FRAMEWORK FOR INTEGRATION OF EGOVERNMENT SERVICES ON A SEMANTIC BASIS

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Abstract. The paper presents the approach taken in the FP6 IST project FP6-2004-027020 Access-eGov aimed at development of a platform for integration of existing electronic and traditional governmental services. A semantic description of services, by means of ontologies using WSMO conceptual model, enables to combine the services into more complex workflow structures such as life events with associated goals, service profiles and various properties. Architecture of the system is based on Web Services and service-oriented peer-to-peer networks. This approach should ensure modularity, flexibility, accessibility, and other required parameters of the proposed solution, which are required from the platform for interoperability in the field of eGovernment.

1. Motivation: Interoperability of eGovernment services

As stated in [1]: "*today eGovernment is at the heart of the EU's drive for economic, social and environmental renewal.*" eGovernment is expected to contribute significantly to improving the development and implementation of public policies as well as to improving the competitiveness and innovation of European economies. Better services for European citizens and businesses, and more efficient implementation of EU policies require, among others, improved communication and closer collaboration between different administrations on regional, national and EU level, aimed at the development of cross-organisation and cross-border dimension of eGovernment. It is obvious that achievement of these goals is impossible without interoperability, which is thus becoming *conditio sine qua non*.

The interoperability (IOP) of eGovernment services, based on standards, open specification and open interfaces, has become a crucial, cross-cutting task [1]. IOP was recognised as a precondition for the implementation of European eGovernment services in the eEurope Action Plan [8] and is explicitly addressed as one of the four main challenges also in the new strategy "i2010 – A European Information Society for growth and employment [9]. i2010 eGovernment Action Plan [10] seeks to "*ensure that eGovernment at national level do not lead to new barriers on the single market due to fragmentation and lack of interoperability.*" This means that interoperability is not only responsibility of EU member states (which are responsible for the interoperability of their own systems), but requires cooperation and coordination at European level – in order to implement common EU policies.

The current situation can be illustrated by fragmentation of existing eGovernment solutions, which are rather "islands of automation" without ability to work together. Heterogeneity of services and systems, deployed by a multitude of public administrations at the national,

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regional and local levels, hinders wider take-up and decreases impact of eGovernment. Thus, in parallel to the development of new sophisticated eGovernment solutions, emphasis should be given on the integration of existing (and future) systems and services, its functional interconnection on technical, semantic, as well as organisational levels [2]. Several typologies of interoperability[4] have been proposed, we will refer to that one endorsed in [3], which fits also our understanding of IOP aspects of *technical*, *semantic*, and *organisational* interoperability.

The Access-eGov Project (Access to eGovernment Services Employing Semantic Technologies) described in this paper also addresses the problem of interoperability. The project is funded within the Information Society Technologies, 6th Framework Programme of the EU, contract No. FP6-2004-27020[5]. It is a three-year project, which started in January 2006 (i.e. at the date of submitting this paper – February 2007 – the first project year finished), with total estimated effort of 410 person-months. The project consortium consists of 11 partners from five countries (Slovakia, Poland, Germany, Greece, Egypt) and is coordinated by the Technical University of Kosice, Slovakia. The Access-eGov project is primarily focusing on the semantic interoperability, which of course needs to be supported by the technical interoperability.

While trying to integrate the existing government services, different levels of development in individual administrations (and countries) need to be taken into account. Although the number of electronically enabled services is growing, there are still a lot of services available only in a "traditional" (i.e. face-to-face) form. That is why, the Access-eGov provides a way to integrate all the government services - electronic as well as the traditional ones - by means of their semantic description and annotation. It is noteworthy that the services themselves are supposed to be based and managed by individual administrations (service providers) and referenced by API (in case of electronic services) or by some textual description (in case of traditional services).

Within the Access-eGov project the following components have been designed with the aim to support the interoperability of government services:

- Reference ontology covering basic domain knowledge and processes for locating and contracting eGovernment services;
- Rule-based editorial component (as plug-in or add-on for web applications) to insert a semantic mark-up to eGovernment applications by public administrations;
- Tools for finding and brokering information according to semantic requirements through which the services will be accessible to users and/or other eGovernment applications;
- A platform for composition of services into complex process definitions (covering life events/business episodes) enabling semantic interoperability of eGovernment services;
- A distributed security infrastructure providing multiple security services for user authentication, data protection, and easy administration of complex security policies.

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[4] Interoperability is defined as: "*the means by which the inter-linking of systems, information and ways of working, whether within or between administrations, nationally or across Europe, or with the enterprise sector, will occur"* [2] or *„the ability of information and communication technology systems nd of the business processes they support to exchange data and to enable sharing of information and knowledge* " [3].

[5] http://www.accessegov.org

From the user's perspective, the Access-eGov is envisioned to provide also a pro-active *Personal Assistant tool* that will guide the user through the proposed combination (scenario) of identified relevant services leading to fulfilment of the user's need. This web-based application, as a tiny client, will expose functions of the Access-eGov platform as for example: user login and profile management, service discovery, composition, and execution, visualisation of workflow scenarios for services, browsing and searching capabilities.

2. Access-eGov system description

2.1 Data structure

Integration of existing government services, both electronic and traditional, requires finding a set of common concepts that are general enough for description of full functionality of these services. In particular, these concepts should be generic, i.e. they should be used as building blocks in sequences, loops, conditions, and other workflow scenarios. These characteristics are given by the fact that the government services can be viewed and modelled as a workflow.

In Access-eGov, the following concepts of this kind were defined [4]:

- *Life event* denotes a specific situation in the life of citizen (or in a life cycle of an organisation) that requires a set of governmental services to be performed;
- *Goal* is a formalisation of user needs, i.e. the objectives the user may have when consulting a service, including functionality the service should provide from the user's perspective. The goal is expressed by specifying the requested outputs and effects;
- *Service* is an atomic activity provided by a public administration. It can be either electronic or traditional;
- *Service profile* specifies the „content" of the service, i.e. what the service provides for users. Formally the service profile is specified as a logical expression consisting of terms that constrain type and property values of various resources required for or provided by the services. Service profile can also be viewed as a set of functional and non-functional properties for a single service. It includes specification of inputs, outputs, preconditions, and effects of elementary services, interconnected by logical expressions and constraints of type and property values;
- *Composed service* is a recursive structure of elementary services. Their composition can be specified by logical control constructs such as sequences, *if-then-else* branching, and iterations - this enable to define complex operations and looping execution in a workflow scenario.

Moreover, life events can be categorised into groups and may be organised in multiple hierarchies. Using the *Personal Assistant tool*, users can „browse" or navigate through the categories in order to select an appropriate life event.

Multiple goals can be assigned to a complex life event. Optional preconditions can be specified for life event's goals, which will allow users to customise their specific life event. Preconditions are formalised as logical expressions with input variables provided either explicitly by the user or taken from the user profile (preconditions are not dependent on service invocation). More complex life events can organise the goals to more complex workflow models specified as composed service.

2.2 System ontologies

Ontology is powerful knowledge representation formalism for modelling real-world concepts (e.g. objects, procedures) together with its mutual relationships and express them in a semantic way that is defined and agreed upon by communities of users (e.g. collaborating organisations). The semantic properties of relations and concepts are captured by a set of axioms - logical expressions in some structured formal language. In the Access-eGov system, ontology was chosen as a repository of data structures as well as a knowledge base for semantic description of the identified concepts - life events, goals, services, etc. Three different ontology types are used in Access-eGov, namely:

- *Life events ontology* contains semantic descriptions of possible life events, including its goals and generic scenarios;
- *Service profiles ontology* describes atomic services by means of functional and non-functional properties for particular service. The ontology contains information on fees, forms, input and output artefacts, responsibility for the service, availability (e.g. opening hours of the office), address and contact information, and physical accessibility constraints.
- *Domain ontology* is used to represent all the relevant information related to the domain of government, including eGovernment concepts. It covers such non-functional properties as general and organisational structure of public administration, concepts describing quality of service, security or trust, as well as concepts related to user management and profiling.

The ontologies can be combined and mapped to each other. In particular, an ontology can have M:N relations to other entries in the repository. This mapping mechanism [4] is important especially due to the fact that it is not expected that each public administration will use the same common ontology for semantic description of their services and life events. Each organisation can have its own domain ontology, which needs to be mapped on other existing ontologies. Mappings are stored in the ontology repository, together with the corresponding mapped ontologies. The ***Mediation*** component loads and translates the mappings into the rules that are used to merge ontologies and to translate specified incoming instances from the input ontology to the instances of the target ontology.

2.3 Architecture and functionality

To address the problem of interoperability between different types of legacy back-end systems, implementation of web services in conjunction with service-oriented peer-to-peer architecture was chosen as the most promising approach. The system architecture, presented in Figure 1, is designed as highly modularised and logically composed from a number of components interacting with each other as independent services.

Overall, the Access-eGov system may be sub-divided into three major component groups: 1) the Access-eGov infrastructure itself; 2) Personal Assistant tool and corresponding end-user interfaces; 3) Administration and management tools (e.g. Annotation service component), which are not integral parts of the infrastructure, but are affiliated to it. The government services are based on the premises of its provider, i.e. they are simply made available through the Access-eGov system, and thus they do not form an integral part of the Access-eGov system itself. The services are either electronically available (directly via web service interfaces or web forms) or they are traditional office services that are semantically described and registered within the Access-eGov system. Of course, only executable services will

dispose of an electronic XML interface to the system infrastructure. Public administrations (service providers) are supposed to annotate the services that should be exposed to the users (citizens or businesses). The service-related metadata are then transferred to the persistent data layer via executable core components. Providers may use a generic *Annotation service* component, available as a web-based application [6].

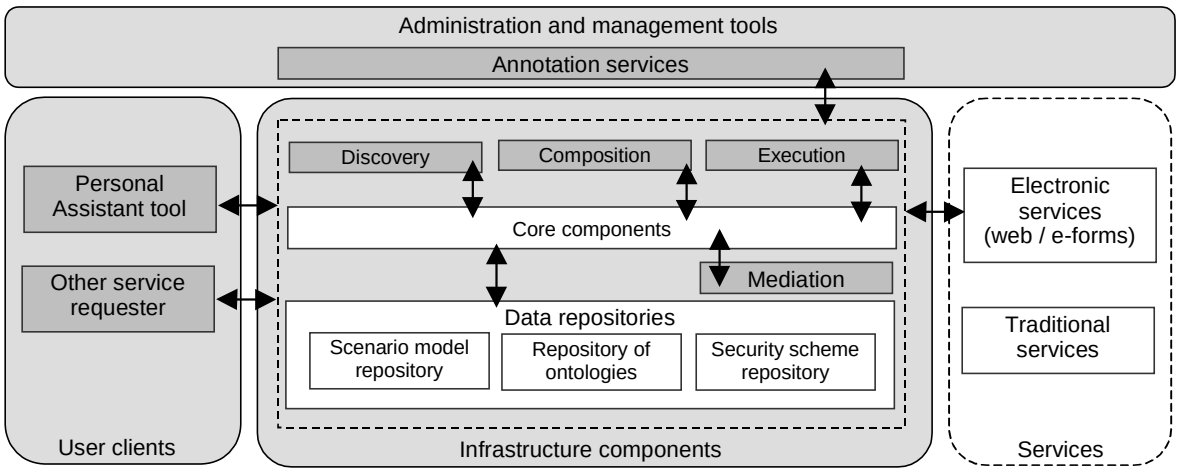

Figure 1: System architecture of the Access-eGov system

The *core components* consist from in-memory object model of ontologies; web service entry point that makes infrastructure components available to the *Personal Assistant tool* and *Annotation service component*; security and notification services. These components are mediated on the data level to resolve possible data heterogeneity problems [5]. As mentioned above, the mediation is based on ontology mapping and its translation to the rules for ontology merging. The *Discovery*, *Composition*, and *Execution* modules [5] are responsible for managing the composed services, particularly for searching capabilities, orchestration, merging, chaining or decomposition of elementary services according to the given scenario, and for the execution of services in the workflow sequence. In the process of service discovery, functional properties of goals and services are semantically matched by the *Discovery module* to select the services, which are able to achieve these goals. Non-functional properties specified by the requester are then used to additionally filter or reorder the discovered services according to the user's preferences. In addition to the semantic discovery, a full-text searching capability is also provided. Full-text queries are matched to the text extracted from unstructured non-functional properties, i.e. name, description, etc.

In case that the *Discovery component* cannot find proper services, which are able to achieve a requested goal, the goal description is delegated to the *Composition component* that tries to orchestrate existing services to the new scenario to solve the goal. This process includes decomposition of the complex goal to atomic sub-goals and its consequent resolving by a semi-automatic approach based on the generic scenarios defined for the life event categories. Finally, for successfully identified and composed services the *Execution component* creates and executes process instance for the user scenario according to the specified process model.

2.4 Technology used

The requirement of integration of existing governmental services on a semantic basis determines the usage of semantic web services formalisms and tools as the "option No. 1".

Two different approaches to implementation were considered as suitable for technology platform of the Access-eGov system: process-oriented and service-oriented. After the analysis of pros and cons [4], the ***service-oriented approach*** based on common conceptual model was selected as the most appropriate solution.

In particular, the Web Service Modelling Ontology (WSMO) [7] was chosen as the best candidate for the implementation platform. The main reason for that was that WSMO provides a conceptual model for the description of ontologies, Semantic web services, goals, and mediators, which fit best to the proposed architecture of Access-eGov system. This approach also offers the WSMX execution environment, which enables discovery, selection, mediation, and invocation of semantic web services. WSMX is based on the conceptual model provided by WSMO, being at the same time a reference implementation of it. WSMX also provides a test bed for WSMO and a potential to prove its viability as a means to achieve dynamic interoperability of semantic web services. The WSML language provides means to formal description of all the elements defined in WSMO and used in the Access-eGov system. Internal data representation of WSMO elements can then be obtained through parsing the WSML descriptions into the WSMO4j[6] data object. Selection of a proper application architecture and middleware component technology was agreed after a detailed analysis of existing possibilities [4]. Finally, a combination of web services and service-oriented peer-to-peer architecture was taken as the best candidate due to its modularity, possibility of local or remote accessibility from any platform, fault tolerance, scalability, and ease of deployment.

"Behaviour" of the Access-eGov system in various possible installations can be described using the scheme of structural view, presented in Figure 2. Three vertical levels represent:

- *User level*, where citizens use the *Personal Assistant tool* to find and execute desired services, and public administrations (i.e. the Access-eGov system administrators on the side of public administrations) annotate the services by the *Annotation service component.*
- *System level* consists from the Access-eGov system itself, represented by peer-to-peer nodes called AeG P2P nodes. Each node contains the modules and components as they were presented above on Figure 1. According to the functionality needed in a particular AeG P2P node, the actual number of installed optional components may vary.
- *Services level* contains electronic and traditional services from the provider side.

Three horizontal levels represent particular organisations, e.g. a public administration, department, etc. In such an organisation, one AeG P2P node will be set up, which can be administered by this organisation, but at the same time co-operating over the P2P network with other nodes installed at other organisations. Individual nodes may be configured with a "reduced functionality" according to the needs or restrictions of the given organisation. There are three possible installation types depicted in the scheme:

- *Organisation A* - with fully featured AeG P2P node installation. It provides services both to the *Personal Assistant* and *Annotation service* user interfaces;
- *Organisation B* - with limited AeG P2P node functionality implemented. It does not provide a user interface to citizens. Users can use the web or traditional services described in this AeG P2P node via other (fully featured) nodes (using P2P);

[6] http://wsmo4j.sourceforge.net/

- *Organisation C* - does not have an AeG P2P node installed; it only annotates its electronic and traditional services using an AeG P2P node outside the organisation. Such organisation will only need to be able to access the Annotation service.

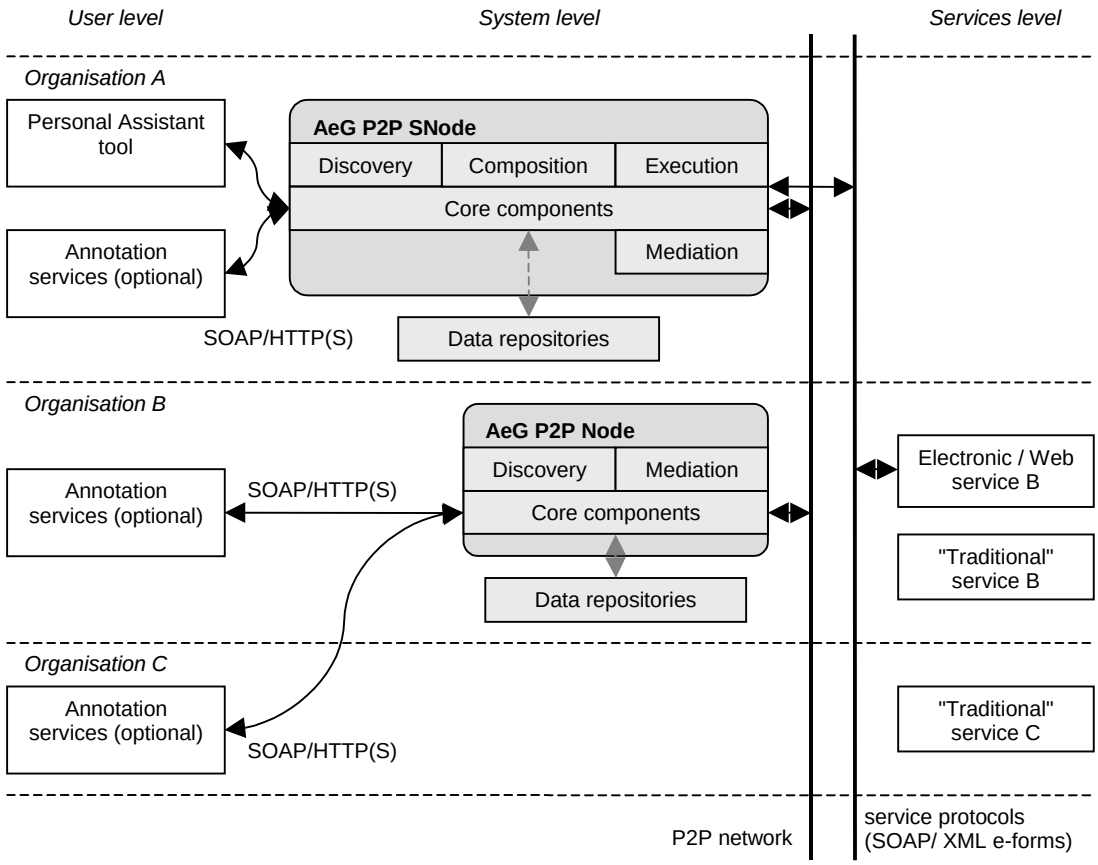

Figure 2: Structural view of Access-eGov system, installations in peer-to-peer network

Several communication types are utilised in the scheme of the system implementation. The HTTP(S)/SOAP protocol is used for interactions between the user and system levels. The peer-to-peer network handles mutual communication between AeG P2P nodes. Each node can act independently of other nodes, however, there can be a need for communication between two AeG P2P nodes, e.g. when a user connected to one node needs a web service described at the other node. Communication between the services and nodes uses the protocols defined by the services - SOAP or XML-based are supported. The SOAP/XML protocol is also used for internal communication between the AeG P2P nodes and their data repositories.

3. Conclusions and future work

The Access-eGov system was designed as a modular framework for integration of existing electronic and traditional services provided by public administrations. The services are semantically annotated by means of system ontologies, using the WSMO conceptual model. This approach enables to combine the elementary services into more complex workflow structures – life events with associated goals, service profiles, and various properties. System architecture, based on web services and service-oriented peer-to-peer networks, ensures flexibility, accessibility, and other required parameters of the proposed solution to be a good platform for interoperability in the field of eGovernment.

Currently (February 2007), the design of the Access-eGov system and its components has been finalised and implementation is in the initial phase. The Access-eGov system will be tested on three pilot applications in Germany, Poland, and Slovakia within two trials. According to the work plan, first prototype of the system should be ready by the end of 2007. Based on the evaluation of the first trials (within which individual components of the Access-eGov platform will be tested in real settings), implementation of the architecture and individual components of the Access-eGov platform will be adapted accordingly. More information on the Access-eGov project can be found at www.accessegov.org.

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