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FOUNDATION FOR INTELLIGENT PHYSICAL AGENTS

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FIPA Contract Net Interaction Protocol Specification

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37 represented 17 countries worldwide. Further information about FIPA as an organization, membership information, FIPA
38 specifications and upcoming meetings may be found at <http://www.fipa.org/>.

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47 **1 FIPA Contract Net Interaction Protocol**

48 The FIPA Contract Net Interaction Protocol (IP) is a minor modification of the original contract net IP pattern¹ in that it
49 adds rejection and confirmation communicative acts. In the contract net IP, one agent (the Initiator) takes the role of
50 manager which wishes to have some task performed by one or more other agents (the Participants) and further wishes
51 to optimise a function that characterizes the task. This characteristic is commonly expressed as the price, in some
52 domain specific way, but could also be soonest time to completion, fair distribution of tasks, etc. For a given task, any
53 number of the Participants may respond with a proposal; the rest must refuse. Negotiations then continue with the
54 Participants that proposed.

55
56 The representation of this IP is given in *Figure 1* which is based on extensions to UML1.x. [Odell2001] This protocol is
57 identified by the token `fipa-contract-net` as the value of the `protocol` parameter of the ACL message.
58

¹ Originally developed by Smith and Davis.

59

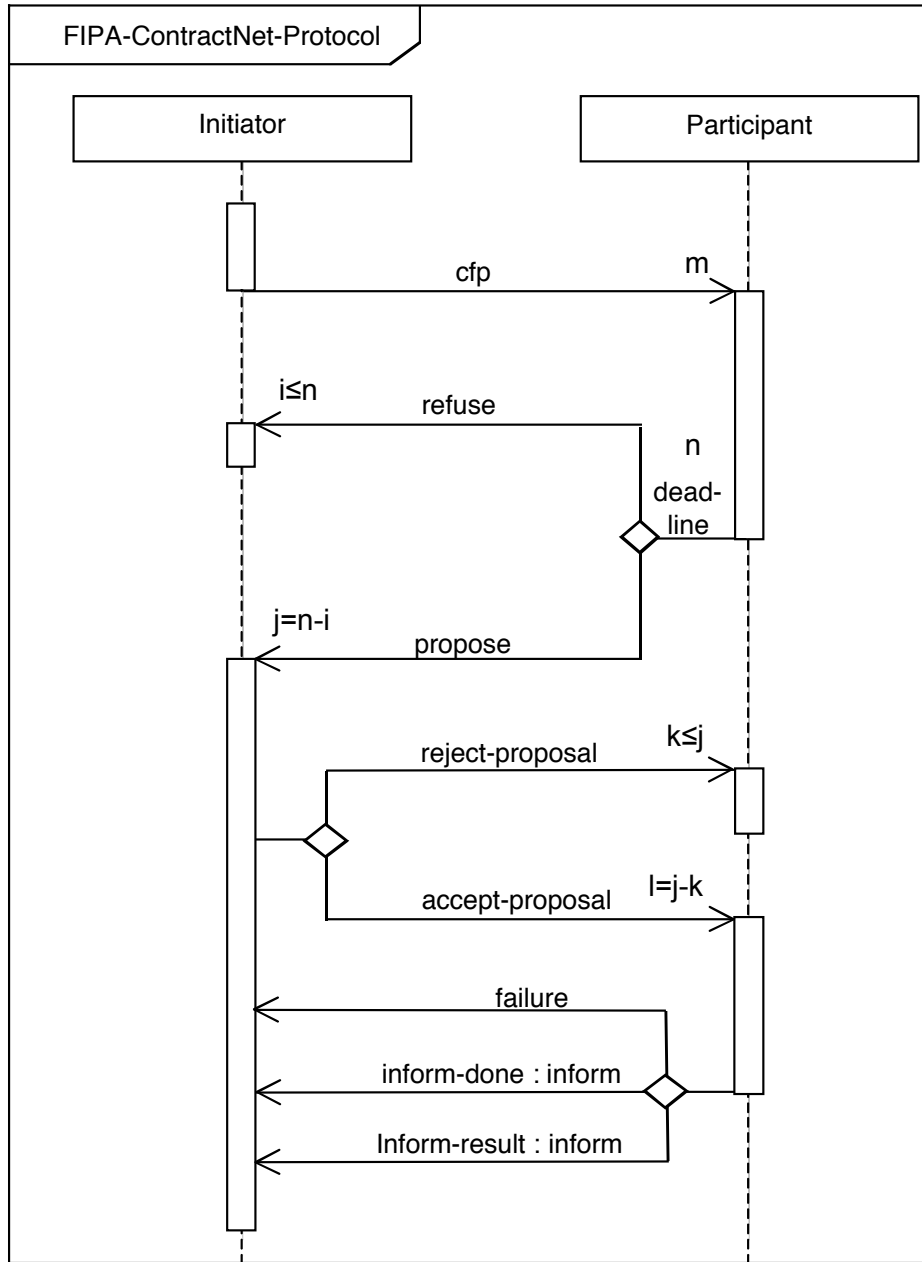


Figure 1: FIPA Contract Net Interaction Protocol

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64 **1.1 Explanation of the Protocol Flow**

65 The Initiator solicits m proposals from other agents by issuing a call for proposals (`cfp`) act (see [FIPA00037]), which
66 specifies the task, as well any conditions the Initiator is placing upon the execution of the task. Agents (Participants)
67 receiving the call for proposals are viewed as potential contractors and are able to generate n responses. Of these, j
68 are proposals to perform the task, specified as `propose` acts (see [FIPA00037]).

69
70 The Participant's proposal includes the preconditions that the Participant is setting out for the task, which may be the
71 price, time when the task will be done, etc. Alternatively, the $i = n - j$ Participants may `refuse` (see [FIPA00037]) to
72 propose. Once the deadline passes, the Initiator evaluates the received j proposals and selects agents to perform the
73 task; one, several or no agents may be chosen. The l agents of the selected proposal(s) will be sent an `accept-`

74 `proposal act` (see [FIPA00037]) and the remaining k agents will receive a `reject-proposal act` (see
75 [FIPA00037]). The proposals are binding on the Participant, so that once the Initiator accepts the proposal, the
76 Participant acquires a commitment to perform the task. Once the Participant has completed the task, it sends a
77 completion message to the Initiator in the form of an `inform-done` or a more explanatory version in the form of an
78 `inform-result`. However, if the Participant fails to complete the task, a `failure` message is sent.

79
80 Note that this IP requires the Initiator to know when it has received all replies. In the case that a Participant fails to reply
81 with either a `propose` or a `refuse act`, the Initiator may potentially be left waiting indefinitely. To guard against this,
82 the `cfp` includes a deadline by which replies should be received by the Initiator. Proposals received after the
83 deadline are automatically rejected with the given reason that the proposal was late. The deadline is specified by the
84 `reply-by` parameter in the ACL message.

85
86 Any interaction using this interaction protocol is identified by a globally unique, non-null `conversation-id`
87 parameter, assigned by the Initiator. The agents involved in the interaction must tag all of its ACL messages with this
88 conversation identifier. This enables each agent to manage its communication strategies and activities, for example, it
89 allows an agent to identify individual conversations and to reason across historical records of conversations.

90
91 In the case of 1:N interaction protocols or sub-protocols the Initiator is free to decide if the same `conversation-id`
92 parameter should be used or a new one should be issued. Additionally, the messages may specify other interaction-
93 related information such as a timeout in the `reply-by` slot that denotes the latest time by which the sending agent
94 would like to have received the next message in the protocol flow.

95

96 **1.2 Exceptions to Interaction Protocol Flow**

97 At *any* point in the IP, the receiver of a communication can inform the sender that it did not understand what was
98 communicated. This is accomplished by returning a `not-understood` message. As such, *Figure 1* above does not
99 depict a `not-understood` communication as it can occur at any point in the IP. The communication of a `not-`
100 `understood` within an interaction protocol may terminate the entire IP and termination of the interaction may imply
101 that any commitments made during the interaction are null and void. However, since this IP broadcasts to more than
102 one Participant, multiple responses are also possible. Each response, then, must be evaluated separately – and some
103 of these responses might be `not-understood`. However, terminating the entire IP in this case might not be
104 appropriate, as other Participants may be continuing with their sub-protocols.

105

106 At any point in the IP, the initiator of the IP may cancel the interaction protocol by initiating the meta-protocol shown in
107 *Figure 2*. The `conversation-id` parameter of the cancel interaction is identical to the `conversation-id`
108 parameter of the interaction that the Initiator intends to cancel. The semantics of `cancel` should roughly be interpreted
109 as meaning that the initiator is no longer interested in continuing the interaction, and that it should be terminated in a
110 manner acceptable to both the Initiator and the Participant. The Participant either informs the Initiator that the
111 interaction is done using an `inform-done`, or indicates the failure of the cancellation using a `failure`.

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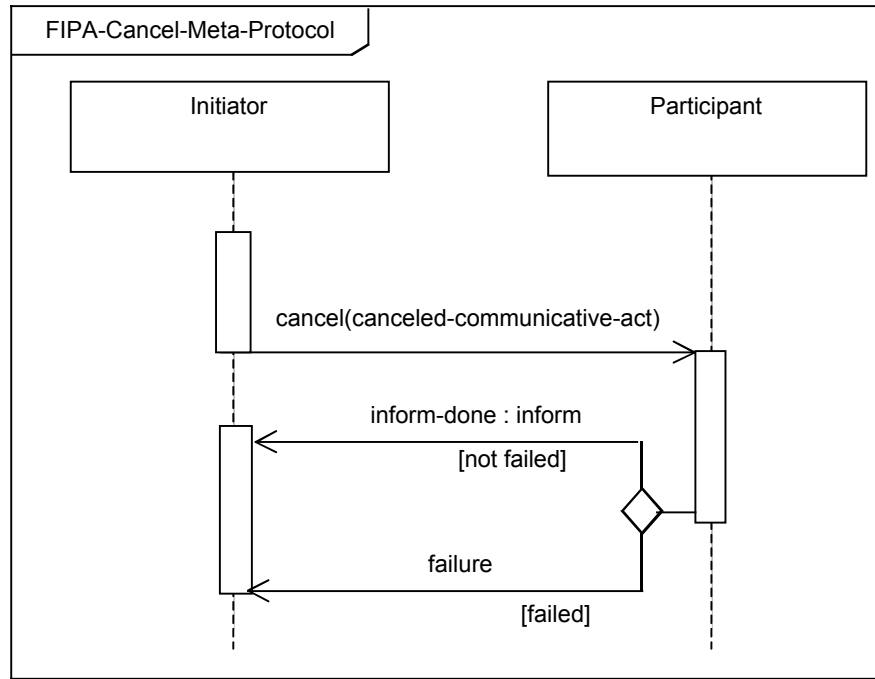


Figure 2: FIPA Cancel Meta-Protocol

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This IP is a pattern for a simple interaction type. Elaboration on this pattern will almost certainly be necessary in order to specify all cases that might occur in an actual agent interaction. Real world issues such as the effects of cancelling actions, asynchrony, abnormal or unexpected IP termination, nested IPs, and the like, are explicitly not addressed here.

120 **2 References**

- 121 [FIPA00037] FIPA Communicative Act Library Specification. Foundation for Intelligent Physical Agents, 2000.
122 <http://www.fipa.org/specs/fipa00037/>
- 123 [Odell2001] Odell, James, Van Dyke Parunak, H. and Bauer, B., *Representing Agent Interaction Protocols in UML*.
124 In: Agent-Oriented Software Engineering, Ciancarini, P and Wooldridge, M Eds., Springer, pp. 121-
125 140, Berlin, 2001.
126 <http://www.fipa.org/docs/input/f-in-00077/>
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128 **3 Informative Annex A — ChangeLog**

129 **3.1 2002/11/01 - version G by TC X2S**

- 130 Page 1, Figure 1 : Reworked and expanded the section description of the IP
- 131 Page 2, Figure 1: The communication labeled `inform-ref` was changed to `inform-result` for clarity ; the
- 132 purpose of this communication is to inform the initiator of a result and `inform-result`
- 133 implies `inform-done`.
- 134 Page 2, Figure 1 : The `not-understood` communication was removed.
- 135 Page 2, Figure 1 : To conform to UML 2, the protocol name was placed in a boundary, x is removed from the
- 136 diamonds (xor is now the default), and the template box was removed.
- 137 Page 2, line 72: Added a new section on Explanation of Protocol Flow
- 138 Page 1, line 72 : Reworked and expanded the section on Exceptions to incorporate a meta-protocol for
- 139 Cancel.
- 140 Page 1, line 72 : Added a paragraph explaining the `not-understood` communication and its relationship
- 141 with the IP.

142 **3.2 2002/12/03 - version H by FIPA Architecture Board**

- 143 Entire document: Promoted to Standard status
- 144