Semantic Integration of eGovernment Services in Schleswig-Holstein

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Abstract. The paper presents an example of e-government service integration on a semantic basis, as it was designed within the Access-eGov research project and applied in the Schleswig-Holstein state government. The case study follows up the application of a requirements-driven approach for designing e-government service interfaces with respect to the informational needs of citizens and business users. Using this approach, a conceptual model for e-government services was developed, formalised in the WSML ontology language, and used for semantic annotation of the services as a basis for integration. A subsequent field test was focused on the evaluation of produced semantic description on the client-side system components as Annotation tool and the Personal Assistant Client. The results of the field test have been evaluated and are presented in as lessons learned.

Keywords: Semantic interoperability, e-government, service integration, WSMO, user-driven approach.

1 Semantic Interoperability of E-Government Services

Given the diversity of information and processes on local and all upper levels of administrative services, semantic interoperability is perceived as a key aspect on the road to e-government integration and improved service quality. Multiple interoperability frameworks have put semantic interoperability on the agenda; for example the European framework [3, p. 16] defines it as "ensuring that the precise meaning of exchanged information is understandable by any other application that was not initially developed for this purpose" and enabling systems to "combine received information with other information resources and to process it in a meaningful manner". This framework also points out that the semantic interoperability is related to the specific e-government services as they are serving life event or business episode [3, p. 20].

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The requirements of (semantic) interoperability, i.e. technical capability for interoperation, derive from the challenges of integration: "E-Government Integration is the forming of a larger unit of government entities, temporary or permanent, for the purpose of merging processes and/or sharing information." [11]. Most integration cases in the area of e-government are concerned with merging existing and/or creating seamless electronic services.

Semantic integration of e-government services means in this context that all relevant information, which is processed to enable information sharing and process handling within seamless services, is based on successful mediation and/or translation of the meaning the processed information has for the service users (citizens, businesses, even other administrations) and/or for the service providers (one or more administrative units, maybe also private service providers).

Despite some available standardization, the main challenge of achieving semantic interoperability in e-government rests with the administrations as the providers of the services. For semantic integration based on Semantic Web technologies, machine-readable enhancements of process information are needed, based on understanding of the content. This cannot be done by a simple one-step procedure, and administrations, facing the paramount annotation effort required to enable machine processing, are still seeking for best practices that may guide them in these activities. Research is ongoing (e.g. [1], [2], [11]) but applying and testing semantic technologies and solutions on a large scale is quite a challenge in the huge, diverged and distributed environment of public administration (cf. [13]).

The underlying research question of this paper is: what are appropriate approaches which guide administrations effectively and efficiently in transforming their web resources towards the Semantic Web in order to achieve semantic integration of the provided services? By 'effectively' we mean successful in meeting requirements of administrations, citizens and businesses; and 'efficiently' refers to use of limited resources, scalability and applicability in real-life administrative environments.

The contribution of this paper is based on a case study conducted within the frame of the Access-eGov research project (see www.access-egov.org): we follow up on the application of a requirement-driven approach (proposed to support semantic integration of e-government services) in Schleswig-Holstein as well as on the subsequent field test in order to evaluate the efficiency and effectiveness of the applied approach, to discuss the lessons learnt and propose future research based on this case study. The data for this research was collected through individual documentation of workshops within the administration, analysis of design/development documents, "think-aloud" observations of administration staff members as well as citizens as service users, and online survey among service users. All authors of this paper have contributed to preparation, execution and evaluation of the Schleswig-Holstein experience for more than two years. However, individual contributions have contributed according to specific roles such as software developer, method developer, ontology creator, information manager, trainer, and evaluator.

The paper is structured as follows: the next section describes the semantic interoperability and integration challenges as well as the expectations towards Access-eGov technologies from the perspective of the Schleswig-Holstein state government. The third section briefly outlines the requirement-driven approach for (re-)designing e-government service interfaces and then follows up step by step the application of this

approach in Schleswig-Holstein. The fourth section focuses on the field test of the enhanced service interfaces and the retrospective evaluation of the design approach. The final section summarises the lessons learned, suggests improvements for practice and concludes with outlining future research.

2 E-Government Integration Challenges in Schleswig-Holstein

The German federal state of Schleswig-Holstein consists of 1,120 municipalities, which belong to eleven different districts (*Kreise*). While the larger municipalities have their own administration each, there are more than 900 municipalities with less than 2,000 inhabitants which share a common administration with several municipalities. All these administrations offer a set of services to their citizens, like issuing passports, wage tax cards, and different kinds of certificates or registration of enterprises, new places of residence, marriages, deaths, births etc., resulting in a huge amount of municipal services offered all over the state. In addition to these, there are services that are offered by administrations at the district, state and national level.

In a given life situation, for instance when wanting to build a house, get married or establish an enterprise, different offices of different administrations have to be contacted by a citizen to get the required documents, forms, permits etc. At the beginning of such a process, citizens often do not know which offices of which administrations they need to contact and they need to find the responsible administrations, using for example various government web sites. The e-government services of the different administrations are usually not integrated and cannot be accessed by citizens via a single platform. Therefore, citizens who want to use the e-government services have to access a variety of web sites to get the information on relevant services and to possibly also use them. On the other hand, each local administration offers mostly identical information on the same kinds of services.

The state government Schleswig-Holstein is aiming at integrating the different web resources containing the service information and at making these accessible via a single platform but still leaving the data and its maintenance in the administrations' legacy systems. An approach to this is suggested in the research project Access-eGov in which semantic annotation of web resources is supposed to make the meaning of the distributed information explicit and to thus allow to integrate it in a system interpreting this annotated data. The annotated data can then be used for displaying and searching the services, and also for generating a user scenario in which different services are combined according to a citizen's needs. For the semantic annotation however, a common conceptual model of the service descriptions is required: the relevant concepts, attributes and relations that make up a service description and the relevant administrative processes have to be identified and agreed upon.

In a field test in Schleswig-Holstein, accomplished within this research project, this approach has been followed on the example of the life event "marriage". In this life event, possibly different registry offices have to be contacted one after the other by a citizen to issue the required documents in preparation of the marriage. The services of the registry offices in Schleswig-Holstein were thus to be annotated on the basis of a common conceptual model and to be made accessible to the Access-eGov platform.

Eleven registry offices (responsible for about one fourth of the state's inhabitants) volunteered to participate in this field test. Their participation was bound to the condition that little time and effort would be required for service annotation and that existing IT systems would not necessarily have to be changed. Therefore, a tool for annotating data, which can easily be used in any environment and by untrained users, and which allows effective service annotation, was required.

3 Semantic Integration Based on a Requirement-Driven Approach

Drawing on information architecture and information quality concepts, Klischewski and Ukena [7], [8] introduced a requirement-driven approach for designing e-government service interfaces in relation to users' informational needs. The suggested process alerts the administrations to focus on the intended common understanding of citizens (or businesses) and administrations concerning the description of the service. The design approach includes the following tasks:

1. Identify informational needs: Analyzing prior knowledge of citizens and the diversity of informational needs of different groups of citizens.
2. Identify required information quality (IQ): Informational needs of each user group are analyzed with respect to required IQ properties: scope, relevance etc.
3. Create glossary of topics & terms: A glossary is created that contains all relevant topics and terms needed for describing the services in question; each entry provides a short description of the topics and the corresponding informational needs.
4. Create controlled vocabulary: Based on the glossary a controlled vocabulary is created: each service and general topic to be described should be represented by a main term and possibly additional related terms.
5. Group & relate terms: Relating all items of the controlled vocabulary through defined relations.
6. Design an ontology: Fixing the meaning of the terms and their relations in a formal way; verifying that formal meaning reflects informal description in the glossary (and vice versa).
7. Implement semantics: Use of the above constructs for service description and operation (e.g. creating service profiles in WSMO).

This approach has been applied in order to meet the integration challenges in Schleswig-Holstein and to improve the semantic interoperability between the technical systems involved. In the following, for each of the steps we describe the tools used and the outputs generated, as well as specific problems faced during application of the approach (due to limited space for presentation we combine the description of two subsequent steps).

3.1 Analysis of Informational Needs Required Information Quality

The first two steps were accomplished by specification of a scenario and use cases, described in a free-text form, which was then transformed into a more structured table

format containing identified information needs — goals and corresponding services. The scenario describes what two citizens, one with German citizenship and one with a foreign citizenship, need to do in order to get married, and how they use Access-eGov system (AeGS) to support them in manoeuvring through the administrative process.

A list of proposed services together with related information (laws and regulations, required documents etc.) was thus compiled as depicted in Table 1.

Table 1. Example: Identification of information needs (user's goals) and corresponding administration services

Goal, aim of the citizen	**Corresponding service**
Get a marriage certificate	**Name:** Issue a marriage certificate **Description:** If the citizens want to, they can obtain a marriage certificate after marriage. Also international marriage certificates can be obtained. **Responsible:** The register office at the marriage location **Costs:** 7 Euros (cost for further copies: 3.50 Euro)

For the user partners within the project, it was not always clear what kind of information was expected from them. So the tables for identifying information needs were constructed in tight co-operation with system developers, using UML diagrams and workflow modelling schemas to obtain a visual representation of the modelled entities. In addition, special attention had to be paid to the detailed description of spatial responsibilities of geographically distributed offices, in order to be able to integrate their services for the given scenario.

3.2 Creating Controlled Vocabulary

From the previous tables, a glossary containing all relevant topics and terms related to the modelled services was created in a table format with columns for the terms in German and English languages, accompanied with a short description what the term means and how it relates to other terms. The glossary terms were then grouped and organised into hierarchical subgroups of categories (see Table 2):

Table 2. Category *Document* from the Access-eGov controlled vocabulary

Category: **Document**	
Subcategories:	Certificate, Form, Notification, Payment Receipt
Attributes:	Title, Description of purpose
Description:	Used for concepts that refer to the artefacts as: *certificates* provided by the administration, *forms* to be filled in by citizens, *notifications* issued by an administration in order to inform a service consumer about certain changes in status, *payment receipts* which a citizen receives after having paid a fee.

3.3 Design and Implementation of Ontologies into the AeG Platform

As a next step (step 5), a set of other relations and mutual dependencies was identified between the categories and concepts, using the relationships expressed in the textual descriptions of the categories. In addition, elements of the WSMO conceptual model, enhanced and modified for the purposes of the AeGS [4], as well as several existing standards and ontology resources[1] were reused and combined with the categories from the controlled vocabulary. This resulted in a conceptual model, of which a fragment is depicted in Figure 1. The figure shows the identified domain concepts (represented as rounded squares) and their relation (represented as named arrows). The boundary objects [7], highlighted in grey, can be directly instantiated and were used to annotate the non-functional properties of the services.

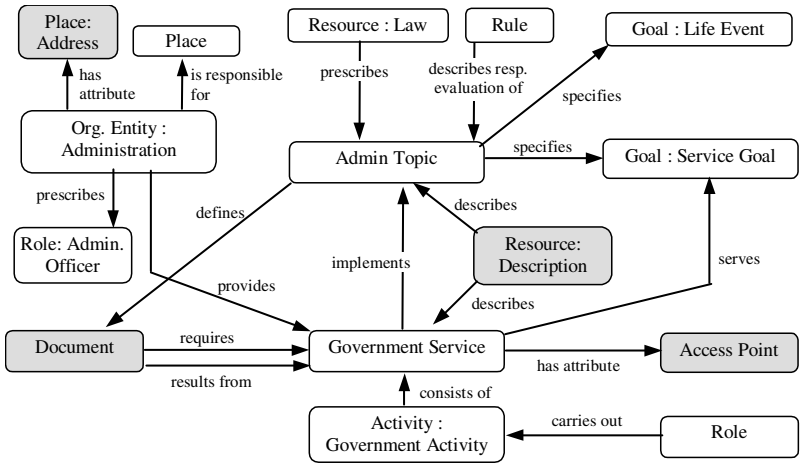

Fig. 1. Fragment of conceptual model, as it was identified for the Access-eGov system

Based on this model, the resource ontologies for life events, service profiles, and domain concepts were developed and implemented in WSML [4]. The resulting ontology was communicated back to the user partners (domain experts) by re-writing it into the tables of goals and services (Table 1) in order to verify that the formal meaning reflects the informal descriptions in the glossary. This proved to be necessary a couple of times and after several iterations, the meaning of terms and relations was fixed and the formal WSML representation of ontologies was produced.

3.4 Annotation of Government Services

The ontology specified in the previous step was further enriched by "business rules" consisting of conditional if-then-else expressions, loops, and workflow sequences, to

[1] Namely, DublinCore (dublincore.org) was used for metadata and document types; vCard (www.w3.org/2006/vcard/) for addresses and personal data; WSMO ontologies for description of date, time, and location; Terregov, DIP, DAML, GEA, GOVML, AGLS metadata set, and IPSV ontologies were reused for description of specific e-government concepts [4], [7].

be capable of modelling complex structures of government services and scenarios. A common way for the semantic description of workflow structures is to use a choreography and orchestration process model. The WSMO framework provides the model based on the Abstract State Machines (ASM) [5]. However, the process model is used within the AeGS to guide citizens to achieve specific goals and to co-ordinate activities performed by all actors — citizens, traditional public administration services, and web services. Skokan and Bednar [12] have found that the current proposal of the WSMO specification [10] does not fit these objectives, because models based on state machines are not structured in a way suitable for the interaction with the human actors. For these reasons, an extension of the WSMO specification was designed and implemented [12]. The extended model is based on the workflow CASheW-s model [9], originally proposed for the OWL-S specification, with the dataflow and WSMO mediation extensions. The Access-eGov model reuses the state signature from the WSMO specification and replaces the ASMs transition rules with the workflow constructs. A shared ontology state signature allows reusing grounding of the input and output concepts to the communication protocols via WSDL. The workflow model consists of activity nodes. A node can be an atomic node (*Send*, *Receive*, *AchieveGoal* and *InvokeService*), or control node (*Decision*, *Fork* and *Join*).

The example below presents the WSML formalisation of the life event for marriage (expressed as a complex goal), by means of the orchestration interface:

```
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}
```

By interpreting this formal description, first the batch of answers to the pre-defined questions (Q1) needs to be received from the user by the process. Then the other subgoals (*ApplyForMarriageGoal*, etc.) need to be achieved in the right 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).

A formalised WSML representation of the ontology containing all the definitions (concepts, classes) of services, goals, and life events can be produced as a result of the 7-step procedure. To use this ontology in a real e-government application, the *Annotation Tool* [4] was designed in the Access-eGov project and implemented as a standard

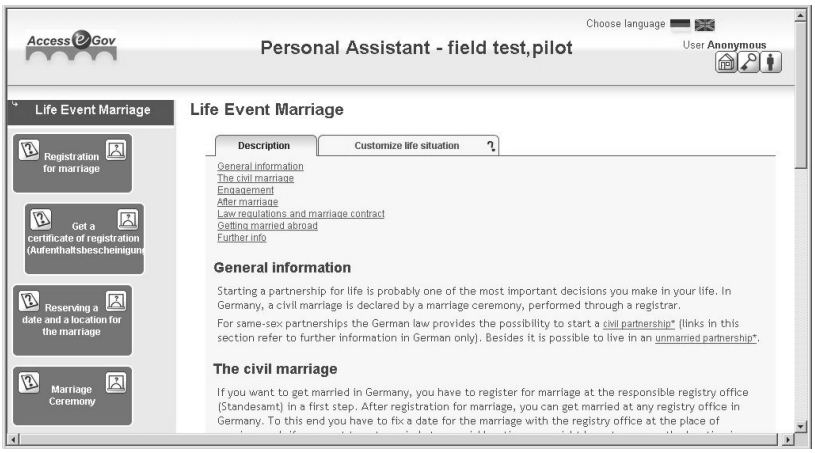

Fig. 2. Personal Assistant Client, user interface. Browsing the Marriage Life Event.

web application, using the WSMO object model and JSF technology. The Annotation Tool enables administration officers to specify the non-functional properties as parameters of the services. A template mechanism was implemented to ease the maintenance of pre-defined workflow sequences for the annotated services. The tool provides a simple user access control and multilingual support on both interface and data levels. In addition, a simple "content grabber" functionality enables linking a 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 the annotation of the external web pages and semantic integration of their content into a unified e-government application.

On the side of citizens, the *Personal Assistant Client* (Figure 2) was developed as a tool that provides browsing, discovery, and execution capabilities of proper services according to the specified life event or goal. In the following section, the field test of using the tools providing enhanced service interfaces and the retrospective evaluation of the design approach is described in detail.

4 Application Test and Evaluation of Design Approach

The objective of the field test in Schleswig-Holstein was to ensure the involvement of the public administration in order to include their domain expertise into the design of the ontologies, to evaluate if the citizens' and administration officers' requirements were met, and to test the components in a real world setting. In particular, by testing and evaluating the Personal Assistant Client, it was to be verified:

- if the information quality meets the requirements of the information consumer,
- if the information is provided in such units in the semantic mark-up component that it can be displayed in a sufficiently structured manner, and
- if the used information is correct from the service providers' point of view.

The first trial of the field test took place from October 2007 to January 2008. The results of this trial will be used for the further modification of the AeGS components.

4.1 Trial Test in Schleswig-Holstein

Two main phases of the trial can be distinguished: First, the administration officers had to create service annotations by using the Annotation Tool. After that, citizens where asked to use the Personal Assistant Client to retrieve information about these services.

The implemented ontologies (cf. section 3) together with the Annotation Tool were prerequisites for the beginning of the first phase. At this point, administration officers had a tool at their disposal to carry out the actual annotation of their services. In order to facilitate the annotation effort and support the administration officers, a training workshop was conducted during which officers in the participating administrations of Schleswig-Holstein started annotating the services that are related to the life event marriage. The annotation was completed successfully by all officers within a few weeks following this workshop. Officers who were not able to attain the training were provided with a short handbook on the usage of the annotation.

After completing the annotation procedure by the officers, citizens used the Personal Assistant Client to help them to locate the information about services related to marriage. In order to reach as many citizens as possible, announcements were released to the press as well as posted on the web sites of participating communities. In addition, the administration officers were asked to inform citizens about the availability of the Personal Assistant.

4.2 Evaluation of the Trials

The evaluation was carried out, using different tools for different target groups and test objectives: online questionnaires, "think aloud" sessions[2] [6], and user workshops. The evaluation of the Annotation Tool consisted of a user workshop and a "think aloud" session. The feedback was collected, prioritised, and provided to system developers in order to modify the tool accordingly. The Annotation Tool proved to be relatively easy to use and was even successfully used by untrained annotation authors who only had the short handbook at their disposal. Feedback from the officers during the workshop showed that the properties for the description of services met their requirements. However, for administrations that had to annotate the services of about 10 to 25 municipalities in their area of responsibility, the manual labor of entering the annotation was time-consuming. This was anticipated and partial automation of this process is planned for the second trial. The "think aloud" session revealed several issues regarding the usability of the user interface. Most of these have already been resolved during the first trial while some were postponed to the second trial.

The Personal Assistant was evaluated by a workshop with public authorities, as well as "think aloud" sessions and an online questionnaire, both aimed at citizens. With the online questionnaire, system users were asked to assess the system's information quality

[2] Users were video-taped while using a prototype of the Annotation Tool and the Personal Assistant Client and were asked to say aloud what they are thinking when using the system to complete a certain task.

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 tool could support users in the specific life situation to manage the life event, to identify the required steps, the involved offices, and finding out what traditional or electronic services these offer, i.e. to compose the different services in such a manner that it could be understood by citizens. In the workshop for the evaluation, administration workers (service providers and Internet authors) were asked to discuss the Personal Assistant among each other. The results of the discussions were then collected and ordered according to priority from the participants' point of view.

These tests and the workshop resulted in a set of new requirements and change requests regarding usability of the system. With respect to the provided information and its structuring, citizens found that the descriptions were in some cases too long and not sufficiently structured. It seems that the textual descriptions of concepts in the ontology need to be adapted to a greater extent to a hypertext environment, i.e. as short texts with links to additional information instead of one long text. Furthermore, the usage of administrative terminology in the interface proved to be lead to misunderstandings in a few cases; the problematic terms were identified and were adapted to common language. Only few changes were required to ensure the correctness of the provided information from the service providers' point of view.

To summarise, the feedback from citizens and administration officers suggests that the main areas that require improvement are usability aspects of the respective user interfaces. The collected data shows no indication that the implemented ontology and the underlying conceptual model have any defects.[3] Furthermore, the conceptual model does not initially differentiate traditional and electronic services, thus giving the same labels to traditional and electronic services fulfilling the same goal. For citizens using the Personal Assistant this was confusing because they cannot immediately tell what kinds of services are offered.

5 Lessons Learned and Future Work

By using the approach outlined above, it proved to be possible to design an ontology for the annotation of service profiles, which could be used to integrate different services of different administrations that are relevant in a given life event. According to the achieved results and evaluation presented in the previous section, the requirement-driven approach to developing the semantic structures has proved to be effective as there were no major changes required to the ontology and conceptual model, neither with respect to citizens looking for services information nor with respect to administration officers annotating the services. To this end we conclude that the presented method is suitable as a framework for supporting the interoperability of heterogeneous government services provided by geographically and/or hierarchically distributed administration offices. However, several issues were identified by users as more or less problematic and will need further elaboration in the second prototype. We believe

[3] It must be mentioned, however, that this is currently a conjecture which still remains to be verified in a more systematic way during the second trial.

that at least some of these lessons learned can be generalized on the field of e-government as whole:

(1) The glossary turned out to be a central artifact of communication between all actors involved in the design and implementation of the ontology. However, the intended usage of the glossary was not completely clear from the beginning. This led to some uncertainty how the terms in the glossary should be described. In practice, the description of the glossary terms was intended by its author (the information manager) to describe the relevant concepts *for* the developers *from* the user's point of view. This is in accordance with the approach as described above. However, the developers also used the descriptions from the glossary in prototype of the Personal Assistant Client *as is*. This was not anticipated nor intended by the information manager but seemed logical at the time from the ontology creator's point of view.

(2) The importance of the human-computer interface cannot be underestimated as it directly affects the usability of tools and has significant impact on user satisfaction and on the efficiency of the whole process. This interface, despite the sophisticated and complex technology behind, needs to be simple and intuitive, and should be in line with the life-event approach. Furthermore, in order to bypass the usability impact, the overall evaluation strategy should be amended by approaches (e.g. an electronic test agent) which do not primarily rely on human user activities and performance.

(3) Integration of electronic and non-electronic traditional services (one important aim of the Access-eGov project [4]) remains a challenge. It seems that on the semantic level the differentiation between traditional and electronic services is necessary, as non-electronic services need more initial effort for description and explanation in order to enable users to decide and select proper sequence of services according to their individual preferences.

The trial and its subsequent evaluation also revealed demand for future research, mainly concerning the scalability and efficiency of the requirement-driven approach. The main limitation of the first trial has been the existence of only a few pre-defined service scenarios (implemented as WSML statements); therefore it has to be ensured that the ontology will scale to all kinds of services that administrations have to offer, i.e. that the ontology can be used to represent all government services. This extension implies necessity to enrich the functionality of the Annotation Tool, which should support creation, customisation, and maintenance of all the required service descriptions and complex service scenarios.

Additional research is also necessary to validate that content of legacy systems, which contain (partial) service descriptions that lack semantic annotation, can be integrated as well. During the first field test, the Annotation Tool has been used as a means of semantically annotating service descriptions manually, which resulted in duplicate data if the data existed already in legacy systems. Again, for efficiency reasons is not desirable from the service provider's point of view. A "content grabber" and a Web service based approach are being investigated for the second trial as a possible solution to automatically collect relevant service descriptions from annotated web resources and legacy systems.

All in all, the state government of Schleswig-Holstein considers the trial application of the requirement-driven approach for designing machine-readable services

interfaces as a successful step towards semantic integration of its e-government services. At the time of writing, dissemination activities are ongoing aiming for continuation of this integration approach, even beyond the state's geographical and electronic borders.

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