Modeling Analysis and Algorithm Optimization Design of Vehicle Networking Based on Information Transmission

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Abstract. Vehicle Internet is the embodiment of mobile self-organizing network in the field of transportation. It is regarded as a key technology to reduce the incidence of traffic accidents, improve traffic efficiency and passenger driving experience. It has become the central development direction of the country. Because it is widely influenced by government industries and universities, the effective transmission of information is the core and problem of automotive Internet. This article starts with the application needs of vehicle Internet, designed to address different security-related needs in messaging and non-secure messaging applications, modeling analysis and algorithm optimization design combined with the network attributes of the vehicle Internet. High-speed mobility of vehicle nodes, self-organization and the existence of multi-hop networks, the information transmission on the vehicle Internet is very different from the traditional mobile AD hoc network, at the same time, with the continuous expansion of in-vehicle application Internet, different application scenarios have different service requirements, different services require the vehicle information system's Internet to guarantee different modes of transmission. Therefore, this paper studies application-oriented information transmission technology. It improves the efficiency of the entire information transmission system, and it is of great significance to the development of vehicle Internet.

Keywords. Internet of vehicles; safety-related messages; non-safety messages; probability of successful transmission; distance awareness

1. Technical characteristics and application requirements of the Internet of Vehicles

Interaction with information is a systematic task of the Internet of Vehicles, including the physical layer, network layer and application layer. The physical layer and network layer are defined in IEEE802.11P and IEEE1609, which is the recognized communication system for the Internet of vehicles. However, for WLAN standard protocols, there is no clear requirement for resource allocation and routing in the protocol cluster, and the mechanism of security-related and non-secure messages cannot adapt to the high-speed dynamic changes of topology, node density and channel environment. In addition, due to the limited channel resources shared by all vehicle nodes on the vehicle Internet, the use of the channel, reliable transmission of security messages, unsafe throughput messages and other factors pose major challenges to the effectiveness and stability of information transmission on the vehicle Internet. This is a hot research topic in the field of automotive Internet, focusing on the
broadcasting mechanism and the coordination mechanism of information transmission for safe message transmission, service channel for non-secure message transmission.

2. Safety related message transmission method based on distance perception

Based on the research in the field of safety-related information transmission technology, this document proposes a remote sensing-based method for transmitting safety-related messages. This method can reduce unnecessary flooding caused by the judgment of the relay node, and then dynamically restart the possibility of obtaining effective transmission unit information. The non-uniform allocation sequence maintains the ability of remote nodes to improve channel access and data forwarding through the time slots of relay nodes with different distances from the source node, and it is easy to achieve consistency without interactive network status information.

We consider the traffic scenario in Figure 1. The vehicle S is in an emergency situation. In order to avoid major traffic accidents, S sends safety warning messages to surrounding vehicles. The circle in the figure represents the unique hop communication coverage of the vehicle W node. We believe that the effective coverage of safety-related information is determined by the wireless communication radius of the sending node. The direction of the arrow indicates the driving direction of the vehicle node. Below it, A, B, C, D and S are traveling in the same direction. After S successfully sends a safety-related message, all vehicles within its single-hop range will receive this message. According to the existing vehicle Internet, the transmission standards of safety-related messages are different from vehicle nodes. After the potential relay node receives the alarm information.

![Figure 1. Security related message broadcast scenario](image)

Before forwarding the information, first determine whether the node is a relay node. The basis for judgment is to extract the time of the accident from the received security alarm information, and calculate whether the current time is still within the valid time of the security-related message. If it is, regard it as a relay and forwarding node, and enter the next step of the competitive forwarding process; in the multi-hop transmission process, repeat this process for W until the node determines the current node. The time has exceeded the valid time of the security alert information.

In order to reduce the time limit of safety-related information, the relay nodes are very close in time selection, leading to fierce channel access competition, leading to conflicts of safety information, and limiting the forwarding rights of the relay nodes. Security-related information rooms require coverage, and it is necessary to increase the coverage of the room in the shortest time. Obviously, relay nodes farther from the source node can obtain better spatial coverage through forwarding (as shown in Figure 1, we take node A and node C as an example to compare, it is easy to see the coverage of the message transmitted by node C. The range is significantly better than the coverage of the effective coverage node).

Based on routing hop radio method with the existing methods, especially based on the method to determine the location, it needs a round of information interaction between (such as sending civil TS/CTS packets, etc.) to send effective safety information before the source node and relay to optimize the longest relay nodes, this method increases the amount of unnecessary information interaction and security-related information transmission of unnecessary delay, its applicability is reduced greatly; second, although there is no need for information interaction based on positioning, the
waiting time of each relay node is controlled by tailoring, that is using the distance from the source node to generate transmission delay time to reduce information conflicts; if the node density is low or the least stringent node does not exist, the sub-optimal node still needs to wait for a certain delay to access the channel; this research method limits the priority of the relay node to successfully send data packets within a time window, and there is no prior information interaction, and the probability model can be changed without additional waiting time to adapt to different vehicle densities and topologies.

3. Safety related message transmission method based on transmission power control

The multiple transmission delay is affected by each coverage radius, vehicle density and other parameters. However, due to the rapid movement of vehicles in space and the uneven distribution of time, the density of vehicles on the road changes rapidly. Therefore, the multi-vehicle delay performance of the entire system is unstable when selecting fixed transmitter parameters. In this section, based on the idea of performance control, we study the effective trade-off between single-hop delay and average hop in multi-hop broadcasting under different vehicle densities. The purpose of W is to reduce the multi-hop delay in safety-related information. Before designing the transmission algorithm, first make some reasonable assumptions and restrictions to make the subsequent analysis easier to understand. The source node execution flow chart is shown in Figure 2.

- The communication terminals equipped with all vehicle nodes have the same power, the same maximum transmit power, the accuracy of the antenna system and power settings. The European IEEE802.11 and ETSI working groups work on physical layer standards, so this assumption is reasonable.
- The density of vehicle nodes remains unchanged during the effective time of safety-related messages. The effective action time of safety-related messages is usually in milliseconds. It is reasonable to assume that the density of vehicles will not change in such a short period of time.
- Each car is equipped with a GLOBAL positioning system (GPS), which can receive its own geographical location information in real time and synchronously jump from CCH channel and SCH channel. At present, the GPS system covers the whole world and the coverage rate is relatively low, and most vehicles have become the standard configuration that meets the practical application.

![Flow chart](chart.png)
Figure 2. Source node execution flow chart

On the basis of the analysis model, considering the security-related limitations of the coverage of the message room, the multi-point delay is optimized by controlling the power of the vehicle-mounted terminal transmitter, and a multi-point delay reduction algorithm based on the energy control concept is proposed. Verified by simulation, the performance comparison between exhaustive method and genetic algorithm is shown in Figure 2. This paper summarizes the multi-hop delay analysis model based on performance control and the security-related message passing algorithm. The simulation experiment completed the performance comparison between the analysis model in the multi-hop delay analysis and the NS2 network simulator, and verified the above information transmission algorithm search performance in the best liver. The single-hop coverage radius under different vehicle densities and multi-hop coverage conditions. The experimental results show that the model is a multi-hop vehicle that can quantitatively analyze the delay. The designed algorithm can obtain the theoretically optimal single-hop coverage radius, thereby reducing the multi-hop coverage radius. The broadcast delay is skipped, and the feasibility of vehicle density and node current adjustment in the practical application of the algorithm is simply analyzed, which has good practical value.

4. Conclusion
The model proposed in this study takes into account the length of the vehicle and the maximum number of vehicles, safe small road sections (to ensure no collision), vehicle distribution and vehicle density on the impact of multi-hop vehicles. This method does not need to send handshake information to search for the optimal node, thus reducing the cost and waiting time when sending handshake information. Compared with the existing probabilistic routing methods, it only distinguishes the priority of routing, avoids the problem of low information coverage caused by random routing, and does not need the previous information such as node density which is easy to realize.

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