UTILITY ORIENTED G-NEGOTIATION AND COORDINATION FOR GRID RESOURCE MANAGEMENT

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Abstract

The resource management in grid computing can be defined as those operations that control the way that grid resources and services are made available for use by entities like users, applications and services. The consumer who is executing the applications may either directly or indirectly request resources from the grid. Such resource requests are considered as jobs by the grid. Given that resource providers and consumers may have different needs, successfully acquiring commitments through concurrent negotiations with multiple resource providers to simultaneously access several resources is a very challenging task for consumers. In this paper we have presented a concurrent negotiation mechanism that is designed for managing (de)commitment of contracts through one-to-many negotiations and coordination of multiple concurrent one-to-many negotiations between a consumer and multiple resource providers. The utility-oriented coordination (UOC) strategy has been presented and the UOC strategy achieved higher utility, faster negotiation speed, and higher success rates than Patient Coordination strategy for different resource market types.

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I. Introduction

Grid computing is an integrated computer network linking large geographically distributed and heterogeneous computer systems and resources[1], which eliminates the need for dedicated servers for job computations but uses distributive resources collectively to enhance computational power. A grid resource management system should support allocation of computing resources from different administrative, distributive and heterogeneous domain. Due to the complexity, heterogeneity and dynamic nature of grid computing environments, resource management is faced with challenges making it a complex task to match the capabilities of available resources from the resource provider to the needs of the applications for the consumer. Negotiation activities in a grid computing platform are required because participating parties are independent users with different policies[4], objectives and requirements. Negotiation is a standard approach to create the agreements in which the conûicts of the different objectives and policies between the resource users and resource providers must be accepted. That resource providers and consumers may have different requirements and performance goals; successfully obtaining commitments through concurrent negotiations with multiple resource providers to simultaneously access several resources is a very challenging task for consumers. The main focus of this paper is devising a utility-oriented coordination (UOC) strategy for coordinating simultaneous and parallel negotiation activities in multiple e-markets and managing both (de)commitments and commitments of intermediate contracts in each one-to-many negotiation.

II. Related Work

Existing work has been developed for negotiation to single resource such as market driven approach and other approaches. For a survey on negotiation agents, see [14].Since this work explores the issue of applying concurrent one-to-many negotiations with (de)commitments to Grid resource allocation and scheduling[5] this section discusses closely related works on Grid resource negotiation, concurrent negotiation[9], and negotiation with (de)commitments.

A. Grid Resource Negotiation

Preliminary works on applying negotiation mechanisms to Grid resource allocation aims to either integrate methods of negotiation [16] or adapt the negotiation mechanism by selecting from a range of methods . In a recently published survey paper, Sim [6] reviewed and discussed state-of-the-art approaches of Grid resource negotiation mechanisms in terms of their strategies and protocols[3]. Lang [13] adopted a two-phase bargaining protocol for Grid resource negotiation. In [16], the negotiation protocol consists of 1) a distributive negotiation phase, in which self-interested agents adopt heuristic strategies to iteratively exchange bids (make proposals and counterproposals) among themselves, and 2) an integrative negotiation phase, in which agents attempt to find joint gains while trying to maintain the utility distribution outcomes from the distributive negotiation phase. In the Policy-driven Automated Negotiation[15] Decision-making Approach (PANDA), Gimpel et al. [7] adopted a rule-based framework for negotiation in service contracts. In PANDA, rule sets express policies that consider customer satisfaction and business reputation rather than just maximizing utilities. In [8], Lawley et al. investigated the use of negotiation agents for identifying mutually acceptable terms among information publishers (providers) and consumers of message notification services in a Grid computing environment. Ghosh et al. [12] considered resource negotiation in a mobile Grid computing system consisting of mobile devices (sellers of resources) and wireless access point servers, which bargain with mobile devices to purchase resources for providing services to a community of Grid resource consumers.

B. Concurrent Negotiation

Rahwan et al.'s [11] one-to-many negotiation model consists of one buyer and multiple sellers, and the buyer has a number of sub negotiators. There coordinating multiple simultaneous one-to-one negotiations. In DCS, the coordinator agent terminates all negotiations once a negotiation thread reaches an agreement. In PCS, the best offer is chosen when all sub negotiators have completed negotiation. In OPCS, the coordinator uses information about one negotiation outcome to influence the performance of other negotiation threads. There are multiple negotiation threads, and in each negotiation thread, each different sub negotiator conducts a one-to-one negotiation with a different seller. Four coordination strategies[10], i.e., 1) desperate coordination strategy (DCS), 2) PCS, 3) optimized PCS (OPCS), and 4) strategy manipulation coordination strategy (SMCS), were proposed in [11] for controlling and coordinating multiple simultaneous one-to-one negotiations. In adopting PCS for coordinating concurrent multiple one-to-many negotiations in multiple e-markets, the consumer agent terminates all concurrent negotiations when it acquires all the required resources without considering time constraint. The DCS cannot be adopted for coordinating concurrent multiple one-to-many negotiations for resource allocation because in resource allocation of all the required resources must be acquired simultaneously, and the consumer cannot terminate all other one-to-many negotiations and G-negotiation in different e-markets when it only acquires one of its required resources in one e-market[2]. The OPCS cannot be adopted for coordinating concurrent multiple one-to-many negotiations for multiple resources because concurrent negotiation involves negotiations in multiple e-markets.

III. Concurrent G-Negotiation Mechanism

This section describes an approach for the Grid resource management problem under a commitment model where reneging on a deal is allowed for both consumer and provider agents. The Grid resource allocation problem for n types of resources is transformed into a problem of n concurrent one-to-many negotiations, where each one-to-many negotiation consists of multiple concurrent one-to-one negotiations for a particular kind of resource Ri.

A. The Coordinator

The coordinator is used to determine when to terminate all one-to-many negotiation processes based on the information obtained from each commitment manager component so that the consumer's requirements and/or performance goals could be satisfied. In the Grid resource co-allocation problem, three factors are essential for a consumer: (i) successfully obtaining all required resources, (ii) Obtaining the cheapest possible resource options, and (iii) obtaining the required resources rapidly. Since the failure of a one-to-many negotiation for any particular resource will result in the failure of the co-allocation for the consumer, ensuring a high negotiation success rate is the most important. In this paper a strategy, called utility-oriented coordination (UOC) strategy is introduced to coordinate concurrent multiple one-to-many negotiations. In the UOC strategy, agents always prefer higher utility when they can guarantee a very high success rate. For a consumer that requires n types of resources simultaneously, the negotiation mechanism consists of a coordinator and n commitment managers {CM1. CMn}.Each CMi manages multiple one-to-one negotiation threads for Ri, and in each thread, the consumer negotiates with a provider of Ri using the following protocols.

B.Consumer's Protocol

For each one-to-many negotiation for Ri, each CMi manages both commitments and (de)commitments of (intermediate) contracts by adopting the CMSs in A to decide whether to 1) accept a resource provider's proposal and 2) renege on a deal at each negotiation round. Each negotiation thread follows a Sequential Alternating Protocol, where at each negotiation round an agent can 1) accept proposals from providers, 2) propose its counterproposal using the time-dependent concession-making functions. 3) Renege on its intermediate contract.

C.Provider's Protocol

1) If a provider does not have any intermediate contract with a consumer or its intermediate contract was broken by a consumer, then it will generate its proposal using the time-dependent concession-making functions that broadcast to all consumer agents, and then wait for requests for confirmation of contracts from consumers. If there are one or more requests for confirmation of contracts from consumers, then it will carry out the following: 1) send a confirmation of contract to the consumer with the best counterproposal, i.e., the proposal that generates the highest utility 2) wait for a confirmation of acceptance from that consumer; and 3) establish the intermediate contract upon receiving a confirmation of acceptance from the consumer.

2) If a provider has already reached an intermediate contract with a consumer, then it will broadcast its proposal that reached the current intermediate contract. If there are one or more requests for contracts from consumers, then it will consider whether it is beneficial to engage the Consumer with the best counterproposal by determining whether 1) it will obtain a higher utility than the utility generated from its current intermediate contract after paying the penalty fee.

D. Commitment Management

At each negotiation round, each thread reports its negotiation status to its commitment manager. The commitment manager determines whether to accept the proposed offers from the resource providers or whether to renege on an intermediate contract. It is inefficient for a consumer agent to simply accept all acceptable proposals from resource providers and select the best proposal from them because it may be forced to pay a large amount of penalty fees for reneging on many deals. There is a tradeoff for a consumer agent between the number of agreements made and their utility values. Algorithm 1 specifies the steps for commitment management.

Algorithm 1

Commitment management

At each negotiation round t, do the following:

Step 1 : Estimate the reneging probability of each resource provider O_j^i .

Step 2 : Compute the expected utility of each provider's proposal P_j^i (t).

Step 3 : Determine if each (t) is acceptable.

Step 4 : If there are proposal that are acceptable then

The consumer sends a request for contracts to all corresponding resource providers.

Else

Waits for the confirmation of contract from each O_j^i.

Step 5 : If the consumer receives one or more confirmation of contracts then

The consumer accepts the contract that generates the highest expected utility.

Else

The consumer revises its proposal by making concession.

(i) Reneging Probability

A resource can be requested by multiple consumers simultaneously, a resource provider can renege on an intermediate contract established with a consumer. At each negotiation round t, a consumer estimates the probability $P(t)_j^i$. That each resource provider O_j^i $(0 < j \leq ni)$ will renege on a contract based on all proposals it receives at t if it accepts's O_j^i proposal.

$$P^i(t) = \{P_j^i(t) \mid 0 < j \leq ni\}$$

Let $P^i(t)$ is the set of proposals that a consumer receives for Ri at t and let Avg (Pi (t)) be the average of these proposals. The variance of $P^i(t)$ is

$$D\left(P^i(t)\right) = \frac{1}{n_i}\sum_{k=1}^{n_i}[P_k^i(t) - \text{Avg}P^i(t))]$$

If $\text{Avg}\left(P^i(t)\right) - P_j^i(t) \gg \sqrt{D\left(P^i(t)\right)}$ Then there is a very high probability that resource provider O_j^i will renege the contract. If $\text{Avg}\left(P^i(t)\right) - P_j^i(t) \leq \sqrt{D\left(P^i(t)\right)}$.

If $\text{Avg}\left(P^i(t)\right) - P_j^i(t) \leq \sqrt{D\left(P^i(t)\right)}$

Then there will be two possible cases: 1 $P_j^i(t)$ Avg $P_j^i(t)$ (O_j^i's proposal is above average)

2. $P_j^i(t) < \text{Avg}\left(P^i(t)\right)$ (O_j^i's proposal is below average. If O_j^i's proposal is above average, then it has a quite favourable intermediate deal for O_j^i and it is believed that O_j^i is unlikely to break the deal. If O_j^i's proposal is below average, but not too far below average, then reneging and paying a penalty fee is not beneficial for O_j^i. Since O_j^i's proposal is close to average, it is believed that O_j^i is unlikely to obtain a better utility by breaking an intermediate deal to take on a sufficiently better new deal.

(ii) Expected Utility

By making P_{ij}^t into consideration, a consumer's expected utility will be $E_t\left(U_c^i\left(P_j^i(t)\right)\right)$ for the the proposal $P_j^i(t)$ of provider O_j^i at the current round t.

(iii) Acceptable Proposal

A commitment manager determines if a proposal $P_j^i(t)$ from provider O_j^i is acceptable as follows:

1. If a consumer has no previous commitment, then $P_j^i(t)$ is acceptable if it generates an expected utility that is equal to or higher than the utility generated from the consumer's counterproposal.

2. If there is a commitment with another provider O_k^i at round t_{ik} $(t_{ik} < t)$, then $P_j^i(t)$ is acceptable if the following conditions are satisfied:

a. The expected utility of $P_j^i(t)$ must be higher than that of the intermediate contract $P_k^i(t_{ik})$ with O_k^i.

b. The utility gained from accepting $P_j^i(t)$ must be higher than that of Pi k(tik) after paying a penalty fee the same approach for computing the penalty fee.

*(iv) **Request for Contracts***

If there are proposals that are acceptable, then the consumer will first send requests for contracts to all the corresponding resource provider agents and then wait for the confirmation of contracts from the resource provider agents.

*(v) **Confirmation of Contract***

The consumer receives one or more confirmation of contracts, then it will accept the deal that generates the highest expected utility, if the consumer has already reached an intermediate contract with another provider, then it will first renege on the contract before it accepts the new proposal and send a confirmation of acceptance to the corresponding resource provider. Otherwise, it generates a counterproposal using its time-dependent concession-making function and proceeds to the next round.

IV. Result

The experiments were carried to evaluate the performance of Utility Oriented strategy. Fig 1 shows that the set of experiment is compared with the Patient coordination strategy and it supports one to many negotiations in only one resource market. The UOC strategy allows decommitment of contract for both provider and consumer agents. The UOC strategy achieve higher success rate than PCS.

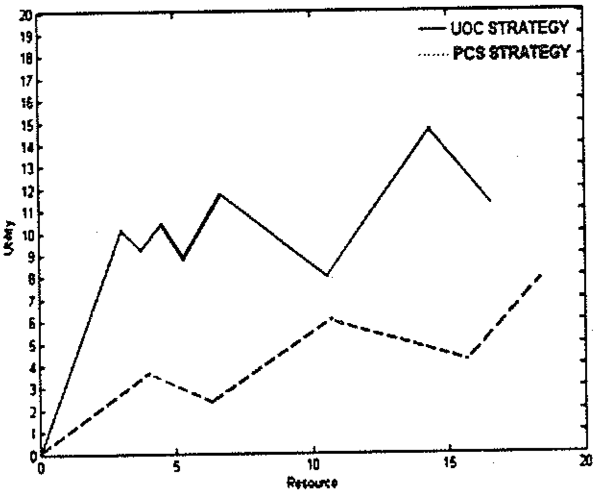

Figure 1 : UOC Vs PCS strategy

V. Conclusion

The contribution of this work is that developing a set of coordination strategies for concurrent one-to-one negotiations for only one resource in only one e-market, this work has developed a UOC strategy for concurrent one-to-many negotiations involving multiple resources in multiple e-markets. The UOC strategy has been developed for managing (de)commitments in concurrent one-to-many negotiations in multiple e-markets In managing (de)commitments, in this work, the conditions for accepting a new proposal do not depend on any threshold . When making decision on whether to accept a new proposal, an agent in this paper considers the expected utility of the new proposal relative to the utilities of all the other (new) proposals. The UOC provides higher utility, higher success rate compared to PCS.

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