

White Paper

Multidimensional context-aware adaptation of Service Front-Ends



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Abstract

The FP7 EU funded Serenoa Project is creating a novel open platform for developing context-aware application user interfaces. Such user interfaces are aware of the changes in the context and can react to them in a continuous way. This includes adaptation to the user's devices, tasks, preferences and abilities, thereby improving the user's satisfaction and performance compared to traditional approaches to user interface design. An additional benefit is a reduction in the cost and development time for creation and maintenance of user interfaces.

AUDIENCE OF THIS PAPER

The aim of this white paper is to provide a high-level description of ongoing work in Serenoa project and to present the results we expect to achieve by the end of the project in September 2013. The target audience for this paper is anyone who may be interested in context-aware applications. Although it is intended to attract the target beneficiaries of this project, as the next section describes, it is also meant to provide a description of the project for a broader audience. Note that although this paper does not describe the technical details in-depth, further information can be found in the public deliverables on the project website (<http://www.serenoa-fp7.eu/>)

We will next describe profiles and background for some potential readers and beneficiaries of this document.

JO, THE DEVELOPER OF FINAL APPLICATIONS

Jo is a developer who has been assigned the task of choosing a software platform to create adaptive applications. He works in an SME (small-to-medium size enterprise) which has been working on desktop applications for many years. Their customers are increasingly demanding ubiquitous access to remote information services. They are used to the heterogeneity of desktop technologies (e.g., the different web browsers and operating systems). However, after studying different surveys, they have realized that for the company to address the diversity of desktop, TV and mobile operating systems and versions, plus the requirements of the ubiquitous user, it will be necessary to make use of assistive development tools. They are looking for tools which enable the creation of user interfaces for multiple target platforms, accessing a common application back-end, together with support for user preferences. They would also like to address customer requests for multiple modes of interaction, e.g., visual, aural and tactile user interfaces.

ANTONIA, THE DEVELOPER OF ADAPTATION TECHNOLOGIES

Antonia is a developer who is in charge of developing adaptation support for ubiquitous applications. The user interface should be able to react to changes in the context of use (e.g. change in the user's position, different lighting conditions, etc.). Antonia wants a general solution for adaptation that permits different situations for different devices, and cleanly separates adaptation from application modules. She has problems in integrating information used for adaptation, because it comes from multiple sources and is not available for all devices. She wants to overcome this limitation, as she thinks it would be useful to exploit information coming from different devices to provide a more precise representation of the context. In addition, she is worried that current development tools force the developer to scatter the adaptation logic across different modules. This complicates maintenance, especially as the application complexity increases.

ANN, THE CONTRIBUTOR TO SERENOA'S FRAMEWORK

Ann works in a telecommunications operator providing TV services. Her company wants to expand their business by providing services already available via TV to other platforms (smartphones, tablets, PCs, etc.). She needs a new software framework able to support the adaptation of these particular services to the new target platforms as their existing software does not scale to all of them.

MARTINA AND MICHAEL, THE END-USERS

Martina lives in the UK and likes surfing the web. She is not interested in technology, but she uses the web daily and believes that she should be able to use either her home computer or her smartphone to shop online. She expects a consistent cross-platform User Experience, with a user interface that adapts to her context of use. Her favourite web site is a French online shop. She expects to connect easily to this web site (and others) from whichever device she uses, to browse in English and to be able to adjust her user preferences.

Michael works for a multinational merchant web site as a manager. He uses his company's enterprise system to access business oriented features to monitor current activity on this web site. He spends most of his day in the office, but also expects to be able to connect to the system when he travels or visits partners. Michael is also colour-blind, which is not a serious problem, but which sometimes prevents him from seeing adequately the dashboard indicators he uses in his daily tasks. He thinks that it would be nice to have a system able to adjust to his disability.

BART AND FRANÇOISE, THE RESEARCHERS

Bart is a post-doctoral researcher in a Research Institute in Brussels. He is a member of three European projects that involves the application of context-aware adaptation. As such, he investigates techniques and criteria for evaluating the benefits of adaptive systems, he tries to define models that formalize context-aware adaptation processes, and he is especially interested in exploring different architectural approaches for implementing context-aware adaptation.

Françoise is a PhD candidate at the same University. Her research project consists in investigating methodologies that support the specification, design and development of context-aware adaptive systems for the e-learning domain. She is mainly interested in the development of authoring environments for designing UIs for different platforms, but she would like to identify the context information and adaptation techniques suitable for adapting UIs for e-learning systems.

MANUEL, THE CIO

Manuel is in charge of the technology and business strategy of an Internet services company. Currently, he is evaluating possibilities for integrating new tools and

methodologies in the development of application user interfaces. He has detected the growing cost and development time for targeting multiple front-ends. Moreover, he would like to enable end-users to set their preferences for the user interface, something that isn't addressed with the existing development process.

DESCRIPTION OF THE PROBLEM

Even though software development environments, standards and engineering methodologies have significantly evolved and matured over the last decade, designing and implementing context-aware application user interfaces is still complex, and therefore expensive.

Businesses are seeing increasing diversity in the kinds of devices being used (i.e. workstations, desktops, laptops, smart phones, tablets, embedded devices, etc.), but this is putting up the cost of developing and maintaining user interface designs. Aligning business and Information Technology (IT) is a constant challenge, not only because of the constantly evolving standards and underlying technologies, but also because of the accelerating pace at which functional requirements change throughout the lifetime of applications. Business applications need to adjust rapidly to fulfil changing requirements, and this trend is accelerating as users require more and more mobility.

Second, implementing Human-Computer Interaction (HCI) systems requires anticipating for a great deal of user-driven interaction combinations that are not always easy to anticipate. Adding context management to the HCI domain increases complexity further because it requires taking into account multimodality (i.e. keyboard & mouse, touch screens, voice, gesture, etc.), geographical location, social context, accessibility and user preferences.

Finally, the underlying technologies involved in the development of user interfaces are multiple and keep changing and emerging at a rapid pace. Development therefore often requires technical experts, who are hard to find and retain. As a matter of fact, most of the effort in a traditional project is spent on infrastructure and technical tasks, and not on business issues. This often contributes to frustration of business stakeholders and end-users. There is also a steep learning curve for each new platform that has to be mastered: Android with Java, iOS with ObjectiveC, Windows with C#, Linux with C/C++, the Web with HTML and JavaScript, and so forth. Translating user interface designs into each of these platforms is time-consuming and expensive.

ABOUT MODEL-BASED DESIGN

A variety of approaches have evolved in response to the above challenges. These include the Eclipse Integrated Development Environment, the Java 2 Platform Enterprise Edition (J2EE), W3C's HTML5, JavaScript libraries (e.g. jQuery), and OMG's Model-Driven Architecture (MDA). These have been supported by work on software development methodologies, such as Model-Driven Engineering (MDE) or Agile project methodologies, such as Scrum or xP, or with UI design approaches such as User-Centred Design (UCD). When it comes to designing user interfaces, Model-Based approaches bring many benefits by filling the gaps where traditional approaches are inadequate for agile development, and

struggle to cope with the reality that requirements aren't fully understood at the outset of a project, but rather emerge as designs are tried out and found to be wanting.

Model based user interface design is about separating out design concerns at different levels of abstraction using both declarative and procedural knowledge. The declarative part is expressed as task models, abstract user interface (AUI) models and concrete user interface (CUI) models, whilst the procedural part is expressed with rule languages for adaptation at both design-time and run-time.

Other Model-Based approach benefits include simplification through automation and code generation, a clean separation of concerns, e.g., IT and business issues, and the fact that the model becomes a common language for all project stakeholders and helps IT align with business. People vary in how they approach the challenges of user interface design. We won't realize the true potential of Model-Based user interface design if we only support a top-down methodology. A significant number of people find it easier to start at the concrete level and refine the abstract level as they go. Subsequent revisions to the abstract level should be possible without throwing away the design work done at the concrete level. However, traditional Model-based design also suffers from a lack of attention to adaptation to the context of use, and this is exacerbated by a lack of standards for expressing adaptation rules.

DESCRIPTION OF THE SOLUTION

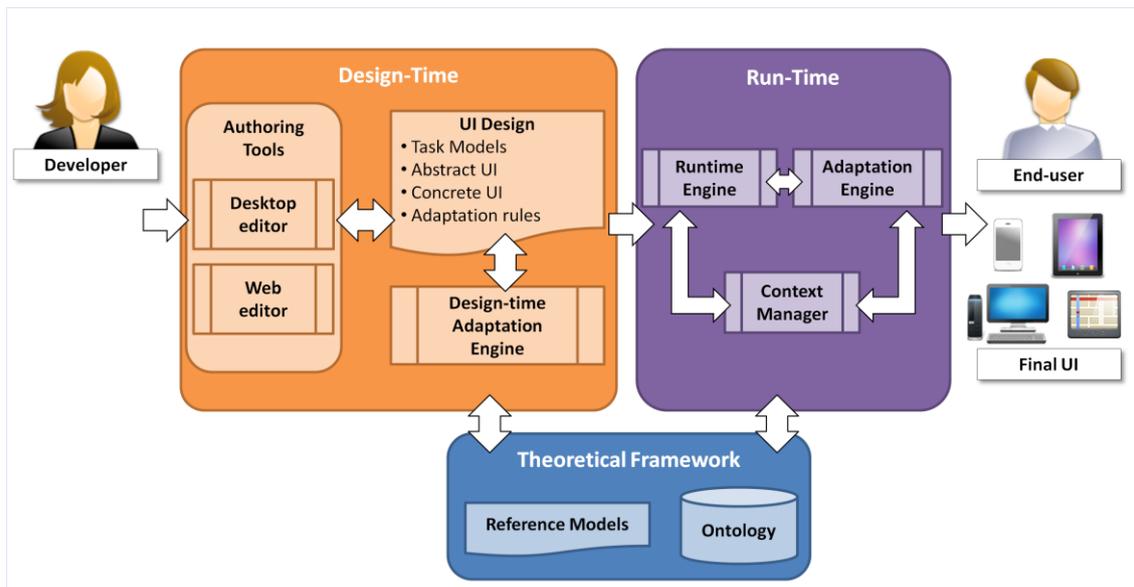


Figure 1. Serenoa's architecture

Serenoa's proposed architecture for supporting user interface adaptation is depicted in Figure 1. Additional details are given in the following sections.

Firstly, at design-time, '[Authoring tools](#)' are used to support the design of model-based user interfaces. The authoring tools support Serenoa's abstract user interface description language, as well as the Serenoa language for expressing adaptation rules (see '[Languages](#)'). For those developers who find it easier to start the definition of the interface at the concrete level and then refine the abstract level as they go, there is a design-time adaptation engine which makes it possible to work at both levels.

Secondly, the '[Theoretical framework](#)' consists of reference models and an ontology. These reference models are aimed at guiding developers and designers during the complete software life-cycle, listing alternative possibilities for implementing context-aware adaptation, and permitting the analysis and comparison of adaptive and adaptable applications. The ontology, based on the reference models, is intended to gather all the knowledge involved in advanced adaptation logic for user interfaces. It is used to inform developers as well as to support adaptation processes in the run-time.

Finally, the run-time phase will transform the description and associated rules of user interfaces into a final user interface implementation. The adaptation engine determines the optimal adaptation for the current context of use, based upon the context models and adaptation rules. To achieve this goal, the context manager provides information related to all the possible contextual dimensions (i.e. the user preferences, the environment, social relationships, etc.) The run-time engine generates the final interactive application according to the context. Currently, this module is composed of a set of sub-modules which cover

several modalities (i.e. mobile web applications, vocal interfaces, avatar-based interaction or desktop business applications). In fact, 'Applications prototypes' showing the functionality of these sub-modules and the whole Serenoa framework are under development, see later section for more details.

AUTHORING TOOLS

Authoring tools help designers, engineers and web authors to easily create context-sensitive user interfaces for different platforms and different interaction modalities, e.g. visual, aural and tactile. The authoring tools will be usable by non-expert programmers, and fulfil some additional key success factors, including the usability of the graphical interface, the availability on multiple platforms and the support for concurrent work by multiple users (business experts, user interface designers and programmers working as a team) appear as very important requirements. The authoring tools will support editing of model-based descriptions at both abstract and concrete levels, together with context-dependent transformation rules. Two types of authoring tools are being developed as proof of concept for the Serenoa architecture:

- **Eclipse-based Plug-in:** this type is a 'plug-in' for Eclipse, one of the most widely used Integrated Development Environments (IDEs) in the research and industrial communities for software development. Since most of the open source and research based authoring environments/tools, i.e. MARIA and LEONARDI and other related libraries are developed in Java, we have also chosen the Java programming language for Serenoa's authoring environment and tools.
- **HTML5-based Browser Application:** the second type being developed is an HTML5-based web browser application that operates on the models that are held on the web server side. This approach allows live concurrent editing by multiple users, so that they could see and discuss the changes which a remote user is making in real time. A server-based design-time adaptation engine allows designers to work at different levels of abstraction, synchronising changes in a cooperative workflow.

Thus, Model-Based languages, i.e. MARIA, UsiXML, and IDEAL2 have been used as basis for not only developing the abstract UI and adaptation logic languages, but also the generation of Abstract/Concrete UIs. The following figures show the outcome of both types of authoring tools; the first version of plug-in for rules editing (Figure 2) and the collaborative Model-Based UI editor prototype, named Quill (Figure 3).

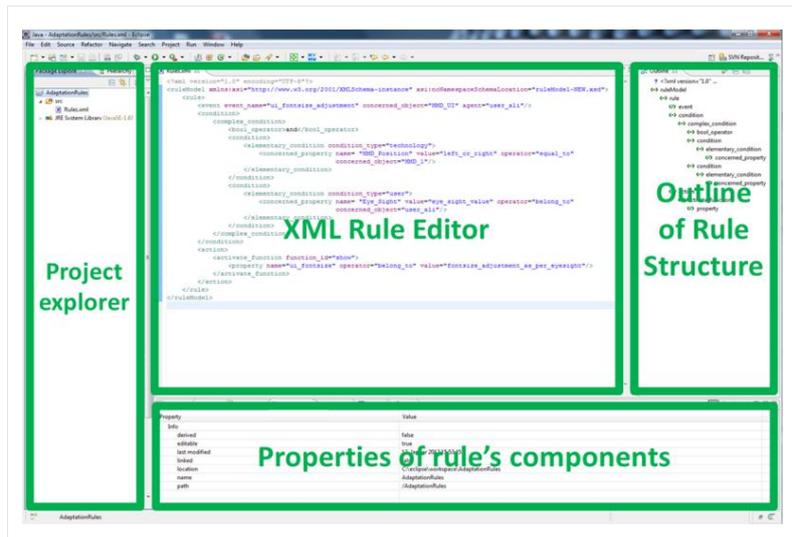


Figure 2. Eclipse-based plug-in

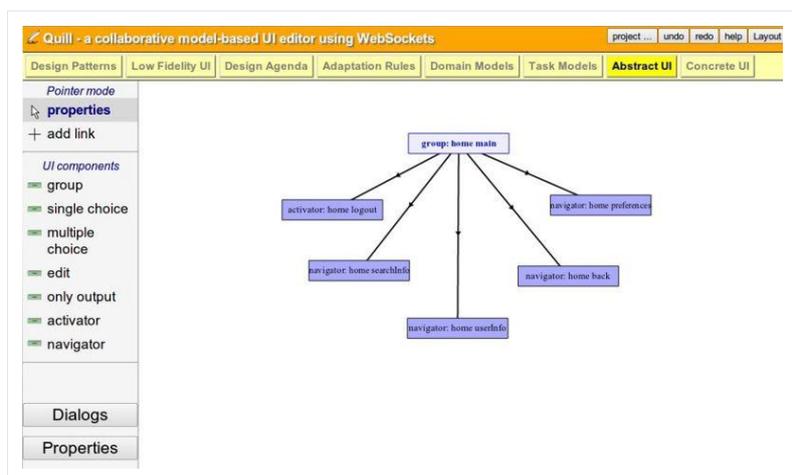


Figure 3. Quill: HTML5-based Browser Application

LANGUAGES

The languages developed in Serena will cover the specification of adaptive SFEs at different abstraction layers, and of the context-dependent transformation rules to be applied on the user interfaces. With the Serena solution, the exploitation of both these languages will be supported not only at design time but also at runtime. At design time, the authoring tools will help the designers, engineers and web authors to easily create and edit context-sensitive SFEs for different platforms (at both abstract and concrete levels) and relevant context-dependent transformations rules. At runtime, the logical descriptions of the SFEs and of the adaptation rules will be transformed in a final, adapted user interface implementation.

- The **Advanced Service Front-End Description Language (ASFE-DL)** is aimed at enabling the development and authoring of context-aware SFEs. The user interfaces modelled through this language will be adapted to the context by exploiting the rules defined through the **Advanced Adaptation Logic Description Language (AAL-**

DL). By leveraging on past expertise on user interface languages that Serenoa members have already authored or co-authored, and on previous experiences they gathered by working in relevant industrial case studies to support requirements of most modern service-based user interfaces, the Serenoa consortium plan to build a more complete language that will allow ASFE-DL to meet the Serenoa requirements and to go beyond the state-of-the-art in this field. The ASFE-DL has been already specified at the Abstract user interface level: it describes the UI through a number of abstract interaction units and associated connections in a modality-independent manner. In the next months the Serenoa project plans to cover also the Concrete user interface level. The ASFE-DL is currently being submitted as an input to standardisation work at W3C.

- The [Advanced Adaptation Logic Description Language](#) (AAL-DL) is a high-level language intended to express advanced adaptation logic in a declarative manner. The basic idea is that the user interfaces modelled through ASFE-DL will be adapted to the context by exploiting the rules defined through the AAL-DL. The AAL-DL rules have been expressed through an Event-Condition-Action (ECA)-based format where: i) events are changes that can occur in the context state or in the UI state; ii) conditions are Boolean predicates referring to context state or UI state; iii) actions are changes affecting the interactive application. In the current specification of the AAL-DL we have considered the definition of first-order adaptation rules (simple adaptation rules like e.g., adapt this service front-end for this platform) and second-order adaptation rules (those that govern the application of adaptation rules by e.g. selecting first-order rules: the action part of a rule can be in turn another rule). In the next version of this language we will consider third-order adaptation rules (strategies that privilege some adaptation approach for usability, performance, reliability or rules that promote or demote sets of second-order rules).

THEORETICAL FRAMEWORK

The Theoretical ground of the Serenoa Project is structured in three main components: a [Context-aware Reference Framework](#) (CARF), a [Context-aware Design Space](#) (CADS) and a [Context-aware Reference Ontology](#) (CARFO). The CARF provides to stakeholders the core concepts for defining and implementing adaptive and adaptable systems. The CADS provides means to analyse, evaluate and compare multiple applications regarding their coverage level of adaptation, especially concerning certain specific dimensions (such as: modality types). The CARFO not only formalizes the core concepts defined by CARF and their relationships, but also enables the request and retrieval of relevant information for defining and executing the adaptation process. Both industrial and scientific domains can benefit of these theoretical models, once they provide support for the whole development life-cycle of adaptive and adaptable applications, i.e. design, specification, implementation and evaluation.

APPLICATIONS PROTOTYPES

The [Warehouse-Management Scenario](#) for the intelligent picking prototype is aimed at providing a seamless context (environment and task) adaptation experience to users in one of the partner's Living Lab facilities in the field of Future Retail Concepts (FRC). This scenario motivates how proactive applications can provide unobtrusive and adequate help (e.g. missing parts, location of necessary parts, etc.) when the user needs help. Thereby, the service time can be reduced while increasing the quality of service. At the FRC, the supply chain continues to Retail Management with five demos, e.g. on price strategy and smart vending and concludes in Retail with eight demos, e.g. on Mobile Payment and RFID Shelves. This opens up the possibility, while following the modular design of the Serenoa components, to create further prototypes, moving from Logistics to Sales scenarios.



Figure 4. Warehouse-Management scenario

With the [E-commerce Scenario](#), we aim at illustrating how different online end-users can take advantage of adaptive SFEs while connecting to both a front-end application and a back-end application. Typical user roles involved in the scenario include online shoppers and employees, acting either as supervisors or customer representatives in charge of following-up with online orders. Based on their roles, such users can access different features, but their UIs are capable of adapting based on different factors such as language, colour-blindness or type of device (either a home computers or a mobile device). In Figure 5, some screenshots showing the front office from a desktop, an iPhone and an Android tablet.

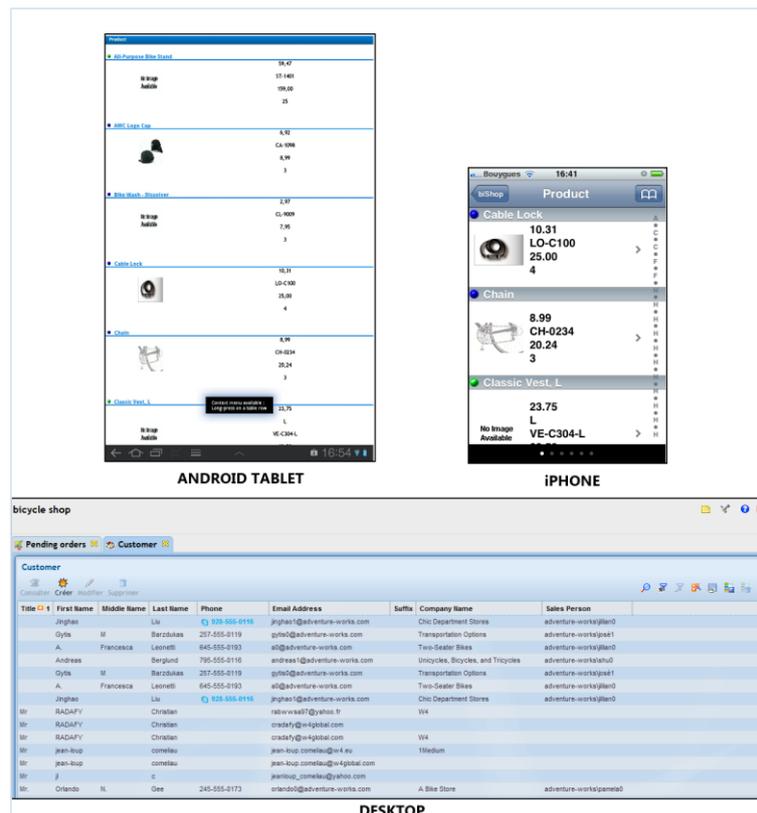


Figure 5. E-commerce scenario (Android tablet, iPhone and Desktop)

The **E-Health Scenario** is shown by means of the improvement of two existing TID's pilot projects (see Figure 6):

- The SARA project (upper) is intended to provide a user interface for chronic disease patients self-monitoring in the form of a (Windows based) tablet PC. The project wants to evolve to provide multi-device support (Android tablet devices, smartphones, etc.) and an expressive virtual assistant in order to engage patients in the usage of the application. This project is now in a pre-market phase, after successful field tests using real patients from the Andalusian health system.
- The HealthDrive project (lower) aims to leverage on consumer devices such as computers, tablet PCs and phones to provide its users access to their personal file on the Andalusian health system. In order to do so, all medical information is digitized and shared by the institutions, with a publicly accessible interface for each user in which she can interact with doctors and see their health records. The inclusion of ECAs (Embodied Conversational Agents) technology for guiding the navigation through all this personal information is also being considered.

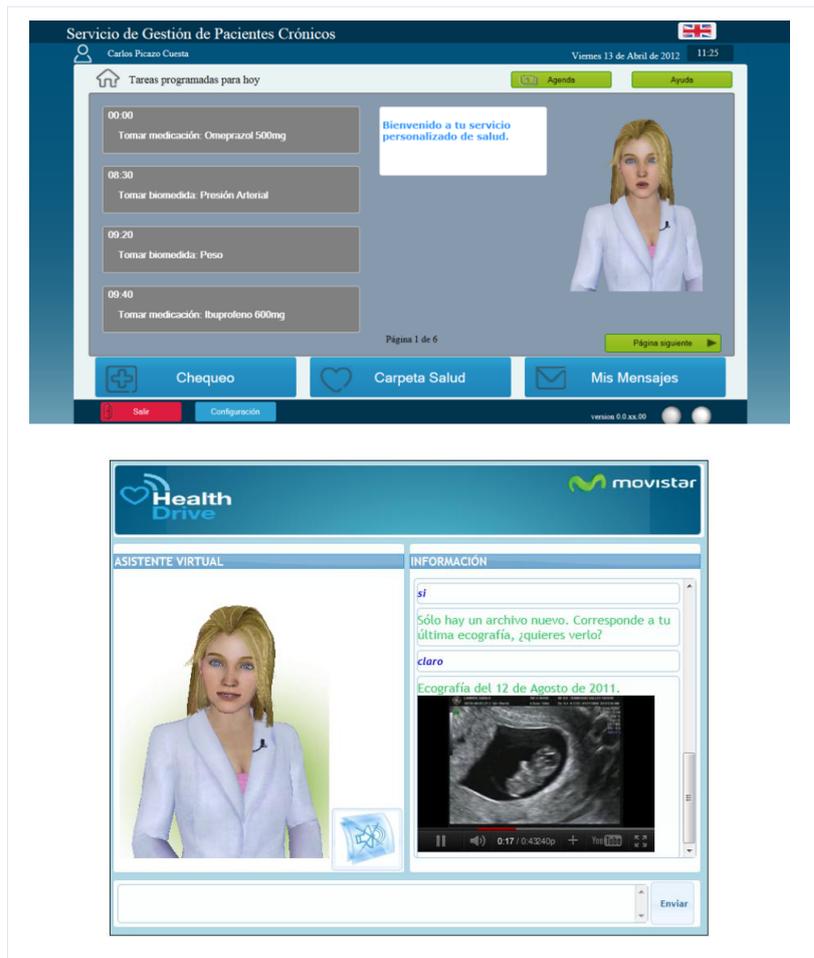


Figure 6. E-Health scenario (SARA project -upper- and HealthDrive project -below-)

ADDED VALUE AND IMPACT

ADDED VALUE

In a general way, the Serenoa project may contribute to the following aspects:

- **Faster time-to-market:** given the support provided by the Serenoa technologies (i.e. authoring tools, adaptation languages and models) the implementation of adaptive and adaptable applications will be easier and more efficient.
- **Reduction of development effort:** instead of spending a lot of resources looking for knowledge about context-aware adaptation, stakeholders can rely in a centralized information source and a dedicated development platform, provided respectively by the theoretical framework, and by the technological framework (i.e. tools, languages, etc.).
- **Promote re-use:** by means of standards and a consistent terminology, the applications can be implemented in a more flexible manner, i.e. with the integration of components and with the extension and updates of existing applications.
- **Efficient solutions:** Serenoa is filling a gap in context-aware adaptation systems by allowing non-expert developers to develop efficient solutions. This is achieved, in particular, by adopting a model-based approach.
- **Increased agility:** because context is often dynamic by nature, adaptation needs to be tuned little by little (and sometimes continuously), based on the feedback provided by the different stakeholders, starting with the end-user. Therefore, the capability for systems to change its behaviour rapidly and to take into account new adaptation rules, thus fitting new contexts, is essential. Serenoa's adaptation engine adds substantial agility to the development process of context-aware systems, which can provide great benefits.
- **Joining efforts:** By analyzing the technological landscape and the current status of the market, Serenoa identifies actual users' needs and orient its efforts in order to progress simultaneously in both scientific and industrial domains. Besides this, Serenoa tries to establish a formal link between the research community and the industry (for instance by means of standardization and dissemination actions).

IMPACT

As a part of the individual exploitation strategies the consortium members demonstrate the Serenoa 'Applications prototypes' and Development Tools to product groups, customers and partners. This aims at encouraging these industrial stakeholders for an adoption of the Serenoa technologies to enhance their existing products or to create new ones.

From the point of view of the academic community, several branches of knowledge are involved with research of context-aware adaptation. As the closest related ones, we can highlight: Human-Computer Interaction, Software Engineering and Architecture, Distributed Systems and Ubiquitous Computing. In the context of Serenoa project, the scientific field may benefit from: concrete requirements for designing and implementing adaptive systems, authoring tools and languages that support the creation of adaptive applications, theoretical frameworks that provide a catalogue of information to support the research in the field, evaluation criteria and possible architectural approaches.

Furthermore, releasing some Serenoa components as open source facilitates the adoption of the results by other members of the community, even any other projects, communities, organizations or anyone interested in this focused area. This issue implies that any of them could take the results and evolve them into something more complete, allowing to increase the impact of the project outside the community of the project. Specifically, Serenoa is expected to produce three types of results: theoretical frameworks, languages, and application prototypes.

- **Theoretical frameworks:** the reference models (CARF and CADs) will be made available for the public by means of written documents (as deliverables and scientific papers). They will also include a detailed description about their methodology, creation, and application available online by means of a web page. The Ontology will be developed based on this theoretical framework.
- **Languages:** the XML schemas describing the languages developed in Serenoa will be made public by putting them available on the project web site. In addition, such results will be submitted to W3C for standardization. The W3C working group on Model-Based User Interfaces (MBUI) has started its work and various Serenoa partners are involved in this group.
- **Application prototypes:** the applications, which will illustrate the Serenoa framework, lay on various software modules: context manager, adaptation engine, runtime engine and the rest of components. In general, the software prototypes will be made publicly available. We envision various policies for making them public: open source, public executable code, videos, etc. The way how they will be made public depends on the organization that is developing them and the type of prototype.

In order to accomplish these results and to arouse interest in the scientific and industrial community, an action planning has been envisaged. Firstly, on August-September 2012, the final version of the Serenoa's architecture will be delivered and the second release of the modules will be available for the evaluation. From then to the end of the project (September 2013) the development efforts will be mainly focused on the final release of the Serenoa's components and tools, the exploitation of them in the Serenoa use cases and the final evaluation.

SERENOA BENEFICIARIES

Serenoa is a framework that simplifies and accelerates the development of context-sensitive applications. This implies the reduction of the time-effort of the development process and its corresponding maintenance costs. The value of the framework is based on a solid model-based architecture, a good methodology and advanced tools to automatically generate applications. Different user roles are susceptible to take advantage of the aforementioned features:

- **Developer:** both final applications developers and those who are interested in adaptive technologies.
- **Researcher:** scientific community interested in context-aware adaptation and related topics.
- **End-User:** indirect beneficiary who gets faster results because of the time-to-market reduction.
- **Executive Director:** professional who may be interested in the creation of new business opportunities.

At the first section, some specific examples of each user profile have been introduced. The possible benefits that each user might obtain from the utilization of the Serenoa framework are listed below:

JO, THE DEVELOPER OF FINAL APPLICATIONS

- Reduction of development time.
- Using the platform facilitates the development of context-aware applications.

ANTONIA, THE DEVELOPER OF ADAPTATION TECHNOLOGIES

- General solution for creating context-dependent applications for different platforms and devices.
- The adaptation rules separate the adaptation aspect from the application logic and User Interface, concentrating in one point the definition of the adaptive behaviour.
- The adaptation rules are able to define changes at different levels of abstraction. Such flexibility on the granularity level allows concentrating the adaptation logic into single and powerful rules, and their reuse for different platforms.
- Exploitation of the information coming from different devices, user preferences or environment sensors for creating a unique and shared representation of the context, taking advantage of all the available data.

ANN, THE CONTRIBUTOR TO SERENOA'S FRAMEWORK

- Taking advantage of the existing modules in order to get a more complete solution for her use case.
- Single development process for multiple target platforms.
- In case she needs support to some specific features (e.g. new modalities), she could contribute with original developments to be integrated in Serenoa's framework.
- Obtain feedback to improve her partial solution by integrating it in a complete framework supported by a community of developers/users.

MARTINA AND MICHAEL, THE END-USERS

Martina

- She is able to browse her favourite online shop from her iPhone or from her home computer.
- She is comfortable when she visits this web site because her user experience is like whether she connects from a device or the other.
- The UI displays content in English.
- She is able to adjust her preferences: which data she wants to see in the catalogue, how items should be filtered or sorted and how to customize the views for her usage on mobile devices.

Michael

- He can confidently leave his office without worrying to miss important events taking place on his company web site: he knows he'll be able to do some monitoring when he travels.
- His colour-blindness is not anymore an issue: he is now able to adjust his preferences on any platform to display only colours he is able to see well.

BART AND FRANÇOISE, THE RESEARCHERS

Bart

- He will be able to retrieve specific techniques and criteria to effectively evaluate the benefits of adaptive systems.
- He can find well-defined models that formalize the theoretical concepts of context-aware adaptation processes, and architectural approaches that enable the implementation of such processes.

Françoise

- She will be able to explore methods that support the design, specification, and development of applications that perform context-aware adaptation.
- She can access authoring environments for designing adaptive UIs for any application domain, including e-learning, and for different devices.
- She can access several context information and adaptation techniques that are relevant for her research topic.

MANUEL, THE CIO

- Cost-effectiveness: one interface description adapts to several contexts of use (i.e. platform, user, and environment).
- Flexibility: the proposed agile methodology guarantees the collaboration between the system and the end user in a self-organized way.
- Convenience: the aim to be a de facto standard would ease the adoption of the technology.

CONCLUSIONS

The Serenoa project is intended to fill a gap in the market for developing context-aware Service Front Ends. Providing simple tools and methodologies to address user-centric systems for a better and more enjoyable user experience potentially benefits a multitude of stakeholders, from researchers and developers to end-users and CIOs.

Starting from a theoretical model consisting of a reference framework and a design space, Serenoa addresses this challenge by adopting a Model-Based approach and by offering a set of tools that can be used both at design time and at runtime for implementing context-aware systems.

At design time, Serenoa's main components include authoring tools that are able to describe the user interfaces and their adaptation rules using two languages to design systems at different abstraction levels. At runtime, Serenoa's main components include the Context Manager to capture the current context related information, an Adaptation Engine to dynamically compute the optimal adaptation strategy and a Runtime Engine to generate the final user interface for each target platform.

The project provides various scenarios as proofs of concept, including a warehouse management application, an example of e-commerce application and an avatar-based e-health project. The project outcomes are expected to accelerate time-to-market of context-aware systems, in order to increase agility and to promote reuse. Dissemination and exploitation efforts are expected to impact the tools used in the industry in the ICT sector and to influence academic actors.

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