FOUNDATION FOR INTELLIGENT PHYSICAL AGENTS

FIPA 97 Specification

Part 5

Personal Assistant

10th October 1997

Geneva, Switzerland

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Contents

Foreword

The Foundation for Intelligent Physical Agents (FIPA) is a non-profit association registered in Geneva, Switzerland. FIPA's purpose is to promote the success of emerging agent-based applications, services and equipment. This goal is pursued by making available in a timely manner, internationally agreed specifications that maximise interoperability across agent-based applications, services and equipment. This is realised through the open international collaboration of member organisations, which are companies and universities active in the agent field. FIPA intends to make the results of its activities available to all interested parties and to contribute the results of its activities to appropriate formal standards bodies.

This specification has been developed through direct involvement of the FIPA membership. The 35 corporate members of FIPA (October 1997) represent 12 countries from all over the world

Membership in FIPA is open to any corporation and individual firm, partnership, governmental body or intemational organisation without restriction. By joining FIPA each Member declares himself individually and collectively committed to open competition in the development of agent-based applications, services and equipment. Associate Member status is usually chosen by those entities who do want to be members of FIPA without using the right to influence the precise content of the specifications through voting.

The Members are not restricted in any way from designing, developing, marketing and/or procuring agent-based applications, services and equipment. Members are not bound to implement or use specific agent-based standards, recommendations and FIPA specifications by virtue of their participation in FIPA.

This specification is published as FIPA 97 ver. 1.0 after two previous versions have been subject to public comments following disclosure on the WWW. It has undergone intense review by members as well non-members. FIPA is now starting a validation phase by encouraging its members to carry out field trials that are based on this specification. During 1998 FIPA will publish FIPA 97 ver. 2.0 that will incorporate whatever adaptations will be deemed necessary to take into account the results of field trials.

Introduction

This FIPA 97 specification is the first output of the Foundation for Intelligent Physical Agents. It provides specification of basic agent technologies that can be integrated by agent systems developers to make complex systems with a high degree of interoperability.
FIPA specifies the interfaces of the different components in the environment with which an agent can interact, i.e. humans, other agents, non-agent software and the physical world. See figure below

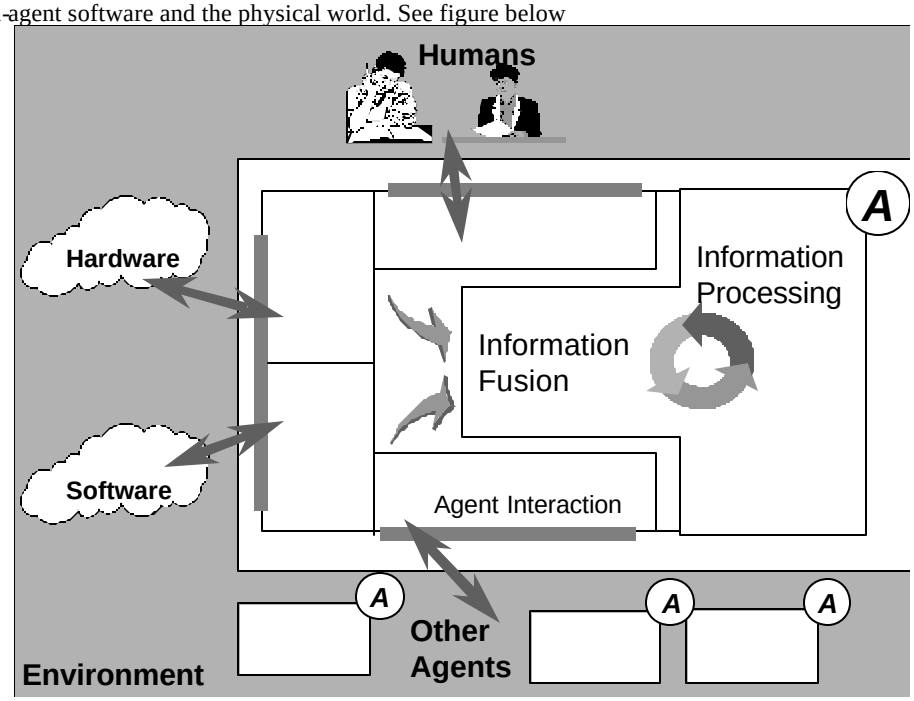

Figure 1 — Outline View of Agent Interaction

FIPA produces two kinds of specification

— **normative** specifications that mandate the external behaviour of an agent and ensure interoperability with other FIPA-specified subsystems;
— **informative** specifications of applications for guidance to industry on the use of FIPA technologies.

The first set of specifications – called FIPA 97 – has seven parts:

— three normative parts for basic agent technologies: agent management, agent communication language and agent/software integration
— four informative application descriptions that provide examples of how the normative items can be applied: personal travel assistance, personal assistant, audio-visual entertainment and broadcasting and network management and provisioning.

Overall, the three FIPA 97 technologies allow:

— the construction and management of an agent system composed of different agents, possibly built by different developers;
— agents to communicate and interact with each other to achieve individual or common goals;
— legacy software or new non-agent software systems to be used by agents.

A brief illustration of the FIPA 97 specification is given below

Part 1 Agent Management

This part of FIPA 97 provides a normative framework within which FIPA compliant agents can exist, operate and be managed. It defines an agent platform reference model containing such capabilities as white and yellow pages, message routing and life-cycle management. True to the FIPA approach, these capablities are themselves intelligent agents using formally sound communicative acts based on special message sets. An appropriate ontology and content language allows agents to discover each other's capabilities.

Part 2 Agent Communication Language

The FIPA Agent Communication Language (ACL) is based on speech act theory: messages are actions, or *communicative acts*, as they are intended to perform some action by virtue of being sent. The specification consists of a set of message types and

the description of their pragmatics, that is the effects on the mental attitudes of the sender and receiver agents. Every communicative act is described with both a narrative form and a formal semantics based on modal logic.
The specifications include guidance to users who are already familiar with KQML in order to facilitate migration to the FIPA ACL.
The specification also provides the normative description of a set of high-level interaction protocols, including requesting an action, contract net and several kinds of auctions etc.

Part 3 Agent/Software Integration

This part applies to any other non-agentised software with which agents need to „connect". Such software includes legacy software, conventional database systems, middleware for all manners of interaction including hardware drivers. Because in most significant applications, non-agentised software may dominate software agents, part 3 provides important normative statements. It suggests ways by which Agents may connect to software via „wrappers" including specifications of the wrapper ontology and the software dynamic registration mechanism. For this purpose, an Agent Resource Broker (ARB) service is defined which allows advertisement of non-agent services in the agent domain and management of their use by other agents, such as negotiation of parameters (e.g. cost and priority), authentication and permission.

Part 4 - Personal Travel Assistance

The travel industry involves many components such as content providers, brokers, and personalization services, typically from many different companies. In applying agents to this industry, various implementations from various vendors must interoperate and dynamically discover each other as different services come and go. Agents operating on behalf of their users can provide assistance in the pre-trip planning phase, as well as during the on-trip execution phase. A system supporting these services is called a PTA (Personal Travel Agent).
In order to accomplish this assistance, the PTA interacts with the user and with other agents, representing the available travel services. The agent system is responsible for the configuration and delivery - at the right time, cost, Quality of Service, and appropriate security and privacy measures - of trip planning and guidance services. It provides examples of agent technologies for both the hard requirements of travel such as airline, hotel, and car arrangements as well as the soft added-value services according to personal profiles, e.g. interests in sports, theatre, or other attractions and events.

Part 5 - Personal Assistant

One central class of intelligent agents is that of a personal assistant (PA). It is a software agent that acts semi-autonomously for and on behalf of a user, modelling the interests of the user and providing services to the user or other people and PAs as and when required. These services include managing a user's diary, filtering and sorting e-mail, managing the user's activities, locating and delivering (multimedia) information, and planning entertainment and travel. It is like a secretary, it accomplishes routine support tasks to allow the user to concentrate on the real job, it is unobtrusive but ready when needed, rich in knowledge about user and work. Some of the services may be provided by other agents (e.g. the PTA) or systems, the Personal Assistant acts as an interface between the user and these systems.

In the FIPA'97 test application, a Personal Assistant offers the user a unified, intelligent interface to the management of his personal meeting schedule. The PA is capable of setting up meetings with several participants, possibly involving travel for some of them. In this way FIPA is opening up a road for adding interoperability and agent capabilities to the already established domain of Personal Information Management.

Part 6 - Audio/Video Entertainment & Broadcasting

An effective means of information filtering and retrieval, in particular for digital broadcasting networks, is of great importance because the selection and/or storage of one's favourite choice from plenty of programs on offer can be very impractical. The information should be provided in a customised manner, to better suit the user's personal preferences and the human interaction with the system should be as simple and intuitive as possible. Key functionalities such as profiling, filtering, retrieving, and interfacing can be made more effective and reliable by the use of agent technologies.
Overall, the application provides to the user an intelligent interface with new and improved functionalities for the negotiation, filtering, and retrieval of audio-visual information. This set of functionalities can be achieved by collaboration between a user agent and content/service provider agent.

Part 7 - Network management & provisioning

Across the world, numerous service providers emerge that combine service elements from different network providers in order to provide a single service to the end customer. The ultimate goal of all parties involved is to find the best deals available in terms of Quality of Service and cost. Intelligent Agent technology is promising in the sense that it will facilitate automatic negotiation of appropriate deals and configuration of services at different levels.
Part 7 of FIPA 1997 utilizes agent technology to provide dynamic Virtual Private Network (VPN) services where a user wants to set up a multi-media connection with several other users.
The service is delivered to the end customer using co-operating and negotiating specialized agents. Three types of agents are used that represent the interests of the different parties involved:

- The Personal Communications Agent (PCA) that represents the interests of the human users.
- The Service Provider Agent (SPA) that represents the interests of the Service Provider.
- The Network Provider Agent (NPA) that represents the interests of the Network Provider.

The service is established by the initiating user who requests the service from its PCA. The PCA negotiates in with available SPAs to obtain the best deal available. The SPA will in turn negotiate with the NPAs to obtain the optimal solution and to configure the service at network level. Both SPA and NPA communicate with underlying service- and network management systems to configure the underlying networks for the service.

One central class of intelligent agents is that of a personal assistant (PA). A personal assistant is a software agent that acts semi-autonomously for and on behalf of a user, modelling the interests of the user and providing services to the user or other people and PAs as and when required. These services include managing a user's diary, filtering and sorting e-mail, managing the user's activities, locating and delivering (multimedia) information, and planning entertainment and travel. Some of the services may be provided by other agents or systems, the Personal Assistant acts as an interface between the user and these systems.

In the FIPA'97 test application, a Personal Assistant offers the user a unified, intelligent interface to the management of his personal meeting schedule. The PA is capable of setting up meetings with several participants, possibly involving travel for some of them. This turns the PA into a multi-agent application, because the services of the PAs of these other users as well as of the Personal Travel Assistant system will be needed.

The design of the PA application is based on a set of scenarios that represent an increasing level of co-operation needed between the PAs of the users involved. In the simplest scenario, the initiator of the meeting specifies time and place, to which other users (PA's) can conform or not. A more flexible scenario, however, involves negotiation about time, place, and possibly other aspects of the proposed meeting (such as attendance).

These scenarios exercise the Agent Communication Language, as well as the Interaction Protocols adopted by FIPA. Also Directory Facilitators, Agent Name Servers, inter-domain address resolution, and possibly one or more Agent Request Brokers to interface with non-FIPA compliant software are used. The PA application uses at least one other FIPA test application, viz. the Personal Travel Assistant.

1 Scope

This part of the FIPA 97 specification defines one of the four test applications that serves as an initial test of the technology-oriented normative parts of the FIPA 97 specification (Parts 1,2, and 3).

2 Conformance

Methodologies for conformance of an implementation to this specification will be published in a later document.

3 Normative reference(s)

FIPA TC1:1997, *International standard for the inter-operation of software agents – Part 1: Agent Management.*
FIPA TC2:1997, *International standard for the inter-operation of software agents – Part 2: Agent Communication Language*
FIPA TC3:1997, *International standard for the inter-operation of software agents – Part 3: Agent/Software Integration*
ISO 8601:1988, *Data elements and interchange formats – Information interchange – Representation of dates and times*
ISO 8601:1991, *Technical Corrigendum 1, Data elements and interchange formats – Information interchange – Representation of dates and times*
versit:1996, *vCalendar – The Electronic Calendar and Scheduling Exchange Format, Version 1.0*(maintained by the Internet Mail Consortium)

4 Term(s) and definition(s)

User
The human user of a *personal assistant*. Usually, there is one personal assistant to a user.
User Interface Agent
A software agent which translates services from a user interface (e.g. graphical or speech-based) into ACL.
Personal Assistant (PA)
A software agent dedicated to and acting on behalf of a *user*. There is usually one user to a personal assistant.
Personal Travel Assistant (PTA)
A software system providing assistance in planning and execution of trips.
Travel Broker Agent (TBA)
A software agent acting as the front-end to the PTA system, which handles travel queries.
vCalendar
The generic term for an electronic , virtual collection of calendaring and scheduling information that can be transferred between computers, PDAs, or other electronic devices through telephone lines, or e-mail networks, or infrared links. How, when, why, and where vCalendar are used depends on the applications developed utilising a vCalendar.

5 Symbols (and abbreviated terms)

PA: *Personal Assistant*
PTA: *Personal Travel Assistance*
API: *Application Programming Interface*
UTC: *Universal Time Coordinated; also known as UCT, for Universal Coordinated Time*

6 Overview of the Personal Assistant Domain

6.1 Introduction

One central class of intelligent agents is that of a personal assistant (PA). A personal assistant is a software agent that acts semi-autonomously for and on behalf of a user, modelling the interest of the user and providing services to the user or other people/PAs as and when required.
A personal assistant is like a secretary, it accomplishes routine support tasks to allow the user to concentrate on the real job, it is unobtrusive but ready when needed, rich in knowledge about user and work.

The notion of a personal assistant is very open-ended. There are many internal and external functions and services that can and will be used to provide and extend a Personal Assistant's basic functionalities. In fact, such openness to new services is a critical requirement where interoperability of PA's functions/services is desirable. The use of agent technology to support the Personal Assistant helps in achieving this requirement.
Examples of such functions/services include:

- managing a user's diaries (e.g., meeting scheduling)
- filtering and sorting mails (e.g., electronic mails)
- managing a user's desktop environment (e.g., file system)
- managing a user's activities, plans and tasks (e.g., workflow)
- locating and delivering (multimedia) information
- recommending entertainment (e.g. movies, restaurants, theatres)
- purchasing desired items
- planning travel, etc.

Whereas this specification focuses on the generic requirements for the personal assistant application, other FIPA application scenarios - especially Personal Travel Assistance (PTA) and Audio-Visual Entertainment and Broadcasting - also include the notion of personal assistance for specific applications.
In particular, the PTA service is different from the Personal Assistant service in the following sense. PTA is an integrated system which spans a particular market segment of the electronic marketplace. On the other hand, the PA provides a user-oriented front-end to a wide variety of different services, one of which may be the PTA travel service.
In this section, we first describe the general model of the Personal Assistant domain as adopted by FIPA, then introduce the particular application, that of scheduling meetings, chosen for the FIPA'97 Personal Assistant application. The next section will provide the detailed specification of the application. A field trial will verify the applicability and feasibility of the specification with regard to the Personal Assistant domain; the details and underlying assumptions of the PA field trial are provisionally described in [FIPA Document fipa7607].

6.2 Personal Assistant Reference Model

In general, a personal assistant comprises:

- Intelligence and associated capabilities such as rationality (reasoning and planning) and adaptability/learning.
- Knowledge including facts, rules and adapted/learned knowledge for and about an end-user.
- Interaction capabilities and facilities with the user, other agents and software/hardware services/functions.
- The services/functions and their procedures for the agent to work with them.

The scope of this composite is limited to the tasks which are given by the user as goals and preferences for behaviour. Other agents will also exist and interact with the personal assistant, but such other agents will not tend to represent particular user's preferences, or access authority and other differentiators. The composite is visualised in the following reference model.

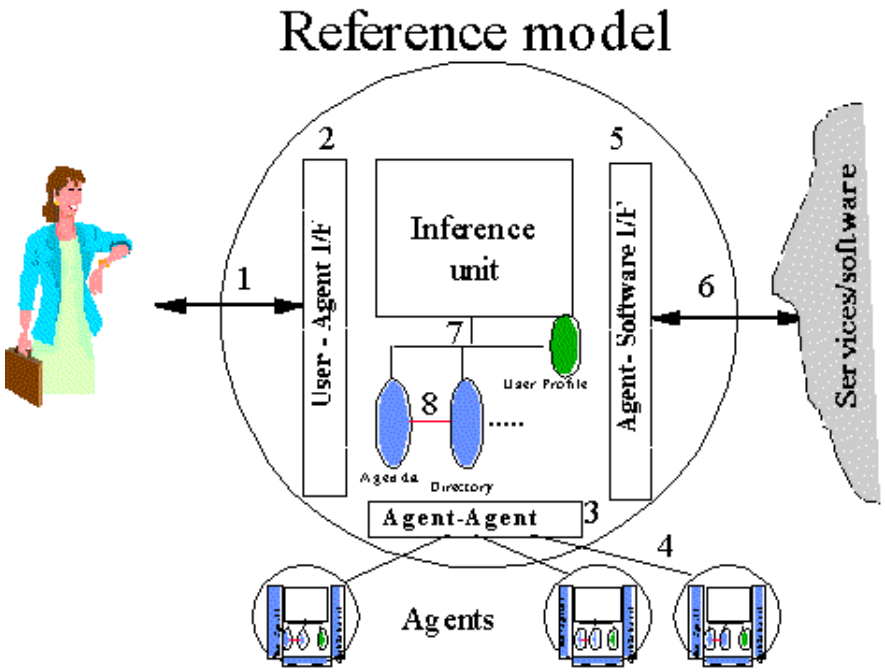

Figure 2 — Personal Assistant Reference Model

The reference model includes the following interfaces/protocols of interaction that are candidates for standardisation.

1) User-Agent Dialogue
2) Multi-Modal User-Agent Interface
3) Agent-Agent Communication Interface
4) Protocols for Agent-Agent Interaction
5) Agent-Software Interfaces
6) Agent-Software Communication Protocols
7) Agent-Functions Interfaces
8) Function Interoperability Interfaces/mechanisms

Multi-modality is the ultimate goal for human-agent interfaces. As a user interacts with a real personal assistant, he/she can speak face-to-face with the assistant or over the phone. Obviously, unconstrained natural language comprehension is also desirable. However, as first steps toward this general goal, "multi-modal" interaction is taken not as requirement for all agents to support all modalities, but merely that any single application should be able to select the one or more modalities required for the application. The composition of the personal assistant should be media-independent in order to allow for this choice, and otherwise provide the multi-modal conversions required such as converting text to speech in order to pass information over the phone.

In order to provide some concrete examples, the following scenarios serve to expose the basic PA's functions/services needed.

6.2.1 Directory Services

One of the basic functions of a PA is the management of the user's directory. This directory includes other people's/organisations' telephone numbers, addresses and personal and useful information about them. This information facilitates responses the PA may provide to user's needs in an intelligent way, based on the context of the request. For example, if the user asks to call an organisation and the PA by reference to the opening and closing time notices that the call cannot be made, it will suggest alternative actions by inferring the user's possible intentions on the basis of the services provided by the organisation. A request for a call to a specific travel agency out of opening hours may result in the PA suggesting contacting a 24-hour call centre of an airline company.

6.2.2 Meeting Scheduling Services

The personal assistant includes, obviously, a calendar facility, that among other things can be used for scheduling of meetings, and negotiation with users and other agents. The functionality includes:

— Identifying a mutually appropriate time for all participants to attend a meeting
— Reserving an appropriate venue for the meeting
— Organising associated facilities (e.g., lunch, OHP, etc.)
— Issuing reminders to participants
— Handling any problems which might arise at a later date
— Cancelling meetings.

6.2.3 Information Management Services

This is a very large and nebulous set of tasks but also addresses one of the most critical needs for intelligent personal assistants. Most professionals are now inundated with too many sources of information, generally this is called "information overload". An agent can serve to semi-autonomously filter, sort, or otherwise respond to all these sources to help off-load some of the more mundane tasks these professionals now must do themselves. Such task include:

— E-mail and news filtering (such as "junk" mail or news appends)
— Sorting and prioritising all sorts of received information
— Automatically responding or forwarding information to another user

A key aspect of such information management is not just filtering out the low priority information, but also providing the timely delivery of high priority items - anywhere, anytime, anyhow. Such delivery is dependent on the user's location, media/equipment limitations, and user preferences. For instance, an agent can be instructed to deliver important e-mail to an end-user even if the user only has a mobile phone by converting the text to speech. Of course, this same text-to-speech delivery of e-mail over a mobile phone can be applied to any text-based information source such as NNTP news, stock quotes, etc. Furthermore, given the cost of mobile phone connectivity, other technologies such as text summarisation can be employed, for most efficient delivery, to save the users time and cost. The provision of such summarisation and media to media transformation could be provided, for example, via external services.

Even under the most constrained situations, such as the user only having a pager, a personal assistant can at least notify the user about the existence and accessibility of an important new multimedia document. Even though the pager device cannot deliver the information, the personal assistant can notify the user of the appropriate equipment in the locality of the user that is available where the multimedia document could/would be sent to.

A less well-developed but equally important aspect of information management is the personal storage and retrieval of information. Even personal computer storage is becoming difficult to manage. Files are often duplicated, directory structures are haphazard, and the file systems themselves does not provide rich indexing and content search facilities. Here, a personal assistant can be asked to file and retrieve documents or even isolated bits of information, much like a personal secretary manages paper-based documents in the office.

As an example of an external service which can be accessed by a PA, we briefly mention travel planning.

6.2.4 Travel Planning Service

A personal assistant can assist in planning the user's trip by interacting with the user, other agents and external directory services (such as yellow pages) and providing an appropriate plan of an intended trip and other guidance services. See the description of the FIPA'97 Personal Travel Assistance application for more details. In particular, the PA may assume much of the functionality of the Personal Travel Assistant agent.

6.3 Personal Assistant FIPA'97 Application

6.3.1 Scenario

The chosen scenario is that of arranging meetings among several participants, located across companies and using different calendar management systems. This has been chosen for several reasons:

— The scenario is instantly applicable to real-life
— Current solutions are unwieldy and proprietary, making integration across networks and other services difficult
— The scenario can be easily extended to incorporate further services

— This class of application has been widely studied, with many agent-based approaches (cf. [Kozieriok & Maes, 1993])

The scenario lends itself well to agent technology, due to the need for

— User profiling
— Integration of heterogeneous software
— Action on a user's behalf (semi-autonomy)
— Local control (in particular, of the user's calendar)

The selected service is an integration of meeting scheduling and travel assistance. The user asks the agent to set up a meeting with several participants. Because the meeting may involve travelling for some of the participants, travel planning forms part of the meeting scheduling.

6.3.2 System Architecture

In this test application, the Personal Assistant provides a single unified interface to the user, and is represented as a single agent, even though it may actually be composed of several agents.

Each user is represented by a Personal Assistant. These PA's negotiate with each other to find an adequate meeting place and time. They interact with Travel Broker Agents (TBAs) to find out about travel schedules etc.

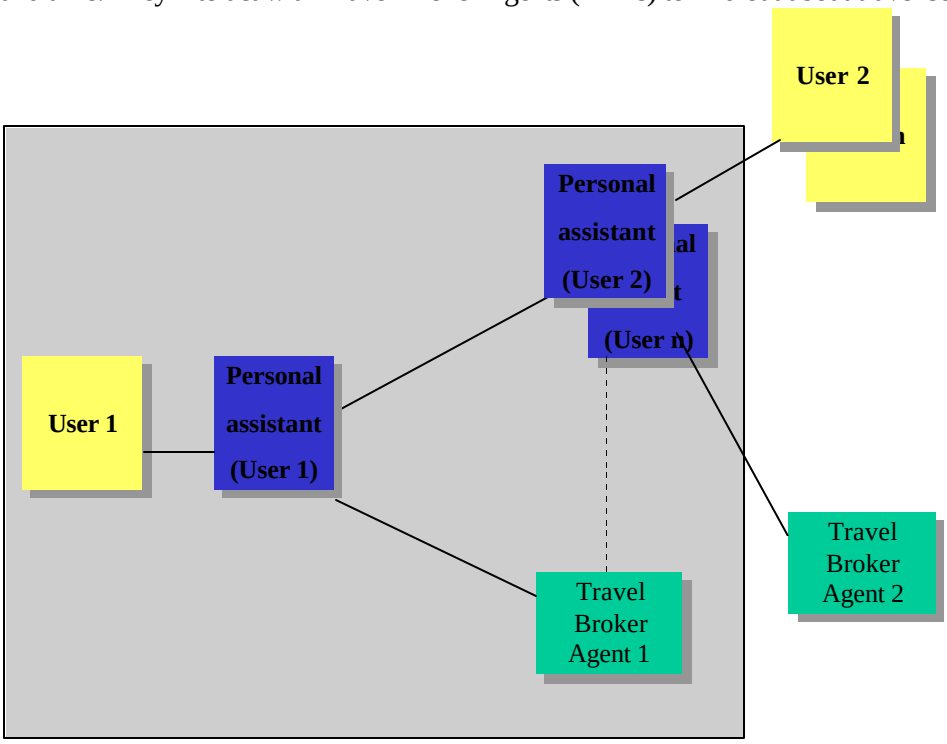

Figure 3 — Agent Interactions in Personal Assistant Application Scenario

The PA may make use of several existing programs to perform its tasks. A possible set of relevant software for this test application is shown in Figure 3.

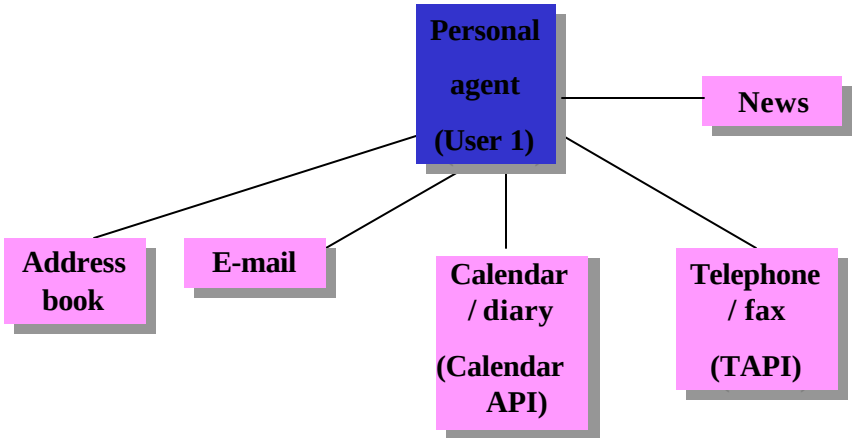

Figure 4 — Integration of External Software

The relationships between the PA and the Agent Management functions is shown in Figure 4.

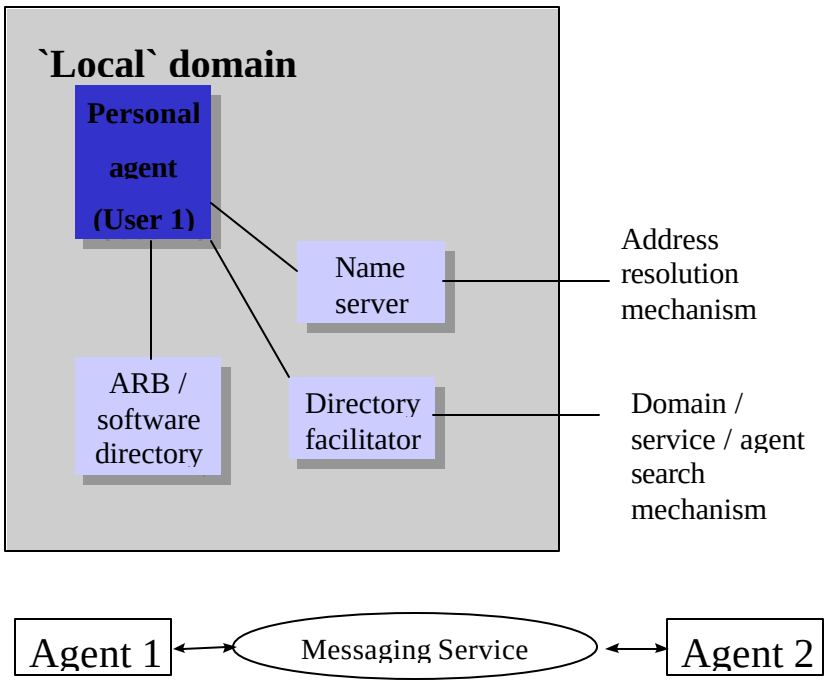

Figure 5 — Interaction with Agent Management Entities

FIPA technical committee TC5 is defining a set of scenarios based on one particular aspect of the Personal Assisant (PA) role, that of arranging appointments for activities, such as meetings, which involve a number of participants. The PAs of the participants must cooperate to ensure that the meeting is arranged for a time and place which is mutually acceptable to all their users. The PAs may also consult agents offering travel broking services as defined by TC4.

Basic scenario: User 1 is chairman of a committee, and asks his PA to arrange a committee meeting.

Subscenario 1: User 1 suggests a specific time, duration and location for the meeting. The simplest case is that all participants are required to attend the meeting.

Subscenario 2: User 1 suggests a range of possible times to start the meeting. The duration and location of the meeting remain specific.

Subscenario 3: User 1 suggests a range of possible times to start the meeting as well as a set of locations at which the meeting can take place.

In the scenarios, only those participants which have personal assistants will be considered in the agent-based negotiation of the meeting. Other possible interfaces (directly between personal agent and another human) will not be required.

It is up to the individual PA application to associate personal assistants with their users. I.e. if the initiator enters a list of participants to the meeting, the initiator's agent needs to be able to communicate with the personal assistants of the participants.

The above subscenarios are in order of increasing sophistication and difficulty of implementation. Further scenarios, which are not directly under consideration in this specification, could be achieved by allowing negotiation about the duration and actual participants in the meeting.

A field trial prototype should demonstrate cooperative meeting arrangement involving several PAs. It should implement at least the functionality required by the simplest subscenario, and preferably more. One or more of the PAs should make use of travel planning services provided by a PTA field trial system. It is preferable that interoperability of at least two independently-designed and implemented types of PA be demonstrated.

The agents in the system must communicate using an agent communication language compliant with the FIPA specification. The messages must be delivered using an implementation of a FIPA message service. The system must be supported by at least one Directory Facilitator (DF, yellow pages) and Agent Name Server (ANS, white pages). However, it is preferable that more than one domain is involved and hence more than one DF and ANS and that inter-domain address resolution, message routing and 'yellow pages' searching be demonstrated.

Certainly further scenarios in the area of personal assistance may be defined and developed.

6.4 FIPA technologies used

Because the test application is primarily meant to provide an evaluation and validation of the normative parts of the FIPA specification, it is here elaborated which parts of the specification are actually used within this application.

6.4.1 Agent Management

This application makes use of the Directory Facilitator as specified in Part 1 and, as such, requires agents to register with the DF according to the mandatory specification given in Part 1 Section 9.2.5 register-agent and 9.2.6 deregister-agent Furthermore, the following optional attributes are also to be used in the Personal Assistant application:

— search(Section 9.2.2)

The particular ontology used and specific representation of these attributes will be defined in the field trial.

6.4.2 Agent Communication Language

This application makes use of the ACL as specified in Part 2 and, as such, requires agents to communicate with each other according to the ACL specification. In particular, the following communicative acts are used in this application:

— cfp, accept-proposal, reject-proposal,not-understood,propose,refuse,inform,failure,perform

Furthermore the FIPA-Contract-Net and FIPA-Request interaction protocols are used, thus, personal assistants conforming to this specification must be capable of handling these protocols.

6.4.2.1 Human-Agent Interaction (*informative*)

Although the FIPA 97 specification does not specifically address the issues of Human-Agent Interaction, we support the position that humans may be viewed as agents in their own right, and that their interaction between software or physical agents may also be accomplished using ACL. Since humans do not speak ACL directly, some sort of translation service from a user-friendly interface (e.g. graphical or speech-based) into ACL is required (cf. Figure 6). This may be accomplished by supplying a special *User Interface Agent*. It is recommended, but not necessary, that a particular PA implementation provide such an ACL-based interface to the user. In particular, experience gained from this approach will benefit future standardisation efforts in this area.

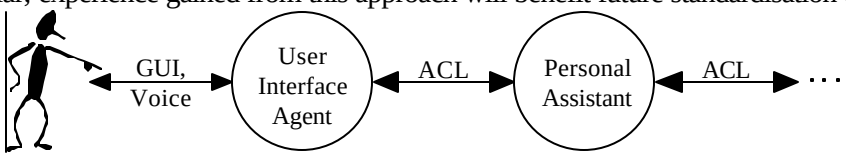

Figure 6 — Agent-Human Interaction via User Interface Agent

6.4.2.2 Contents of Interactions

Thus, the following communicative acts between users and their personal assistants could be used:

a) U -> PA : give task to arrange meeting (including reporting requirements)
b) PA -> U: progress status of task, at least success or failure (with reasons)
c) U -> PA: permission to commit to meeting
d) PA->U: request for permission to commit
e) PA -> U: inform commitment made
f) U -> PA: degree of delegation authority

6.4.3 Agent / Software Integration

As a user's calendar is private to the user and his Personal Assistant, the software wrapping technology specified in Part 3 is not currently used in this application. However, a Personal Assistant may access the following existing software directly via the appropriate interfaces:

- diary or calendar management system: requirements should be identified, they will probably be met by a Calendar API
- address book: basic general-purpose database
- e-mail / fax:
  - PA can send messages to another user who has no PA
  - PA might be able to interpret structured e-mail messages
- TAPI (for communicating via telephone with the user)

6.4.4 Personal Travel Assistance

Participants in a meeting may be required to travel to the location of the meeting, in which case the PA may access a PTA system as specified in Part 4 to arrange a travel plan.

7 Detailed Specification

This section presents the detailed specification of the FIPA'97 Personal Assistant application scenario.

7.1 Informal Description of PA Content Language

The primary object in the PA Application is the action `PA-Meet`. This action is something a human participant in a meeting must carry out, and is thus, the primary subject of negotiation among the humans' Personal Assistants. As there is no standard ontology of actions or objects we must confine the specification to the minimal requirements of PA.

It is suggested that a PA implement the `PA-Schedule` action, which takes a meeing as its argument. A PA can be ordered to perform this action by the user via the user interface agent. The action in turn may triggers the `FIPA-ContractNet` interaction protocol, as applied to the special action `PA-Participate`, which, conceptually, is performed by the participants of the meeting.

It has been decided to adopt the vCalendar format is to be used for the representation of meeting objects. The resultant confirmed meetings which have been confirmed after negotiation among the personal assistants will be represented entirely conformant to Version 1.0 specification, in order to enable straight-forward integration with systems using vCalendar. In particular, the following mandatory parameters of vCalendar are supported by the PA application as follows:

`VERSION: 1.0`
`CATEGORIES:` - implementation specific, can be

- specified by human initiator,
- X-FIPA-Test for meetings which are not actually supposed to occur (e.g. for testing and demo purposes)
- given a default value (e.g. `X-FIPA-Meeting`) by the PA

`DESCRIPTION:` - implementation specific, can be

- specified by human initiator,
- given a default value (e.g. `X-FIPA-Meeting`) by the PA

`SUMMARY:` - implementation specific, can be

- specified by human initiator,

— given a default value (e.g. X-FIPA-Meeting) by the PA
PRIORITY: - implementation specific, can be
— specified by human initiator,
— given a default value (e.g. 0) by the PA
Also, the following optional parameters of vCalendar are required for the PA application:
ATTENDEE;ROLE=ORGANIZER:John Doe for human initiator who is attending
ATTENDEE:John Doe for other participants
SEQUENCE: initially 0, incremented upon confirmation
UID: - implementation specific, globally unique identifier
STATUS: CONFIRMED (when the meeting has been confirmed accept-proposal)

The following optional parameters of vCalendar are also optional for the PA application:
LOCATION: PTA-compliant location designator. If location is given, the PA must/may be able to schedule the required trip to the location.

The following extensions to vCalendar are required for PA:
X-FIPA-ORGANIZER: for human initiator (whether attending or not)

It is, however, necessary to slightly modify Version 1.0 of the vCalendar specification for representing meetings under ongoing negotiation. The modifications are as follows:
DTEND: - UTC (if specified by human initiator) *or* X-FIPA-UnderNegotiation (if meeting start/end times are to be negotiated)
DTSTART: - UTC (if specified by human initiator) *or* X-FIPA-UnderNegotiation (if meeting start/end times are to be negotiated)
STATUS: UNDER NEGOTIATION (in cfp) or CONFIRMED (in accept-proposal)

7.2 Concrete Syntax of PA Content Language

The primary requirement of the content language is the representation of meetings, trips and the actions of scheduling the meeting (as carried out by the initiator's PA) and the action of participating in the meeting (as carried out by the human participants). Due to its simplicity, standard s-expression syntax is chosen.
This section describes the concrete syntax of the content language for the PA application (TC5).
The syntax is expressed in standard EBNF format as summarised in [FIPA Document fipa7612.doc].
Expressions in the content language appear in the ACL message format syntax as value expressions of the ":content" parameter in the ACL message syntax, specifically as in:

```
:content "(" PA-content-message Proposition ")" .
```

The concrete syntax below further specifies the non-terminals PA-content-message and Proposition .

```
PA-content-message      =     "(" PA-Action ")".
PA-Action               =     PA-Meet | PA-Travel | PA-Schedule .
PA-Meet                 =     "(PA-Meet" ObjectId PA-Meeting Result Status Agent
                              StartTime Duration Deadline ")" .
PA-Travel               =     "(PA-Travel" ObjectId PA-Trip Status Agent StartTime
                              Duration Deadline ")" .
PA-Schedule             =     "(PA-Schedule" ObjectId PA-Object Result Status Agent
                              StartTime Duration Deadline ")" .
PA-Object               =     PA-Meeting | PA-Trip .
PA-Meeting              =     "(PA-Meeting" ObjectId Initiator vCalendarObject
                              Protocol ")" .
TimeInterval            =     Time | "[" Time "," Time "]" .
TimeIntervals           =     "[" TimeInterval  + "]" .
TimeIntervalTest        =     "InTimeInterval(" ObjectId".DTSTART , " TimeIntervals
                              ") AND" ObjectId".DTEND = " ObjectId".DTSTART + "
                              Number .
ObjectId                =     String | ObjectId"."String .
Protocol                =     ":protocol" String .
```

```
Proposition            =     "true" | "false" | TimeIntervalTest |
                             ObjectId".LOCATION"|
                             "(" Proposition ")"
                             "(eq" Term Term ")" |
                             "(and" Proposition Proposition ")" |
                             "(or" Proposition Proposition ")" .
Term                   =     NumericalExpression | Time | String.
Reason                 =     Proposition .
NumericalExpression    =     Number | "(" NumericalExpression ")" |
                             "(+" NumericalExpression      NumericalExpression ")" |
                             "(-" NumericalExpression      NumericalExpression ")" |
                             "(*" NumericalExpression
                                 NumericalExpression ")"  |
                             "(/" NumericalExpression
                                 NumericalExpression ")" .
vCalendarObject        =     ":vCalendarObject" CalendarItem .
CalendarItem           =     <Specification of vCalendar objects as in the vCalendar
                             1.0 specification by the IMC and as discussed in
                             Section 7.1> .
AgentReference         =     <Universal Agent Locator as specified in FIPA 97
                             Specification Part 1]> .
Time                   =     <ISO8601-Time; UTC-Format e.g. 19971010T123000Z> .
String                 =     <As specified in FIPA 97 Specification Part 2> .
Number                 =     <As specified in FIPA 97 Specification Part 2> .
```

7.3 Interaction Protocols

The interaction protocols to be used for scheduling meetings are described in this section. On a normative basis, are the protocols used between personal assistants to determine the times and locations of the meetings. On an informative basis are the protocols which may be used between the users and their personal assistants for triggering the meeting scheduling process and confirming the meeting.

7.3.1 Negotiating Meeting Details (normative)

The `FIPA-ContractNet` interaction protocol is used for negotiation of meetings (more accurately, negotiation about the action of participating in the meetings) among the personal assistants. Whereas the intent of the original contract net protocol [cf. Davis&Smith] is to select the best bid(s) of a set of submitted bids, here the accept-proposal message is used only if all bids (i.e. time frames to attend the meeting) have a time frame in common. This is the timeframe that is chosen. As the bids of a contract net imply firm commitment, the PAs need to check with their users the initiator agent.

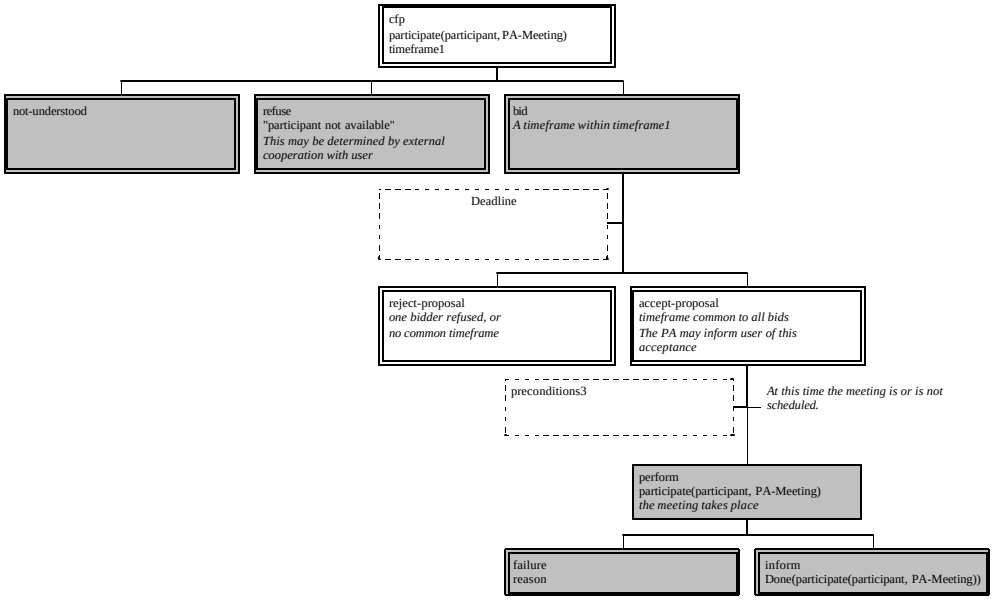

Figure 7 — FIPA-ContractNet (applied to meeting negotiation)

7.3.2 Scheduling a Meeting (informative)

If the interaction between the user and his/her PA is also modelled using ACL, an `Order` protocol can be used in order to initiate negotiation of a meeting:

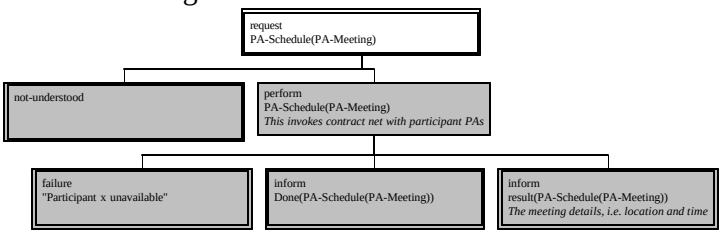

Figure 8 — PA-Order (applied to meeting scheduling)

7.3.3 Confirmation with User (informative)

If the interaction between the user and his/her PA is also modelled using ACL, the `FIPA-RequestWhen` protocol can be used by the PA to confirm the availability of the user at a suggested meeting time.

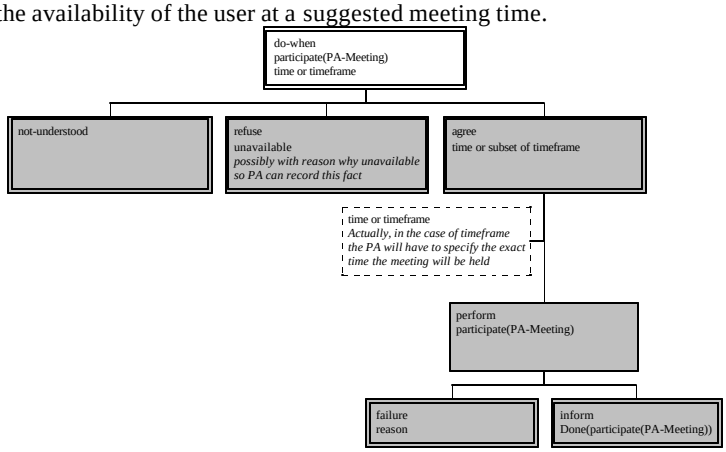

Figure 9 — FIPA-RequestWhen (applied to meeting scheduling)

8 Examples

We give here a concrete example. Suppose John Doe wants to schedule an hour long meeting with some colleagues during some time on a given day. Then John Doe's personal assistant will send the following message to the personal agents of the desired participants:

```
 (cfp
    :sender UA-Donald
    :receiver UA-Wiet
    :content ((PA-Meet
                  :ObjectID WietMeet123
                  :Agent Hans Mustermann
                  :PA-Meeting (BEGIN:VCALENDAR
VERSION: 1.0
BEGIN:VEVENT
UID: 123
SUMMARY: FIPA Demo
ATTENDEE:Hans Mustermann
ATTENDEE;ROLE=ORGANIZER:John Doe
LOCATION:Siemens MchP 53.512
CATEGORIES: X-FIPA-Test
DESCRIPTION: This is just a test meeting. Please do
      not attempt to attend it.
SEQUENCE: 0
PRIORITY: 0
```

```
DTSTART: X-FIPA-UnderNegotiation
DTEND: X-FIPA-UnderNegotiation
STATUS: UNDER NEGOTIATION
X-FIPA-ORGANIZER: John Doe
END:VEVENT
END:VCALENDAR
                                )
              )
            (InTimeIntervals(WietMeet123.PA-Meeting.DTSTART,[[1200,1800]]) ^
DTEND = DTSTART + 60 )
             )
    :ontology FIPA-PA
    :conversation-id UA-Donald345
    :protocol FIPA-ContractNet
    :reply-with Response123
    :reply-by 101097T1300
)
```

9 References

[Kozieriok & Maes, 1993] R. Kozieriok, P. Maes: A learning interface agent for scheduling meetings, in: International Workshop on Intelligent User Interfaces, Orlando, Fl., ACM-SIGCHI, ACM Press, 1993.