PRACTICAL EXPERIENCES WITH ENHANCING SEMANTIC INTEROPERABILITY IN EGOVERNMENT USING WSMO

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Abstract. *The paper describes an approach to semantic interoperability of eGovernment services applied within the FP6 IST Access-eGov project. Within Access-eGov, software tools (called Annotation Tool and Personal Assistant Client) enabling service integration as well as a methodology providing guidance to the user-driven process of creating ontologies were developed. The Annotation Tool supports semantic annotation of available government services (i.e. specification of functional and non-functional properties of the services using concepts in the ontologies) in a user-friendly way. Having annotated the services by public servants using the Annotation Tool, citizens can access the Access-eGov system via a web application - Personal Assistant Client. The Personal Assistant Client supports browsing, discovery, and execution capabilities of services for citizens and businesses according to a selected life event or goal. The methodology and the first versions of the software tools were tested in first trials within three pilot applications in Slovakia ("Building permit" scenario), Poland ("Establishing a company") and Germany ("Getting married" scenario) in real settings of public administrations in late 2007 - early 2008. Feedback of users participated in the first trails was used for the upgrade of the SW tools, which will be subsequently tested in second trials planned for late 2008.*

1. – Introduction

The semantic interoperability, i.e. technical capability of interoperation of provided services, is nowadays considered a key challenge in various fields (e-business, e-health, etc.), and in particular in the field of eGovernment. The interoperability was recognised as a precondition for the implementation of European eGovernment services in the eEurope Action Plan [1] and is explicitly addressed as one of the four main challenges in the i2010 EU strategy [2]. This is important especially for integration and co-operation of existing services - employing solutions based on existing standards, open specifications and open interfaces [3].

One of the most promising approaches to the interoperability is employment of semantic technologies [4], [5]. The semantics provides a capability to model and represent knowledge within a domain by means of explicit formalisation of key domain concepts, their attributes and relations, as well as workflow sequences and structures. Considering the heterogeneous and distributed nature of the eGovernment domain, semantics can be very effectively used as a common background platform for describing the processes and services provided by

governmental institutions on various levels. The common platform then enables to integrate the services, make them interoperable and transparent for the end users (citizens and businesses).

Intensive research in application of semantics in the eGovernment field is going on, mostly focused on integration of back-offices, employing Service Oriented Architecture and Web Services enriched by a semantic description [5], [6], [7]. This research can be documented, for example, by the projects supported by the European Commission within the Information Society Technologies (IST) programme [8]. Most of the solutions apply semantic technologies to ease the system design by modelling the citizen's behaviour, to enable or enhance interoperability of services, to provide a platform for creation of semantically described web services, etc. Provision of better and more integrated public services to citizens and businesses can be recognised as a common goal of all the research efforts. In the following paragraphs, we will briefly mention some of the R&D projects, which can be considered as examples of the existing solutions and approaches.

Terregov project (http://www.terregov.eupm.net) is focused on the semantic requirements of governments at local and regional levels for building flexible and interoperable tools to support the change towards eGovernment services. The Terregov solution provides a specialised ontology as well as the platform for enhancing existing government web services with a semantic description. Such semantically enhanced web services can then be detected, accessed, and orchestrated in an interoperable way. However, the Terregov solution only operates on a regional level of administration and as such, it lacks a more global point of view. In addition, the Terregov solution requires a suite of already existing web services on the side of public administrations. The support for transforming other types of services (as traditional face-to-face services, or electronic services provided by web forms) into required web services is rather limited.

SemanticGov project (http://www.semantic-gov.org) is aimed at supporting the provision of pan-European services to resolve semantic incompatibilities amongst public administration systems. Focus is put on discovery, composition, mediation, and execution of services within complex scenarios, global ontology of semantic components needed for web service description is provided. Again, this approach requires an existence of web services on the side of public administrations. Contrary to the Terregov project, the global level of government services is covered, but the application of the solution on the level of local public authorities is not directly supported.

OntoGov project (http://www.ontogov.com) provides a semantics-based platform for the consistent composition, reconfiguration, and evolution of eGovernment services. The solution includes a set of ontologies to describe and support the lifecycle of eGovernment services. The OntoGov approach mainly focuses on the software engineering side rather than on detection and orchestration of the government services; as a consequence, the interpretation on how the ontologies can be used in practical scenarios can be rather vague. In addition, maintenance and usage of the OntoGov solution requires an expert knowledge and lacks a certain degree of transparency for public servants when using the system.

Besides the outlined projects, we can also mention the eGovernment interoperability frameworks as *e-GIF* in the UK, *SAGA* in Germany, or European *EIF IDABC*. These frameworks provide detailed information and guidelines about central government systems (on national or European level). However, they fail to introduce specific information and rules for building eGovernment solutions for local administration [9].

To sum it up, there exists quite a wide range of approaches, proposals, frameworks, and projects in the area of semantic interoperability in eGovernment domain, especially in creation and maintenance of semantic web services. However, practical outcomes of the current research in this area (see e.g. [4]) are lagging behind expectations. The lack of supporting methodology, specialised tools, and guidelines describing how to create and maintain formal semantic descriptions of the services in practice may be one of the reasons. Another reason can be a weak support for existing types of governmental services, and necessity to change (reengineer) dramatically the way how the governmental services are provided, e.g. by implementing them as semantically described web services.

One of the main advantages of the semantic enhancement of government services is the capability to formally describe meaning and context of government services, both traditional (i.e. face-to-face, "paper-based") as well as electronic ones (provided as electronic forms or web services), without necessity to modify the services themselves. The Access-eGov project (www.access-egov.org), which is a R&D project funded by the European Commission within 6th Framework Programme (FP6), IST programme, is targeting this issue by developing tools as well as a methodology enabling semantic interoperability of government services in practical applications.

2. – Methodology and tools, Access-eGov approach

Main objective of the Access-eGov project is to provide a support for citizens and businesses in their life event situations and business episodes, respectively with access to the government services (either traditional or electronic) in an “integrated” manner. Central position of life events (business episodes) as expressions of user’s needs is in correspondence with the ***life event approach*** [10], an effective and frequently used method in the user-oriented eGovernment solutions. The life event is a situation in the life of the citizen (business episode - in the life cycle of the business organisation), which requires provision of government services and should be semantically described within the system. Life events are usually complex and can be decomposed into several mutually dependent sub-goals. Fulfilment of the sub-goals leads to the solution of the given situation. Each sub-goal can be resolved to (i.e. fulfilled by) a set of government services that are provided either in a traditional way (requiring face-to-face communication and mostly based on some paper forms) or in an electronic way (available on-line via web service interfaces or web forms).

Sub-goals can be conditioned, organised in workflow structures using if-then-else constructs, cycles, and dependencies on outputs of other services - according to the specific case of the citizen or the organisation. During the execution, the list of sub-goals for a life event is customised (e.g. by information provided by the user to specify his/her case) and then dynamically evaluated [18]. Services, which resolve sub-goals, may require some additional inputs provided by other services, so 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 a user scenario by evaluating conditions of sub-goals, and then navigates the user to proper services to fulfil the goals and solve the life event situation.

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

well as organisational level. To design a concrete ontology structure according to the purposes of the Access-eGov project and to fill it in with data properly, three basic resources were identified, namely:

- *conceptual model* provided by selected semantic framework,
- existing and available *ontology resources*, and
- formalised *requirements* collected systematically from user partners of the project.

In the following paragraphs, we will describe each of these resources and the consequent process of ontology design in more details.

After detailed survey and analysis of existing and most used approaches (RDF-S, WSDL-S, WSMO, and OWL-S for ontologies; BPEL4WS for modelling web services in a business process interaction, etc. - see [11 for more details), we decided to apply the WSMO (http://www.wsmo.org) as a basic conceptual framework and implementation platform. The WSMO framework provides a consistent conceptual model for semantic description of web services, with the inclusion of mediators and the distinction between goals and capabilities. It also provides the WSMX execution environment, WSML language specification for ontology formalisation, as well as the WSMO Studio visual development environment. In addition, the WSMO conceptual model fits best the proposed architecture and functionality of the Access-eGov system [11], [18].

However, for modelling the government services based on the life event approach, a need to extend the WSMO conceptual model has risen. Two new top-level WSMO elements were added:

- *Life Event* element as a formal model of user's needs, consisting from multiple goals and services organised into a generic scenario and expressed by orchestration construction consisting from workflow, control-flow and data-flow sequences.
- *Service* element as a generalisation of the *Web service* concept, already provided by WSMO. This extension enables to describe both electronic and traditional government services by means of a service profile, containing functional and non-functional properties, capabilities, and interfaces.

In addition to that, we have modified the process model, since the current WSMO specification provides the process model based on abstract state machines and is not structured in the way suitable for interaction with human actors, which is required for eGovernment applications. That's why we have designed and implemented a workflow-based extension to the WSMO specification [12]. The extended process model used within the Access eGov is based on the workflow CASheW-s model [13]. The state signature is reused from the WSMO specification and replaces the transition rules with the workflow constructs. Shared ontology state signature allows reusing the grounding of 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-flow or data-flow links. The nodes can be divided into atomic nodes (*Send, Receive, AchieveGoal* and *InvokeService*) and control nodes (*Decision, Fork* and *Join*).

The second resource used for the design of the Access-eGov ontology structure resulted from our survey of the worldwide available ontology resources. Using already existing ontologies assures a consistency with the widely accepted standards and avoids unnecessary double work. About 25 ontology resources and standards were analysed [14], and the following ones were finally reused: Dublin Core (http://dublincore.org), SKOS (http://www.w3.org/TR/2005/WD-swbp-skos-core-spec-20051102), vCard (http://www.w3.org/2006/vcard/), SemanticGov (http://www.semantic-gov.org), Terregov

(http://www.terregov.eupm.net), OntoGov (http://www.ontogov.com), ontologies from WSMO (http://www.wsmo.org/WSMO_ontologies.html) and Protege (http://protege.cim3.net/cgi-bin/wiki.pl?ProtegeOntologiesLibrary).

Finally, as the third resource of the ontology design procedure, requirements from the Access eGov user partners were collected in a systematic way to produce ontology models of life events, sub-goals, and provided services for the pilot applications to be carried out within the project (three pilot applications are planned with the project: in Slovakia – getting a building permit, Poland – establishing a company, and Germany – getting married scenario). The *requirement-driven approach* [14], [15], a 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. This 7-step procedure starts with identification of users' information needs for particular case and continues with analysis and creation of more formal representations as controlled vocabularies and ontology-like networked structures of concepts and relations (Figure 1).

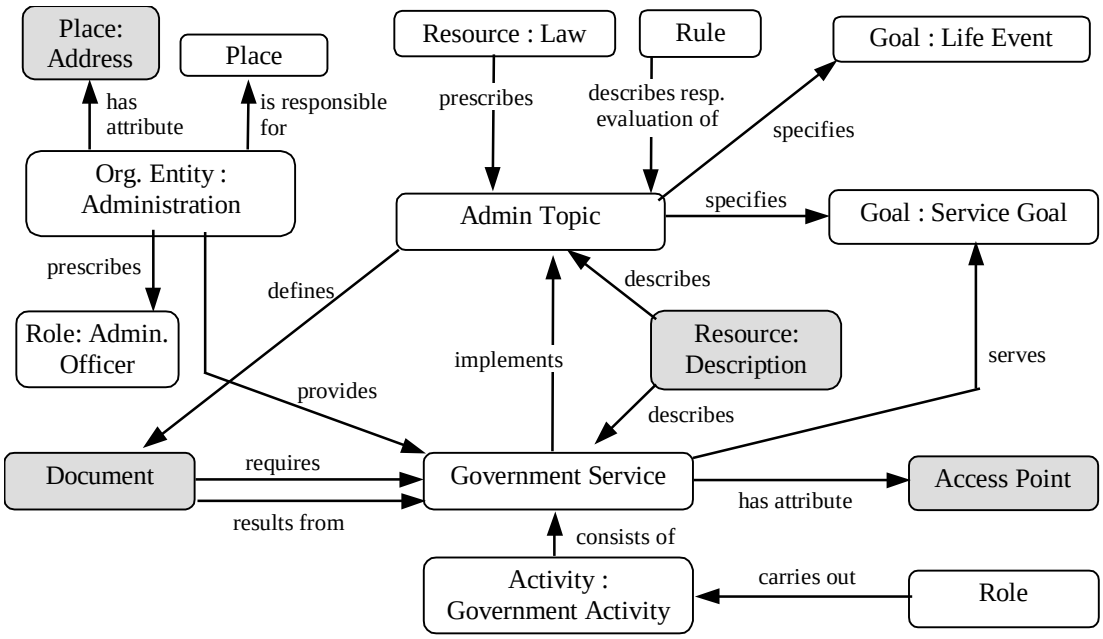

Figure 1: Ontology-like structure of identified terms (concepts) and their relations

At the end of this process, a fully formalised ontology expressed in WSML language is produced, containing all the semantics of life events, goals, services, and workflow structures. For example, the ontology fragment depicted in Figure 2 presents the WSML formalisation of the life event for "getting married" (expressed as a complex goal) by means of the orchestration interface. By interpreting this formal description, first a batch of answers to the pre-defined questions (Q1) needs to be provided by the user. Then other sub-goals (*ApplyForMarriageGoal*, etc.) need to be achieved in a proper order. Transitions in the *controlFlow* part express that all the nodes are executed in a sequence. The *dataFlow* part specifies that the variable from the first node (n1_1, the batch of questions) is equivalent to the variable from the decision node (n1_2).

```
namespace {_"http://www.accessegov.org/ontologies/shg/",
  dc _"http://purl.org/dc/elements/1.1#",
  aeg _"http://www.accessegov.org/ontologies/core/"}
goal MarriageLifeEvent
  nfp dc#title hasValue "Marriage" endnfp
  interface MarriageLifeEventInterface
   orchestration
    workflow
      perform n1_1 receive ?x memberOf Q1.
      perform n1_2 achieveGoal ApplyForMarriageGoal
      perform n1_3 achieveGoal WeddingPlaceReservationGoal
      perform n1_4 achieveGoal WeddingCeremonyGoal
    controlFlow
      source n1_1 target n1_2
      source n1_2 target n1_3
      source n1_3 target n1_4
    dataFlow
      source n1_1{?x} target n1_2{?x}
```

Figure 2 : Fragment of the ontology in WSML notation

The whole process of design and creation of ontologies, based on the requirement-driven approach, as it was carried out within the Access-eGov project for all the pilot applications, is described in detail in [14]. As a result of the 7-step procedure, the following ontologies were created and formalised by WSML language:

- *Access-eGov Core Ontology* containing definitions of basic elements (concepts, attributes, relations) that are shared among the pilot applications and used for annotation of the atomic services. The Core ontology was extended for the German field test, due to complex structure of spatial responsibilities (see description of the pilot applications in the next section).
- *Life-Events Ontology* containing conceptual descriptions of life events, complex goals (also referenced as generic scenarios), and elementary sub-goals for the pilots. Separate Life-Events ontologies were produced for each of the pilot applications.
- *Domain ontologies*, providing domain-specific information for the pilots. The ontologies are fully localized (concepts have labels in several languages – in this case the labels are in English, German, Polish, and Slovak language) and include concepts for description of forms, documents, certificates, location constraints, fees, questions, notification messages, etc. that are necessary to model the inputs and outputs of the provided government services. Separate domain ontologies were produced for each of the pilots.

From the side of the Access-eGov system, these ontologies can be seen as an interface between the technical infrastructure design and the pilot applications. They provide a specification of the inner data structure for system components responsible for discovery, composition, mediation, and execution of services [11].

The ontologies also provide a framework for *semantic annotation* of government services. The semantic annotation can be defined as a formal description of provided services by means of ontology elements, including a composition of the services into more complex goals and life events. This is a key issue, which enables integration and interoperation of services on a semantic basis. The semantic annotation and maintenance of semantically described services is the task of PA employees - they should use the concepts from the ontologies (mostly from the domain ontologies) to specify functional properties, i.e. required inputs and outputs, as well as non-functional properties, i.e. descriptions and preconditions, as parameters of the

services. However, since the semantic annotation of services has to be formally expressed in WSML language, a software tool supporting the annotation process in a user-friendly way is needed. The above mentioned WSMO Studio can be, in principle, used as such a tool, but it is dedicated mostly for WSMO/WSML specialists and is too complicated for standard PA employees with very limited or no knowledge of semantic technologies. This was the reason, we have decided to develop a specialised Annotation Tool [16], which will be easy-to-use and will require only standard PC skills.

2.1 – Annotation Tool

The *Annotation Tool* (Figure 3) was implemented as a standard web application, using the extended WSMO object model and JSF technology. The tool provides for PA officers a set of forms for specification of preconditions and non-functional properties as parameters of the government services. A template mechanism was implemented to ease the maintenance of predefined workflow sequences for the annotated services. A simple user access control and multilingual support, on both interface and data level, is also included in the Annotation tool. In addition, a simple "content grabber" functionality enables to link particular field in the form (i.e. the value of a service parameter, e.g. service hours of an office) with an element on an existing web site of the public administration. This solution enables to annotate the external web pages and semantically integrate their content into a unified eGovernment application.

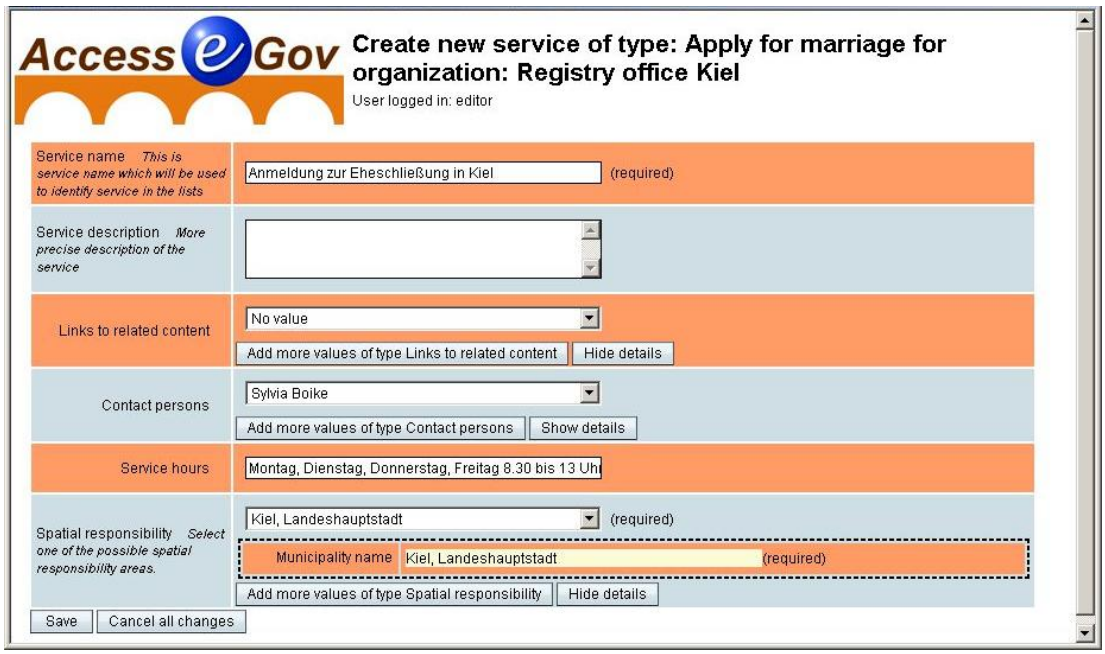

Figure 3 : Annotation tool, user interface. Annotation of a service.

2.2 – Personal Assistant Client

On the side of citizens, the *Personal Assistant Client* (Figure 4) was developed as a tool that provides browsing, discovery, and execution capabilities of proper services for citizens and businesses according to a specified life event or goal.

Again, the Personal Assistant Client was implemented as a web application using JSF technology. Layout, structure, and ordering of tabs in the interface are dynamically created from the annotated services and are customised based on the conditions of the given user.

After selecting a life event, corresponding navigation structure of sub-goals and services is displayed for users in the form of textual information, hyperlink, a field for inserting a specified input value, or an interface for invocation of a web service. Users can browse sub-goals and provide their answers when customisation input is requested. Then the system automatically resolves the sub-goals and navigates the user to a new set of sub-goals and services inferred from the conceptual model. The Access-eGov system can also directly invoke electronic services provided via standardised web service interface. Finally, the user obtains all available information on the life event customised to his/her case, and has also the possibility to execute the actions required for particular services needed for the accomplishing of the life event.

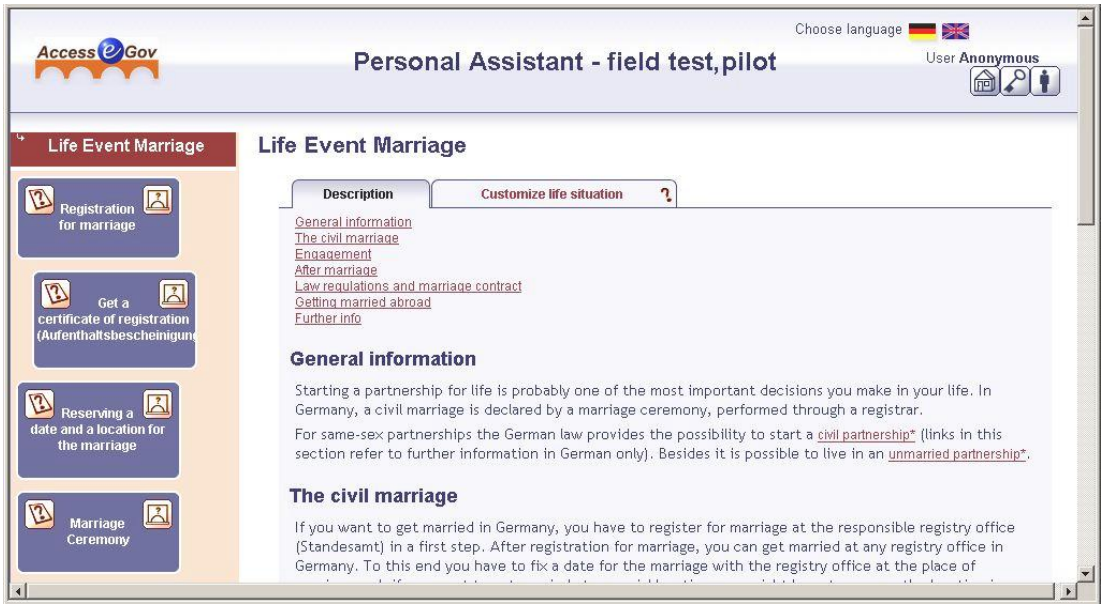

Figure 4 : Personal Assistant Client, user interface. Browsing the Marriage Life Event

In the following section, the Access-eGov pilot applications are described. Focus is put on testing tools providing enhanced service interfaces as well as on the retrospective evaluation of the ontology design approach.

3. – Pilot applications

The first trials of the Access-eGov platform were carried out from October 2007 to January 2008 on three pilot applications and one lab test. As an initial testing of the developed tools, the lab test took place in Egypt, carried out by the German University in Cairo, to ensure the functionality and technical capabilities of the whole system. After the tools were ready for installation and usage by user partners, a field test in Germany and two pilot applications in Slovakia and Poland were carried out to test the applied approach within real settings in the public administration.

3.1 – Lab test in Egypt

The *lab test in Egypt* was designed to test the information consumer perspective through the use of the Personal Assistant Client. Testers were recruited among the students and were asked to perform and document a series of tasks. The documented results were later evaluated with regard to the completeness and correctness of the received information.

The tasks were designed using the scenario and ontology from the German field test and were intended to bring the test as close to real-life situations as possible. 14 testers performed three different tasks each (42 test tasks in total) over a period of three days. The tests were conducted as supervised lab tests with the focus on real-life tasks. Each task took around 90 minutes to complete including organisational overhead. One task was focused on those aspects of the Personal Assistant Client that deliver non-personalised information, while other two tasks focused on customisation by providing personalised information.

3.2 – German field test - "Getting married"

The *German field test* was carried out by Ministry of Finance of Schleswig-Holstein in Germany. It was focused on the life event "marriage" and related procedures. The main aim of this field test was to test integration of different web resources containing the service information and making them accessible via a single platform but still leaving the data and its maintenance in the municipalities' legacy systems. The process of semantic annotation of existing heterogeneous web resources should make the meaning of the distributed information explicit and should allow integration and interoperability of this annotated data. In the "marriage" life event usually different registry offices have to be contacted by citizen to obtain documents necessary for the marriage. Services of the registry offices in Schleswig-Holstein were thus annotated on the basis of a common conceptual model and made accessible via the Access-eGov platform.

The registry offices of eleven municipalities from Schleswig-Holstein have been involved in this field test. Two main phases in the trial can be distinguished: First, the administration officers created service annotations using the Annotation Tool. After that, citizens where asked to use the Personal Assistant Client to retrieve information about these services. In the first phase (September - December 2007), different registry offices described their government services, following the steps of the requirement-driven approach described above (to facilitate this a short training to the involved public servants was delivered). Life events and domain ontologies were produced and the Annotation Tool was updated according to the underlying conceptual model.

In the second phase of the field test (January - February 2008), the Personal Assistant Client providing the support for "marriage" life event was tested and evaluated by the involved municipalities and by the public. For this quite extensive dissemination activities were carried out and an online questionnaire were used for evaluation of the SW tools used.

The results of evaluation of all the pilot applications are presented in section 3.5 below. More detailed description of the German field test, including the process of conceptual model development and specific evaluation of both methodology and tools is provided in [17].

3.3 – Slovak pilot - "Obtaining a building permission"

The *Slovak pilot* has been carried out by the Kosice self-governing region and the municipality of Michalovce. It was focused on supporting citizens during the process of obtaining a building permit, including complex services related to land-use planning and approval proceedings. The objective of this pilot was to make the whole process easier and transparent for citizens, to provide all relevant information about necessary services in a comprehensive and user-friendly way, and finally to improve the service from the citizen's point of view.

At the beginning, a set of four scenarios (i.e. scenarios for land-use proceedings, building proceedings, merged procedure of land-use and building proceedings, and final approval proceedings) for the life event of obtaining building permission was formulated and, using the procedure of requirement-driven approach, the corresponding ontologies were produced. An installation of the Annotation tool connected to this conceptual model was created, which was then used for extensive testing, training of public servants, and annotation of the services. The Personal Assistant Client was connected to the conceptual model containing the annotated life events and services, and the interface of the tool in Slovak as well as in English language was provided.

3.4 – Polish pilot - "Establishing an enterprise"

The *Polish pilot* took place in the Silesian region and was performed by the Gliwice City Hall (GCH). The user scenario of the example process was focused on the life event "Establishment of an enterprise" and involved four main user goals: registration in local government, registration in statistical office, registration in tax office and registration in social insurance agency. The objective of the Polish pilot application was to provide a single entry point where users (citizens and entrepreneurs) can obtain relevant information and are properly navigated by the system within the whole complex process.

Preparation of the pilot was similar as in case of the Slovak pilot. The scenarios prepared contained a detail description of all the steps of the process, as e.g. registration into various institutions, possible paths of registration dependent on individual user's case, all required documents and forms as well as information which must be collected from the user to construct the path relevant to user's needs. According to the scenarios, relevant services (both electronic and traditional services) were identified and information on service providers in the Gliwice area was collected . Using the requirement-driven approach, the data were formalised into the underlying conceptual model.

GCH is an institution of the first contact for citizens interested in establishing an enterprise and often plays the role of information provider and proxy between citizen and the statistical or tax office. GCH was thus able to formulate the user requirements as the most frequent requests of citizens. According to the defined user requirements and identified types of available services, a schema of a "dialogue" with the user has been prepared. All of the questions were formulated as Yes/No questions or questions with a predefined set of answers. Depending on previously chosen answers, further questions are asked and the requirements and relevant forms are introduced to the user. Installations of the Annotation Tool and Personal Assistant Client were created and connected with the produced conceptual model. The interface was translated into Polish language. The testing carried out in realistic setting was similar than in other pilots. The Personal Assistant Client was tested by public in February 2008. There were three groups of testers: domain experts (GCH civil servants involved in process preparations), IT experts (Polish project members) and "the public" (common citizens, people not involved in the Access-eGov project).

3.5 – Evaluation of the pilot applications

Evaluation of the pilot applications within the first trials can be divided into evaluation of the client-side tools (Annotation tool and Personal Assistant Client), and the evaluation of the Access-eGov system in general. Feedback from users shows only minor differences between the evaluation results achieved within the pilot applications, so we can summarise and generalise the results for all the pilots together.

The Annotation tool served its purpose well during the testing. The feedback from the tests shows that the tool was relatively easy to use and was even successfully used by untrained annotation authors who had only a short user manual at their disposal. Few annotators found the process of semantic annotation "not so easy ", because of non-intuitive use of the Annotation tool and a lack of understanding of the information required to be filled in. Also a mixture of user roles and respective rights caused some difficulties. Most of these issues have already been fixed during the trial. Generally, the annotators managed to annotate all services and found the Annotation tool useful and efficient.

The Personal Assistant Client was evaluated by online questionnaire, and in the case of German field test also at the workshop with public authorities, and also by the "think aloud" sessions. The participants tested the quality of provided information, speed, structure and layout of the web site, as well as its navigation and usability in general. The results indicate that system users would welcome improvement of the user interface, especially in its structure, design and navigation among services. Users prefer a step-by-step guidance and ordering of the services instead of having a list of all process steps available (which could be invoked by the user at that time).

On the other hand, the feedback from users does not indicate any drawback in ontology and the underlying conceptual model. Minor comments were on translation of specialised terms (linguistic issues). However, the correctness of the ontology structure indicates that the methodology used for ontology development is correct and provides good results.

A little surprising (at least for system designers and developers) was the fact that users of the Personal Assistant Client found confusing that there was no indication of difference between traditional and electronic services. Original intention was to put all the services (whether traditional, web forms, or web services) on the same level. The feedback from users shows that equal treatment of all types of services is in principle good, but still an indication of the service type on the level of user interface would be welcomed.

4. Conclusion

Evaluation in several different real settings has proven feasibility of the idea presented in the paper. Citizens highly appreciate support in identifying services relevant to their life situations and combining those services in a context-wise way to produce customised scenarios, which are able to cope with various situations citizens are facing. On the other hand, the idea is also quite attractive for public administrations providing services since services are being integrated in a 'front-office' manner – i.e. without interfering with existing working administrations and/or back-office integration. Since this approach enables to combine traditional (face-to-face) paper-driven services with electronic services, it could serve as a vehicle for public administrations to transform their processes in a step-by-step manner, while imposing only low entry barriers - by simply integrating services as they are currently provided and subsequently upgrading traditional services to electronic ones.

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