The construction of a Spatial Data Infrastructure for cultural heritage

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The construction of a Spatial Data Infrastructure for cultural heritage

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Abstract: This paper describes the setup of a thematic Spatial Data Infrastructure (SDI) for cultural heritage data. Unlocking this data using OGC web services like the Web Feature Service (WFS) and the Web Map Service (WMS) creates a variety of possibilities. It allows to embed interactive maps in touristic web applications and to use the data in management or analyses tools. To implement such a SDI in different European cities, the SDI must be able to adapt to local legislation and customs. Different data sources can be added to the SDI depending on local available data sets. The implementation of the SDI in 3 case study cities illustrates the challenges that this SDI has to face.

1. Introduction

The main objective of the ISAAC project is to valorise the relationship between digital heritage and cultural tourism by developing a novel user-centric ICT environment providing tourism E-services that will meet the needs of both tourists and citizens in European cultural destinations through facilitating a virtual access and stimulating learning experience of European cultural heritage assets before, during and after a real visit. The SDI for the ISAAC project is a re-usable web mapping and spatial data delivery service that, because of its nature, can be used in both touristic e-platforms and for management and research task. Most SDI's are not bounded to thematic data, like the ISAAC SDI is set up for cultural heritage data only.

2. Objectives

This paper describes the development of a spatial data infrastructure (SDI) that will be a backbone for E-services providing spatial cultural heritage information to tourists, citizens and other users. This SDI is based on the specific requirements of the ISAAC project, but also looks at a wider context of revealing spatial cultural heritage data to researchers, policy makers and the general public. Therefore the ISAAC specific needs are discussed, as well as the conflict of these needs with the general concept of SDI's, and possible solutions for a practical implementation of a sustainable ISAAC SDI.

3. Methodology

3.1 The three components of a SDI

The three components of a SDI are data, technology and organisation. A very important SDI "best practice" regarding data is the concept of distributed databases. This means that data is stored at its original location in its native format. This prevents data duplication and the need for extra procedures regarding data management and updates. Concerning the technology component, the use of OpenGeospatial Consortioum (OGC [1]) standards is applied to make the ISAAC SDI an open infrastructure. These 2 agreements are the fundament of the data, technology and organisation components.

3.2 SDI Technology

The OGC standards for the exchange of spatial data can operate different kind of spatial data requests. First, the Web Map Service (WMS) can deliver rendered maps based on the underlying spatial data. These maps are interactive, and can be queried by the user. The Web Feature Service (WFS) can deliver the spatial data itself. This is useful when the user has his own application to process spatial data, like a Geographic Information System (GIS). Data delivery is done using the Geography Markup Language (GML).
The Geography Markup Language (GML) is an OGC creation (filed as ISO 19136) to describe geographical features in general, intended as an open interchange format for geographic transactions on the Internet. Unlike more narrow-purposed vector languages, GML has a grammar that allows for the inclusion of geographic features, coverages, observations, topology, geometry, coordinate reference systems, units of measure, time, and value objects.

Since GML is an upwards compliant sub variant grammar of the general eXtensible Markup Language (XML) it is highly accessible for E-service developers. It is simple to parse, filter and/or transform using generic XML technologies. Besides GML is able to contain, within a single document, all data and metadata about layers, projections, features, attributes and groupings that may be returned by a feature data request. For this all to be wrapped into a single document is ideal for transport of such data over the Internet, where the communication protocols are document based, and the request-response mechanism is limited to returning a single document for each request. In addition, having been an official OGC standard for a number of years has created a third important advantage for the use of GML as an interchange format, which is that its status as official standard has encouraged every major GIS software company to support this format. GML is nowadays a format which is widely supported as an interchange format by a large array of GIS tools and applications.

One disadvantage of GML is the filesize. For large datasets, the filesize can slow down the communication speed between server and client. In most cases where communication speed is of importance, the client will access the WMS service that returns an instant map image and not the WFS service that returns the spatial data itself as GML. In cases where GML is needed, large datasets are requested and speed is important the use of BXML [2] can be considered.

3.3 SDI data

All data in the SDI is spatial data, meaning that they have a location on the earth surface. Spatial data can be stored in different data models. The vector data model describes features as points, lines and polygons, the raster model as images. The data storage format that can be used depends on the capability of the web mapping application and will not be discussed here. Metadata should be part of the datasets.

3.4 SDI organisation

One of the challenges of the ISAAC SDI is in the organisational component. The three case study cities have a different cultural and legal background in which they operate. These differences in organisation have an impact on the current arrangement of the ISAAC SDI. One of the trends is the incorporation of SDI in the common information infrastructure[3]. This trend could contribute to the integration of SDI in organisations.

4. Technology Description

4.1 Implementation of the ISAAC SDI

At one hand we have the SDI principles, at the other hand the 3 cities with existing ICT infrastructure and fixed internal procedures. The ISAAC SDI has to fit within these existing frameworks, and at the same time remain open, therefore based on accepted standards. The consequences of these considerations have different impact on the implementation of the SDI for each of the case studies. As a consequence, the ISAAC SDI is tailor made for each of the cities. Sometimes the accessibility of data is an issue, sometimes the SDI has to co-exist with existing applications. When lack of data makes a successful implementation of the ISAAC SDI difficult, free data sources like Google Maps or free and open data sources like OpenStreetMap [4] available under de creative commons license [5] can provide a solution. The SDI can also act as a client of other SDI's and deliver spatial data from an other SDI as if it this data was part of the ISAAC SDI. The ISAAC SDI contains 2 examples of this concept, as can be seen in table 2.

The ISAAC SDI is being implemented using WMS and WFS services. The implementation shows cases of general application, and city-specific implementations of SDI principles. The software used for the setup of the SDI (UMN MapServer [6] and OpenLayers [7]) was installed on a central location. As more data comes available from the participating cities, the SDI will continue to grow. Tourism E-services will be built upon the SDI backbone by other parties. Since the SDI works with standard formats, communication between SDI and e-services is not complicated to accomplish. Samples of the implementation of the ISAAC SDI are available on www.spinlab.vu.nl/isaac.

4.2 Technology availability

Since not all cities had a WFS and a WMS service available (see table 1), these services were set up on a central location. For the sustainability of the ISAAC SDI the cities should set up their own SDI node.

Table 1: Available Technology

City	WFS/WMS
Leipzig	Not available yet
Amsterdam	WFS & WMS
Genoa	Unknown

4.3 Data availability

For each city, at least 2 datasets are available. Most of them are stored locally, some of them are distributed datasets and served as WMS or WFS layers (see table 2). There is not a compulsory data model, since the WMS and WFS services can handle different data formats.

Data items can be labelled using the ISAAC nomenclature to allow standardised search functions. This labelling is not mandatory for the functioning of the SDI, but useful for services on top of the SDI. The labelling of data items is the task of the data provider, in this case the municipalities.

Table 2: Available data

Leipzig	**dataset**	**Storage location**
Points of interest	Photo locations	Local, with links to e.g flickr.com
background	OpenStreetMap	local
	Aerial pictures Landesvermessungamt Sachsen	WMS
Amsterdam	**dataset**	**type**
Points of interest	monuments	Local
background	Topographic map	WFS/WMS
Genoa	**dataset**	**type**
Points of interest	Points of interest	Local
background	Topographic map	local

4.4 Organisational Issues

The organisation of the three case study cities is different in cultural and legal aspects. These aspects can slow down or even hinder the implementation of the SDI in several ways. This can be because of the distribution of tasks and responsibilities within the organisation, or legal directives on for example the use of data. The ISAAC SDI was installed on a central location as a showcase, to avoid organisational issues. Since the final goal is a sustainable SDI, all nodes on the infrastructure should be independent. Therefore the cities should, in time, implement their own WMS and WFS services.

5. Results

The WMS is a re-usable Web2.0 service that can deliver rendered maps (see figure 1) to the ISAAC platform or any other client: from desktop to palmtop or mobile phone. The potential of displaying maps on mobile devices is one step to the realisation of *the literate traveller*[8] or could be part of a Location Bases Service (LBS) [9]. Layers can be turned on and off, layers can be queried or contain dynamic links and the user can zoom and pan on the map.

The WFS service can deliver the spatial data behind the map to local or regional administrators that manage the city or region and to scientists that are interested in using the data in their GIS for further analyses. Relevant meta data is delivered on request.

Figure 1: Example of a rendered map

6. Conclusions

Implementation of the ISAAC SDI so far has proved to be able to solve data accessibility and data availability issues and that the SDI can co-exist with already existing applications.

At this moment, the ISAAC SDI is meant as a backbone of the ICT framework of the ISAAC project, and the cities of Amsterdam, Genoa and Leipzig are case study cities. In future, the use of the ISAAC SDI is not limited to these cities, and also non-urban cultural heritage can be included in this SDI. The purpose of the ISAAC SDI is to be a European framework for the exchange of spatial cultural heritage data, for both tourism, policy making and research.

The implementation of the SDI for the 3 case studies has proved that the differences in data availability, technological capacities and organisation have impact on the arrangement of the SDI. Due to the flexibility of the SDI concept it was possible to create a custom made solution for each city.

However, the quality of the data, including the semantics, relevant selections and language issues, remains the responsibility of the individual cities.

A future challenge is the further implementation of the concept of distributed databases, and the set up of individual nodes in stead of a central location for the SDI services.

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