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An Agent-Based Architecture for a Cooperative Information System Supporting the Homecare

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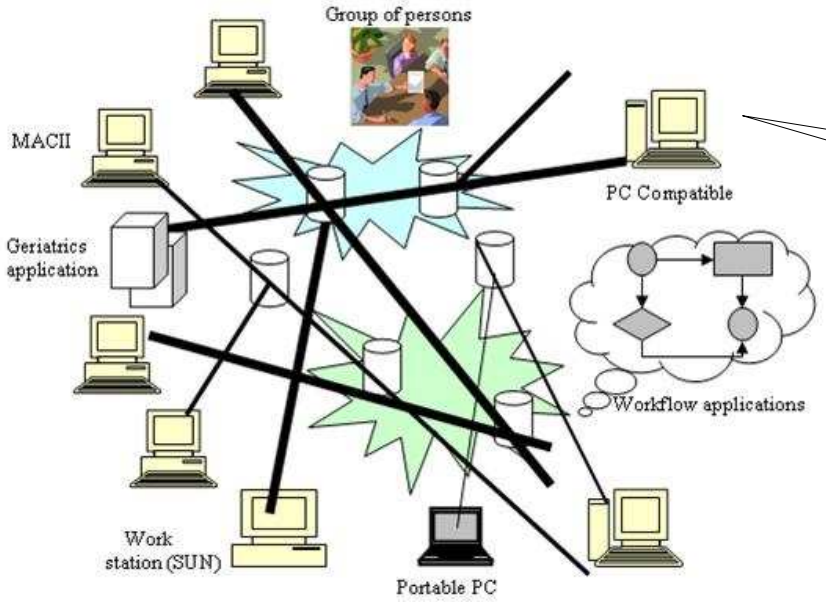
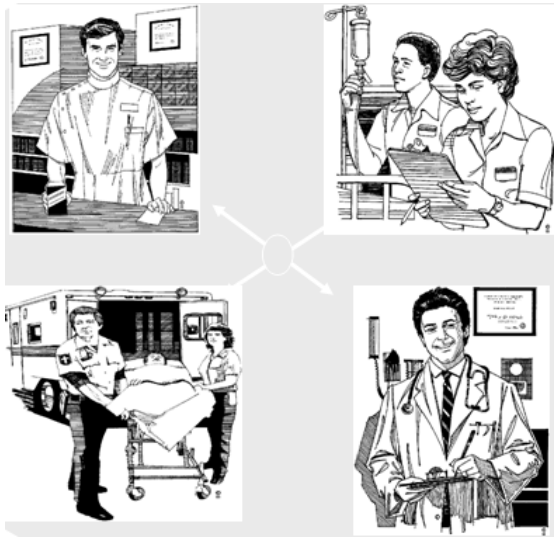
Introduction



- Virtual space
  - ➢ Share information
  - ➢ Cooperate
    - ➔ Objectives
    - ➔ Distributed resolution of problems

- The homecare is a virtual organization
  - ➢ Set of cooperating partners
    - ➔ heterogeneous and autonomous information systems



Problematic

- The homecare takes place in a particularly mobile and dynamic environment. It evolves constantly during its existence
  - heterogeneous information
  - wide quantity of data brought back by the multi-field members of the team
  - distribution and traffic of information
  - complexity of tasks
    - Problem of coordination

- The real issue in a homecare system is that of its organization rather than the lack of means it possesses.
  - The lack of Architecture for cooperative information system (CIS) supporting the homecare

Goals

- To set up a CIS adapted to the concrete needs of the homecare
  - The CIS contains the solution of all posed problems
- To construct an agent-based architecture which allows to see the homecare as a simple organization of a set of cooperating systems
- In this solution we try to surmount some obstacles and problems:
  - coordination and negotiation of partners
  - syntactic and semantic interoperability
  - fast evolution of technology

Homecare (1/4)

- The homecare concerns every person, having a temporary or permanent inability. It has for main objective to improve the comfort of the patient into good care conditions
  - To achieve this goal, it requires the coordination of all partners
- The homecare which is developed today is based on this principle of partnership: the coordination and sharing of information between the various implied actors
  - Every type of actor manipulates one or several types of documents which are specific for him. So, needs of information and its manipulation are specific to each one
  - All roles of partners are based on the role of coordination and communication including planning and organization of various actors' interventions, and information sharing

Cooperation at hospital VS cooperation in homecare (B.Souf)(2/4)

- Hospital
  - Participants of the same structure
  - Usual meetings
  - Different supports of information

- Homecare
  - Participants of different structures
  - Few meetings
  - Often minimal medical information

Development of homecare (3/4)

- The classification criterion of existing work is the used technology
  - The computerized medical file (Braunstein)
  - Telecommunication and wireless (Braecklein)
  - Groupware (Yuitori Network)
  - Intelligent house (Noury)
  - Agent technology
    - Cooperation inter-partners (Vassilis)
    - Coordination (scheduling) (Itabashi)
- These works concern some types of diseases, like:
  - Chronic diseases
  - Old persons

Discussion (4/4)

- The homecare is a complex system which demands a distinct coordination from all actors (variety of scenarios , organisms, partners and their activities)

- The interoperability is seen according to two levels:
  (i) interoperability was simply translated by the communication (connectivity) within the homecare network
  (ii) interoperability translated by the connectivity, the exchange and the information sharing (intermediate platform)

- The medical data is often constituted by heterogeneous data (lack of standards). This data can be the exchange object between partners

- The lack a generic solution of homecare poses problems to the notion of portability and reusability.

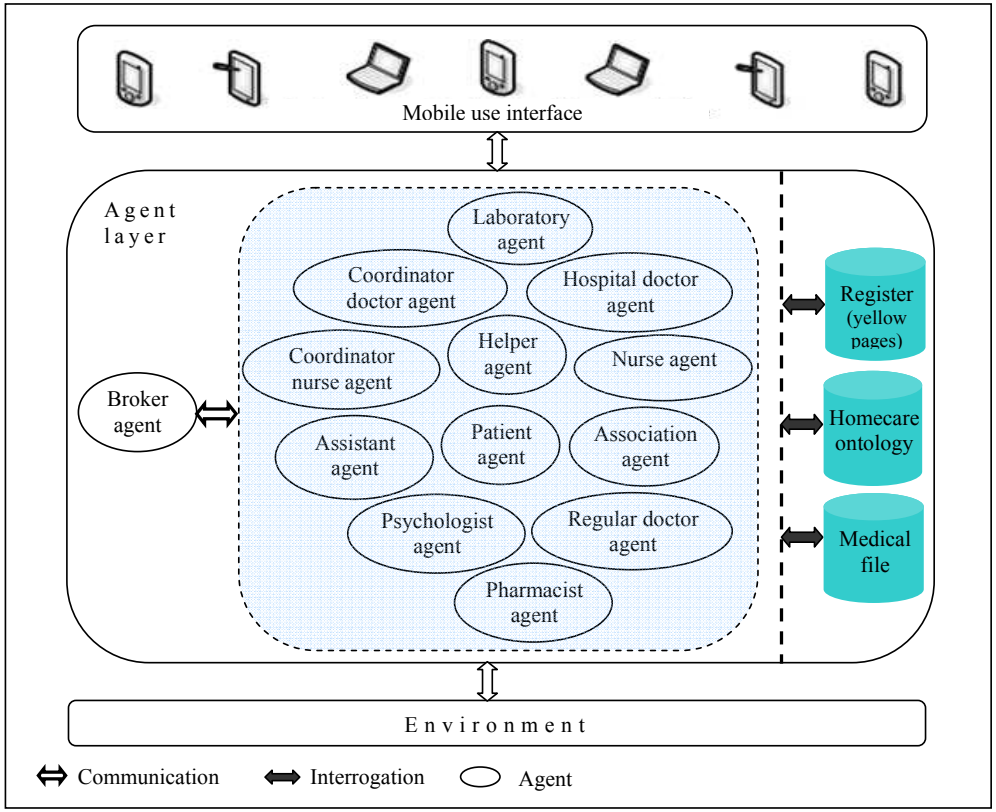
An Agent-Based Architecture for the Homecare (ABAH) (1/12)

Principles of the proposed architecture, ABAH

- The purpose of this work is to build an agent-based architecture for a CIS supporting the homecare
  - This architecture facilitates the interoperability and the accessibility to information; and it offers to the homecare partners the same functionalities as if they belong the same structure (the same space)
  - Independent of any application in the field of homecare
  - Every partner is represented by an agent. These partners are geographically dispersed
  - All the agents form a cooperative, and complex multidisciplinary system
- agents are capable of interacting (coordination, negotiation) between them to interpret and accomplish their tasks

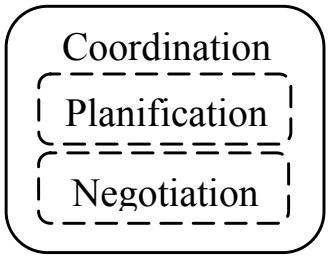
ABAH : an Agent-Based Architecture for a CIS supporting the Homecare **(2/12)**

Completely distributed architecture

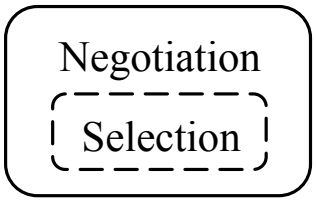


The adopted agents (3/12)

- The considered agent is cognitive
  - foresees and anticipates actions
- Autonomy
- Flexibility (sociability and pro-activity)
- Informational
- The agent constitutes the basis of the system and contains the necessary modules for autonomy, reasoning and communication
- Two types of agents:
  - Broker agent
  - Partner agent



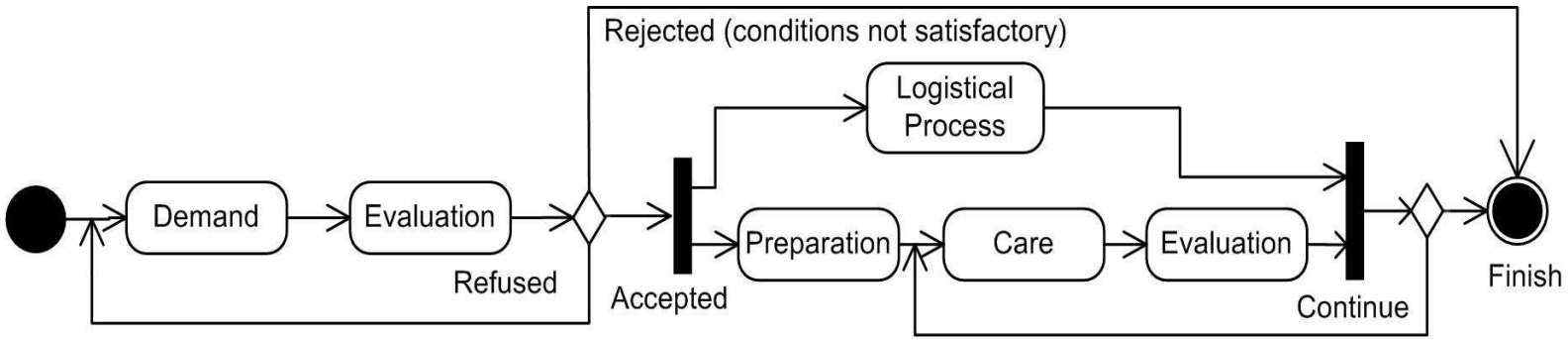
Process module of partner agent



Process module of broker agent

Functioning of the homecare organization (4/12)

- After an evaluation of the situation, the homecare process (logistical process and care process) starts
  - The constitution of the homecare organization go through:
    - **Selection of the best offers**
    - **Negotiation of the contract**
    - **Care**



Homecare process (state diagram)

Partners selection phase (5/12)

- we adapted the Contract-Net protocol for the choice and the preliminary selection of the candidates
- Offers are estimated by using a multi-attribute utility function. The choice of the potential contracting parties depends on the value of the obtained utility described as follows:

$$\text{Utility Value} = \sum (\text{attribute value} * \text{weight})$$

- The evaluation is based on attribute values (i.e. the criteria of the partners' selection e.g. experience) and the weights included in the utility function
- The task is attributed to the contracting party that presents the best offer

➔The broker uses on this order to select another contracting party if the current member refuses or the reply time is exceeds

Contract negotiation phase and commitment (6/12)

- The contract negotiation phase determines in a formal way the commitment agreements

- The adopted contract negotiation mechanism is based on the exchanges of propositions and counterproposals in time. This negotiation is based on a compromise. thus,

  ➔The potential contracting parties become official partners

  ➔The broker just consults the classification of the selection phase of contracting parties and will choose the following one (case of disengagement or exceeded response time)

Care phase (7/12)

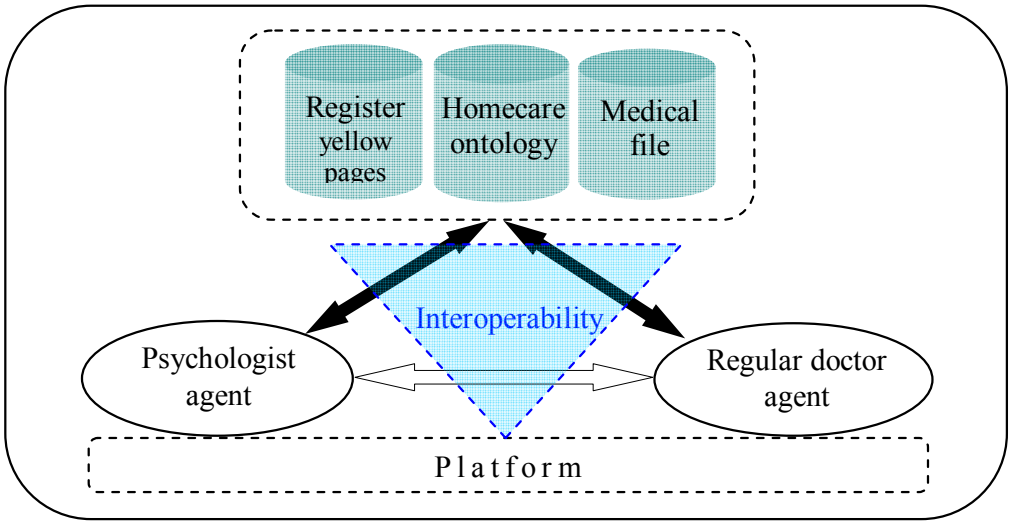
- Every agent plans and coordinates its tasks with the other cooperative agents
- Any decision-making, note or action must be stored in the medical file, to keep any trace of intervention
- Every agent consults only the information which it concerns according to the rights of access
- Agents are of different fields of activity, and for any assent and communication without ambiguities. So, an ontology for the homecare seemed necessary for cooperation

Tasks coordination and conflicts resolution (8/12)

- The environment of agents is evolutionary and events can arise during the planning phase and\or plans run
- Coordination by distributed planning
  - The multi-agent solution is based on the approach of global partial generalized planning (a basic coordination in the GPGP technique)
  - Every agent elaborates its own plan locally and coordinates it in a distributed way. It reacts to the unforeseen situations by modifying its plans, i.e. an alternation between planning phase and carrying out phase

The interoperability in ABAH (9/12)

- The interoperability is the faculty that all partner agents of the homecare's exchange and share data and information through standards and compatible norms and consequently mastery of the heterogeneous



Interoperability levels in ABAH: interaction example between the psychologist agent and the regular doctor agent

Common communication protocol (10/12)

- The communication mode which we adopted is : sending of messages
- ACL FIPA
  - ➔Interoperate the distinct agent society from the homecare

Syntactic interoperability (standard exchange format)

- XML
  - ➔ Resolve the syntactical conflicts which result from the use of different data models
  - ➔ to Generate messages, extraction of information, etc.
  - ➔ reusability (distribution)

Message in ACL FIPA containing a report structured in XML

```
(inform
:sender   Nurse agent
:receiver Regular doctor agent
:language XML
:ontology Homecare
:content (<report>
            < clinical exam>
               <weight> 54 </weight>
               <tension> 14-8 </tension>
               <fever> 37 </fever>
            </clinical exam>
            <conclusion>
               <ecg> normal </ecg>
            </conclusion>
         </report>
          )
)
```

Semantic interoperability

- XML imposes no semantic constraint on the meaning and the sense of documents

  ➔ an ontology is vital for the homecare (i.e. badly interpreted information can put in danger the patient life)

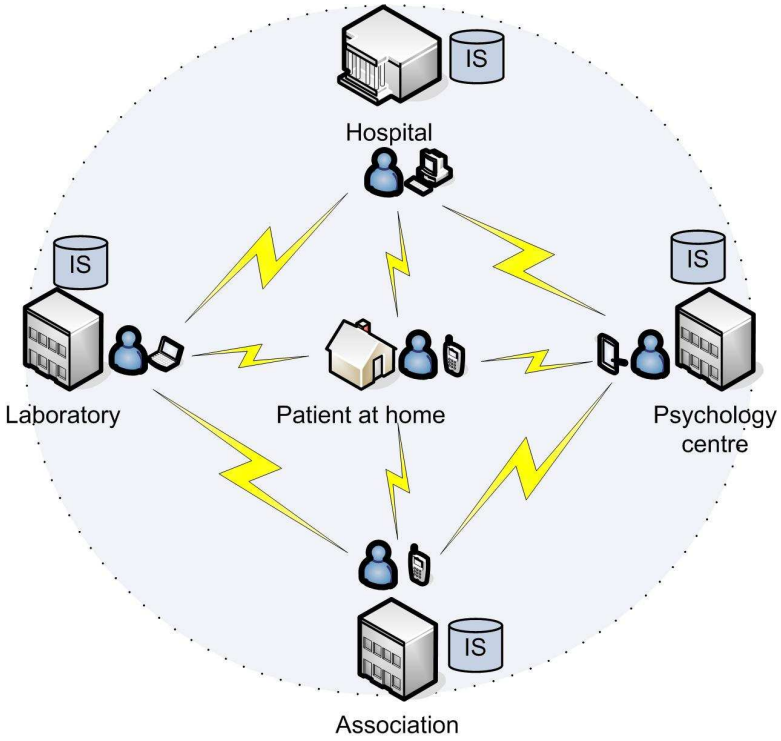
Sharing database

The database serves as a medical file (we impose the use of a RDBMS), it guarantees:

- An overview between partner agents to collect, enrich and exchange structured medical data
- The interoperability between health organizations “reference” in the sense of a patient agent's passage from an organization to an other

The contribution of mobile communication-tools (12/12)

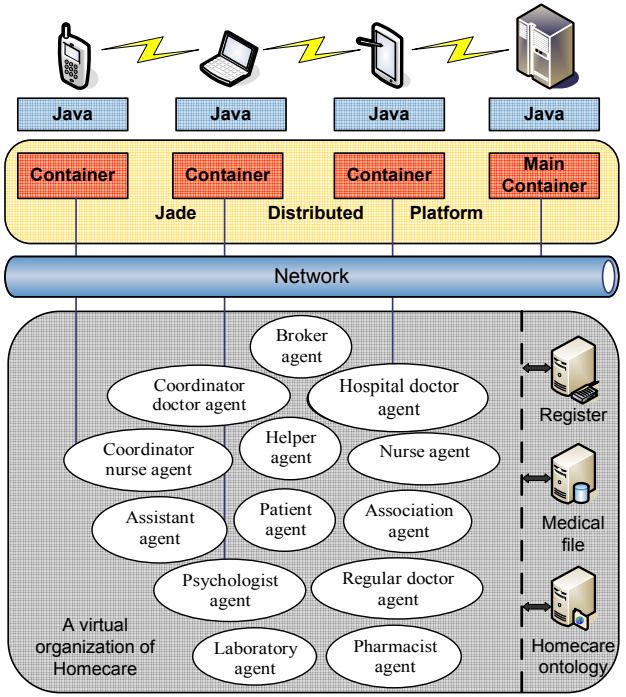
- Partner agents of the homecare are different in term of forming, competence or task to carry out
- It is necessary to take into account their mobility
- ➢ Mobile tools such as PDAs and mobile phones constitute an essential condition for the homecare success (A.Francoise)



Implementation of ABAH (1/3)

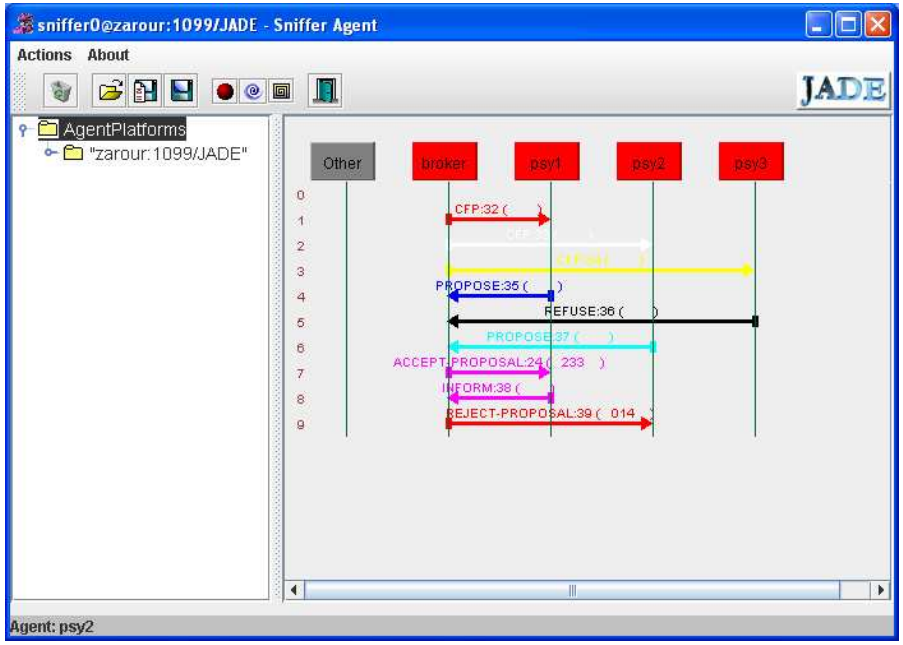
- We have used standards. For example, we have used the XML technology to represent the exchanged information between agents via the standard communication language ACL-FIPA
- JADE is used to the deployment of ABAH. It takes into account the FIPA specifications for the multi-agent systems interoperability

the implementation of ABAH as a virtual system of patient's care at home by using JADE, where every agent of the organization is launched in a separate host and in a different container.



Selection Phase (2/3)

The broker agent is interested to determine appropriated profile (example: psychologist agent specialized in the homecare field, experimented, etc.) to avoid any loss of selection time and possibly, a precious time of negotiation.

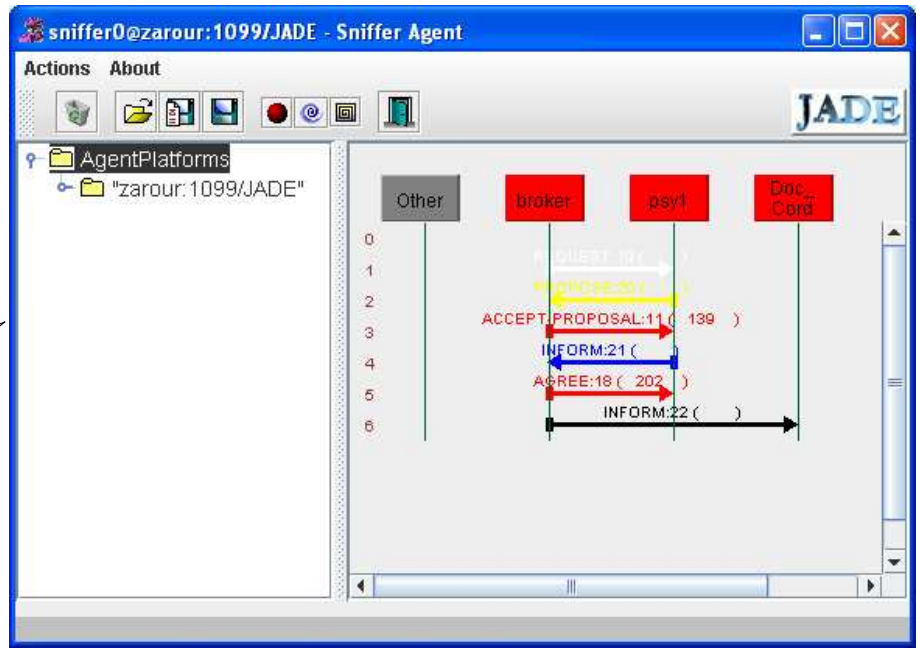


simulation of the selection phase of a potential partner agent

Negotiation phase(1/3)

Further to the selection of the psy1 potential agent, the broker agent enters with this last one in a negotiation phase (propose, accept - propose, etc.) to determine formally the contract clauses, and so becomes an official partner agent.

Simulation of the negotiation phases between the broker agent and the psy1 agent



Conclusion and future work

- ABAH is represented as an agent-society which forms a cooperative and intelligent multidisciplinary system
- It facilitates the interoperability and the accessibility to information. Also, it is independent from any application in the field of patient's care at home (chronic diseases, independent persons, etc.)
- Knowledge is completely distributed between the partner agents
- To implement ABAH, we have based on standards (XML, JAVA, ACL FIPA)

- Improvements are in progress concerning the protocol of selection and negotiation
- To achieve ABAH system:
  - ✓ The development of a specific ontology for homecare (adapted to ABAH architecture and functioning)
  - ✓ Elaboration of a dedicated security system

Thank you for your attention