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Abstract: Issues of semantic interoperability and service integration for e-government portals are the domain of interest of the present paper. We propose a Conceptual Model for One-Stop e-Government Portals based on the Semantic Web Service technology. We describe our research into building the three basic ontologies and their integration with standard ontologies. The result is a project-independent reusable model. At the same time, we outline a simple methodology for applying the proposed conceptual model into a specific scenario.

Keywords: E-Government, One-Stop Portal, Knowledge Management, Ontology, Semantic Web Services, Life Events.

1. Introduction and related work

The current trend in e-Government applications calls for integrated services that are effective, simple to use, shaped around and responding to the needs of the citizen, and not merely arranged for the provider's convenience. In this way, the users need have no knowledge of -- nor direct interaction with -- the government entities involved. Thus, services need to be interoperable in order to allow for data and information to be exchanged and processed seamlessly across government.

Many projects are being developed and various approaches have been proposed for the design of architectures to deliver e-government services. To quote a few examples, *eGOV* (eGov), *FASME* (FASME), *EU-PUBLI.com* (EuPubli), *eGovSM* (Mugellini 2005) propose solutions supporting service-based systems. However, no one adopts the Semantic Web technologies for the representation of concepts and actions.

In the recent years, organizational knowledge models have been proposed (Gualtieri 2005), (Bonifaccio 2005), (Maicher 2005), aimed at building formal models of processes, resources, goals of enterprises. The models consist of ontologies based on a vocabulary, along with specifications of the semantics of the terms in the vocabulary.

In the e-Government scenario, efforts are under way in which semantic technologies are involved. The *e-POWER* project (Van Engers 2002) adopts solutions to model inferences, like consistency checking and enforcement in legislation. The *SmartGov* project (SmartGov) developed a knowledge-based platform for assisting public sector employees to generate on-line transaction services. *ICTE-PAN* (ICTE) proposes a methodology for modelling Public Administration (PA) operations, and tools to transform models into design specifications for public portals.

Such projects demonstrated the feasibility of semantic technologies, although no one explored the opportunities offered by a Semantic Web Service (SWS) infrastructure for the interoperability and integration of services. The *ONTOGOV* project (OntoGov) develops a platform that facilitates the consistent composition, reconfiguration and evolution of services. It relies upon the SWS technology, although its focus is rather on the service life-cycle than the interoperability and integration issues.

In our project, we extend the concept of One-Stop Government Portal (Wimmer 2001) and propose the application of Knowledge Management techniques -- in particular, ontologies -- to achieve interoperability and integration issues and responding with the best services to the user needs.

In this paper, we present the approach we adopted to design the ontologies and combine them into a sound conceptual model, which in turn serves as the basis of the semantically-enhanced middleware of a public portal. Our work is grounded on a technological paradigm capable to fit the distributed organization of knowledge, with focus on the supply of services. Both Public Administrations (PA's) and citizens will benefit from a standard conceptual model for describing public services and life events: PA's will have a shared description structure, thus the production and management of information and services will be eased, while interoperability among agencies would be fostered. On their side, citizens will more easily navigate through different services and administrations.

The paper is structured as follows. Section 2 gives a short presentation of the main topics of our research, followed by the introduction of the tools we have adopted. Section 4 describes the methodology for constructing the conceptual model. As a driver for the section, we give a short overview of a case study adopting our conceptual model. Section 5 contains our conclusions and future work.

2. The main topics

2.1 Semantically-based e-Government portals

A promising solution for interoperability and integration issues is offered by the so-called *One-Stop Government Portals* (Wimmer 2001). They integrate distributed components such as: Content Management Systems (CMS) for documents and information; workflow management techniques; cooperation solutions for the PA's involved; content personalization subsystems for the end-users. Knowledge Management (KM) techniques (Bercic 2003), (Apostolou 2005) play a key role in integrating the heterogeneous components by means of a *semantically-enhanced middleware.*

In our approach, the latter operates between the portal and the web services interfacing the functionalities of the back-offices. In particular, *ontologies* enable the use of vocabularies concerning a domain in a consistent manner (Gomez-Perez 2004): they are tools to formalize knowledge and encode abstract-level data models such as life events, workflow procedures and services. The resulting framework allows for the semantic description, discovery, composition and invocation of services supplied by different Public Administrations, as well as the semantic description, publishing and updating of life events, in such a way to provide citizens with a personalized list of services satisfying their needs in a particular situation.

2.2 Adopting the semantic approach

The main issues addressed in the development of a Semantic Web application are (Klischewski 2003):

- *Conceptual modelling.* Defining the ontologies that describe the semantic structure of the knowledge in a service-supply scenario: the business logic of the services; the dependencies among the actors collaborating in the business logic; the user needs.
- *The infrastructure for semantic interoperability.* Enabling the automated interpretation and paving a common ground to services.

In the present paper we focus on the former issue. Ontologies are the basic infrastructure for the Semantic Web: everybody agrees on this, as the very idea of the Semantic Web hinges on the possibility to use shared vocabularies for describing resource contents and capabilities, whose semantics is described in a (reasonably) unambiguous and machine-processable form.

Another key technology used in our application is the Semantic Web Services (SWS). They enable the semantic interoperability of distributed services on top of data (XML) and protocol (SOAP) standards (Nilo 2003). The semantic description facilitates activities such as the automated discovery and composition of services.

3. Tools for conceptual modelling

To design the ontologies we followed a deductive approach based on existing upper and specialized ontologies, with the assistance of domain experts. In particular, we used the Description & Situations (Gangemi 2003, Section 3.1) as the reference upper ontology, and WSMO (Dumitru 2005, Section 3.2) for describing Semantic Web Services. We also used OCML (Operational Conceptual Modelling Language, Motta 1999) as the ontology description language.

3.1 Upper ontologies: DOLCE, Description&Situations

Also called *foundational*, serve as starting points for building domain ontologies, to provide a reference point for easy and rigorous comparisons among different approaches, and create a framework for analyzing, harmonizing and integrating existing ontologies and metadata standards. They are conceptualizations containing specifications of domain-independent concepts and relations, based on formal principles from linguistics, philosophy and mathematics. Upper ontologies are ultimately devoted to facilitate mutual understanding and interoperability among people and machines.

DOLCE (Descriptive Ontology for Linguistic and Cognitive Engineering) belongs to the WonderWeb project Foundational Ontology Library (WFOL) and is designed to be minimal, in that it includes only the most reusable and widely applicable upper-level categories, rigorous in terms of axiomatization and extensively researched and documented (Oltremari 2002). It has been chosen due to its internal structure -- rich axiomatization, explicit construction principles, careful reference to interdisciplinary literature, commonsense-orientedness. In addition, being part of the WFOL, DOLCE will be mapped onto other foundational ontologies -- possibly more suitable for certain applications -- and be extended with modules covering different domains (e.g., legal and biomedical); with problems and lexical resources (e.g., WordNet-like lexica). Internal consistency and external openness make DOLCE specially suited to our needs. Figure 1 shows the taxonomy of DOLCE basic categories.

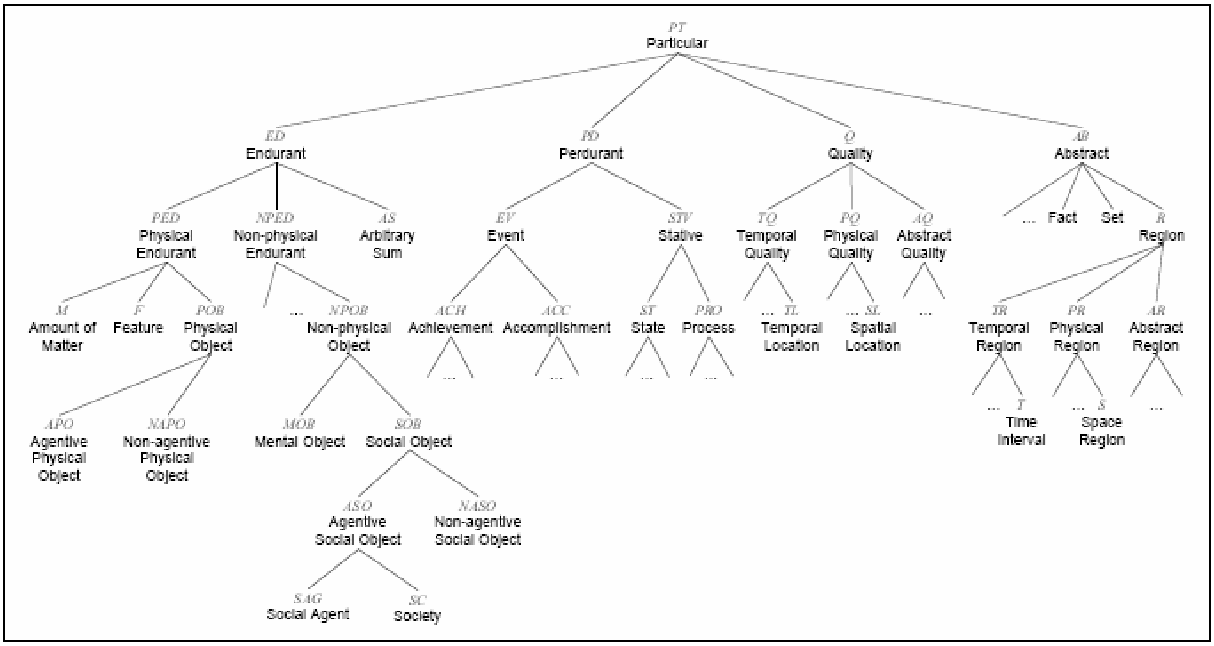

Figure 1: Taxonomy of DOLCE basic categories.

In particular, we used the Description&Situations (D&S or DOLCE+) (Gangemi 2003) -- a module of the DOLCE ontology. D&S is a theory describing context elements -- non-physical situations, plans, beliefs,… -- as entities. D&S introduces a new category, *Situation,* that reifies a state of affairs and is composed by entities of the ground ontology (DOLCE). A *Situation* satisfies a *Situation Description*, which is aligned as a DOLCE non-physical endurant and composed of descriptive entities, i.e., *Parameters*, *Functional Roles* and *Courses of Events*. Axioms enforce that each descriptive component links to a certain category of DOLCE: *Parameters* are valued by *Regions*, *Functional Roles* are played-by *Endurants* and *Courses of Events sequence Perdurants.*

3.2 Web Service Modelling Ontology (WSMO)

WSMO and OWL-S (OWL-S) aim at representing web services that make use of ontologies. The two efforts take different approaches: WSMO stresses the role of mediation in order to support automated interoperation between services, while OWL-S stresses action representations to support planning processes that provide automated composition. In our approach, we use WSMO for the following reasons: (i) it allows decoupling; (ii) addresses the integration and interoperability issues; (iii) offers a clear-cut separation between goals and services; (iv) it is centred on the Mediation concept: it helps mismatch resolution and supports heterogeneous knowledge.

The main components of WSMO are the following: Goals, Web Services, Ontologies and Mediators. *Goals* represent the types of objectives that users would like to achieve via a web service. The WSMO definition of goal describes the state of the desired information space and the desired state of the world after the execution of a web service. A goal can import existing concepts and relations defined elsewhere, either by extending or simply re-using them as appropriate. *Web service* descriptions represent the functional behaviour of an existing deployed web service. The description also outlines how web services communicate (choreography) and how they are composed (orchestration). *Ontologies* are used by the three other WSMO components. Finally, *Mediators* specify mapping mechanisms (Cimpian 2005). One of the main features of WSMO is that goals, ontologies, and web services are linked by mediators; four kinds of the latter are defined:

- *OO-mediators:* provide translation and harmonization between ontologies that are used by the Web services or any other WSMO component;
- *GG-mediators:* provide a way to match goals at different levels of granularity. For example, a GG-mediator may take the responsibility to refine the goal *buy the ticket* to the goal *buy a train ticket* upon recognizing that there is a subclass relation between the two concepts;
- *WW-mediators:* resolve the interoperability issues between Web Services at all levels: data, process, and protocol. Problems are solved at the level of both the single Web service choreography, and the orchestration of multiple Web services;
- *WG-mediators:* handle partial matches between goals of the client and functionalities provided by web services.

Concerning the needs for mediation within SWS's, WSMO distinguishes three levels of mediation:

- Data Level Mediation: between heterogeneous data sources; within ontology-based frameworks like WSMO, this is mainly concerned with ontology integration.
- Protocol Level Mediation: between heterogeneous communication protocols, i.e. translation between technical transfer protocols (e.g. SOAP, HTTP, etc.).
- Process Level Mediation: between heterogeneous business processes; this is concerned with mismatch handling on Web Service Interface description for information interchange between web services and clients.

WSMO Mediators create a mediation-orientated architecture for Semantic Web Services, providing an infrastructure for handling the heterogeneities that possibly arise between WSMO components, as well as implementing the design concept of strong decoupling and strong mediation. A WSMO Mediator serves as a third party component connecting heterogeneous elements and resolving mismatches between them. Figure 2 shows the general structure of WSMO (Cimpian 2005).

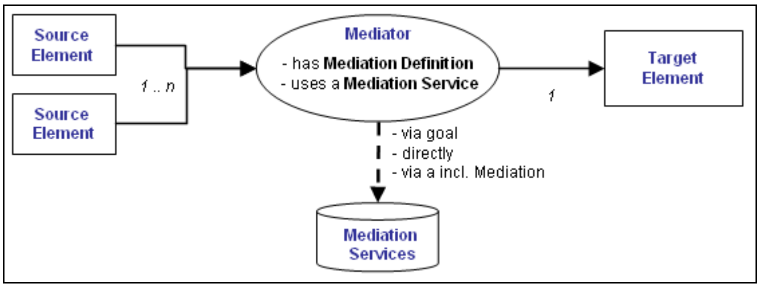

Figure 2: WSMO Mediator Structure

4. A methodology for constructing the Conceptual Model

Both Public Administrations (PA's) and citizens benefit from a standard conceptual model for describing public services and life events. The aim of the application of the methodology is the mapping of an e-Government System Reference Model with meta-ontologies -- i.e., ontologies defining classes and relations, instantiated with sub-classes and sub-relations. In this way, the result is a project-independent standard, a reusable model for e-government applications: it describes the global, uniform view of the scenario using commonly accepted or standardized concepts and properties (attributes and relations), and may have domain specific extensions. Its concepts/properties are either mapped or being mapped onto those in the organizational models.

To introduce how agreed Public Administrations (PA's) can use the Conceptual Model for developing specific extensions, we worked out a case study within the *change of circumstance* scenario, as a part of a portal for the Essex County Council. The end-users are the caseworkers of a Community Care department, helping the citizen to report his/her change of circumstance to the different agencies involved in the process. The citizen has to inform the County only once about the change and the Community Care department automatically notifies all the agencies involved. An example might be when a disabled mother moves in to her daughter's home. The change of circumstance provokes a change in which services and benefits -- health, housing, equipments, etc. -- the citizens are eligible to receive. Multiple service-providing agencies need to be informed and interact. The case study involves services in two different domains (involved agencies):

- *Citizen Assessment (Community Care Department):* relates to information about citizens registered in Essex County Council for assessment of services and benefits. This information is stored in the SWIFT database.
- *Order Equipment (Housing Department):* relates to information about equipments which are provided to citizens registered in Essex. This information is stored in the ELMS database.

4.1 Mapping the system reference model

In order to better clarify our approach, we briefly introduce the e-Government System Reference Model. As shown in Figure 3, there are four main actors in an e-government system: (i) *Politicians*, who define the laws; (ii) *Public Administrators* (i.e., domain experts), who define processes (workflow) for realizing services following the laws; (iii) *Programmers*, implementing services and applications; (iv) *End-users*, who use the services. It is important to notice that, at every level, the language could be different: indeed, a politician uses quite different languages/concepts as compared with a programmer, and, overall, end-user knows what he/she wants to achieve (moving house, getting married, etc.), but does not know exactly which services match the needs.

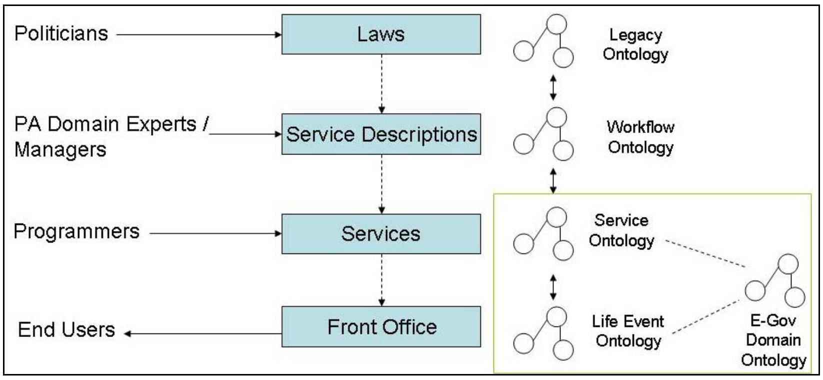

Figure 3: Mapping the E-Government System Reference Model.

We mapped the reference model with four ontologies, one for each level of the model (Figure 3):

- *Legacy Ontology*: defines the concepts and relations describing the laws and the political knowledge that defines the services;
- *Workflow Ontology*: concepts and relations describing the workflow of specific services from the PA point of view;
- *Service Ontology*: contains the description of services in terms of Semantic Web Services (SWS).
- *Life Event Ontology*: defines a hierarchy of topics, concepts and relations of life events.

The Legacy ontology is connected with the Workflow ontology, since a law defines a service workflow; each workflow element -- or the whole service -- refers to a law or a part of it. A service workflow is mapped onto the choreography and orchestration of the correspondent SWS descriptions. SWS descriptions are connected with the life event ones, associating the PA with the user point of view.

The two latter ontologies are connected with the *E-Government Domain Ontology*, defining concepts and relations of the PA's domain. It is a sort of interface between the PA's point of view (Service Ontology) and the user one (Life Event). It describes the building blocks for the descriptions of the two above ontologies.

We applied a bottom-up methodology: from the user to the politicians. We focussed on the definition of the E-Government Domain, the Life Event and Service Ontologies. They are the basic elements for defining the semantically-enhanced middleware.

4.2 The E-Government Domain ontology

It encodes concepts of the PA's: organizational, legal, economic, business, information technology and end-user. Our aim was not to cover all the aspects connected with the e-Government. In fact, distinct PA's could use the same concepts differently; a single Public Administration (PA) may not share the same point of view and have different interoperability needs by other PA's. The domain standardization can help, but it does not necessarily unify the aims and languages of all the actors involved. It is important that every PA keeps its autonomy in the description of its own domain; as we shall describe in the following, this does not affect our ultimate goals of interoperability and integration.

We defined a meta-ontology that resides on three levels of abstraction: the *instance, the conceptual level* and *bridging level*. The first contains all instances of the conceptual level within the single PA domain.

The *conceptual level* (Figure 4a) is composed by a Domain Ontology Reference Model (named E-Government Upper Level Ontology in Figure 4) and all PA Domain Ontologies. The former describes commonly accepted and standardized concepts and properties, the latter describe the specific extensions within every PA domain. In our work, we have defined the Domain Ontology Reference Model as an extension of D&S upper ontology (Section 3.1). In particular, we added concepts such as: legal-agent, person, postal address, citizen, organization, agency, etc. The PA Domain Ontologies are domain- and context-dependent. They are defined by each PA ending and adapting the Domain Ontology Reference Model with the concepts and the relations used for describing its services. Figure 4b shows the domain ontologies of the case study. *Change-of-circumstances-citizen-ontology* and *swift-services-ontology* describe the Citizen Assessment domain. *Change-of-circumstances-equipment-ontology* and *elms-services-ontology* describe the Order Equipment domain. Swift-services-ontology and elms-services-ontology are domain ontologies describing concepts of specific back-office databases and they are not derived from the *egovernment-upper-ontology*.

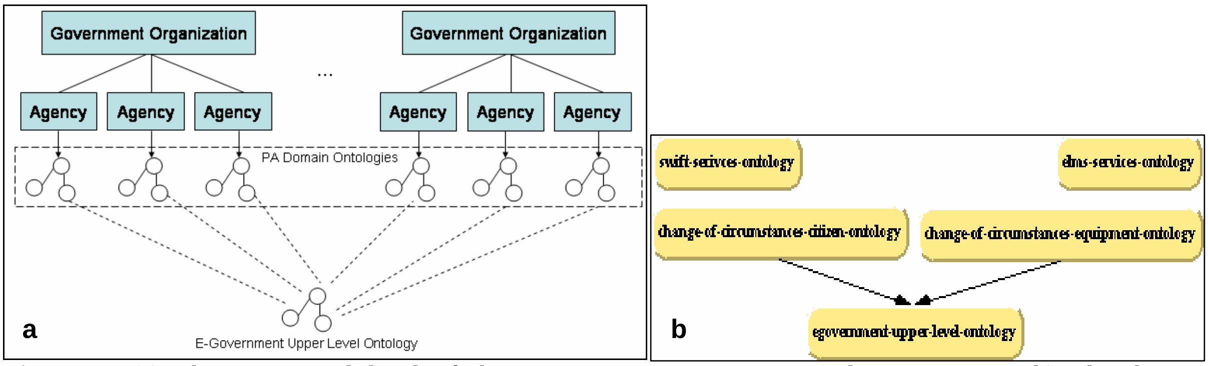

Figure 4: (a) The Conceptual level of the E-Government Domain Ontology structure. (b) The domain ontologies of the case study.

The *bridging level* has been introduced for resolving mismatch problems between similar concepts defined in different PA Domains. The bridging level is part of the Service Ontology (mismatch resolution is strictly connected to the service description) and it is described in Section 4.4.

4.3 The Life Event ontology

Usually, life event ontologies simply define a taxonomy of life events, and a service is related to one of the topics of the taxonomy. In our work, we refer to the life event ontology as the model describing the user point of view. A life event allows the user to identify his/her particular situation and better describe what he/she wants to achieve.

The Life Event Ontology is a meta-ontology: a model for describing life events of a specific domain or project. As the E-Government Domain ontology (Section 4.2), we derived the Life Event ontology from the D&S upper ontology (Section 3.1). In particular, we refer to the D&S *situation* and *description* concepts. This is the reason why we used D&S instead of DOLCE as upper ontology. Actually, a life event has a double nature: it is an event, and so defines a process that a user wants to achieve, but it is also a situation, and so describes a particular moment (and needs) of the user life.

In Figure 5, we report the UML diagram of the Life Event Ontology. The concepts *description*, *situation*, *event*, *role* and *course* are defined in D&S. The *life event* concept defines a hierarchy of topics and can branch into sub-life events. Moreover, at each life event it is possible to associate one or more user Goal defined in the Service Ontology (Section 4.4), representing what a user should do to achieve the desired result. Every life event is associated to a *life event description* that defines:

- the event in terms of norms, information objects (documents), parameters, and results;
- the specific (unique) situation of a user in terms of involved agents (applicant, actors and provider), objects and procedures involved.

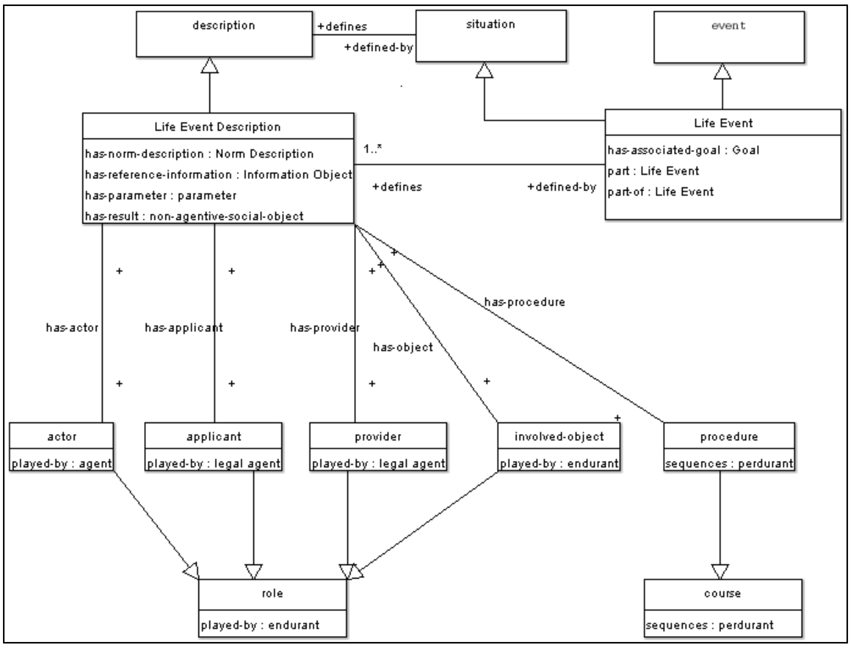

Figure 5: The Life Event Ontology.

The defined properties of the life event description refer to concepts (agent, legal-agent, non-agentive-social-object, endurant, perdurant, etc.) of the E-Government Domain Ontology (Section 4.2).

The life event concepts derived from the Life Event Ontology allow to: (i) define a taxonomy of events for organizing services; (ii) derive instances describing the particular situations of the citizens, allowing the introduction of an instance reasoning module for improving the answers of the systems; (iii) through the connection with the Service Ontology, obtain the services that satisfy the citizen needs in his/her specific situation.

Figure 6 shows the Someone Move In life event and part of its description within our case study. *Someone-Move-In* is a sub-class of the *Manage-Family-Related-Life-Event.* It refers to three different goals of the Change-of-circumstances-citizen-goals and Change-of-circumstances-equipment-goals (Section 4.4): *notify-change-of-address-goal*, *redirect-equipment-to-new-address-goal*, and *notify-change-of-family-goal*. *Someone-Move-In-Description* defines the following roles: *moving-dat*e as parameter, *citizen-applicant* as applicant, *government-provider* as provider, three different involved actors (*moving-in-person*, *destination-family-group*, and *origin-living-unit*), and *modified-living-unit* as result. The defined roles (not reported in the figure) refer to concept of the Change-of-circumstances-citizen-ontology (Section 4.2).

```
(def-class Someone-Move-In  (Manage-Family-Related-Life-Event)
((defined-by :type Someone-Move-In-Description :min-cardinality 1)
 (has-associated-goal  :value moving-in-person-change-of-address
                       :value redirect-equipment-to-new-address
                       :value family-change-of-circumstance)
 (moving-in-person-change-of-address
                       :type notify-change-of-address-goal)
 (redirect-equipment-to-new-address
                       :type redirect-equipment-to-new-address-goal)
 (family-change-of-circumstance
                       :type notify-change-of-family-goal))
```

```
(def-class Someone-Move-In-Description (Life-Event-Description)
((has-parameter :value has-moving-date)
 (has-moving-date :type date-parameter)

 (has-applicant :value has-citizen-applicant)
 (has-citizen-applicant  :type citizen-applicant)

 (has-provider :value has-government-provider)
 (has-government-provider :type government-provider)

 (has-actor    :value has-moving-in-person
               :value has-destination-family-group
               :value has-origin-family-group)
 (has-moving-in-person :type moving-in-person)
 (has-destination-family-group :type destination-family-group)
 (has-origin-living-unit :type origin-living-unit)

 (has-result :value has-modified-living-unit)
 (has-modified-living-unit :type modified-living-unit))
```

Figure 6: The Someone-Move-In life event description (OCML code) derived from the Life Event Ontology.

4.4 The Service ontology

It is the core of the conceptual model and contains the Semantic Web Services (SWS) definitions. It plays a double role: allows the description, composition, discovery, and invocation of the service supplied by the different PA's and it is the glue of the conceptual model, integrating all the defined ontologies. It is composed of four ontologies (Figure 7): Web Service, Goal, WG Mediator and OO Mediator, following the WSMO definitions (Section 3.2).

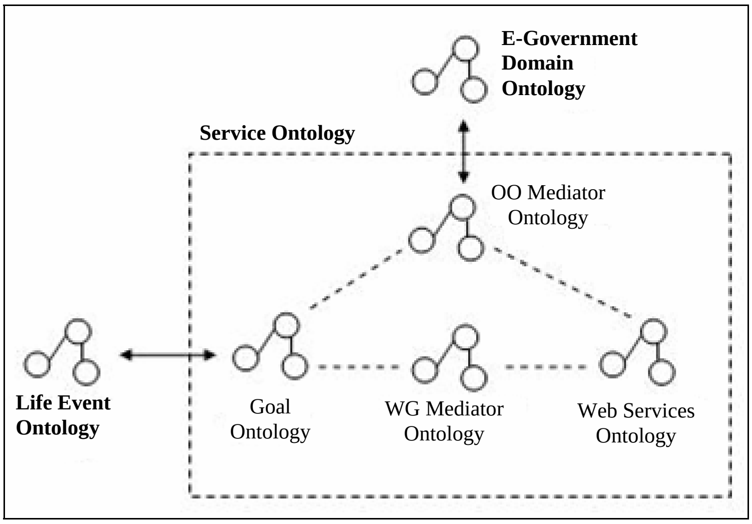

Figure 7: The Service Ontology and its relations with the Life Event and E-Government Domain ontologies.

The *Web Service Ontology* contains the functional behaviours (capability) of all the supplied services. It is the description of the service-supply scenario from the PA's point of view. By means of the choreography and orchestration definitions, a web service is defined as the composition of several services generally supplied by different PA's (*integration issue*).

The *Goal Ontology* represents the goals that users would like to achieve. It is the semantic interface between the Service and the Life Event ontologies.

The *WG Mediator Ontology* contains all the WG-Mediators connecting a goal (source) with all the web services (targets) that satisfy it, allowing the discovery and invocation processes (*user need matching issue*). A web service may be selected by a discovery process, and then executed when a goal is required. Beside this, each mediator can be connected with a mediation service (expressed as a Goal) that allows the resolution of a mismatching problem at the protocol and process levels between services and user goals, or services and services (*interoperability issue*).

The *OO Mediator Ontology* contains all the OO-Mediators that (i) connect an element of the Service Ontology (Goal or Web Service) with the specific PA Domain it refers to, and (ii) connect two concepts of distinct PA Domains that, for instance, are semantically equivalent but described differently, allowing the resolution of the mismatching problem at the data level (*interoperability issue*). The latter is the *bridging level* of the E-Government Domain Ontology, as introduced in Section 4.2.

Figure 8 shows the *notify-change-of-address-goal* (used in the Someone-Move-in life event, Section 4.3) with its inputs and output referring to concepts of the Change-of-circumstances-citizen-ontology (Section 4.2), the *notify-change-of-address-mediator* with the previous goal as source component, and part of the *county-council-provider-notify-change-of-address-ws* description referring to the previous mediator and specifying the assumption for the execution of the web service.

```
(def-class notify-change-of-address-goal (GOAL)
((has-input-role       :value has-new-address
                       :value has-old-address
                       :value has-client-name
                       :value has-client-id
                       :value has-source-provider
                       :value has-target-provider)
(has-output-role       :value has-confirmation)
(has-new-address       :type string)
(has-old-address       :type string)
(has-client-name       :type string)
(has-client-id :       type integer)
(has-source-provider :type service-provider)
(has-target-provider :type service-provider)
(has-confirmation       :type string)))
```

```
(def-class notify-change-of-address-mediator (wg-mediator)
((has-source-component :value notify-change-of-address-goal))

(def-class county-council-provider-
           notify-change-of-address-ws-capability
          (capability)
((used-mediator :value notify-change-of-address-mediator
 (has-assumption :value
  (kappa (?psm)
  (and (unit-of-organization
           (role-value ?psm 'has-target-provider)
           ?agency)
       (county-council-organization ?agency))))
```

Figure 8: Goal, Mediator and Web Service Capability descriptions (OCML code) derived from the WSMO ontology.

Following the WSMO approach, every PA creates a service description for each web service it is going to supply through the portal. This step typically occurs once for every service deployed, and does not need to be repeated, if the service does not change. If it does, only the particular description has to change, without affecting the other descriptions. All the descriptions are shared, in such away that a PA can compose a web service with others - referring to available descriptions - or associate it with an existing goal. Figure 9 shows a graphical representation of the service ontologies (grey boxes) of the case study and their dependencies on the respective domain ontologies (light boxes). It is important to notice the absence of dependencies between ontologies crossing the two different domains.

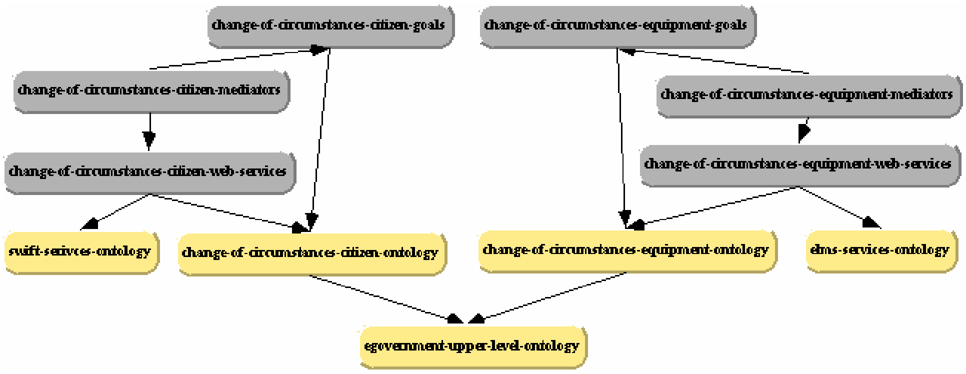

Figure 9: The derived service ontology structure (grey boxes) for the Change of Circumstance e-government scenario.

5. Conclusions and future work

In this paper, we described a methodological approach for constructing a conceptual model, which is the base for a semantically-enhanced middleware, enabling interoperability and integration issues within a service-supply scenario. We presented the steps in the construction of the conceptual model. As tool supports, we rely on well-known technologies like WSMO and D&S. The proposed model offers significant advantages over other strategies. (i) It allows Public Administrations (PA's) keeping autonomy in the description of their domain. (ii) It splits the scenario description into end-user and PA points of view, mapping the existing links. A particular care has been placed to user point of view with the introduction of specific meta-ontology for Life Events. (iii) It is based on the promising technology of Semantic Web Services enabling description, composition, discovery, and invocation of Web Services and mismatching resolution among heterogeneous domains. Beside this, the result is a project-independent standard, a reusable model that can be applied in different scenarios. We have applied the proposed approach to a case study of the Change of Circumstance scenario, as a part of a portal for the Essex County Council.

For future developments we identified a number of open issues. First, we shall extend the definition of the conceptual model: the workflow and legacy ontologies have to be defined. In particular, the former will address interesting issues about the service workflow from both the user and the PA points of view; another issue is mapping a semantic description of a workflow into the SWS choreography and orchestration (Service Ontology). In addition, we plan to apply distributed knowledge management models to our conceptual model, in order to develop a more flexible approach reducing the shared knowledge at the minimum and leaving autonomy to the PA's. A parallel work regards the development of the infrastructure for semantic interoperability (Section 2.2): for our case study we adopted the IRS-III framework (Domingue 2004) for the creation and execution of semantic web services.

Acknowledgment

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