Contract Net Protocol

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Outline

- What is Contract Net Protocol
- FIPA Standards
- Step-by-Step Example
- Existing Systems
- Demo
- Shortcomings
- Future Plans and Goals
Imagine...
Contract Net Protocol (CNP)

- Originally proposed by Smith (1980)
- Fully automated negotiation
  - Distributed problem solving
  - Electronic marketplace for buying and selling of goods
- Two types of agents Initiator and Participant
- At any time, any one agent can be an Initiator, Participant or both
- Allows contracting as well as subcontracting
CNP - Sequence of Steps

1. Initiator sends out a Call for Proposals (CFP)
2. Each Participant reviews CFP’s and bids on feasible ones
3. Initiator chooses the best bid and awards a contract to that Participant
4. Initiator rejects other bids
FIPA Standards

- Stands for Foundation for Intelligent Physical Agents
- Contract Net Interaction Protocol Specification
- Makes use of Communicative Act Library Specification
Step-by-Step Example

1 Initiator
- Wants 100 units of commodity A
- Maximum price of 5.00 price units/unit of A
- Delivery time of 2:00 PM est

4 Participants
Initiator Sends Out CFP
Participant Response to CFP

- P1 – No Response
- P2 – Refuse
- P3 – Propose @ 3.50/unit
- P4 – Propose @ 4.00/unit
Deadline Passes

Initiator → Refuse → P2

P3: Propose @ 3.50/unit → P1

P4: Propose @ 4.00/unit → P2

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Initiator Response to Proposals

- Find the Lowest cost in price units
  \[ P_3 < P_4 \]
- Accept P3’s proposal
- Reject P4’s proposal
Deadline Passes

Initiator -> Reject Proposal
Accept Proposal

P1
P2
P3
P4

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Contract Established

- Contract between Initiator and P3
  - 100 units of A
  - 3.50 price units/unit A
  - Delivery time of 2:00 PM est

- One final message
After Delivery at 2:00 PM est
Existing Systems

- TRACONET @ U of Massachusetts
- Aircraft Coordination @ Honeywell
- INTERRAP
- MadKit
TRACONET

- Automated delivery truck routing
- Simulation has two companies
  - A with 3 dispatch centers
  - B with 2 dispatch centers
- Significant savings over local solution using heuristic parallel insertion algorithm
<table>
<thead>
<tr>
<th>Dispatch center</th>
<th>Deliveries</th>
<th>Vehicles</th>
<th>Average delivery length</th>
<th>Cost savings in 15 minutes</th>
<th>Cost savings in 30 minutes</th>
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<td>A1</td>
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<td>10</td>
<td>121 km</td>
<td>5%</td>
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<tr>
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Honeywell

- Coordinate aircraft mission and defense
- Contract net used for task assignment to highest bidder
- Negotiation before and during flight
INTERRAP

- Automated loading dock with miniature robots
- Use cooperative planning
- Resolve goal conflicts and allow synchronized actions
Agent Framework
  • Aides in agent development
Simple Contract Net example
Simulated Travel Agency
MadKit Demo
Shortcomings

- Systematic Failures
- Communications Infrastructure
- Scheduling (real time or time slices)
- All agents must be synchronized
- Time-Bound Framework
- Integration of agents
Future Plans and Goals

- Create a hybrid Initiator/Participant Agent
- Fulfillment of one contract by multiple agents
- Eliminate central arbiter
  - Any agent can make a request
  - The net will find the solution
Contract Net Protocol

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