Spatial Data Integration for e-Government Workflow Processes

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Abstract. Workflow systems had evolved to offer greater functionalities that could satisfy the organizations' needs and requirements, actually also taking advantage of the spatial information that can be taken from geographic information systems, with the benefits that this entails. However, new tendencies from government agencies' in some countries, such as Mexico, have sought the inclusion of open source software applications to perform their activities, appearing the problem that workflow systems that incorporate geo-referential information are expensive. This paper presents a comparison between different open source workflow systems; from them, Bonita workflow was selected to be modified to integrate into it the use of geographic information within the modeling process, describing the followed steps to modify the ProEd process definition tool, for the incorporation of a map viewer inside the executable process of the system. Finally, the advantages of incorporating geographic information in a workflow system focused on e-Government processes are discussed.

Keywords: Distributed systems, workflow management, Web application, Geographic Information System.

1 Introduction

The workflow systems had searched automation of the politics and procedures from business processes, associating people and work groups to the activities, for the management of the works and activities to be realized in an organization, making with this the possible the cooperation among different people and groups. Therefore, the incorporation of a workflow system inside enterprise and institutions for their process management has repercussions in the service and attention to the client, and in the efficacy and productivity they have in their activities, due to the speed up of the transactions and the control over the managed data. The grown of an enterprise is a key element in respect to the competitiveness against others in the business market, independently of the referred sector.

These types of systems had improved their characteristics in order to satisfy the actual organizational requests and necessities; between the more remarkable claims are: Web access, a graphic modeling for the business processes, distributed

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architectures, standards adoption that guarantee the interoperability between diverse applications, etc.

Another really important characteristic didn't previously mentioned and that is relevant for the purposes of this article, is related to the functionality need of the workflow systems to include a geographic information support. This necessity could be covered through the integration of the functionalities available by the now so popular geographic information systems (GIS).

The relevance of using geographic information relays in the manner of represent the information with higher level of detail, bringing more elements to the person in charge for a more confident decision taking; with the traditional workflow systems, this wasn't enough feasible.

An example of a sector which had taken advantage of the workflow systems related to geographic information, is the cadastre of the government agencies, this is due to most of the transactions realized inside them need to incorporate the use of maps and sketches.

This last, in conjunction with the actual government necessities about dispose a system that allows to manage their process, with the goal of enhance the attention to the users, and at the same time trying to fulfill with the objectives of different austerity edicts (such as minimize costs related to software acquisition, material resources and stationery) have propitiated the development of this investigation.

According with the organization activity profile, the kind of procedures and information used and managed should vary, so some organizations must require the manipulation of geo-referential information (e.g. as the ones that requires to use and show a map to define a point of interest, or as a reference) in one or more different activities that compose a process.

A problem presented in this type of processes is that they can't be modeled by the majority of the actual *workflow* systems, because in general, they don't consider an interaction with components of geo-spatial services during the modeling phase, nor in the final Web application generated; meanwhile, the workflow systems that consider such characteristics, in fact are expensive and focused to particular activities, without the chance to modify or adopt them to the particular necessities of an organization.

This situation causes a minimum or also null automation of the processes that are needed and implemented inside the enterprises, generating: show or bad customer services, delays in the response times for requests and solicitudes, development of expensive ad-hoc systems and low scalability in the management of their procedures, excessive time consumption to modify (if possible) the part of the system that controls a specific procedure, etc.

In the present paper the integration of geo-referential information functionality inside an open source workflow system for e-government processes is presented. For the modeling of processes that involve geo-referential information, are presented the steps that have been followed to modify an open source tool that haves a form editor, and the adding of the necessary components for the handling of geo-referential information. So in this way, a workflow system that considers geo-spatial data could help in reality for a better decision-taking.

The sections of this article are distributed as next: section II addresses the problematic that motivates the perform of this project; to establish a context of the technologies implicated in this, an introduction about the geographic information

systems, the workflow systems and e-government, are presented in sections III, IV and V, respectively.

Section VI presents some examples of workflow system for particular applications that have some integration with geographic information systems. Section VII presents some representative workflow editors, their characteristics and a comparative between them.

The overall process to realize the implementation of the project proposed to solve the identified problem is described in section VIII. Finally, conclusions related are presented in section IX.

2 Workflow Situation in Government Dependencies

Some organizations such as government dependencies need to achieve their transactions and negotiations using geographical information (geo-referential data), as part of the information needed to accomplish a service request, being this the basis over that the decision taking to accept or reject a request is made, for example, construction licenses procedures, water intake request and outflow reports, among others. Studies as [1] shows the relevance of integrating geographic information systems in e-Government activities, as well as the social and political characteristics that must be taking into account for this kind of developments.

With the recent tendencies that have been occurred inside this kind of organizations, where the maximum reduction of costs is wanted in which is referred to software acquisition, it has been opted to adopt open source solutions (such as GIS works as [2] or workflow ones as [3] or [4]), being desirable not only specific-work frameworks but also to count with workflow systems that have under such characteristics the combine and manipulation of geo-referential data.

Meanwhile, comparatives between workflows such as [5] are made to compare the characteristics and benefits among these systems, that can help in the definition of workflow processes, such as in the case of e-government ones.

The problem is that the few systems which let process this kind of information are expensive because of the acquisition and payment of software licenses, meanwhile on the other hand, the open source workflow systems don't consider the use of information of this nature, or they do it in a restrictive way.

As a direct consequence, this type of processes can't be modeled with the actual open source workflow systems, having consequences this in a few or null automation of the transactions offered by this organizations, causing among other situations: a bad customer service, delays on the response times to a request, expensive ad-hoc systems development which would result with a low scalability for the procedure management, as well as an excessive time consumption to modify and give maintenance to the system that controls the process.

Some works have presented the integration of geographic information for e-government activities, such as cadastre (i.e. Online Cadastre Portal [6]) or maintenance of public road (i.e. Road maintenance management system, RMMS, [7]), among others; but these had been in the majority of the cases ad-hoc implementations

that search solving for specific problems, and that are not focused on the integration of open standards.

Because of the consideration of the previous reasons, this paper propose to modify an open source tool for process definition, which integrates the necessary components to the workflow system architecture, with the purpose of being able to model business processes which includes the use of geo-referential information.

In next sections are presented a brief overview of the geographic information systems and its use, as well as a description of the workflow systems, being the understanding of these systems the basis for the geographic information use inside a workflow system.

3 Geographic Information System (GIS)

A Geographic Information System (GIS) according to 1 is a system for the management, analysis and visualization of geographic knowledge, structured in different information sets, such as: interactive maps, geographic data, geo-processing models, data models and metadata, where the interactive maps provide an interactive vision of the geographic information, giving to the user the necessary tools for the interaction with this information.

In 8 is mentioned that a GIS is conformed by the following components:

1) Hardware equipment. This is the computer hardware in which the geographic information system operates; it is composed by general use equipment and specialized one.
2) Software. These are the set of functions and software tools that are used to analyze, store and display the geographic information. Between these are founded the database management system (DBMS), the graphic user interface, tools for data input and data manipulation, tools for geographic search, analysis and visualization.
3) Data. The most important part of a GIS. The system is in charge of integrating spatial data with other data resources and even it can utilize the most common database managers to administrate the geographic information.
4) Human resource. This refers to the personal who operate, manage and develop over the system, and that are also responsible for accomplish the decision taking.
5) Procedures. A geographic information system operates according a well structured plan, with clear rules, such as the models and operative practices features of each organization.

Those components let process and display the geographic information in a digital way, generating outputs according to the necessities of each different user group.

A GIS has a variety of different applications, as the ones mentioned in 10 and 11, highlighting among them: installations management, cadastre, urban design, transport services, geographic marketing, natural resources management, civil protection works, archaeological deposit studies, scientific research, education, automated cartography, territorial management, social equipment, digger resources, transit engineering, demographic studies, planimetry, 3D digital cartography, among others.

The use of geographic information can complement a variety of aspects for the model making of work flows, in the cases where the use of this kind of information be primordial, it's because this that it's necessary to know the characteristics and the components that conform a workflow system.

4 Workflow Systems

The Workflow Management Coalition (WfMC) is an international organization who has developed standards for workflow systems, which have been used for the communication between the components of a system. It's in this way that the workflow systems that adopt this standardization are available to interoperate between them.

A workflow system, according to the WfMC 11 is defined as: "*A system that defines, creates and manages the execution of workflows through the use of software, running on one or more workflow engines, which is able to interpret the process definition, interact with workflow participants and, where required, invoke the use of IT tools and applications*".

4.1 Reference Model

This organization had published a reference model [13] that specifies a framework for the workflow systems, identifying their characteristics functions and interfaces.

In Fig. 1 is shown the interfaces and components that can be found in a workflow system architecture.

Those components are described next:

Process Definition Tool. It is used to create a description about the processes in a resolvable computer way. This tool can be based in a language for formal process definition, in an interaction model between objects or only by a set of rutted rules for information transfer between the participants [14].

Workflow Engine. The workflow engine is software that provides the control for the executable environment for an instance of the workflow. Commonly, it provides facilities to: interpretation of the process definition, maintain control for the instances of the processes: create, activate or finish them, among others; to let navigation across the workflow activities, to bring up support for the user interaction, to let the user controls the data and applications and to summon external applications [15].

Workflow Service Representation. This is used for the interpretation of the process description and it is in charge of the control of the different instances of them, the establishment of the activities sequence, the adding of elements to the task user schedule, and for the invocation of necessary applications. All these tasks are made for one or more workflow engines, which are responsible for the management of the execution for the different instances of a group of process.

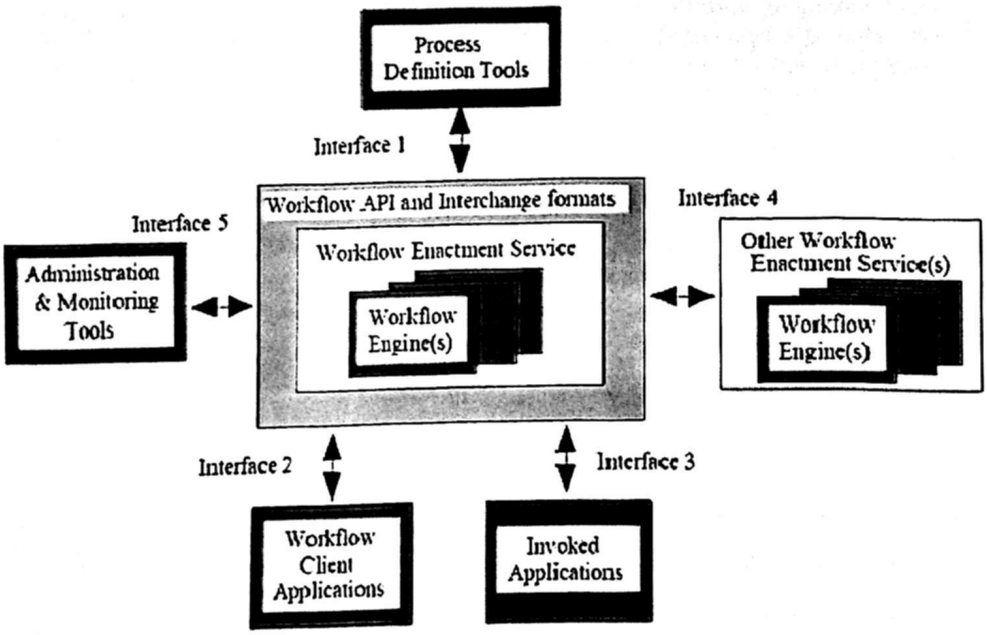

Fig. 1. Workflow reference model - components & interfaces.

Workflow Application Program Interface (WAPI). The WAPI can be sought has a set of API's (Application Program Interface) and functions for data interchanging, supported by the workflow representation service; these lets the interaction between the workflow representation service with other resources and applications.

It's important to denote that the open source workflow systems, in general, have adopted the reference model previously described. The next section describes some popular systems that incorporate the functionality of the geographic information systems together with workflow systems.

5 e-Government

The e-Government approaches let the citizens be informed, in a regional, state or federal scope, giving them access to a variety of services offered in a digital way. This can also be used by the Government as a way to guarantee and take advantage of the information accessed and its use.

Between the advantages of the government digitalization, is the transparency and speed up of different processes, as tax declarations, licensing requests, passports or

any transaction, making use of the actual information technologies, in an integrated process of continuous innovation.

The characteristics that an e-Government project must consider, includes: that it be open, according to the international Internet standards, totally oriented to the society, integrating the different government services in their business and jurisdiction processes towards a complete integrated system.

Four main kinds of activities take place in these systems [16]:

- Show information on Internet: notifications, regulatory services, holidays, etc.
- A two-way communication environment, in cases between the government agency and the citizen, a business or also another agency.
- Conducting transactions, e.g. conducting services and grants.
- And for governance, like in the voting and electoral campaigning.

Actually, some countries' government has been adopting open source software, as alternatives against proprietary software, in a way to minimize costs and to take more control over the applications, being possible to adapt them to the particular governmental necessities.

It's because this that is necessary to adapt and implement the necessary changes of the existing platforms, in order to give them a higher functionality, according to the newest and increasing necessities of the society, as is the case of the use and integration of geospatial information in some agencies' transactions.

6 Workflow Systems Integration with GIS: Representative Examples

6.1 GeoPISTA

GeoPISTA [17] is a territorial information system used in city halls; it lets implement the necessary functionalities for the territorial management: urban planning, cadastre, habitant census, contaminant activities, patrimony, infrastructures, activity licensing, urban guides, etc.

It lets elaborate small processes or work flows (such as user control, documentation flow, date management, etc.) and also lets control the documentation and/or observation storage generated by any element from the application [18]. It has been programmed in Java, characterizing the application as a multiplatform one.

GeoPISTA Components:

In [19] are mentioned four different elements that integrate GeoPista's structure: databases, data servers, GIS clients and modules, described next:

1) **Data server**. It works with the PostgreSQL database management system, using the PostGIS extension, used to handle with the geographic information. The database is structured according to a predefined model for each application ambit (infrastructures, referente information, patrimony, etc.) and over such model the rest of the applications are supported.

2) **Internal basic services.** The cartography administrator is in charge of present the geographic information in the form of maps, as well as to manage the users with different permissions and has the task to resolve concurrency problems of data access. On the other hand, the map server lets publish geographic information on Internet.
3) **Clients.** They let the user to navigate across the geographic information, to make queries over this and to analyze it, to edit the data and also print maps. GeoPISTA lets connect some common commercial solution GIS (ArcGis, MicroStation and AutoCAD) with its system.
4) **Specific modules.** A set of modules that brings assistance in the municipal management, in such scenarios as urban planning, construction licensing procedures, infrastructures, contaminant activities inspection, among others.

6.2 The Dorado

The Dorado [20] is a digger concession system, which has as objective to make a more efficient activities management, from a request income until the granting and posterior following of the audition step.

Dorado Component Architecture

The system is based on a client/server environment for the data management, from the spatial data to the administrative processes. It lets the manipulation of information external to the system in a transparent and automatic way for the integration between the application and the operative system.

The processes coordination is through the use of the M&B Process product. The management of the spatial data model uses development applications under MapObjects (ESRI) object libraries.

Functionalities

The system is divided in five modules, which are described next:

1) **Client attention module.** It provides tools that let administrate and coordinate all the requests that income from the public, in general, or by the digger business customers.
2) **Arrangement module.** It lets income and validate the taxes of the requests, the work assignation between the different functionaries and to take control of the time that spends each process. The spatial component fulfills with the functions of cadastre actualization, including spatial validations, as much as in the incomes in the areas as well as in the technical evaluation processes.
3) **Audition module.** It lets register, follow and evaluate the activities of daggering exploration and exploitation. It manages the control of concessions and the administration for gold, diamonds and precious jewels merchants; also, it covers the related to taxes, penalties and digger rights extinction.
4) **Executive statistic information module.** It presents the business information to the ministry high directive.
5) **Maintenance module.** It provides tools that give support to the system processes, such as the actualization of information and the management of the

multi-user platform of the spatial data; it also lets have process for a massive data charge used for the actualization for cadastre data.

6.3 ArcCadastre

ArcCadastre [21] is a system for the management of cadastre and geographic information, such as the map generation based on GIS systems; it manages cadastre measurements and field information.
It has been developed in cooperation with ESRI Inc. and is based in the following platforms:

- ArcGIS
- Survey Analyst (used for planimetry and calculus functions).
- ME Objects, de Safe Software Inc., utilized to import and export data in different file types.

The activities are managed and monitored within help of a work flow; the easiest of them is a control list, meanwhile another form lends the user through the different steps in a hierarchical order. The most complicated flows requires more personalization, this is obtained through programming modifications with VB or C++. The information is stored in geographic databases. ArcCadastre gives support to store information in many databases managers, such as MS Access, Oracle, IBM, Informix and the Microsoft ones.

7 Workflow Open Source Systems

7.1 Workflows Standardized under the WfMC Model

JaWE / Shark. JaWE (Java Workflow Editor) is a graphical editor of workflow processes, based on Java and XML, and is compatible with the WfMC specifications. It works with the XPDL processes definition language (XML Process Definition Language) 12.

Shark is a workflow engine based on the WfMC and OMG (Object Management Group) specifications. It uses the XPDL definition process language, and can be used in different environments such as a Web application or swing applications, and can be installed as a CORBA service or it can be accessed by client applications through CORBA ORB or by an EJB container [23].

Bonita. Bonita workflow 24 accomplishes with the WfMC reference model specifications 13. It is developed according with the J2EE specification, it's distributed under a LGPL license and it uses the XPDL process definition language.

It uses JOnAS application server (Java Open Application Server) 25, which is developed also under the J2EE specifications. It's in charge of the security management and the messaging with other services.

Bonita's environment is based over the Web, so it can be accessed through any Web browser.

To realize the process model is used the ProEd process definition tool, which is incorporated in Bonita. The modeled process is stored in XPDL format, which will be interpreted by the workflow engine.

7.2 Workflows non-Standarized under WfMC Model

JBoss jBPM. JBoss jBPM is interoperable with all the integration technologies based on J2EE, such as Web services, Java messaging, J2EE, JDBC (Java Database Connectivity) and EJBs (Enterprise JavaBeans) connectors [26].

The main components of this tool are:

- jbpm-server. A preconfigured JBoss application Server.
- jbpm-designer. An Eclipse plugin for process modeling in a graphical way. It provides a program model oriented to process with jPDL process definition language jPDL (jBOSS Process Definition Language).
- jbpm-db. A compatibility package for the database. JBoss jBPM can be configured with databases as: Oracle, MySQL, Hypersonic SQL, PostgreSQL, among others, and can be implemented over any application server.
- jbpm. Component developed under Java (J2SE) for the process management definitions and the execution environment for the running of the process instances.

Intalio. Intalio is an open source system for the business process management; it accomplishes with the J2EE specification and is developed under a MPL license (Mozilla Public License). It utilizes the BPEL language (Business Process Execution Language), it generates Web services and includes a rule engine and a Web user interface 27.

The definition processes tool used is a development environment based over Eclipse; it lets that a BPMN model (Business Process Modeling Notation) can be converted to an executable process, without writing code, this can be achieved through a combination of proprietary generating code algorithms.

Workflow Systems Comparative

Table 1 shows a comparative between the previously described workflow systems. In this, are evaluated the following aspects: WfMC model adoption, Web based user interface, if it counts with a definition process tool based on a Web application, if it incorporates a formulary editor, the process definition languages supported, if it is implemented under the J2EE specification, and the type of distribution license it has.

The following characteristics were considered for a integration between a workflow system with a GIS:

WfMC model adoption. The proposed model by the WfMC establish a set of interfaces that lets an interaction between the components of a workflow system, one of them (interface 3, from the Fig. 1) allows the communication with external

systems, being a crucial point for the developers of a project if the functionalities of a GIS are wished to be used inside a workflow system.

Form editor. This point refers to the characteristic about if a tool used for process modeling incorporates a form editor, which be used to define and manipulate the forms. This kind of component is necessary to take into account, because for a integration with a GIS is necessary to add to the forms a special class of data type: a geo-spatial data component.

Database interoperability. The workflow interoperability with different database managers is a relevant characteristic to be considered, due mainly because the geo-spatial information used to reference a geographic place or zone must be stored into a manager that supports this special kind of data.

License. The type of license of distribution for a workflow system should be considered, due that if the selected tool is going to be modified, is necessary to get the source code, as well as the freedom to make the appropriate changes to workflow's components.

The relevant characteristics that were taken into account for the study case of this paper were:

· **Web client.** The workflow system must incorporate a web client or a Web process manager console, with the purpose that this can be acceded from the majority of the clients.

Web modeling. It is needed that the tool proportioned by the workflow system could also be acceded via Web.

Process definition language. The language used for the process definition must be a standardized language, because it needs to be interpreted by other workflow engines, towards an interoperation between different systems that could collaborate between them.

Adoption of the J2EE specification. The J2EE specification defines the guidelines for the development of multilayer distributed systems, making this characteristic desirable in a workflow, as a evaluation criteria.

Table 1. Open source workflow systems comparative.

System	WfMC model adoption	Formulary editor	Database interoperability	License	Web client	Web model	Process definition language	J2EE
JaWE/ Shark	✓	✓		LGPL	✓		XPDL	
Bonita	✓	✓	✓	LGPL	✓	✓	XPDL	✓
jBPM		✓	✓	LGPL	✓		jPDL	✓
Intalio		✓	✓	MPL	✓		BPEL, BPMN	✓

As can be seen in the previous table, the workflow system that more satisfies the previously explained requirements is Bonita workflow; Bonita also provides a set of mechanisms called *hooks*, which let connecting this workflow system with external systems. These mechanisms were provided thanks to the adoption of the WfMC reference model.

8 Solution Method

To visualize the benefits that involves the implantation of the presented workflow system, one practical example are the governmental dependencies, in which the most of the paperwork and procedures that are offered to the citizens, that imply the use of geo-spatial data, such as the ones that requires the use of maps or sketches to set the specific location of a required service; examples of this type of procedures are: requirements for construction licenses, water inlets, water leak, among others.

The existing problem in these dependencies is the way in which the procedures for the services are realized, mainly because at the moment of making the registration of a request, this is usually filled by hand, and after this, it is assigned to the respective personal in charge for the following of that request. The previous situation causes an inaccuracy in the information proportioned by a user, when defining the geographic location of the required service; also the high consumption of stationer resources, caused by filling errors, by the number of realized requests, the accidental lose of requests, delayed delivery in the request's responses, bottle necks, among others.

To solve this problematic (briefly described in section II), the following solution method was developed:

8.1 Workflow Open Source System Analysis

For this activity, it had been developed an analysis about the main open source workflow systems, which are available through Internet. The analysis results are presented in section 7.

Considering the previous evaluation, the Bonita workflow was selected to be modified with the pertinent changes with the purpose of integrating into it the necessary modules for geographic information functionality and process.

8.2 Bonita Workflow Analysis

The Bonita workflow administrative console is named jiapAdmin, which is a Web application developed using JSP (Java Server Pages) in which are managed the basic system configurations and the process management. It handles four different user roles, described next:

1) **Administrator**. It is in charge of modifying the basic data configuration of the workflow engine, for the users administration and their configuration. It is the user with higher privileges.

2) **Designer**. It can access to the process administrator to create or modify processes models using the ProEd workflow editor. It can manage the process models (such as import different process in XPDL format or erase process).
3) **Operator**: It is in charge of establish user preferences, display, refold or start process, finish process instances, access to information about the process instances, start, finish or cancel an activity in a specific instance, configure and bring access to the logs and process instances historical.
4) **User**. It is the user with less privilege, its activities are focused in starting workflow process, he can start, stop and cancel activities and display the finished activities which are still visible.

jiapAdmin communicates with the workflow engine through the APIs provided by Bonita.

Architecture

Bonita workflow architecture is presented in Fig. 2, in this can be identified the two principal components of it: the ProEd process editor and the workflow engine.

The first component is the ProEd definition process tool (Process Editor), which was developed using java language. It lets make models in a graphic way, using the BPMN standard (Business Process Modeling Notation). It saves the model processes in XPDL format.

ProEd incorporates a formulary generator called xformeditor, which is based on XForms, a markup language for Web formularies that separates the data from the logic of the presentation.

The second component is the workflow engine, which is executed over JOnAS application server; This one is in charge of bring the necessary components (Web container, EJB container, message services, security, etc.) to give support to the logic business and data access functions.

Bonita workflow incorporates three APIs, with through them, other applications, as jiapAdmin can interact with the workflow engine. These APIs are described next:

- **User's API.** It provides total control over the process in execution, for example, to start or finish an activity. It can retrieve automatically the identity of a user in the context of the J2EE security.
- **User registry API.** It lets create and modify the user properties inside Bonita system.
- **Project API.** It incorporates functions necessary to define a workflow process, such as the creation of activities, transitions, roles, actions, etc.

According to the realized functions, the APIs can call to the following beans, which are situated in the EJB container:

- User session register. It provides an interface that is used to user creation and management, as well as groups creation.
- Project session. It provides an interface used to process creation, node (activities) and edges (transitions) definitions, and for properties listing and modifications.
- User session. It implements commands and petitions related to: user's projects, lists of task to do, execution of activities, start/finish/cancel process commands.

- Engine session bean. It implements the states machine and controls the processes executions.
- Container Manager Persistence (CMP). It matches the fields from Bonita to their respective table inside the database.
- XPDL session. Module that analyses a XPDL file. During the analysis process of the XPDL file, the module calls directly to the session project bean of the API. In fact, this task will call a java client, which wills carry out a call to the XPDL session bean, responsible of the analysis and interaction with Bonita's API [29].
- Message controller. It implements the notification of the changes in the definition and execution inside a workflow process. Each user interaction is notified to Bonita's nucleus and a JMS (Java Message Service) event is launched. It is also in charge of redirect the messages, through email or by instant messaging.

The authentication mechanism is realized through JAAS (Java Authentication and Authorization Service), a standard way to configure the security of a J2EE application.

The process data and process instances are managed by a database. JOnAS utilizes by default the HSQL database manager, however, this can be replaced.

Formgenerator utilizes Chiba [28] as a formulary processor, which is a JavaBean application which can be integrated inside the application. This is summoned each time a form is displayed, for the register of information about an activity or process.

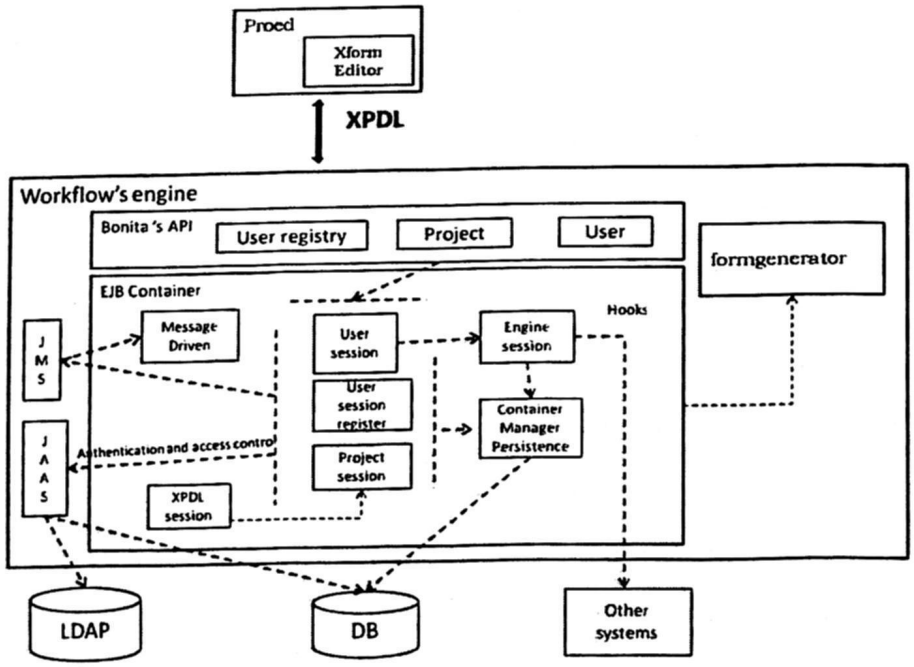

Fig. 2. Bonita workflow architecture.

8.3 Solution Design

As a result of Bonita's workflow architecture and functionality analysis, it was discovered that the ProEd process editor incorporates the xformeditor form maker, and that the Bonita's workflow engine has the formgenerator module for the management of the formularies which uses the Chiba form process. By taking into account that Chiba supports JavaScript code [30] and that the library used to create OpenLayers map visors is coded in JavaScript, it had decided that the best solution consists in modify the ProEd process definition tool, for adding into it a geo spatial component, as well as the develop of a Web manager console that can proportionate a friendly interface against the final user. Coming next the proposed solution design is described.

ProEd process editor Tool modification

It's necessary to make the pertinent changes of the ProEd process editor and the xformeditor formulary generator, to add the modules that let insert a map viewer inside a formulary. These modules are responsible for: the management of the geo-spatial component as an attribute inside the business process, the insertion of a script for the map viewer inside the form, and the petitions making to the map server for the display of available map catalogs to the user. The map viewer is in charge of managing the following properties:

- Map Server direction (URL).
- The requested maps themselves.
- Map layers to be showed over a map.

The maps viewer is developed over JavaScript, using the OpenLayers library; this brings the following activity facilities over a showed map:

- Zoom in.
- Zoom out.
- Pan.
- To specify the layers to be showed.
- Set POIs (Point Of Interest) over a map.

Web Process Manager Console Modification

This step consists on the modification of the Web process manager console, which is used to interact with Bonita workflow. This application needs a usable and intuitive interface against the final user. As a result of that, the process manager console must follow usability user interface principles, focused on a easiest and simple use for the final user.

The manager console consists on a Web application based on the MVC (Model-View-Controller) design pattern, which lets separate the data, the user interface and the control logia as three different components (see Fig. 3).

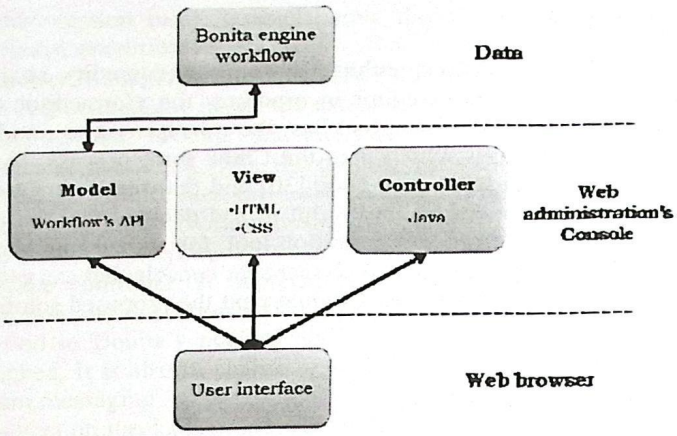

Fig. 3. Web process manager console architecture.

8.4 Implementation

This activity is composed by the modification of the ProEd process definition tool, adding as a spatial component a map viewer inside the xformeditor formulary editor.

The modification to the Web application was made using JSP technology and struts, inside the Eclipse's integrated development environment.

Once realized the respective modifications to the ProEd's tool for process definition, and the ones for the process management console, the architecture shown in Fig. 4 was obtained:

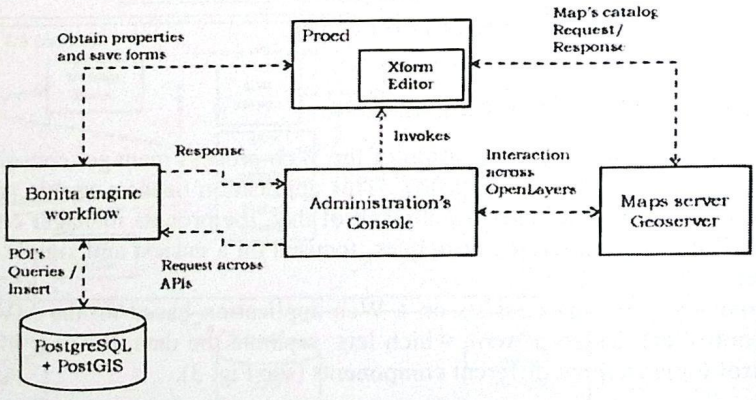

Fig. 4. Architecture for the definition and management of processes interconnecting a form editor (*ProEd*) and a map server (*GeoServer*) for geo-spatial data.

As can be seem in the previous picture, through the manager console, the modified ProEd process editor can be called to realize the model of the process. With this, ProEd has acquired the functionality to realize petitions to Geoserver, and obtain a catalog of the available, and that these maps could be displayed to the user, selecting the needed ones, and display them within the map viewer each time a process is executed. Once selected the maps and their layers to be displayed, an according script is created inside the form, and it's saved inside the workflow engine.

When a process is imported and deployed inside the workflow engine, it can be executed, and when this happens, the management console summons the respective forms for the process. When the form is loaded, the defined map viewer inside it realizes a map request to the map server, requesting also the layers to be displayed; this communication is made in real time, using the OpenLayers library.

The insertion of POIs is made through a *hook* component, which is proportioned as a part of the Bonita workflow engine. The hook is programmed to retrieve the coordinates of the POI, and insert them into a spatial database, as well as retrieve them in the cases that they already exist in any of the instances of a process.

One example of the new functionality that the workflow engine has acquired, is shown in Fig. 5; in this figure can be observed an instance of a process in execution, in which a spatial component has been defined, showing a loaded map of Cuervanaca City, in Morelos, Mexico. Such as has been previously explained, the map is loaded from Geoserver map server, in real time, using the OpenLayers library.

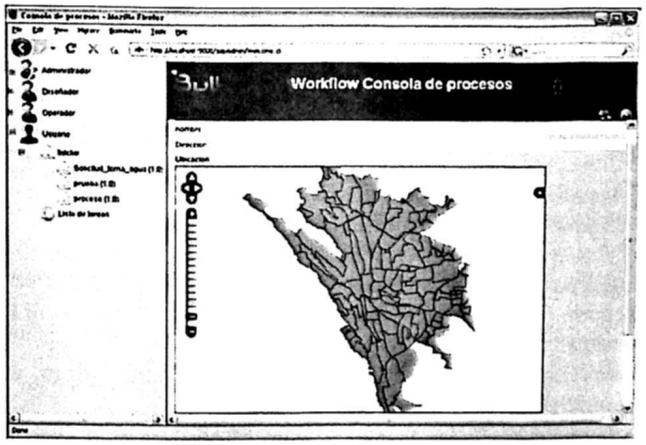

Fig. 5. An example of the geo-spatial functionality in an open source workflow engine (in this case, based on Bonita).

8.5 Testing

The development of this activity consists on conducting the implementation of the government dependencies process, any one in which it could be necessary the

management of geographic information, letting the user to introduce a geographic localization for a specific request.

Also, it was developed a test plan based on the IEEE 829-1998 standard [31], used for software testing; through this one, the tool functionality for the process definition and the developed Web application are verified.

The characteristics to be tested are listed next:

- Connection to the map server. This test tries to verify that PorEd editor correctly can establish a connection with the map server.
- Interaction with the map server. This test is focused on verify that the ProEd editor can request the catalog of the available maps on the map server.
- Forms definition with spatial data. This is oriented to verify that the created formularies with ProEd tool will be correctly stored in the workflow engine and that these could contain geospatial components.
- Map server connection. This is focused to test that the embedded map viewer inside a formulary of an execution activity, could establish a communication with the map server specified in the activity properties during the process modeling.
- Map interaction. The map visor capacity is verified to be used in operations such as: zoom in, zoom out, pan and selection of layers to view.
- Spatial database interaction. The capacity to do insertions and consults over the spatial database is verified, with the purpose of POIs storing and retrieval for each process instance.

Finally, the implementation of this integration between GIS and a workflow engine into an organization such as town government dependencies could prevent the problems and errors exposed at the beginning of this section, also with the following advantages:

- Cost reduction over stationary consumption, when the requirements are made through electronic format.
- Reduction over the error margin in the requirements filling, due to if the geographic location is managed through electronic ways, it can have a better precision for locating zones and places in a digital map, with more confident coordinates and a more realistic level.
- Improvement of the service quality offered to the citizen, at reducing the response times for the requests.
- An accessible system that can be accessed through a Web browser, so, it doesn't need specialized installation software for each computer that needs to access to the system.
- The payment of licenses is avoided, thanks to the use of open source products, working in favor of saving costs, and supporting government's austerity decrees.
- Time reduction used to make modifications over the process modeling.
- Use of a tool with a friendly user interface, that can be adopted to the particular necessities of a process, letting to the users' system the execution of their work, at following the required service solicitudes.
- Interoperability with other tools that fulfill the WfMC specifications.

- A scalable system that lets establish communication between systems through the use of hooks..

9 Conclusions

It had been adopted that the use of open source software, particularly in the case of workflow systems, due to a financial perspective, they can save licenses payments, against the proprietary software competitors; it also allows to make software adaptations for the particular necessities of an organization, because commonly the source code is available; its use doesn't no imply any dependency with a particular operative system; it ensures the permanence and reusability of the information, thanks to the use of open and standardized formats, and no use of closed standards that lose their currency with the time.

The study and analysis of diverse open source workflow systems were presented; from these, Bonita workflow was been selected as a very interesting choice, due to its characteristics which are offered as a set of APIs used to establish a communication with the workflow engine, the information access via Web and by the use of standardized notations used to make the processes models.

The geographic information support in Bonita workflow is achieved through the modification of the ProEd process definition tool, what is made by the incorporation of the necessary classes that allows defining a spatial component (map viewer) during the form definition in the process model step.

The use of a workflow system with the previously mentioned characteristics in this paper, could allow disposing of a set of functionalities in a government agency that lets create a totally scalable, manageable and reusable business process. This is obtained through the use of a graphic language used for the business process definition, by the support for the manage of geo-referential information during the process definition, by the automatic generation of the Web application used to manage the defined processes and finally, by the support of the Web application for geo-referential information in a manner of map views that helps for a more founded decision taking.

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