Empowering End Users to Create Interactive Workspaces by Service Composition

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Abstract. Services mashup and content composition are becoming important in modern interactive systems. Such techniques allow people to better satisfy their contextual needs. This paper presents motivation, objective, challenges and current status of PhD research, which started a few months ago and will last for about three years. I will be working to identify models, technologies and interaction paradigms, which can enable end users to flexibly integrate services and resources into interactive workspaces, pervasively accessible and sharable through different devices.

Keywords: End-User Development, Service Composition, Platform Independent Models, Platform Customization

1 Research Problem

The growing amount of resources and services available on the Internet and the possibilities offered by Web 2.0 are pushing end users to evolve from passive information consumers into information producers, able to access available resources and manipulate them in order to generate new content. From a Human-Computer Interaction (HCI) perspective, this demands for new interaction paradigms that should enable people to access content, move it across the boundaries of specific applications from which the content is first accessed, get it into personal interactive workspaces where they can integrate it and also create new content to be possibly shared with other people. An interesting proposal to make this possible is to decouple content, functionality and devices and to allow users to focus on information without being confined to a particular prepackaged application context [1].

Service composition paradigms have been proposed since the 90's. More recently, Web mashup methods have been proposed to create web application by using web resources. Specifically, Web mashup create new application starting from heterogeneous components such as SOAP/WSDL Web services, RESTful Web services, JavaScript libraries, content wrapped from HTML Web pages. Mashup technology claimed to be more oriented to end users, but this claim revealed unrealistic because the adopted composition languages are not actually suitable for end users. This might

be due to the fact that the research on mashups has primarily focused on technologies and standards, with little attention on easing the mashup creation process, which often involves the manual programming of the service integration. Some mashup tools, called mashup makers that provide graphical user interfaces for combining mashup services, have been proposed [2-5]. With respect to manual programming, such platforms make easier some mashup composition tasks. However, to some extent they still require an understanding of the integration logic (e.g. data flow, parameter coupling, etc.). Some recent studies found that, although some prominent platforms (e.g. Yahoo!Pipes) simplify the mashup development, they are still difficult to use by non-technical users [6, 7]

The research I'm interested for my PhD tries to combine End User Development (EUD) principles and techniques with the potential of mashup models and technologies. The aim is to develop intuitive and easy-to-use composition mechanisms and environments that empower people, who do not have technical skills, to perform composition of services and resources that are available in the Web in order to create new contents and applications that can fulfill their situational needs.

More specifically, my research questions are: which models, technologies and interaction paradigms can support end users to create interactive workspaces by integrating heterogeneous services and resources? How contents, applications and devices can be decoupled to allow users to focus on information without being constrained to a particular pre-packaged application context [1]? How can we allow end users to collaborate with peers to create interactive workspaces that can be shared and used on different devices like tablets, smart-phones, large multi-touch display installed in public setting?

2 Theoretical Background

The basis of my research is provided by End-User Development (EUD) and Meta-Design approaches.

End-User Development (EUD) refers to the active participation of end users in the software development process, in order to modify, and even create, software artifacts [8, 9]. Thus, tasks that are traditionally performed by professional software developers are transferred to users, who need to be specifically supported in performing these tasks. User participation in the software development process was so far limited to providing information about requirements, use cases and tasks, and to involvement in prototype testing. EUD means that end users actively contribute to shaping the software they will use, i.e. they are enabled to creating/modifying software artifacts. EUD activities may go from simple parameter setting to integration of pre-packaged components, up to extending the system by developing new components. Since several years, some EUD-oriented techniques have been adopted by software for the mass market, such as the adaptive menus in MS Word™ or some Programming by Example techniques in MS Excel™ more recently, some mobile operating system like Android and iOS offer the possibilities to end users to customize their interface and services.

The design of systems that enable EUD activities requires a new design paradigm, called meta-design, which means "design for designers" [10, 11]. This new paradigm allows various stakeholders, including end users, to become co-designers of applications. Software engineers do not design the final application, as in traditional design, but they create software environments through which different stakeholders can contribute to the design of the final application. Meta-design is a two-phase process, the first phase being designing the design environments that allow system stakeholders to participate in the design (meta-design phase), the second one being designing the final applications as a joint work of the various stakeholders, who collaborate by using their design environments.

The Software Shaping Workshop (SSW) model proposed in [10, 12] is a meta-design model. It is based on the consideration that several stakeholders, including end users, have to be involved in the design of an interactive system, since they all bring different and important expertise, i.e. they are "owners" of a part of the problem: end users know the application domain, software engineers know the technology, Human-Computer Interaction (HCI) experts know human factors, graphic designers know how to create appealing graphical designs. In order to contribute to system design, such people need different software environments, specific to their culture and skills. The professional developers involved in traditional design constitute here the team of meta-designers, who creates software environments through which the other stakeholders, acting as designers, contribute to the development of a final application. Thus, a software environment is like a virtual laboratory, through which a user shapes software artifacts, in analogy to the artisan laboratory (or workshop) in the real life, where a carpenter shapes a piece of wood or a blacksmith shapes a piece of iron. According to this analogy, these software environments are called Software Shaping Workshops (in short SSWs). Inspired by the SSW model, I am working to the development of a general platform that supports all stakeholders involved in the different phases of the creation of personal workspaces.

The model proposed by Fischer to support meta-design is Seeding, Evolutionary and Reseeding (SER) [13]. A new system is not completed at design time, but system design starts from seeds which are developed by meta-designers (professional designers) collaborating with end users; a subsequent evolutionary growth follows, one the basis of modifications coming from end users at use time, and then a reseeding phase occurs. The seeding phase concerns the definition of the initial state (seed) of a system, which will be used by end users to perform their activities. The reseeding is performed by any designer to modify the initial state of the system.

EUD and meta-design are at the basis of my research, which aims at empowering people to flexibly create their interactive workspaces with tools that can let them flexibly compose contents and functionalities. My research will provide a contribution to the so-called culture of participation [14, 15], that promotes a shift from consumer cultures, where produced artifacts are passively consumed, to new approaches that , thanks to current technology, provide people with the means to actively participate to the creation of new ideas, knowledge, and products [16].

3 Research Approach

The approach of my research work is to combine EUD principles with the potential of mashup models and technologies. This should bring to the definition of intuitive, easy-to-use composition mechanisms. Working within the IVU Lab of the University of Bari, we started from a generic mashup platform developed by researchers of the Polytechnic of Milan [17], with whom we are collaborating, and we are studying how it can be adapted with respect to the requirements identified within specific communities of users. In particular, we have already analyzed how our new prototype is suitable in a context of Cultural Heritage [18].

The new platform we are developing allows user to access services and resources available on the Web and to create interactive workspaces where they compose such services and resources to support specific need. The composition of such interactive workspaces exploits a "lightweight" paradigm for resource integration. The underlying idea is to replace fixed, pre-packaged applications with elastic composition environments that, thanks to a separation among data, functions and presentations, make interactive environments "emerge" at run-time based on composition actions performed by end users" [18].

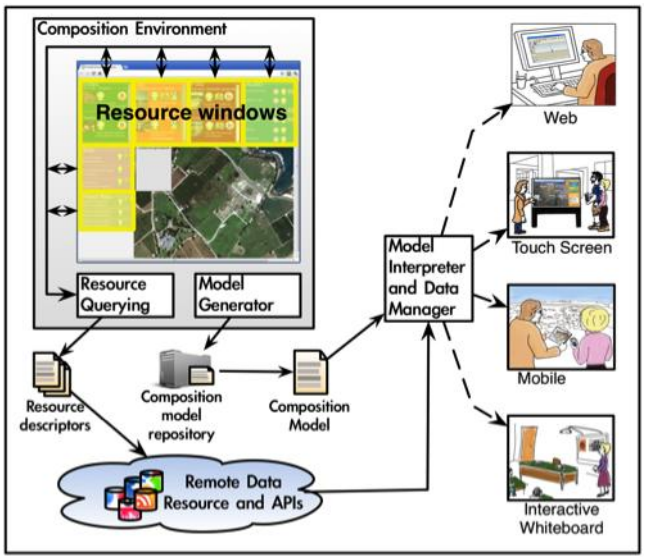

Fig. 1. High-level view of the platform architecture

The platform provides intuitive visual mechanisms, which allow end users to easily integrate heterogeneous contents without any need to program or to use complicated design notations. The current interaction paradigm is based on drag&drop of con-tent items extracted from third-parties or personal data sources and moved onto predefined templates of the user interface. The overall organization of our platform is illustrated in Figure 1. A composition environment (see the left part of Figure 1),

accessed by any of various devices, like a desktop computer, a mobile device or a large multi-touch display, shows the con-tents retrieved by querying selected Web resources, registered and described into the platform. Each resource descriptor specifies properties, such as the resource URI and the value of some parameters that the platform has to know for querying the corresponding service. Resource registration is instrumental to enrich the platform with all and only the resources that are deemed useful in a given domain and for specific users.
The user gets such contents and fills them in visual templates, i.e., templates made available in the platform to easily create the user interface of the workspace under construction. The example in Figure 1 refers to the composition of a workspace on a map template, on which the user drags some of the elements s/he has retrieved, e.g., 3D reconstructions from Google Sketchup, photos from FlickR, videos from YouTube. The results of such a visual composition is a composition model, internally represented as an XML-based schema; the user can store this schema on the platform server and download it anytime and anywhere for its execution on different devices. The schema specifies the services included in the composition, the way they have to be queried based on the composition created by the user, and the way the retrieved contents have to be displayed through rendering elements of the visual template.

Lightweight execution environments allow the execution of the created workspaces on different devices. The composition schema created on the basis of the user composition actions indeed constitutes a Platform Independent Model (PIM), which can be interpreted locally on a given device by means of a dedicated, lightweight runtime environment addressing the device native technology. The application code is then automatically generated and executed on the device, showing data dynamically extracted from the remote resources.

4 Challenges

Different aspects of interactive workspaces need to be studied in depth in the near future to best adapt the platform to end users' needs. One of the most important aspects regards the customization, since almost all the composition platforms pro-posed until now tried to be domain-independent. But more general does not mean more usable or more powerful: if a system restricts the possibility to customize both the platform functionality and the composition language, this becomes an obstacle for the adoption of such platforms as tools for enhancing user productivity [19].

To cope with this challenge, it is designed a platform Composition Environment, (shown at the top left of Figure 1), with which service management experts, working with domain experts, choose and package service-based resources according to specific composition scenarios in a specific application domain. Such resources embed the logic, defined by the experts, for querying services and visualizing the resulting data set. The so-created resources, identified through the resource descriptors, are used by the Model Interpreter and Data Manager. This is a module that, running on the different devices, is in charge of the customization with respect to the characteristics of the

device and of the target domain. Using this module, end users can manipulate the resources and select the contents of interest to compose their workspace. This platform architecture satisfies the end users' needs which emerged during preliminary studies.

To understand the potentials and limitations of the composition and the use of interactive workspaces with the platform, in November 2012 it is performed a formative evaluation with real users. In particular, this study involved 2 professional guides and 28 visitors at the archeological park of Egnathia, in Italy. The results provided useful indications on the real benefits of the platform and requirements for future work.

One of the most important requirements which emerged during this study in the field was the need for collaboration mechanisms among end users [20]. Starting from the preliminary results of this study, have been identify two dimensions in the collaboration with experts: the time at which the collaboration takes place and the resources of physical or computational nature, used by participants. The temporal dimension distinguishes collaboration synchronously and asynchronously. For the second dimension, the resources can be created during the collaboration process itself, or be produced or retrieved by individuals working on their own. These two dimensions are orthogonal because systems and procedures can accommodate any combination of them. However, some problems emerged regarding the use of individual resources during collaborative work. How to smoothly integrate them in synchronous sessions. How to asynchronously communicate the availability of new resources to collaborators. How to protect resources intended only for personal usage, and how to change their status to public.

Finally, since ICT is becoming more and more ubiquitous, the platform has to be deployable on different devices, for example, smartphones and tablets for mobile use, desktop pcs for home use, interactive displays for co-located multi-user tasks, etc. In the recent past, I've carried out works on multi-touch displays [18, 21]. Now I'm investigating the benefits of the use of such displays in interactive workspaces, thanks to the inherent ability to enable collaboration among co-located end users.

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