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# CADEAU: Collecting and Delivering Multimedia Content in Ubiquitous Environments

Oleg Davidyuk<sup>1,2</sup>, Iván Sánchez<sup>2</sup>, Jon Imanol Durán<sup>3</sup> and Jukka Riekkii<sup>2</sup>

<sup>1</sup> INRIA Paris-Rocquencourt, Domain de Voluceau, 78153, Le Chesnay, France  
Oleg.Davidyuk@inria.fr

<sup>2</sup> Dept. of Electrical and Information Engineering, University of Oulu,  
Erkki Koiso-Kanttilan katu 3, Oulu, 90570, Finland  
{Firstname.Secondname}@ee.oulu.fi

<sup>3</sup> Fundacion European Software Institute, Parque Tecnológico Edf. 204,  
Zamudio, 48170, Spain  
Jon.Duran@esi.es

**Abstract.** The aim of our research is to support users in composing applications from various multimedia resources provided by the ubiquitous environment. In order to approach this goal, we present CADEAU, a prototype for Collecting And DELivering multimedia content in Ubiquitous environments. This paper introduces the user control techniques, basic technologies and a concrete application which demonstrates how the CADEAU prototype can be used.

## 1 Introduction

During the past years, we have witnessed that our public and private environments are increasingly becoming ubiquitous, i.e. being populated with various ‘smart’ resources. Ubiquitous environments assist users to accomplish their everyday activities in an intelligent, adaptable, continuous and secure way. However, this vision also increases complexity and sometimes requires users to spend considerable efforts to accomplish even a simple task. Consequently, the users are still reluctant to accept and use these environments.

Our research aims to increase the usability of ubiquitous environments. For this purpose, we develop new mechanisms to allow users to accomplish and control their tasks easily. In our earlier work [1], we presented a system that automatically assembles user applications according to their preferences and needs. We also conducted a user evaluation study on the system’s prototype and found out that users need optional mechanisms to control the application composition, because they do not trust an autonomic system that undertakes all actions on their behalf.

The main contribution of this paper is the CADEAU prototype, which allows users to control the application composition using three user interaction methods. In this paper, we present the implemented prototype and a concrete multimedia application, which demonstrates how CADEAU can be used.

## 2 Application composition in CADEAU

The goal of CADEAU is to make the realization of tasks in the ubiquitous environments easy for users. A user only needs to specify a high-level description of the desired task to CADEAU (running on a server), which will accomplish it as required. CADEAU realizes user tasks by composing appropriate applications from software components that are allocated onto resources in the environment. These resources may provide, for example, multimedia, sensing, computational or data processing capabilities.

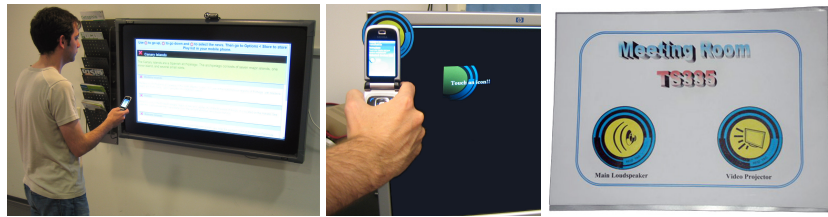
Initially, the prototype supported the autonomic application composition only. However, as we found out during the user evaluation, users may prefer to control the application composition manually (see [1] for details). Thus, we additionally developed the manual and the semi-autonomic control methods in CADEAU. These methods are based on the NOKIA 6131 mobile phone, which plays the role of the interaction tool between the user, CADEAU and the real world. Figure 1 (left) demonstrates how a user is interacting with the prototype. These methods differ from each other on how much the user is involved in the control. The prototype offers these methods so that the users can choose the appropriate method on the account of their needs, situation and the application, as users requested during the evaluation. We believe that one method cannot always be better than the others.

**The manual method.** The user has full control over the application composition and is able to choose resources by simply touching them using his mobile phone. This method is based on the RFID technology. Thus, each resource has an RFID tag attached; these tags contain resource identity information that is accessed when touching tags. The environment provides a control panel with RFID tags for non-visual resources (e.g. a Web service) or for resources located in a hard to reach places (e.g. on the ceiling). An example of a visual resource and a control panel are shown in Figure 1 (the middle and the right pictures respectfully). The mobile phone's UI informs the user about the resources he has already chosen and reminds about the ones he needs to accomplish his task (Figure 2, left). The user can also replace the chosen resources by touching other ones of the same type. When all necessary resources are chosen, the user requests the CADEAU prototype to deploy and start the application.

**The semi-autonomic method.** The user's control is restricted to the options suggested by the prototype. CADEAU dynamically produces an ordered (best-first) list of application configurations and presents it to the user. These configurations have been optimized according to the criteria specified by the user before. The user can browse the application configuration list and identify the resources used in each configuration by clicking the phone's middle button. In this case, the resources providing display capabilities respond to the user by showing the 'splash screen' while the audio resources play a welcoming audio note. This optional feature helps the user to locate and identify the physical resources that are associated to each application configuration. The user may also omit this step (e.g. if he is familiar with the environment) and start the

application without identifying the resources. Due to space limitations, we do not include figures to demonstrate the GUI of this method.

**The autonomic method.** This method supposes that the user is not willing to control the application composition, thus CADEAU is given full autonomy. The application is composed according to user specified criteria (e.g. the nearest, the fastest or the cheapest option), his preferences (e.g. fidelity requirements) and situation in the environment, and is started without distracting the user. At first, CADEAU searches for resources according to their capabilities, location and quality. Next, an application configuration is produced: the application is allocated onto the resources according to the aforementioned criteria. More about the optimization criteria and the application allocation algorithms used in CADEAU can be found in [2]. The user interacts with the application when the resources, specified in the application configuration, are locked (to prevent other users and application accessing them) and the application components are deployed onto them.



**Fig. 1.** User interacting with the prototype (left), a public display resource (middle) and a control panel (right).

### 3 Application

We have implemented an application to demonstrate how the CADEAU prototype can be used. Consider the following scenario: John is reading a newspaper in a cafeteria. The newspaper has some hidden multimedia content (audio, video and images) that can be accessed when touching the newspaper with a RFID-enabled mobile phone. John touches the newspaper titles and, shortly after, the system prompts John to browse the hidden content on a nearby wall display. John browses the list of multimedia files and selects the most interesting ones by pressing the mobile phone's middle button. When files are chosen, the system stores files' links in John's mobile phone. Later this day, John decides to watch the videos and listen to the audios in a conference room at work. John decides to use a semi-autonomic method to choose appropriate resources. The system suggests John several combinations of a display, an audio system and Web servers that host the multimedia files. John chooses the combination named 'nearest

resources' and starts the application that plays the multimedia files using these resources. John can control the playback (stop, pause, next/previous) by pressing the phone's middle button (Figure 2, right).

The collection of content is initiated when the user touches RFID tags in the newspaper (shown in Figure 2, middle). The information from the tags is communicated to CADEAU, that is running on a server, via the HTTP requests/responses sent over GPRS. Content browsing is based on a Web browser and Javascripts which are controlled with the mobile phone via HTTP/GPRS protocol. The mobile phone's UI is implemented using Java MIDlets. The content delivery and the playback are based on two flash players, the JWMediaPlayer and the JWImageIterator (available from [www.joerenwijering.com](http://www.joerenwijering.com)).



**Fig. 2.** The manual method's GUI (left), the newspaper (middle) and the controller's GUI (right) used with the application.

## 4 Conclusion

This paper has briefly introduced the CADEAU prototype that supports the autonomic (solely based on the user specified criteria) or user controlled application composition. The latter provides two control methods (the manual and the semi-autonomic) that use the mobile phone as an interaction tool. The user chooses these methods depending on the application, the situation or his needs. We also implemented an example application which enables collecting and delivering of multimedia content across multiple environments.

## References

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