# ACIS: A Collaborative Hypermedia Geospatial Community Information System of Afghan Monuments and Sites

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**Abstract**

The growing popularity of community information systems that have been highlighted with the emerging term "Social Software" or web 2.0 illustrates the possibilities of novel paths for the creation and sharing of information. The potential of these techniques for the heritage preservation sector has been explored in ACIS (Community Information System of Afghan Monuments and Sites). ACIS has been deployed for a project in the conservation of cultural heritage in Afghanistan in order to support a geographically dispersed expert community of practise combining methods both from Geographic Information Systems and Community Information Systems making consequent use of Multimedia Standards such as MPEG-7 and MPEG-21.

**Keywords**

Cultural heritage management, multimedia, metadata, mpeg-7, mpeg-21, communities of practice

## 1. Introduction

In the past few years the World Wide Web has experienced a new era, in which diverse user communities are greatly involved in the generation of digital content (e.g. multimedia based social network sites such as *YouTube* or *Flickr* among many others). Notable is the rising interest in Geographic Information Systems (GIS) both in private and commercial web sites. Research and educational institutions have to reflect on the new ways and possibilities of interaction of user and data in order to generate information. The recent example of the German Archaeological Institute to provide general information on its areas of action to the public by simply using Google Earth functionality is just one example[1]. Since such a feature in the first instance provides information in one way (Institution to User) comment and interaction functionalities require active participation from the other side. Observations of community based web projects are the focus of research at Chair of Informatics 5 (Information Systems) at RWTH Aachen University.

The aim is to contribute to the ongoing research discussion on the future of collaborative information systems from the field of Information Science by consequent use of interoperable multimedia standards for the generation of a semantically enriched multimedia content. The scenarios and validity of concepts are tested in field activities of RWTH Aachen Centre for Documentation and Conservation at the Department of History of Urbanization at the Architecture Faculty.

In this paper we describe the ACIS (Community Information System of Afghan Monuments and Sites), a system that has been designed to support intergenerational learning communities by geographical hypermedia information systems in the area of cultural heritage. ACIS is designed to bring together generations of scientists in cultural heritage management and has been deployed within the context of the UNESCO project for the preservation of the World Heritage site Bamiyan in Afghanistan.

The rest of the paper is organized as follows. Section 1 pertains to our engagement in assisting conservation work in cultural heritage management, while means of contemporary information systems that address the problems and modern ICT approaches including social software are discussed in Section 2. Section 3 provides a framework for multimedia-centric services that help to create Community Information Systems for enhanced multimedia knowledge sharing in virtual communities of professionals. Multimedia content

[1] see http:/www.dainst.org/index_6932_de.html

interoperability is discussed by employing MPEG-7 and MPEG-21 multimedia metadata standards. In Section 4 the application of these technologies shows how international communities are supported and how scattering multimedia information is collected and managed. Finally, we conclude this paper with an outlook at ongoing research work in Section 5.

## 2. Motivation and problems

The preservation of cultural heritage sites in developing and post-conflict countries is a particular case. Problems are especially severe in Afghanistan due to internal and external armed conflicts and war in the past 25 years. Under the appeals and guidance of UNESCO and ICOMOS the Aachen Center for Documentation and Conservation at the Architecture Faculty of RWTH Aachen University cooperates among others in the recovery of the cultural heritage sector (ICOMOS 2006). Capacity building activities in cultural heritage management and projects in preservation of some of the most important monuments of the country[2] are key activities always in close cooperation with the national institutions.

Cultural heritage management includes the documentation of past and present conditions, the evaluation of conservation concepts as well as the execution of measures. Decisive knowledge and a living framework of partners and methods are essential for conservators, architects, site managers and urban/regional planners as well as the cooperation and support of involved stakeholders in order to ensure long-term preservation goals.

The creation of a policy framework that involves national cultural and planning institutions as well as experts and stakeholders in order to set up a sustainable protective environment is part of this integrated planning approach. The adoption of a Cultural Master Plan for the UNESCO World Heritage site of the Bamiyan Valley is one of the most important outcomes of the project so far. It is important to mention at this stage that mutual understanding on the above mentioned issues under the local conditions is extremely difficult to achieve.

From empirical experience it can be said that the intensive use of pictographic as well as photographic imagery in the communication process proved to be highly useful when explaining abstract concepts such as “protective zoning” and “authenticity”. Moreover ,the media artefacts produced in this context become the witnesses of preservation efforts of cultural heritage. They might serve as a primary source in the future in case the physical original gets lost.

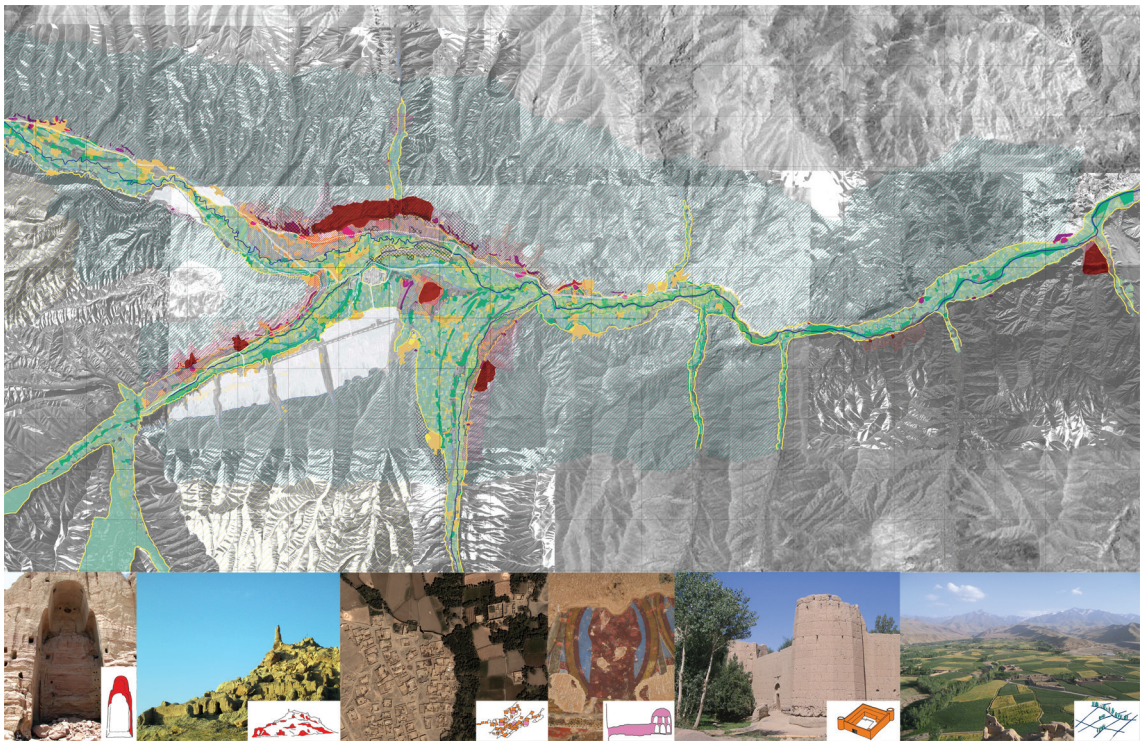

*Fig. 1. Pictographic explanations accompanying the UNESCO Cultural Master Plan for Bamiyan.*

[2] see http://www.bamiyan-development.org/projects/cultural-master-plan

## 3. Methodology

### 3.1. Communities of practice and virtual communities

The situation in developing and post-conflict countries is dominated by insecurity issues with a devastating impact on the human resource sector as the country has lost the experiences and knowledge accumulated by prior generations. New channels of communication have to be established as the involved experts are dispersed globally crossing languages and cultural habits. Also, awareness raising activities and knowledge sharing about the existence of cultural sites has to be encouraged, bearing in mind that ongoing looting of historical sites is a reality in these countries. As a consequence, this approach involves experts and non-experts of different age, skills and cultural background who share a common interest.

Bearing in mind the multitude of requirements an information system for cultural heritage management has to reflect, under these circumstances we introduce here, the concept of Communities of Practice (CoP) as the fundamental approach for information systems:
"Communities of practice are groups of people who share a concern or a passion for something they do and who interacts regularly to learn how to do it better." (Wenger 1998)

The theoretical approach of Communities of Practice (CoP) integrates identity theory, theories of practice and theories of social structure and situated experience. CoP are characterized by the production of shared meaning and collective identity based on the common (daily) practice of group members, active membership and in-group awareness (Lave and Wenger 1991; Wenger 1998) that can be summarized as processes of collective learning.

### 3.2. Information systems, media and knowledge exchange in the web 2.0

Such an intergenerational learning process as mentioned above is based on processing experiences from one generation to another. However, this process is, up to now, mostly based on face-to-face communication neglecting the capabilities of computer supported virtual communities. To divert the necessary knowledge in our case on cultural heritage towards the young generation of experts we propose a collaborative inter-generational learning community approach. It will provide globally dispersed scientists and activists an option for a sustainable cultural


*Fig. 2. Intergenerational learning of Afghan experts.*

heritage work by means of networked information systems without necessarily being physically present. While the first generation internet allowed easy access to a vast range of published materials, the second generation internet now allows to contribute to it (web 2.0). The recent development of the internet towards an ultimate exchange and communication platform where many people collaboratively produce and consume different digital media artefacts can be considered a chance for the above mentioned scenario. Characteristics of these new approaches in collaborative work labelled with the term of "social software" are the variety of users from professionals to encouraged amateurs and the adoption of a free form of term association to multimedia artefacts called "tagging" regardless of taxonomies and conventions. The use of a large variety of digital media in a non-scholarly manner particularly demands the system being capable of reflecting the discursive nature of knowledge creation and the versatile media in use. On the other hand, the perceived usefulness of such free associative tagging of multimedia resources, contrasts with the need for efficient data structures, algorithms and interoperable infrastructures to store, maintain, and deploy multimedia artefacts on the web. Summarizing, it can be said that learning in the non-technical environment is the result of knowledge sharing processes and media settings intertwined with each other. It is not that multimedia artefacts might stand alone and serve as learning objects – this is not sufficient, as distinct interrelations between media and complex cultural interfaces to these media exist (Manovich 2001).


*Fig. 3. Meaning of media artifacts – semantic knowledge and episodic knowledge.*

*Fig. 3* shows how multimedia artefacts can be understood differently, keeping heterogeneous communities in mind. Particularly, as a content of a multimedia artefact has to be considered from various viewpoints (*semantic knowledge*) and can be interpreted in different ways (*episodic knowledge*). Thus, in non-technical disciplines it is crucial to consider the situational context as a distinct concept within the overall knowledge exchange process (Brown and Duguid 2000). For that reason, the traceability of the complete discourse linked with any multimedia artefact is required at any time, as it depends on the context whether a statement can be considered as correctly understood.

## 4. Technology

### 4.1. Community hosting service – The ATLAS Architecture as a theoretical media framework for addressing, transcribing and localizing knowledge

Within the research on communities at the Department of Information Systems and Databases we have developed a novel community hosting service (cf. *Fig. 4*) in conjunction with a community-centred development process. The Architecture for Transcription, Localization, and Addressing Systems (ATLAS) combines approaches from various disciplines such as software engineering, sociology and cultural sciences led by the concept of transcriptivity as a design principle for computer science (Jarke and Klamma 2005; Jäger 2002). While learning takes place users successfully internalize the transcribed knowledge that has been created within a community by creating new content for the community. Aspects of usability and sociability (Preece 2000) are considered by constantly assessing and supporting community needs when creating multimedia artefacts.

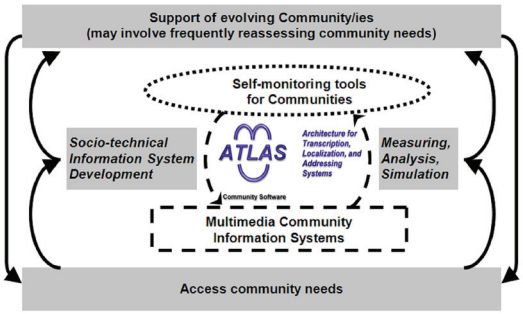


*Fig. 4. Self-reflexive Information System Architecture ATLAS.*

These multimedia artefacts are managed in a community repository together with community relevant information while all the metadata is stored in an MPEG-7 compliant repository to ensure interoperability and scalability of the community engine with other information systems. ATLAS components use both repositories. On the database/repository level we use and develop further scalable state-of-the-art database technologies for the management of mass data and metadata in community systems. On the middleware level we realize scalable community hosting services

like single-login, variable and fine-granular access control, mobility support, multimedia management, multimedia annotation, interoperable search and retrieval, matching, data/text/media mining etc. Metadata described by metadata standards serves as the vocabulary of transcribed multimedia artefacts. Part 5 of the MPEG-7 metadata description standard (ISO 2003) provides advanced multimedia description schemes to describe and manage multimedia artefacts and collections. Hence, using MPEG-7 to capture knowledge allows community members to browse multimedia artefacts, multimedia collections and hypermedia graphs in order to express the semantic and episodic relations between objects. MPEG-7 can be extended for arbitrary purposes through the data definition language XML Schema (Brown *et al.* 2001).

ATLAS has been successfully implemented within the PROLEARN Network of Excellence (www.prolearn-project.org) an EU 6th ICT Framework Programme in Professional Learning focussing on technology enhanced professional learning. Our approach is heavily influenced by the results from the work package about personalized, adaptive learning (Spaniol *et al.* 2003).

### 4.2. Data and system interoperability

Interoperability can be enhanced by specifications such as interoperable GIS standards promoted by the Open Geospatial Consortium (OGC). The eminent multimedia metadata standards include MPEG-7 (Kosch 2003) and MPEG-21 (Bormans and Hill 2002). In addition, metadata for cultural information and for cultural objects such as historic buildings, archaeological sites and museum objects appropriately are e.g. CIDOC[3] and MIDAS Heritage (FISH 2003). With a crosswalk among the standards, the condition, description and other characteristics of heritage sites can be easily converted to another metadata standard, making use of advanced XML mapping functionalities (Hunter 2002).

## 5. Community Information System for Afghan Monuments and Sites (ACIS)

Within the UNESCO/ICOMOS activities in Afghanistan we have addressed the above topics with a series of approaches in order to examine the outreach and impact of IT technologies in these regions. The system was primarily designed to register and collect dispersed information on the cultural and historic sites of Afghanistan. Based on an analysis of requirements the system developed to address users from four different angles: the government and administration sector such as the Ministry of Information, Culture and Tourism of Afghanistan, the research sector and academics in different countries, the preservation sector such as engineers and planners in the field of cultural heritage conservation and the general interested public domain. In the following section the main components of the system are presented and discussed.

### 5.1. Hosting factual knowledge – Geospatial Information System

Geographic information systems are the platform to allow the user to analyze and explore data. Maps play an important role in a Geographic Information System (GIS) because they are a sort of graphical user interfaces that allow the user to explore data with a geospatial dimension (Kraak 2003). Textual information alone cannot represent the spatial information properly and efficiently. Thus, a Geographic Information System supported by cartography and spatial queries compose the main ACIS concepts. The system was initiated by ICOMOS as a capacity building initiative to set up a list of registered historic monuments and archaeological sites for the national inventory list of Afghanistan (Klamma *et al.* 2005; 2006).

The database model allows a very flexible inclusion on various pieces of information such as:

- Basic Information: Village/settlement, House no., Coordinates, House name, Function, Inhabited/Abandoned, Type, Access, Owner
- Site Characteristics: Description, Description of context, Component/Material (Wall, Surfaces int./ext., Roof, Doors/Windows, Decoration), Condition
- History: Original function, Date of construction, Transformations, Anecdotal accounts, Published accounts, Previous surveys
- Relevance: Historical, Urban, Architectural, Technical
- Photo Documentation: Film, Photo no., sketch and photo position plan (Date, Surveyor,

[3] The CIDOC Conceptual Reference Model (CRM) has been adopted as ISO 21127:2006 see: http://cidoc.ics.forth.gr/

Settlement/village, Monument, and Film No.)

The accuracy of the geographic data associated to the entries ranges from reconnaissance level derived from literature to precise GPS readings for those sites visited within the training program. Within the UNESCO preservation project for the safeguarding of the cultural landscape of Bamiyan more than 40 historic monuments, archaeological sites and outstanding examples of vernacular architecture have been surveyed by Aachen Center for Documentation and Conservation of RWTH Aachen University in the summer of 2005, and precisely located on a map derived from Quickbird High-Resolution remote sensing imagery.

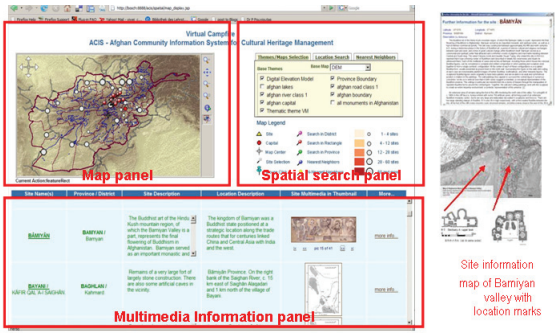


*Fig. 5. Left: the main user interface with spatial search and query result panel; right: detailed site information window with map of Bamiyan valley (site plans can be included and linked if available).*

## 5.2. Hosting the views from communities – www. bamiyan-development.org

A widespread Zope/Plone platform was used to establish a virtual community related to the development of Bamiyan in order to generate the community development.

The platform is used to disseminate UNESCO preservation goals and to provide information on development issues to a dispersed user community. Users contribute to the content by providing multi-media items that can be commented and put in relation to each other. The community interaction is carefully monitored, however, the exchange is limited to the creation of Hyperlinks and commenting functions.

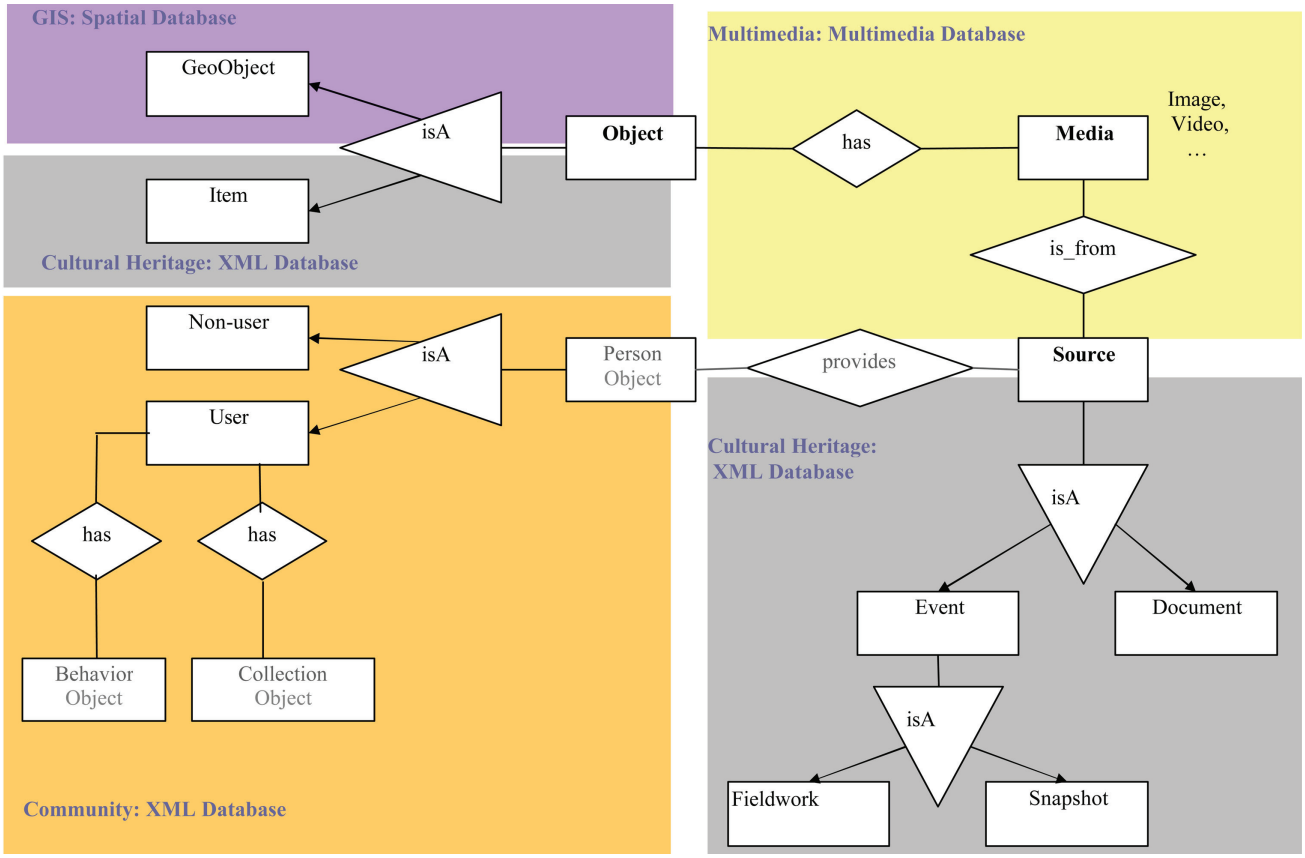


*Fig. 6. Three kinds of database technologies are applied: spatial database, XML database and multimedia database.*

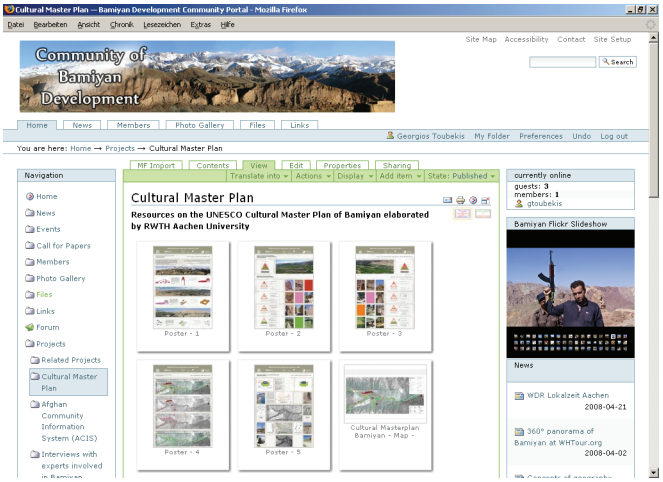


*Fig. 7. Zope/Plone – Community Website Portal for Bamiyan.*

### 5.3. Hosting semantic knowledge – cross-media semantic tagging with MPEG-7 LAS services

However, the semantics of the multimedia contents in community communication and collaboration is hard to capture and complex to compute. Observations from other research prototypes have shown that participation is fostered by allowing a free association of terms to be added to the content descriptions. This was deployed successfully by a web-based high-level annotation tool for arbitrary images using a Lightweight Application Server for MPEG-7 Services (LAS) for server side computations within the ATLAS architecture. LAS is a platform independent Java implementation of a lightweight middleware platform for service oriented architectures (SOA) developed at the Chair of Computer Science 5 for the purpose of providing network services which can be shared among various tools supporting the work of communities in practice (Spaniol *et al.* 2006). The MPEG-7 Services provided in LAS are used in order to support collaboration in communities by the exchange of multimedia contents and their low- and high-level semantic descriptions. In their conceptualization, LAS-MPEG-7 Services try to bridge the gap between "folksonomy-style" high-level semantic information about multimedia and purely technical low-level content descriptions provided e.g. by the Dublin Core standard.

The tool supports two types of tagging: keyword tags and semantic tags which are assigned to multimedia content descriptions in specific community contexts. Keyword tagging enables users to assign a set of plain keywords to an image, as it can be done in Flickr. Semantic tagging goes a step further by allowing users to define semantic entities and to assign semantic entity references to an image. These are more expressive than plain keywords, because they carry additional semantics. For example one could not derive from a plain text keyword "Buddha", that it describes a person, while for semantic tagging, "Buddha" has been modelled as a semantic entity of type agent. For validation of the

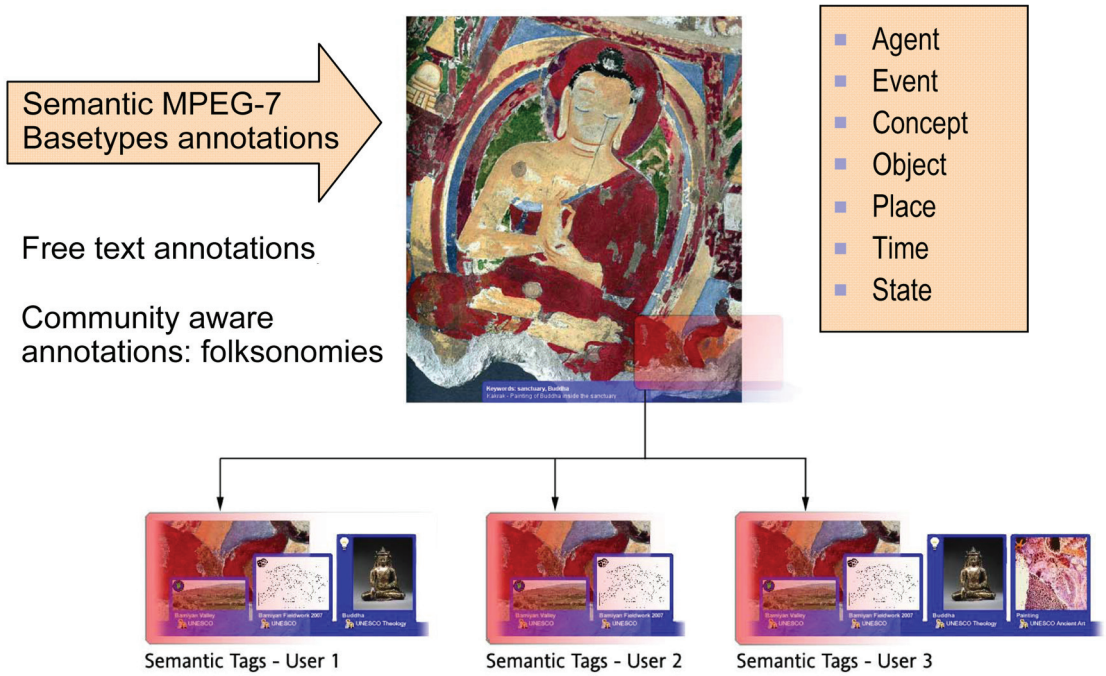


*Fig. 8. Multi-user view of MPEG-7 annotation tool for images and videos.*

concept the service is successfully implemented for the six so called semantic base types (*Agent, Object, Time, Place, Event and Concept*).

It reflects community awareness depending on the context where a user is currently involved in terms of tag visibility. If a semantic tag has been added in a specific community context and the viewing user is member of this community, the semantic tag is rendered as a thumbnail being part of a multimedia information overlay. Otherwise the tag is invisible to the user. In order to demonstrate community dependent tag visibility on the client side, *Fig. 8* shows three different user views on the same image depending on the users' individual community memberships in M7MT. The previously introduced theoretical approach of chapter 2.2 has been mapped to one possible real world scenario of the Bamiyan-Development community and its sub-communities tagging a picture of a Buddha fresco in Bamiyan Valley, Afghanistan during a fieldwork. The lower part of *Fig. 8* shows the semantic tag thumbnails collection for each of the different user u1, u2 and u3.

As a result structured XML documents can be derived, which are also able to comprise the various content description formats such as Dublin Core and in the future CIDOC-CRM enriched by community derived content annotation.

## 6. Conclusion and future work – The Virtual Campfire project

Future research will focus on open questions in the area of mobile community information systems. Within the newly established UMIC (Ultra High-Speed Mobile Information and Communication) Cluster of Excellence of the German Research Foundation mobile application scenarios in the field of cultural heritage management will be further analysed and investigated in the Virtual Campfire project. Special focus will be given to elaborate the generation and dissemination of episodic knowledge by means of non-linear storytelling as well as interoperability through metadata and physical device domains in interaction with new the generation of mobile devices. In particular, the MPEG-7 compliant multimedia services for semantic multimedia tagging will be assessed in a media integrated storytelling approach to support learning from digital stories in communities of practise. Virtual Campfire will provide a set of services enabling communities to produce images, audios and videos by mobile devices with the relevant location information based on the platform independent LAS framework.

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## References

Brown, Allen, Matthew Fuchs, Jonathan Robie and Philip Wadler (2001). *XML Schema: Formal Description. Technical report*, W3C working Draft. http://www.w3.org/TR/2001/WD-xmlschema-formal-20010925.

Brown, John Seely and Paul Duguid (2000). *The Social Life of Information*. Harvard Business Press.

FISH - (2003). *MIDAS: A manual and Data Standard for Monument Invetories*. Forum for Information Standards in Heritage. http://www.english-heritage.org.uk/Filestore/nmr/standards/ Midas3rdReprint.pdf

Hunter, Jane (2002). Combining the CIDOC CRM and MPEG-7 to describe multimedia in museums. In: David Bearman and Jennifer Trant (eds.) *Museums and the Web 2002, Selected Papers from an international conference*. Pittsburgh: Archives & Museum Informatics.

ICOMOS (2006). Afghanistan: ICOMOS Actions in Afghanistan. In: John Truscot, Michael Petzet and John Ziesemer (eds.) *Heritage at Risk 2004/2005*, K.G. Saur, 26–31.

Jäger, Ludwig (2002). Transkriptivität - Zur medialen Logik der kulturellen Semantik. In: Ludwig Jäger and Georg Stanitzek (eds.) *Transkribieren - Medien/Lektüre*. München:Fink, 19–41.

Jan Bormans and Keith Hill (2002). *MPEG-21 Overview v.5, ISO/IEC JTC1/SC29/WG11/*

*N5231*. http://mpeg.chiariglione.org/standards/mpeg-21/mpeg-21.htm

Jarke, Matthias and Ralf Klamma (2005). Transkriptivität als informatisches Designprinzip. Mediale Spuren in rechnergestützten Entwicklungsprozessen. In: Gisela Fehrmann, Erika Linz and Cornelia Epping-Jäger (eds.) *Spuren, Lektüren: Praktiken des Symbolischen*. München: Fink, 105–120.

Klamma, Ralf, Marc Spaniol, Matthias Jarke, Yiwei Cao, Michael Jansen and Georgios Toubekis (2005). ACIS: Intergenerational Community Learning Supported by a Hypermedia Sites and Monuments Database. In: Peter Goodyear, Demetrios Sampson and David. J.-T. (eds.) *Proceedings of the 5th International Conference on Advanced Learning Technologies (ICALT 2005), July 5–8, Kaohsiung, Taiwan*, Los Alamitos, CA: IEEE Computer Society, 108–112.

Klamma, Ralf, Marc Spaniol, Matthias Jarke, Yiwei Cao, Michael Jansen and Georgios Toubekis (2006). A Hypermedia Afghan Sites and Monuments Database. In: Emmanuel Stefanakis, Michael Peterson, Costas Armenakis and Vasilis Delis (eds.) *Geographic Hypermedia: Concepts and Systems*. Berlin: Springer, 189–209.

Kosch, Harald (2003). *Distributed Multimedia Database Technologies Supported by MPEG-7 and MPEG-21*. Boca Raton, FL: CRC Press.

Lave, Jean and Etienne Wenger (1991). *Situated Learning: Legitimate Peripheral Participation*. Cambridge: Cambridge University Press.

Manovich, Lev (2001). *The Language of New Media*. Cambridge, MA: MIT Press.

ISO - (2003). *Information technology – Multimedia content description interface – Part 5: Multimedia description schemes [MPEG-7], ISO/IEC 15938-5:2003*. International Organization for Standardization.

Preece, Jenny (2000). *Online Communities: Designing Usability, Supporting Sociability*. John Wiley and Sons.

Spaniol, Marc, Ralf Klamma, Holger Janssen and Dominik Renzel (2006). LAS: A Lightweight Application Server for MPEG-7 Services in Community Engines. In: K. Tochtermann and H. Maurer (eds.) *Proceedings of I-KNOW '06, 6th International Conference on Knowledge Management, Graz, Austria, September 6–8, 2006*, Graz: Springer, 592–599.

Spaniol, Marc, Ralf Klamma and Matthias Jarke (2003). ATLAS: A Web-Based Software Architecture for Multimedia E-learning Environments in Virtual Communities. In: Wanlei Zhou, Paul Nicholson, Brian J. Corbitt, Joseph Fong (eds.) *Advances in Web-Based Learning - Proceedings of the 2nd International Conference on* web-based learning (ICWL 2003), Berlin: Springer, 193-205.

Wenger, Etienne (1998). *Communities of Practice: Learning, Meaning, and Identity*. Cambridge, UK: Cambridge University Press.