

The Research of Resource Auction Incentive Mechanism in Mobile P2P

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Abstract—Due to the anonymous participation and voluntary resource contribution in mobile P2P systems, a subset of users begins to consume much more resources available on mp2p than they wish to contribute, this leads to the prevalence of "free riding". In order to raise the whole mobile network searching efficiency, this paper presents a resource auction incentive mechanism system. The system incentivizes peers to contribute effective resource through auction economic pattern, it also means that the number of peer's contribution directly influences its download speed. For this reason, this system arouses users to offer bandwidth and upload more resources, thus the system can raise every customer's download efficiency. Finally, the simulation results showed that the incentive mechanism is fair and effective, it can encourage the node sharing more storage resource, raise the whole network efficiency, and it also can optimize the function of the whole network.

Keywords: incentive; mp2p; auction; resources

I. INTRODUCTION

Nowadays, with the advance of mobile wireless communication technology and the increasing number of mobile users, the mobile p2p will have good prospects. With the promotion of 3G in China, more and more people want to share and transfer the data between their mobile devices. In particular, with the restraints of wireless network and mobile devices, a subset of users begins to consume much more resources available on mp2p than they wish to contribute, there is a free-rider problem in mobile p2p network, the majority of users do not willing to contribute resources without any external incentive mechanism, this caused that minority user provide large resource to majority peer. In current mp2p network system, it is key factor of how to improve the capability of mp2p, and how to encourage mp2p peers of rational and self-interested to contribute peer's resources effectively and reasonably.

If users contribute fewer effective resources, the total amount of public resources will be reduced; if users contribute more resources, many resources are likely to be invalid, or even worthless resources, and this may waste system storage resources. Thus, we present resource auction incentive mechanism system, system incentivizes peers to contribute effective resource through auction economic pattern[2]. Due to the dynamic nature of moving hosts, we allocate resource depending on the reputation of moving node, the higher reputation nodes have the priority to gain the resource, because they have much virtual currencies to compete, who give the most virtual currencies to seed may have the fastest downloading speed. This incentive mechanism induced users to share the resource, who contribute more resources may gain virtual

currencies from system and improve the reputation, it can have higher competitive in next competition.

II. BACKGROUND

Many people have presented incentive mechanisms for mp2p system. Such as, J. Suomalainen presents a security analysis of a P2P incentive mechanisms for mobile devices, he explores security issues related to a centralized incentive mechanism by analyzing and classifying threats and potential security mechanisms. Anirban Mondal presents incentive transfer-rate differentiation for P2P content sharing over wireless access networks, he proposes a novel architecture for contribution-based transfer-rate differentiation using wireless quality of service (QoS) techniques that motivates users to contribute their resources for wireless content sharing.

In this paper we present the incentive mechanism from the point of view of auction. Auction is a method of selling things in which each item sold to the person who offers the most money for it. Auction has English auction, Dutch auction, and a combination of English and Dutch auction style. First, we describe the auction application in economic. Then, we describe the auction mechanism architecture for mp2p incentive system. We contribute resources by analyzing which mechanisms are available and how they can be applied for an incentive mechanism. Finally, we present related research work and prove the availability of this mechanism.

III. THE AUCTION INCENTIVE MECHANISM IN MP2P

The goal of mobile peer-to-peer network incentive mechanism is to establish an appropriate mechanism environment, and to induce every node (at least the majority) to adopt cooperative and responsible behavior, thus this system have a healthy and sustainable development[3]. Each node can get reputation according to the resources which he have even contributed to others. In this paper, we through the auction mechanism to encourage node's cooperation and contribution, and the peers bid for resources in auction, who can get the resources by pay for it with virtual money is the winner. The peers can get virtual money through share their resources.

■ Auction mechanism in economic

In this mp2p network, every node participate in auction mechanism in the form of virtual currency, seller is the node who provide resources and get virtual currency, while buyer is the one who gain the resources from the seller and pay for it in virtual currency. When one node needs resources, he can

broadcast request to neighbor node and take part in bidding, we assume that every node is for the purpose of utility maximization and large benefit in the process of auction[4].

Assume that all bidders's evaluations conforms to the independent private value models, risk-neutral and symmetric, and, every bidder exactly know the value of goods, but not the evaluation of other bidders. N bidder give the evaluation of good is $v_i = (v_{i,1}, v_{i,2}, \dots, v_{i,n})$, the first high evaluation is

$v_{i,1}$, the second is $v_{i,2}$, and so on. Their evaluation is originates independently from (0,1) uniform distribution, that is, the cumulative density function $F(x)=x$. The seller appraises own value is p, certainly the seller may also suppose p is 0 (free resources)[1]. However, from the perspective of the seller, seller in order to pursue the largest benefits, it will need to set an optimal reservation pricer r, and $r > p$, also

$$p = r - \frac{1 - F(r)}{f(r)} \quad (1)$$

when r and p satisfied the above equation, the seller will be gain greatest benefits. When a node joins the mp2p network for the first time, the system will donate certain virtual currency to new node, so that network new node has the qualifications to participate in the network auction.

■ Auction mechanism in mp2p

The entire the auction process can be described as follows: firstly, user broadcast the request query to the super node, the super node is responsible for the collection and management information of each node, through this message the super node know the auction node's situation and this buyer's evaluation of resource in auction; secondly, super node transmit this message to the resource owner (seller); finally, the seller received the message from the super-node, then it select the highest evaluation of all the buyer node as the winner after a comprehensive comparison[5]. The super node's selection has certain rule in mp2p, their position usually change in the network for high dynamic of mobile node, thus it causes the entire network topology changed, but the choose of super node will not give unnecessary details here.

When the seller deal with the messages from super node about the seller, there have two situation: (1) When all bidders's evaluation is smaller than r, the seller decided not to sell this resources, the income is 0; (2) the seller selected the highest evaluation from n bidders, the winner only need to pay the second highest evaluation, the benefit of seller is $v_{i,2} - p$. According to the definition of equilibrium, any behavior deviation from the balanced is unlikely to have beneficial, each bidder obtain the greatest benefits only under the premise of reporting real type. Because their evaluation is originates independently from (0,1) uniform distribution, by calculating, the buyer expected earning is $u_{winner}(v)$,

$$u_{winner}(v) = E(v_{i,1} - v_{i,2}) = E\left(\frac{1 - F(v_{i,1})}{f(v_{i,1})}\right) = \frac{1}{n+1} \quad (2)$$

the currency that the buyer needs to pay is u_{price} ,

$$u_{price} = E(v_{i,2}) = \frac{n-1}{n+1} + \frac{1}{(n+1)2^n} \quad (3)$$

seller's average return is $ER(n) = E(v_{i,2} - p)$, we make the conclusion that when more buyer participate in the auction, the seller may obtain greater income[7]. In order to maintain the fairness of entire auction, if the buyer automatically gives up the right to use the resources after the auction, the currency that he pay will not be returned; if the seller has the behavior of stopping auction, then the buyer doesn't need to pay the corresponding currency.

The figure1 is the auction model of multiple buyers and sellers. Now we assume that there have m goods (resources) for auction, and n nodes have the purchase request, that is, many buyers and the seller have traded probability at the same time, then we introduce one kind of goods combination auction model, the model is take the revenue maximization as the goal. Suppose $v = \{v_1, v_2, \dots, v_n\}$ as the bidders; $a_j = \{a_{1,j}, a_{2,j}, \dots, a_{n,j}\}$ express the quantity of j goods in i auction item, $a_{ij} < 0$ express that the commodity is on sale,

$a_{ij} = 0$ express that the demand commodity is not in the auction project, $a_{ij} > 0$ express that buyer is competing for the commodity, and a_{ij} is integer; p_{ij} expresses the bidder's evaluation for this combination auction model, $p_{ij} > 0$ express the buyer's evaluation, that is, the node is buyer, $p_{ij} < 0$ express the seller's evaluation, that is, the node is seller.

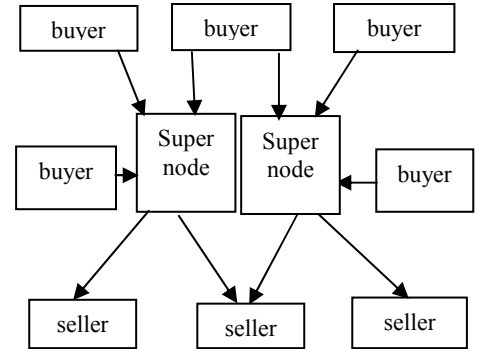


Figure1 the auction model of multiple buyers and sellers

When many buyer bids for goods, the seller needed to find a distribution program which can cause total utility maximum. Suppose the purchase demand of buyers are provided completely by the seller, a_{jk} express the quantity of j items in k auction project, v_k is quantity of total goods in k auction project; x is a binary variable for each bidder, it means that the competitive success or failure. This article proposed an effective Lagrange multiplier, we can find λ_i by the Lagrange algorithm which causes objective function maximization[6], the problem have transform into unconditional extreme value of the lagrange function, this method is known as the Lagrange multiplier method, the model can be expressed as follows:

$$L(\lambda) = \sum_{j=1}^n p_j x_j + \sum_{i=1}^m \lambda_i (v_i - \sum_{j=1}^n a_{ij} x_j) = \sum_{j=1}^n (p_j - \sum_{i=1}^m \lambda_i a_{ij}) x_j + \sum_{i=1}^m \lambda_i v_i \quad (4)$$

the constraint condition is:

$$\sum_{j=1}^n a_{jk} x_j \leq v_k \quad (5)$$

the condition expressed that the number of bidder's purchased items does not exceed the total number, and $x_j \in (0,1), 1 \leq k \leq m, 1 \leq j \leq n$. Lagrange max of the objective function is $L(\lambda^*)$,

$$L(\lambda^*) = \max_{0 \leq x_j \leq 1} \{ \sum_{j=1}^n [\sum_{i=1}^m (p_j - \sum_{i=1}^m \lambda_i a_{ij})] x_j + \sum_{i=1}^m \lambda_i v_i \} \quad (6)$$

the above equation must exist an 0~1 optimal solution which enable the objective function to obtain the maximum, $\lambda^* \geq 0, \forall i = 1, 2, \dots, n$, x_j is a binary variable,

$$x_j = \begin{cases} 0 & , \sum_{j=1}^n (p_j - \sum_{i=1}^m \lambda_i a_{ij}) \leq 0 \\ 1 & , \sum_{j=1}^n (p_j - \sum_{i=1}^m \lambda_i a_{ij}) \geq 0 \end{cases} , j = 1, 2, \dots, n \quad (7)$$

The seller can get the seller's income approximate maximum value through λ^* , this combination auction model can be applied in the mp2p resources auction system.

■ Simulation

We have made a simulation experiment in two mp2p system, and we inspect the number of effective resources with the change of time. In our simulated environment, there were 130 independent mobile peers, and we set simulation time for one hour. The simulation results are shown in Figures 2 and 3, the number of resources increase gradually with the change of time, but the resources's number in auction incentive mp2p system is more than in non-incentive mp2p system obviously at the same time. The node's shared resources is directly related to its contribution resource in auction incentive mp2p system, that is, the node who contribute more resources may obtains more. The experiment proved that this incentive mechanism can improve the number of effective resources in mp2p, and incentive user node to contribute more resource, thus the incentive mechanism have achieved anticipated effect.

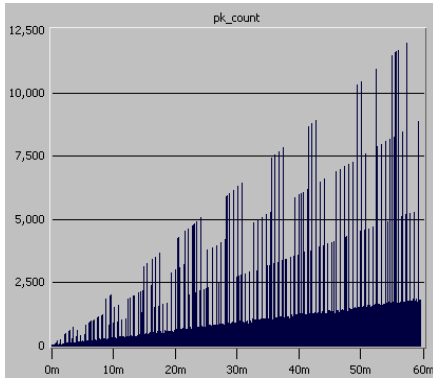


Figure2 the change of effective resources number in non-incentive mechanism

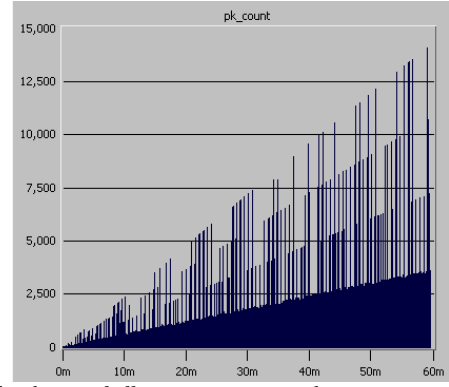


Figure3 the change of effective resources number in incentive mechanism

IV. CONCLUSION

We proposed a new mp2p incentive mechanism in this paper, all resources are at the price of virtual currency in incentive mechanism. System use price leveraged to control the allocation of network resources. We have chosen the auction which required a minimum pricing information way, the algorithm have incentive compatibility. We described the principle of the auction and calculate how many expected revenue can the contribution node obtain. Finally, it can encourage the node sharing more storage resources, and raise the whole network efficiency. Also, this article does not take the bidder collusion problem into account, if the all bidder mutually coordinated bidding motion, this will result in loss of seller's benefits, which will be also a research direction in mp2p network auction.

ACKNOWLEDGMENT

This paper is based on the Anhui province international scientific and technological cooperation project, and the second author acknowledge the partial support from wuhu ruier science and technology limited company. We would like to thank the project management department.

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