using enhanced relevance-based approach because in figure 2 network control traffic set higher priority and get more bandwidth than user traffic. So lower priority traffic cannot get more bandwidth than higher priority traffic as it happens in the existing scenarios. That's why the global benefit is improved by adding the network parameter in relevance-based approach.

4.2 Performance evaluation of network traffic and user traffic

In this study we have fifty vehicles, moving with a speed of speed 20 to 30 m/s and simulation time is 50 seconds. Figure 3 shows the behavior of network traffic and user traffic using enhanced relevance-based approach.

Figure 3 shows that network messages have higher priority and it get more medium than user traffic. At time 10, 20, 30, 40, 50 sec, 148, 294, 441, 635 and 636 messages for user traffic and 196, 343, 491, 684 and 706 packets for network traffic are received. It is clear from the simulation that high priority traffic (network traffic) gets more medium than user traffic and the overall benefit of network is higher when we consider the network parameter in the message benefit.

5 Conclusion

Relevance-based approach is proposed for VANETs to give the safety and high priority traffic more bandwidth. But the network parameter is missing in existing message benefit formula. So the proposed approach enhance the global benefit by adding the network parameter in relevance-based approach for network control traffic and simulation shows that global benefit is improved by using enhanced relevance-based approach as higher priority traffic get more medium than lower bandwidth traffic.

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