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A SEMANTIC WEB SERVICE COMPOSITION FOR E-GOVERNMENT SERVICES

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ABSTRACT

Emerging from e-business ideas in the late 1990s, e-Government is seen as a concept that is focused on fully exploiting Internet and information and communication technologies to deliver effective government services to citizens, businesses, and other stakeholders. However e-Government has some specific features as opposed to traditional e-business scenarios, because of the enormous challenges it faces in achieving interoperability, integration and security, which are of interest to our dynamic Web service composition research and on which semantic Web service composition architecture could be properly demonstrated. From these reasons, we propose in this paper an approach for the composition of semantically described e-Government Web services, enabling citizens to dynamically compose services according to their goals and through a single point of access.

Keywords: *Web Service Composition, Semantic Web Services, E-Government, Multi-agent systems, AI Planning.*

1. INTRODUCTION

The United Nations defines electronic government (e-Government) as the act of utilizing the internet and the world-wide-web for delivering government information and services to citizens [1]. The World Bank defines e-Government as the use of information and communications technologies (ICT) to improve the efficiency, effectiveness, transparency and accountability of government [2]. In other words e-Government is a way for governments to use the new technologies to provide people with more convenient access to government information and services, to improve service quality and to provide greater opportunities to participate in the democratic institutions and processes.

The application of information technologies in the governmental setting is a common concern in many countries that are attempting to revitalize their public administration to make it more proactive, efficient, transparent and more customer-oriented. The Moroccan government acknowledges these goals and has been constantly working to achieve them at provincial and national level. As a result, several projects have seen the light under the Moroccan e-Government initiative, those projects are so diverse and handle interactions between government and citizens (G2C) such as Watiqa [3], government and businesses/commerce (G2B) such as E-invest [4], between government and governments /agencies (G2G) such as GID.gov.ma [5], as well as citizen interaction with their government (C2G) such as Fiqra [6].

One of the main challenges of e-Government initiatives relies on efficiently integrating all heterogeneous public information systems and business processes of government in a secure manner. As a contribution toward this aim, we propose in this paper a semantic Web service composition for e-Government services based on intelligent artificial techniques.

The layout of this paper is as follows. The second section discusses the impact of semantic Web service composition on e-Government services efficiency. The third section is devoted to related work. The fourth section describes the architecture of a one-stop government portal based on our semantic Web service composition platform, which we are realizing as an experimental testbed. The fifth section presents an e-Government process which will be used as an example to illustrate the platform functionalities. The conclusion and future work are presented in section six.

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2. E-GOVERNMENT AND WEB SERVICE COMPOSITION

In order to enable faster, cheaper, more personalized and more efficient delivery services, e-Government programs must make the transition to the customer-centric approach, just as businesses have done in the response of the internet technologies. Today citizen and business, the client of government, expect the same level of convenience and access to efficient and effective services from their government as they receive from commercial enterprises such as banking and retail. They demand easy access to information, and want interactions with government agencies to be seamless and fast.

In order to deliver seamless services to citizens it is necessary to enable a real interagency cooperation which allows services and information sharing, while reducing the need for users to provide redundant information already held by the authorities. Technically this requires the shift from isolated silos in public administration to one integrated government. In many governments, citizen data is housed in multiple data silos that are contained in legacy systems and distributed throughout the organization. These legacy systems, which often store data in different formats, are usually unable to communicate. To overcome this barrier, governments need to integrate cross-functional systems and databases together to deliver one-stop e-Government services [7] to the public that encapsulates the size and complexity of government. As a result, when citizens use a particular online service, they may be asked to use another related services in one-go. This one-stop user experience will enhance overall user satisfaction of e-Government services. Technology play a pivotal role in enabling this envisioned one-stop government as it can brings real solutions to integration, interoperability, coordination and security issues.

On the other hand Web service composition refers to the process of combining several Web services to provide a value-added service [8, 9]. It is emerging as the method of choice for building cross-organizational applications on the Web [10, 11]. Toward dynamic semantic Web service composition has been the subject of our researches, as it has been argued in [12] our goal is to automate the whole composition process including discovery, composition, execution and interoperation of Web services. Our proposal stems from the following basic underlying hypothesis: The synergy between four basic technologies namely; Semantic Web (SW) [13], Multi-Agent System (MAS) [14], Autonomic Computing [15] specially self-healing propriety and Artificial Intelligent Planning (AIP) techniques [16], can leads to the development of an effective platform that supports personalized, integrated and interoperable Web services.

E-Government has some specific features as opposed to traditional e-business scenarios; the e-Government domain is a large, heterogeneous, dynamic and shared information space with various semantic differences of interpretation. From these reasons, e-Government seems to be an obvious and promising application field for our semantic Web service composition approach. And since the e-Government services require a high degree of interoperability and distribution due to the numerous entities they imply, a semantic Web service composition technology is a potential candidate to solve a significant number of e-Government problems. Therefore, the combination of these two areas is very much natural. E-Government provides an ideal test-bed for our semantic Web service composition approach and, on the other hand, semantic Web service composition architecture provide an ideal platform for distributed, integrated and citizen-centric e-Government.

3. RELATED WORK

One of the key features of developing online services is to structure and design composite services to gain real benefits for existent services. In the literature, several studies have been undertaken all over the world by different research communities in the field of e-government services composition and integration.

Table 1 presents some of the major e-Government projects that aim to provide a one stop shop e-services approach.

The **ontoGov** (Ontology-enabled e-Gov Service Configuration) represents a platform that facilitates the composition, the configuration and evolution of e-gov services. Its main role is, on the one hand, to offer public administrations a global view of service configuration models, and on the other hand to improve given services to users. ontoGov is ontology based approach with a change management capability based on well-known MAPE management system [17].

WebDG, another approach for composing web services, WebDG is a comprehensive Web Service Management System for e-Government applications. The approach proposes an ontology-based framework for the automatic composition of

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Web services. It presents an algorithm to generate composite services from high level declarative descriptions. The algorithm uses composability rules, in order to compare the syntactic and semantic features of web services to determine whether two services are composable [18].

eGOIA (Electronic GOvernment Innovation and Access) is a Service Composition Management Framework that show future-oriented public administration services to a broad public in Latin America. The vision of the eGOIA project is the provision of a single virtual space supporting the interaction of citizens and the public administration. eGOIA is focuses in a technology-independent description, the different aspects of collaboration are developed following the concepts of MDA (Model Driven Architecture); services and related metadata are first modeled independently of technology and platform, by means of UML and EDOC[19].

eMayer is a Web Services based platform that is built as a holistic service framework for the deployment and delivery of e-Government enterprise services for European municipalities. The approach focuses on the security mechanisms that have to be supported by e-Government architecture in order to address security requirements. The design of the platform is based on the ISO/RM-ODP standard [20].

Table 1: E-Government projects.

Projects	Country /region	Technology	Objective
ontGov	Europe	Semantic based platform	- Composition, configuration and evolution of e-gov services - Self-management system
WebDG	USA	Semantic based platform	- Automatic composition of web services - Optimized querying of e-government services
eGOIA	Latin America	model-driven approach	- Horizontal and vertical integration of Public administrations
eMayer	Europe	Web services ISO/RM-ODP standard	- Secure and interoperable e-Government enterprise services

Many e-Government projects are being developed and various approaches have been proposed for the design and the development of architecture to deliver e-Government services to citizens. Most of recent e-Government projects support the one stop shop e-services vision and use semantic technologies to deal with composition, integration and interoperability issues. Unlike our approach, no one of such projects has explored the possibility of using Artificial intelligence for the automation of the composition process of public administration services.

4. PROPOSED APPROACH

Figure 1 shows the high level overview of the proposed Web service composition approach applied to e-Government. The architecture extends the one defined in [21].

As depicted in Figure1 the platform consists of four layers, namely i) communication layer, (ii composition layer, iii) ontology layer and, iv) legacy system layer.

Legacy system layer (low layer) contains the legacy applications available in each of the public administration (PA) involved in the system.

Communication layer (high layer) is none other than the GUI. It effectuates the connection between the system and the user, and allows him both looking for e-Government services and executing services offered by the platform.

In the following we will explain each of the other two layers in more detail, as they show how different legacy systems can be integrated to offer personalized services.

4.1 Ontology layer

Ontology is crucial component, it represents one of the pillars of our Web services composition architecture as it allows to solve the aforementioned interoperability problem [22][23]. According to [24], ontology is a group of hierarchically structured concepts designed to describe a domain, it provides a shared and common understanding of the structure of information among people and software agents and can serve as a framework for a knowledge base. Thus we use ontology as a knowledge models to capture semantic content of e-Government domain, user profile and e-Government Web services in a manner that can be automatically processed by a machine. Aside from the semantic representation of concepts, ontology also provides a data type description which specifies the data component of applications [25]. So Ontologies are application

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independent, which contribute to the semantic interoperability of applications [26].

Our system integrates: (a) e-Government domain Ontology that contains the domain's types, concepts and relations among them. (b) e-Government Service Ontology plays the role of a UDDI [27] registry with extended functionalities allowing the storing of rich semantic description of Web services involved in public administration services. (c) QOS Ontology specifies shared knowledge and vocabularies about quality of service proprieties and their relationship with respect to semantic services. (d) User profile Ontology incorporates concepts and properties used to model the user preferences and extra information, the latter play a major role in the personalized process of the delivered services.

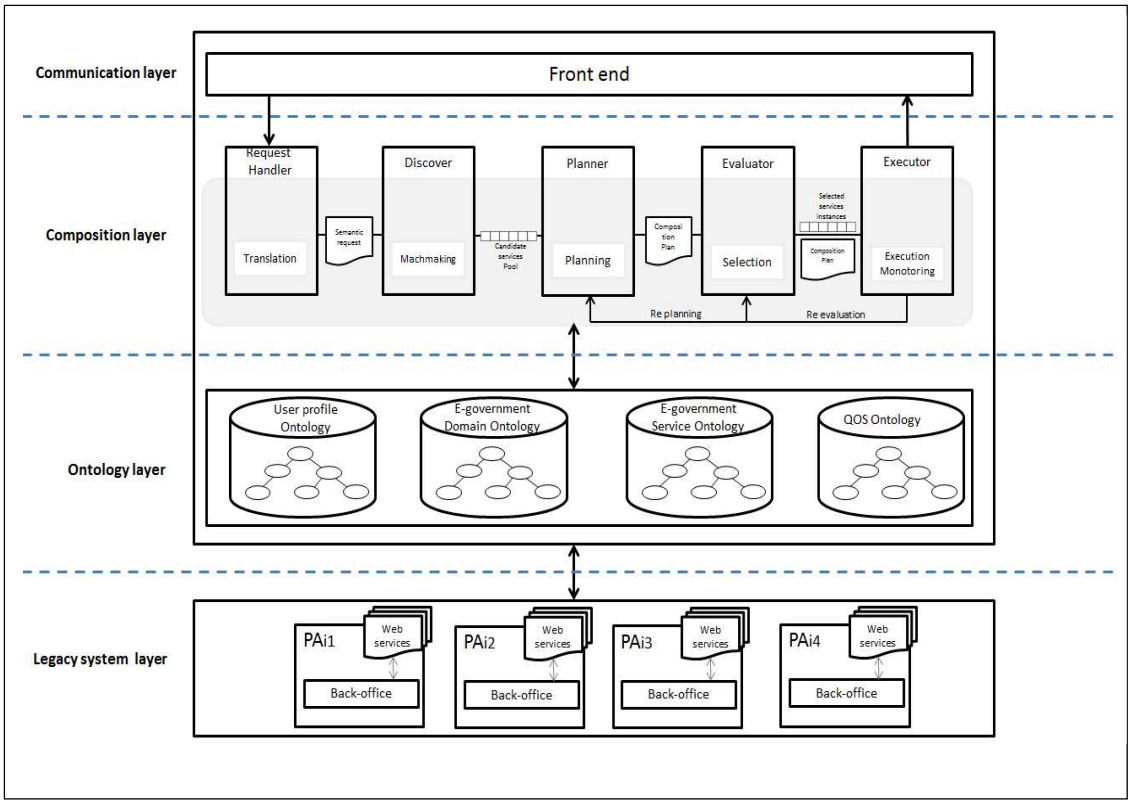

Figure 1: The High Level Architecture Of The Proposed Approach

4.2 Composition layer

Composition layer is the core component of the proposed semantic Web services based e–Government services composition which provides the required functionalities such as discovery, composition and execution of services. It is composed of a set of intelligent agents capable of interacting and cooperating in order to co-build automatically a composition plan. The composition process is depicted under four phases namely: i) analyze, ii) planning, iii) evaluation and iv) execution.

The aim of the first phase is to define semantically the requested service, starting from an abstract specification of the user request, the Request Handler agent uses natural language processing tools to translate the request expressed in natural language phrases into a semantic format with the respect of e-Government domain ontology. This semantic request is then enriched by adding user preferences retrieved from information stored in user profile ontology.

During the second phase a composition plan is generated in two steps namely, discovery and plan construction, the first step is to find all candidate services that can potentially lead to satisfying the desired functionality, to do so, Discover agent first checks if any existing service in the e-Government service repository matches exactly the requested service. If one or more services are found, they are directly sent to the

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Evaluator, by this way the system avoid unnecessarily wasting planning effort. Otherwise the Discover looks for candidate services that can potentially participate to construct the new composite service. The search is based on a matchmaking algorithm [12] using the service ontology repository and the domain ontology repository. In the second step the Planner agent coordinates a set of Manager agents that act on behalf of discovered WS. They work cooperatively using IAP techniques [28] to co-build an abstract composition plan.

Given a composition plan, an important challenge for the system is to find the "best" composite service execution plan with respect to user specifications. The evaluation phase deals with this issue. Indeed in order to select the best composite service execution, Evaluator agent uses QoS ontology to rank the alternative concrete composite service through the use of quality of service techniques [29]. The highest ranked plan (closest to user goals) is sent to the Executer that takes in charge the execution of the selected plan. It is also responsible for storing the generated composite service in the e-Government service repository for sharing and possible future reuse in latter to other request. Since inconsistencies may occur at runtime, eventual re-planning and reevaluating operations may be necessary to ensure that the system run correctly.

4.3 Composition Process Based On The Layered Architecture

The layered architecture of the system bridges the gap between user needs and agencies offers.

Indeed a citizen interacting with the government usually needs a service that typically requires starting more than one administrative procedure at several different public institutions and often knows only what he/she wants (for example to build a house, to move or to start a new business), but does not know which administrative procedures apply in his or her particular case, which public institution is competent for handling that case and what else is needed to complete the procedure (what application, which supplements, where and how to find all the necessary information, etc).

On the other hand, the existent organization of government is based on a division of work between several fields or competences. Accordingly, administrative offers (procedures and services) are adapted and distributed over several public institutions, each of them has its own information system and usually there is no communication channel between their IT infrastructures.

The role of the system is to lead the citizen from his/her problem to the appropriate service or services by encapsulating the complexity of public institutions. Indeed with an architecture based essentially on intelligent agents and ontologies, the middleware element formed by ontology and composition layers provides mechanisms to coordinate existent services in order to provide a new personalized service. Starting from an informal, incomplete and ambiguous request, intelligent agent explore e-Government services repository , where PA services are published in a semantic manner, to find the right combination of services that satisfies the user requirements, the use of IAP techniques makes this process dynamic and automatic. Then agents take in charge the execution of the composition process in a changing heterogonous environment based on autonomic computing architecture. As a result the system provides a value added services that are more convenient for users' needs and perceptions and increase efficiency in terms of costs and productivity by reusing autonomous Public Administrations while keeping their internal processes and legacy systems intact.

5. CASE STUDY

Throughout this study, and to evaluate the performance of the proposed architecture, we chose to discuss the service: «Obtaining a building permit » as a case study. We chose this service because it requires the invocation and composition of Web services from multiple governmental agencies and entities [30].

Building a house is a complicated matter, especially for individuals. In morocco, there exists no exchange of information between different players in the building process. This means that the private builder has to transfer information from each process and provide every player with this information. These latter is mostly not familiar with the building process as most individuals build one house in a lifetime and consequently he is usually not aware of the full range of services available within his municipality or commune for the building purpose, thus making coordination and composition mechanisms necessary in order to ensure that the citizen makes use of the full range of services available.

Let us consider the following scenario typical to building houses domain; after the acquisition of a

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terrain a citizen, let's call him Ali, wants to build a house. First of all, Ali must go to the Urban Commune to request an application form and others printed delivered by the commune (information note, data sheet …). After filling the delivered forms Ali must constitute a technical file composing by multitude architecture plans (cadastral plan, Location map in Lambert coordinates, Façade plan…) and a copy of the architect contract. Then Ali must go to the National Agency for the Land Register to extract the certificate of land ownership. Afterwards, he must get a discharge payment of examination fees of civil protection services from the General Direction of Civil Protection. Finally, the citizen must return to the Commune to deposit his file and to pay the application fees. This process is presented by Figure 2, its takes much time and requires much moving.

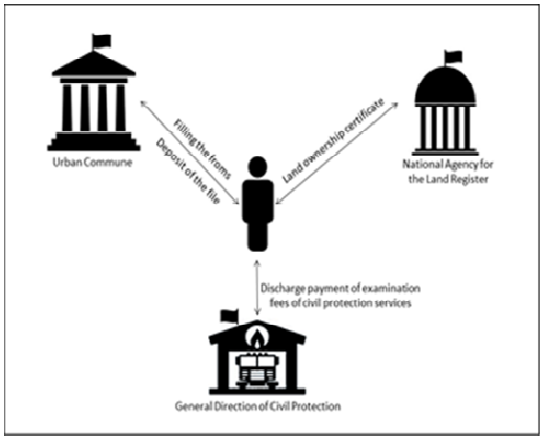

Figure 2: Obtaining building permit process

To implement an electronic service for this scenario, those three administrations should cooperate. Our proposed approach takes into account this requirement and allows, starting from a single access point, the launch of the whole process related to the selected scenario.

After being connected and authenticated by the e-Government system, the citizen requests the "building permit" service. The communication layer of our system takes in charge transmitting to the citizen the form to be filled; the citizen fills the e-application form with the required information requested by the Commune and then uploads the required attached documents (technical file).When the citizen validates his keyboarding, his request and the information he provides will be encrypted and transferred to the composition layer. It is on this level that the process is launched. Indeed the composition system invokes multiple services contained in distinct applications servers (Legacy layer) and published semantically in e-Government services ontology as Web services, the mechanism of invocation respects of the generated composition plan. This made up service is represented in Figure 3. Once the process is finished, a response to the request as well as a building permit certificate (In the case of approval) will be sent to the citizen.

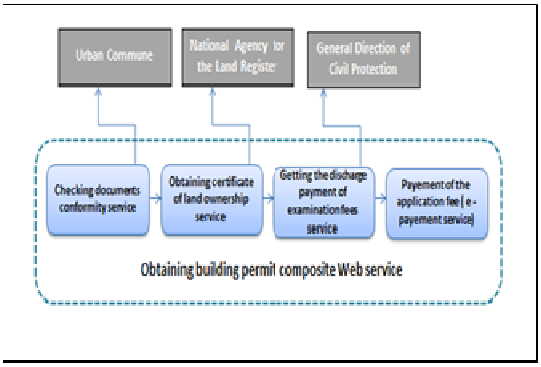

Figure 3: Representation of the composition of "Obtaining building permit" service

From this case study, we can conclude that the proposed Web service composition system makes e-Government services more citizen-friendly by making it possible to the citizen to profit from various services while saving time and effort. In the scenario presented above, Ali will be able to get his building permit without having to present himself at the three administrations implied in the process of building permit request. Hence he does not need to know how the government deals with the information within its disparate departments. This strategy could potentially also enable for interactions with external organizations that do not comprehend the public administration, but offer services that are necessary for a given scenario (such as the Bank, architects, telecom operators…).

6. CONCLUSION

We are convinced that semantic Web services provide a solution to cross the borders between existing administrations services in Morocco. Hence compositions of e-government web services in dynamic way provide a personalized service that improves the satisfaction of the citizen and thus increase the quality of public services. Beyond of the extent of the organizational and social reform to be undertaken, we propose, in future-oriented vision, a technological-based approach towards an effective e-Government that provides added-value to its citizens.

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In this paper, we propose dynamic semantic web services composition architecture for e-Government. We have described in details the proposed layers for the architecture and outlined their interactions. Then, we applied this architecture for a Moroccan case study, in the context of implementing obtaining building permit web service.

Our future work includes the completion of the proof-of-concept prototype but before, we plan to pursue this work by implementing other applicative scenarios to more validate our architecture.

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