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1 FIPA Request Interaction Protocol

The FIPA Request Interaction Protocol (IP) allows one agent to request another to perform some action. The representation of this protocol is given in Figure 1 which is based on extensions to UML 1.x. [Odell2001]. This protocol is identified by the token fipa-request as the value of the protocol parameter of the ACL message.

![Figure 1: FIPA Request Interaction Protocol]

1.1 Explanation of the Protocol Flow

The FIPA Request Interaction Protocol (IP) allows one agent to request another to perform some action. The Participant processes the request and makes a decision whether to accept or refuse the request. If a refuse decision is made, then "refused" becomes true and the Participant communicates a refuse. Otherwise, "agreed" becomes true.

If conditions indicate that an explicit agreement is required (that is, "notification necessary" is true), then the Participant communicates an agree. The agree may be optional depending on circumstances, for example, if the requested
action is very quick and can happen before a time specified in the reply-by parameter. Once the request has been agreed upon, then the Participant must communicate either:

- A failure if it fails in its attempt to fill the request,
- An inform-done if it successfully completes the request and only wishes to indicate that it is done, or,
- An inform-result if it wishes to indicate both that it is done and notify the initiator of the results.

Any interaction using this interaction protocol is identified by a globally unique, non-null conversation-id parameter, 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, for example, it allows an agent to identify individual conversations and to reason across historical records of conversations.

### 1.2 Exceptions to 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 message. As such, Figure 1 does not depict a not-understood communication as it can occur at any point in the IP. The communication of a not-understood within an interaction protocol may terminate the entire IP and termination of the interaction may imply that any commitments made during the interaction are null and void.

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 parameter of the cancel interaction is identical to the conversation-id parameter of the interaction that the Initiator intends to cancel. The semantics of 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.
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.
2 References


http://www.fipa.org/docs/input/f-in-00077/
3 Informative Annex A — ChangeLog

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

Page 1, Figure 1: The communication labeled inform-ref was changed to inform-result for clarity; the purpose of this communication is to inform the initiator of a result and inform-result implies inform-done.

Page 1, Figure 1: The not-understood communication was removed.

Page 1, Figure 1: Reworked the protocol flow to make the agree optional which also involved changing the exclusive-or with the agree to a different AUML notation.

Page 1, Figure 1: To conform to UML 2, the protocol name was placed in a boundary, x is removed from the diamonds (xor is now the default) and the template box was removed.

Page 1, line 41: Reworked and expanded the section description of the IP.

Page 1, line 50: Added a new section on Explanation of Protocol Flow.

Page 1, line 50: Reworked and expanded the section on Exceptions of Protocol Flow to incorporate a meta-protocol for cancel.

Page 1, line 50: Added a paragraph explaining the not-understood communication and its relationship with the IP.

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

Entire document: Promoted to Standard status.
FIPA Query Interaction Protocol Specification

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1 FIPA Query Interaction Protocol

The FIPA Query Interaction Protocol (IP) allows one agent to request to perform some kind of action on another agent. The representation of this IP is given in Figure 1 which is based on extensions to UML1.x [Odell2001]. This protocol is identified by the token fipa-query as the value of the protocol parameter of the ACL message.

![Figure 1: FIPA Query Interaction Protocol](image)

1.1 Explanation of the Protocol Flow

The Initiator requests the Participant to perform some kind of inform action using one of two query communicative acts, query-if or query-ref (see [FIPA00037]). The query-if communication is used when the Initiator wants to query whether a particular proposition is true or false and the query-ref communication is used when the Initiator wants to query for some identified objects. The Participant processes the query-if or query-ref and makes a decision whether to accept or refuse the query request. If the Participant makes a refuse decision, then “refused” becomes true and the Participant communicates a refuse. Otherwise, “agreed” becomes true.
If conditions indicate that an explicit agreement is required (that is, “notification necessary” is true), then the Participant communicates an agree. The agree may be optional depending on circumstances, for example, if the requested action is very quick and can happen before a time specified in the reply-by parameter. If the Participant fails, then it communicates a failure.

In a successful response, the Participant replies with one of two versions of inform:

- The Participant uses an inform-t/f communication in response to a query-if where the content of the inform-t/f asserts the truth or falsehood of the proposition, or,
- The Participant returns an inform-result communication in response to a query-ref and the content of the inform-result contains a referring expression to the objects for which the query was specified.

Any interaction using this interaction protocol is identified by a globally unique, non-null conversation-id parameter, 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, for example, it allows an agent to identify individual conversations and to reason across historical records of conversations.

### 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 message. As such, Figure 1 does not depict a not-understood communication as it can occur at any point in the IP. The communication of a not-understood within an interaction protocol may terminate the entire IP and termination of the interaction may imply that any commitments made during the interaction are null and void.

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 parameter of the cancel interaction is identical to the conversation-id parameter of the interaction that the Initiator intends to cancel. The semantics of 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.
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.
2 References


3 Informative Annex A — ChangeLog

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

Page 1, Figure 1: The not-understood communication was removed
Page 1, Figure 1: Reworked the protocol flow to make the agree optional and made explicit the different inform response content expected for a query-if as opposed to a query-ref
Page 1, Figure 1: To conform to UML 2, the protocol name was placed in a boundary, x is removed from the diamonds (xor is now the default) and the template box was removed
Page 1, line 42: Reworked and expanded the section description of the IP
Page 1, line 54: Added a new section on Explanation of Protocol Flow
Page 1, line 54: Reworked and expanded the section on Exceptions of Protocol Flow to incorporate a meta-protocol for cancel
Page 1, line 54: Added a paragraph explaining the not-understood communication and its relationship with the IP

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

Entire document: Promoted to Standard status
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1 FIPA Request When Interaction Protocol

The FIPA Request When Interaction Protocol (IP) allows an agent to request that the receiver perform some action at the time a given precondition becomes true. This IP provides a framework for the request-when communicative act (see [FIPA00037]).

The representation of this IP is given in Figure 1 which is based on extensions to UML1.x. [Odell2001]. This protocol is identified by the token fipa-request-when as the value of the protocol parameter of the ACL message.

![Figure 1: FIPA Request When Interaction Protocol](image)

1.1 Explanation of the Protocol Flow

The initiator uses the request-when action to request that the participant do some action once a given precondition becomes true. If the requested agent understands the request and does not initially refuse, it will agree (see [FIPA00037]) and wait until the precondition occurs. Then, it will attempt to perform the action and notify the requester accordingly.
If after the initial agreement the participant is no longer able to perform the action, then it will send a failure action (see [FIPA00037]) to the initiator. Once the action has completed and the failure, inform-done, or inform-result has been sent, the conversation ends.

Any interaction using this interaction protocol is identified by a globally unique, non-null conversation-id parameter, 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, for example, it allows an agent to identify individual conversations and to reason across historical records of conversations.

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 message. As such, Figure 1 does not depict a not-understood communication as it can occur at any point in the IP. The communication of a not-understood within an interaction protocol may terminate the entire IP and termination of the interaction may imply that any commitments made during the interaction are null and void.

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 parameter of the cancel interaction is identical to the conversation-id parameter of the interaction that the Initiator intends to cancel. The semantics of 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.

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.
2 References

http://www.fipa.org/specs/fipa00037/

http://www.fipa.org/docs/input/f-in-00077/
3 Informative Annex A — ChangeLog

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

Page 1, Figure 1: The communication labeled inform-ref was changed to inform-result for clarity; the purpose of this communication is to inform the initiator of a result and inform-result implies inform-done.

Page 1, Figure 1: The not-understood communication was removed.

Page 1, Figure 1: To conform to UML 2, the protocol name was placed in a boundary, x is removed from the diamonds (xor is now the default) and the template box was removed.

Page 1, line 42: Reworked and expanded the section description of the IP.

Page 1, line 56: Added a new section on Explanation of Protocol Flow.

Page 1, line 56: Reworked and expanded the section on Exceptions of Protocol Flow to incorporate a meta-protocol for cancel.

Page 1, line 56: Added a paragraph explaining the not-understood communication and its relationship with the IP.

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

Entire document: Promoted to Standard status.
FIPA Contract Net Interaction Protocol Specification

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1 FIPA Contract Net Interaction Protocol

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

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

¹ Originally developed by Smith and Davis.
1.1 Explanation of the Protocol Flow

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

The Participant's proposal includes the preconditions that the Participant is setting out for the task, which may be the price, time when the task will be done, etc. Alternatively, the \( i=n-j \) Participants may \textit{refuse} (see \cite{FIPA00037}) to propose. Once the deadline passes, the Initiator evaluates the received \( j \) proposals and selects agents to perform the task; one, several or no agents may be chosen. The \( l \) agents of the selected proposal(s) will be sent an \textit{accept-}
proposal act (see [FIPA00037]) and the remaining k agents will receive a reject-proposal act (see [FIPA00037]). The proposals are binding on the Participant, so that once the Initiator accepts the proposal, the Participant acquires a commitment to perform the task. Once the Participant has completed the task, it sends a completion message to the Initiator in the form of an inform-done or a more explanatory version in the form of an inform-result. However, if the Participant fails to complete the task, a failure message is sent.

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

Any interaction using this interaction protocol is identified by a globally unique, non-null conversation-id parameter, 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, for example, 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 parameter 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 parameter 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 message. As such, Figure 1 does not depict a not-understood communication as it can occur at any point in the IP. The communication of a not-understood within an interaction protocol may terminate the entire IP and termination of the interaction may imply that any commitments made during the interaction are null and void. However, since this IP broadcasts 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 parameter of the cancel interaction is identical to the conversation-id parameter of the interaction that the Initiator intends to cancel. The semantics of 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.
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2 References


3 Informative Annex A — ChangeLog

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

Page 1, line 42: Reworked and expanded the section description of the IP
Page 2, Figure 1: The communication labeled inform-ref was changed to inform-result for clarity; the purpose of this communication is to inform the initiator of a result and inform-result implies inform-done
Page 2, Figure 1: The not-understood communication was removed
Page 2, Figure 1: To conform to UML 2, the protocol name was placed in a boundary, x is removed from the diamonds (xor is now the default) and the template box was removed
Page 2, line 72: Added a new section on Explanation of Protocol Flow
Page 2, line 72: Reworked and expanded the section on Exceptions of Protocol Flow to incorporate a meta-protocol for cancel
Page 2, line 72: Added a paragraph explaining the not-understood communication and its relationship with the IP

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

Entire document: Promoted to Standard status
FIPA Iterated Contract Net Interaction Protocol Specification

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Contact: fab@fipa.org
Change history: See Informative Annex A — ChangeLog

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1 FIPA Iterated Contract Net Interaction Protocol

The FIPA Iterated Contract Net Interaction Protocol (IP) is an extension of the basic FIPA Contract Net IP (see [FIPA00029]), but it differs by allowing multi-round iterative bidding.

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

1.1 Explanation of the Protocol Flow

As with the FIPA Contract Net IP, the Initiator issues \( m \) initial call for proposals with the cfp act (see [FIPA00037]). Of the \( n \) Participants that respond, \( k \) are propose messages (see [FIPA00037]) from Participants that are willing and able to do the task under the proposed conditions and the remaining \( j \) are from Participants that refuse.
Of the $k$ proposals, the Initiator may decide this is the final iteration and accept $p$ of the bids ($0 < p < k$), and reject the others. Alternatively the Initiator may decide to iterate the process by issuing a revised cfp to $l$ of the Participants and rejecting the remaining $k-l$ Participants. The intent is that the Initiator seeks to get better bids from the Participants by modifying the call and requesting new (equivalently, revised) bids. The process terminates when the Initiator refuses all proposals and does not issue a new cfp, the Initiator accepts one or more of the bids or the Participants all refuse to bid.

Any interaction using this interaction protocol is identified by a globally unique, non-null conversation-id parameter, 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, for example, 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 parameter 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 parameter 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 message. As such, Figure 1 does not depict a not-understood communication as it can occur at any point in the IP. The communication of a not-understood within an interaction protocol may terminate the entire IP and termination of the interaction may imply that any commitments made during the interaction are null and void. However, since this IP broadcasts 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 parameter of the cancel interaction is identical to the conversation-id parameter of the interaction that the Initiator intends to cancel. The semantics of 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.
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.
2 References


3 Informative Annex A — ChangeLog

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Page 1, Figure 1: The not-understood communication was removed
Page 1, Figure 1: To conform to UML 2, the protocol name was placed in a boundary, x is removed from the diamonds (xor is now the default) and the template box was removed
Page 1, line 42: Reworked and expanded the section description of the IP
Page 1, line 57: Added a new section on Explanation of Protocol Flow
Page 1, line 57: Reworked and expanded the section on Exceptions of Protocol Flow to incorporate a meta-protocol for cancel
Page 1, line 57: Added a paragraph explaining the not-understood communication and its relationship with the IP

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

Entire document: Promoted to Standard status
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1 FIPA Brokering Interaction Protocol

The FIPA Brokering Interaction Protocol (IP) is designed to support brokerage interactions in mediated systems and in multi-agent systems, for example, [Finin97].

Generally speaking, a broker is an agent 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. The use of brokerage agents can significantly simplify the task of interaction with agents in a multi-agent system. Additionally, brokering agents also enable a system to be adaptable and robust in dynamic situations, supporting scalability and security control at the brokering agent.

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-brokering as the value of the protocol parameter of the ACL message.
1.1 Explanation of the Interaction Protocol Flow

The FIPA Brokering Interaction Protocol (IP) is a macro IP since 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. This embedded IP guides some parts of the remainder of the interaction, thus parts of this protocol are written very generically.

The Initiator of the brokering interaction begins the interaction with a proxy message which contains the following: a referential expression denoting the target agents to which the broker should forward the communicative act, the communicative act to forward and a set of proxy conditions such as the maximum number of agents to which the message should be forwarded. The Broker processes the request and makes a decision whether to agree to or refuse the request and communicates either an agree or a refuse communicative act accordingly. Communication of a refuse terminates the interaction.

Once the Broker 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 Broker returns a failure-no-match and the interaction terminates. Otherwise, the Broker may modify the list of matching agents based on the proxy-condition parameter. It then begins m interactions with the resulting list of n agents with each interaction in its own separate sub-protocol. At this point, the Broker should record some of the ACL parameters (see [FIPA00061]), for example, conversation-id, reply-with and sender, of the received proxy message to return in the r replies to the Initiator.

Note that the nature of the sub-protocol and the nature of the replies are driven by the interaction protocols specified in the communicative act from the proxy message. As the sub-protocol progresses, the Broker forwards the responses that it receives from the sub-protocol to the Initiator. These messages are defined as the reply-message-sub-protocol communications, and may be either successful replies as defined by the sub-protocol or failure. 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 recruited inform). When the sub-protocol completes, the Broker forwards the final reply-message from the sub-protocol and the brokering IP terminates. However, there can be other failures that are not explicitly returned from the sub-protocol, for example, the agent that is executing the sub-protocol has failed. If the Broker detects such problems, it returns a failure-brokering, which terminates the IP.

A second issue to address occurs because multiple agents may match and therefore multiple sub-protocols (m of them) may be initiated by the Broker within the brokering IP. In this case, the Broker may collect the n received responses and combine them into a single reply-message-sub-protocol, or may forward the reply-message-sub-protocol messages from the separate sub-protocols individually (1 p n). This is complicated by situations such as one agent responding with a failure while a second agent returns a reply-message, or the situation where results are inconsistent. The Broker must determine whether to resolve such situations internally or forward the responses to the Initiator. In doing this, the Broker must also be careful to avoid disruptive acts such as directly forwarding a failure from a sub-protocol, which would have the inadvertent effect of ending the brokering IP.

Any interaction using this interaction protocol is identified by a globally unique, non-null conversation-id parameter, 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, for example, 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 parameter 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 parameter 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 message. As such, Figure 1 does not depict a not-understood communication as it can occur at any point in the IP. The communication of a not-understood within an interaction protocol may terminate the entire IP and termination of the interaction may imply that any...
commitments made during the interaction are null and void. However, since this IP broadcasts 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 parameter of the cancel interaction is identical to the conversation-id parameter of the interaction that the Initiator intends to cancel. The semantics of 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.

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.
2 References


3 Informative Annex A — ChangeLog

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

Page 1, line 42: Reworked and expanded the section description of the IP

Page 2, Figure 1: The not-understood communication was removed

Page 2, Figure 1: Used a more generic set of communicative acts which the Broker is going to forward the responses it received from the sub-protocol and if the Broker notices some failure, such as no response at all from the sub-protocol after a given time period, then the Broker may send the Initiator a failure of its own

Page 2, Figure 1: Multiple sub-protocols indicated by inserting m, n and p respectively on three arcs; m sub-protocols can be started, resulting in n responses that the Broker can consolidate into p responses to the Initiator

Page 2, Figure 1: To conform to UML 2, the protocol name was placed in a boundary, x is removed from the diamonds (xor is now the default) and the template box was removed

Page 2, line 70: Added a new section on Explanation of Protocol Flow

Page 2, line 70: Reworked and expanded the section on Exceptions of Protocol Flow to incorporate a meta-protocol for cancel

Page 2, line 70: Added a paragraph explaining the not-understood communication and its relationship with the IP

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FIPA Recruiting Interaction Protocol Specification

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1 FIPA Recruiting Interaction Protocol

The FIPA Recruiting Interaction Protocol (IP) is designed to support recruiting interactions in mediated systems and in multi-agent systems, for example, [Finin97].

A recruiter agent is a form of broker, which, generally speaking, is an agent 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 and sends the query to those agents.

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 recruiter agents can significantly simplify the task of interaction with agents in a multi-agent system. Recruiter agents also enable a system to be adaptable and robust in dynamic situations, supporting scalability and security control at the recruiting agent.

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.
1.1 Explanation of the Interaction Protocol Flow

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

The Initiator of the recruiting interaction begins the interaction with a proxy message which contains the following: a referential expression denoting the target agents to which the recruiter should forward the communicative act, the communicative act to forward and a set of proxy conditions such as the maximum number of agents to be forwarded. The Recruiter processes the request and makes a decision whether to agree to or refuse the request, and communicates either an agree or a refuse communicative act accordingly. 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 parameter. It then begins m interactions with the resulting list of n 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 message containing a separate designated-receiver parameter from the interaction Initiator, it needs to start each sub-protocol with a reply-to parameter containing 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 parameter 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 are 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 parameter 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. 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 recruiting IP terminates.

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 m responses). This is complicated by such situations as one sub-protocol responding with a failure 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 parameter, 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, for example, 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 parameter 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 parameter that denotes the latest time by which the sending agent would like to have received the next message in the protocol flow.

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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 parameter of the cancel interaction is identical to the conversation-id parameter of the interaction that the Initiator intends to cancel. The semantics of 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.
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2 References


3 Informative Annex A — ChangeLog

3.1 2002/11/01 - version G by TC X2S
Entire document: Changed the name Destinator to Designated Receiver
Page 1, line 42: Reworked and expanded the section description of the IP
Page 1, Figure 1: The not-understood communication was removed
Page 2, Figure 1: Used a more generic set of communicative acts which indicates that the sub-protocols are going to forward their responses (failure or references) to either the Initiator or the Designated Receiver
Page 2, Figure 1: Multiple sub-protocols indicated by inserting m and n respectively on two arcs; m sub-protocols can be started, resulting in n responses
Page 2, Figure 1: To conform to UML 2, the protocol name was placed in a boundary, x is removed from the diamonds (xor is now the default) and the template box was removed
Page 2, line 69: Added a new section on Explanation of Protocol Flow
Page 2, line 69: Reworked and expanded the section on Exceptions of Protocol Flow to incorporate a metaprotocol for cancel
Page 2, line 69: Added a paragraph explaining the not-understood communication and its relationship with the IP

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Entire document: Promoted to Standard status
FIPA Subscribe Interaction Protocol Specification
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1 FIPA Subscribe Interaction Protocol

The FIPA Subscribe Interaction Protocol (IP) allows an agent to request a receiving agent to perform an action on subscription and subsequently when the referenced object changes.

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-subscribe as the value of the protocol parameter of the ACL message.

1.1 Explanation of the Protocol Flow

The Initiator begins the interaction with a subscribe message containing the reference of the objects in which they are interested. The Participant processes the subscribe message and makes a decision whether to accept or refuse the query request. If the Participant makes a refuse decision, then “refused” becomes true and the Participant communicates a refuse. Otherwise, ”agreed” becomes true.

If conditions indicate that an explicit agreement is required (that is, “notification necessary” is true), then the Participant communicates an agree. The agree may be optional depending on circumstances, for example, if the requested action is very quick and can happen before a time specified in the reply-by parameter.

In a successful response, the Participant replies with an inform-result communication with the content being a referring expression to the subscribed objects. The Participant continues to send inform-result messages as the objects denoted by the referring expression change. If at some point after the Participant agrees, it experiences a

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Figure 1: FIPA Subscribe Interaction Protocol
failure, then it communicates this with a failure message, which also terminates the interaction. Otherwise, the interaction may be terminated by the Initiator using the cancel meta-protocol as described in Section 1.2.

Any interaction using this interaction protocol is identified by a globally unique, non-null conversation-id parameter, 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, for example, it allows an agent to identify individual conversations and to reason across historical records of conversations. Additionally, because it may be important to preserve the sequence of the inform-result messages, it is important that the message transport used for this IP preserve the ordering of messages.

### 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 message. As such, Figure 1 does not depict a not-understood communication as it can occur at any point in the IP. The communication of a not-understood message within an interaction protocol may terminate the entire IP and termination of the interaction may imply that any commitments made during the interaction are null and void.

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 parameter of the cancel interaction is identical to the conversation-id parameter of the interaction that the Initiator intends to cancel. The semantics of 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.

![FIPA Cancel Meta-Protocol](image)

**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.
2 References


3 Informative Annex A — ChangeLog

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

- Page 1, Figure 1: The not-understood communication was removed
- Page 1, Figure 1: Reworked the protocol to insert an optional agree
- Page 1, Figure 1: Deleted the explicit cancel from the protocol diagram because it has been moved to the meta-protocol section
- Page 1, Figure 1: Added guards to the diagram to indicate that the protocol may be terminated by reaching the end of the conversation-length
- Page 1, Figure 1: To conform to UML 2, the protocol name was placed in a boundary, x is removed from the diamonds (xor is now the default) and the template box was removed
- Page 1, line 42: Reworked and expanded the section description of the IP
- Page 1, line 54: Added a new section on Explanation of Protocol Flow
- Page 1, line 54: Reworked and expanded the section on Exceptions of Protocol Flow to incorporate a meta-protocol for cancel
- Page 1, line 54: Added a paragraph explaining the not-understood communication and its relationship with the IP

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

- Entire document: Promoted to Standard status
FIPA Propose Interaction Protocol Specification

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1 FIPA Propose Interaction Protocol

The FIPA Propose Interaction Protocol (IP) allows an agent to propose to receiving agents that the initiator will do the actions described in the propose communicative act (see [FIPA00037]) when the receiving agent accepts the proposal.

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-propose as the value of the protocol parameter of the ACL message.

![Figure 1: FIPA Propose Interaction Protocol](image)

1.1 Explanation of the Interaction Protocol Flow

The Initiator sends a propose message to the Participant indicating that it will perform some action if the Participant agrees. The Participant responds by either accepting or rejecting the proposal, communicating this with the accept-proposal or reject-proposal communicative act, accordingly. Completion of this IP with an accept-proposal act (see [FIPA00037]) would typically be followed by the performance by the Initiator of the proposed action and then the return of a status response.

Any interaction using this interaction protocol is identified by a globally unique, non-null conversation-id parameter, 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, for example, it allows an agent to identify individual conversations and to reason across historical records of conversations.

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 message. As such, Figure 1 does not depict a not-understood communication as it can occur at any point in the IP. The communication of a not-understood within an interaction protocol may terminate the entire IP and termination of the interaction may imply that any commitments made during the interaction are null and void.
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 parameter of the cancel interaction is identical to the conversation-id parameter of the interaction that the initiator intends to cancel. The semantics of 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.

![FIPA-Cancel-Meta-Protocol](image)

**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.
2 References

http://www.fipa.org/specs/fipa00037/

[Odell2001] Odell, James, Van Dyke Parunak, H. and Bauer, B., Representing Agent Interaction Protocols in UML.
http://www.fipa.org/docs/input/f-in-00077/
3 Informative Annex A — ChangeLog

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Page 1, Figure 1: The not-understood communication was removed

Page 1, line 42: Reworked and expanded the section description of the IP

Page 1, line 54: Added a new section on Explanation of Protocol Flow

Page 1, line 54: Reworked and expanded the section on Exceptions of Protocol Flow to incorporate a meta-protocol for cancel

Page 1, line 54: Added a paragraph explaining the not-understood communication and its relationship with the IP

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1 FIPA English Auction Interaction Protocol

In the FIPA English Auction Interaction Protocol (IP), the auctioneer seeks to find the market price of a good by initially proposing a price below that of the supposed market value and then gradually raising the price. Each time the price is announced, the auctioneer waits to see if any buyers will signal their willingness to pay the proposed price. As soon as one buyer indicates that it will accept the price, the auctioneer issues a new call for bids with an incremented price. The auction continues until no buyers are prepared to pay the proposed price, at which point the auction ends. If the last price that was accepted by a buyer exceeds the auctioneer’s (privately known) reservation price, the good is sold to that buyer for the agreed price. If the last accepted price is less than the reservation price, the good is not sold.

In Figure 1, the auctioneer’s calls, expressed as the general cfp act (see [FIPA00037]), are multicast to all participants in the auction. For simplicity, only one instance of the message is portrayed. Note also that in a physical auction, the presence of the auction participants in one room effectively means that each acceptance of a bid is simultaneously broadcast to all participants and not just the auctioneer. This may not be true in an agent marketplace, in which case it is possible for more than one agent to attempt to bid for the suggested price. Even though the auction will continue for as long as there is at least one bidder, the agents will need to know whether their bid (represented by the propose act - see [FIPA00037]) has been accepted. Hence the appearance in the IP of the accept-proposal (see [FIPA00037]) and reject-proposal acts (see [FIPA00037]), despite this being implicit in the English Auction process that is being modelled.

Note that the proposals that are submitted by the bidders primarily concern the bidding process. In response to a cfp to submit bids to purchase a good X, a proposal would be something of the order: “I propose that the bidding level be raised to purchase price Z and I assert that I am able to pay Z for X.” This allows the auctioneer to be confident that the bidder can indeed pay the price without committing to actually paying it until the auctioneer specifically requests X (at price Z) from the winning bidder.

At the end of the IP, the auctioneer will typically enter a request IP (see [FIPA00026]) with the winning bidder to complete the auction transaction.

The representation of this IP is given in Figure 1.
1.1 Exceptions to Interaction Protocol Flow

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

http://www.fipa.org/specs/fipa00026/

http://www.fipa.org/specs/fipa00037/
FIPA Dutch Auction Interaction Protocol Specification

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1 FIPA Dutch Auction Interaction Protocol

In the FIPA Dutch Auction Interaction Protocol (IP), the auctioneer attempts to find the market price for a good by starting bidding at a price much higher than the expected market value, then progressively reducing the price until one of the buyers accepts the price. The rate of reduction of the price is up to the auctioneer and they usually have a reserve price below which not to go. If the auction reduces the price to the reserve price with no buyers, then the auction terminates.

The term "Dutch Auction" derives from the flower markets in Holland, where this is the dominant means of determining the market value of quantities of (typically) cut flowers. In modelling the actual Dutch flower auction (and indeed in other markets), some additional complexities occur. First, the good may be split: for example the auctioneer may be selling five boxes of tulips at price X, and a buyer may purchase only three of the boxes. The auction then continues, with a price at the next increment below X, until the rest of the good is sold or the reserve price met. Such partial sales of goods are only present in some markets; in others the purchaser must bid to buy the entire good. Secondly, the flower market mechanism is set up to ensure that there is no contention amongst buyers by preventing any other bids once a single bid has been made for a good. Offers and bids are binding, so there is no protocol for accepting or rejecting a bid. In the agent case, it is not possible to assume, and too restrictive to require, that such conditions apply. Thus it is quite possible that two or more bids are received by the auctioneer for the same good. The protocol below thus allows for a bid to be rejected. This is intended only to be used in the case of multiple, competing and simultaneous bids. It is outside the scope of this specification to pre-specify any particular mechanism for resolving this conflict. In the general case, the agents should make no assumptions beyond "first come, first served". In any given domain, other rules may apply.

The representation of this IP is given in Figure 1.
1.1 Exceptions to Interaction Protocol Flow

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.