# NFCMuseum: an Open-Source Middleware for Augmenting Museum Exhibits

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***Abstract*— Near Field Communication (NFC) technologies are mature and are meeting the mass market in many application domains [1]. They provide the possibility to automate many processes that had been lacking such features. Museum exhibits are one such case, and have traditionally been static pieces that do not interact with users or provide any additional context. In this demonstration we present an open-source middleware for museology. Our work uses external devices such as media renderers to create an augmented reality environment around visitors to improve interaction and the overall experience from the exhibit, while giving museum management valuable information about visitor behavior. The NFCMuseum middleware is part of the ASPIRE project [2] funded by the European Union and is available for download at the OW2 Consortium website [3].**

***Keywords : NFC, Event Driven, complex event processing, ECA, OSGi, RFID***

## I. CONTEXT

New information technologies can augment the information available to visitors during museum visits, making exhibits interactive and personalized according to user based preferences. Near Field Communication (NFC) [1,4] is one promising technology for increasing interaction between visitors and works of art, creating an augmented reality museum. Augmented reality makes it possibly to change the focus of interaction, shifting away from the artifact. The interactive system becomes the environment itself, and is no longer in a single precise location, but instead, it is a series of surrounding objects or devices.

In our demonstration, visitors can specify their preferences, including, but not limited to, whether or not they suffer from any kind of handicap, their language of preference or their background knowledge of the subject at hand. The environment around a work of art will adapt itself and provide additional contextual information to a visitor. Such information can be either visual, auditive (or both), and aids the visitor by providing a more complete and satisfying environment.

## II. MUSEUM EXHIBIT USE CASES

### *A. Visitors*

Visitors must install client-side software on their NFC enabled device, such as an NFC-enabled telephone. Such a device must also provide a means of communication of longer range than NFC (e.g., Wi-Fi, Bluetooth). The client software is configured with the user's preferences (e.g., language, specific interests, visual or auditive handicap). A visitor in the museum can then approach and read RFID enabled objects, enacting a series of events in the visitor's immediate surrounding environment. These events include a visitor receiving information pertaining to the solicited object directly on their NFC device (e.g., a Wikipedia [5] webpage, a multimedia file), or information and events can be sent to the surrounding environmental devices, such as, visual devices (e.g., UPnP [6] media renderers) or audio devices (e.g., speakers). Visitors can move on to the next exhibit, halting the previous actions from the earlier exhibit, and creating new actions according to the current exhibit. Of course, information is recorded, so if a visitor returns to a previous exhibit the effects can be restarted, continuing where they had been halted, or new events can be sent to the surrounding environment. At the exhibit exit, the system may propose a quick survey to the visitor for evaluating the exhibit.

### *B. Museum Managment*

The Museum curator can use the system to collect relevant information regarding visitors' habits. For instance, it is possible to visualize visitors' most common paths or the average time spent between works of art. With such information, correlated with the surveys filled by the visitors, people in charge of the museum can rearrange rooms, remove works of art that are not often visited or where visitors do not stop, or simply be aware of the museum's most attractive pieces. Using the administration interface, it is possible to configure system preferences, including adjusting peak period preferences, or modifying events and media that can be sent to external devices.

## III. MIDDLEWARE ARCHITECTURE

The proposed architecture consists of client-side software installed on the NFC readers, server-side software that centralizes administration tasks and evaluates Event Condition Action (ECA) [7] rules, and software that controls the exhibit augmenting devices themselves. The client-side software is installed on the NFC enabled device. It registers client preferences and communicates with the server when RFID tags are read. Client preferences are sent to the server each time they are modified. On the server-side of the architecture we use two main technologies: JavaEE [8] and OSGi [9]. The JavaEE server is used for the administrative web-interface, for recording the event history, and finally for creating the reports. On the other hand, the ECA rule evaluation system is implemented on top of the OSGi gateway, as are the controllers for communicating with the physical devices that exist in the environment.

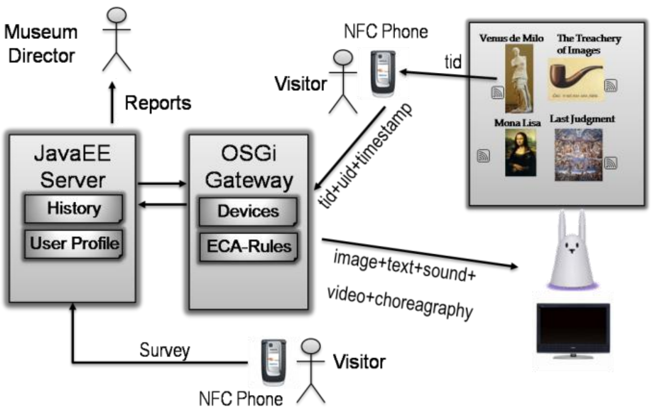


Figure 1: Platform Architecture Demonstration.

When an NFC device reads an RFID tag, it sends an event to the server. The event is recorded for later use in the reporting process and also to create an event history. Each event is a tuple consisting of the *RFIDTagID*, the *UserID(PhoneID)*, and the *TimeStamp*. The server software receives the events and triggers the ECA rules that are currently active in the system. Conditions evaluate the events and can select actions to be performed. Each ECA rule receives the event, the user profile, the user's history (i.e., previous events related to the user), and the administration preferences that have been set (e.g., peak museum hours, number of visitors in the area). For example, at peak hours, actions sent to the NFC enabled telephone are preferred because they are personal, and actions sent to media renderers should be avoided, since they can be used for group events. ECA rules are provided dynamically and can be added, removed, and modified without restarting the application. This provides the museum with the possibility of adapting its exhibits without causing a full application restart. Of course, museums are generally closed at night and rules could then be updated, but this implies that the museum must be able to anticipate future activity, something that is error prone at best and can reduce visitor satisfaction. ECA rules can also be associated to specific device handlers or drivers. When devices disappear their matching rules are deactivated, when devices reappear the rules are reactivated. Finally, actions, associated with conditions that are evaluated to true, include sending events and media to physical devices (e.g., image, text, video, audio, choreography), including to the NFC telephone itself, the media renderers, or the auditive devices.

## IV. ICPS DEMONSTRATION

For the ICPS2008 demonstration, we will use Nokia NFC 6131 handsets, copies of paintings simulating works of art, several RFID tags (type MiFare), Nabaztag electronic rabbits [10], and UPnP Media Renderers. For communication purposes, we will setup a Bluetooth network between the NFC phone handset and the server, and a Wi-Fi network for communication between the server and the Nabaztag electronic rabbits. The demonstration presents an example of how the system would react in a real-world environment. Various user profiles will be presented, including multiple languages, different cultural levels (adults and children), and varying handicaps (i.e., visual or auditive). Responding to low attendance periods versus peak attendance periods will also be demonstrated. The events presented will include displaying information regarding the work of art on the NFC handset, sending media to the UPnP media renderer, and playing choreographies on the Nabaztag rabbits. Our implementation uses the JOnAS JavaEE OSGi based application server [11] and the Felix implementation of the OSGi specification [12].

## V. REFERENCES


[1] Florian Michahelles, Frederic Thiesse, Albrecht Schmidt, John R. Williams, "Pervasive RFID and Near Field Communication Technology," IEEE Pervasive Computing, vol. 6, no. 3, pp. 94-96, c3, Jul-Sept, 2007

[2] ASPIRE, http://www.fp7-aspire.eu/

[3] OW2, http://www.ow2.org/

[4] Near Field Communication Forum, http://www.nfc-forum.org/home

[5] Wikipedia, http://wikipedia.org/

[6] UPnP Forum, "Understanding UPnP™: A White Paper", June 2000, http://www.upnp.org/download/UPNP_UnderstandingUPNP.doc

[7] Sharma Chakravarthy, Roger Le, Rajesh Dasari, "ECA Rule Processing in Distributed and Heterogeneous Environments," International Symposium on Distributed Objects and Applications, p. 330, 1999.

[8] Java Enterprise Edition, http://java.sun.com/javaee/

[9] OSGi Alliance, http://www.osgi.org

[10] Nabaztag, http://www.nabaztag.com/

[11] JOnAS , http://jonas.ow2.org

[12] Felix, http://felix.apache.org/