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Semantic Integration of Government Services - the Access-eGov Approach

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Abstract: The paper describes a front office approach to integration of government services on the semantic level including results of first prototype testing in real settings in three EU countries. The proposed approach, developed within the Access-eGov project, enables integration of traditional (i.e. face-to-face) and existing electronic services. This semantic integration provides a technical solution to the problems faced by the end users (citizens, businesses) of the government services – they are usually looking for a government service (or more frequently for a series of such services) leading to fulfilment of a stated goal (e.g. to establish a new company, to get married etc.). The proposed solution provides end users with a personalised (i.e. adapted to his/her personal data/situation) scenario of services corresponding to the given goal including detailed information on individual services in this scenario. In the event that the services are available electronically, they can be executed online, increasing thus ultimate benefits to the end user.

1. Introduction

Today the key challenge in eGovernment seems to be integration and interoperability of existing governmental services. From this aspect semantic technologies are one of the most promising approaches to interoperability. Availability of formal description of meaning and context of services, without necessity to modify the services themselves, is the main advantage of this approach.

However, practical outcomes of the current research in this area (see e.g. [8]) are somehow behind expectations. One of the reasons may be a non-existence or not sufficiently developed methodology, tools, and guidelines describing how to design, develop, implement, and employ semantic government services in traditional (i.e. face-to-face) as well as in electronic form.

2. Objectives and Approach Used

Within the FP6 IST Access-eGov project[i] our main objective is to support citizens or businesses in their life event situations, where the life event is a situation in the life of citizen or during the life cycle of the business organization, which requires delivery of some government service.

Life event is usually quite complex and can be decomposed to many sub-goals, fulfilment of which leads to a solution of the situation. Each sub-goal can be resolved to (i.e. fulfilled by) government services, which can be provided in the traditional way (face-to-face communication, mostly paper-based) or in the electronic way (available directly via web service interfaces or web forms). The Access e-Gov platform provides the user with all information required for the visit to the responsible government offices in the event that

only traditional services are available, or creates one single entry point that can be used to directly invoke electronic services.

The sub-goals can be conditioned according to the specific case of the citizen (or of the organization), so the list of sub-goals for the life event has to be dynamically evaluated. The sub-goals conditions can be dependent on the customization of the life event – i.e. information provided by the user to identify his/her case; or on the outputs of services, which fulfil the preceding sub-goals. Services, which resolve the sub-goals, can require some additional inputs provided by other services, thus the sub-goals can be further decomposed to sub-sub-goals and so on. During the service resolution process, the Access e-Gov system dynamically creates scenario for the user by evaluating sub-goals conditions and then navigates the user to services to fulfil the goals and solve the life event situation.

Ontologies, as powerful knowledge representation formalism for modelling real-world concepts, were acquired as a basic mechanism for semantic modelling and annotation of the life events, goals, sub-goals, services, and other specific concepts from public administration domain. This approach allows integration of existing (and to be implemented) systems and services, their functional interconnection on technical, semantic, as well as organisational level.

Three basic resources were identified for design of ontology structures within the Access-eGov, namely:

1. Conceptual model of selected ontology implementation platform (in our case, the WSMO framework was selected as the most promising solution – see next section for more details).
2. Already existing ontology resources that can be reused for the Access-eGov purposes. It also assures consistency with the widely accepted standards and avoids unnecessary double work. About 25 ontology resources and standards [7] were analysed and based on this analysis the following ones were reused: Dublin Core[ii], SKOS [iii], vCard[iv], SemanticGov[v], Terregov[vi], OntoGov[vii], ontologies from WSMO[viii] and Protege[ix].
3. The requirement-driven approach [5], [7] as a 7-step procedure for collecting user requirements in a systematic way. This method, originally designed and developed within the Access-eGov project by one of the project partners (German University of Cairo), was used as the main resource for ontology creation procedure, starting from identification of users' information needs for particular pilot applications, continuing with analysis and creation of more formal representations as controlled vocabularies and ontology-like networked structures of concepts and relations, and ending with fully formalised ontology expressed in WSML language, containing all the semantics of life events, goals, services, and workflow structures.

In particular, the design of ontologies by means of the requirement-driven approach, as it was performed within the Access-eGov, includes the following tasks/steps [5]:

1. Identification of informational needs: Analysis of prior knowledge of citizens/ businesses (as envisioned users of the application) and the diversity of informational needs of different groups of citizens. This step resulted in specification of user scenarios written in a free-text form.
2. Identification of required information quality (IQ): Informational needs of each user group were analysed with respect to required IQ properties: scope, relevance, etc. Use-case diagrams and free-text descriptions of the trials were produced as results of this step.
3. Creation of glossary of topics & terms: A glossary was created that contains all relevant topics and terms needed for describing the services in the trials; each entry provides a short description of the topics and the corresponding informational needs.

4. Creation of controlled vocabulary: Based on the glossary of topics and terms, a controlled vocabulary was created in a table format. Each service and general topic to be described was represented by a main term and possibly additional related terms.
5. Grouping and relating the terms: All the items of the controlled vocabulary were grouped and structured through defined relations. Ontology-like structure (Figure 1) was produced as a result of this step.
6. Designing ontology: The meaning of the terms and their relations was fixed and expressed in a formal way, by means of selected ontology formalisation language (WSML in this case). It was also verified that formal meaning reflects informal description in the glossary (and vice versa).
7. Implementation of semantics: The above constructs were used for service description and operation (e.g. for creating service profiles in WSMO, including preconditions, post-conditions, and workflow sequences of services and complex goals). Resulting fully qualified ontology formalisation was then used by client-side tools (see section 4) as a specification of inner data structures, as well as a framework for semantic annotation of governmental services (both electronic as well as traditional ones).

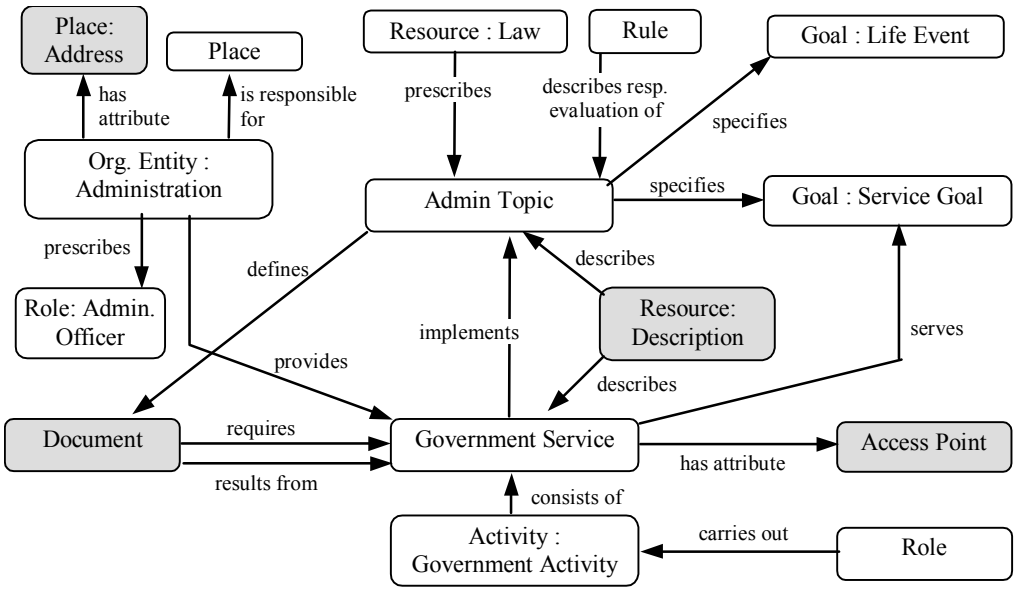

Figure 1 Ontology-like structure of identified terms and their relations.

Finally, the ontology was verified by public administrations (user partners of the project) on the real-world data. Instances of the classes were populated and included into the ontology for each pilot application. Minor enhancements of the general structure were done to adapt the ontology to the data provided by public administrations. The resulting WSML ontology was published as a part of the Access-eGov deliverable D7.1 [7] and is available for further reuse at the Access-eGov project web site.

3. Technology Description

Since Access-eGov is envisioned to build a service-oriented platform, it is supposed to be highly modularized and shall be logically composed of a number of components interacting with each other (confer to structural view for more details on service interaction).

The overall Access-eGov system (also called the platform) may be sub-divided into three major component groups[x]:

- The AeG Infrastructure itself,
- The AeG Personal Assistant client and equivalent end user interfaces,

- AeG Administration and Management Tools (e.g. Annotation services), which are not integral parts of, but affiliated to the AeG Infrastructure.

The actual services are still hosted under the responsibility and on the premises of the participating public administrations or their data centres. They are simply made available through Access-eGov and thus do not form an integral part of the overall Access-eGov system.

Public administrations are supposed to annotate those services that they are willing to expose to the public. These kinds of service-related meta-data will be transferred to Persistence layer via executable Core components. Therefore, domain experts may use a generic Annotation service component that is available as a web-based application.

The AeG Personal Assistant accesses AeG Infrastructure functionality via standardized interfaces and communicates with executable Core components that are charged with Discovery, Composition and Execution of registered public services. The AeG Personal Assistant may only communicate with these Core components in order to gain access to persistently held data.

Goal repository, Scenario Model Repository, Service Repository, Domain Ontology Repository and Security Scheme Repository form components of the Persistence layer.

Public administrations may choose which of the above mentioned AeG Infrastructure components they want to install on their premises or data centres. Such a "local" installation of the AeG Infrastructure components is supposed to interact as a peer in the peer-to-peer overlay network that Access-eGov is likely to consist of. The more components are installed locally (Core + Mediation + Persistence + Discovery + Orchestration + Execution), the more functional value a node will bring to the overall Access-eGov system. Other service requesters will also be granted access to the AeG Infrastructure via XML-based interfaces.

Specification of a common semantic basis for description of the services is based on WSMO[xi]. The WSMO framework provides a consistent conceptual model with the inclusion of mediators and distinction between goals and capabilities. For modelling the government services, the life event approach [3] was adopted, where the life event concept plays a central role, being a formal representation of user's point of view, his/her needs and requirements. As a consequence, to the top-level WSMO elements were added:

- Life Events – as formal models of user's needs, consisting from multiple goals and services organised into generic scenario and expressed by orchestration construction consisting from workflow, control-flow and data-flow sequences.
- Services as generalisation of Web service concepts. This approach enables to describe both electronic and traditional government services by means of a service profile, containing functional and non-functional properties, capabilities, and interfaces. If there is no executable service available for traditional service, the textual description of the required inputs (e.g. documents and forms, etc.) and requested actions (e.g. visit of a particular office) is specified as the non-functional property.

Semantic modelling and annotation that should be provided by public authorities, i.e. specification of a particular service, its functional and non-functional properties as preconditions, inputs and outputs, mutual dependencies between services and design of workflow sequences, was performed according to the above-mentioned requirement-driven approach [5]. The result is a formalised WSML representation of the ontology containing all the definitions (concepts, classes) of services, goals, and life events.

The process of solving the life event situation consists of a set of specific goals that should be achieved, as well as from activities performed by all actors - citizens, traditional public administration services and web services. All these aspects are part of the process model that is the core control and data structure of the Access-eGov platform. The current

WSMO specification for the process model is based on the abstract state machines (ASMs). Within the Access-eGov project we have come to the conclusion that the ASMs-based process model is not structured in the way suitable for interaction with human actors that is required for eGovernment applications. For this reason we have designed and implemented a workflow-based extension to the WSMO specification. Besides the previous objectives, the following facilities were identified as useful for a process model to provide support for modelling orchestrated scenarios:

- Compatibility with the standard process modelling notation (i.e. BPMN) in order to visualize scenarios to the users and to use standard tools for modelling;
- Compatibility with the proposed standard workflow modelling languages (i.e. WS-BPEL).

The Access-eGov model is based on the workflow CASheW-s model. The state signature is reused from the WSMO specification and replaces the ASMs transition rules with the workflow constructs. Shared ontology state signature allows reusing the grounding of the input and output concepts to the communication protocols via WSDL for invocation of web services. Workflow model consists of activity nodes connected with the control or dataflow links. Node can be an atomic node (Send, Receive, AchieveGoal and InvokeService), or control node (Decision, Fork and Join).

4. Pilot applications, experiments, evaluation

To test the designed approach and the developed tools in real settings, the first prototype of the Access-eGov system was implemented and tested via three pilot applications - in Germany, Poland, and Slovakia. Within these trials, ontology based knowledge models were designed by public servants using the Annotation Tool developed for this purpose. The real life event situations – marriage (Germany), setting up a new company (Poland) and request for building permission (Slovakia) – were used for evaluation of the proposed approach and supporting tools. The first trial was held from October 2007 to January 2008.

4.1 Evaluation strategy

Within the Access-eGov project, eGovernment services are considered as performing information processing with the aim of information integration from the user point of view who have a certain goal in mind: a service included in the trial is briefly described by its informational input and output, the service providers involved, and the set of activities the service consumers have to perform. Improvements from the user point of view can be found in: (a) the informational output, as well as in (b) the process itself. Improvement evaluation therefore can build on criteria elaborated in relation to (1) information quality, (2) process automation, rationalization and reengineering (including change to e-service delivery), as well as (3) other issues such as accessibility, ease of use, security and trust [9].

However, measuring the information quality is far from trivial. For example, Lillrank [6] distinguishes two basic types of information quality: (1) the quality of information as an artefact, and (2) the quality of information as deliverable. In practice, services such as in e-government are most often combinations of artefacts and negotiated results. However, for describing the trials and setting up measurements this distinction is crucial because in the first case it presupposes a stable context with predefined meanings of data accepted by all stakeholder involved – whereas in the second case the frame for valuing the information may differ between information provider and consumers, or needs to be established, clarified etc.

Important criteria for the process evaluation can be derived from the area of business process automation and reengineering, the most important are considered process cycle time (i.e. time between providing informational input and receiving desired informational

output), the number and complexity of steps within user activities, integration/reduction of various media (e.g. paper-based vs. electronic).

Besides the information process and its informational output, it is important to investigate other non-functional issues such as accessibility, usability of interfaces, security and trust. Within the context of the Access-eGov project, accessibility and ease of use are the most important criteria from the user's point of view. However, the evaluation strategy mainly focuses on relative improvements (before vs. after) whereas 'ease of use' should apply to any developed Access-eGov component even if there has been no equivalent before.

Evaluation was carried out using such tools as online questionnaires, "think aloud" sessions [4] and user workshops for different target groups consisting from administration officers and citizens. The participants were asked to assess the system's information quality aspects, i.e. relevance and comprehensibility of the information, speed, structure and layout of the web site, as well as its navigation and usability in general. The aim of the "think aloud" sessions was to find out if the tools support users in specific life situations to manage the life event appropriately. Whether they help to clearly identify the required steps in terms of services (traditional or electronic) needed, involved municipalities, and whether the whole process is well understood by citizens.

4.2 Evaluation results

Evaluation outcomes were collected from the pilots in Slovakia, Poland, German field test, and Lab test in Egypt. These outcomes cover assessment of both components the Annotation Tool (AT) and Personal Assistant Client (PAC) [2].

General expectations from the Annotation Tool:

- Web-service interface is available that takes web page as input and returns either the same web page containing semantic mark-up for a specific service (or services) or only the mark-up as an output;
- Web service interface is available that can be used to make content available for annotation;
- Service Profiles can be identified by URIs and are accessible from non-Access-eGov applications;
- Ontology Managers can register ontologies, thus making them available to Access-eGov, and notify users about ontology changes.

The Annotation Tool developed as an instrument for public administration served its purpose well, regardless of few comments delivered by the testers. An example of testers' comment is requirement of an enhancement of annotation of territorial responsibilities (Slovak and Polish application). All requirements for the Annotation Tool enhancement are technically feasible to be incorporated within the second trial, leading to an improved Annotation Tool version to be ready for second trial planned for autumn 2008.

Communication of citizens with the Access-eGov platform is occurring through the Personal Assistant Client, which provides main web-based user interface for functionalities of the platform components. The list of functionalities provided by PAC includes:

- Registration of citizens in the platform and managing of the user profiles;
- Navigation and selecting of the life event from the hierarchical list of life event categories;
- Customization of life event - to get a list of suitable services with the wizard-like questionnaires generated for the particular user case;
- Browsing of the detailed information about the selected services (i.e. contact data, etc.).

The PAC testing identified some crucial issues, which need to be addressed. Even if the requested functionality for users was available, PAC's user-interface requires modifications

in its structure, design and navigation. The feedback collected during the first trial showed that the system was not very easy to use and might confuse users when going through the process. The freedom of having all process steps available, which could be processed by the user at the time, was in the contradiction to user's expectation to be guided through the process step by step. Also the semantically relevant information projected to the web content was displayed sometimes in a broader form than preferred by users. The ease of use criterion requires a more structured way of relevant information presentation. In addition, only information relevant to the user should be provided by the system.

5. Related work

The potential of applying semantic technologies in the eGovernment domain was recognised in last years and gained attention of researchers from academic and industry. Research effort in the eGovernment field can be documented, for example, by the projects supported by European Commission within the IST program[xii]. Most of these solutions are applying semantic technologies to ease the system design by modelling the citizen's behaviour, to enhance the interoperability of services, etc. The common goal is to provide better public services to citizens and businesses, using the advantages of semantic-driven approach. The Terregov and OntoGov projects can be mentioned as the examples (and, in fact, some achievements of these projects, namely parts of produced domain ontologies, were reused also within the Access-eGov).

Terregov[xiii] is an Integrated Project launched in 2004 in the area of eGovernment. Its goal was to allow local government (and government-related) agencies to offer online access to their services in an interoperable way, and allow them to participate in orchestrated procedures involving such services provided by multiple agencies. Nonetheless, the Terregov solution still lacks an inter-, if not supra-national point of view needed in today's European Union member states, as the project only operates on a regional level of administration. Services can so far be detected and requested by public servants only (apart from the French pilot). Additionally, single agencies appear to be too rigidly bound up to the Regional Integration Centres: some functionality that is needed on the local level is only offered at the Centre.

The OntoGov[xiv] project develops a platform that facilitates the composition, reconfiguration and evolution of eGovernment services. OntoGov encompasses a multitude of needful ontologies to describe and support the life-cycle of eGovernment. This elaborate approach mainly focuses on the software engineering side rather than on detection and orchestration of e-services and thus leaves room for interpretation on how these ontologies can be used in practical scenarios. In addition, the process modelling is the only part that can be done by other than application-experts, so OntoGov lacks a certain degree of transparency to public servants using the system. Its ontology work is heavily bound to OWL-S and can therefore not easily be converted to a newer, more flexible semantic technology like WSMO.

6. Conclusions and Future Work

The paper describes a front office approach to integration of government services on the semantic level including results of first prototype testing in real settings in three EU countries. For the testing the Access-eGov platform in its first version was used. It is a generic solution for described approach implemented under open source licence that adds another - integration - layer to existing government services. It does not interfere with existing eGov systems – no back office change is needed, just semantic description of an existing system needs to be added to the AeG system.

The pilots carried out within the Access-eGov project have shown that the approach outlined above provides a good platform to design an ontology for the annotation of service profiles used then for integration of several services of different administrations that are relevant to the given life event.

Future research is required to justify scaling up the ontology to all kinds of services offered by administrations, i.e. that the ontology can be used to represent all kinds of government services. Also several issues identified by users - namely visualisation of workflow sequences, descriptive texts used, and enhancement of navigation elements in the process of browsing services for a particular life event – will be resolved in the second prototype.

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