Abstract—The provision of solutions to fulfill requirements in the domain of eGovernment is a complex task. In order to achieve high quality services, a lot of features must be taken into account: accessibility, interoperability, usability, and so on. One of those features that must be beard in mind is the support for retrieving the desired service from any Public Administration. Citizens should be provided with tools to conduct their searches in a convenient manner for their needs. To achieve this high level goal, this paper proposes some artifacts: LifeEvents and AdministrativeServices. Those concepts are described using semantic tools, i.e., formal description techniques for knowledge in software environments. Besides, this technologies provides support for advanced recovery procedures as shown on the paper.

Keywords: eGovernment, Semantics, Accessibility, Discovery of services

I. INTRODUCTION

From the huge quantity and quality of new services in the domain, it is clear that eGovernment is becoming more and more popular. Information and Communication Technologies (ICTs) are providing a complete new support to deliver services to citizen in the scope of Public Administrations. The eGovernment domain is a promising eTechnology with a lot of future.

eGovernment is defined, according to the United Nations, as

“the use of information and communication technology (ICT) and its application by the government for the provision of information and basic public services to the people”[1]

According to the World Bank[2], eGovernment

“refers to the use by government agencies of information technologies that have the ability to transform relations with citizens, businesses, and other arms of government”.

Therefore, it seems important to bear in mind that eGovernment is not solely a simple replacement of technology to provide a 24/7 service. Indeed, provision of eGovernment solutions involves a huge effort in re-engineering all processes involved in the public service to place the citizen at the center of the process. As a matter of fact, this technology forces PAs to re-orient and improve services by positioning the citizen at the center of all provided operations. These services should be, whenever possible, an end-to-end transaction in order to achieve a one-stop digital administration.

Within the domain, a number of areas can be pointed out: eProcurement[3], eDemocracy[4], eVoting[5], eParticipation[6], eRulemaking. …

Upon the review of already developed solutions, we find out limitations in deployed eGovernment web portals and identify some concrete problems to overcome (see section II). In particular, this papers addressed problems related to the discovery and accessibility (in terms of software architecture) for services in the domain.

Bearing these concepts in mind, the use of a modeling tool called LifeEvent (LE hereafter) is proposed. This artifact models services from the point of view of the citizen in terms of their need. These LEs implies the use of Administrative Services (AS hereafter) to actually carry out services. The main goal of this proposal is to support in an simple manner from the point of view of the citizen searches and queries about domain services, as shown on section III.

In order to increase the possibilities of the system regarding automatization and interoperability issues, semantics is bring into scene. Nowadays, among the scientific community, semantics is usually considered the enabler technology to develop this sort of solutions. This technology offers us a new set of tools and capacities which have not been completely explored yet (see section IV). Therefore, its application to LEs and ASs introduces a fairly nice support to advanced searches (see section V). Finally, some conclusions are presented to the reader in section VI.

II. ANALYSIS OF THE PROBLEM & MOTIVATION

As mentioned above, eGovernment can be considered as the next generation of service paradigm for the civil service. ICTs are surely bound to play a paramount role in this task. Also, we can notice a strong demand of eGovernment solutions. This demand has two components. On the one hand, there is a growing demand of public services from citizens who are willing to take advantage of ICT based solutions. On the other hand, there is a latent demand due to new laws in most countries compelling them to cover a wider range of services with telematic support. This can be illustrated with some meaningful examples such as the Spanish case. This administration has approved a law[7] to guarantee the access
to services provided by public administration under the support of ICTs.

Anyway, a common feature in all solutions is the use of the Web support to deliver contents. Acting as a front-end solution for citizen, these Web pages offer an access to services. Nevertheless, as shown below there is still a long road ahead in order to achieve the desired quality level. In a not very formal manner, we can classify the available services on web portals according to the following categorization[8], from simpler to more complex:

- Presence. Just information to access on the web such as forms to download, web maps, …
- Information about the town. It is possible to access information updated periodically about specific topics related the PA: transport, minutes from meetings in the council hall, map of the city, useful telephone numbers, …
- Interaction. Support for assistance from the PA in a digital manner: email support for information and some operations.
- Complex operations. Real operations supported in a holistic manner: support for personal folder, tax payments, security features, …
- Support for political management. Services related to eDemocracy are available: support for polls, interaction with the agenda of the meeting in the council hall, …

The vast majority of eGovernment solutions are presented to citizens by means of Web portals. The highest functioning Web portals show a complete system integration across agencies, whereas portals with the lowest level of functionality provide little more than access to forms and static pieces of information. High-functioning portals create a true one-stop service for citizens. In particular, usability, customization, openness and transparency represent key aspects of portal functionalities. Regretfully, upon the review of web portals[9], several drawbacks can be outlined. In our case, we are going to focus on problems related to locating services. This is not a simple task. When looking for a particular service in the web site of a PA, it is not a trivial task to find the proper place where the service is held. This is due to the wide variety of classifications for services, mechanisms for its invocations, visual interfaces and even problems such as finding out beforehand if the administration is responsible for the wished service.

By means of the review of several already deployed eGovernment platforms[9], notable difficulties for citizens have been unveiled. Two main shortcomings are present in current-fashion solutions from the point of view of the citizen:

- It is not a simple task to discover which is the right service for a particular situation in the life of a citizen. This problem may be due to the variety of administrations that can be in charge (e.g., requesting a grant can depend on different administrations), to the difficulties in finding the services (e.g., the use of some searchers can be difficult if the user is not involved in administrative issues) or to the lack of information in the expected format.

- Administrations have not foreseen mechanisms to orchestrate services. In those situations where the citizen needs support from two or more administrations, he/she is on his/her own.

In general, no special treatment for locating the desired services is provided. This way, there is no a common or interoperable service to deal with the addressed goal: searching the most suitable service for a citizen from several administrations.

III. LIFEVENTS TO MODEL SERVICES

Taking into account the above mentioned considerations, a LE-based approach is proposed to deliver advanced tools in locating services. The very first goal is to model services from the point of view of the citizen and no longer from the perspective of the PA and its internal procedures.

Therefore, LEs can be defined in the scope of this proposal as “any particular situation in the life of a citizen that must be dealt with and requires assistance, support or license from PAs”. Those situations are considered from the point of view of the citizen and only include operations meaningful for the citizen. We can consider as LEs, in the frame of this proposal, situations such as paying a fine, getting married, moving, losing one’s wallet …

Taking the analysis of the domain, already existing tools and the first evolution of the prototype as a basis, we are in a position to identify some relevant fields in the definition of LE:

- Task. Title for the considered operation.
- Description. High level description of the desired operation expressed in natural terms from the point of view of the citizen. This field will support human-driven selection procedure to finally choose the right LE.
- Input documents. All operations carried out by the administration require some input document. The citizen must provide, at least, a signed form in order to invoke the operation. This field states required documents to undertake the LE. We do not include simple forms or similar documents in this category since only meaningful documents for the citizen are taken into account at this point.
- Output documents. Of course, as a result of any performed operation, the PA in charge, whatever this may be, must provide an output expressed in terms of the ontology. This information will be put together into one or several documents. The content of the output will vary, ranging from the expected document (e.g., a certification, a license …) to information about potential failures in getting the expected document. This field will state the legal documents that will be issued to the citizen in response to his/her request. On the basis of these fields searches can be described.
- Scope. We must identify the scope in which we want an operation (local, national, international…) to be recognized.
- Area. The particular area concerning the LE: education, taxes, health care, retirement, …
• Security Conditions. The conditions for the security mechanism involved in the whole process, such as identification of both parties, cipher methods, etc. Using this field, the citizen can express the minimum conditions required to deal with his/her personal documents.
• Version. LEs can be modified and changed from one version to another. This information, which aims at tracking versions and providing coherent management of LEs, is not to be displayed to the citizen.

Note that no PA is attached to a LE as a LE may involve several PAs and the citizen may not be aware of this situation.

A. Administrative services

If we take the definition of LE as a basis, a single LE can—and normally does—involve different operations in different administrations. For our proposal it is quite important to model these situations also. As already mentioned, LEs just model the need but for an eventual invocation, it is necessary to know which administrative services are required to really have a service. In order to model those interactions, another accessory artifact is introduced in the system: the Administrative Services. PAs can, and normally do, provide support to perform simple operations held directly by them. These operations may involve a more or less complex back-office mechanism but, in any case, they are invoked and fulfilled in a certain PA. Therefore, the fulfillment of a LE could involve several ASs in different PAs. ASs include the following data:

• Title. Brief name for the AS.
• Description. This information will be used in the description of ASs as components of LEs.
• Deadline. The maximum span of time for the response from the PA before the operation is considered approved/dismissed. This information is used to estimate how long an entire LE may last.
• Public Administration. Information about the PA; it is responsible for the execution of the PA and it is used to decide about the scope of the operation.
• Law. Information about the supporting laws involved in the current AS. This could allow citizens to gather further information or support from government or lawyers in case of any eventuality.
• Input and Output documents. As in the case of LEs, these documents will provide the information about the required inputs to the system and the expected outputs. This information plays a main role in making decisions about the orchestration of ASs.
• Internal operations. Although an AS is easily executed in a PA, this process may have a number of steps that will be used to inform the citizen about the evolution of his/her request.
• Related ASs. This field informs about ASs that can usually fall together. These ASs will be the most likely to be coordinated.

IV. Semantic support

The semantic web has emerged as a new promising technology aimed at addressing information instead of data, i.e., it enables software agents to treat data in a meaningful manner. Making this possible would allow new mechanisms to operate on a higher level of abstraction. Also, by means of this technology, it is possible to express knowledge in a formal and interoperable way. These features will support the provision of the support claimed in this paper.

A. Semantics

The “semantic”, as an IT researching field, was born in the early 2000’s. In May 2001, Sir Tim Berners-Lee published the foundational article presenting the semantic web to the world[10].

“The Semantic Web will bring structure to the meaningful content of Web pages, creating an environment where software agents roaming from page to page can readily carry out sophisticated tasks for users”.

The main goal of this idea is to make machines capable of understanding the information within the web. This feature will allow them to make more complex interactions without the need of human support. To accomplish this ambitious goal, a long evolution on the technological side has taken place during these last years. In this context, ontologies are a key element. In the literature, several definitions or approximations to the concept of ontology are provided. A rather suitable definition for ontology may be[11]:

An ontology is a formal, explicit specification of a shared conceptualization of a domain of interest.

By means of this definition, we are addressing an ontology as a support to present abstract information about a certain domain in a concrete way by means of a machine-understandable data format.

To express an ontology in a formal manner, different languages[12] are at our disposal. OWL (Ontology Web Language)[13] is the W3C Recommendation intended to provide a fully functional way to express ontologies. To make different levels of complexity possible, OWL provides different sublanguages with increasing expressivity: OWL Lite, OWL DL and OWL Full. By using OWL, we are addressing a standard, solid and interoperable platform for the provision of this solution.

Another semantic tool that serves our propose quite nicely is Semantic Web Rule Language (SWRL)[14]. This is a proposal for a rule-language in the Semantic Web broadly accepted. By mean of logic rules, it enables the generation of new knowledge not existing previously in the system.

B. Applying semantics

Up to now, LEs and ASs, as tools to model services in the domain, have been presented with no binding to any technology in particular. For obvious reasons some technical support has to be chosen in order to advance in our proposal.
In our case, we decided to make good use of semantics to derive advantages in the system as shown below.

Semantics, in the present case, is presented by means of a modular system of ontologies that describes all entities involved in the process.

Several acceptable options to develop an ontology that may fit our needs are available, such as Cyc[15], Kactus[16], Methontology[17], On-To-Knowledge[18], etc. The chosen option in our case was Methontology[17]. The main reasons for this election were good support with software tools (such as Protégé[19] or OntoEdit[20]), platform-independence; in addition, it is recommended by FIPA[21] and it has been tested in several large scale projects.

The resulting ontology includes the definition of all the meaningful data in the system. Therefore, this ontology must be known and shared by all agents. It is mainly made of some basic classes that characterize the ground.

- citizens. As the system final users, they are expected to be able to invoke all services available and interact with information in the system.
- documents. They provide the legal support for all operations in the system. Security concerns must be deployed in their management, since they compel agents to respect the contents of the documents.
- LifeEvents. These elements model the need of citizens and they are the drivers towards the service completion provided by the Digital Lawyers. Certainly, their definition includes already mentioned fields.
- AdministrativeServices. This class holds the properties to express all the knowledge about ASs as they are defined in previous sections.

In this ontology, we have reused previously proposed metadata. For example, in the task of defining the citizen, one of the main classes in the system, FOAF (Friend of a Friend)[22] has been reused. Also, metadata from European standardization bodies has been reused to mark documents in the system, in particular, CWA 14860[23] from CEN[24]. This is part of a general philosophy leading toward the maximum possible agreement and reusability both for the ontology and the software based on it (see Fig. 1).

Several properties have also been identified regarding the LEs. These permit the implementation of mechanisms to discover which LE can be invoked or how it can be composed. For example, by means of the property generates, it is possible to discover which document can be achieved as the result of the completion of a certain LE or AS.

To take advantage of SWRL, it is useful to add some properties to be able to mark individual as preferred, in our case. This way, two properties were added: suitableLE in class citizen to mark a possible LE and suitableAS in class LE to link it to a AS that can be part of. A number of rules were introduced to the inference system to generate this new knowledge. Some examples are:

- To check that the area of interest of the LE and the citizen match:
  \[
  \text{citizen: interestedAt(\text{\textit{?cit}}, \text{\textit{?area}})} \land \\
  \text{le: relatedToArea(\text{\textit{?le}}, \text{\textit{?area}})} \land \\
  \text{citizen: suitableLE(\text{\textit{?cit}}, \text{\textit{?le}})}
  \]

- To checks that the LE and the AS corresponds to the same region:
  \[
  \text{le: originRegion(\text{\textit{?le}}, \text{\textit{?reg}})} \land \\
  \text{as: inverse\textunderscore{}f\textunderscore{}agency\textunderscore{}Responsible(\text{\textit{?as}}, \text{\textit{?pa}})} \land \\
  \text{pa: RuledRegion(\text{\textit{?pa}}, \text{\textit{?reg}})} \rightarrow \text{le: suitableAS(\text{\textit{?le}}, \text{\textit{?as}})}
  \]

V. SEARCHING SERVICES

Taking advantage of this artifacts and semantic support available, it is possible to provide support for advanced searching services. Taking into account the profile of the citizen, i.e., areas assigned, documents owned or desired, current location, and so on, it is possible to personalize the possible LE the citizen may be interested at. Also, it is possible to discover which are the best ASs that may be invoked to fulfill a particular LE. This decision is guided by the use of the SWRL included in the system.

Briefly, there are several high-level functions defined to support these functionalities:

- searchLEbyInputDocument To locate those LEs that require some document as input.
- searchLEbyArea To locate those LEs related to some particular area.
- searchASbyOutputDocument To locate those LEs that require some document as input.
- relatedAS To put in contact ASs that may be related in terms of area, administration, or expected output.

Some of them take advantage of SWRL rules and others are implemented by mean of SPARQL queries. In order to implement this features, Jena[25] plays a paramount role. This library was the chosen option due to the large community of programmers currently working on its development and the support for required semantic operations such as executing queries or merging new instances.

To apply the suggested SWRL rules and look for suitable LE according to a particular profile the following code is applied:

```java
// Generating the query in the BPS
String queryString=BPS.generateQuery ();

// Generating a ResultSet object
// with the data
Query query = QueryFactory .
              create (queryString );
QueryExecution qe =
              QueryExecutionFactory .
              create (query , individuals );
ResultSet rs = ResultSetFactory .
              copyResults (qe . execSelect () );
qe . close ();
```

The following snippet shows how to recover all individuals from the ontology, LE in this case, that fit on a SPARQL[26]...
query, which is the chosen method used to select the LEs/ASs that fit the user needs.

To make use of the mentioned SWRL rules, they have to be translated to Jena-based rules. Thus, our first rule is expressed under this new form as follows:

\[
(\text{cit} \text{ rdf:type citizen:Citizen}), \\
(\text{area} \text{ rdf:type area:Area}), \\
(\text{cit citizen:interestedAt area ?area}), \\
(\text{le le:relatedToArea area ?area}) \\
\rightarrow (\text{le le:suitableLE ?cit})
\]

For its inclusion in the software prototype, just a few lines are enough:

```java
// First of all, read // the rules from a file List rules = Rule.rulesFromURL(rules_file);

// Attach the reasoner GenericRuleReasoner reasoner = new GenericRuleReasoner(rules);
// create the inference model // for the new knowledge model = ModelFactory.
createInfModel(reasoner, baseModel);
```

Once this code is executed, the system will be aware of this knowledge and will be able to use at its convenience for reasoning processes. It is important to take into consideration that the discovery of the suitable ASs for the completion of a LE is performed taking this features as the basis.

These searches will be conducted on a shared pool where LEs and ASs from different PAs will be included. Of course, all of them will be described by means of the proposed ontology. This would allow the federation of contents from several PAs making possible the access to different services from a single service point. These features will be implemented by high-level functions such as ManageLE or ManageAS. The following code is responsible for including a new LE in the knowledge of the system:
// Generating an ontology model
// and loading data
OntModel individuals =
    ModelFactory.createOntologyModel();
individuals.read
("http://pledge.det.uvigo.es/" +
"global.owl");

// Generating an ID for the new LE
String ID = LE + PA.toString() +
    lastKnownIndex.toString();

// Creating of the new LE
Resource le1 = individuals.
    createResource(ID);

// Defining its properties le1
    le1.addProperty(individuals.
        getProperty(LE+"Name"),
        individuals.createTypedLiteral
            (name, XSDDatatype.XSDstring));

// Adding object properties
    le1.addProperty(individuals.
        getProperty(LE+"requires"),
        individuals.getResource
            (LE+DocumentPledge.ID().
                toString()));

// Storing new contents
// on a permanent manner
try {
    FileOutputStream fos =
        new FileOutputStream
            ("/dataPool/data.owl");
    individuals.
        write(fos, "RDF/XML-ABBREV", 
            "http://pledge.det.uvigo.es/" +
            "global.owl");
    fos.close();
} catch (IOException e) {
    e.getMessage();
}

Of course, further details about the conformance to local or
national laws regarding documentation and legal procedures
are not considered at this point and further implementations
of the system should take care of them.

VI. Conclusions

The main goal of this paper is the introduction of an
ontology-based support to facilitate tasks related to services
locating. By means of LE, several advances have been achieved:
services are defined in a more user-friendly manner, a uniform
mechanism to characterize them is available, and their
localization becomes easier as the semantic annotation provides
new tools.

As already mentioned, eGovernment is currently a research
field where a lot of effort is being placed. As a result, a
large number of efforts and initiatives have arisen. In the
literature, we can also find some interesting initiatives that
make use, at different levels, of semantics applied to LE-based
concepts in some manner: the Finnish Web site Suomi.fi[27],
the EIP.AT project[28], the SemanticGov project[29], and the
Access-eGov project[30]

Regarding these projects, the presented proposal goes a step
further and suggests features not provided in these platforms
such as the provision of a LEs pool from different PAs,
semantic mechanisms to discover the proper LE, a new and
flexible mechanism to compose new services from already
existing operations, etc

This proposal takes into consideration limitations and short-
comings from the technological environment, especially from
the semantic environment, where a lot of work is yet to
be done. Nevertheless, some issues related to the design of
an accurate semantic matcher were overcome thanks to the
approach selected, where some simplifications are possible.

VII. Acknowledgment

This work has been funded by the Ministerio de Educación y
Ciencia through the project “Servicios adaptativos para e-
learning basados en estándares” (TIN2007-68125-C02-02) and Xunta de Galicia, Consellería de Innovación
e Industria “Diseño y Desarrollo de un marco semántico
para el modelado de servicios en la administración pública.
Aplicación a la provisión de servicios frente al ciudadano”
(PGIDIT06PXIB322285PR)

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