

# Time-bound negotiation framework for electronic commerce agents

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## Abstract

For efficient and informative coordination of agents especially in electronic commerce environment, a time-bound agent negotiation framework is proposed utilizing a time-based commitment scheme. By attaching commitment duration to agent messages, the traditional contract net protocol is extended to a time-bound negotiation framework (TBNF). The proposed negotiation framework has a new message type which allows for parties to agree upon the extension of a commitment duration, and a novel commitment concept in the form of negative commitment. The semantics of the messages with the commitment duration are interpreted, and then the three typical negotiation protocols are formally defined and compared — *nothing-guaranteed protocol*, *acceptance-guaranteed protocol*, and *finite-time guarantee protocol* — which can be incorporated into TBNF. The TBNF should provide a background for efficient and effective electronic commerce negotiation while accommodating each agent's adaptive negotiation strategy. © 2000 Elsevier Science B.V. All rights reserved.

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## 1. Introduction

As electronic commerce becomes more popular, the role of automated negotiation systems is expected to increase. For example, when a virtual shopping mall receives product orders from a cus-

tomers, it is necessary to make the delivery orders automatically without human intervention, generate a request for proposal (RFP) and announce it to multiple delivery companies (as shown in Fig. 1).

Then, the mall and delivery companies will negotiate over the price and quality (e.g., delivery date) of a specific delivery service. In this case, each agent is self-interested, the contractor agent (i.e., delivery company) is resource-constrained, and the status of agents constantly changes.

In such an electronic commerce environment, the efficient coordination of multi-agents is very important for the performance of each agent and the whole system. Contract Net Protocol [14] has been the most

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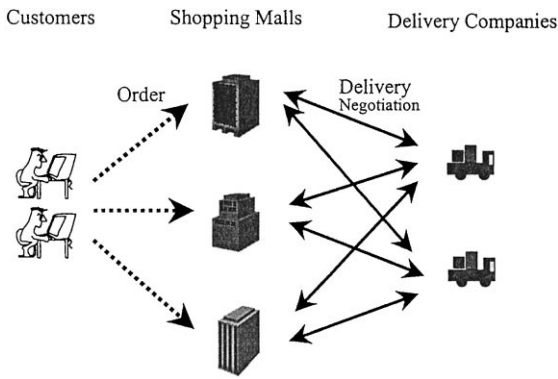


Fig. 1. Dynamic delivery negotiation in virtual shopping mall context.

commonly used method for coordinating agents in negotiation. Contract Net Protocol specifies communication and controls in a distributed problem solver [3]. This communication protocol concerns how contract managers announce the tasks to other agents, how potential contractors return bids to the manager, and how the manager then awards the contract (a manager is responsible for monitoring the execution of a task and processing the results of its execution, and a contractor is responsible for the actual execution of the tasks). The basic steps of the protocol are listed below and shown in Fig. 2.

- A manager issues a task announcement describing the task and the criteria for bids.
- Contractors send bids announcing their willingness and ability to perform a task.
- The manager sends the award message to a successful contractor.
- The contractor sends an acknowledgement of the award back to the manager, either accepting or rejecting it.

The original Contract Net Protocol can be somewhat simple for a specific purpose. However, it needs to be modified to satisfy various system requirements for improving performance. Therefore, there has been research conducted on the extension of the protocol by:

- Introducing new speech acts such as temporal grant, temporal reject, definitive grant, and defini-

tive reject when tasks exceed the capacity of a single agent. The context involves an extended Contract Net Protocol [5].

- Introducing fuzzy theoretic techniques for determining next task announcement and the best bid [17].
- Using directed contracts and forgetting by case-based reasoning to reduce communication loads [15].
- Enabling agents to choose levels of commitments dynamically for iterative task allocation negotiations [10].

In this paper, we propose a negotiation framework emphasizing the commitment duration attached to every message (commitment is an agreement or pledge to do something in the future [7,12]). The time-bound framework provides a good background for choosing a proper negotiation protocol especially for a dynamic situation where desired tasks and available resources may be changing as the system is executing tasks. The following is a scenario for a delivery problem in a virtual shopping mall, which inspires this research.

### 1.1. A Delivery Problem in a Virtual Shopping Mall

1. A shopping mall agent (SMA1) asks a delivery company agent (DCA) if a product PA can be delivered to its buyer from a warehouse in 3 days.
2. DCA schedules its own facility (e.g., trucks) for the delivery of the product PA and replies 'Yes' to SMA1.
3. However, SMA1 has not yet awarded the bid to DCA.

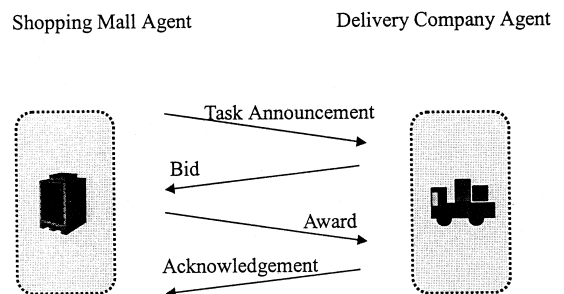


Fig. 2. Message flows between a manager and a contractor.

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