Thanks to the reviewer’s comments and suggestions, which really are a great help for us to improve our manuscript.

According to the comments of the reviewer, we have revised our manuscript carefully. We added the appropriate references, corrected the relevant contents, and redrew the Figure 1. The revised parts are using the track changes mode in the revised version of our paper. The revised manuscript and the detailed responses to the comments of the reviewer are attached. We hope that our revision can meet the comments well.

Response to Reviewer 1 Comments:

Thank you very much for reviewing our paper. Your comments are very important and helpful for us. The response is as follows:

Point 1:

This sentence requires a proper reference: The primary goal of most applications is to be designed by minimizing power consumption, maximizing total network utilization, providing optimal load balancing, and other generic resource optimization techniques.

Response 1:

Thanks for your careful review. We missed the reference which was cited later in this article. We add it as follows:

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The primary goal of most applications is to be designed by minimizing power consumption, maximizing total network utilization, providing optimal load balancing, and other generic resource optimization techniques [10].

......

Point 2:

It is not clear the benefits of using game theory for the proposal in the introduction.

Response 2:

Thank you for your good comments. After careful consideration, we believe that the introduction lacks the relevant discussion on the benefits of applying game theory to solve the transmission control problem, which led to the incoherent logic of the content. We added the discussion at the end of the second paragraph in the introduction. The changes are as follows:

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The purpose of each switch is to achieve the maximum transmission of information under the premise of satisfying their demands. In the case of limited resources such as computing, storage, bandwidth, and others, competition arises between network nodes including the switch and the controller nodes in SDN. How to improve the efficiency of data forwarding by means of optimization strategy is the key problem that the 5G network technology needs to consider. Game theory has been studied and applied in the field of optimal allocation of network resources with competitive relations [13-15]. The behavior and objective of multi-player competition can be abstracted as a game model, and then the equilibrium solution can be obtained by solving the model. The reasonable game model will provide an efficient foundation for engineering design.

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Point 3:

It is not clear the main motivation about transmission control schemes. What are the benefits?

What are the main drawbacks that need to be solved?

Response 3:

Thank you very much for your comment. The lack of direct discussion on the main motivation...
of the transmission control mechanism makes the manuscript difficult to understand. After careful consideration, we added the description of the problem at the third paragraph in the introduction and modified some descriptions to the last paragraph of the relevant work. The changes are as follows:

......

The key problem of the transmission control mechanism is to improve the negative impact of network bottleneck bandwidth on the overall performance of the system [16-18]. In the model, the queuing game theory is used to establish a mathematical model of the competitive behavior and target between SDN nodes. The optimal strategy of the nodes is obtained by solving the theoretical equilibrium solution of the model, so as to relieve the transmission pressure of controller nodes which are easy to be congested and realize the maximum network efficiency. Here, the behavior of nodes is divided into the following two categories: whether the request of switching nodes join to the queue of the controller node, and the admission fee value set by the controller node. These two kinds of behaviors are related to each other. The goal of the system is to maximize data transmission within the network carrying capacity. The objective is abstracted as an effect function, which consists of the benefit obtained from completing the data service, the admission fee to be paid and the waiting cost. Such a design takes into account the throughput and delay of the important network indicators in SDN and constructs the optimal system strategy by game among nodes. At the same time, due to the independence of the model in switch request parameters design, it is conducive to system upgrading according to specific network requirements in the future, and more suitable for the future changeable individual requirements of network function virtualization. The main drawbacks of the solution are the bottleneck bandwidth and the limitation of end-to-end delay on network performance. The main contributions can be summarized as follows:

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In this paper, the optimal software-defined transmission control scheme is proposed by confirming the area of the controller’s queue length. The switch’s benefit, controller’s profit and social welfare of the transmission control platform (TCPL) are formulated. On this basis, the
optimal queue length is calculated and discussed in first-come-first-served and last-come-first-served with preemption discipline. The optimal admission fee is obtained in relation to the queue length. It assumes that each switch request gets its own benefit after completing service. The controller announces the admission fee to the switch, the switch then calculates each request's minimum benefit through subtracting the admission fee and the cost of queuing. If the request's benefit is nonnegative, the switch request joins the controller to be serviced. In this model, how to find the optimal admission fee is the key. It formulates the controller’s profit, maximizes the value and iteratively modifies under the first-come-first-served (FCFS) and last-come-first-served with preemption (LCFS-PR) discipline to get the unique queue length which is the threshold value. In the meanwhile, the social welfare of the TCPL is obtained with the queue length. According to the relationship between the threshold queue length and the admission fee, the optimal admission fee is obtained finally. With the above design, a novel software-defined transmission control scheme of the single switch single controller is modeled over the 5G network. Based on it, how to extend the result to the multi-switch single controller model is discussed. The most important distinction between the two models is the different arrival rates of the TCPL. Therefore, the improved model is built to solve the transmission control problem under the situation of a multi-switch single controller. At last, the effective software-defined transmission control algorithm is designed for promoting network performance in 5G networks.

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Point 4:

IMO, authors must introduce papers related to transmission control schemes. Specially, young references.

Response 4:

Thanks for your suggestion. We add 3 references at the third paragraph of the introduction in our revised manuscript. The changes are as follows:

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The key problem of the transmission control mechanism is to improve the negative impact of
network bottleneck bandwidth on the overall performance of the system [16-18].

......


**Point 5:**

What are the players in this game? What are the competing resources to consider a game theory?

**Response 5:**

Thanks for your comment. Through reading and studying the reviewer comments careful, it was true that our system model described in the manuscript was not clear and accurate enough, which led to our game process been hard to be understood. Our response is as follows. The game players were the network nodes including the switch and the controller nodes in the system model and the strategies were the actions of the players in making decisions based on the optimal admission fees. The switch requests chose whether or not to join the queue by setting the equilibrium solution optimal admission fee of the queuing game. The competing resources were computing, storage, bandwidth, and other network resources. In the model, they were embodied by the contention of network service resources for users, that was, whether the switch node needs to get data transmission service and whether the controller node provides service.

We have added the following changes to the manuscript:

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3.2. Problem description

In the system architecture, different users are connected to the network by the switch of the data layer and the data flow is realized through the information of the controller. The game players are the network nodes including the switch and the controller nodes in the system model and the strategies are the actions of the players in making decisions based on the optimal
admission fees. The switch requests choose whether or not to join the queue by setting the equilibrium solution optimal admission fee of the queuing game. The competing resources are computing, storage, bandwidth, and other network resources. In the model, they are embodied by the contention of network service resources for requests, that is, whether the switch node needs to get data transmission service and whether the controller node provides service. After the switch requests to accept the service of the controller, it will get benefits and pay the waiting cost when waiting in the queue. The controller gets its profit from the admission fee for requesting services. Obviously, different switch requests want the fastest service and the highest net revenue, but the system resources are limited. Queuing game theory can exactly get the optimal strategy of the system and Nash equilibrium from the local and global point of view according to the switch’s benefit and the social welfare of the system. Therefore, the problem of 5G system resource allocation can be mathematically modeled by using queuing game theory, and the optimal strategy of game participants can be obtained by solving the mathematical model, so as to obtain the optimal transmission control mechanism of the system. The relevant parameters are defined below.

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**Point 6:**

*Figure 1 is difficult to read.*

**Response 6:**

*Thanks for your comment. We redrew the Figure 1 and add the description. The changes are as follows:*
A Transmission control system model using the TCQG algorithm is shown in Figure 1. The user terminals are connected to the network through 5G base station, and the data plane switches are connected to the small base station network. Data information is transmitted between switches. Multiple switches are subordinate to an SDN controller, transmitting control information, obtaining rules or other control instructions for data flow. The TCPL consists of a multi-switches single controller, and the TCQG algorithm is applied to the transmit link from the switch to the controller which is prone to congestion. Each controller has a buffer providing requests of switches the queue space to wait for being serviced.

Point 7:

The paper must introduce the simulation methodology and parameters.

Response 7:

Thanks for your comment. We add the introduction of the simulation methodology and parameters. The changes are as follows:

Firstly, the values of the common simulation parameters are defined in Table 2.
2018b, the theoretical value of the model is calculated and analyzed. By substituting these parameters in the formulas (2), (15) and (17), the optimal queue length and the admission fee of the system in the different models can be calculated. Then, with the optimal results, the TCPL obtains the maximum social welfare.

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In the second realistic simulation, the average end-to-end delay and the throughput of the contrast algorithm and the TCQG algorithm are compared to show the improvement of the network performance. The Wardrop load-balancing algorithm of literature [24] is selected to simulate the contrast transmission control scheme.

A realistic simulation environment is built by using the OMNeT++ 5.5.1. All the schemes and data sources are simulated on the Intel (R) Core(TM) i5-6200U CPU @ 2.3GHz using the C++ language. The basic network unit for SDN information transmission with the multi-switch single controller is structured. The relevant simulation Settings are assumed as follows. Switch requests are generated by the Poisson distribution with parameter $\lambda$. The arrival rate of controller requests is obtained with the formula (18). The service rate of the controller follows the Poisson distribution with parameter $\rho$ ($\lambda < \rho$) and the waiting cost of requests for the unit time is constant $C$. In the simulation process, the requests join to the controller based on whether the net benefit returned by the controller is non-negative or not. The net benefit is calculated using the conclusion of Theorem 2 about the admission fee. The specific parameters used are the same as the numerical simulation, as shown in Table 2. The TCQG algorithm runs for 100 seconds in each simulation experiment, and the experiment is repeated 5 times with different random number seeds. The following simulation results are obtained.

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Thank you for your good comments again. It is helpful for us to improve the manuscript. We look forward to hearing from you regarding our submission. We would be glad to respond to any further questions and comments that you may have.

Yours sincerely

Chao Guo