AGENT COMMUNICATION LANGUAGES COMPARISON: FIPA-ACL AND KQML

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Abstract: *When designers, developers and systems architects attempting to design, build and test agent applications, particularly communities of multiple agents, and agents need to talk to each other there is a standard for agent communication language. This article provides an overview of the two main communication language - Knowledge Query and Manipulation Language (KQML) and The Foundation for Intelligent Physical Agents – Agent Communication Language (FIPA-ACL).*

Keywords: *agent systems, security intelligence, agent communication, language, fipa, kqml, software agent*

1. INTRODUCTION

In Information Technology increasingly is emerging a new kind of computer program that acts for a user or other program in a relationship of agency and that is a software agent. They are one of the most exciting new developments in computer technology. They can be used to quickly and easily build integrated enterprise systems. Although there is no single definition of agent [1], all definitions agree that the agent is essentially a special software component that have autonomy, which provides interoperable interfaces between any systems and / or behave like a man working for a client in achieving its agenda. Even if an agent systems is based on an agent working within an environment and if necessary interaction with users, they usually consist of multiple agents. These multi-agent systems (MAS) can model complex systems and to introduce the possibility of the agents to share common or conflicting goals. Such agents may interact with each other indirectly (by acting on the medium) or directly (through communication and negotiation). Agents may decide to cooperate for mutual benefit, or may compete to meet their own goals.

Agent-based computing has been a source of technologies to a number of research areas, both theoretical and applied. These include distributed planning and decision-making, automated auction mechanisms and learning mechanisms. Moreover, agent technologies have drawn from, and contributed to, a diverse range of academic disciplines, in the humanities, the sciences and the social sciences.

The Faculty of Computer Systems and Control at Technical University of Sofia began research on the application of intelligent systems for information security. During the study, was made a survey of the various standards that must be observed in the construction of agent-based systems. One such standard is the communication between agents. This article provides an overview of the two main communication language.

2. AGENT COMMUNICATION LAGUAGES

The language is the ability to acquire and use complex systems of communication. The power of agent systems depends on inter-agent communication. The language is

not only like "natural language", for example Bulgarian, Greek or English, but also it serve a purpose, namely the communication between willing (or unwilling) participants [2]. So like humans agents to understand and share information, software agent need the same – a language. So in order to interact in a shared language, to build a communities of agents that can tackle problems that no individual agent can agents need an Agent Communication Language.

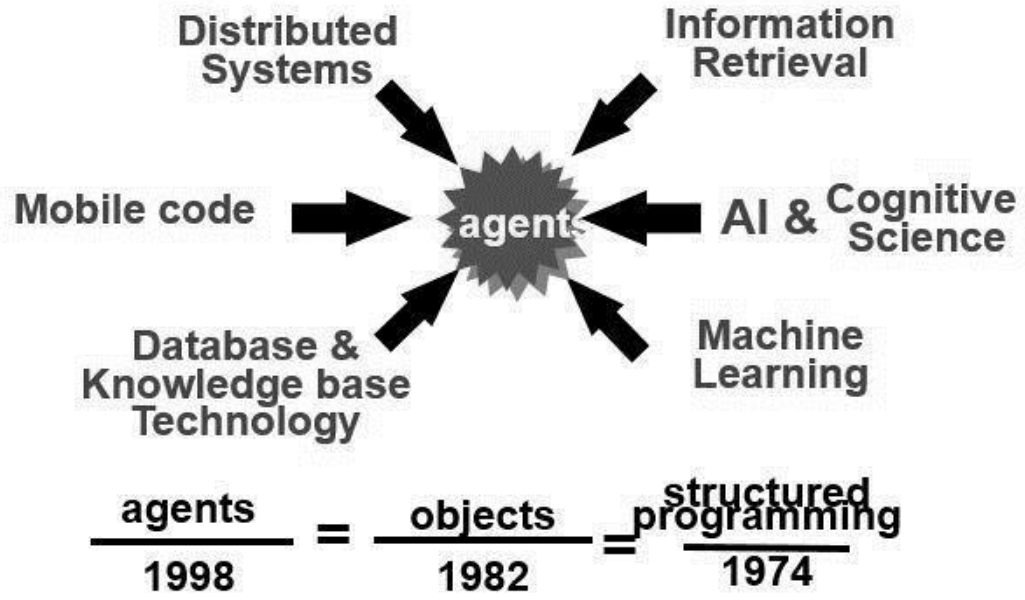

Fig. 1. Agents: A system-building paradigm

Powerful agents need to be able to communicate with users, with customers, with system resources, and with each other if they are to cooperate, collaborate, and negotiate and so on. Common agent languages hold the promise of diverse agents communicating to provide more complex functions across the networked world. Indeed, as agents grow more powerful, their need for communication increases.

There are two agent communication languages that a spread across in agent technology world – Knowledge Query and Manipulation Language (KQML) and The Foundation for Intelligent Physical Agents – Agent Communication Language (FIPA-ACL).

So in 1990 The Knowledge Sharing Effort (KSE) was initiated by DARPA with encouragement and relatively modest funding from US government agencies. Its goal was to develop techniques, methodologies and software tools for knowledge sharing. KSE focused on defining common language for knowledge sharing. In the KSE model every virtual knowledge bases that can exchange information using language is viewed as agent. This is represented in three layers [3] - specifying propositional attitudes, specifying propositions and specifying the ontology. Every layer has a language associated with it. The Knowledge Interchange Format for propositions was specifically

designed to make it useful as a mediator in the translation of other languages. Ontolingua was design for describing ontologies with it, and make use of the world-wide web to enable wide access and provide users with the ability to publish, browse, create, and edit ontologies stored on an ontology server. Knowledge Query and Manipulation Language (KQML) for propositional attitudes.

3. KQML

As mention above Knowledge Query and Manipulation Language (KQML) was developed by DARPA in 1990. The KQML language is divided into three layers:

- Content layer – makes no commitment about this layer. It bears the actual content of the message. KQML can carry any language, including expressed as ASCII strings. It is ignored by every KQML implementation except the part where the layer ends.
- Communication layer – it encodes the message that describe the lower-level communication parameters. In this layer the agents exchange packages. A package is a wrapper around a message which specifies the parameters. Such parameters are sender, recipients and unique identifier.
- Message layer – it is used to encode a message that applications would like to transmit to one another. These message can be divided to two general types:
    - Content messages – contains a description of a piece of knowledge being offered or sought. It is the core of the KQML. This layer determines the kind of interactions one can have with a KQML – speaking agent.
    - Declaration messages – used to announce the presence of an agent, register its name, provide description of the general types of information that the agent will send/receive, and meta information about the content messages send between agents.

The syntax of KQML is based on a balanced--parenthesis list. The initial element of the list is the performative. A KQML message is also called a *performative.* A performative is expressed as an ASCII string using the syntax defined by this section.

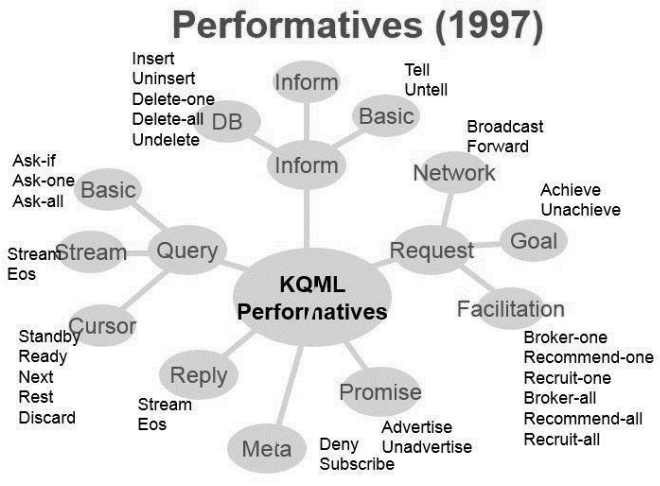

Fig. 2. KQML Performatives

This syntax is a restriction on the ASCII representation of Common Lisp Polish-prefix notation. The remaining elements are the performative's arguments as keyword/value pairs [4]. An example of KQML message is:

```
(ask-one
:sender joe
:content (PRICE IBM ?price)
:receiver stock-server
:reply-with ibm-stock
:language LPROLOG
   :ontology NYSE-TICKS)
```

In this message agent joe representing a query about the price of a share of IBM stock. Also the KQML performative is ask-one, the content is (PRICE IBM ?price), the receiver of the message is to be a server identified as stock-server and the query is written in a language called LPROLOG.

During its first years KQML semantic description was only an informal and partial. Semantics of each performative is defined in terms of:

- Preconditions - indicate the necessary states for an agent to send a performative and for the receiver to accept it and successfully process it.
- Postconditions - describe the states of the sender after the successful utterance of a performative, and of the receiver after the receipt and processing of a message.
- Completion conditions - indicate the final state, after a conversation has taken place and the intention associated with the performative that started the conversation has been fulfilled.

4. FIPA

The Foundation for Intelligent Physical Agents (FIPA) [5] was found in 1996 to produce software standards for agents and agent-based systems. The first documents of FIPA, named FIPA97 standard, state the normative rules that allow a society of agents to exist, operate and be managed. FIPA 97 describes three technology areas – Agent Communication Language, Agent Management and Agent Integration.

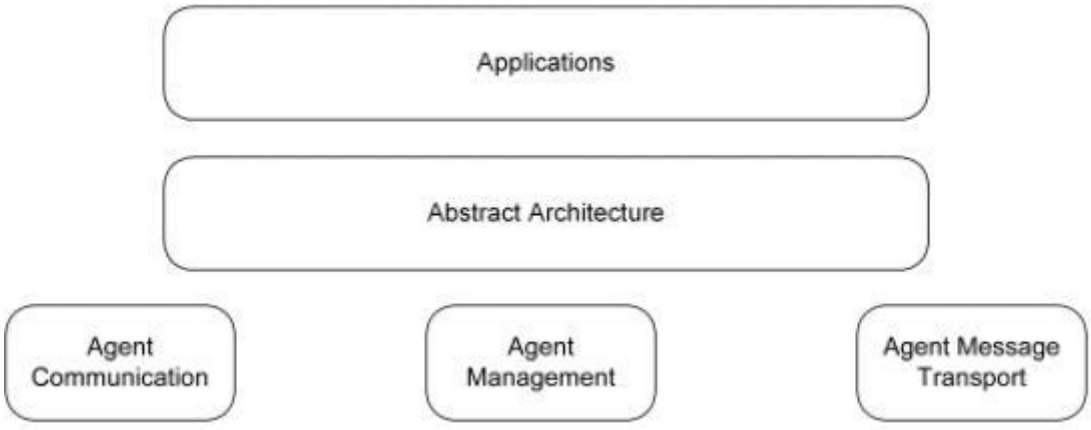

Fig. 3. FIPA 97 categories

To complete a task or a goal the agents must communicate to each other. In network communications TCP/IP communication protocols provide such standards that facilitate the basic transfer of information. To exchange messages agent communications use Agent Communication Language (ACL). FIPA ACL is a language that specifies a standard for encoding, semantics and pragmatics of messages, but does not set out a specific mechanism for their transportation. Since different agents will run on different platforms on different networks, messages are encoded in textual form, assuming that agents has some means of transmitting like SMTP, etc. Simple example of ACL message is:

```
(request
        :sender (agent-identifier :name alice@mydomain.com)
        :receiver (agent-identifier :name bob@yourdomain.com)
        :ontology travel-assistant
        :language FIPA-SL
        :protocol fipa-request
        :content
                ""((action
                    (agent-identifier :name bob@yourdomain.com)
                        (book-hotel :arrival 15/10/2006
                                    :departure 05/07/2002 ... )
                ))""
)
```

SL is the formal language used to define FIPA ACL's semantics. It can represent propositions, objects, and actions. Its origins can be traced to the work of Cohen and Levesque [7], but its current form is primarily based on the work of Sadek [6]. Semantics of each communicative act is specified as sets of SL formulae that describe the acts:

- Feasibility pre-conditions - describe the necessary conditions for the sender of the CA.
- Rational effect - represents the effect that an agent can expect to occur as a result of performing the action; it also typically specifies conditions that should hold true of the recipient.

5. CONCLUSIONS

The speech act concept is very popular around the agent communities. Agent Communication Languages have followed a 10-year path of evolution. The first language KQML was very popular at its time, but with the multi agent systems it has an issues. Recent years FIPA has presented more disciplined approach of dealing with the problems. The two languages are almost identical with respect to their basic concepts and the principles they observe. Also KQML and FIPA AC messages look syntactically identical. The main two differences are in the details of their semantic frameworks and in their treatment of registration and facilitation primitives. The two languages does not have all answer to all agent based technologies but the standard of FIPA-ACL is still in

the process of constant renewal. So our hopes are some day to have an unified agent communication language standard that will easy the work for the developers.

6. REFERENCES

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