

Integrating Adaptive Web Techniques with Web Services

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Abstract

Enterprise software infrastructure traditionally comprises a number of independent systems in order to support customer needs and business processes complicating this way productivity, performance and maintenance. Instead there are hypermedia facilities based on widespread standards that provide over a user-friendly, well-known framework richer functionality and features.

In the paper, we present the design, implementation and evaluation of the combined use of web services and adaptive web-based techniques. We describe a large-scale hypermedia framework that improves the efficiency and performance of conventional enterprise activities like customer services (registration, activation, billing, support) and document management. The presented approach aims to cover these fundamental needs for a network of customers, collaborators and intranet employees.

1. Introduction

It is commonplace after several year of web-based hypermedia applications' development that they are mostly the result of an implementation ad hoc, growing usually from small to large applications and becoming very soon both complex to use and difficult to maintain [5]. Moreover web systems seem to suffer from inabilities as they deliver the same pages and the same set of link to all users. A remedy for the negative effects of the traditional "one-size-fits all" is to follow common practices of the adaptive web research area [2]. Adaptive web makes it possible to deliver personalized views or versions of a hypermedia document, improving this way usability and thus productivity, for all the users with diverse needs and knowledge backgrounds gaining access to the system [3].

In parallel trail, recent technological advancements, concerning the web, lead the accelerating creation and availability of web services to be a major www trend. Web services are services that usually include some combination of programming and data, but possibly human resources as well. They are made available from a business's Web server for Web users or other Web-connected programs. Web services range from such major services as business interaction and customer relationship man-

agement down to much more limited services such as checking of stock quotes and checking-in for an air travel.

In our case we strive to synthesize all the applications that an enterprise needs, using web personalization techniques in order to increase user-friendliness, boost productivity and reduce administrative costs. The key in all this architecture are the XML Web Services, which are pieces of reusable code that has been based on widespread standards and which some application can use, without it gets to know that was created or functional system or platform is supported.

In the sequel we describe an approach in which we elaborate the direct web service of new customers and business associates and well-known adaptive techniques for the intranet web, providing extra productivity for the company. Key features are the object-oriented method followed for smooth and swift incorporation of the re-engineered processes with the already existing infrastructure, the adaptive web-based environment utilized in both intranet and extranet users, and the web-unification of all the enterprise applications under the common umbrella of a single architecture through the use of web services.

In the following sections we will address: the approach followed; the technological functionality of the extranet and intranet web services provided; adaptation features that personalize processes to the needs of the user; the support of standardization to improve scaling, re-usability and maintenance; overview of the collaborators' feedback and future directions in design and implementation.

2. The Approach

The design and development process was addressed as follows, having in mind that a number of different kinds of specialists played distinct roles:

- 1) Data experts designed the structural model;
- 2) Application architects built pages and the navigation between them;
- 3) Style architects drew the presentation of pages;
- 4) Site administrators decided users and personalization options, including business rules.

This is in fact the layout description of the OOHDM (Object-Oriented Hypermedia Design Method) that is an object-oriented evolution of HDM which uses abstraction and composition mechanisms in an object oriented

framework to describe complex information items and specify navigation patterns and interface transformations.

In OOHDM, a hypermedia application is built in a step-by-step process supporting an incremental or prototype process model. Each step focuses on a particular design concern, and an object-oriented model is built. Classification, aggregation and generalization/specialization are used throughout the process to enhance abstraction and reuse. In order to provide detailed documentation our method includes a number of deliverables that depict the above steps to documents that can be used for reference.

Before proceeding during the design we assembled a list of prime key requirements, in order to include them into the abstract - outline and technology environment. After a series of interviews with the IT executives and the distribution of a short questionnaire we obtained the following set of directions:

- To be simple to use
- To support unified adaptive Web-based interface
- To provide usual application-based operations (e.g. full error-handling, keyboard shortcuts & restrictions)
- To improve inter-organizational communication with a wide spectrum of collaborators and suppliers
- To allow single sign on for the intranet users
- To integrate all the pre-existing computer-based operational components

Overall the users needed an adaptive web application environment through which they would be able to implement existing business processes through corresponding web applications and services.

3. Functional Specifications

3.1. Overview

Our approach included the following functional parts:

- Web Service software interface that will receive applications from collaborators' national network
- Web Service software interface that will enable communication with the hardware suppliers
- Management of customer applications for a set of services
- Automation and Integration of the process for the acceptance of the application internally
- Management and customization of the provided services (web-based configuration facility)
- Customer activation and connection with a service
- Customer activity profile logging
- Integration of the process
- Online customer document management
- Helpdesk and technical support service
- Web-based administration facilities

Finally the whole environment is built so as to optimize the availability and the security of its services. We proceeded in the creation of an extensive web farm – clustered hosts and we elaborated URL re-writing and cookie-less technology to provide cross-browser support. Below we describe briefly some of the operational components that they are included in the environment.

3.2. Operational Specifications

The aim of our approach is to cover a set of fundamental operations concerning the specifications explained below.

Management of Customer Applications: The process for the approval of an application includes stages and it is designed so as each stage to have a distinguishable confirmation. In this way we achieve so much the desirable procedure for evaluation, but also to a large extent the scalability of this operation. In the final approval of an application, this operation informs transparently the billing system and the customer acquires a unique identification code.

Management of Services: In the operations that concern the management of the provided customer services and also the creation of new ones, we have created a framework that covers a number of different configuration options. Each process covers completely the creation, activation, interconnection and de-activation or deletion of the corresponding service. The management of services influences immediately the interconnection with the identification code of each customer.

Customer Activity Profile Logging: The management of customers includes analytic registrations for the customers' activity. The background history list includes the services that are connected to the customer, the technical support visits and installations, reported problems and generally all customer contact with the company. This operation includes also overall reports per category of logging (services, technical cover and personal contacts), so as to provide supervisory views of enterprise activity.

4. Web Services & Technologies Involved

After clarifying the set of specifications, we had to perform the integration of our new system into an existing software and hardware infrastructure of different users with more or less contradicting behaviors.

Extranet collaborators and multi-level marketing collaborators needed a service ready to deliver their demands in a autonomous and 24x7x365 time frame availability. On the other hand it was unacceptable and resource-expensive to support an extranet dedicated machine, because this would complicate the customers' data interaction with their main-frames (synchronization of personal accounts, credit cards & sensitive data manipulation)

Suppliers pressed towards the direct connection of their local data warehouses with the intranet database in order to boost response in enterprise demands. However such a policy would possibly jeopardize enterprise data security. Even if security hazards were not an issue, the integration of a large number of suppliers' database connections into the intranet service would prove to be difficult to administer and costly to support in software client license terms.

In order to face the dilemmas posed by the described relationships we enabled a solution with the use of the promising technology of XML web services. We believe that we have faced in this way all of the previously named operational discomforts

4.1. Web Services at hand

Users – collaborators and suppliers in our case – have the opportunity to access for the first time services through a peer-to-peer arrangement rather than by going to a central server. Besides the standardization and wide availability to users and businesses of the Internet itself, web services are also increasingly enabled by the use of the XML as a means of standardizing data formats and exchanging data. XML is the foundation for the Web Services Description Language (WSDL).

However web services are meaningful only if potential users may find information sufficient to permit their execution. The focus of Universal Description Discovery & Integration (UDDI) is the definition of a set of services supporting the description and discovery of (1) businesses, organizations, and other Web services providers, (2) the Web services they make available, and (3) the technical interfaces which may be used to access those services. It provides an interoperable, foundational infrastructure for a web services-based software environment for both publicly available services and services only exposed internally within an organization.

The use of emerging technology will very rapidly support several activities of the company including its collaborators, so that it simplifies and accelerates the process of communication. They are a platform that enables collaborators of company to have access in the process of registration of application of customer.

Moreover there will be given selected access in briefings on the course of service and situation of customer via web. Web services provide operations for collaborating institutions but also for customers with complete functionalism based in a common standard (protocol SOAP and XML). There is no need it gets to know and they intervene directly in internal completed system of company. The services of such type will initially allow in collaborators of company to register and to watch applications of customers without they have access in the central system of company but with complete functionalism.

4.2. Turning Business Processes into Web Services

In order to deliver successfully the web services, we assumed the following three-layer logic. At first we elaborated the integration of the internal re-engineered business processes. In the sequel we determined the connection points for the web services and finally we shall publish these web services to the open public Internet. We present the first couple of layers of our design procedure in Figure 2. We present a piece of a simplified business process flowchart with a corresponding outline of the implementation that we developed. In a second act we located the internal connection point as the potential access point for a user coming from the external hyperspace (indicate on the same figure as layer 2). As a final act we implemented the infrastructure to support the web service that it would enable all customers and associates to take advantage of the company's business services through a published web interface. Layer 3 is depicted in Figure 3.

5. Adaptation Features

Nevertheless there were some requirements that had to be met, which went beyond the business logic covered by the web service approach; a user friendly interface that would enable the overall increase of productivity. A rather simplistic approach would have been to make a customary implementation of a large number of interfaces. Yet, each of the different groups should have got a different solution, tailored to the specific requirements. This meant the design of a number of different interfaces for more than 20 separate user groups, in 7 departments with 3 sectors each. This would have been a solution, though time-consuming and impossible to maintain & upgrade. In this way only a temporary fluctuation of the productivity rates would have been achieved. In the mid-term (i.e. after 6-12 months considering the new services' action plan of the enterprise at hand), the administration & support costs would counter-balance any positive result.

We suggested that a proper solution should incorporate the following:

- Capabilities for single-point central management support and upgrade.
- Integration of group-based features and facilities.
- Personalization support that would enable users to transform themselves the interface to their personal work habits.
- Adaptive characteristics that would boost response time to user's interaction automatically.
- Maintenance of the users' profile within and outside of the enterprise intranet network without losing functionality.

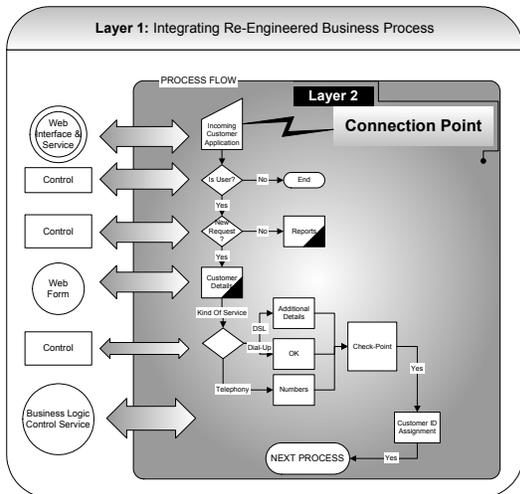


Figure 1: L1 & 2 Web Service Creation Approach

Therefore, we proposed a unique adaptive web-oriented interaction layer over the enterprise applications that it would elaborate the above suggestions and would natively couple with the new functionality of the web services.

In particular, adaptation features enable personalization of the interface and the flow of business processes to the different characteristics and role of each internal user. The user profile records information concerning the user and his knowledge state [1]. This information is vital for the system's operation according to the user's needs and preferences. The method is an implicit collection of user's actions and it requires minimum user involvement.

The user profile, that is holding all the personalization features, is explicitly modeled in the structure schema in the form of predefined entities called User, Group and Activity. Groups describe sets of users with common characteristics, whereas users denote individuals. Users always belong to at least one group, at first the default one (generic users). Each user or group is described by means of specific Activity properties that form the profile. Activity properties are modeled as special type of entities in the structure schema. As the normal entities, user and group profiles are internally sub-structured into attributes and components, which are used for writing derivation queries. Their features were used to store group-specific or individual content.

5.1. Personalization

In order to support personalization, declarative expressions (Object Query Language) were added to the structure schema, which define derived content based on the profile data. This personalized content is used both in the composition of the user profile and in the definition of presentation specifications for each modeled case. Furthermore XML syntax was used to define in high-level

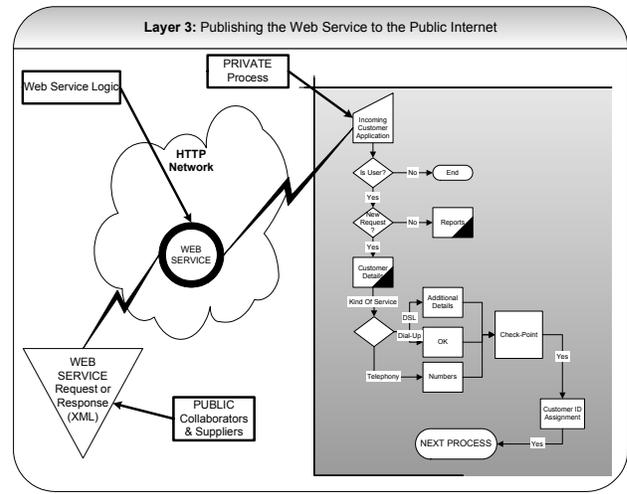


Figure 3: L3 Publishing the Web Service

abstraction the reactions of the user profile to site-related events caused by the users or business processes. These rules provide in detail the adaptation done.

The interaction between the users and the environment is proactive in two senses. First the users work with a specific department of the environment and therefore they choose what activities to perform by clicking on hyperlinks. In response to that the user model autonomously determines which content to render, by anticipating the effect of the user clicks. This feature was modeled, by expressing the filling semantics of pages. In the case that the user accessed a page, which contains an index over an entity pointing to data on that entity, the content of the pointed data is pending, i.e., it depends on the user's choice and the user's profile of one element in the preceding index unit. In order to cope with pending elements are filled using with a default value expressed by means of a declarative query (e.g., the object of a preceding index unit that satisfies a given predicate). Alternatively leaving the pending element empty, so that the user must explicitly perform a selection in one or more preceding units to display the content of the pending unit or filling the pending unit with a predefined default value (e.g., the first element chosen from a preceding index unit) was used in corresponding cases.

5.2. Declarative and Procedural User Modeling

All hypermedia elements and their presentation styles were defined so to take personalized data into account. This can be done in two complementary ways through the declarative and the procedural personalization. In the first case the environment designer defines derived concepts (e.g., entities, attributes, multi-valued components) whose definition depends on user-specific data. In this way, customization is specified declaratively; the system fills in the information relative to each user when computing the

content of units. In the latter, procedural personalization XML syntax is used for writing modeling conditions that compute and store user-specific information. The modeling conditions are a multiple event-condition-action. They specify the event to be monitored (e.g. onclick, ondoubleclick, onchange), the precondition to be checked when the event occurs (e.g. course succession, prerequisites, communication data streams), and the action to be taken when the condition comes true. Typical tasks performed by modeling conditions are the assignment of keywords to the user profile appropriate level and activity, based on dynamically collected information (e.g., the path traversal history), the collaborative filtered information notification to users upon the update of the modeling profile (elaborating push technology) and custom usage logging of user actions.

As an example of declarative personalization, the computations for categorizing the communicational data stream to keywords and proper storage location according to the user model personalization. As an example of procedural personalization, the modeling condition that assigns a user to the “advanced researcher” group based on the educational topic attendance and questionnaire info.

6. Administration Issues

During the last few years many methods for hypermedia and Web design have been proposed. We proceeded so as to support a large number of different services that may evolve continuously and expand rapidly over time. Web application development is a multi-facet activity involving different players with different skills and goals. In that sense there is a need for an application environment that is not only covering the wide spectrum of different business operations. This environment is based on careful and organized design that facilitates reusability and supports maintenance for a long period of use.

To achieve that, standardized representation was used for the user modeling profile, the courses and the communicational services. The environment made use of classical notations like the E/R model, the ODMG object-oriented model, and UML class diagrams. To cope with the requirement of expressing redundant and calculated information, a simplified, OQL-like query language was employed, by which it is possible to specify derived information. This synthesis of methods allowed separation of concerns that is a key requirement for Web modeling.

7. Feedback, Conclusions and Future Work

In this paper we describe the design and implementation of an adaptive web environment, for the specific needs of a large nation-wide enterprise. We coupled

adaptive web techniques with efficient web service facilities to provide a unique interaction experience. In this way we offered a common and effective umbrella for all the enterprise operations and together we minimized the need for training of the employees and collaborators.

We evaluated the impact of our work to the internal users (50 users) and external collaborators & suppliers (245 users) of the end-user enterprise twice (2/2002, 7/2002); firstly after the first prototype (alpha version) and later on after delivering the 75% of the operations. The feedback, received showed that users found helpful the fact that they could find departmental information and operations categorized in a personalized sense. On the other hand some found tiresome the wide-spectrum of personalization choices. That is why we are thinking to add different types of categorization providing a simple and a more extensive one. It seems that we shall provide some differentiation of the categorization provided among communication tools available.

Concluding we believe that both adaptivity features and web services lead towards the same goal – improvement of productivity. Adaptation research area provides promising techniques that they enable us to tailor interaction to different users of the same enterprise and this means that the internal users elevate their productivity. Concurrently web services provide easy access points for the collaborators and customer (that is external users), augmenting further the productivity of the application host. Future work aims to investigate techniques and features so as to embed adaptation features into the web services themselves. Finally we will work to personalize additional services and operations in order to include different types of users such as stockholders and customers.

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