1

2 **FOUNDATION FOR INTELLIGENT PHYSICAL AGENTS**

3

4

FIPA Recruiting Interaction Protocol Specification

6

Document title	FIPA Recruiting Interaction Protocol Specification		
Document number	XC00034G	Document source	FIPA TC C
Document status	Experimental	Date of this status	2002/10/18~~05/10~~
Supersedes	None		
Contact	fab@fipa.org		
Change history	See *Informative Annex A — ChangeLog*		

7

8

9

10

11

12

13

14

15

16

17

18 © 1996-2002~~0~~ Foundation for Intelligent Physical Agents
19 —http://www.fipa.org/

20
21 *Geneva, Switzerland*

consequential, which may result from the use of this specification.

Foreword

The Foundation for Intelligent Physical Agents (FIPA) is an international organization that is dedicated to promoting the industry of intelligent agents by openly developing specifications supporting interoperability among agents and agent-based applications. This occurs through open collaboration among its member organizations, which are companies and universities that are active in the field of agents. FIPA makes the results of its activities available to all interested parties and intends to contribute its results to the appropriate formal standards bodies where appropriate.

The members of FIPA are individually and collectively committed to open competition in the development of agent-based applications, services and equipment. Membership in FIPA is open to any corporation and individual firm, partnership, governmental body or international organization without restriction. In particular, members are not bound to implement or use specific agent-based standards, recommendations and FIPA specifications by virtue of their participation in FIPA.

The FIPA specifications are developed through direct involvement of the FIPA membership. The status of a specification can be either Preliminary, Experimental, Standard, Deprecated or Obsolete. More detail about the process of specification may be found in the FIPA Document Policy [f-out-00000] and the FIPA Specifications Policy [f-out-00003]Procedures for Technical Work. A complete overview of the FIPA specifications and their current status may be found in the FIPA List of Specifications. A list of terms and abbreviations used in the FIPA specifications may be found in the FIPA Glossaryon the FIPA Web site.

FIPA is a non-profit association registered in Geneva, Switzerland. As of Juneanuary 20020, the 56 members of FIPA represented many17 countries worldwide. Further information about FIPA as an organization, membership information, FIPA specifications and upcoming meetings may be found on the FIPA Web site at http://www.fipa.org/.

Contents

1   FIPA Recruiting Interaction Protocol

The concept of an information brokerage has been widely used in mediated systems and in multi-agent systems in particular (for example, see [Finin97]). The FIPA Recruiting Interaction Protocol (IP) is designed to support these ~~brokerage~~ recruiting interactions in multi-agent systems.

A Recruiter agent is a form of broker. Generally speaking, a ~~B~~broker is an agent ~~which~~ that offers a set of communication facilitation services to other agents using some knowledge about the requirements and capabilities of those agents. A typical example of brokering is one in which an agent can request a broker to find one or more agents who can answer a query. The broker then determines a set of appropriate agents to which to forward the query, sends the query to those agents. ~~and relays their answers back to the original requestor~~.

In the case of recruiting (as opposed to brokering), the answers from the selected target agents either go directly back to the original requestor or to some designated receivers. The use of ~~brokerage~~ Recruiter agents can significantly simplify the task of interaction with agents in a multi-agent system. ~~Brokering~~ Recruiter agents also enable a system to be adaptable and robust in dynamic situations, supporting scalability and security control at the ~~brokering~~ recruiting agent.

The FIPA Recruiting IP is a macro IP, because the `proxy` communicative act (see [FIPA00037]) for brokerage embeds a communicative act as its argument and so the IP for the embedded communicative act is also embedded in this IP. When the embedded communicative act includes some actions that would be done by the agents determined by ~~broker~~ recruiter agents, then this IP would be extended for notifying the result of the actions.

The representation of this IP is given in *Figure 1* which is based on an extension of UML 1.x. [Odell2001] This protocol is identified by the token fipa-recruiting as the value of the protocol parameter of the ACL message.
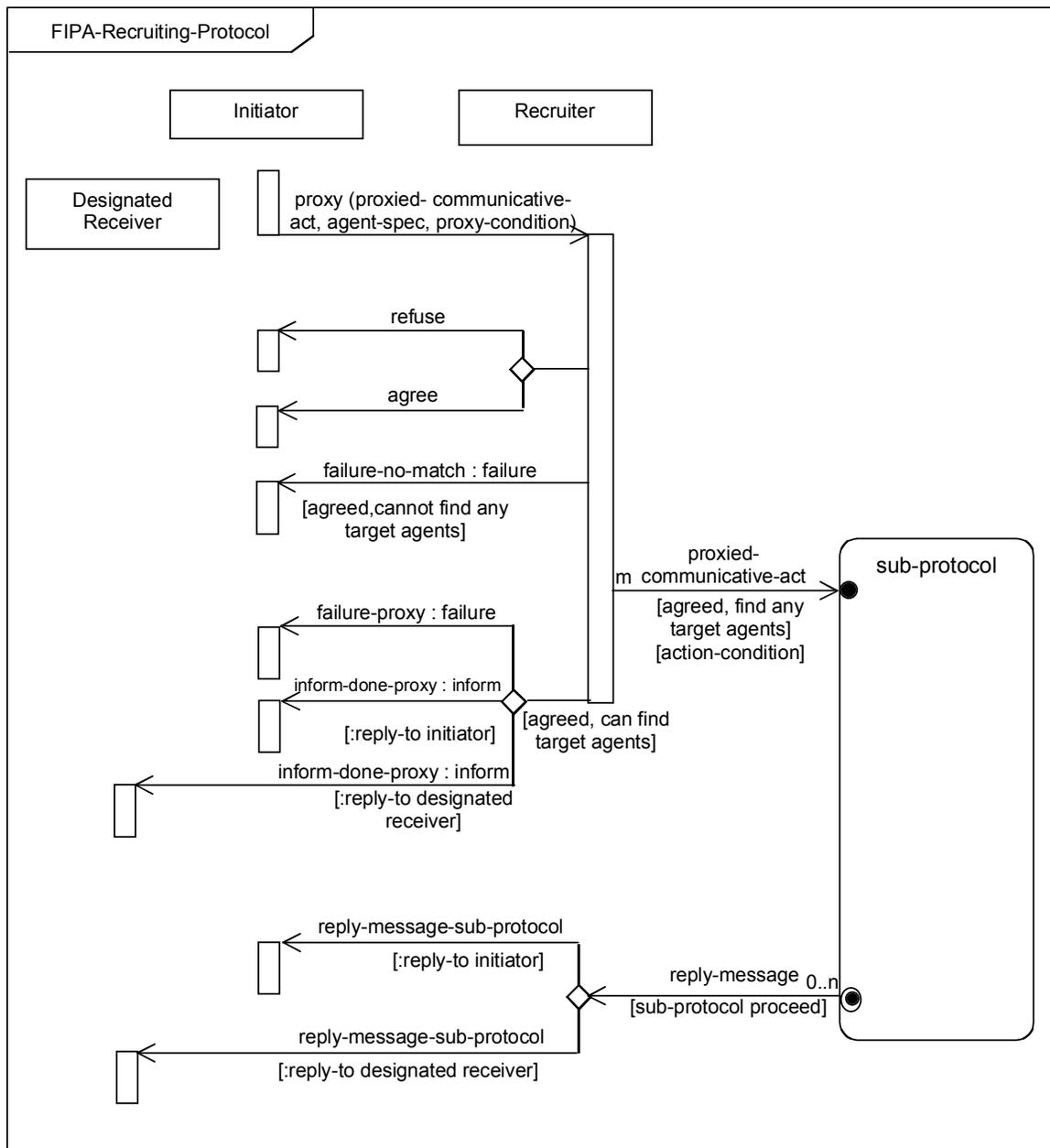
FIPA-Recruiting-Protocol

Initiator

Recruiter

Designated Receiver

proxy (proxied- communicative-act, agent-spec, proxy-condition)

refuse

agree

failure-no-match : failure

[agreed,cannot find any target agents]

proxied-
m communicative-act

[agreed, find any target agents]
[action-condition]

sub-protocol

failure-proxy : failure

inform-done-proxy : inform

[:reply-to initiator]

[agreed, can find target agents]

inform-done-proxy : inform

[:reply-to designated receiver]

reply-message-sub-protocol

[:reply-to initiator]

reply-message 0..n

[sub-protocol proceed]

reply-message-sub-protocol

[:reply-to designated receiver]

79
80
81
82

Figure 1: FIPA Recruiting Interaction Protocol

83 **1.1 Explanation of the Interaction Protocol Flow**

84 The FIPA Recruiting Interaction Protocol (IP) is a macro IP, because the `proxy` communicative act (see [FIPA00037])
85 for recruiting embeds a communicative act as its argument and so the IP for the embedded communicative act is also
86 embedded in this IP. This embedded IP guides some parts of the remainder of the interaction, thus parts of this
87 protocol are written very generically.

88

89 The Initiator of the recruiting interaction begins the interaction with a `proxy` communication. The `proxy`
90 communicative act contains the following: a referential expression denoting the target agents to which the recruiter
91 should forward the communicative act, the communicative act to forward, and a set of proxy conditions such as the
92 maximum number of agents to be forwarded. The Recruiter processes the request and makes a decision whether to
93 agree to or refuse the request, and communicates either an `agree` or a `refuse` communicative act accordingly.
94 Communication of a `refuse` terminates the interaction.

Once the Recruiter has agreed to be a proxy, it then locates agents per the description from the `proxy` message. If no such agents can be found, the Recruiter returns a `failure-no-match` and the interaction terminates. Otherwise, the Recruiter may modify the list of matching agents based on the proxy-condition. It then begins *m* interactions with the resulting list of *m* agents, with each interaction in its own separate sub-protocol. The initiation of the sub-protocol should be done with care, using the ACL parameters (see [FIPA00061]) to correlate the responses to the request. If the Recruiter has been given a separate Designated Receiver from the interaction Initiator, it needs to start each sub-protocol including a ÷`reply-to` designating the Designated Receiver, and the ÷`conversation-id` of the original conversation. If the Recruiter instead is to indicate that the Initiator should receive the replies, then the ÷`reply-to` should designate the Initiator, and the ÷`conversation-id` of the recruiting conversation. Other ACL parameters may also need to be propagated.

Note that the nature of the sub-protocol and the nature of the replies is driven by the interaction protocols specified in the communicative act from the proxy message. As the sub-protocol progresses, it forwards its responses back either to the Designated Receiver or to the Initiator, depending on the value of the `reply-to` in the `proxy` message. These messages are defined as `reply-message-sub-protocol` communications, and may be either successful replies as defined by the sub-protocol or `failure`s. If the initial proxy was an `inform`, there may in fact be no replies from the sub-protocol (and in fact means that the interaction is identical to a brokered `inform`).— When the sub-protocol completes, the Recruiter forwards the final `reply-message-sub-protocol` from the sub-protocol and the ~~brokering~~recruiting IP terminates. ~~If these communications are failures, then the subprotocol will return~~ ~~failure-~~ ~~sub-protocol~~ ~~either to the Designated Receiver or to the Initiator, and this terminates the IP (at least with respect to~~ ~~the failed sub-protocol).~~

A second issue to address occurs because multiple agents may match and therefore multiple sub-protocols may be initiated by the Recruiter within the recruiting IP. In this case, the sub-protocols may be communicating multiple `reply-message-sub-protocol` communications from the different agents involved in the IP (for a total of n responses). This is complicated by such situations as one subprotocol responding with a `failure`~~ sub-protocol~~ while a second sub-protocol returns a `reply-message-sub-protocol`, or the situation where results are inconsistent. The agent that receives the messages must determine how to detect and resolve such situations internally.
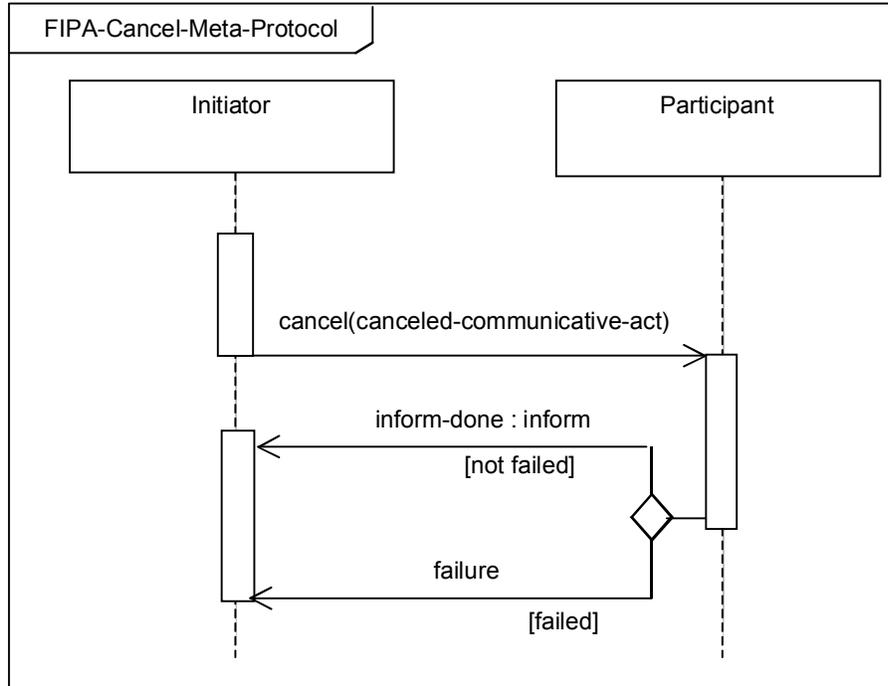
Any interaction using this interaction protocol is identified by a globally unique, non-null `conversation-id`, assigned by the Initiator. The agents involved in the interaction must tag all of its ACL messages with this conversation identifier. This enables each agent to manage its communication strategies and activities, e.g., it allows an agent to identify individual conversations and to reason across historical records of conversations. In the case of 1:N interaction protocols or sub-protocols the Initiator is free to decide if the same `conversation-id` should be used or a new one should be issued. Additionally, the messages may specify other interaction-related information such as a timeout in the `reply-by` slot that denotes the latest time by which the sending agent would like to have received the next message in the protocol flow.

1.2   Exceptions to Interaction Protocol Flow

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

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

150

Figure 2: FIPA cancel meta-protocol

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.

~~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 of cancelling actions, asynchrony, abnormal or unexpected IP termination, nested IPs, and the like, are explicitly not addressed here.~~

2   References

[Finin97]   Finin, T. Labrou, Y. and Mayfield, J., KQML as an Agent Communication Language. In: Software Agents, Bradshaw, J. (editor), MIT Press, 1997.

[FIPA00037]   FIPA Communicative Act Library Specification. Foundation for Intelligent Physical Agents, 2000. `http://www.fipa.org/specs/fipa00037/`

[FIPA00061]   FIPA ACL Message Structure Specification. Foundation for Intelligent Physical Agents, 2000. `http://www.fipa.org/specs/fipa00061/`

[Odell2001]   Odell, James, H. Van Dyke Parunak, and Bernhard Bauer, "Representing Agent Interaction Protocols in UML," *Agent-Oriented Software Engineering*, Paolo Ciancarini and Michael Wooldridge ed., Springer, Berlin, 2001, pp. 121-140. `http://www.fipa.org/docs/input/f-in-00077.`

172   # 3   Informative Annex A — ChangeLog

173   ## 3.1   2002/05/10 - version G by FIPA Architecture Board

Line	Reference	Description
174	Page 1, lines 43-61:	Changed explanation to be more directly related to recruiting IP as opposed to brokering IP.
175	Page 2, Figure 1 :	The «not-understood» communication was removed
176-179	Page 2, Figure 1 :	The last set of communicative acts was removed and a more generic one was inserted. The more generic one indicates that the subprotocols are going to forward their responses (failure or references) to either the Initiator or the Designated Receiver. Also, changed the name « destinator » to « designated receiver »
180-181	Page 2, Figure 1 :	Multiple subprotocols were indicated by inserting m and n respectively on two arcs. M subprotocols can be started, resulting in n responses.
182	Page 2, line 69 :	Added a new section 1.1 entitled « Explanation of the Protocol Flow »
183-184	Page 2, line 69 :	Renumbered old section 1.1 to section 1.2. Added a paragraph explaining the not-understood communication and its relationship with the IP.
185	Page iii	Regenerated Table of Contents
186	Page x, line y:	<blah>
187	Page 3, after Line 78:	Added reference to FIPA00061

188