

# A FIPA-Compliant Agent Framework integrating Protégé-2000

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We proposed a software architecture named COSMO (*Connaissances Organisées par un Système Multi-agents à l'aide d'Ontologies*) built around non constraining process of knowledge management. It combined functions from Jade (Java Agent DEvelopment Framework) and Protégé-2000 to realize the federate model suggested by Prince (Prince). The federate model makes it possible to frame the communication among the various information systems or components software. To ease the communication, Prince proposes to offer three footbridges covering the physical, symbolic and semantics levels of the exchange. The paradigm of the multi-agents systems (MAS) define formal specifications for the three levels of the exchange. The integration of Protégé-2000 with our solution COSMO enabled us to abstain from developing the functionality responsible for the management of the semantic level (ontologies). Moreover, Protégé-2000 offers various access methods to use directly allowing the agents to directly use its functionality by the means of numerous application program interfaces.

The attribution of ontologies to agents allows us to transmit the semantic knowledge required to direct them in the realization of their tasks. The software agents can, for example, use these ontologies to direct their research of information by identifying the specific meaning. Thus, this formalization of the semantic level limits the number of invalid results obtained by the software agents. Ontologies can also support, by the same means, the communication among software agents. Agents will then compare their respective ontologies and will find concepts commonly shared before allowing the exchange of information. Therefore, it diminishes the possibility that the agents exchange information symbolically identical but different semantically.

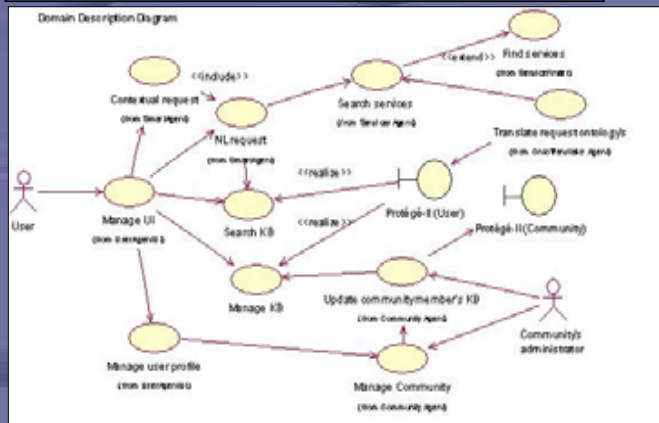
The OWL is the most interesting proposition to structure information diffused on the Internet. The expression of constraints on relations and terms of the shared ontologies allows agents to reason and to carry out structured request on knowledge diffused over Internet.

Protégé-2000 offers functionality to manage the language representation diversity that we usually found in the organizational memory. It presents a convivial interface offering various functionality of management and attribution of ontologies for these various formats of representation of information (XML, RDF, RDFS, OIL, Prolog, PAL, OKBC, etc...). One can then use this application to index and to memorize knowledge of the organizational memory for an user, a community or an organization.

COSMO architecture

The software specifications of our architecture were carried out inside the methodology Process for Agents Societies Specification and Implementation (PASSI). We followed the principles of the *Model Driven Architecture* (MDA) and used the *Agent Unified Modeling Language* (AUML) which is an adaptation of the much known UML, much known language UML for MAS.

Figure-1 Domain Description diagram



The Domain Description diagram underlines the functionalities assumed by COSMO. For a detailed view of the formal specification see Caron Sébastien, *COSMO: Connaissances Organisées par un Système Multi-Agents à l'aide des Ontologies*, PUQ, 2003.

Functionality to support these processes can be easily improved or be redefined by adding or modifying the agents presented in our specifications. We use the software agents then to carry out all the tasks supporting these functionality. For example in an information request task, users have only to transmit their requests to an agent which is then given the responsibility to find the response by using the terms available and defined in the user's ontology. The agent can then communicate and collaborate with other agents to widen the field of its research. Ontologies are defined or imported by the user using the convivial interface of Protégé-2000. Several functionality are available to simplify this task. By assuring the participation of the user in the ontology definition process, we make sure that the software agents share the point of view of the user. COSMO is totally built on this principle: Execution of manual or automated requests, and the indexing of the knowledge of the organizational memory is based on the viewpoint (ontologies) defined by the user. We also proposed a way of managing the various ontologies within the various communities or organizations.

As illustrated in this diagram, user interacts only through UserAgentUI. This agent manage all the interactions among the user and the other agents. He also have to sort the results from the information requests before presenting them. The requests carried out in textual manners are transmitted to the SmartAgent who must translate textual or contextual research into two types of requests: one addressing to the Protégé-2000 knowledge base and the other addressed to the ServicesAgent. Protégé-2000 answer information requests addressed by the SmartAgent by going through its knowledge base.

The agents live in JADE's containers distributed on various terminals belonging to the network. Agents sail and communicate through the organizational memory to carry out the requests and to organize information available. The various possible interactions can be indexed inside the three following categories: software agent/natural agent, software agent/software component (Protégé, linguistic Analyzer and Web services), software agent/software agent. The communication among agents is done with use of messages define by the Agent Communication Language (ACL). This language is normalized by the FIPA (Foundation for Intelligent Physical Agents) and support the content languages FIPA-SL, RDF and XML.

The ServiceFinder identifies and updates the services or agents available on the Web and dispose to answer the requests. The ServicesFinder agents are assigned tasks by the ServicesAgent. To carry out their requests they will ask various data sources (agents, services web, web pages). A request, which was formulated so that no result is generated, is immediately take in charge by the OntoTranslator Agent. Original ontology of the request is modified in a more abstract ontology allowing to widening the initial field of research. This new ontology is transmitted to the agent of research which tries to carry out the request using this new ontology. The results are then presented in a sorted way at the user by the UserAgentUI. It should be noted that user could also directly carry out requests on the knowledge base or simply sail towards information of the organizational memory.

In the figure below, we present the overall picture of the information process realized by COSMO and emphases our modular approach to satisfy the different needs to manage the complete chain process of information.

Figure 2 – Information process realized by COSMO

