# Multi-Agent System for Integration Process Business and Ontologies for the Government Online Strategy

**Maria Claudia Bonfante**
Rafael Núñez University, Cartagena
Colombia

**Juan Pablo Paz**
LG CNS. Bogotá Colombia

**Andrés Castillo**
Pontificia de Salamanca University, Madrid
Spain

## Abstract

*This work presents the justification of the Integration of three (3) technologies: Ontology, Multiagent Systems and Business Process to support the Governmental Online Strategy in Colombia. The architecture is integrated in first place by one component assure the model of government processes that has the more significant relations, the works flows, activities, decisions, resources used and the actors which performed task doing the technologies of Business Processes Management. In second place, should be maintained the knowledge modeling of the government that allow common language of the information interchange and the interoperability between its entities, which only this possible doing use of the Ontologies, where is included the concepts, its properties, and the relations between them. And third multi-agents technology is included, that integrated the previous functions, validating the syntactic of the business processes that are holding on the web platform on BPEL format and validated meaningfully against a RDF from paperwork and Services Ontologies. To the Multi-agent systems is perform unit and stress testing.*

**Keywords:** Government Online Strategy, Multiagents, Business Processes, Ontologies, Protégé, JMETER

## *Introduction*

In Colombia the national Government has the intention to change its entities digital and open, is it that incorporate the Information Technology Communications of transversal form transforming its internal operation and its relations with its customers. For this, the entities should dispose offices electronic where access is available for all information, also to the management paperwork and services on line, keeping the conditions of the accessibility, usability, quality, safety, and privacy reservation.

In this form, the public's entities could keep the information of its process in relations with paperwork and services, space of interaction, budget execution, operation, investment, organizational structure, related regulation, recruitment and share the information its with the interested users and researches. One of the conflicts is the differences caused between design business processes in the different organizations, which use different terms, notations and different representations the same business process, making it difficult the development of the application and the interoperability of the same.

This article is structured as follow: in the first part, a review is made from de works that have integrated the three technologies: SYSTEMS MULTI-AGENTS, BUSINESS PROCESSES AND ONTOLOGIES; at the second part system architecture is described and its components; at the third part its explained the platform implementation; at the four part its show the tests and finally are given some conclusions and future perspectives.

## *Systems Multi-Agents, Business Processes and Ontologies*

A software agent is considerate like an entity with objectives, that is allow doing actions equipped with domain knowledge and situated around it.

For its part, a system Multi-agent is a group agents that give intelligent and cognitive abilities, which allow show behaviors oriented proactive; also, can establish integration processes, competitive and cooperative with other to satisfy its objectives. A agent it development in an environment and able to perceive his surroundings to communicate with others agent. In last has an autonomous behavior with the purpose to satisfy its objectives.

The architecture agents has been applied to the e-learning, as it relates to the work of Jimenez et al (2009) and Castillo et al. (2004); in the context of music, like it's mentioned in the Wulfhorst's work (2003); in the field of industrial automation (Bravo et al., 2004); and the system to control the traffic (Vicente y Garcia, 2005). Has been applied precautions for monitoring public transport systems as noted (Paz, 2013). Also has been applied in works of high complexity like the retrieval systems in Internet also can be seen in the work of Cesamo et al (2003). That is the paradigm of MAS is applied to solve the complex problems of daily living.

For Ramos and Núñez (2009) Ontology is a taxonomy of concepts with attributes and relations, which provides an agreed vocabulary for semantic networks of interrelated unit's information. Exits around this technology very good advance and which are arranged methodologies for its design, tools its builds and language to ontology.

The technology integration of MAS and the use of ontology allow the development complex applications that benefit from the properties of autonomy, proactivity and dynamism, technologies provided by agents and interoperability of data and processes that ontologies offer.

The use of MAS and ontologies it's relevant in work like Beydoun et al (2009). According to an SMA is suitable for domains involving interactions between different people or organizations with different objectives.

There are several forms to use the MAS y the Ontology. For example, the ontologies are used to represent the knowledge of an agent. Each agent captures knowledge about its own scheme (local knowledge) and also the knowledge about others scheme.

In another, by Ribeiro et al (2008) the business processes increase the level of automation within their life cycle and also provide support to users' and developers. The semantics can also be applied in the faces of modeling, implementation, execute and analysis of business processes. The semantic component has been proposed Pedrinaci work`s et al (2008) and Damjanoci (2009), where proposed architecture to the monitory and management process using an engine of semantic execution.

According Caetano (2005), a business model keeps the relations that are significant to the business between the different concepts of organization, like: the activities, the resource used by the activities and the actors that just take. In another side Ramos (2010) said that the analysis of a tedious becomes problematic posed by not having efficient access to the knowledge previously purchased the development of similar projects.

Ours propose is to integrate three components: MAS that give intelligent and cognitive capacity that allow showing proactive behavior oriented. Another component is related by the model of knowledge that enabling a common language of information interchange, which its only is possible doing use the Ontologies. And, finally in view of the importance of business modeling, and with the objectives in order to reuse previously acquired knowledge to the development of software applications deploying these processes, This reduces the time in analysis and development of software projects, included a third component conformed by business process repository, that contain the standardized process by the governmental entities and they will be validated and recommended by others users. This will allow build applications with the focus to processes.

### *Description of Architecture Proposal*

The architecture proposal to give support to the "GOVERNMENT ONLINE" strategy is showed on the figure 1. In the conceptual diagram of three components are observed: Model knowledge, MAS and the process model.

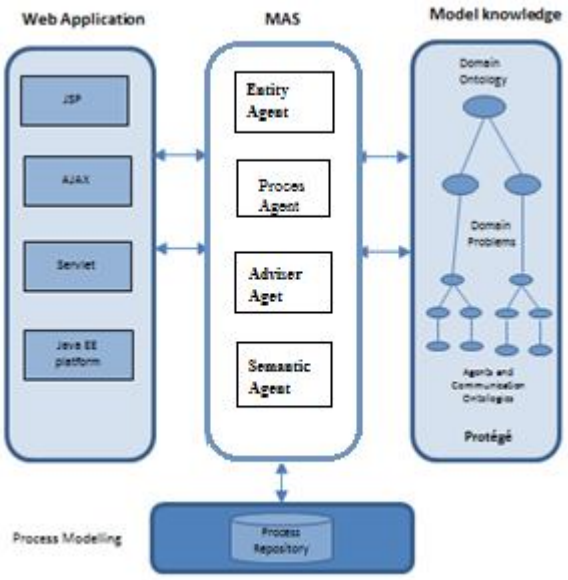


**Fig. 1: Architecture Integration of Technologies MAS, Ontologies and Business Process**

**Model knowledge:** Is constituted a set of ontologies that operate like Dominion universal vocabulary; these are: the problems, agency works and communication between agents. The ontology hierarchy for the treatment of problems of high complexity has been relevant by Chamekh and Talens (2013), whose propose a hierarchical structure to the follow form:

- **Domain Ontology:** Describe the domain the problem knowledge and the requirements of the solution that, in ours case study will be the government entities Colombia: like example will take the concepts and relations with the mayor. The Mayor is the public entities composed of government secretaries; administration responds to a development plan that has goals and projects. The mayor is composed by lows that can be decrees or rules that regulate its activity, has allies to private companies, and also provide services to the community.
- **Domain Problems:** It can help to describe different kind of problem of this domain, that is to say, will describe the reasoning process used to solve a particular problem; for example, the paperwork problem and services, o the petitions problem, complaints and claims in a government entity. The ontology in the figure 2 shows how the concepts of a process that takes place in a government secretary relate. This process they are of a type, have requirements and must submit documents such as filling out a form.

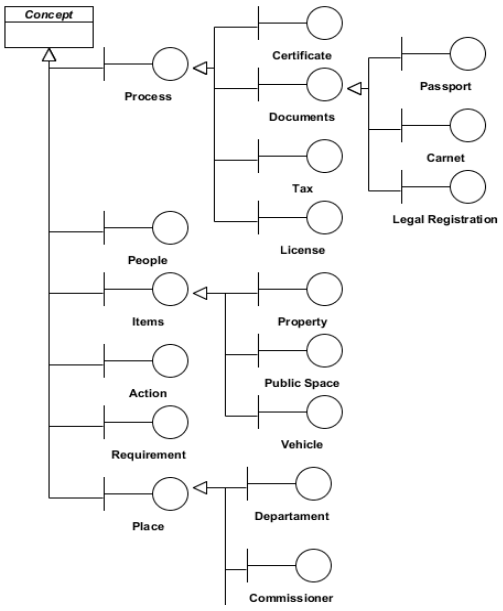


**Fig 2: Taxonomy Concepts Paperwork and Services Problem**

- **Agents Ontologies:** Describe the knowledge required for the tasks of the software agents. Ontology for the local knowledge of agents contains information fromthe environment in each agent, and the tasks, as well as the mechanisms and resources available to meet the task. In this ontology, proposed by Garcia (2009), the information of the agents is modeled on the environment of business processes, this is, characteristicis modeled that present the business processes. These characteristics are described through file BPEL, for example: process, atomics activities, decisions, participants etc.
- **Communication Ontology:** Is used for the communication between agents, and also was propose by Bhavna et al (2009). This describe a language common of communications between agents will interact so that they can, cooperate, negotiate and compete.

**Multiagent System Design:** This component it's integrated by a group of four agents. The intelligent agents, validate and will share the process`s knowledge (atomics activities and participants) to get optimization of them.

To present the requirement of MAS is Use Case diagram observed in Figure 4. The users should create a profile (Public entities, TIC Sector, citizen). Some users will be interested to hold the Business processes of government entities, others to consult for application development and other like citizen, to know the process in one respective service. The user can observer which process has been recommended by the system with the purpose of evaluating performance.

The SMA intervention in the use case Manage Process described in the following figure:

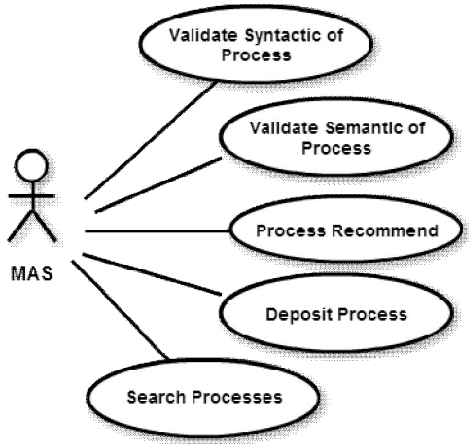


**Fig.3: Use Case MAS**

- Validate syntactic of process. The MAS will receive petitions to go in process to repository, to most be validated syntactically to verify its build against the DTD of process. It will accept files BPEL.
- Validate semantic of process. The MAS most validate the semantic of a process moving the ontologies of domain, problem and agent task.
- Process Recommend: The MAS can will recommend validate process, as syntactic as meaningfully, to the users that can be interesting in the same.
- Deposit Process. The processes shall be kept valid on a process repository for documentation.
- Search processes. Upon receiving the request from a user profile and identified, the MAS to should look on the processes in the repository and display the result of its search.

The task of the agents is those below:

- Entity: This agent will identify the profile for each user that enters the platform, which can be entities of the government or an enterprise of the TIC Sector.This agent user data capture platform, which can be TIC Sector, entities government or can be and a citizen. He can identify the user profile and his interest of consult, hold, comment and recommend a business process.
- Process: Responsible for obtaining knowledge of a file BPEL (atomic activities and participants) and validate the syntactic of a processes (file BPEL), against the DTD of process, is used JDOM to try the file. Also be deposited in a repository process once validated.

- Adviser: Arrange recommend it validated business processes to the user form the platform after identified his profile, for the company to run a social event (to recommend another or qualify. Also most look the business Process that can be better for a specific user.
- Semantic: Responsible determine the semantic distance from its concept identified in the file BPEL against the ontology the business process and calculates the degree of semantic similarity of the process.For determinate the semantic similitude of the process need to convert the ontologies described, modeling component of knowledge, in the graph expanded and represent each of the value tags RDF y RDFS (Class, properties, instances) in one semantic network, respecting the relationships between them. In the first place, are located all the tags (rdfs:class) and (rdfs:subClassOf) to establish that a class inherits from another.

**Process Modeling:** Access and reuse of business process models represent useful features that resolve a particular problem. This justifies include the third component of this architecture, which represents the logical processes of public bodies, and is consistent with the changing dynamics of organizations. This repository will BPEL files validated.

### *Implementation of the Platform*

The agents implemented in JADE, which is the framework for the development of more agents used by researchers. The Packages that were used for deployment were: Jade.core.Agent, jade.core.behaviours, jade.lang.acl, jade.domain. FIPA Agent Management, jade.domain and jade.core: JADE includes packages for working with languages content of messages in the communication of agents. JADE also allows the management of ontologies to represent the application domain through concepts, predicates, actions and exchange items ontology between agents such as jade.content and jade.content.onto. Ontological classes have been organized into a package mypackage.onto Gel.jar content, which is loaded at the start and made available to all agents Platform.

For the integration of a web application with JADE is necessary to implement a Servlet as shown in the following figure. The servlet receives a request for a JSP page and invokes a Gateway agent or making out of a behavior as in our case. The servlet extends the HttpServlet class. The gateway agent will be initiated from the Servlet through JadeGateway.init () method, once initiated communication with the JadeGateway.execute () method is performed, and if the agent gateway want to end the use JadeGateway.shutdown () method.

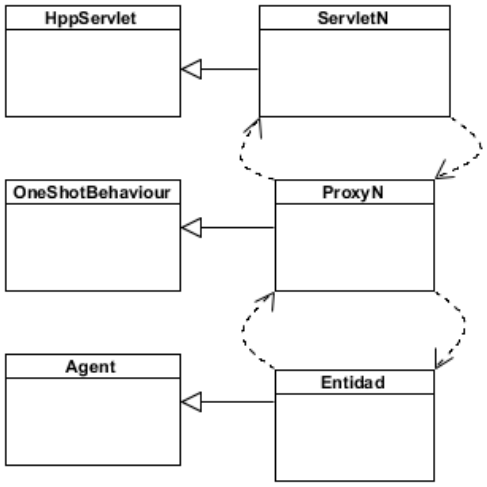


**Fig. 4: Integration of a Servlet and JADE**

A proxy agent Gateway Agent extends the class or One Shot Behaviour behavior. This agent acts as a bridge between the servlet and JADE. In implementing the Proxy agent must import the libraries associated with languages and ontology: jade.content.lang.Codec, jade.content.lang.sl.SLCodec, jade.content.onto, and the library associated with Ontology mypackage.onto.

The Process Agent performs the syntactic validation, and if you agree with the BPEL DTD file, it sends a message to the Semantic Agent who calculates the Semantic Distance and the degree of semantic similarity process against the hierarchy of ontologies.

The API used to query Ontology is JENA, then sent to the Business Agent who informs social event on the process. Finally, the Adviser Agent check what processes are validated state of the process and determined to recommend to users depending on their interests.

### *Testing Platform*

Unit testing and stress were performed for the proposed architecture. Unit testing was to measure the response time of the agent to an application, number of roles taken by the agent, time to perceive their environment. Number of objectives achieved by the agent, time to reach your goals, time change of state of each agent time and cooperation with other agents

Stress test measured the average time it takes service execution agent process, for which the following were identified: number of instantiated start of the test agents, number of agents increase per time period, number of primary children run, period of increase, peak number of agents and the number of services running on main thread running.

The tool JMeter was used, it was necessary to publish the agent tasks as a Web Service using Process WSIG (Web Services Integration Gateway).The test showed that the bigger the number of running services, performance and the average response time to service requests such improved computing resources. The execution of a service was second and the average execution time of 200 services is 5 seconds.

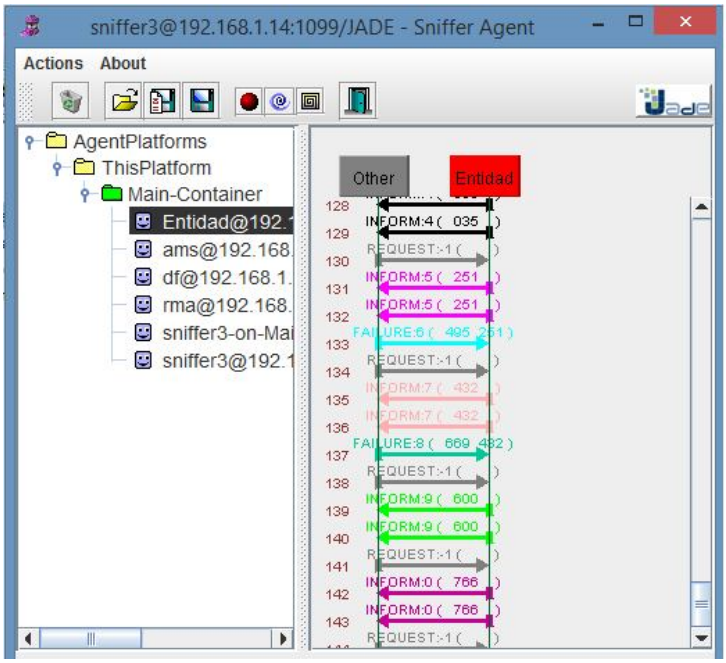


**Fig. 5: Snifer Simulated Responding to Requests from Jmeter for the Entidad Agent**

### *Conclusions*

This work justified the integration of three mature technologies to support the strategy of "Government Online"; however, this setting can be applied to health, education and justice sector. The hierarchy of ontology proposal will maintain knowledge of the proposed context. The repository ensures the reusability of business processes for business development projects like software. The SMA ensures semantic validation processes and recommended according to the user profile. This will also help to resolve conflicts caused by differences in the design of business processes of different organizations, which use different terms, notations and different representations of the same business process, something that hinders the development of applications and the interoperability of the same.

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