

## DEVELOPING RELIABILITY MODEL IN CONTRACT NET PROTOCOL

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### ABSTRACT

*Contract Net Protocol (CNP) is a task sharing/interaction protocol consisting of a collection of nodes called software agents purposely used for communication necessitated in a distributed multi agent environment. The conventional FIPA CNP allows the initiator agent to allocate task to contractor agents but does not allow the evaluation of reliability of contractors. In this paper we concentrate on the reliability of contractor agents that facilitates the initiator agent for awarding the task to optimal/best contractor. In this work we proposed a Reliability Model (RM) in the conventional CNP. Development of Reliability Model (RM) in conventional CNP will ensure the reliability of agents which is more decisive for open, dynamic and heterogeneous multi agent systems.*

**Keywords:** *Agent communication, Multi-Agent Systems, Reliability, Interaction Protocols, Negotiations.*

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## 1. INTRODUCTION

Computers will essentially be a necessity of life, like the oxygen we breathe. In the next 20 years, computers will become so cheap that they will be used everywhere – ultimately every product will have at least one computer chip in it. More complex items like cars, machinery etc. would have hundreds, thousands or more computer chips. Each computer chip will control a different module of the item. But now few questions are raised: How will one computer work on the problem solely in distributed systems? How will these computers interact and communicate with one another? How will they work together, solving common goals, to fulfill human needs and desires? A distributed system using Contract Net Interaction Protocol could solve these problems, revolutionizing not only the way we think of computers but our entire world. A distributed system could literally connect every computer to other computer by creating an intelligent global net. The possibilities of this distributed network compared to the current internet would be like comparing the modern computer to the abacus used in ancient times.

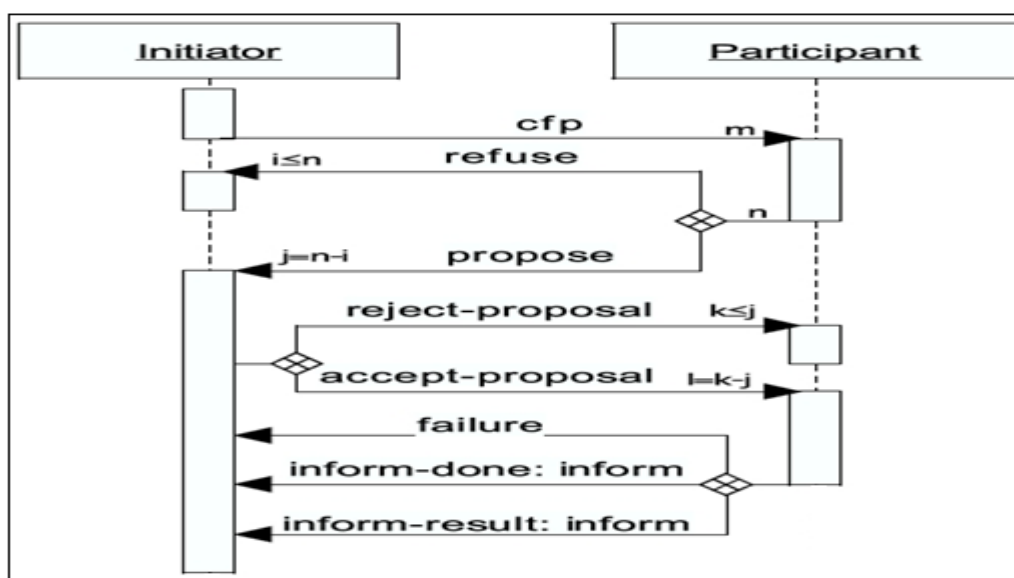
Contract Net Protocol is basically an interaction protocol facilitates the agents for negotiation through the use of contracts. CNP facilitates the agents to distribute the tasks among each other. In CNP, various software agents make a net wherein each agent node can act as Manager (Initiator) or Contractor (Participant) performing different tasks at different times. Contract Net creates a means for contracting as well as subcontracting tasks (or jobs). In fact a manager is responsible for monitoring the execution of a task and processing the results of its execution. On the other hand, a contractor is responsible for the actual execution of the task. Firstly CNP was used to create an electronic marketplace for buying and selling good. As we stated earlier that Manager has to take the decision of awarding the contract to the contractors. But sometimes it is not sure at manager level that the agent to whom the contract is going to be awarded is the best one or not. So there is a possibility that the agent may possess with incomplete information, non-satisfactory, self-interested etc. meaning that the final solution maybe be the best for the agents involved, but not for the system as a whole. So it becomes very complicated for the manager to choose the appropriate contractor for the particular task.

The current scenario strongly demands a protocol that can evaluate the reliability of agents for effective communication between manager and contractor. The focus of this work is to propose a reliability structure in CNP, used by the manager before awarding the contract to any contractor. The structure of our paper is as follows. Section 2 contains introduction to

state of the art CNP. Section 3 describes the challenges. Forth section presents the proposed work.

## 2. CONTRACT NET PROTOCOL (CNP): AN OVERVIEW

Contract Net Protocol was initially proposed by Smith and David in 1980, which is a task sharing protocol and is major employed to allocate tasks to software agents. CNP is a high level protocol which is concerned with the interpretation of the communication rather than the transmission of bit streams. It supports communication among agents in distributed MAS. High level protocols provide structure that help system designers decide what the agents should say while communicating rather than how they should say it. CNP being high level protocol facilitates distributed control of cooperative task execution with efficient inter node communication and also allows participation in fully automated competitive negotiations. The agents can exchange their roles for different contracts as CNP allows further delegation of subcontracts to other agents. It categorizes agents as Initiators/Managers or Participants/Contractors. Foundation for Intelligent Physical Agent (FIPA) standardized contract net protocol is depicted in fig.1.



**Figure1: FIPA Contract Net Interaction Protocol**

The whole working of CNP revolves around the Initiator Agents (IA) and Contractor Agents (CA). IA and CA perform four steps repeatedly until the contract gets awarded. These steps are listed as follow:

- The manager/initiator agent sends out a Call for Proposals (CFPs) to all possible contractors.

- Each CA reviews the received CFPs and bids on the most feasible contracts before the mentioned deadline.
- The Initiator chooses the best bid and awards the Contract to the respective participant.
- Initiator rejects the other bids.

Electing the best contractor among all possible contractors for a particular job is not an easy task for the manager. This is the biggest challenge that the manager aims to achieve. There are some more challenges in the case of CNP that are discussed in the further section.

### **3. CHALLENGES**

The literature presented provides a fact that Multi Agent Systems have come a long way and it is widely used in different areas of research. MAS are making use of CNP to achieve the better communication for solving a problem co-operatively. There are several emerging trends that suggest that agent technologies will be vital in future, for areas such as the MAS. A critical look at the preceding section reveals various unfolded challenges that still need attention and hence can be worked up on; however three major challenges are being listed as follows:-

#### **3.1 Authentication**

Generally, Authentication is the process of determining whether someone or something is, in fact, who or what it is declared to be. In our CNP Authentication is any process by which a manager verifies the identity of a contractor agent who wishes to perform the task. In a Multi Agent System (MAS), authentication is complicated by the fact that a request may have originated on a distant agent and may have traversed multiple agents and network channels that are secured in different ways and are not equally trusted. In a multi agent system when the manager agent broadcasts a task *i.e. cfp*, it is accepted by all possible agents weather they belong to the task or not. So there is a possibility of bidding/responding by the agents that are destructive, self-interested or may have incomplete knowledge leading the irrelevant results, system crash or any other major problem. To avoid these problems bids should be authenticated and known to the manager.

#### **3.2 Reliability**

In general, reliability is the ability of an agent or system to perform and maintain its functions in routine circumstances, as well as hostile or unexpected circumstances. As discussed in previous sections in a Multi Agent System (MAS), the initiator agent receives many bids from the responding contractor agents. Now there is a possibility that the responding agents

are pretending to be reliable but not in reality. So before granting the bids to any contractor agent the initiator agent should analyze the reliability of that contractor agent. But in CNP the initiator agent does not use any kind of parameters by which the reliability of the contractor agent can be measured. Therefore a modified research of CNP that computes reliability of the contractor agent is desired.

### 3.3 Registration and Verification

Registration is also a big challenge in Multi Agent System (MAS). As we know that message is broadcasted to all agents. These agents may have constructive or destructive information. Although agent registration is used to check the trust worthiness of agents. However, an older constructive agent which has traveled various domains, might turn to a destructive agent and hence. Only the registered and trustworthy agents should be considered by the initiator and ignore otherwise. So there should be a fool proof way to verify the agents.

## 4. THE PROPOSED WORK

Reliability and Credibility are the major issues for effective communication in MAS because agents are free to participate or leave a system dynamically. So there is a possibility that agents are unreliable, incredible, non-satisfactory, destructive, self-interested or possessed with incomplete knowledge. The intensions of agents don't remain static because they have to work with intelligence, co-operation and co-ordination.

The above presented literature strongly needs a protocol that could evaluate the reliability of interacting agents. In order to meet the above requirement, we introduced a Reliable Contract Net Protocol (RCNP) that helps IA to select the reliable communication partners. Now we introduce the following three factors that take part to check the reliability of contractor agent.

- **Learning:** Learning is a perpetual process of an agent to attain the skills from its past experience of life. In our work Learning can be measured by three factors that are as follow:-
  - 1) **Interaction Learning:**-It is achieved by the interaction level of an agent with the other agents during its life.
  - 2) **Trained Learning:**-It is achieved by giving training to the agents to react in unpredictable situations.
  - 3) **Knowledge-Based Learning:**-It is achieved through the knowledge of an agent gained by the agent itself.
- **Credibility:** The credibility of a witness contractor agent is based upon the ability of the jury to trust and believe what it says, and relates to the accuracy of its testimony as well as

to its logic, truthfulness, and sincerity. It is the integration of the relevant results of contractor agent provided to the users and the time/experience it has spent in a multi agent system. It is presumed that by spending much time in a multi agent system the agent will definitely be experienced. The more experience of an agent will lead to high expertise. So there are some following factors that can affect the credibility of agents:-

- 1) **Experience:-**It is the total time duration or we can say the experience of an agent that it has spent in a multi agent system. One year time-duration of an agent will score one point of experience and it is incremented year by year.
  - 2) **Relevant Result:-**it is achieved by the results given by the contractor to initiators for their task to be executed. The more relevant results provided will lead to high R.R factor and vice-versa.
- **User Satisfaction Feedback:** This is the testimonial given by the users to check their satisfaction level by giving them points out of 10. User Satisfaction Feedback is given after the task is completely handed over to initiator agent. So in our work, when the task is over the user gives a feedback so that the for-coming users may check the reliability from the user satisfaction perspective.

So there are the above three factors by which we can evaluate reliability of agents. All these three factors play equal role while evaluating reliability of agents. Traditionally, in CNP an agent is awarded the contract without evaluating the reliability of it. In proposed architecture we calculate the values of Learning Factor (LF), Credibility Factor (CF) and User Satisfaction Feedback (USF) of an agent by giving them the points out of 10. The reliability decision of an agent is taken on behalf of the average of the above whole values. The formula used to evaluate the reliability is as follow:-

$$\text{Reliability Percentage} = (LF + CF + USF) / 3$$

We have mentioned the following criteria to evaluate the reliability of an agent after evaluating Reliability Percentage (RP).

$$\text{Reliability} = \left\{ \begin{array}{ll} \text{Not Reliable} & \text{if RP is less than 25} \\ \text{Less Reliable} & \text{if RP ranges between 25 \& 50} \\ \text{Average Reliable} & \text{if RP ranges between 50 \& 75} \\ \text{Most Reliable} & \text{if RP is greater than 75} \end{array} \right\}$$

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