

An Activity-based Approach Towards Development and Use of E-government Service Ontologies

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Abstract

In order to assist bottom-up efforts by administrations annotating their Web resources with adequate metadata, we introduce and follow an activity-based approach towards development and use of ontologies for e-government services. Specifically, we analyze two scenarios related to e-government services through identifying goals and activities of administrations and their clients, on the basis of which we determine the need for sharing perspectives and (electronic) boundary objects. We claim that such an analysis narrows down development and use of metadata, lowers the barriers of ontology usage (for metadata production), and efficiently guides development of e-government ontologies towards the needs of citizens, businesses and administrations alike.

1. Introduction

The vision of the “Semantic Web” has received considerable attention also in the area of e-government. With “semantic interoperability” high on the agenda of many e-government frameworks, many projects are under way seeking to exploit the potentials of the available basic semantic technologies. In particular, many experts emphasize the importance of incorporating metadata and ontologies (see section 3), but good practice and guidelines for design, development, implementation and operation of semantic solutions in e-government are still under research. Up to now, most research efforts on e-government ontologies start from modeling the domain or from technical considerations. In contrast to these top-down approaches, we assume that dissemination of the Semantic Web in e-government also requires substantial bottom-up efforts by administrations annotating their Web resources with adequate metadata. However, any approach in this direction must take into account that especially small governments and administrations with limited resources will use semantic artifacts only when benefits directly related to administrations’ activities can be expected.

This paper focuses only on the role of ontologies in developing and using metadata for e-government services. Extending previous research on e-government ontology

design driven by user requirements [23], we introduce an activity-based approach towards development and use of ontologies for e-government services. The aim of the research is to clarify the role of ontologies in sharing meaning among e-government stakeholders (administrations, citizens businesses, even IS developers) and developing and using metadata for e-government services in order to enable advanced search and integration. The design questions such as “what is the (ideal) contribution of ontologies in developing and using metadata?”, “how can the need and required scope of ontologies for developing and using metadata be identified?”, “what are requirements concerning the quality of ontologies such as completeness, complexity?” or “what are success factors in employing ontologies for metadata development and use?” we seek to answer from a perspective taking into account the actual use situation of semantic artifacts. To this end, we introduce and follow an activity-based approach towards development and use of ontologies for e-government services: that is, identifying goals and activities of administrations and their peers (citizens, businesses, other administrations) on the basis of which we analyze the need for sharing perspectives and (electronic) boundary objects. We claim that such an analysis helps to focus the development and use of metadata, lowers the barriers of ontology usage (for metadata production), and efficiently guides development of e-government ontologies towards the needs of citizens, businesses and administrations alike.

The paper is organized as follows. First we introduce the activity-based approach for analyzing the role of ontologies in e-government services. Second, we consider the current and intended extent of ontology application in e-government and take into account existing e-government research. Third, we analyze two activity scenarios from the ongoing Access-eGov research project in order to identify boundary objects in need for semantically controlled metadata. Forth, we explore the administrative production of metadata in order to highlight the required contribution of ontologies. Finally, we discuss how our approach extends the state-of-the-art and point to future research.

2. Tracking ontology use in service relations

Based on activity theory, Korpela et al. [24] have proposed a model explaining the development and use of information systems (IS). They stress that IS development is ultimately about work development or “activity development”, and the basic task is to analyze the work activity to be facilitated by the would-be IS. The starting point is that IS users need improved facilities to address problems in their clients’ activities, i.e. “the clients’ activity implies what kind of facilities the user will need” (p. 297).

We apply and adapt this model to examine the role of ontologies in would-be e-government services (see figure 1): The ontology users’ clients are the users of semantically empowered e-government services, i.e. the ontology beneficiaries; the ontology users are those (in administrations) who annotate e-government services by metadata on the basis of given ontologies; the ontology developers are selected IT and domain experts; and ontology researchers are those who seek to provide insights into the role of ontologies in the specific application domain and to guide appropriate ontology development. The activities of developers, users and their clients are facilitated by activity results of their predecessors in the model’s chain (“sleeping” means it is a possibility of becoming useful when future users awaken it to life as a means in their own activity).

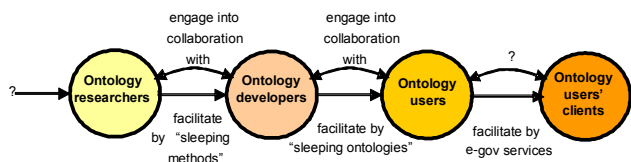


Figure 1. Elementary relations between ontology beneficiaries, users, developers, and researchers (adopted from [24])

This framework allows to trace and backtrack the role of ontologies from e-government service use to ontology research: how the ontology users take into account the needs of their clients, how the ontology developers must foresee the rationale of the ontology users, and what does this teach the ontology researchers (based on what epistemological assumptions)? To understand the activities of e-government service users and providers in detail, we refer to the model of “perspective making — perspective taking” introduced by Boland & Tenkasi [5] as applied to cross-community sense-making by Novak [30]. In this context, semantic artifacts, i.e. artifacts designed to incorporate meaning and to contribute to knowledge transfer, can be considered as “boundary objects” [38] that support perspective taking. Beyond the investigation of visible boundary objects (e.g. [30]) we focus on metadata and ontologies as electronic artifacts that (in principle) still can be understood by humans, but are mainly used by other artifacts (e.g. responsibility finding application,

personal software assistants) to make meaning explicit for e-government users.

For our approach in this paper it is important to note that we focus on the social actors, their activities and efforts of trying to make others understand. That means our inspection of the role of ontologies starts with looking into the information and knowledge sharing from administration to citizens and business with the aim of improving the e-government service relations—and not with enabling software agents (acting on behalf of their users) processing e-government service metadata (although this of course is an important function of using semantic artifacts). This allows sorting out more relevant issues from less important ones, and it eventually relieves ontology developers from modeling everything there is in the administration domain. Our suggested analysis approach subsequently identifies the following four issues:

(1) **Goals:** The starting point for using e-government services is a specific, case-based need of a citizen or business employee. The aim or goal of service use is to ultimately satisfy this current need. It has been pointed out before that often a “citizen is needs-aware, but not services-aware” whereas administrations are “services-aware, but not needs-aware” [15], [34]. For our analysis we extend the notion of goals also to administrations: while for citizens and business users their goal is need-fulfillment, the goals of administrations are related to their mission of service provision, i.e. generally speaking handling affairs of citizens and businesses in compliance with laws and regulations. Specifically it means administrations are committed to providing certain results according to service prescription and taking into account case-based circumstances.

(2) **Activities:** If a goal is the aim towards which an effort is directed, then the activities are the means to achieve this end. Within our analysis, we follow the approach of Korpela et al. [24] describing a (work) activity on the basis of outcome (“raison d’être”, i.e. the goal), object, (collective) actors, means of work, means of coordination / communication, mode of operation. In particular, we are interested in the means of work and means of coordination and communication the service consumers and administrations use while performing activities to complete the tasks that ultimately lead to goal achievement.

(3) **Perspective making / taking:** Novak ([30], p. 2) summarizes perspective making (PM) as “processes through which members of a community express, develop and exchange knowledge”, and perspective taking (PT) as “the development of an understanding of the knowledge perspective of an unfamiliar community”. These concepts are based on Boland & Tenkasi [5]: “Perspective making is the process whereby a community of knowing develops and strengthens its own knowledge domain and practices. As a perspective strengthens it complexifies and becomes

better able to do knowledge work” ([5], p. 356) In our analysis we use these concepts to specify the means of work as well as the means of coordination and communication as far as they reflect the need for information and knowledge sharing among the actors involved. Hereby an administration can be considered as a collective actor and as a “community of knowing” [5] or “community of practice” [25], but their counterparts (citizens and businesses as service consumer) do not reach the same level of perspective coherence; we can only consider them as the community of not-knowing (see above: citizens are “needs-aware, but not services-aware”). PM in e-government means that the administrations involved develop a shared perspective (with certain interests and vocabulary), including “activities from collaborative problem solving to cooperative gathering and structuring of information to narrative exchanges” ([30], p. 2). PT mainly happens on the side of citizens and businesses as service users, it comprises “the understanding of implicit structures and contexts determining the meaning of information” ([30], p. 2). Novak points out that cross-community knowledge exchange actually requires interplay of perspective taking and perspective making through which unfamiliar knowledge is “internalized by contextualizing it within one’s own thought world and expressing it in one’s own terms”. ([30], p. 2)

(4) **Boundary objects:** The concept of boundary objects was first introduced by Star & Griesemer [38]. Boundary objects can be used by several (collective) actors in order to satisfy the informational needs of both. Bowker & Star [6] see the creation and management of boundary objects as a key process in successful interaction of communities: “Such objects have different meanings in different social worlds but their structure is common enough to more than one world to make them recognizable, a means of translation.” ([6], p. 297) In our analysis we seek to identify those boundary objects that assist in perspective making and taking because we assume that controlling the semantics of these objects is the primary use of ontologies for e-government services. The 4-step analysis is applied to two activity scenarios about the use of e-government services—online responsibility finding and marriage application—that are currently under research in the EU-funded project Access-eGov (www.access-egov.org): both of these scenarios shall be empowered by administration employees using ontologies for metadata creation in order to facilitate information and knowledge sharing with citizens in relation to accessibility and use of e-government services.

3. Ontologies, annotations and metadata in e-government

The term ‘ontology’ originates from philosophy where it denotes either a discipline—the part of metaphysics

which is concerned with the nature of existence—or a systematic account of existence (i.e. things, processes, properties) ([8], p. 1303]). When the term ‘ontology’ was adopted in the field of computing, it was used in the sense of a conceptual scheme or artefact. Ontologies no longer pertain to entities of a ‘given’ reality but to symbolic abstractions [41] and are often denoted as ‘formal’ or ‘computational’.

In his seminal paper, Gruber [16] defines an ontology in computing as “an explicit specification of a conceptualization”, a conceptualization being “the objects, concepts, and other entities that are assumed to exist in some area of interest and the relationships that hold among them” ([16], p. 908). The entities are assumed to correspond to real world domains with objective criteria for conceptualization. Thus, formal ontologies are designed to capture reality and enable the de-contextualization of knowledge.

However, the insistence on the rigorous formal nature of ontologies cannot be upheld in view of the increasingly wide-spread use of the term by practitioners. This is recognized also in the AI community. For example, Welty and Smith identified a number of different usages of the term ‘ontology’ (cf. fig. 2).

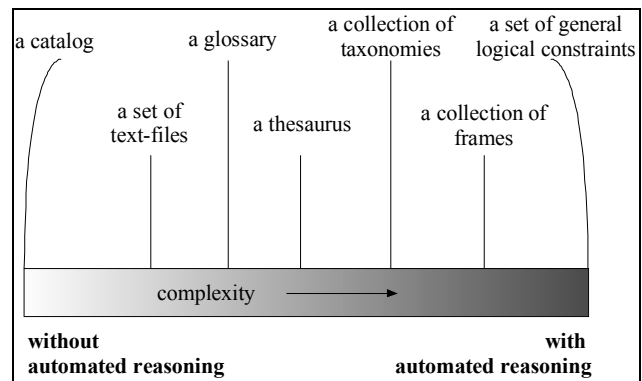


Figure 2: “An ontology is...” [37]

The notion of ontology has received much attention as the knowledge base for empowering potential Semantic Web applications through semantically controlled annotations and metadata. In the context of the Semantic Web “annotation” usually refers to *semantic* annotation, i.e. enriching digital content with information about its meaning and context in such a way that this semantic annotation is readable by machines. [3] Semantic annotation enables software agents to process the content of web pages and other digital resources in a way that is meaningful to human users. The goal is to ensure that humans and machines “understand” the same information in the same or at least a similar way.

Technically, semantic annotation can be applied to Web resources in the form of semantic mark-up (semantic enhancements of regular HTML-mark-up) or, more

generally speaking, metadata. In the true sense of the word metadata is “data about data”, but it may also be understood as information about information. Metadata is usually applied to a resource by *annotating* these resources with information that describes the content, structure and context of a resource. [14] Different metadata standards have been developed to identify which aspects are relevant for annotation, the Dublin Core metadata standard being one of the most well known. [11]

The use of semantic structures and semantic web technologies are suggested or used for a number of different purposes. A simple list of terms is used by current responsibility finders, such as DiBIS of the city of Hamburg, Germany [10], but also intended for use in the future German-wide responsibility finder [9]. Thesaurus-like structures can be found among government standards like IPSV/GLC [18], AGIFT [29]. These controlled vocabularies are mainly intended for use as encoding schemes for metadata to describe resources, like documents, services, agencies and databases. [28] Metadata is mainly being used by administrations to facilitate the retrieval of electronic resource, either by the administration themselves or citizens and business users (for example, cf. [12], [28]). Dublin Core is also the basis for many metadata standards in the area of e-government. [39]

The EU-PUBLI.com project [7] uses ontologies to mediate between organizational, linguistic and cultural differences on the application’s presentation and communication layer in order to achieve process-integration [21] and inter-agency interoperability. The SAKE project [35] aims at enabling “agile” e-government by providing a semantic-enabled attention-management, content-management and groupware system.

Peristeras et al. [32], [40] suggest the GEA reference model for the government domain, including detailed models and implementations in specific ontology languages like OWL-S and WSMO to cater interoperability. Formal descriptions of service interfaces by ontologies are used in the Access-eGov project to increase accessibility for citizens (and business users) and to offer automated service orchestration by extending WSMO to formally represent “life-events” like marriage based on inputs, outputs and other properties. In the area of legislation, metadata is used to facilitate integration of and access to legislative information [26]. Ontologies of law are used to formalize, compare and harmonize law in the E-power project [4], or semantic portals, which relate legislative information to its context in the legislative process in order to support information and knowledge sharing [19]. Ontologies are also suggested (e.g. [27]) or put to use in design of e-government services themselves (e.g. [36], [31]) and to evaluate the service quality [33].

Summing up, the use of ontologies in the area of e-government is implemented or projected mainly for the support of knowledge sharing among systems users

(and/or provide them with a shared knowledge base) or for enabling automatic semantic processing, i.e. computerized processing of meanings related to the real world.

In general, the importance of incorporating metadata and ontologies is uncontested, but best practices and guidelines for the design, development, implementation and operation of semantic solutions in e-government are still under research. According to Fonseca & Martin [13] the recommended relation of ontologies and metadata is that computational ontologies capture invariant domain knowledge and serve as basis for promoting shared understanding, and conceptual schemas link data to provided ontologies. For our investigation of development and use of e-government service ontologies we similarly assume that ontologies capture the knowledge invariant domain issues that shall be shared between (distributed) admin users and citizen / business (and even e-service and ontology developers), whereas annotations and metadata are created by administration users in order to link given Web resources to given ontologies. We now proceed to our activity-based analysis of two e-government services with the aim of identifying the use of ontology in metadata production and narrowing down the scope of ontologies in ontology development.

4. Case analysis

In this section we investigate the interplay of administrations and citizens for two different but related cases of administrative service usage: (1) responsibility finding and (2) marriage application. For the analysis we apply the activity-based approach as introduced above in order to identify those boundary objects that play an important role in interaction between administration and citizen and/or between several administrations with regard to service provision. These boundary objects have the power to mediate between the different communities. Currently, many of these boundary objects lack electronic support and/or the electronic representation lacks semantic description. For example, most services require filled-in forms: In order to support electronic services, paper forms and other boundary objects need to be transformed into electronic artifacts. We focus on the boundary objects to the extent they are framing the service interface, i.e. what meaning do they carry and/or which perspectives do they mediate so that citizens, businesses or other administrations can access the service and integrate it into more comprehensive processes (e.g. life event management), because access and integration shall eventually be performed automatically by machines.

The cases presented are extracts of activity scenarios. Both scenarios focus mainly on offline activities (i.e. without significant electronic support for the given case) as they have emerged in practice throughout the years.

Table 1: “Responsibility Finding”

Aspect	Administrations	Citizens / Businesses	Comment
(1) Goals	Administration-officers want to effectively guide citizens in order to save time and work on both sides	Want to satisfy a certain need, depending on their current situation	Citizens (and businesses) have a need or they want to achieve a certain goal. They do not necessarily know which services they must request in order to achieve a goal or satisfy a need. Thus, they start looking for a service based on their needs / goals. Administrations may provide special services for directing citizens to the right service (e.g. call-centers).
(2) Activities	Administration-officers advise citizens with respect to which service a citizen needs in his / her situation	Citizens consult administrations to find the right services and directions of what to do to match their need	Citizens may consult administrations through different channels, depending on which channels of access an administration decides to offer, e.g. designated employees, call-center, various electronic interfaces (website, kiosk), personal software assistant, etc.
(3) Perspective making / perspective taking	PM: As service providers, officers usually know which services are offered and/or required, what is their input and output, and how services are interrelated. PT: should take the citizens’ perspective into account when offering advice and guidance	PM: As problem owners, they look for services based on their current case-related needs and goals PT: Experience shows that they frequently ask about available / required services and the responsible authority (as service provider) relative to their own location	This was a recurring theme among the administration officers the authors were in contact with. They usually emphasized that citizens mostly ask about services and responsible service providers.
(4) Boundary objects	Published summaries of: <ul style="list-style-type: none"> • services (with respect to needs / goals, input / output and responsible service provider) • administrative authorities (including structure and responsibility as service providers) • location (of administrative authorities / citizens) Specific items: <ul style="list-style-type: none"> • service descriptions (process steps, fees, etc.) • documents to be provided 		These published summaries can have many forms, e.g. the listing of zip codes, organizational charts of governments and administrations, directories and signposts as paper handouts or placards. Specific items may be provided in different ways, traditionally (mail, print, telephone etc.) and/or electronically (e-mail, web-sites etc.).

They are based on real-life service usage in Schleswig-Holstein, Germany, and they serve as blueprints for demonstrating newly developed technology currently under research in the EU-funded project Access-eGov concerning the accessibility and integration of e-government services. The activity scenarios are published in 0 and are based on empirical findings through the authors’ previous work with public administrations in Germany (see also [17], [20]):

- As part of the requirement elicitation process within the Access-eGov research project several interviews and a workshop were conducted with public administration employees from Schleswig-Holstein.
- Another workshop was conducted with a number of registry officers from Schleswig-Holstein who described their daily work routines and problems as well as common requests and misunderstandings when communicating with citizens.
- Both authors have participated in several meetings with public administrations members from all over

Germany seeking to integrate the available content of local responsibility finders into a nation-wide responsibility finder [9].

The kind of officers that the authors were in contact with come from communal, state and federal administrations and include office clerks (who interact with citizens and perform services, like the registry officers from Schleswig-Holstein), officers whose primary concern is public relations (like editors) as well as high-level officers of different kinds (e.g. information management, IT strategy management). Our goal is to identify those *semantic* features of the boundary objects—by examining their use in the different activities during service execution—which need to be preserved when transforming the boundary objects into electronic artifacts or to upgrade existing electronic artifacts in order to sustain the boundary objects’ mediating powers when operated through machines.

The first case is concerned with responsibility finding (see table 1), i.e. the service consumer trying to find the

right service and the responsible service provider. The second case (see table 2) is concerned with the usage of a specific service in the context of marriage. This includes also aspects of interoperability between different administrations with possibly different work practice that have to cooperate in accepting documents (serving as boundary objects between administrations) as the result

of each others activities. Administrations interacting with each other require forms, certificates, documents and possibly other things or pieces of information to be exchanged. These requirements—both when interacting with citizens and other administrations—are usually based on laws and regulations, often including local rules and individual work practice.

Table 2: “Marriage Application”

Aspect	Administration	Citizen	Comment
(1) Goals	The officer at the register office (offering the services related to marriage) must ensure that only couples that are legally allowed to marry will receive a marriage certificate.	A couple wants to get married according to the current law.	Administrations perform services in compliance with laws and regulations that have been set by the legislative authorities.
(2) Activities	<p>The administration provides information regarding the service: prerequisites for marrying, required documents, steps to take, marriage certificate as final outcome of the legal act</p> <p>The administration-officer will advice and/or assist the couple in obtaining necessary documents. This may also involve identifying other services that the couple needs to utilize.</p> <p>The officer accepts and checks the provided documents.</p> <p>If approved, the officer proceeds with internal preparations for the issuing of a marriage certificate.</p> <p>When all requirements are fulfilled, the officer issues an <i>application for marriage</i> (“Anmeldung zur Hochzeit”).</p>	<p>If not already accomplished through responsibility finding, the couple contacts their local register office to get information about <i>how</i> to get married.</p> <p>If needed, the couple obtains the necessary documents from other authorities.</p> <p>The couple fills out forms and provides all necessary documents to the register office.</p> <p>After having received the <i>application for marriage</i> from their local register office, the couple can make an appointment for their marriage ceremony with any register office and/or register officer in Germany.</p>	<p>From the register office the couple will learn about the requirements for marriage. German register offices often provide detailed information regarding the most common case through their web-site and through printed documents available at the register office, such as information about opening hours, required documents, fees etc.</p> <p>In the simplest case, both partners have never been married before, have no premarital children, do not have an academic degree, are both of German nationality, and will both be present at the wedding. Then each need an identification card (or passport), a proof of residence registration (“Meldebescheinigung”), and an ancestry proof (“Abstammungsurkunde” or a transcript from the family register). More difficult cases could require, e.g. in some cases of foreign citizenship, a translated birth certificate attested by a German embassy, as well as similar documents regarding any previous marriages.</p> <p>In particular, the register officer has to give case-based advice to the couple regarding where certain documents are available. E.g. knowing where to get the required copy from the family register depends on whether, when and where the couple’s parents were married.</p> <p>On the date of their marriage the couples goes to the chosen register office where the officer performs the wedding, issues the marriage certificate and hands it over to the couple.</p>
(3) Perspective making / perspective taking	<p>PM: The kind of documents to be provided is predetermined by law and regulations (and beyond this by the officer’s own choosing).</p> <p>PT: Taking into account the couple’s individual circumstances in order to strike a balance between his / her goal to satisfy the law and his / her intention to best serve the couple.</p>	<p>PT: The couple has to learn that legally getting married means to first supply a number of documents and proofs, that there are no reasons opposing their wish to marry, second to receive an “application for marriage” and finally to receive a marriage certificate.</p> <p>PM: The couple’s individual circumstances (e.g. citizenship,</p>	As service providers, administrations and their officers carry out the service-related activities primarily in accordance with current law and their own local requirements and/or practices. It is the primary duty of the officer to check for legal reasons opposing the couple’s wish to get married. To this end, the officer requires the couple to provide a number of documents that prove that they are not currently married etc. As service consumers, the couple has to adopt the administration’s perspective in order to utilize a service.

		being divorced, being an orphan) have an impact on which documents they must provide and where these documents can be obtained.	While the law and federal / state regulations apply to all administrations, the set of local regulations and routines may lead to different ways of service execution. These differences may become apparent when two administrations need to interact as well as when citizens interact with one or more administrations.
(4) Boundary objects	<ul style="list-style-type: none"> • Artifacts (e.g. leaflets) informing citizens about the legal process of marriage, to a certain degree including: <ul style="list-style-type: none"> - Process model (i.e. series of activities) - Processing rules according to prerequisites (“business rules”) • Forms that need to be filled (created for the purpose of and by administrations) • Documents to be provided by citizen (e.g. proof of identity, birth certificate) • Access points to related services • “Application for marriage” document 		Forms are created for the purpose of and by administrations, reflecting process steps and business rules. Laws and regulations are the common basis for the creation of forms and for the other requirements for service provision (certificates, personal information etc.). Because of this common basis administrations with differing local rules and work practices are able to interact in a meaningful way.

5. Administrations as ontology users

In this section we discuss how upgrading the electronic service interfaces through semantic annotation and working with the ontologies at hand is related to activities practiced before. For this we refer to an activity scenario that has been elaborated within the frame of the Access-eGov project (see [2]) that includes the basic annotation steps to be performed (see table 3). The scenario is part of the requirement analysis and, in contrast to the activities of the other cases (tables 1 and 2), these activities are not yet observed in practice.

In this scenario, an administration officer takes the role of an editor: s/he describes the available service interfaces of the two cases mentioned above by annotating Web resources with metadata based on ontologies. The aim is to semantically upgrade the service interface by including any Web-based information about the service in focus (even though the service itself may be performed in a traditional non-electronic mode). This upgrade should allow machine-based processing in order to automate all or significant parts of the service provision. The semantic annotation itself should link the Web resources to the shared domain knowledge as encapsulated by the ontology (or ontologies) the editor is provided with. For example, the editor can chose from catalogues or taxonomies of citizens’ needs / goals, administrative services, administrative authorities, and locations to annotate the interfaces of services provided by a specific registry office. According to the type of service, the editor could move on to provide more metadata on details about the service such as input, output, process steps, business rules etc. – all of which can be prescribed by ontologies.

It should be noted that the same boundary objects appear again: Having identified them as a part of existing practice (table 1 and 2) they are assumed to play the same role with regard to knowledge sharing and promoting

shared understanding (perspective making / taking) in the envisioned annotation scenario (table 3).

However, due to the large scope, variety and complexity of the domain and to the novelty of the issue, it is unrealistic to expect that all annotation of the service interface and all required ontology development will be done in one step (manually or automatically). Rather it needs a step-by-step approach that involves and motivates administrations in the semantic annotation process according to their capabilities. To this end we suggest that the activity-based analysis introduced above can be used as follows for tailoring and narrowing the agenda for the annotation process to be carried out by administrations:

1. Selecting services for which the interfaces need to be semantically upgraded (creating a service priority list).
2. Performing activity analysis for each of the services as above, including perspective making / taking and boundary objects.
3. Prioritizing the boundary objects of each service (i.e. creating a boundary object priority list) according to their importance in electronic service accessibility and knowledge sharing (perspective making / taking)
4. Annotating the boundary objects according to given ontologies (see activities in table 3).

In the above annotation scenario, the administrative perspective making and taking as well as the boundary objects of case 1 and 2 are combined because from the citizen’s point of view the service interface is highly relevant for finding *and* consuming the service. However, this compilation does not yet reflect any priorities. This can and should be done in each case according to the capabilities and strategic objectives of administrations when taking their steps towards the Semantic Web. For example, an administration aiming for semantic support of responsibility finding will start with the objects of case 1, whereas objects of case 2 are more relevant for integrated life event management.

Table 3: "Annotation"

Aspect	Administration editor	Comment
(1) Goals	Electronic publication of semantically enhanced service interfaces	to satisfy citizens' and business users' needs more efficiently
(2) Activities	<ul style="list-style-type: none"> • Editor assesses existing service interfaces (electronic and non-electronic) and identifies information and other resources (e.g. forms) yet need to be made available. • Editor collects additional service information if needed • Editor annotates the relevant service interfaces and other resources with metadata based on given or chosen ontologies • Editor publishes annotations (after approval if needed) 	
(3) Perspective making / perspective taking	<p>PM: As service providers, officers usually know which services are offered and/or required, what is their input and output, and how services are interrelated. On the basis of this the editor performs the above activities, i.e. decides which service interfaces and resources are to be annotated and how.</p> <p>The kind of documents to be provided is predetermined by law and regulations (and beyond this by the officer's own choosing).</p> <p>PT: Take into account the citizens' perspective when preparing for advice and guidance being offered automatically.</p> <p>Taking into account the couple's individual circumstances in order to strike a balance between his / her goal to satisfy the law and his / her intention to best serve the couple</p>	<p>As ontology users and creators of metadata the administration controls how the information resources and service interfaces are annotated which has impact on the kind of automatic processing that will be possible (search, composition of services etc.).</p> <p>Here the administrative perspective making and taking of case 1 and 2 is combined.</p>
(4) Boundary objects (case 1 & 2 combined)	<p>Published summaries of:</p> <ul style="list-style-type: none"> • services (with respect to needs / goals, input / output and responsible service provider) • administrative authorities (including structure and responsibility as service providers) • location (of administrative authorities / citizens) <p>Specific items:</p> <ul style="list-style-type: none"> • Artifacts (e.g. leaflets) informing citizens about the legal process of marriage, to a certain degree including process model (i.e. series of activities), processing rules according to prerequisites ("business rules") • Forms that need to be filled (created for the purpose of and by administrations) • Documents to be provided by citizen (e.g. proof of identity, birth certificate) • Access points to related services • "Application for marriage" document 	

We assume that for the aforementioned reasons automation of initial semantic annotation of e-government service interfaces is still a long way down the road. In consequence, the role of ontologies in this annotation process is providing the editor with the shared domain knowledge, thus empowering and at the same time restricting the activities of the editor. The linking of Web resources to ontologies requires a basic understanding of scope and structure of the ontologies in use as well as the capability to digest the results of the activity-based analysis and the set priorities that reflect the service- and administration-specific issues.

Therefore we conclude that successful semantic annotation requires the contribution of administration employees that are experienced in the activities that are about to be automated (here: responsibility finding and marriage application) or have direct access to this experience (e.g. through colleagues) so that they can master the perspective making and taking involved in the annotation in order to link boundary objects adequately to ontologies at hand.

6. Towards development of service ontologies

The administrative editors mentioned above are portrayed as the source for ontology demand and usage requirements, we do not see them as the ontology developers. Ontology development should be done by teams comprising expertise from administration (some editors may be included), IT and language research. However, the aforementioned design questions concerning the need and required scope of ontologies for developing and using metadata as well as the requirements concerning e.g. completeness and complexity should be answered in view of the role of these ontologies in the annotation process and the contribution of metadata during usage of semantically empowered e-government services as described above. The ontology development can benefit from the same kind of steps as suggested for the ontology use:

1. Selecting services for which the interfaces need to be semantically upgraded (creating a service priority list).

2. Collecting a variety of activity analysis for these services, including perspective making / taking and boundary objects.
3. Analyzing and prioritizing the boundary objects of these services (i.e. creating a boundary object priority list) according to their importance in electronic service accessibility and knowledge sharing (perspective making / taking)
4. Creating ontologies for annotating the boundary objects in focus (cf. activities in table 3).

In our view, the success of ontology development depends on striking the balance between standardization and situatedness: On the one hand, the domain's conceptualization needs to be standardized, while, on the other hand, the ontologies' situatedness—its being used in different work-practices and its inhabiting of different social worlds—calls for the acknowledgement of a variety of perspectives; perspectives that exist within administrations as well as on the side of citizens and business.

The reason for this need to balance two opposing requirements (standardization and situatedness) comes from the use of ontologies for the annotation of boundary objects. Boundary objects always have this “dual nature” of being plastic enough to accommodate the needs of different social worlds while being stable enough to keep their own an identity. [6] This dual nature of boundary objects needs to be preserved during the process of annotation and thus also needs to be accounted for when designing the ontologies in order for the boundary objects' mediating powers to unfold.

Summing up, based on our approach the role of ontologies in developing and using metadata is to preserve the mediating powers of the boundary objects. The need and required scope of ontologies for developing and using metadata can be determined by identifying the features of the relevant boundary objects and their current (or future) use in perspective making and taking. The requirements concerning the quality of ontologies—such as completeness and complexity—can be decided from the important features that have been identified as being relevant for the process of perspective making and taking.

Comparing to technology- and domain-oriented ontology development approaches, the activity-based approach presented here

1. provides a method how to conceptually link ontology research and development to ontology use
2. may guide the development of ontologies and of development methods towards the needs of citizens, businesses and administrations
3. lowers barriers for ontology usage because administrations can follow up the benefit through production and use of metadata that is most relevant for supporting information and knowledge sharing according to given administrative activities and strategies

We consider this activity-based approach not as an alternative but rather as complement to technology- and domain-oriented approaches. Ontology development should be regarded as an iterative process which builds on existing conceptualizations (including extant ontologies, if available) and evaluation of ontology application.

The mediation of perspectives between administrations on the one hand and citizen and business users on the other hand is ideally part of the personal interaction in traditional government services. Our approach strives to transfer these mediating aspects from their non-electronic context and introduce them into the world of e-services. Citizens and business users should ultimately benefit from such an approach by finding their own goals adequately reflected and their tasks suitably supported. It should be restated that this paper focuses only on the role of ontologies in developing and using metadata for e-government services. To what extent this can be applied to other e-government areas remains to be explored.

The approach presented has been grounded in activity theory and developed based on scenarios. Therefore future research in this area will follow up on the empirical side: What is the actual take-up of this approach and the ontology usage by administrations? How can the success of the annotation process be evaluated? How does the annotation actually impact the process of perspective making and taking? And if this research remains promising it should be investigated how this approach may be effectively combined with other ontology development efforts in the field.

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