



ICHIM
PARIS 21-23 SEPT. 05



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Digital Culture & Heritage
Patrimoine & Culture Numérique

Bibliothèque nationale de France, PARIS
Sept. 21st - 23rd, 2005
21 - 23 septembre 2005



**NOMADIC COMPUTING IN INDOOR CULTURAL
SETTINGS:
INTELLIGENT CONNECTIVITY, CONTEXT
AWARENESS AND THE MOBILE MUSEUM
EXPERIENCE**

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**Published with the sponsorship of the
French Ministry of Culture and Communication**

Actes publiés avec le soutien de la Mission de la Recherche et de la
Technologie du Ministère de la Culture et de la Communication, France

Interprétation simultanée du colloque et traduction des actes réalisées
avec le soutien de l'Agence Intergouvernementale de la Francophonie

Abstract (EN)

The IST European co-funded project DANAE is providing a full framework for the dynamic and distributed adaptation of scalable multimedia content based on media streaming technologies. It forms the backbone for the public release of a nomadic, interactive, multimedia guide that is expected to reach its final form by mid 2006 in the framework of an experimental deployment at the Museon. By using technological bricks provided by all partners involved in the DANAE project, this interactive guide will take advantage of the best of the wireless connectivity and multimedia capabilities of the new devices to offer innovative and therefore largely unexplored ways of presenting information. It will use for example 3D avatars for presenting the information and will deal as well with real time visitor contextual parameters. Other key issues like content creation techniques, content adaptation, dynamic update of multimedia applications and interactive presentation design will be also discussed in this paper.

Keywords: MPEG21, MPEG4, media streaming, dynamic adaptation, 3D avatars, context awareness, geo-localisation, museum handheld device.

Zusammenfassung (DE)

Das IST Projekt DANAE - ko-gesponsort durch die EU - stellt einen vollständigen Rahmen für die dynamische und verteilte Adaptation von skalierbaren Multimediainhalten zur Verfügung.

Es stellt das Rückgrat für das öffentliche Release eines nomadischen, interaktiven Multimedia-Guides dar, dessen endgültige Form zur Mitte des Jahres 2006 erwartet wird. Dieser interaktive Guide macht Gebrauch von den besten Multimedia- und Vernetzungseigenschaften neuer Geräte, indem er von dem technologischem Know-how aller am Projekt beteiligten Partner profitiert. Dadurch ist der Guide in der Lage Information innovativ zu präsentieren. Es werden dreidimensionale Avatars verwendet, um Informationen darzustellen. Außerdem wird die Erkennung von Umgebungsänderungen integriert ("context awareness").

Weitere Kernthemen wie Techniken zur Kreierung von Inhalten, Adaptierung von Inhalten, das

dynamische Update von Multimediaanwendungen und interaktive Präsentationsdesigns werden ebenfalls in diesem Artikel besprochen.

Schlüsselwörter (DE): MPEG21, MPEG4, Media streaming, dynamische Adaption, 3D Avatars, Context Awareness, Geo-lokalisierung, Museum Handy.

Résumé (FR)

DANAE, projet européen IST (Information Society Technologies), a pour objectif de fournir un système complet permettant l'adaptation dynamique et distribuée de contenus multimédias « scalables » en utilisant des informations contextuelles. Ce système formera le squelette d'une plate-forme offrant aux visiteurs une application nomade de guide multimédia interactif qui sera finalisée mi-2006 dans le cadre d'une expérimentation au Museon. En s'appuyant sur les modules technologiques fournis par les différents partenaires impliqués dans le projet DANAE, ce guide interactif saura tirer profit au mieux de la connectivité sans fil ainsi que des possibilités multimédia des nouveaux terminaux portables. Il offrira alors aux visiteurs un moyen innovant et encore largement inexploré d'accéder à du contenu multimédia grâce par exemple à des avatars 3D tout en étant capable de tenir compte en temps réel des paramètres contextuels du visiteur telle que sa position géographique. D'autres problèmes cruciaux seront également abordés dans cet article tels que les techniques de création et d'adaptation de contenu, la mise à jour dynamique de l'application multimédia cliente ainsi que la conception de présentations interactives.

Mots clés: MPEG21, MPEG4, contenus multimédia streamés, adaptation dynamique, avatars 3D, paramètres contextuels, geo-localisation, terminaux portables.

I. Introduction

One of the key issues regarding museum educational policies is the notion of interpretation of the exposed objects as well as the presentation of the context from which the exposed object is extracted. This paper examines the creation of a portable multimedia guide which will reach its completion in mid 2006 and will highlight the techniques for the specification, development and implementation. We will also focus on the notion of content creation, wireless delivery, dynamic adaptation and context awareness which includes a large variety of factors such as platform capabilities, users' preferences or visitor location.

The first part of the paper focuses on the state of the art concerning current trends throughout the world of handheld multimedia devices (e.g. tablet PCs or pocketPC) and their usage in museums. The second part will mainly focus on several issues which could constitute actual barriers for the creation and implementation of this kind of guides, namely human barriers, technological barriers and economical barriers. Then, we will present DANAE approach to these issues for the mobile and interactive guide that is being created for the Museon, one of the eleven partners of the IST funded DANAE project. The final part will be dedicated to the conclusions and perspectives of our approach.

II. State of the art

1. Interpretation in a museum setting

Interpretation is one of the key issues regarding museum educational policies (Hooper-Greenhill, 2000). Within the museum setting, traditional interpretation means include a wide variety of media, ranging from explanatory textual labels, to posters, educational programs, audio guides, guided tours, printed material - such as books brochures and leaflets - or multimedia applications. And while in the past museums were mostly focused on their collections, via acquisition and research, today more and more museums strive to develop a long lasting and meaningful relation with their visitors, dedicating part of their studies to museum visitors and their need and their behavior (Hooper-Greenhill, 1994).

Moreover, since 1994, the World Wide Web has been exercising an important influence on the creation and dissemination of interpretative material related to the understanding and appreciation of cultural heritage. At more or less the same time, several exhibitions started to introduce multimedia installations in their exhibitions with complementary interpretive material for the contextualisation of exposed objects. The digital era was also of great influence for the traditional tape audio guides. Nowadays most institutions use digital audio guides that have the capability of storing more recorded data in several languages simultaneously (Tellis & Proctor, 2003).

2. Ubiquitous computing

In parallel, the notion of ubiquitous computing (Dourish, 2001) is emerging, supported by an abundance of new and more powerful portable platforms (handheld PCs, tablet PCs, 3G mobiles) and the unprecedented development of wireless networks. The combination of powerful multimedia capabilities and wireless connection in one device opens actually very wide prospects. It is for this reason that throughout the world, more and more indoor and outdoor cultural institutions offer their visitors tours using interactive handheld mobile devices. Within this context, some of the new challenges we will face soon, are the development of new ways for content creation and structure, delivery and adaptation, both in terms of human factors (Harper, 2003) as well as in terms of hardware resources.

3. State of the art

This omnipresence of smaller and more and more capable computers has already made its appearance in the museum setting. “Mariposa” was one of the first European prototypes related with museum handheld devices developed for the Dialogue Museum in Louvain La Neuve in Belgium (Lefftz et al., 2003). The project results were very encouraging even though the project itself has not run through completion due to economic reasons. The prototype was developed for a Tablet PC as a response to the public’s request to see more multimedia terminals in the museum. Special attention was given to the design of the application so that the virtual object would not compete with the exposed object. All information was stored locally. There was no automatic geo-localisation module and therefore the screen was not updated automatically when

the visitor moved through the exhibition. A bit earlier and from the other side of the Atlantic, the Exploratorium, a popular science museum in San Francisco, published as early as 2001 the outcomes of a forum, regarding electronic guidebooks. The convictions were counterbalanced by the open questions concerning the use of this new media for museum learning purposes (Exploratorium, 2001). Another well published project is the Sotto Voce project developed for an historical house at Filoli, California (www.filoli.org) even though it is not easy to compare an application for an historical house with an application for a museum. More recently in the United States, the Smithsonian announced the introduction of museum handheld devices in all of its galleries having first run successful experimentations with museum handheld devices in the Renwick Gallery (Tellis, 2004).

Back to Europe, the Tate Modern together with Antenna Audio has been experimenting from 2002 with a portable multimedia guide connected with a wireless network and using location based technologies (Wilson, 2004). In Germany the Dinohunter edutainment suite introduced in the Senckenberg paleontological museum developed a module called DinoExplorer. The visitors are expected to download the application from the web site of the museum that is used in a pre-visit and post-visit level (Sauer et al., 2004) but in this case a rising matter is the configuration of the handheld devices on which the application is downloaded.

When examining the characteristics of stationary, PC based applications versus applications on handheld devices we realise that there are several differences as to the design and implementation of the produced interpretation material. It has been argued that PC based applications tend to become another exposed object while an application running on a handheld device accompanies the visitor throughout his visit and facilitates on site information retrieval. Consequently, the portability of the device enhances the interaction between the user and the exposed object and thus facilitates hands-on learning as well as group interaction. On the contrary, research has shown that when interacting with a stationary kiosk application visitors spend less than 10 minutes times in overall (Economou, 1998).

The portability as well as the reduced size of the platform introduces some hot issues regarding the design, interface and navigation. Visitors should not be confused neither frustrated when using the handheld device (Butz, 2002). From the curator's point of view, it has been mentioned that the handheld device should not – in any case - compete with the exposed object neither

undermine the capabilities of the visitors to interact directly with the objects when visiting a gallery or a museum (vom Lehn & Heath, 2003). Yet, we are convinced that in the near future all kind of interpretation material will be able to be stored and streamed to the visitor's handheld device, after consideration of the visitors' preferences, age, group composition or even learning disabilities. In this sense it is a matter of particular interest to investigate how the combination of sound, text, video, animation, 3D avatars coupled with edutainment activities, streamed in real time and filtered to match a particular user profile would affect visiting and learning in the museums.

III. Issues and barriers

As we saw in the previous chapter there is an actual trend in the museum setting to renew the classical audio guide offer with next generation multimedia handheld devices. However, few museums are currently able to propose a complete offer with handheld devices tours, integrating full fledge multimedia applications giving access to a large content in the framework of their visit. Despite their will to adopt new technologies, museums have to face some issues and barriers which are mainly technological but also human and economical.

1. Human and economical barriers

The adoption of new multimedia handheld devices to guide visitors leads museums to first face many "human" related issues. The creation and production of the multimedia application is an entire problem since there aren't any "off the shelves" solutions regarding the design, the interface, the navigation and the services visitors could access. How to implement an application which should absolutely not compete with the current exhibition but supplement it? How to allow a visitor to dig deeply into a subject without losing the narrative of the exhibition? In this sense, a significant (but difficult to quantify) amount of work is needed to select relevant contents (text, image, video, speech) from the museum database, to rewrite/reproduce some text or audio contents, to structure them and finally to insert them into an harmonious application that allows to keep the story and the philosophy of the exhibition.

Each museum has to find the best trade off on every aspect and progress gradually by improving the system with feedback from the previous prototypes. This feedback comes mostly from visitors, who also have to get familiar with these technological innovations. What they also expect from these new technologies is that they fulfill two needs that in fact are contradictory: assistance and autonomy (Deshayes, 2004).

On another level, museums have to face economical barriers due to the cost of the deployment of such a system. They need to acquire new devices (several categories of devices sometimes), new wireless delivery network and specific servers. They have to work on the content creation, application design and implementation, to have people to educate visitors to this new portable guide, to insert those new devices in the pre-existing system (like a web site, stationary PC platform, current tour), to find a new "business model" to take advantage of the museum shop at the entrance or exit. At the same time they know that the technologic development in the field of ubiquitous computing is quite fast and that the dialectics of progress is quite influential in this domain. What is quite advanced today maybe rather outdated tomorrow. Therefore the question whether it would be the right moment for an investment of this kind is fully justified.

2. Technological barriers

Powerful, multimedia capable, wirelessly connected and portable, the new generation multimedia handheld devices allowing to implement applications adapted to each visitor needs with personalized interfaces, multi-modality, contextual services, dynamic content adaptation and an infinite information source, appear to be the new "grail" for museums to assist the visit and ease the interpretation. However, in addition to previously mentioned human and economical issues, museums have to face also some technical issues, mainly linked to content creation, context awareness and delivery.

Content creation is indeed a concrete issue. As soon as all elementary media (text, video, audio, pictures) have been selected and gathered in a coherent manner, the application itself needs to be implemented. A manual implementation page by page is only feasible for experiments with limited amount of data. When content of the future multimedia guide becomes very large, the system should be able to retrieve directly the content from the museum's database, making it

easier to keep it up-to-date. Next to this automatic system other tools are needed to be able to produce a coherent story (with a 3D avatar for example) and to well stitch the different objects and themes into an all full-fledged scenario. The scenario itself should be well balanced so that the mobile guide corresponds to visitors' main usage: getting the maximum of information easily, in a minimum amount of time.

Context awareness capabilities appear to be an absolute necessity to take advantage of the ubiquitous potential of such a mobile guide and serve at its best the visitor needs. Those capabilities allow to enhance the adaptation of the mobile guide application to the visitor: to personalize the interface and the content itself, to ease the navigation, to push the right content according to visitor preferences or to propose thematic tours. In this sense, context awareness capabilities allow to provide the almost perfect guide that serves the visitors' desire to better understand the exhibition and increase his knowledge intensively with a tailor-made guide in a short period of time. There are two main categories of contextual information: static contextual information like age of the visitor, level of knowledge, user preferences, type of device (screen size, color numbers, processing power), type of connectivity, and dynamic contextual information like the visitor location in the museum. Context parameters of both types are aggregated into the current visitor context which is thus taken into account to adapt and update the existing scenario of his mobile guide.

Delivery of the content appears to be the last main issue museums have to overcome. How to deliver the content to the mobile device when the visitor is asking for it? The first obvious solution was to store the all content locally into the device which solves at the same time all delivery issues. As we have seen in the first chapter, this first solution has been adopted in many experimentations. However, despite the constant increase of the memory capacity of portable devices the size needed to store all possible scenarios, originating from different contextual parameters, with all audio and video clips, turn out to be extremely huge. The second main drawback in storing locally the full content is that all devices have to be updated as often as the scenario content is updated.

To deliver the content through a wireless connection is the second alternative possibility. The current explosion of wireless network (e.g. 3G, GPRS, Wi-Fi, Wi-Max, BlueBooth) offers a set

of off the shelf solutions answering to most of the needs. In the framework of museums, Wi-Fi connectivity appears to be the best solution when handheld devices are Tablet PC or Pocket PC. Dealing with Wi-Fi connectivity, the main issue is to size the network in term of number of access points and their position in the museum, essential to provide the best quality of service to the visitor. However, the sizing operation is usually done on basis of an average usage of the content by a statistical group of visitors. Except by oversizing the network, it is practically impossible not to have bandwidth problems (e.g. many visitors ask for video at the same time, visitors grouped around the same place and then connected to the same access point). The quality of service is then actually deteriorated (e.g. video stream is stopped; audio speech becomes incomprehensible – glitch, hatched). Dynamic adaptation of the streamed content is one of the solutions to overcome bottleneck problems and provide always the best possible quality of service.

IV. The DANAE approach

1. The DANAE project

DANAE is an IST co-funded project under FP6 and aims at designing a platform based on MPEG-21 for the delivery of multimedia content in a context-aware environment. The work in DANAE covers:

- the definition of scalable media formats
- the adaptation of multimedia content to session context
- the transport and delivery of multimedia content to the end-user.

The DANAE project gathers a consortium of research labs, network operators, industrial partners and one museum, the Museon in The Hague, the Netherlands. For this museum, an application is specifically developed and implemented on top of the DANAE platform, to illustrate the pioneering service concepts and features made possible by the project.

2. The Museon mobile interactive guide

The Museon has collections ranging from natural science and science to archaeology, history and ethnology. The collection policy is largely determined by educational considerations; the museum uses its collection to illustrate the stories that it wants to tell. In this context interpretation is of utmost importance.

The DANAE experiments coincide with the museum's renovation of the permanent and semi-permanent exhibition spaces. It comprises a 1000 m² open space surrounded by eighteen 100 m² spaces. In these new exhibitions the multidisciplinary and educational character of the Museon is fully expressed. The approach is conceptual: the exhibition cannot be considered as a collection of single objects, but the objects should primarily be seen as illustrations to a story that is told using the interrelationship of the objects on display. In the exhibition selected chapters from the history of Earth to Mankind are presented, focusing on topics like geological processes, evolution, oceans and wetlands, evolution of man, archaeology, energy, warfare, religion and the creativity of mankind. The eighteen separate spaces are used to enter into selected separate aspects of the story that is told by the large exhibition.

Guided tours on handheld devices

In the new exhibition we can easily see the added value of guided tours. A guide might draw attention to the interrelationship within specific parts of the exhibition and provide additional background information to the themes. He could also draw attention to specific objects on display, which can be seen as exhibition highlights or with which interesting stories are related and that is easily overlooked by the self-guided visitor. Nevertheless, frequent tours by human guides are not foreseen. However, we may expect guided tours on handheld devices able to fill the gap, combining the advantages of a traditional guided tour with personalization of the information offered.

Geo-localisation

The geo-localisation system, allowing to localize quite precisely visitors in the exhibition space, is integrated in the DANAE framework. This component, being one of the specific contextual information pieces, is used as a means to provide contents to a user that are relevant at his current

location. It is based on an off the shelf WLAN software-based positioning system, allowing to calculate devices' positions thanks to Wi-Fi access points. The solution has been technically validated on the Museon premises. The large space where the experimentations take place, with many concrete columns and magnetic fields caused by large doors that separate the central exhibition space from the adjacent smaller exhibition rooms, appeared to require more access points than was expected before. With the installation of additional access points during the last experiment in May 2005 an average of 1.5 - 2 meter precision has been reached, depending on the position in the exhibition area. This precision is sufficient for the approach that was chosen, due to specific characteristics of the exhibition layout.

The exhibition is characterized by a high density of objects and a great diversity of displays that are different in size, shape, positioning and complexity. This situation makes it extremely difficult to predict the visitor's precise intention when entering a theme and moving within this theme. Which display or object draws his intention specifically? What does he request additional information about? At what moment does he require this information? On the longer run the employment of fuzzy logic might answer these questions, but at this moment the system only marks the current zone on an exhibition map and sends a notification when the visitor enters a new theme and new information comes available. The information itself is not pushed automatically.

A virtual human guide

The first thing that the visitor gets when activating a theme on his device is a spoken introduction, supported by still or moving images and a two different 3D avatars. The 3D avatars acting as human guides are based on painted models coming from the Belgian painter Jean-Marie Boomputte. The Dutch voices are recorded in a sound studio first; thereafter the virtual humans are animated using dedicated software. For the English version the use of a text to speech generator is possible, which provides of course a higher degree of flexibility in the development process and avoids the costs of a voice and studio, but does not yet generate the same quality as a recorded voice.



Fig. 1: One of the avatars. On the left the original design by Jean-Marie Boomputte.
On the right two screen shots of the 3D avatar.

After the theme introduction a representation of the different displays surrounding the visitor is displayed. Selection of one display may give access to another explanation by a virtual human, but sometimes only to additional information about objects on display. This in most cases is just text supported by images, video clips, slide shows and animations.

Tablet PC and PDA

The museum application is developed for both tablet PC and PDA. From a technological point of view the first device is the easiest one, since it is as powerful as a laptop. Also the larger screen as compared to a PDA offers clear advantages.

However, the size of the device and its corresponding weight is at the same time the main disadvantage. The evaluation that is foreseen, will make clear whether the advantages will counterbalance this advantage, but the expectation is that the visitors will prefer the small size of a PDA.

From device to device

A PDA is not the most comfortable device for watching movies and high quality slide shows. In this case, DANAE provides an elegant solution via the so-called "session mobility" function. A video, animation or high quality slide show started on one device may be transferred to another one, being another PDA or a tablet PC but also a computer that is part of the exhibition connected to a large flat screen for example. This enables a visitor to watch the selected rich media application on screens that offer a much better visual quality than the screen of a PDA. This

feature runs also in the inverse mode: a video that is part of the exhibition can be transferred to the mobile device, for example for watching it in quieter spot, taking the quality loss for granted.



Fig. 2: Design of the user interface of the Museon mobile & interactive guide for tablet PC.

The map on the top right is dynamically updated with the user's current location and provides access to the map application. The icons on the right symbolize the different exhibition themes. When a user enters a new theme, this is made visible by means of a white circle around the relevant icon.

Map application

The geo-localisation system component also plays a central role in another part of the museum application: the map. Currently on a floor plan of the museum a visitor can see his precise location as well as the location of other visitor's that have registered with them and also carry a mobile device or Wi-Fi tag. He can also see which parts of the exhibition he has visited.

The map application can be improved to provide other features like a way finding tool. Then it would play a central role in a thematic tour through the exhibitions guiding the visitors to specific parts of the exhibition and specific objects on display. It could also be the basis for gamelike educational applications based on collaboration between museum visitors.

IV. Dynamic multimedia adaptation

The DANAE project aims at designing a platform for context-aware dynamic multimedia content adaptation. The typical content is an interactive scene that allows a user to navigate in a potentially complex page hierarchy to reach specific content mixing text, 2D and 3D avatars, audio and video such as the pilot Museon mobile & interactive guide. The context information deemed appropriate in the Museon application is the location of the user, user preferences (e.g. age of the user, the preferred language), the terminal capabilities of the end-user device and the available network bandwidth. The location awareness being treated sufficiently in the previous chapter, here we will focus on the dynamic adaptation of multimedia content.

Contrarily to most interactive guides, the approach pursued in DANAE tries to avoid having the content reside completely in the end-user terminal. In effect, the storage capacity of handheld devices, though increasing at a steady pace, is far too limited compared to the size of audio & video material which is available. This however implies being able to download or stream the content on demand with a reasonable latency and quality for the end-user. Thus DANAE has opted for content streaming over Wi-Fi. Additionally, the connected approach allows for on-the-fly generated content such as the already mentioned map application locating in realtime the end-user and the group of persons he belongs to (e.g. family or friends).

DANAE has based its architecture on MPEG technologies. Multimedia content uses not only the state of the art in video and audio compression but also the graphical representation of the multimedia scenes from MPEG-4. Content and context meta-data utilize mostly MPEG-21.

The adaptation framework

One of the most significant features of the DANAE client-server architecture (simplified view depicted in Figure 3) is the ability to adapt the content to the user context.

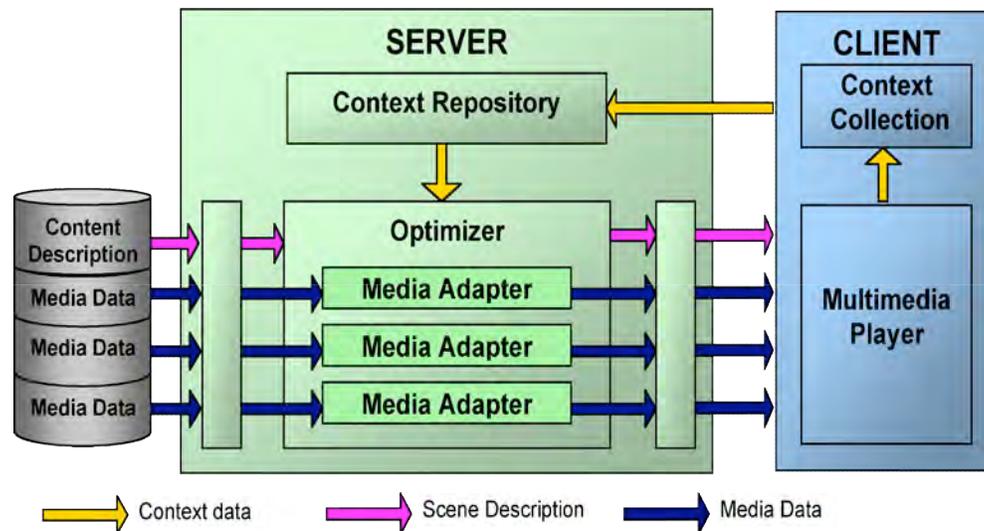


Fig. 3: Simplified DANA E adaptation architecture.

The adaptation involves a client (in the end-user terminal) which collects the user context and requests multimedia scenes. All adaptation decisions and actions are taken by the server which is able to modify the way content is presented by changing the layout, the type of media and their bitrates. For instance, a scene adapted for a PC will have a horizontal layout including large portions of text and high bit-rate video. The same scene adapted for a PDA will have a vertical layout with audio instead of text and low bit-rate video.

As an initial context is needed for adapting the scene, the client will first collect all user and terminal profile information available. The information of this context can be static like terminal capability, network class (Wi-Fi in our case) and user preferences or dynamic information like network bandwidth currently available or the user location. Once collected, the context is sent to the server and stored in a repository that keeps the data available for content adaptation.

When the player requests the server for a specific multimedia content, an MPEG-21 based representation of this content is used to compute the best adaptation according to the data stored in the context repository.

One of the first MPEG-21 benefits for adaptation is the media-agnostic description of bitstreams with associated metadata information on how to proceed for slimming down media units (e.g. encoded video frames) and what will be the resulting quality. Another benefit of MPEG-21 is the possibility to include processing instruction of a content description, allowing for a first level of specific adaptation.

The Optimizer is a key module inside the adaptation architecture. It has first to select the right media according to the user preferences (like audio vs. text), terminal capability (like available codecs or video size matching the devices) and available network bandwidth. Conjointly, the Optimizer decides the bandwidth allocated to each media. Finally, the Optimizer selects a presentation scene with an adapted layout that refers to the selected media. Once the adaptation decision is made, the Optimizer creates and sets up the media adapters corresponding to each stream being adapted. Then the media delivery from server to multimedia player can start.

During the session, the context may vary over time: the network characteristics or the player performances may decrease or increase (for instance the number of users connected to an access point may limit the available bandwidth). This will induce a context modification at the client side which will forward this information to the server via the context repository. This information can be used to re-allocate a new bandwidth to each media by modifying the relevant media adapters settings. Further, if the changes are drastic enough, the Optimizer may compute a new layout with eventually new media.

Content creation

Content creation is a key issue in the development of interactive guides. Not only the large quantity of multimedia content but also the ability to generate multi-device content are significant challenges. Thanks to the dynamic adaptation of multimedia the content developers can concentrate on the content creation itself without taking into account the specific devices on which the contents will be displayed. In this respect currently DANAE has stressed its efforts on facilitating the creation of the interactive scenes through a high-level XML language specific for the Museon application, which design principles are inherited from X-HTML + CSS, and which describes the layout and styling of the multimedia scene, the embedding of media components as well as the interaction. Among the media components defined in this language, not only audio, images and video can be embedded in the scene but also more complex constructs such as panoramic images and slide shows. This scene is then compiled in an efficient binary MPEG-4 representation for the delivery. The benefits of this approach are that high-level constructs are used in a manner close to HTML authoring which is well-known to many authors and that MPEG specifics are hidden from the authoring process. For audio and video, specifically, the project develops scalable audio and video coders with their associated MPEG-21 metadata. Thus only

one encoding for each audio and video resource is made, from which the server will dynamically extract the audio and video adapted to the available bandwidth and display size.

V. Conclusions and perspectives

As we discussed in this paper, the DANAE framework used in the context of ubiquitous computing with powerful, multimedia capable, wirelessly connected new generation handheld devices, opens an actual "new age" for museum learning purposes by providing a portable guide which assists the visit and eases the objects contextualisation thanks to a real time adapted multimedia application. The system that is implemented at the Museon, based on DANAE framework, allows to face the main technological issues linked to content creation, context awareness and delivery. Then, the DANAE platform enables developers to create multimedia handheld applications without worrying about specific devices, available bandwidth or other low level technical issues. In this sense, it makes possible a clear distinction between the creative aspect of content creation and the technological aspect of the application development. It thus promotes the development of new authoring tools, making it possible to move the focus totally on the creation of contents and the information retrieval directly from the museum's collection and content management systems. Content providers can fully concentrate on the enhancement of the contents and exploration of the new possibilities for the interpretation and appreciation of exhibits. Gamelike, interactive and collaborative applications could be developed and evaluated as to their effectiveness in comparison with more traditional edutainment approaches. Visitors could also interview experts via a live video connection at fixed time slots visitors could get in touch with experts, answering specific questions. Using a digital camera together with the handheld device new types of educational quests through the exhibition could be developed.

Personalisation is another important aspect. By offering the visitors a more extensive preference menu we could enable them to tailor the user interface fully to their personal preferences: font size, speech instead of text, text instead of speech, selection of avatars. Via the analysis of the behaviour of individual visitors we could tailor the application on the fly to a visitor's specific preferences. In this respect also the analysis and interpretation of the logfiles generated by the server, eventually completed with questionnaires or interviews, could demonstrate the

effectiveness of our approach in cultural heritage institutions and provide valuable input for the further enhancement of the application. It would influence the layout and even the functionality of the handheld application, but it would barely have impact on the process of content creation.

The DANAÉ Project is a European co-funded project under IST-1-507113 contract. We thank all members of the DANAÉ project whose valuable contribution has made the work described possible. For more information on the DANAÉ project and its members please see: <http://danae.rd.francetelecom.com>.

References

- Butz, A., Taming the urge to click: Adapting the User Interface of a mobile museum guide, *Proceedings of the ABIS 2002 workshop*, available at <http://www.kbs.uni-hannover.de/~henze/lla02/>
- Cotarmanac'h, A., Cazoulat, R. (2004), Architectures for multimedia content adaptation and delivery over heterogeneous environments, *Broadband Europe 2004*
- Deshayes, S. (2004), L'usage des supports mobiles au musée, des audioguides classiques au multimedia nomade. In *Ichim 2004 Digital culture & heritage*, Electronic Edition, Berlin 2004.
- Dourish, P. (2001), *Where the action is: The Foundations of Embodied Interaction*. Cambridge Massachusetts: The MIT Press.
- Economou, M. (1998), The Evaluation of Museum Multimedia Applications: Lessons from Research, *Museum Management and Curatorship*, Vol 17, no.2, 173-187
- Exploratorium (2001), *Electronic Guidebook Forum*, San Francisco, Exploratorium
- Deshayes, S. (2004), L'usage des supports mobiles au musée, des audioguides classiques au multimedia nomade. In : *Ichim 2004 - Digital culture & heritage, Electronic Edition*, Berlin 2004.
- Di Giacomo et al., T. , Benchmark-Driven Automatic Transmoding of 3D to 2D Talking Heads, *CAPTECH 2004*
- Harper, R.(2003), People versus Information: The Evolution of Mobile Technology. In L.Chittaro (Ed) *Mobile Human Computer Interaction 2003*, Berlin : Springer-Verlag
- ISIS, "ISIS : Intelligent Scalability for Interoperable Services," IEE CVMP, (march 2004), pp. 295-304.
- Hooper-Greenhill, E. (1994). *Museums and their visitors*. London and New York: Routledge
- Hooper-Greenhill, E. (2000). *Museums and the interpretation of visual culture*. London and New York: Routledge
- Lefftz, M. (2003), d'Hoedt, S., Debecker, M., Mariposa: des bornes nomads interactives au musee de Louvain-La- Neuve, in *ICHIM 2003 Proceedings*, Archives and Museum Informatics Europe, electronic edition, Paris: 2003

- Lehn, D. vom and Heath C. (2003), Displacing the object: Mobile Technologies and Interpretive Resources. In *ICHIM 2003 Proceedings, Archives and Museum Informatics Europe, electronic edition, Paris: 2003*
- Sauer, S. (2004), Osswald, K., Goebel, S., Edutainment environments. A field report on DinoHunter: Technologies, Methods and Evaluation Results. In D. Bearman & J. Trant (Eds.) *Museums and the Web 2004 Proceedings*. CD ROM. Archives & Museum Informatics, 2003
- Tellis, C. (2003) and Proctor, N., The State of the art in museum handhelds in 2003. In D. Bearman & J. Trant (Eds.) *Museums and the Web 2003 Proceedings*. CD ROM. Archives & Museum Informatics, 2003
- Tellis, C. (2004). Multimedia Handhelds: One Device, many Audiences. In D. Bearman & J. Trant (Eds.) *Museums and the Web 2004 Proceedings*. CD ROM. Archives & Museum Informatics, 2004
- Wilson G.(2004), Multimedia Tour Programme at Tate Modern. In D. Bearman & J. Trant (Eds.) *Museums and the Web 2004 Proceedings*. CD ROM. Archives & Museum Informatics, 2004