A study of NR-V2X HetNet with Mixed Awareness Range and Transmission Power

Jicheng Yin, Seung-Hoon Hwang*

Dongguk Univ., *Dongguk Univ.

Jicehng.yin@dgu.ac.kr, *shwang@dongguk.edu

Abstract

3GPP defined C-V2X to support the connection between vehicles and other equipment. Awareness range and transmission power are important parameters that affect the range and quantity of transmission, and the same values are used for all vehicles in one scenario with the original scheme. In this work, we proposed a novel scheme that can support different awareness ranges and transmit powers in the same scenario. This method can both ensure that special messages can be transmitted to more neighbors, and also reduce the power interference of other messages. And based on the simulations, we concluded the proposed scheme can provide better performance.

Ⅰ. INTRODUCTION

The V2X realizes connection and communication between vehicles and surrounding vehicles, pedestrian, infrastructure, and networks. C-V2X has two resource allocation methods, one is a centralized mode (Mode3 in LTE-V2X, Mode1 in NR-V2X), The other is a distributed mode (Mode4 in LTE-V2X, Mode2 in NR-V2X) in which users autonomously select resources with Sensing-based Semi-persistent Scheduling (SB-SPS) without base station coverage. This work focus on NR-V2X Mode2. C-V2X supports periodic Cooperative Awareness Message (CAM) or event-triggered aperiodic Decentralized Environmental Notification Message (DENM) for broadcasting information [1]. And the DENM is closely related to driving safety, and the successful transmission should be ensured in the same scenario. In addition, vehicles broadcast messages to all the neighbors that are within a distance, hereafter called this distance as awareness range and denoted as Raw. In [2], they tested different SB-SPS parameter values for CAM and DENM respectively and it provided an understanding of C-V2X Mode 4. [3] proposed adaptive separate resource pool, and the number of resources used for DENM will be adjusted according to the number of DENM.

Because some special message contains content that is closely related to life safety, we hope that it can send a wider range and receive a higher success rate. Based on this, in this work, we consider setting up the HetNet by setting different awareness range (Raw) values, and further use different transmit powers (P_{TX}). The remaining are as follows: Section II is the research motivation, and simulation results provided in Section III, finally is Conclusion.

Ⅱ. RESEARCH MOTIVATION

When utilizing the same Raw in one scenario, there will be two impacts: if the Raw is too small, and some important event messages (such as DENM) cannot be accepted by relevant vehicles, which will cause serious consequences, and if all vehicles use larger Raw and produce unnecessary interference, resulting in poor packet receiving performance. Therefore, the Raw in different value should be considered, so that the important messages will be received by more neighbors, and the other basic message can also maintain a stable performance. This article first considered only one type of message in the scenario, testing the impact of Raw and transmission power. Next, design different sizes of Raw and further use different P_{TX}. The purpose is to enable some special message to send more neighbors and use a high packet receiving ratio.

Ⅲ. SIMULATION

A. Simulation settings and metric

Table 1. Main parameter settings.

Parameters	Values
Vehicle density (rho)	100 vehicles/km
Bandwidth	10 (MHz)
MCS	3
Message size	300 (Bytes)
Message generation interval	0.1s
Awareness range(Raw)	Variable
Transmit power(P_{TX})	23 or 18(dBm)

Packets reception ratio is the ratio of correctly received data packets to the total number of transmitted data packets.

B. Impact of awareness range and transmission power

The X-axis of Figure 1 is different Raw value, and each line represents a different P_{TX}. It can be seen that whether increasing Raw or reducing P_{TX} will lead to a decrease in PRR, and when the power value is smaller, the impact of Raw will be greater, from 150 meters to 250 meters, PRR drops sharply when the P_{TX} is 10dBm. From Table 2 that the larger Raw (80m and 150m), the more neighbors and the more packets that need to be transmitted.

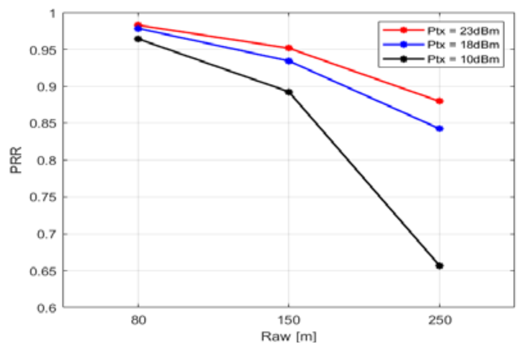

Figure1. PRRs of different *Raw* and transmission power.

C. Mixed scheme for *Raw* or P_{TX}

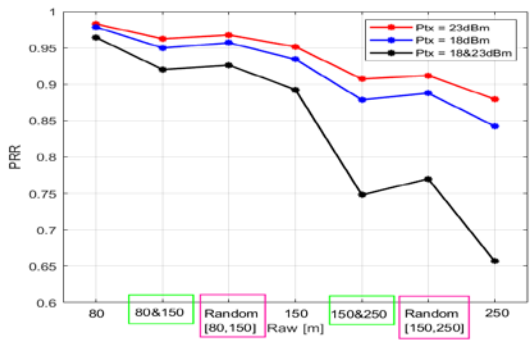

Figure2. PRRs for mixed *Raw* in one scenario.

This section tests using different Raw and P_{TX} for all vehicles in the same scenario. In addition to the original scheme, there are also two mixed Raw settings shown in Figure 2. The green box indicates that all the vehicles use two Raw, and half use the former Raw, other half use the latter one. The pink box is all vehicles use different Raw values, and the values are randomly generated in the range [80, 150]m or [150, 250]m. The results show that the mixed Raw can achieve better performance than the original high value. For example, the PRR of mixed 80&150m and Random[80,150]m is higher than original 150m.

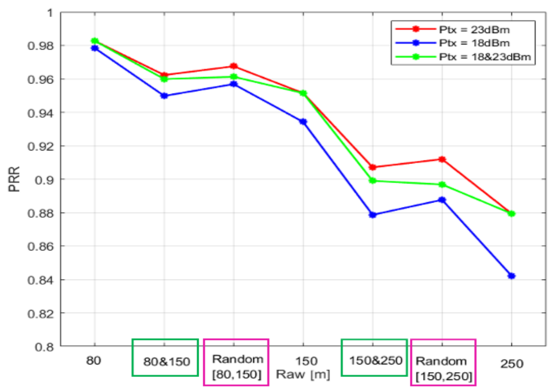

Figure3. PRR for mixed transmission power when consider mixed *Raw* in one scenario.

Figure 3 provides the PRR when considering mixed P_{TX}, and only power value 18 and 23dBm mixed case is considered here. The red and blue lines are the fixed P_{TX}, while the green line is the mixed case, and the value setting is consistent with the mixed Raw. That is, when Raw has two values and the P_{TX} also has two values, and a high Raw uses a high P_{TX}, and vice versa. When the Raw of all vehicles is randomly generated, the P_{TX} is randomly generated in range [18, 23]dBm. In addition, when there is only one Raw, the maximum P_{TX} 23dBm is used. Similar to the mixed Raw performance, the mixed power can achieve a higher PRR than the original lower power. We can also conclude from Table 2 that the mixed mechanism can achieve higher PRR while the number of packets transmit to neighbors is also improved. The reason is that we apply different P_{TX} to Raw of different sizes. High Raw needs to be sent to more neighbors, so use a higher P_{TX}. This avoids excessive power interference, and also ensures that some special messages can be sent to more neighbors with higher P_{TX} and Raw.

Table 2. Average neighbors N_{nei}, total packet transmission N_{Trans} and PRR for different Raw and P_{TX} .

Scheme	Raw [m]	P_{TX} [dBm]	N_{nei}	N_{Trans}	PRR
Original	80	23	16	313972	0.9827
Mixed	*Raw1* = 80 *Raw2* =150	PTX1=18 PTX2=23	22	447256	0.9602
	Random in [80,150]	Random in [18,23]	24	449495	0.9613
Original	150	23	29	579860	0.9515

IV. CONCLUSION

This article uses different Raw and P_{TX} in the same scenario, and the result can get better performance. Future work will consider mixed scheme using other resource allocation-related parameters for different message types.

ACKNOWLEDGMENT

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