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Research on grid resource distributive method based on market economics model

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Abstract. Grid is an internet-based new technology, provides users with a wide range of sharing resource through the integration of computing, storage and information resources distributed in areas. Now some ways have been to solve resource distributive problems, but all these ways are based on only one goal, Resource management and scheduling in the environment of grid still remains a tough question. This paper mainly discusses how to satisfy clients multitask and multi-goal through building linear programming model under the market economic environment. The linear programming model not only gives the tasks the best resources to use but also enhances resource matching and using efficiency.

Key words. Grid resources, market economy, model, strategies.

1. Introduction

Grid technology has become a hot research and cutting-edge computer field, it represents the following internet and web technology after the third wave[1]. Grid is a concept developed from the power grid, and its goal is to use network services, like

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electricity, as can quickly and easily provide users with the necessary hardware and software resources services[2].Grid resources originated in the people's demand for deeper sharing in heterogeneous, dynamic, distributed environment, to achieve computing resources, storage resources, data resources, information resources, knowledge resources, hardware and software resources in an effective and comprehensive sharing of aggregate. How this resource dynamic grid environment is correct, rational management and deployment of resources to become a serious problem[3].

2. The introduction of economics

Grid has a strong economic and social similarities, the grid is intended to integrate various resources to provide efficient computing capabilities, economic and social goal is to optimize the allocation of social resources, and create more wealth; grid to solve the heterogeneous system resource sharing, to achieve social and economic exchange of goods; grid resources are dynamic, market-traded goods is always changing; grid resource scheduling to solve the load balancing of economic activity to maintain balance between supply and demand balance and fairness; network grid resources are autonomous management strategy to solve local conflicts and global management strategy, the main economic activity is selfish, personal interests and to coordinate the social conflict of interest[4].

In a sense, the grid can also be seen as a society, the problems faced by the grid system in the economy and society also exist. The market mechanism as a solution to an important means of social resources, has been proven to be very successful. Therefore, the grid resource management in the introduction of market mechanisms, has a strong practical significance[5].

3. Grid service market structure

Grid services market, similar to the reality of the commodity market, there are three main roles: Grid service providers (Grid Service Provider, GSP), the grid resource consumers (Grid Resource Consumer, GRC), Grid Resource Broker (grid Resource Broker, GRB), which in the relationship between grid services market by Figure 1.

When GSP grid resource providers have resource information available for sale, the first agent to download resources from the resource agent in resource market is responsible for product registration information, and maintenance of information constantly updated. When the resource needs of consumers GRC has the resources, and resource providers, like, first download the application proxy, by the application of agents in the market to find the right resources available. In a grid environment, resources, agents and application agents there is no fixed relationship between the connection, but when they need it in the temporary grid services market to establish contacts, resources transactions[6].

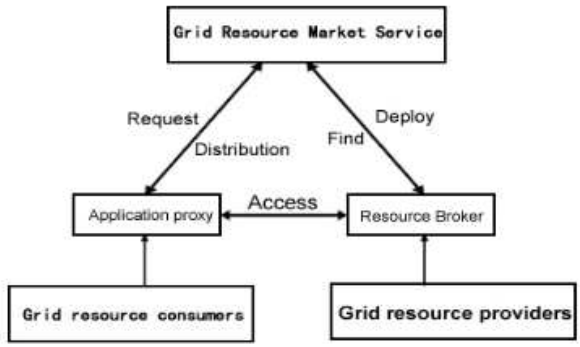

Fig. 1. The role relationship of grid services market

4. Based on market economy grid resource scheduling

4.1. Scheduling model

GRACE (Grid Architecture for Computational Economy, the economic grid computing architecture) is distributed based on a more mature, computable economics, architecture model.

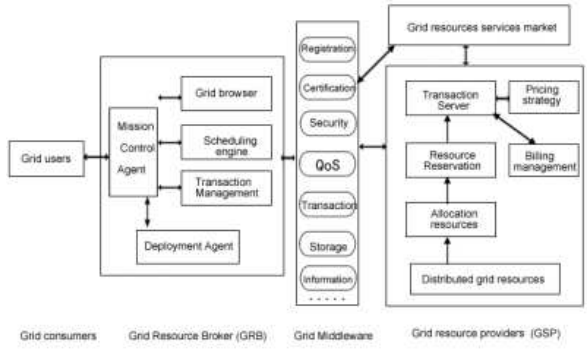

Fig. 2. GRACE architecture model

In the GRACE model, GRB grid resource agent is responsible for resource discovery, selection and binding, and other key tasks, including user grid job control agent to accept the request and make it standardized; grid scheduling engine browsers and are responsible for resource discovery and selection; transaction server is responsible for grid resource provider with each GSP consultation resource prices; deployment of agents according to the results of the task scheduling and resource binding. Part of the Globus grid middleware provided by the certification, registration, QoS and other services. Grid resource service providers to build a software system by running the grid interface and the grid market directory (Grid Market Directory, GMD for service registration, release the price of resources, while providing trading services

for the grid (Grid Trading Service, GTS), so that resources can smooth the transaction, and under the guidance of the implementation of GRB consumer's request. Resources during the transaction, GRB through the interaction with the GSP GMD grid market directory as an intermediary, they use the commodity market model and interaction protocols for resource trading.

4.2. Scheduling policy

Resource consumers and resource providers GRC GSP as a grid environment are two important roles, they each have requirements for resource scheduling and strategy.

1) The basic idea is that consumers of resources: time limit on their needs, hoping to use the least amount of resources to address the cost issues it raises.

2) resources on the basic idea is: in order to attract customers (resource consumers), they will provide competitive service entrance, so that it has the resources to get the maximum levels of use.

Market-based economy in the grid, the user QoS (Quality of Service)requirements (deadline and budget constraints calculated) to select resources, and because the resources of a grid environment with distributed, heterogeneous, shared characteristics, and by different organizations depending on the policy and charging mechanism has, it is difficult to use traditional scheduling algorithms to meet user QoS requirements. At the same time, due to scheduling algorithms need to adapt to changes in load and grid resources can be used to complete an execution environment while meeting deadlines and budget constraints, so the Nimrod-G presented two adaptive algorithms for scheduling deadlines and budget constraints

Table 1. Nimrod-G algorithm of scheduling

Algorithm/Strategy	**Execution Time(Deadline,D)**	**ExecutionCost(Budget,B)**
Cost Opt	Limited by D	Minimize
Cost-Time Opt	Minimize when possible	Minimize
Time Opt	Minimize	Limited by B

Above scheduling policy from different angles to meet the user requirements, application-level QoS-based scheduling algorithm. Completion time scheduling policy priority tasks in the user-defined minimum completion time and cost constraints, the shortest task completion time; cost of priority scheduling policies in a user-defined minimum task completion time and cost constraints, as far as the most economical scheduling task.

Table 2. Requirements for the task of execution

TASK	TASK0	TASK1	TASK2	TASK3	.....	TASKn
Demand handling capacity	10	16	20	24		128
Memory	64	128	64	256		512
Maximum tolerance time	1h	4h	8h	10h		20h

Users can choose according to their own circumstances appropriate scheduling policy. Resources to achieve results if consumers did not ask the time, then he can choose the cheapest, but poor performance computing resources at the lowest cost so that they complete their tasks. Similarly, if users need to complete the task as soon as possible, then he must pay a higher cost to use the good performance computing resources[7].

5. Utility function based grir resource scheduling

Utility in economics refers to when a certain amount of consumer spending several kinds of goods or services meet the level of felt. In the grid resource management, grid resource providers to measure the effectiveness of virtual organizations or to the user satisfaction with the services[8]. As the grid resources by different organizations with various organizations on resource management strategies vary, but the quality of service requirements of users are not the same, the user's QoS requirements of various utility function in the framework based on interpretation of results is with[9]. Such QoS requirements can be based on network load and resources dynamically adjusted. In the grid environment to establish a market-based economics grid resource management mechanism is an effective way. Market mechanisms for the grid resource management provides an efficient, scalable, stable resource allocation mechanism.

5.1. The market for resource scheduling model formal description

In order to better describe the grid services market transactions, the symbols used in the model are defined as follows:N: total number of grid service requests

M: total number of resources

K: service type, K M J = {J_1, J_2 ... J_N}, N a set of operationsR = {R_1, R_2 ... R_M}, M a collection of resourcesP = {P_1, P_2, ..., P_K}, vector of prices of services$C_j$jth service providers the ability of alle^i_k completion of the k classes the cost of service requestsI_i i-th agent's budgetIn this model, defined as the service provider grid producers, consumers, users or grid applications, both in a fully competitive market transactions, through the price mechanism to regulate supply and demand of resources. In economic theory, has proven in a fully competitive market, there is price equilibrium, and equilibrium is the optimal allocation of resources, the total system utility maximization.

5.2. utility function and utility maximization

To avoid non-linear optimization problem the computational complexity, the use of Cobb-Douglas utility function model, to establish the user's demand function. Defined as follows: Definition 1: Let S be the quality of service user requirements (completion time), R is the user agent to accomplish this task reserved for the cost, resource scheduling utility function as follows:

$$U(S,R) = aln(QS) + (1-a)ln(R) \tag{1}$$

Among ,Q for the completion of the service user's job vector, S is the time to complete each service vector, R is reserved for user fees for the completion of tasks. A is a preference for S and R user needs adjustment threshold in the range of Budget constraints: (where P is the service price vector)

$$I = QP + R \tag{2}$$

By solving the marginal rate of substitution MRS_{SR} has been the demand function. Definition 2: In a perfectly competitive market, there is an equilibrium between supply and demand, competitive balance is the marginal rate of substitution Rate equal to the price.

$$MRS_{SR} = \frac{\partial U/\partial S}{\partial U/\partial R} = \frac{\alpha R}{(1-\alpha)S} = P \tag{3}$$

the user utility maximization, resource consumption, to determine the best solution.By the formula (1), (2) to get user demand function:

$$S = \max\left\{\frac{\alpha(I-QP)}{(1-\alpha)P}\right\} \tag{4}$$

For multiple services, total market demand and demand for the service, as follows:

$$S_t = \sum_{i=1}^{N} \max\left\{\frac{a_i(I_i - Q_i P}{(1-\alpha_i)P}\right\} \tag{5}$$

The equilibrium price can be calculated according formula.

$$P = \frac{\sum_{i-1}^{N} \frac{\alpha_i I_i}{1-\alpha_i}}{S_t + \sum_{i-1}^{N} \frac{\alpha_i Q_i}{1-\alpha_i}} \tag{6}$$

By the user's utility function further defined to meet the needs of utility maximization function is to maximize utility, the user should take the strategy. Demand function using the scheduling system can calculate the optimal price and allocation scheme.

5.3. The optimal scheduling algorithm based on utility

Utility-based optimal scheduling policy, the goal is to set the level of utility, through the full scheduling options User QoS service object, such as the lowest cost, shortest, etc. Symbols are defined as follows:D_i: User-defined deadline for completing the task t_i

ETC(t_i r_j)The expected task t_i execution time on a resource r_j

F: Users are willing to pay the cost of servicesC(t_i r_j): The cost of the task t_i using the resource r_j. The following shows the time and budget constraints minimum cost scheduling algorithm:1 Find the resources available, the query grid information resource on the server information;2 Resource transactions, utility values calculated by the utility function, according to the formula (6) calculate the equilibrium price, calculate the Services;3 Ascending order according to the list of resources services;

5.4. The two task scheduling mechanism

Utility function based scheduling systems, resource consumers (users or applications) to maximize its efficiency With the function of the strategies, such as in a certain time frame to complete the task at minimum cost; service providers To maximize their income and high resource utilization strategy. In this scheduling system used in two scheduling.Mechanism, the global job scheduling and local scheduling.1) Global scheduling strategy Global job scheduling application-level scheduling, based on utility functions (such as time, budget, etc.). GRE scheduling may accept the task of global scheduling, it may take By the local scheduler task. There are some scheduling policy, such as the processor is divided into different time slots, while sub With all of the operations or first-come first-serve (FCFS); stimated job completion time which the shortest, first execute it;Market-based mechanisms to implement the user would like to first to complete the job and so on.

6. the significance of grid resource management

A. The market mechanism to encourage the sharing of resources. Most of the current grid system for a number of academic research and development, they tend to emphasize the sharing of resources and work together, with little regard to the resources of the price factor. However, in practice, a large number of resources is not free to use, through the introduction of market mechanisms for compensation for the use of resources, attract more resources to increase the grid, to the establishment of large-scale grid systems. This is a commercial driver grid system an important guarantee of sustainable development. B. The market model can adapt to heterogeneous resources and dynamic nature. Grid is an autonomous, heterogeneous, dynamic distributed systems, by introducing the market mechanism, each resource owners and users are seen as a natural economy and society, by the price mechanism to reflect the dynamics of supply and demand resources changes in supply and demand changes through the optimal allocation of resources.C. The market model can adapt to the wide distribution of the grid. The market mechanism is not centralized management

decision-making body in each market participant according to their preference for autonomous decision-making, through the market mechanism to obtain the necessary resources. This decentralized, user-centric allocation of resources suitable for grid environment.

7. Conclusion

The introduction of competition in the market economy model grid system, in order to effectively solve the grid resource management and scheduling to provide a better idea. Grid based on economic models for grid resource management to provide resources to effectively manage, evaluate the resource distribution and allocation strategies can also help consumers to use the economy-driven resource scheduling policy to use light loads and low-cost resources to achieve the optimal allocation of grid resources as a whole and rational utilization.

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