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SDN resource scheduling strategy based on three-tier pricing mechanism of bilateral market

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ABSTRACT

In recent years, due to the increase of network users, network resources wasting on a global scale is becoming more serious. Traditional resource scheduling policy can not meet the current allocation of network resources; we propose a SDN resource scheduling strategy based on bilateral market three-tier pricing mechanism. Respectively, each layer of the three-tier pricing mechanism integrates into the three-tier architecture of the SDN, and introduces the concept of a bilateral market, changing SDN resource scheduling into a commodity trading in economics.

Keywords: bilateral market, resource scheduling, pricing mechanism

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INTRODUCTION

Currently, the Internet has been closely linked with the development of the whole society and future innovative technologies together, people's lives have been inseparable from the Internet. Since the tradition TCP / IP network protocol is adopted in1983, through thirty-year's development, TCP / IP has occupied a dominant position. However, with the popularity of Internet, the increase of users, the diversity of services, the traditional code address resource (IP address) can not meet the current needs of the network, and exposes more and more problems [1,2].

At the same time, Internet is also facing a serious waste of resources [3]. Again, it is the uneven distribution of network resources problem. Because of the traditional network using a single approach to every user fairly, so it can not distinguish the service well and truly reflect the users' demand of resources. Then, this situation results in massive waste of resources. So how the Internet can reflect the users' real needs of resources to achieve full utilization of resources, and to get a balanced and effective distribution among unlimited users with the limited resources is also becoming the current problems of the Internet. This paper starts from the SDN architecture by analyzing the role of prices in the allocation of network resources, and proposes a three-tier pricing mechanism to optimize the scheduling of network resources.

Research on Multi-platform Based on Bilateral Market

Introduction of Bilateral Market. For the definition of the bilateral market, different scholars have described the different angles. Firstly, from a structural point of platform, Wright (2004) considered that there were two different users in the bilateral market. Each user transacted with another user through platform in the market, and accessed to benefits in the process. This platform worked for an intermediary role [4]. Chinese scholars, Shang Xiufen and Chen Hongmin (2009), described that the bilateral market is a specific market whose core is their trading platform to attract different types of users, to encourage participants' interaction and transaction. Then, the market can get benefits [5]. Secondly, from the perspective of cross-network externalities [6], Rochet and Tirole (2003) described it from this point of view, if the platform subsidized to the users of both sides of each transaction according to cross-network externalities, the market will have a bilateral market characteristics. The owners of these markets need to solve the problem that pulled more users to the platform through researching that whether users need subsidy. They opened up a new direction for the study of the behavior of such markets platform [7]. Chinese scholar, Luo Liang (2005), believed

that if the user enterprises can be divided into "seller" users and "buyer" users in a market, there existed cross-network externalities between these two types of users, and the companies can internalize this indirect network externalities by attracting buyers and sellers to take part in the participation. So this market is called "bilateral market" [8].

Resource Scheduling Strategy Based on Cloud Computing. Literature [9] proposed a resource scheduling strategy based on rent theory and dynamic multi-level resource pool. According to the virtual cloud computing technology, the servers, storage devices and other network resources were all integrated and divided, so that resource can allocate according to the needs and grow automatically. Virtual resources were dividedly into n slots virtually, and resources would be classified to form a resource pool to achieve multi-level resource pool according to a common characteristic of resources (operating system, memory size, etc.). It is resource scheduling of multiple platforms. One of these resource pools acts as a service to interact with the outside halo, to maintain other resource pools' load balancing, to assign a series of resource scheduling problems.

We can make fully use of the multi-level resources pool structures advantages with this load balancing model of multi-platform. For communication-intensive tasks, trying to assign them to the same resource pool network domain and reducing the overhead of inter-process communication are the best way to effectively reduce the idle time of resources and improve utilization of resources.

Research on SDN Three-tier Pricing Mechanism Based on SDP

Introduction of SDP. Pricing mechanism is the core of resource allocation of economics, the current era has entered a "software defined" era, SDP(Software Defined Price) is similar to SDN(Software Defined Network) and the users can use the software to define resource prices. In the three layers framework of SDN, each has a series of SDP mechanism. Resource interaction between each two layers can use this price strategy to negotiate in order to achieve transaction resources successfully. SLA is a protocol specification by between the resource providers and users to consult, to agree resource price, performance and so on. SLA applies simple language so that both sides can exchange instead of using complicated language specification. SDP is proposed not only to communicate between providers and users, but also for multi-platform communication.

SDP Mechanism of Control Layer. The control layer is considered as a trading platform from the perspective of platform. This platform in order to give the parties adequate economic information, the platform owner can introduce a market allocation mechanism. In this mechanism, the decision-makers do not directly determine the allocation of resources between the consumers, but by a kind of price leverage to make the platform to reach a state of equilibrium between supply and demand.

Meanwhile, the platform can charge some level fees to the resource provider based on trading volume of both sides, income, resource types and so on. Here, the income of platform can be determined by resource trading volume I, the number of leased bandwidth c and users punishment S. Firstly, the platform determines the price charged p_c based on resource types; Secondly, all the virtual link, the platform charges the costs$\partial(c)$ of the resource providers for renting the amount of bandwidth; S is a kind of punishment because of the congestion caused by the users excessive using of resources [10]. So we can get the revenue of platform W_c .

$$W_c = I \cdot p_c + \partial(c) + S \qquad (1)$$

Because of the different pricing strategies of various resources, we integrate these pricing strategies into the controller. Which resources are traded, the platform will call the kind of resources pricing mechanism, and then to collect profits based on the trading volume I.

SDP Mechanism of Data Plane Layer. The data plane layer is considered as a "seller" in the bilateral market, it is a resource provider. When it receives service requests from the upper layer, "seller" will check whether their own resources meet upper layer's requirements. If it meets these requirements, the "seller" will be traded with the users through the platform. But how to determine whether the service can meet the requirements of the top, not only to check if they own such resources, but also to determine the size of their income after providing this service. Here is how to determine the income of "seller".

Firstly, setting the price $p(x, y, z)$of different resources x, y, z, then transporting the service through the renting bandwidth. Finally, we can get the benefits of "seller":

$$W_d = I(x, y, z) \cdot p(x, y, z) - \partial(c) - B \qquad (2)$$

$I(x, y, z)$represents the amount of resources required by the service, B is the compensation which "buyer" charges for "seller" due to the delay.

SDP Mechanism of Application Layer. The application layer is considered as a "buyer" in the bilateral market, it is the users. Each user will selfishly maximize their own interests as a target, and proposes various "unreasonable" demands to resource provider.

Because of the pressure from the "seller", the user has to develop pricing strategies in their favor. Therefore, whether the services which are provided by "seller" meet their QoS guarantee, and also determine their own pricing policies by delay. Each delay corresponds to a price function $P(d)$, which reflects a kind of function relationship between the quality of service which is provided by "seller" and the charge of users. It is about d's non-incremental. The smaller delay, the more fee the user pays [11]. According to $P(d) = B$, we can draw the user's final income:

$$W_a = U(x, y, z) + P(d) - S \qquad (3)$$

$U(x, y, z)$is the satisfaction of services which the users provide to "seller", and the users must pay a necessary penalty S because of the congestion caused by the excessive using of the platform.

It can be seen that the allocation strategy of traditional network resources emphasizes the sharing and collaboration of network resources, and it does not take the price factor into consideration. But, in practice, a lot of resources are not free to be used. If you want to attract the resource owners to take part in the network, you must ensure their interests.

SDN Resource Management Model Based on Bilateral Market

SDN Resource Management Architecture Based on the Bilateral Market. SDN is a complete network environment consisting of the application layer, a control layer, the data plane layer. For the three-tier architecture model in this section, we propose a SDN resource management system to efficiently allocate resources.

In SDN resource management architecture, the resource providers are called producer, and the demanders of resources are described as consumer. So this model includes: the layer of resource providing, SDN controller, resource management system, the user layer. The resource management system is shown in the following:

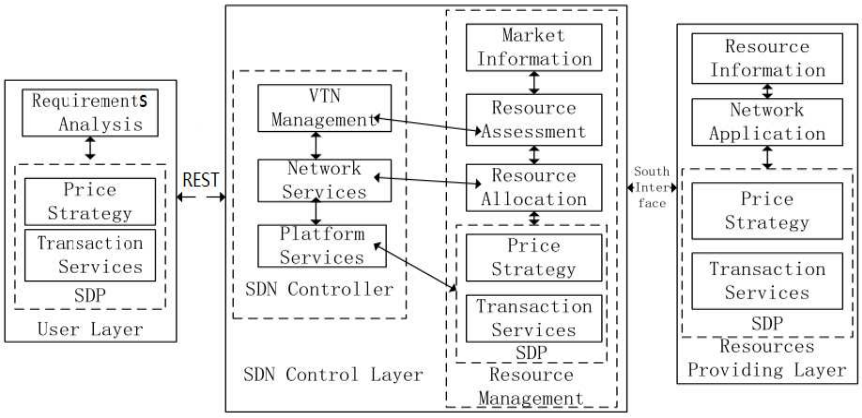

Fig.1 SDN system resource management system

As shown above, resource scheduling can be divided into the following steps:

1) The user layer corresponds to application layer in the SDN framework. In the user layer, the users take their own demands to SDN controllers including the required resources and the necessary exchanging information such as price, time constraints, preferences and so on. And it passes to the SDN controller by API REST.

2) SDN control layer is mainly composed of SDN controller and resource management system, SDN controller receives a request from the user layer by API REST, and this request is submitted to the resource management system after finishing a summary in SDN controller.

3) The resource providing layer is described as the data plane layer. This layer is mainly responsible for the resource updating in real time, dynamically adjusting the transaction price and quantity of each trading platform based on market information.

CONCLUSION

Scheduling problem of network resources and the market economy have many similarities, so there are two main resource allocation models based on market economy, one is based on the price of the model, and the other one is based on the game theory. The model based on the market price is mainly Kelly model [12] as a representative, and the model based on the game theory is mainly PSP auction mechanism [13] as a representative. A lot of research has been made on these two models. This paper mainly proposes a new SDN resource scheduling strategy based on bilateral market three-tier pricing mechanism, and the pricing mechanism is integrated into the SDN three-tier architecture to allocate the network resources effectively and reasonably with the bilateral market platform.

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