Editor's Comments

All the reviewers acknowledge the contributions and appreciate the merits of the proposed scheme. Nevertheless, there are some points that can be addressed to improve the paper further. For example, the paper considers only two types of links, i.e., high and low mobility. It will be good if the system model can be extended and incorporate the arbitrary number of mobility levels, instead of just two, for example, high, medium, and low mobility. In the current model, it is assumed that the constraints on delay and rate. Is there any way that we can ensure the feasibility of the problem given these constraints? Moreover, the presentation quality of the paper has to be improved significantly including the writing, organization and description of math notations. A few places in the paper appear to be inconsistent and can be confusing.

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Reviewer: 1

This paper develops the optimal power allocation scheme based on game and pricing in vehicular communication networks with consideration of channel uncertainty and multi-user interference. To improve the reliability and stability of the D2D-V system, the distributed robust power control algorithm and nonuniform price bargaining algorithm are proposed as a novel robust Stackelberg game scheme. The simulation results validate that the proposed power control scheme has better robustness, and the D2D-V transmission rates also get a promotion. In general, the paepr is interesting. To further improve the paper, there are some issues to be addressed and clarified.

1. It is stated that the practical communication environments are included in this paper. Beside the vehicle speed is considered, are there some specific features to describe the dynamic environments? If not, there is lack of motivation to consider the complex channel, the mobility is the basic characteristic in the vehicle networks.

2. In section III, to transform the uncertain probability constraints into a certainty form, two kind of converting ways, the Bernstein approximation and integral methods, are introduced, why? What are the motivations? Can you combine them or develop only one way to simplify the analysis?

3. The uncertain channel gains are considered and the probability constraints are used to describe the uncertainty. I think it is reasonable to use ergodic capacity to show the network performance. However, it is stated that the Channon capacity is adopted as shown in (10) and the same form is used in the optimization problem.

4. BER is also introduced in the resource allocation, and it is formulated as a constraint of the optimization problem. I still doubt the expression of BER. The BER is a measureable index for the communication pairs and it is affected by many factors. I think it is rough only to consider the SINR as shown in (13).

5. Page 6, the titles of subsections B and C are same, please check.

6. The upper and lower boundaries of channel gains are introduced to tackle the optimization problem. It is necessary to explain how to get these parameters. Moreover, as shown in (25), I think it is a conservative mathematical treatment, because most cases are not the extreme boundary cases. Please clarify.

7. Some important references on channel estimation and medium access for vehicular communication should be discussed in the paper: “Channel estimation based on deep learning in vehicle-to-everything environments,” IEEE Communications Letters, DOI: 10.1109/LCOMM.2021.3059922; “Infotainment and road safety service support in vehicular networking: From a communication perspective,” Mechanical Systems and Signal Processing, vol. 25, no. 6, pp. 2020-2038, Aug. 2011; "A tutorial on 5G NR V2X communications," IEEE Communications Surveys & Tutorials, doi: 10.1109/COMST.2021.3057017.

8. In Fig. 1, it seems that the D2D pairs are grouped based on the location. How to get the D2D groups in mobile scenario? Moreover, the channel reuse is also considered, how to allocate the subchannels to the vehicle users?

9. In Fig. 14, the utilities of primary users and vehicle users show different tends with the increasing vehicle speeds. What are the reasons behind the results? What is about the total utility? Is there a tradeoff between them? How to validate?

10. Please check the manuscript carefully to avoid any errors and typos.

Reviewer: 2

The resource allocation scheme in D2D enabled vehicular communications is studied in this paper, and a robust Stackelberg game approach is proposed to achieve the optimal solutions. A distributed robust power control and nonuniform price bargaining algorithm is proposed to approach the game equilibrium. In general, the topic is interesting and the paper is solid. However, there are still some issues to be addressed further.

1. A "distributed" robust power control and nonuniform price bargaining algorithm is proposed in this paper. For the distributed manner, only local information is required. Form the expression of the iteration formula, it is more like a centralized one. It is necessary to show clearly what the information are required to collect or exchange.

2. In the introduction, "To overcome these challenges above, we propose a robust resource allocation scheme game-based to realize effective interference management and maximize the benefits of all parties", a detailed description should be shown to illustrate the internal relationship between the proposed scheme and the challenge.

3. Fig. 1 and Fig. 2 need to be improved. For example, the word size, the distinction between orthographic and italics, the thickness of the line, messy channel gain labeling are meaningless. What does "n" mean in Fig. 1 and Fig. 2? Besides, which icon represents the eNB? How does the model reflect network scalability?

4. There is no explanation for “CU-I”,“V2I link”, “CU-V”, and “V2V”,especially for “I”. This will make reader who have no communication foundation confused.

5. The Bernstein approximation and exponential integration methods are used to transform the uncertain probability constraints into a certainty form. However, the motivations are suggested to give clearly. For instance, why does not the uniform method such as integral transformation convert the probability constraint?

6. The pricing scheme is introduced in the proposed framework, however, the definition and the physical meaning of the price should be given. Moreover, the pricing or bargaining process should also be stated clearly.

7. Only the simple scenario, one CU and four clusters, is simulated in the simulation. However, when the vehicle density is large, can the proposed algorithm guarantee good communication performance?

8. There are some typos and errors in the manuscript, please polish the whole paper carefully.

Reviewer: 3

The paper addressed the optimal power allocation problem in D2D enabled vehicular networks. The distributed robust power control and nonuniform price bargaining algorithm was proposed based on the Stackelberg game. The optimization scheme attempt to guarantees user QoS with the constraint of maximized utility requirement. Moreover, the probability forms of interference, delay, and delivery rate constraints are introduced to guarantee the robustness under changing channel gains. The power allocation algorithm is developed to achieve practical execution scheme. Simulation results validate the convergence, robustness and improved transmission rate of the proposed scheme. Overall, the manuscript is well organized, however there are still some issues to be clarified and improved.

1.Two channel models are considered in the manuscript to describe the low mobility link and high mobility link, however, the channel power gains are affected by many factors. Why only the Doppler effect is considered? Please clarify.

2.According to the Theorem 3, there is a precondition to approach the GE. I wonder that if the condition can not be satisfied, how can the users allocate the power? My question is not casual as the channel conditions are changing, the precondition will not hold all the time.

3.As for the delay and delivery rate constraints, it is unclear that how to get the relationship between the constraints and the optimization variables. Moreover, there are several parameters introduced in the formulas (13) and (14), more discussions about them are needed, such as how to choose them, are there effect on the optimal solutions?

4.In table I, the index sets $I$ and $J$ are same, please check.

5.There are too many notations and symbols are introduced when introducing Bernstein approximation of the interference constraints in section III, it is confusing and difficult to follow. If the results come from existing conclusion, it is better to quote the reference and reduce the expressions. If not, please move it to the appendix.

6.In the simulation part, figure 3 and 4 are the power levels of cellular user and D2D user, they can be combined. The legends in figure 7, figure 8 and figure 9 are missed. In figure 14, the legend should be $U\_{sum}$.

7.The contributions should be refined to highlight the difference and novelty compared with existing works. And also the more relevant references on the price reward and punishment mechanism are suggested to review, because the Price-Penalty is one of motivations in this paper to get the optimal power allocation.

Reviewer: 4

This paper applies game theory to realize a well-function D2D-V communication system. Considering a non-cooperative setting where the CU and D2D-V users are selfish and profit-driven, a resource allocation framework based on the Stackelberg game is proposed to model the single-leader-multiple-follower hierarchical competition. The channel uncertainties are included in the formulated optimization problem, and the distributed algorithm is developed to determine the optimal solutions. The paper is well written. I have some main concerns as follows.

1. In the section of Related Works, the connection between paragraphs should be strengthened to form a closer work.

2. Clear definition and notations are needed. In the Notations, $\Upsilon$ is the parameter of exponential distribution. However, it appears twice in this paper. Besides, the Euclidean space $R^N$ should be added to the Notations.

3. To find the optimal solution of the upper subproblem P2, the original objective function is transformed. When the interference term is regarded as a constant value, it seems that the transformation is only a simple logarithmic transformation and has little significance. So I think this transformation is redundant.

4. The research is under channel uncertainty, multi-user interference, and a high-speed environment. For the vehicular movement characteristics, there are relevant contents in the simulation, but I don't understand how the vehicle speed affects the system performance.

5. Eq. (27), (28), and (29) are the theoretical basis of Bernstein approximation. However, what does $\rho$ mean in Eq. (28)? There is no clear explanation.

6. Convergence performance is demonstrated in Fig.3, 4, 5, and 6. In my opinion, the optimal variables should be with the same convergence performance. It seems that the power of vehicles, prices, and utilities are with lower convergence than the power of CU. Why?

7. In the Simulation, Fig. 12 shows the comparison of actual outage probability of different papers with the parameters ε1= ε2= ε3= 0.1. Why is it 0.1? Can this conclusion be successful for other values?

8. There are some drawing problems in the simulation figures.

- The width of the line in Fig.3, 4, 5, and 6 is different from it in Fig.7, 8, 9, and 11.

- In Fig.10, the description of ε1, ε2, and ε3 are confused. Besides, this figure aims to show the utility values of the lower network versus outage probability 0.1,0.2,0.3, and 0.4. So it is better to remove the intermediate ticks (0.05, 0.15, 0.25, and 0.35).

- In Fig. 12, 1, 2, 3, and 4 represent four D2D-V users, respectively. However, 1, 2, 3, and 4 represent the four methods "Stackelberg game with imperfect CSI," "The SCA", "Stackelberg game with perfect CSI" and "The D.C. program." The description is conflicting and needs to be adjusted.

9. Some typos and minor concerns:

- The formation of section titles is not unified.

-Introduction: Second, ..., but fail to the spectrum utilization. fail to--> fail in.

-Section II. A: the period for D2D-V transmitters or CU broadcasting their CSI -> "broadcasting" --> "to broadcast".

-Section III.B: "Transformations of the Lower Subgame" appears twice. The first should be "Transformation of Upper Subgame". The second should be "Transformation of Lower Subgame".

1. a "distributed" robust power control and nonuniform price bargaining algorithm is proposed in this paper, but it is more like a centralized one?
2. Some places need to be improved in the system model and simplified model. For example, the word size, the distinction between orthographic and italics, the thickness of the line, messy channel gain labeling are meaningless, all of which make Fig. 1 and Fig. 2 uncomfortable.
3. Better matching should be done, what does "n" mean in Fig. 1 and Fig. 2? Besides, which icon represents the eNB? More importantly, how does the model reflect scalability?
4. In the introduction, "To overcome these challenges above, we propose a robust resource allocation scheme game-based to realize effective interference management and maximize the benefits of all parties", this sentence is unreadable, and a detailed description should be shown to illustrate the internal relationship between the proposed scheme and the challenge.
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11. Eq. (27), (28), and (29) are the theoretical basis of Bernstein approximation, however, what does “” mean in Eq. (28)? The authors did not give any explanation.
12. Convergence performance is demonstrated in Fig.3, 4, 5, and 6. The power of vehicles, prices and utilities convergence at eight steps, but the power of CU convergence at four steps, why?
13. In the Simulation, Fig. 12 shows the comparison of actual outage probability of different papers with the parameters ε1= ε2= ε3= 0.1. Why is 0.1? Can this conclusion be successful for other values?
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1. Some typos and minor problems:

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-Section II.A: the period for D2D-V transmitters or CU broadcasting their CSI -> “broadcasting” should be changed to “to broadcast”.

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