Fostering self-adaptive e-government service improvement using semantic technologies

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Abstract

In this paper, we introduce FIT, a STREP Project sponsored by the European Union starting in 2006. The overall objective of FIT is to develop, test and validate a self-adaptive e-government framework based on semantic technologies that will ensure that the quality of public services is proactively and continually fitted to the changing preferences and increasing expectations of e-citizens. We give a brief overview on the FIT scenario and indicate where and how we plan to utilize Semantic Web technologies.

Motivation

Although an e-government system has a complex structure, users interact only with a front office[1], which is usually realized as a portal sometimes combined with Email for delivery purposes. The web portal is a channel to publish administrative services on-line, spreading from only providing information about a service to completely treating a public service via the web site, including decision and delivery (Cap Gamini, 2003). Therefore, the structure and the design of a front office have a crucial importance for the success of the e-government.

Currently, the technological possibilities rather than user needs have determined the development of front offices, so that a large percentage of potential users of e-government still prefer to access government services through traditional channels (mostly face-to-face) (Gareis, 2004). The main problem is that users, especially those without web experience, are often lost in the information space of a portal and need some specific helps or hints that are usually provided in a brick-and-mortar environment, like getting help in finding the office responsible for a service, or in filling up a formulary. Indeed, the most crucial characteristic of a front office is to be inclusive, i.e. to enable the accessibility of each service to each user. On the other hand, in order to increase the pay-off of using an e-government system, the delivery of services has to be very efficient, which means, for example, that an (experienced) user can perform a service without being bothered with irrelevant information. Therefore, this potential conflict between simplification of e-government services to ensure inclusion, with potentially less efficiency gains, and the skills required to enable active user participation, leads to a need for a customized delivery of services. Such a delivery will bridge the digital divide by ensuring inclusiveness across a diversity of needs, which is one of emerging trends in public needs for e-government services (EU Report, August 2004).

Moreover, despite the hypermedia-based infrastructure of the web, the state of the art in the development of front offices is publishing a service in isolation, without considering all contexts in which it can be used and expressing the cross-dependencies between services. For example, in the current front offices there is usually one static grouping of services, although there are many possible ways to structure them depending on the current user's need (i.e. working context). This fact can be used as an explanation why finding the most suitable service for a particular need is one of the most reported usability problems in e-government (EU Report, December 2004).

Finally, measurement of the users' satisfaction with e-government shows that due to the increased users' expectations, the level of users' satisfaction do not seem to increase anymore at some point. It means that the quality of public services is a more complex category and depends on the possibility to anticipate changes in users' needs. In order to support the continual improvement of the quality of public services, the focus of a front office should be shifted from an infrastructure for delivering a service to an intelligent platform for discovering needs for service improvement that will meet users' expectations. In that way an e-government system becomes more proactive offering more and more qualitative services to its customer.

Therefore, the delivery of public services in a front office should be tailored to the preferences, needs and expectations of each user individually. Moreover, in that way e-government can reach to a large extend the intimacy/adaptability a user is used to get in a real administrative office, where the public administrator understands the user's specific situations and can act reasonably. Together with the advantages of online transactions—no waiting queues, no restriction in office hours, no driving time—adaptability will help that the acceptance of e-government exceeds that of real administrative offices.

1 Front office is a computer infrastructure in an organization designed specifically as an interface for communicating with external customers

In this paper we introduce the FIT (**F**ostering self-adaptive e-government service **I**mprovement using semantic **T**echnologies) project that will specify, develop and deploy a holistic framework and supporting tools for an inclusive and personalized e-government, by enabling continual adaptation of the services to the changing needs and preferences of users, through the application of the semantic technologies. Moreover, it will lay a foundation of a self-adaptive e-government, which automatically discovers deficiencies in its functioning and fits itself in order to satisfy ever increasing users' expectations.

FIT approach

There are two challenges in realizing an adaptive front office. First, experience shows that web users tend to be reluctant to provide the feedback about their satisfaction/expectations via filling questionnaires or forms. In order to avoid asking users explicitly, means for capturing their preferences implicitly are required. Second, many of the current generation of public services are off-line services converted for on-line use without further development and optimization of the services. It means that the description of public services must be extended with the information about users' preferences in order to enable their customized delivery. This makes the customization process more difficult since the changes in the back office are required as well.

Figure 1 illustrates the above presented problems in the existing e-government systems and how FIT will address these problems. More specifically, FIT intends to provide:

- a personalized front office (instead of a uniform one) that will enable personalized and „inclusive for all" access, regarding users' preferences, needs and expectations;
- a quality-driven bidirectional platform (instead of one way service delivery) that will enable context-aware delivery of services and implicit capturing of users' feedbacks about the usability of the front office;
- a customized back office (instead of an inflexible one) that will ensure multi-context views (shown as a new dimension in "To-Be" situation in Figure 1) on public services based on the user and quality model;
- a framework to support knowledge sharing between front offices, i.e. how to use best practices learned in one front office in other offices.

Note that the fourth issue is not explicitly shown in Figure 1, since it goes beyond the customization of a front office, enabling the customization of a community of them.

Resolving all these issues leads to the realization of a self-adaptive e-government system, i.e. a system that incorporates mechanisms to assess how a service is performing based on different criteria, and then enables to take action to optimize it. Indeed, it helps to find the "weak places" in a service delivery regarding the users' needs, ensures that generated recommendations reflect the users' needs, and promotes the accountability of a government. Moreover, this approach lays a foundation for a collaborative platform for exchanging experience in serving users between e-government portals. In that way FIT addresses three of four key challenges defined for the e-government in the EU in the next decade (EU Report, August 2004), namely knowledge-based, user-centered and networked e-government.

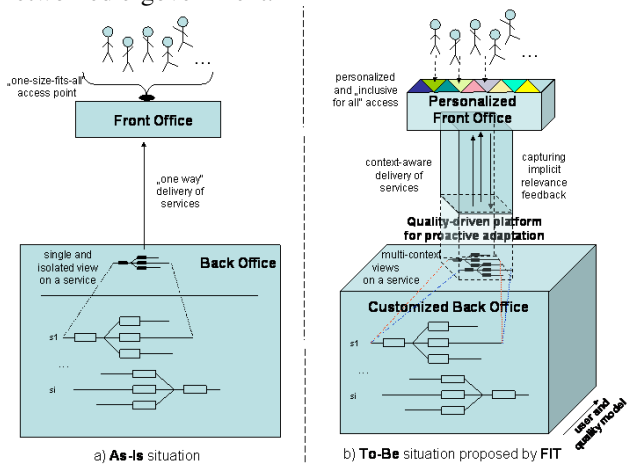

Figure 1: As-Is vs. To-Be situation

FIT Scenario

Since the goal of FIT is to create self-adaptive e-government, we will adapt autonomic computing initiative. FIT will be realized according to the ontology-based ***MAPE*** (***M***onitor ***A***nalyze ***P***lan ***E***xecute) model (Stojanovic, et al., 2004), which uses ontologies as the backbone of the adaptation process. The approach abstracts the management architecture into four common functions: collect data, analyze data, create a plan of action, and execute the plan. Indeed, the conceptual framework decomposes the control loop into four parts:

- Monitor – mechanism that collects, organizes and filters the data about users' interactions with the e-government portal;
- Analyze – mechanism that aggregates and transforms the collected data, correlates this data with background knowledge (e.g. domain knowledge, quality model, user model, administrative processes) and makes proposals for improvement;
- Plan – mechanism to structure actions needed to realize requests for improvement by modifying the underlying administrative process description. The planning mechanism uses "learned" business rules to guide the work;
- Execute – mechanism to update the portal according to the changes applied in the business process descriptions and the needs of users.

By monitoring (**M**) the behavior of users and analyzing (**A**) this data, planning (**P**) which actions should be taken and executing (**E**) them, a kind of a "usage loop" is created.

Figure 2 depicts this "usage loop". A user is searching for an on-line service by querying and/or navigating through an e-government *portal* (cf. 1 in Figure 2). All activities that the citizen performs are acquired in the *Semantic Log* (cf. 2), which is structured according to the *Log Ontology*, and contains meta-information about the content of visited

pages whose meaning is represented in the *Domain ontology*. This log data is analyzed in the *Knowledge Discovery module* (cf. 3) that detects anomalies in the design of a portal and/or on-line services, whose repairing improves the usability of this portal. The context information (described through *Quality ontology*, *User ontology*, *Administrative processes ontology*) is used to improve the learning. This discovered knowledge is incorporated in the existing administrative processes, through business rules (cf. 4) in order to be interpreted by a workflow engine. Finally, since the underlying portal provides a view on on-line administrative processes, all changes made in the processes are reflected on the portal (cf. 1), by tailoring the portal to the users' needs, which implicitly arose. The repetition of this cycle leads to the continual improvement of an e-government system.

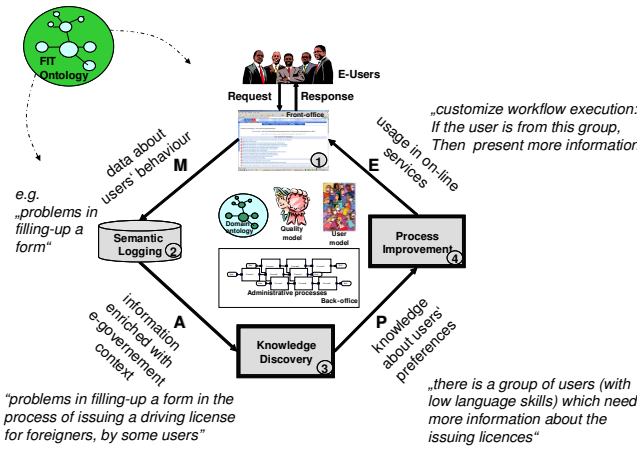

Figure 2: Closing the Semantic Loop in using an e-government system: The conceptual architecture of FIT according to the MAPE model

For example, if many citizens spent a lot of time on filling in a form of a service or they cannot finish the corresponding activity, then the Knowledge Discovery module will learn preference rules for such groups of users (e.g. which additional content should be shown in order to make the process more efficient). For a new user, the system will discover, by analyzing the clicks the user made in the current web session, which group of e-citizens he/she could belong to. Consequently, the execution of e-services will be customized according to already learned preference rules and the user will be able to finish a task efficiently. Similarly, more advanced users will profit from the customization by not being "bored" with information, which is useless for them. In that way, FIT aims to be a user-friendly platform that integrates the results from the analysis of the usage data with the tools that guide the process of modifying the portal.

FIT Ontology

In order to enable formal specification and analysis of the adaptation process all factors that influence the adaptation as well as the relationships between them should be defined formally and explicitly. This formal model will be captured in the FIT ontology. In order to develop it, the following available information will be used:

- Website structure - The way that the website is physically laid out can be useful toward understanding usage behavior and interpreting system suggestions. The semantic information about the reasons why the structure exists in the way that it does may also inform the system.
- Website content - The content of web pages themselves is essential toward determining particular topical interests and understanding the relationships between pages.
- Website usage data - The most important data set is the recording of interactions of users with the website, in other words, the way that the website is used.
- User data - Information about the people using the system can help in understanding their interests, or in finding common groups of users which share interests.

The explicit representation of the semantics of all relevant data through the FIT ontology will enable e-government to provide a qualitatively new level of functionalities. For example, the gap analysis that will enable the discovery of problems (deficiency) in the e-government portal in case that no service is found for a given user's request.

The FIT ontology will play a role of an e-government upper ontology, by ensuring that there is "one model in one place" and that the e-government is "decentralized but connectable". In that way the FIT ontology can be used as a basis for the federated navigation and inference.

Finally, the FIT ontology will be combined with information about the "usage" of some entities from the e-government domain, which will support the discovery of frequently used resources as well as unused resources that might indicate the existence of a problematic situation. This will lead to the development of a proactive e-government that uses predictive methods to drive its adaptation.

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