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ATHENA

Guidelines for Geographic Location Description

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[1] OJ L 79, 24.3.2005, p. 1.

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EXECUTIVE SUMMARY

Guidelines for Geographic Location Description

It is just a matter of time when we would realise that merely browsing by “word“ or searching for a combination of words will not be enough for efficient object discovery in increasingly larger pool of objects in cultural collections of Europeana portal. Collections momentarily consist of tens of millions of object but soon expected to be counted in several hundreds of millions. The efficient search engine could not be imagined without consideration of **spatial and time dimension** of objects, their historical and cultural context.

We consider **geographic location** as one of the most important aspects of information which pertains to every cultural heritage item. Examples include provenience, current institution, location of event, etc. Therefore the formalized location attribute (e.g. geocode, geographical coordinates) will significantly enhance the power of searching and visualizing the cultural content of Europeana and other cultural portals as well.

The aim of this ***Guidelines for Geographic Location Description*** is to provide basic information for geographic location description of digital cultural content, which could be used by museums, other cultural institutions, content holders, curators, and information engineers**.**

Guidelines begin with introduction to the concept, technology and tools of **geographic information systems (GIS)**.

GIS and other geographic description terms are described next to understand the concept and specifics of GIS technology and its connections with cultural heritage.

Fourth chapter answers the question do **meta data from ATHENA project** content providers that are describing digital cultural content contain geographic coordinates or standardized geographic names, so that geographic coordinates can be determined »automatically«.

Interoperability of geographic information which pertains to digital cultural content is in focus next. The chapter presents a framework for modeling geographic information about cultural heritage objects. It provides an overview of relevant standards. The accent is on **cross-relational aspects of standards** that could enable their connection in support for systematic implementation of geographic information in cultural heritage field.

Final chapter provides **advice to cultural institutions** on introducing geographical data. It explains how to begin with the process of enrichment for existing individual objects description as well as object collection descriptions. Concise guidance to possible immediate actions of cultural institutions is distilled in 10 quick thoughts and the curriculum for training in basic concepts of GIS is proposed. Seven types of GIS models are the core of the *Guidelines for Geographic Location Description*. They were developed with aim that museums, archives, libraries, audiovisual institutions and other data providers clearly understand what they should be working on and implement in the future. We prepared small sample database for each model and a prototype internet applications, performed simulation and discussion of issues pertaining to each model.

Videos demonstrating features of each **GIS model** are published as adds to this report at Athena website for users to view.

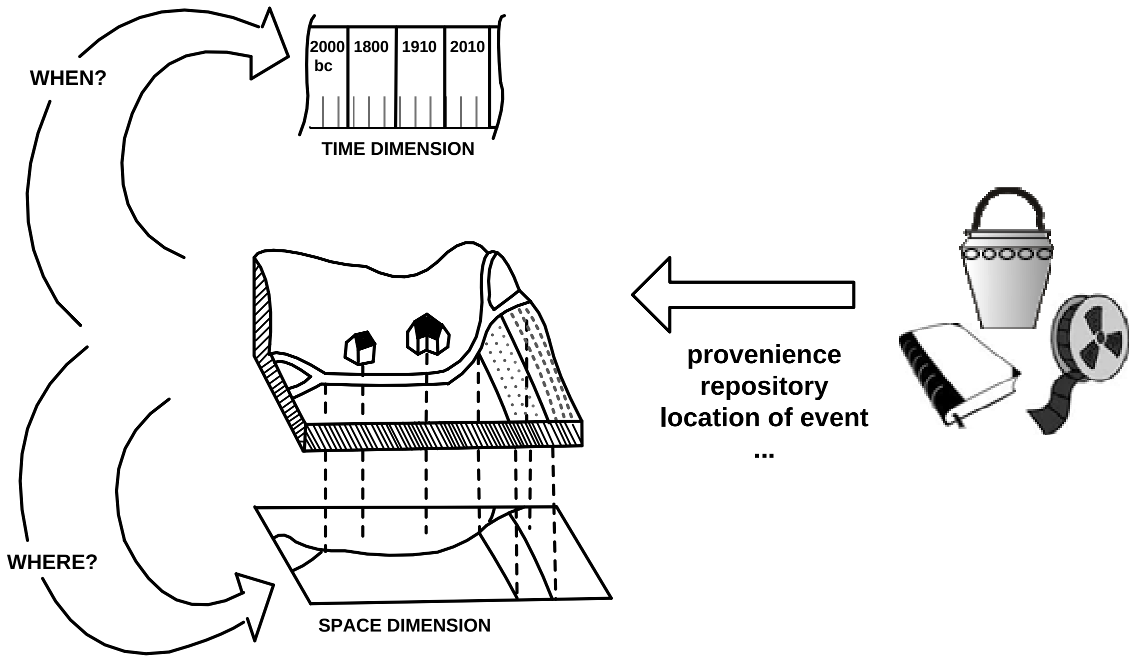
Several appendices are added at the end of this report which in detail presents recommended GIS resources and links, detail answers on using geographic names and coordinates by ATHENA project partners. Aspect of geographical information in standards relevant for different digital cultural contents is comprehensively explained and further elaboration of GIS models for digital cultural contents are presented.

1. PURPOSE OF GUIDELINES

It is just a matter of time when we would realise that merely browsing by “word“ or searching for a combination of words will not be enough for efficient object discovery in increasingly larger pool of objects in cultural collections of Europeana portal. Collections momentarily consist of tens of millions of object but soon expected to be counted in several hundreds of milions. The efficient search engine could not be imagined without consideration of **spatial and time dimension** of objects, their historical and cultural context.

We consider **geographic location** as one of the most important aspects of information which pertains to every cultural heritage item. Examples include provenience, current institution, location of event, etc. Therefore the formalized location attribute (e.g. geocode, geographical coordinates) will significantly enhance the power of searching and visualizing the cultural content of Europeana and other cultural portals as well.

Scheme: Mapping of Real World Entities into Spatial and Time Dimension



Regarding this, the **added value** of inclusion of geographic location in Europeana consist of:

- browsing Europeana efficiently through space and time;
- searching the content more user friendly, without need to type geographical names;
- making possible discovery of overlapping cultural content on the same location but originating from different sources and different times;
- mapping and visualizing the cultural content;
- performing GIS calculations and simulations.

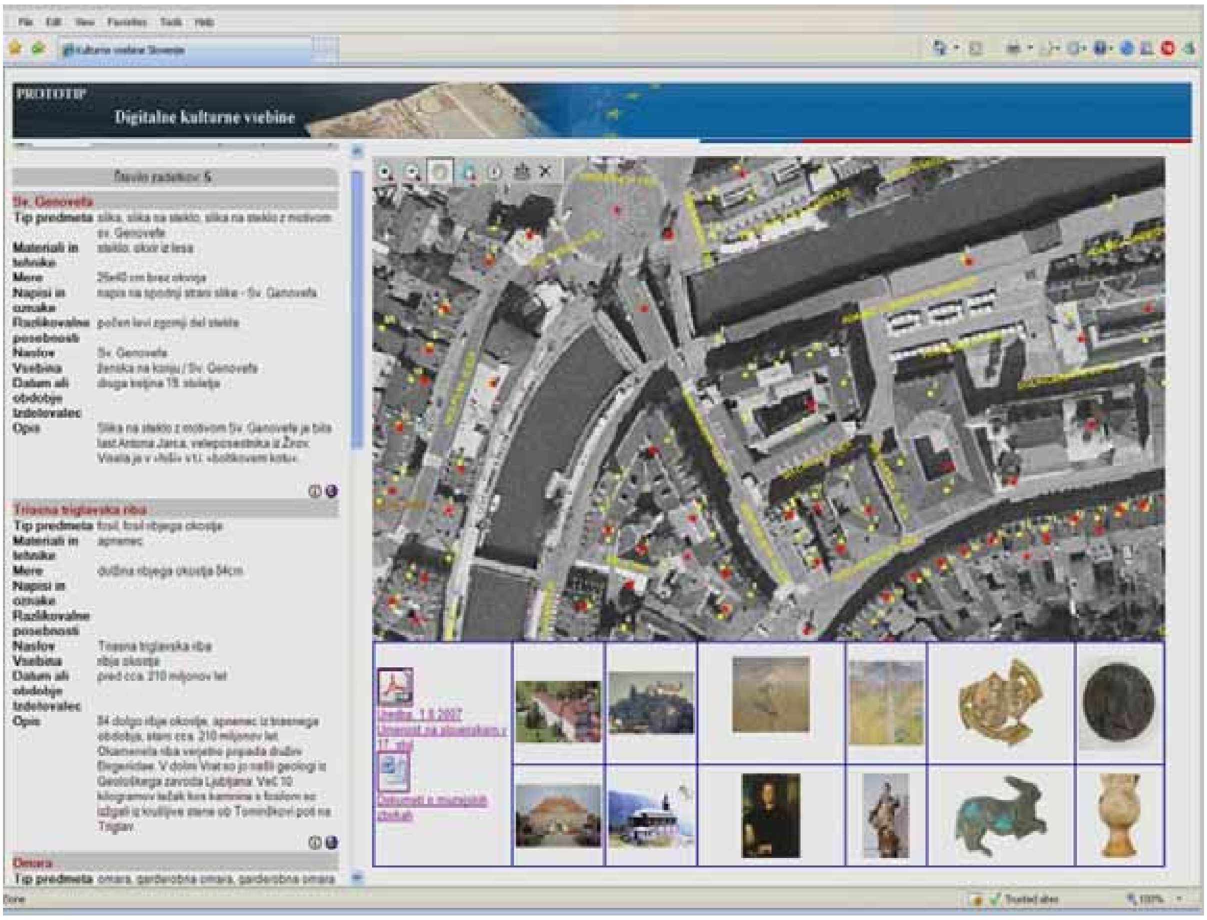
The aim of these Guidelines for Geographic Location Description is to provide basic information for geographic location description of digital cultural content, which could be used by museums, other cultural institutions, content holders, curators, and information engineers**.** The following questions are in focus:

- how to meet cultural documentation standards with the requirements of geographic information standards (ISO, OpenGIS, ...);
- how to create the appropriate structure of geographic model for cultural content;
- how to automatically encode geographic data of the cultural content;
- how to exploit geographic information when using digital cultural content;
- how to take the advantages of the infrastructure for spatial information established by EU Inspire Directive.

The **discovery of the power and value of geographic information** for digital cultural content has already been done by several EU projects as Digmap and other projects as well.

For example one of the results of Minerva eC Project were »Technical Guidelines for Digital Cultural Content Creation Programmes Version 2.0: September 2008 The GIS (Geographic Information System)«. Their aim was to introduce GIS. GIS can be used to integrate, store, edit, manage and present data which are spatially referenced (i.e. linked to location). The data that may be integrated in a GIS include raster images (e.g. digitised historic maps), vector images (e.g. maps captured using drawing software or data captured in the field using electronic measuring instruments), text and numeric data (e.g. databases describing the attributes of a location). Geographic Information should be created and stored using nonproprietary and open data formats such as the OpenGIS Geography Markup Language (GML) and standards maintained by the Open Geospatial Consortium (OGC) and ISO. There are over 40 ISO standards which address a diverse range of functions. Use of proprietary data formats may be appropriate however projects should explore a migration strategy to open formats.

Scheme: Possible Portal of Digital Cultural Content Including Geographic Information System[1]



At this moment the current Europeana portal includes only classical search, browsing facets and object data without map view. The next significant step is planned to be realised at the end of this year. EuropeanaConnect as a EU funded project namely aims at extension of access modes to Europeana content by developing spatial and temporal interface which enables establishing a chronologial and geographical context for interaction with Europeana database. It will combine spatial and temporal metadata for visualisation and thus enrich user experience. The interactive and generic map of geo-related tagged events, places and characters in Europe combined with timeline will be result of these developments. In addition Europeana plans to extend its access possibilities by building user interface for mobile devices. When these plans would be realised they would mean significant improvement of Europeana services. Mobile devices would display information about cultural heritage objects in geographical context. Information would be integrated in mapping application besides other public and private services. In that way it would facilitate access to and awareness of cultural heritage.

[1] From video of simulation prepared for International Conference Culture OnLine, 5-7.6.2008, Brdo by Franc J. Zakrajsek: Digitalne kulturne vsebine v prostoru in času/Digital Cultural Content in Space and Time.

However new access modes may not produce the expected impact if they do not become as much familiar for uses and data providers as the classical text searching.This deliverable aims to contribute to this scope.

What are the purposes of these Guidelines?

- To raise awareness of GIS technologies potential in cultural sector;
- to make introduction to fundamental GIS concepts by explaining basic GIS terms to all readers thus furthering better understanding;
- to demonstrate benefits that can be achieved by inclusion of geographic information in process of creating digital cultural content;
- to offer basic recommendations and tools how to tackle possible bottlenecks in introducing GIS;
- to make strong suggestions to all Athena and Europeana content providers on ways how to enrich current content with appropriate geographic information in short but also long term.

However these Guidelines are not:

- research in development of new GIS methods;
- scientific in-depth theory or discussion of new methods in great detail;
- development of GIS software, adds-in, API-s;
- technical specifications of GIS portals and data bases;
- requirements for thesaurus or SKOS;
- or detail plan for GIS implementation in cultural institutions.

Therefore the **primary audience** of these Guidelines are content providers of Athena and other Europeana projects. They are also useful to curators, librarians and archivists who are considering introduction of application of GIS in their institutions and content. Besides these audiences Guidelines also target Europeana and other portals who are in the process of preparing strategies for wide GIS implementation.

2. INTRODUCTION TO GIS

The chapter introduces the concept, technology and tools of **geographic information systems**. Its thirty years history testify how astonishing technology became a complex system that integrates computer software, hardware, data, methods and personnel to help manipulate, analyse and present information that is tied to a spatial location. But how can this technology address the challenge of connecting the objects, persons and events with each other including past, present and future features by using geographic space? How can we strengthen the synergy of information on cultural heritage in this way?

2.1 CONCEPT OF GIS

A **geographic information system (GIS)** is a computer-based tool for mapping and analyzing things that exist and events that happen on earth. GIS technology integrates common database operations such as query and statistical analysis with the unique visualization and geographic analysis benefits offered by maps. These abilities distinguish GIS from other information systems and make it valuable to a wide range of public and private enterprises for explaining events, predicting outcomes, and planning strategies.

After 30 years of synthesis and development, there are still many **competing definitions of GIS**. However, most definitions identify a computerized database in which every "object" has a precise geographical location, together with software to perform functions of input, management, analysis, and output. An "object" in GIS terminology is the phenomena of interest as digitally represented in the database (i.e. an irregular samplings of points, a grid of regularly-spaced points or cells, a line, or a polygon). The database will also contain numerous attributes that also serve to distinguish one object from another, as well as information on the relationships between the objects. A GIS as a computer-based tool is used to help people transform geographic data into geographic information. The definition implies that GIS is somehow different from other information systems, and that geographic data are different from non-geographic data.

Many have characterized GIS as one of the most powerful of all information technologies because it focuses on integrating knowledge from multiple sources and creates a crosscutting environment for collaboration. It combines a powerful visualization environment with a strong analytic and modeling framework that is rooted in the science of geography. This combination has resulted in a technology that is science-based, trusted, and easily communicated across cultures, social classes, languages, and disciplines. To support this vision, a GIS needs to support several views for working with geographic information.

- **Database View**:
  GIS as a geodatabase is a structured database that describes the world in geographic terms. A GIS as a spatial database contains datasets that represent geographic information in terms of a generic GIS data model — features, rasters, attributes, topologies, networks, thematic layers and data sets, and so forth.

- **Map View**:
  GIS is also a method for geovisualization. It is a set of intelligent maps and other views that show features and feature relationships on the earth's surface. Various map views of the underlying geographic information can be constructed and used as

"windows into the geographic database" to support query, analysis, and editing of geographic information. Each GIS has a series of two-dimensional (2D) and three-dimensional (3D) map applications that provide rich tools for working with geographic information.

- **The Model View**:
  GIS is a tool for geoprocessing. As such it includes set of information transformation tools that derive new geographic information datasets from existing ones. These geoprocessing functions take information from existing datasets, apply analytic functions, and write results into new derived datasets. Geoprocessing involves the ability to program your work and to automate workflows by assembling an ordered sequence of operations.

Questions a GIS can answer

- Location: What is at a given location?
- Condition: Where does something occur?
- Trends: What has changed since ...?
- Patterns: What spatial patterns exist?
- Modeling: What if ...?

Scheme below provides examples of GIS Layering where different layers are added to basic map (e.g. streets, monuments, territoral units).

Schema: GIS layering

2.2 GIS TECHNOLOGY

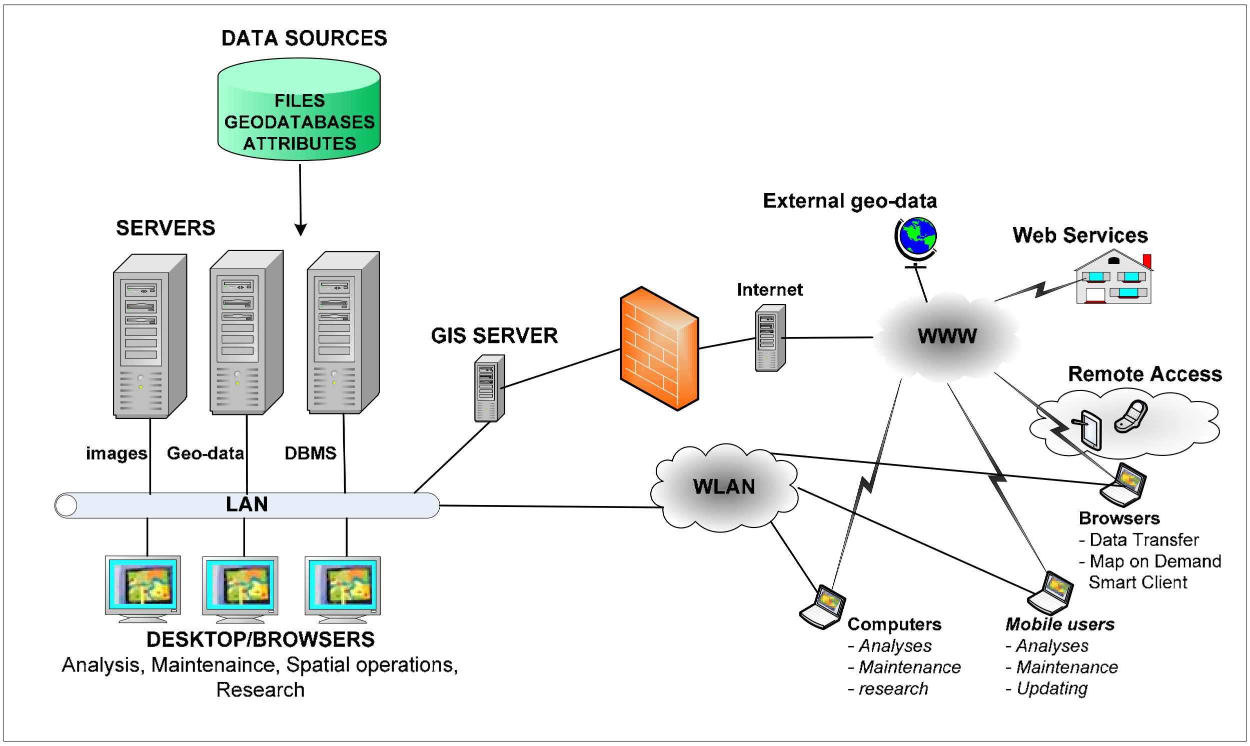
GIS is in technical terms a system which includes mapping software and its application to remote sensing, land surveying, aerial photography, mathematics, photogrammetric, geography, and tools that can be implemented with GIS software.

The term describes any **information system** that integrates stores, edits, analyzes, shares, and **displays geographic information**. In a more generic sense, GIS applications are tools that allow users to create interactive queries (user created searches), analyze spatial information, edit data, maps, and present the results of all these operations. GIS systems allow geographers to collate and analyze information far more readily than is possible with traditional research techniques.It is an **integrating technology** as it draws upon and extends techniques that geographers have long used to analyze natural and social systems.

In GIS as digital database a **common spatial coordinate system** is the primary mean of reference. It requires means for data input, storage, retrieval, and query, data transformation, analysis, and modeling and data reporting as maps reports, and plans.

GIS as database does no contain just a locational information as street addresses, but uses geo-references as the primary means of storing and accessing information. It integrates different technologies and as such can be viewed as a process rather than as merely software or hardware. The way in which data is entered, stored, and analyzed within a GIS must mirror the way information will be used for a specific purposes.

Scheme: GIS Architecture



2.3 GIS AS TOOL

Geographic information system **integrates computer software, hardware, data, methods and personnel** to help manipulate, analyse and present information that is tied to a spatial location.

- spatial location – usually a geographic location
- information – visualization of analysis of data
- system – linking software, hardware, data
- personnel – a thinking explorer who is key to the power of GIS

Computerized mapping and spatial analysis have been **developed simultaneously in several related fields**. The present status would not have been achieved without close interaction between various fields such as utility networks, cadastral mapping, topographic mapping, thematic cartography, surveying and photogrammetery remote sensing, image processing, computer science, rural and urban planning, earth science, and geography.

The effective use of large spatial data volumes is dependent upon the existence of efficient geographic handling and processing system to transform this data into usable information.

The GIS technology is used to assist decision-makers by indicating various alternatives in development and conservation planning and by modelling the potential outcomes of a series of scenarios. It should be noted that any task begins and ends with the real world. **Data are collected about the real world**. Out of necessity, the product is an abstraction; it is not possible but also not desired to handle every last detail. After the data are analysed, information is compiled for decision-makers. Based on this information, actions are taken and plans implemented in the real world.

GIS is an important technology to support databases, multimedia, internet and other information technology in the **field cultural heritage digitalization**. Here are some **examples of uses** of GIS technology for protecting, management, education and marketing of cultural heritage:

1. Location data for cultural objects in museums, archives and libraries:
   - provenience,
   - place of events,
   - place of acquiring, context, layer,
   - place of present location of object,
   - places connected with object, authors, organisations.

2. Location data for objects of immovable cultural heritage:
   - macro location (scale 1: 50000 and more): overview level
   - mezzo location (scale 1:5000): identification in nature level
   - micro location (scale 1:100 and less): detail level

3. Tool for evidencing, registration, documenting cultural heritage, antiques, geological and biological samples, archeological, ethnological objects and art.

4. Tool for analysing, evaluation (architectural, social, economic, art meaning), vulnerabilty, sensitivity and risk estimation, strategic use planning, conservation,

restavration, maintaining and monitoring state of art and use of immovable cultural heritage.

5. Legally valid GIS layer of protection areas is a basis for spatial plans procedures and building permission issuing.

6. Tool for archeological research, excavations, analyses and documenting as topological, network, geostatistical analyses and expert systems.

7. Two or three dimensional presentations of individual data and statistics of cultural heritage on static and historical maps (e.g. historical GIS)

8. Interactive web / local visualization, virtual reality, multimedia presentations in space and time, actors and events related to cultural heritage.

9. Measuring impacts on cultural heritage, searching optimal cultural routes, geocoding documents to follow in space and time, planning development of cultural tourism, mapping accessibility of museums, mapping routes exhibitions, ...

2.4 GIS HISTORY MILESTONES

Geographic Information System (GIS) is a computer based information system used to digitally represent and analyse the geographic features present on the Earth' surface and the events taking place on it (non-spatial attributes linked to the geography under study). In order to represent the meaning digitally one have to convert analog into a digital form. "Every object present on the Earth can be geo-referenced", is the fundamental keystone of associating any database to GIS. We use term 'database' as a collection of information about things and their relationship to each other, and 'geo-referencing' refers to the location of a layer or coverage in space defined by the co-ordinate referencing system.

Work on GIS began in **late 1950s**, but first GIS software was developed only in late 1970s from the lab of the ESRI. Canada was the pioneer in the development of GIS as a result of innovations dating back to early 1960s. Much of the credit for the early development of GIS goes to Roger Tomilson. Evolution of GIS has transformed and revolutionised the ways in which planners, engineers, managers etc. conduct the database management and analysis.

Mathematics, planar graphs, topology, surveying: Graph theory is the foundation for understanding networks and topology used in geographic information systems. This theory helps to classify and model connectivity and adjacency relationships among geographic features. When we abstract a geographic system to its underlying graph, we have at our disposition a useful model for understanding the connectivity of that system.

Tobler, W.: **Geocoding Theory**, **1972**: Tobler in this article refers to geocoding as place naming, and says there are two types of place names. First one is telling something about the place and second one such as coordinates, is describing the geographical relationships of the place. The first type requires reference to outside sources or to a map to infer situation, but a coordinate system makes the geographical relationships explicit. Geocoding generally moves from place names to a more explicit geocoding of relationships, and good geocoding systems should be able to translate data geocoded by place names to geocodes describing the relationships of places, such as hierarchial areal unit codes, or coordinates defining places as points, lines or areas.

Specialized use in cartography and spatial simulations, **1975**: Geocoding has undergone marked transitions to accommodate and exploit changes in both data format and user expectations. These transitions can clearly be seen in the input, output, and internal processing of the geocoding process. The input data suitable for geocoding have expanded from simple postal addresses to include textual descriptions of relative locations. The output capabilities of the geocoding process have moved from simple nominal geographic codes to full-fledged three-dimensional (3-D) geospatial entities. Likewise, the internal processing mechanisms that produced the geographic output have moved from simple feature assignment to complex interpolation algorithms using a variety of heterogeneous data sources.

Use in different fields, **1985**: Act of turning descriptive locational data such as a postal address or a named place into an absolute geographic reference has become a critical piece of the scientific workflow from year 1985. The process of geocoding forms a basic fundamental component of spatial analysis in a wide variety of research disciplines and application domains (e.g., health, crime analysis, political science, computer science).

Formalization and standarisation, **1995**: The growing use of GIS in the past decades is accompanied by intense efforts for standardisation of data structures and methods for the interchange of spatial data. Especially in interdisciplinary work the integration of data from different sources is a central requirement, which is only partially met by the current state-of-the-art GIS. Current standards try to enable lossless data interchange and communication between different systems, data producers and users. Those standards concentrate on a technical level of interoperability. However, when integrating data from different sources it is very common that there remains a high-level incompatibility that cannot directly be dissolved. The data might be incompatible due to differences in resolution, attribute coding and scales, resulting from varying collection purposes. In this paper we examine ways to help overcome such high-level incompatibilities and discuss possible corresponding standardisation attempts. Several types and sources of incompatibilities are discussed. Their removal is often based on prediction (in a general sense).

We can date really **wide use of GIS** from year **2000 on**. It is used in agriculture for a variety of applications. GIS is also used in business as a tool for managing business information of any kind according to where it's located. GIS is a common technique for planning and management of electric/gas utilities, risk management, water/wastewater industry, for environmental studies and management, forestry, geology and hydrology. GIS performs its essential function in land use planning and mapping as it is its most known application. We should also mention its usefulness in local government, in the military, site planning and in transportation.

The Global Positioning System (GPS), **2000**, is a burgeoning technology, which provides unequalled accuracy and flexibility of positioning for navigation, surveying and GIS data capture. By positioning we understand the determination of stationary or moving objects. These can be determined as in relation to a well-defined coordinate system, usually by three coordinate values and in relation to other point, taking one point as the origin of a local coordinate system. This technology is used by GIS for a development different navigation applications.

Google Earth, 2005, is a wide spread GIS application that allows user to view satellite imagery, maps, terrain, 3D buildings for the world. It enables to explore a geographical content, cultural places, tourism and others.

The INSPIRE Directive, 2007 established an infrastructure for spatial information in Europe to support Community environmental policies, and policies or activities which may have an impact on the environment. The Directive addresses 34 spatial data themes needed for environmental applications, with key components specified through technical implementing rules. This makes **INSPIRE a** unique example of a legislative “regional” approach. The INSPIRE directive aims to create a European Union (EU) spatial data infrastructure. This will enable the sharing of environmental spatial information among public sector organizations and better facilitate public access to spatial information across Europe.

Appendix 1: GIS Resources and Links provides further literature and hyperlinks on GIS Concept, Technology, use and its history.

3. BASIC TERMINOLOGY OF GIS

This chapter shortly describes basic **GIS and other geographic description terms**. Following definitions of basic terms are given to understand the concept and specifics of GIS technology and its connections with cultural heritage.

Co-ordinate
Co-ordinate is presented as x, y and possibly z-values which define a position in co-ordinate system. Examples of co-ordinated systems are system of latitude and longitude used on the Earth's surface or Cartesian system.

Digital OrthoPhoto
Digital Orthophotos combine the image characteristics of a photograph with the geometric qualities of a map. Unlike a standard aerial photograph, relief displacement in orthophotos has been removed so that ground features are displayed in their true ground position and accurately represent earth's surface. This enables direct measurement of distance, areas, angles, and positions.

Digital Topographic Map
Digital Topographic Map is a Topographic map in digital form for example as can be viewed at Google Maps web service.

Gazetteer
Gazetteer is a geographical dictionary or directory which contains information on places and place names and is meant to be used in conjunction with a map or atlas. It typically contains geographical profile of a country, region, or continent as well as the social statistics and physical features, such as mountains, waterways, or roads. For example gazetteers provide information on the location of places, dimensions of physical features, population, GDP, literacy rate, etc.

Geocoding
Geocoding is the process of determinig the geographic co-ordinates of a location by its address, postcode, or other explicitly non-geographic descriptor.

Geographic information
Geographic information is any data with direct or indirect reference to specific location or geographical area (ordinal, cardinal or nominal).

Geographic metadata
Geographic metadata are data about the content, quality, condition, and other characteristics of geospatial data.

Geographic thesaurus
Geographic thesaurus is a structured vocabualary of geographical names.

Geoontology
Geoontology enables addition of geographic geospatial semantic information to the Word Wide Web. It is a method of representing knowledge through a declarative formalism where geographic objects and phenomena have describable relationships between them - for example subclass, part of, above. Geoontology provides an organizational structure for

classifying data that can be discovered by computers using community-accepted vocabulary or science terms, taxonomic representation of classification schemes etc.

GeoParsing

Geoparsing is the process of assigning geographic co-ordinates to textual words and phrases in free texts for example "ten kilometers east of Rome" and also other media for example audio recordings. Geoparsed features can then be mapped and entered into GIS. It can be used to plot portions of content on map or to use map as filter in seaching for content. Geoparsing is capable of handling ambiguous references in unstructured content whereas geocoding relies on unambiguous structured location references.

GIS (Geographic Information System)

GIS is a system of hardware, software and procedures to facilitate the management, manipulation, analysis, modelling, representation and display of georeferenced data to solve complex problems regarding planning and management of resources (NCGIA, 1990).

GIS layer

GIS Layer is a usable subdivision of a data set, generally containing elements of a particular theme for example soils, road network, country polygons etc. The subdivisions are registered to a common co-ordinate system, which facilitate analysis and integration across the various themes.

GIS portal

GIS portal is web application that connects geospatial data producers and users by enabling producers of geospatial information resources to create and post metadata records (citations describing their information resources) and enabling users of geospatial information resources to search for and discover metadata records that cite the particular resources that will be helpful to them. GIS portal provide the means for users to preview and access geospatial information resources cited by the metadata records.

GIS standards

GIS Standards are internationally acknowledged requirements of quality or performance level for computing (software, hardware etc.), data collection and transformation (geodetic control, coordinate reference system etc), spatial data processing (functionality of GIS software, data models etc.), data presentation (cartographic presentation etc.), data management (metadata), exchange (format) and also personnel.

GML (Geography Markup Language)

Geography Markup Language is an XML grammar for expressing geographical features. GML is used for two purposes: as a modeling language for geographic systems and also as an open interchange format for geographic transactions on the Internet. Its grammar has two parts the schema that describes the document and the instance document that contains the actual data. A GML document is described using a GML Schema that enables users and developers to describe generic geographic data sets including points, lines and polygons.

Google Maps

Google Maps is a basic web mapping service application and technology provided by Google company. It provides also Google Maps API. It offers street maps, a route planner and business locator for numerous countries.

INSPIRE
INSPIRE stands for Directive 2007/2/EC of the European Parliament and of the Council of 14 March 2007 which came into force on 15 May 2007and was published in the official Journal on the 25th April 2007. It aims to create a European Union spatial data infrastructure and will enable the sharing of environmental spatial information among public sector organisations and better facilitate public access to spatial information across Europe. It is based on a set of common principles for data collection and maintenance, sharing, scalability etc.

Location
Location means either distinct place in the real world or position defined by a set of co-ordinates within a spatial database for example street number.

OpenGIS
OpenGIS is the brand name associated with the standards and documents produced by the Open Geospatial Consortium, Inc (OGC). OpenGIS standards are developed in process of consensus building between OGC members from industry, government and academic spheres with a purpose of establishing interoperability for geoprocessing technologies. OpenGIS is a registered trademark of the OGC.

Reverse geocoding
Reverse geocoding is the process of finding an address, toponym or an other type of resource for a given lattitude longitude pair.

Raster data
Raster data are one of the three types of spatial data in a GIS besides image and vector data. Geographic space is presented as a matrix of cells. Numeric values which are assigned to the cells determine map features. Cell data are arranged in a regular grid pattern in which each unit or cell in the grid is assigned an identifying value based on its characteristics. Examples of raster data are digital aerial photographs, imagery from satellites, digital pictures, scanned maps etc.

SKOS (Simple Knowledge Organization System)
Simple Knowledge Organization System is a common data model for knowledge organization systems such as thesauri, classification schemes, subject heading systems and taxonomies. SKOS enables expression of a knowledge organization system as machine readable data, its exchange between computer applications and publishing on the Web. It represent knowledge organization system as a concept scheme comprising a set of concepts that can be labeled with lexical strings and assigned notations. Concepts can be linked to other concepts by semantic relation properties and group into collections.

Topographic map
Topographic map depicts terrain relief showing ground elevation either by use of contour lines or spot elevations. It represents the horizontal and vertical positions of the features. As a graphic representation it delineates natural and man-made features of an area in a way that shows their relative positions and elevations.)

Vector data
Vector data are one of three types of spatial data in a GIS besides image and raster data. They are a co-ordinate based data structure generally used to represent map features. Each liner feature is represented as a list of ordered x and y coordinates. Oppose to raster data which

associates attributes with a grid cell vector data associate attributes with the feature. Vector data structures have three different types of elements: nodes as single sets of co-ordinates which define a point; lines as curvilinear strings of co-ordinates to define a curved line (e. g. road); and polygons as collections of lines which determine an area (e. g. city).

WMS (Web Map Service)
Web Map Service (WMS) is a standard protocol for serving georeferenced map images over the Internet that are generated by a map server using data from a GIS database. The specification was developed and first published by the Open Geospatial Consortium in 1999.

WFS (Web Feature Service)
Web Feature Service is a standard protocol for serving vector data encoded in Geography Markup Language (GML) to client from multiple servers.

4. GEOGRAPHIC LOCATION ASPECT IN ATHENA PROJECT CONTENT

Do meta data describing digital cultural content contain geographic coordinates or standardized geographic names, so that geographic coordinates can be determinated »automatically«? This chapter presents the answers to this questions concerning Athena project content. The source of this analysis is theATHENA-WP3 Standards Survey which gathered the information on the collections that ATHENA project partners are going to provide to Europeana.

4.1 GEOGRAPHIC NAME TERMINOLOGY AND CO-ORDINATE STANDARDS

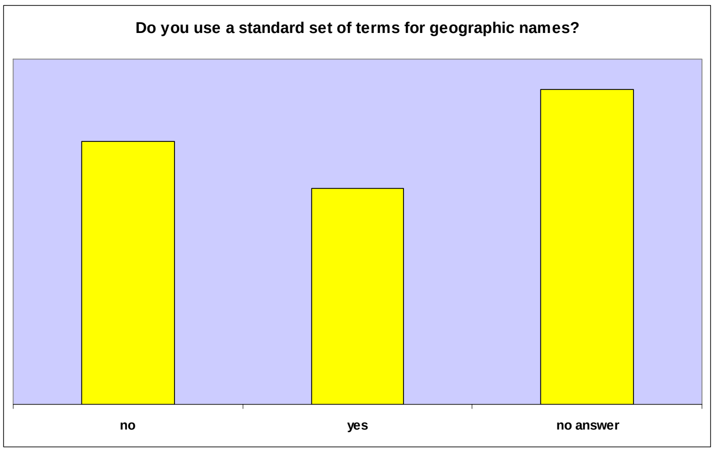
Answers (n=184) reveals that only 27,2% partners **use standard set of terms for geographic names**. Further only 4,9% of partners are using geographic co-ordinates to describe their collection. 39,7% partners did not answer regarding the use a standard set of terms for geographic names and 40,8% regarding the use of geographic co-ordinates to describe this collection.

Do you use a standard set of terms for geographic names?

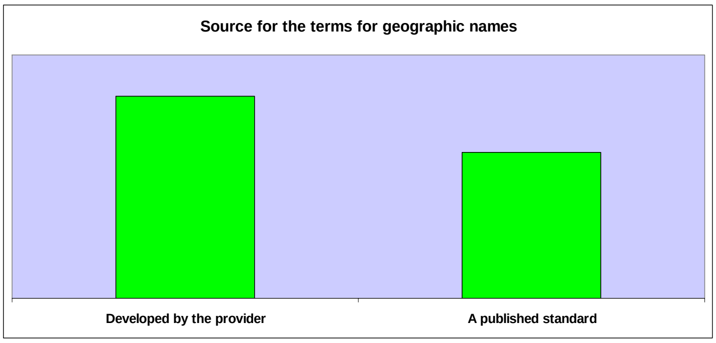
yes	no	No answer
27,17%	33,15%	39,68%

Are the geographic co-ordinates used to describe this collection?

yes	no	No answer
4,9%	54,3%	40,8%



The survey bring out interesting data about standards in use. ATHENA Partners are using already published **standards** or they developed the standard set of terms for geographic location.



Belgium (6 museums, 2 archives, 2 aggregators)

- ISO list of short country names (English)
- Getty Thesaurus of Geographic Names (TGN): http://www.getty.edu/research/conducting_research/vocabularies/tgn/

Finland (3 museums)

- YSA - General Finnish Thesaurus: http://www.yso.fi/onto/ysa/ysa_juuri
- Tampereen virastokartta (Tampere city official map) Published by Tampereen yhdyskuntatuotanto, 1/2007

France (2 aggregators)

- INSEE: http://www.insee.fr/fr/methodes/nomenclatures/cog/
- Getty Thesaurus of Geographic Names (TGN) [only for archaeology collections]: http://www.getty.edu/research/conducting_research/vocabularies/tgn/
- Dictionary "Petit Robert".

Germany (1 museum)

- German National Library. Subject headings (Schlagwortnormdatei, SWD; licensed, not public)
- National Statistical Bureau. List of municipalities (Gemeindeverzeichnis; licensed, not public)
- Getty Thesaurus of Geographic Names (TGN) [licensed but not in use]: http://www.getty.edu/research/conducting_research/vocabularies/tgn/

Greece (5 museums, 4 archives, 1 aggregator, 9 other)

- Getty Thesaurus of Geographic Names (TGN): http://www.getty.edu/research/conducting_research/vocabularies/tgn/

Italy (5 museums, 3 archives, 1 aggregators, libraries 3, other 4)

- Indirizzario di Pompei, from: L. Esherbach, Gebäudeverzeichnis und Stadtplan der antiken Stadt Pompeji, Köln, 1993

Poland (1 museum, 1 other)

- http://www.nukat.edu.pl/nukat/pl/kaba.phtml?dl=2&id=88&etykieta=151

Slovenia (1 museum)

- Country Code: ISO 2-letter code (As a thesaurus for localities is used ATLAS SLOVENIJE, 4th edition (2005) - Mladinska knjiga, Ljubljana.

Sweden (1 museum)

- SCB (Swedish standard geographical names)
- National Board of Antiquities Geographical Names

United Kingdom (5 museums)

- Getty Thesaurus of Geographic Names (TGN) [for reference]: http://www.getty.edu/research/conducting_research/vocabularies/tgn/

Museums, archives, aggregators, libraries and other use standards that are developed by providers or are internationally acknowledged standards for geographic location terms.

4.2. USING GEOGRAPHIC CO-ORDINATES STANDARDS TO DESCRIBE THEIRCOLLECTIONS

Seven institutions are using **geographic co-ordinates standards** to describe their collection. Two institutions are said they were going to use them in the future. Partners use:

- EPSG:3004
- Gauss Boaga
- latitude/longitude
- Country, X,Y, Z, UTM, location/place
- Lambert 2 extended
- Lambert 97

Standards cited above are used in museums and by Historic environment agency in Slovenia, Sweden and United Kingdom.

4.3 SURVEY RESULTS

Survey results reveals that ATHENA project partners rarely use the standard set of terms for geographic names. Only few collections contain geocodes. They do not exploit the opportunities that spatial information may offer for provenience, location, production place or any other aspect of information for cultural objects. Situation is somewhat better with regard to archeological sites and objects but still not satisfying. Similar situation is observed in Europeana Network.

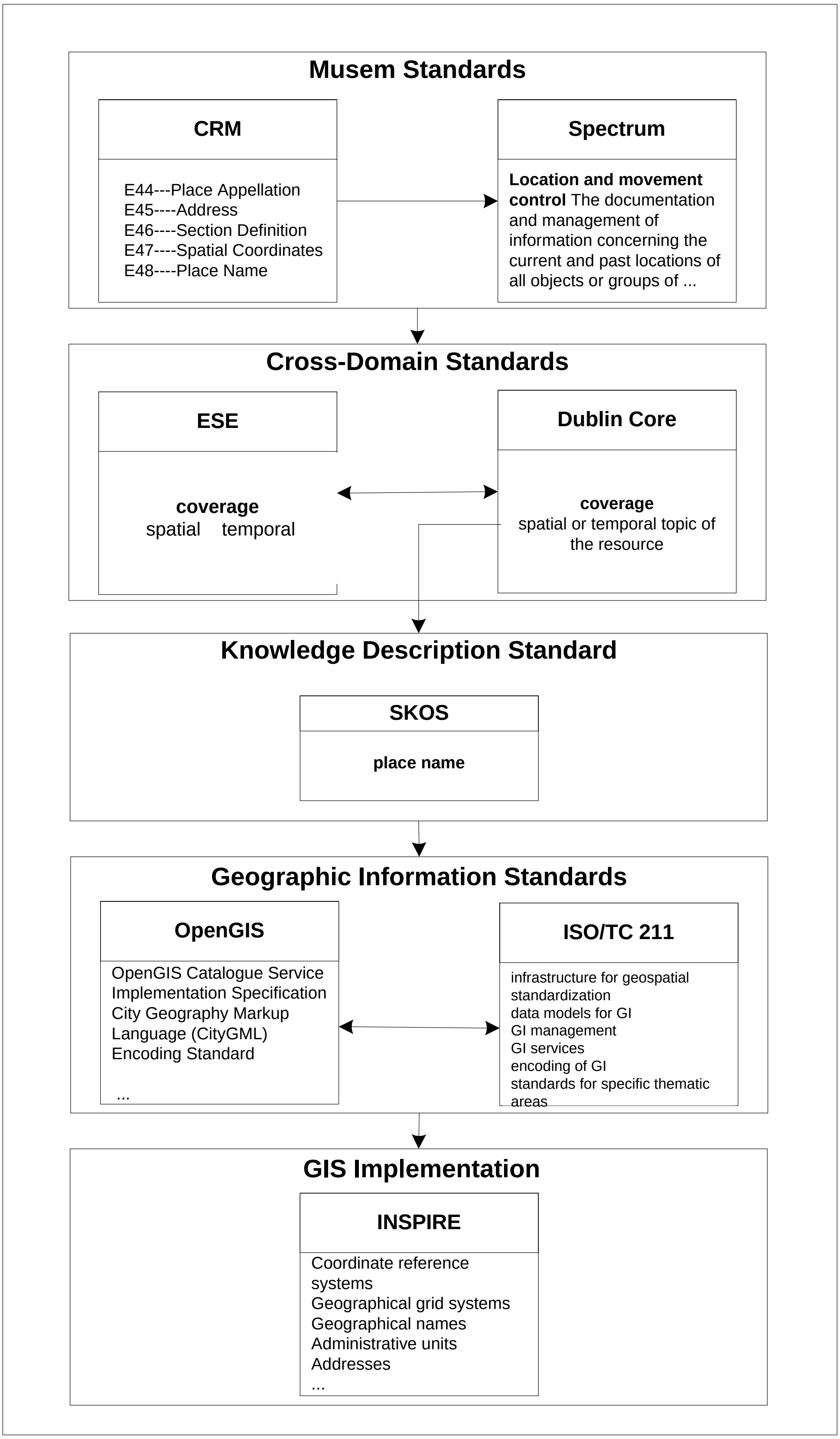
Appendix 2: Detail Answers in ATHENA Survey contains a table with detail answers from ATHENA Survey on use of Standards for geographic and answers on the use of Standards for geographic co-ordinates.

5. **GEOGRAPHIC** INFORMATION IN STANDARDS CONCERNING DIGITAL CULTURAL CONTENT

Interoperability in geographic space of digital cultural content must be ensured by standards, recommendations and other frameworks concerning geographic information, geomatics and GIS, and the meta data standards of digital cultural content on the other side. The chapter presents a framework for modeling geographic information about cultural heritage objects. It provides an overview of relevant standards. However we would also like to expose in our believe the key issue that is interoperability of geographic information which pertains to digital cultural content.

The accent is on **cross-relational aspects of standards** that could enable their connection in support for systematic implementation of geographic information in cultural heritage field. This is the aim for examination and presentation of standards from different domains. Standards, whether de facto or de iure can be viewed from three perspectives. First perspective is object description standards that are presented by Conceptual Reference Model (CRM), Museum Documentation Standard SPECTRUM, Europeana Semantic Elements Specifications (ESE) and Dublin Core Metadata Element Set (DCMES). Second perspective presents Simple Knowledge Organization System (SKOS) as cross domain standard and third perspective consist of geographical information standards as are ISO/TC 211 geographic information / geomatics standard, OpenGIS standard and EU Directive INSPIRE. Schema below demonstrates their connections and provides overview for the chapter.

Scheme: Geographic Information in Standards



5.1 CIDOC CONCEPTUAL REFERENCE MODEL (CRM)

Geographical information is included in CRM on **conceptual level as »Place«**. The model provides for its connection with other key elements of digital content description (physical and temporal enitites).

Cultural heritage informatisation presents a case of complex informatisation which concern coordinated participation of different content resources, different institutions as information providers, various users of information and also different technological support systems. Semantic interoperability is seen as one of the key mechanisms for enabling cooperation between different subsystems of cultural heritage.

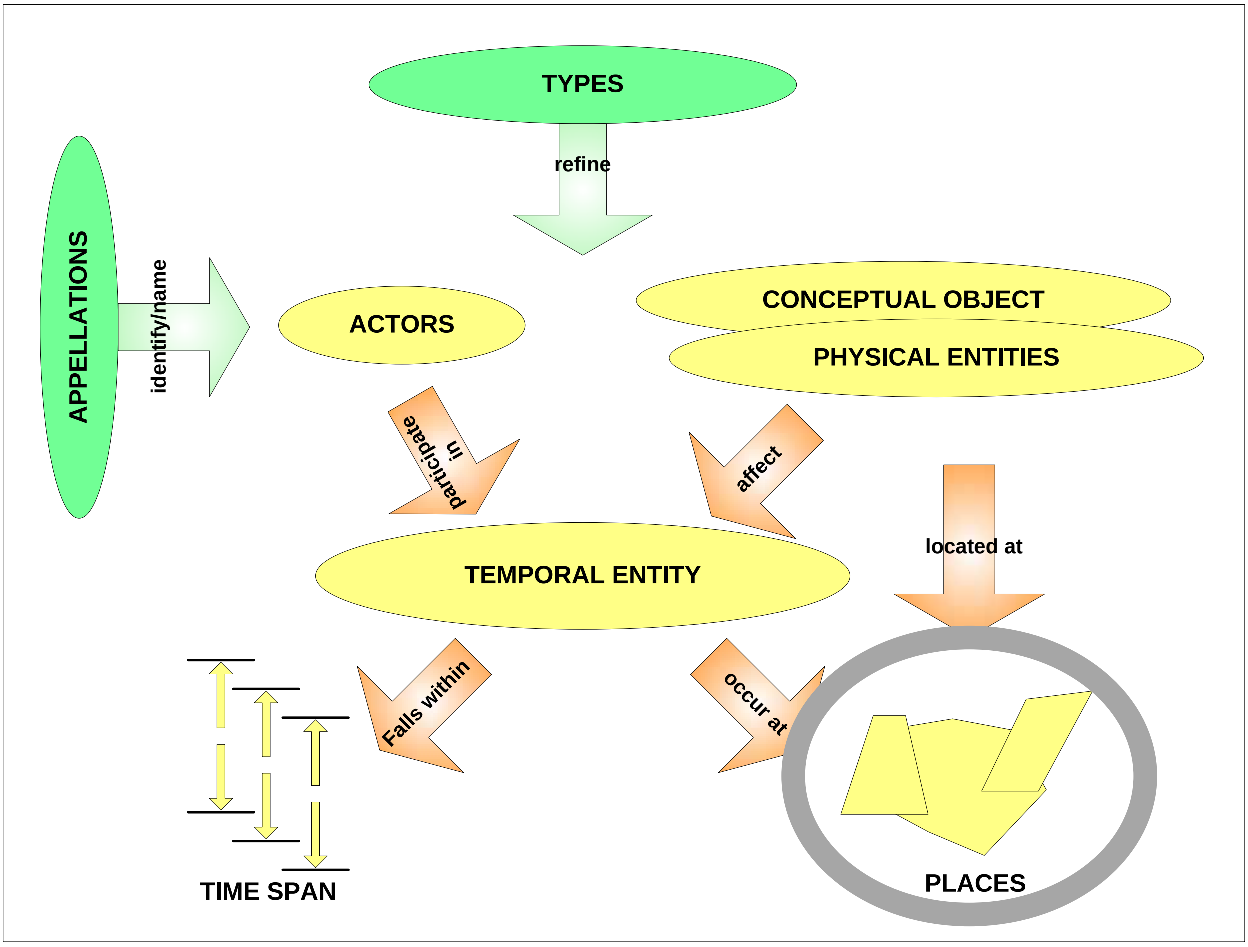
Use of CIDOC Conceptual Reference Model (CRM) is proposed for data modeling in cultural heritage information subsystems. The model is a formalized ontology which is intended to promote a shared understanding of cultural heritage information by providing a common and extensible semantic framework that any cultural heritage information can be mapped to. It is intended to be a common language for domain experts and implementers to formulate requirements for information systems and to serve as a guide for good practice of conceptual modelling. It is the culmination of over 10 years work by the CIDOC Documentation Standards Working Group and CIDOC CRM SIG which are working groups of CIDOC. Since 9/12/2006 it is official standard ISO 21127:2006.

CRM CIDOC is defined with the following content:

- principles of modelling,
- definitions of entities classes,
- definitions of attributes and connections with entities.

Qualitative scheme below illustrates CIDOC CRM conceptualisation of museum documentation at very general level. Actors, for example persons or groups cooperate in Temporal entities (e.g. events) which are influenced by Physical entities (e.g. things) and Conceptual entities (e.g. ideas). They occur at Places in specific Time-Span. Naming can be used for identification of any entity and likewise Types for classification of corresponding level of detail.

Scheme: Qualitative Scheme CIDOC CRM



Source: Crofts, N. et al. (2003). The CIDOC Conceptual Reference Model: A Standard for Communicating Cultural Contents. Cultivate Interactive (9). Retrieved 14. November 2009, from http://www.cultivate-int.org/issue9/chios/

Appendix 3.1.: CIDOC Conceptual Reference Model contains more information on purpose and scope of CIDOC CRM and its advantages as object oriented semantic model. CIDOC CRM functionalities are explained in its role as facilitator of exchange and integration of cultural heritage information. Appendix also reports about interesting development of tool for mapping cultural heritage information into CIDOC-CRM compliant data model. Special table enumerate CIDOC CRM Class Hierarchy. Links and sources for the topic are provided.

5.2 MUSEUM DOCUMENTATION STANDARD SPECTRUM

SPECTRUM standards use geographic information to describe different key aspects of object information and management which have spatial relevance. Standard lists them mainly under **“place information group”.**

SPECTRUM is an open standard for management of information in museums. It describes procedures for documenting objects and the processes they undergo, as well as identifying and describing the information which needs to be recorded to support the procedures. Version 3.2 was published in 2009 by Collection Trust in United Kingdom. LIDO metadata standard (Light Information for Describing Objects) is based on SPECTRUM standard.

Information groups containing geographical information
Standard defines several information groups which contains information units referencing geographical locations. There are several types of information groups.

Object groups are used to record aspects of an object. Groups with their descriptions having information units referencing geographical locations are listed here:

- **Object collection information** record information about the field collection of objects, e.g. during an archaeological excavation.
Information unit: **Field collection place.**
- **Object description information** record the categories of the description of an object.
Information unit: **Content – place.**
- **Object history and association information** record the historic use and associations of an object.
Information units: **Associated event place, Associated place**.
- **Object production information** record the aspects of the creation of an object.
Information unit: **Object production place**
- **Address information** is information group normally used for current information which is used and updated. For historical information Place information group is used. Its information units reference place postcode etc.
- **Place information** is information group used for historical or static location information.

The table SPECTRUM information units lists all information units along with their definitions and examples (in Appendix 3.2).

LIDO: new standard development under way ATHENA project is developing new LIDO metadata standard (Light Information for Describing Objects). Standard will be based on SPECTRUM standard however less complex. It will use CISOC Conceptual Reference Model (CRM) and would have full support for multilinguality.

Appendix 3.2: Museum Documentation Standard SPECTRUM explains in more detail structure of SPECTRUM standard and its two levels information requirements. Standard defines procedures which are briefly described. Information units pertaining to place context are listed together with examples. Further resources and links are provided.

5.3 EUROPEANA SEMANTIC ELEMENTS SPECIFICATIONS (ESE)

Europeana Semantic Elements specifications (ESE) uses **geographic information** to further specify subject description of digital object. Its limitations are further elaborated below.

Europeana Semantic Elements specifications document specifies metadata elements for digital objects which will be used for Europeana portal operations especially for harvesting and searching. It is required that providers' metadata would map to Europeana Semantic Elements specifications. The document is published as a result of Europeana project cofunded by European Union eContentplus programme. Version 3.2.1 was issued on 6 November 2009.

Applicability for geographic location description of digital cultural content: Metadata element "coverage" as declared in Dublin Core, can contain both temporal and spatial object descriptions and does not differentiate between them. However distinction between temporal and spatial aspects of object is crucial to geocoding. The refinement metadata element »spatial« can contain spatial characteristics such as geographic names, latitude/longitude, or other established georeferenced values. However this refinement does not allow complex or sophisticated georeferencing, but attention to standard schemes and controlled vocabularies should provide useful results. Controlled vocabulary terms can be drawn from recommended vocabularies, or standard labelling within the value can provide useful assistance to users and applications.

Europeana portal approach to geographical location information: The Europeana portal uses different metadata elements for geographical location aspect of digital objects. Information about geographical location can be found in subject or description element. However users cannot search for geographic information in specific field but only together with other subject information. Metadata Mapping & Normalisation Guidelines for the Europeana Prototype recommends use of spatial metadata element for geografic information instead of using coverage element. Also when mapping to subject metadata element is discussed use of spatial metadata element is recommended. Europeana Outline Functional Specification specifies that geographic coverage metadata element should enble automatic enhancement and also manual enhancement by experts with intent to be used for map-based searching and representation (Dekkers, 2009 p.26).

Appendix 3.3: Europeana Semantic Elements Specifications (ESE) provides more information on coverage data element and overall structure of Europeana Semantic Elements. It also presents XML schema, describe coverage metadata element together with example of detailed item from Europeana portal. Further information can be found in resources and links.

5.4 DUBLIN CORE METADATA ELEMENT SET (DCMES)

Similar to ESE, DCMES uses **geographic information** to further specify subject description of digital object. Also this standard lack the formalization of geographic information.

The Dublin Core Metadata Element Set is a vocabulary of fifteen properties for use in resource description. It is metadata standard and includes two levels: Simple and Qualified. Simple Dublin Core comprises fifteen elements; Qualified Dublin Core includes three additional elements (Audience, Provenance and RightsHolder), as well as a group of element refinements (also called qualifiers) that refine the semantics of the elements in ways that may be useful in resource discovery. It was published as version 1.1 on 14 January 2008.

Applicability for geographic location description of digital cultural content: Metadata element “coverage” as declared in Dublin Core, can contain both temporal and spatial object descriptions and does not differentiate between them. However distinction between temporal and spatial aspects of object is crucial to geocoding. The refinement metadata element »spatial« can contain spatial characteristics such as geographic names, latitude/longitude, or other established georeferenced values. However this refinement does not allow complex or sophisticated georeferencing, but attention to standard schemes and controlled vocabularies should provide useful results. Controlled vocabulary terms can be drawn from recommended vocabularies, or standard labelling within the value can provide useful assistance to users and applications.

Appendix 3.4: Dublin Core Metadata Element Set (DCMES) contains basic information about Dublin Core Metadata Elements and its XML schema. Resources and links are also provided.

5.5 SIMPLE KNOWLEDGE ORGANIZATION SYSTEM (SKOS)

SKOS provides a framework also for **structuring of geographic names** in form of thesauruses or controlled vocabularies.

Simple Knowledge Organization System (SKOS) provides a model for expressing the basic structure and content of concept schemes such as thesauri, classification schemes, subject heading lists, taxonomies, folksonomies, and other similar types of controlled vocabulary. As an application of the Resource Description Framework (RDF), SKOS allows concepts to be composed and published on the World Wide Web, linked with data on the Web and integrated into other concept schemes. Standard SKOS has a status of W3C Recommendation from 18 August 2009. In comparison to Web Ontology Language (OWL) SKOS does not require additional data modelling for representation.

The Simple Knowledge Organization System is a common data model for knowledge organization systems such as thesauri, classification schemes, subject heading systems and taxonomies. Using SKOS, a knowledge organization system can be expressed as machine-readable data. It can then be exchanged between computer applications and published in a machine-readable format in the Web.

In basic SKOS, conceptual resources (concepts) are identified with URIs, labeled with strings in one or more natural languages, documented with various types of note, semantically related to each other in informal hierarchies and association networks, and aggregated into concept schemes. In advanced SKOS, conceptual resources can be mapped across concept schemes and grouped into labeled or ordered collections. Relationships can be specified between concept labels. Finally, the SKOS vocabulary itself can be extended to suit the needs of particular communities of practice or combined with other modeling vocabularies.

Applicability for geographic location description of digital cultural content: standard SKOS has potential to aid user access to digital resources via place name. SKOS could provide standard way of representing geographical thesauruses and other controlled vocabularies using Resource Description Framework (RDF). Information encoded in RTF can then be exchanged betwwen computer applications in interoperable way for use in Semantic Web.

Appendix 3.5: Simple Knowledge Organization System (SKOS) provides for further explanation of SKOS basic structure and lists URI. Application of SKOS is demonstrated by example. Resources and links are also suggested.

5.6 ISO/TC 211 GEOGRAPHIC INFORMATION/GEOMATICS

These ISO standards provide for **fundamental structure** of geographic information thus enabling its computational processing.

ISO addresses the field **Geographic information/Geomatics as TC 211**: standardization in the field of digital geographic information. This work aims to establish a structured set of standards for information concerning objects or phenomena that are directly or indirectly associated with a location relative to the Earth. These standards may specify, for geographic information, methods, tools and services for data management (including definition and description), acquiring, processing, analyzing, accessing, presenting and transferring such data in digital / electronic form between different users, systems and locations. ISO published 48 standards under the direct responsibility of TC 211 by November 2009.

There are several Liaisons that have actively adopting and implementing ISO/TC 211 standards. **The Global Spatial Data Infrastructure (GSDI)** is coordinated actions of nations and organizations that promotes awareness and implementation of complementary policies, common standards and effective mechanisms for the development and availability of interoperable digital geographic data and technologies to support decision making at all scales for multiple purposes. The UN interest in geographic information is broad, and obviously runs the gamut of UN sectors. The **UN Geographic Information Working Group (UNGIWG),** was established for the needs of peacekeeping actions, sustainable development and the eradication of poverty. This working group collaborates with ISO/TC 211 and uses ISO standards it has developed and has become a Class A Liaison of ISO/TC 211. **Infrastructure for Spatial Information in Europe (INSPIRE)** initiative aims to make harmonized and high quality geographic data and information readily available for formulating, implementing, monitoring and evaluating Community policy and for the citizen to access information about the environment, whether local, regional, national or international. INSPIRE recognizes ISO standards as a foundation for its work. These and other global geographic organizations constitute the traditional user community for ISO/TC 211 standards. Currently, ISO/TC 211 has initiated its outreach activity to user communities to enable them to take advantage of the considerable international investment in the development of these standards.

Appendix 3.6: ISO/TC 211 geographic information/geomatics provides description of ISO/TC 211 standards with further links for information.

5.7 OPENGIS: OPEN GEOSPATIAL CONSORTIUM

The main concern of OPENGIS consortium is development of standards and specifications which establish **interoperability in processing of geographical information**.

The Open Geospatial Consortium, Inc. (OGC) is a non-profit, international, voluntary consensus standards organization that is leading the development of standards for geospatial and location based services. International industry consortium of 384 companies, government agencies and universities participate in a consensus process to develop publicly available interface standards. OpenGIS® Standards support interoperable solutions that "geo-enable" the Web, wireless and location-based services, and mainstream IT.

The OGC develops and releases a variety of documents. The Abstract Specification documents a platform independent abstract model for most OGC specification development activities. The Abstract Specification provides a reference model for the development of OpenGIS standards. Many elements of the OGC Abstract Specification are OGC Member approved ISO TC 211 International Standards. An OGC standard is a document, established by consensus and approved by the OGC Membership, that describe rules, guidelines or characteristics for interfaces and encodings aimed at the achievement of the optimum degree of interoperability.

Appendix 3.7: OpenGIS: Open Geospatial Consortium provides description of OpenGIS standards with further links for information

5.8 INSPIRE EU DIRECTIVE

The common **European spatial infrastructure** is going to be established in next years. It is a great opportunity to use this infrastructure also for digital cultural heritage.

The INSPIRE Directive established an infrastructure for spatial information in Europe to support Community environmental policies, and policies or activities which may have an impact on the environment. The INSPIRE directive came into force on 15 May 2007 and will be implemented in various stages, with full implementation required by 2019. INSPIRE is based on the infrastructures for spatial information established and operated by the 27 Member States of the European Union. The Directive addresses 34 spatial data themes needed for environmental applications, with key components specified through technical implementing rules. This makes INSPIRE a unique example of a legislative “regional” approach. The INSPIRE directive aims to create a European Union (EU) spatial data infrastructure. This will enable the sharing of environmental spatial information among public sector organizations and better facilitate public access to spatial information across Europe.

The INSPIRE Directive ensures that the spatial data infrastructures of the Member States are compatible and usable in European Union. The Directive requires that common Implementing Rules are adopted in a number of specific areas (Metadata, Data Specifications, Network Services, Data and Service Sharing and Monitoring and Reporting). These Implementing Rules are adopted as Commission Decisions or Regulations, and are binding in their entirety. The Commission is assisted in the process of adopting such rules by a regulatory committee composed of representatives of the Member States and chaired by a representative of the Commission (this is known as the Comitology procedure). The Consolidation Team (CT) consists of staff of the European Commission from the three DGs, DG Environment, Eurostat and JRC. DG Environment acts as the overall legislative and policy coordinator for INSPIRE, Eurostat acts as the overall implementation coordinator and supports the IR developments on data sharing and monitoring. JRC acts as the overall technical coordinator of INSPIRE, and is responsible for the development of Implementing Rules for metadata, data specification and network services. JRC is also responsible for the development of the INSPIRE geo-portal. The regulatory nature of the Implementing Rules requires the Commission to present them to a Regulatory Committee of Member States representatives, referred to as the INSPIRE Committee.

Appendix 3.8: INSPIRE EU Directive describes INSPIRE Data Themes and provides further links.

6. IMPLEMENTATION OF GIS IN DIGITAL CULTURAL CONTENT

The purpose of this chapter is to provide **advice to cultural institutions** on introducing geographical data. It explains how to begin with the process of enrichment for existing individual objects description as well as object collection descriptions. At the beginning the general concept and basic principles are suggested then seven types of GIS models are presented from the simplest to more complex ones. These basic models could be implemented as single one or in combination. Concise guidance to possible immediate actions of cultural institutions is distilled in 10 quick thoughts. Finally the curriculum for training in basic concepts of GIS is proposed.

6.1 CONCEPTUAL MODEL

It is a commonly quoted estimation that up to 80% of all digital data generated today includes geospatial references. Some of these digital data, like digital maps and other cartographic products, are directly geo-referenced with geographic coordinates. However a large volume of the available data do not use coordinates but are indirectly geo-referenced with place names and other text descriptors of geographic objects and features.

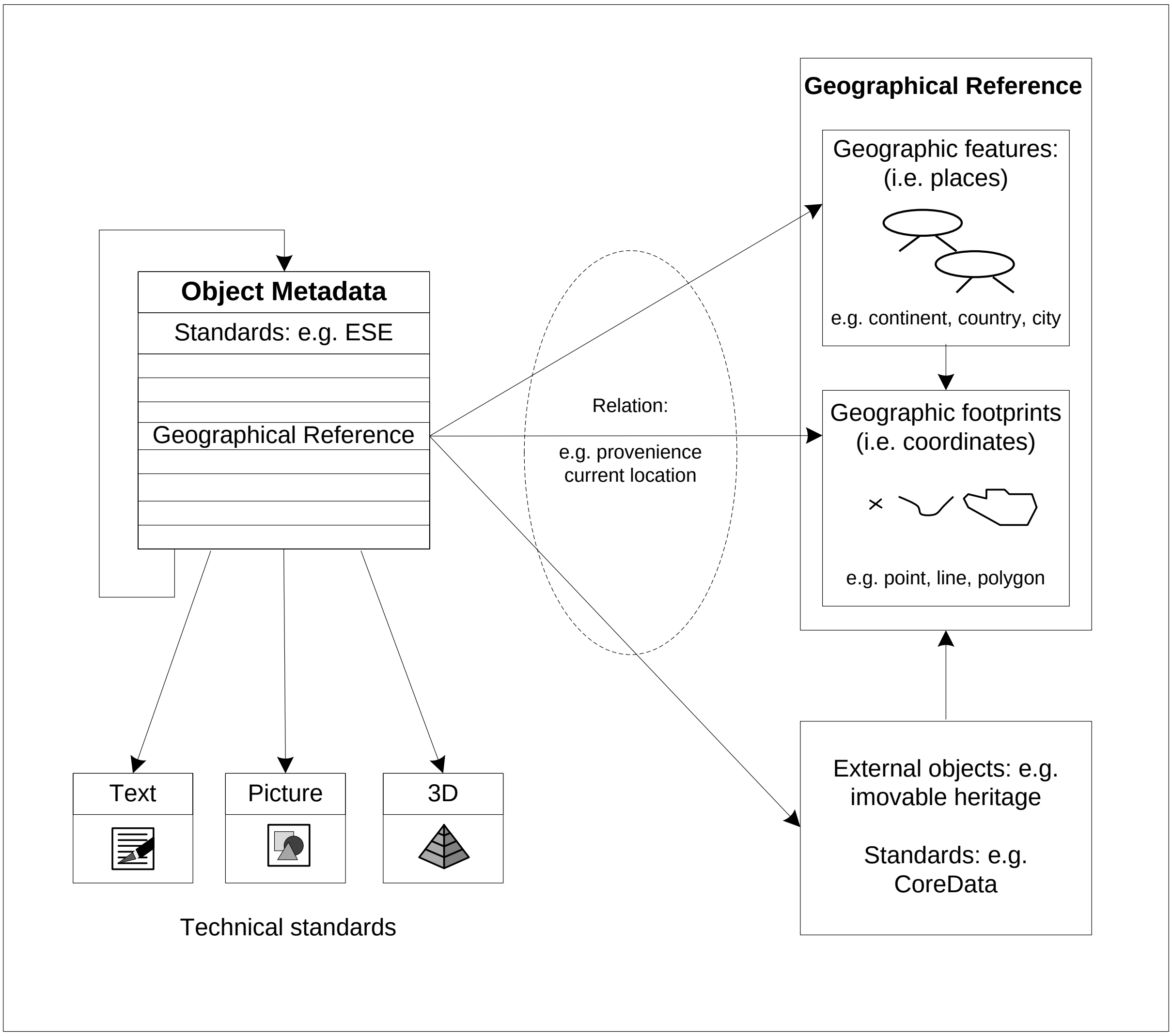
Geocoded digital cultural content is fairly new issue, especially when we are talking about movable cultural objects as are books, paintings, museum objects, intangible heritage and other objects collected in libraries, museums, archives, audiovisual and other cultural institutions. Geographic information systems technology is a tremendous tool when identifying and searching digital cultural objects in global world, using geolocation services for cultural tourism, discovering the cultural content in the education and lifelong learning processes, and in adding value using cultural content in creative industry.

The **digital cultural object** is one element of digital cultural content. It is described with metadata as specified for example in Europeana semantic elements specification. Metadata connects to digital text, pictures or other multimedia representations.

The **geographical reference** could be described as:

- Digital geographic coordinates as footprint of the point polyline, polygon or some more complete geo topological structure.
- Geographical names from the geographic ontology in the form of thesaurus or preferably in the form of “skosified” thesaurus.
- Link to the other digital cultural object which is geocoded.

Scheme: Conceptual Model of GIS of Digital Cultural Content



Appendix 4 provides resources and links for data structure supported by GIS (Appendix 4.1). Geocoding is further described in Appendix 4.2. Appendix 4.3. explains retrieval with ontology and in addition provides comparison of the functionalities of the ADL, Getty and GeoNames gazetteers and a list of Online gazetteer services with facts.

6.2 POSSIBLE GIS MODELS

The proposed seven prototypes of GIS models were developed with aim that museums, archives, libraries, audiovisual institutions and other data providers clearly understand what they should be working on and implement in the future. These GIS models range from simplest to most complex.

In our work within Athena project we have developed concepts of these possible GIS models and prepared small sample database for each model. We have also developed prototype internet applications, performed simulation and disscusion of issues pertaining to each model. Videos demonstrating features of each model are published at Athena website for users to view them.

The proposed GIS models are listed below:

- »Provider« which contains only geographic locations of content providers,
- »Country« which represents graphical representation of country of content providers,
- »Current« which contains current geographic location of the physical objects,
- »Event« which contains geographic locations of events concerning physical objects,,
- »Identify« makes use of geo topological relations among several GIS entities.
- »Historical maps« which refer to geocoded historical maps
- »3D« which refers to three dimensional representation of movable or immovable cultural objects

These basic models could be implemented as single one or in combination.

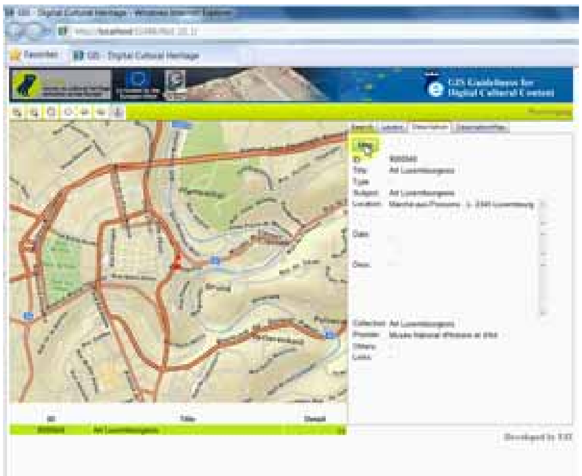
GIS MODEL : PROVIDER

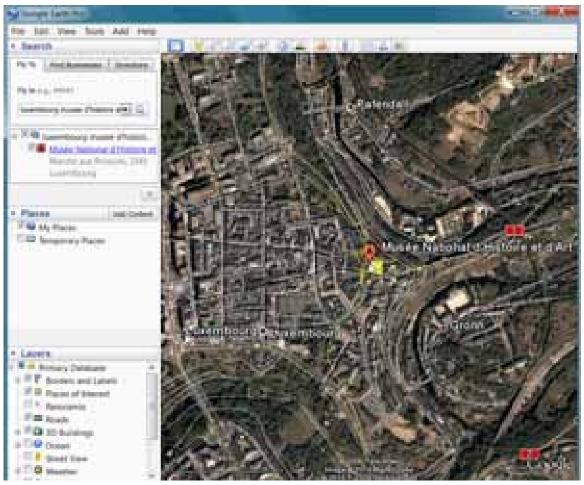
Concept

This is the simplest approach introduction of geographic location when presenting digital cultural content.
The concept of this model is that each content provider has the geographic coordinates of its location (point) on the earth surface. Therefore when somebody click on the map on this location all the collections of this content provider are shown. On the other side when somebody select the collection the location of the content provider could be zoomed on the map.

Prototyping

As a prototyping data base we use Athena project collections and the location of their content providers. We have geocoded all Athena content providers using simple GoogleEarth free internet tools.





Discussion

This model is very simple but very effective.
The geographic coordinates of content provider usually already exists but if not they could be easily identified by few clicks only.
The map view of the content provider is providing the geographic context of collection and also the interesting sight for the cultural tourism if the location of the content provider is also the location of physical cultural objects.
We suggested that each content provider within Europeana projects also deliver its coordinates along with the description of the collection.

GIS MODEL : COUNTRY

Concept

This is the generalization of the GIS model »Provider« when the provider of digital cultural content is identified by the country of the provider (European or other).

The concept of this model is that someone »click on the map« in order to select the country of the collection instead to use long pull down menu of the country names. Similary when somebody search for certain object / subject for example »situla« all countries on the map are coloured with a certain colour.

Prototyping

As a prototyping data base we use Athena project collections and the country of their content providers.

Discussion

This model is not a real GIS layer but more graphic scheme.

It could be used at digital cultural portals as overview map and at lesser degree as large map.

As we are informed this model is going to be the first GIS model introduced in Europeana.

GIS MODEL : CURRENT

Concept

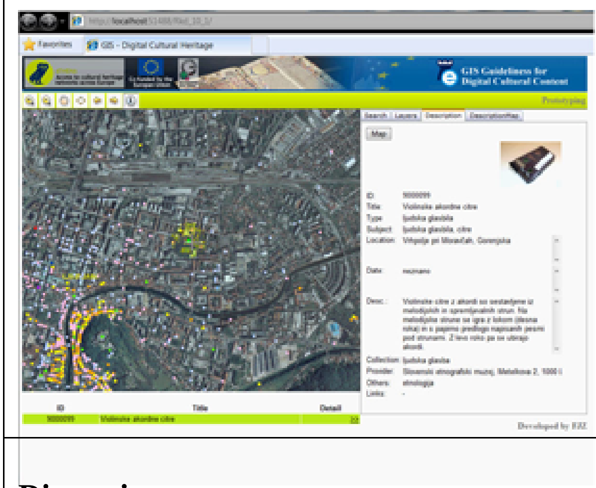
The model named »Current« describes current geographic location of the physical object. In comparison with GIS model »Provider« the location is defined on collection/provider level, but in this model the location is defined on object level.

The same concept could be used also for static immovable cultural object as are architectural buildings, monuments or archeological sites. Even more, moveable cultural object could be indirectly geocoded to these objects when they are presented in these objects or in some other way connected with them.

Usually geo reference are points but could also be polygons or segments.

Prototyping

As a prototyping data base we use Athena project sample objects. If they do not have coordinates we determined them by use of some internet geocoding tools as GeoNames.org.



Discussion

This model is very transparent and could cover all the Europena objects in near future.

The benefits of this model are not only as »where is?« and »what is here?« functions but also as the background for more complex spatial / time search.

In this case the map colouring and symbolisation could also be used when presenting some atribute of the object (e.g.datation).

The bottleneck of this model is the shortage of coordinates of objects. The data mining or artificial expert system is wellcomed for semi-authomatic geocoding.

GIS MODEL : EVENT

Concept

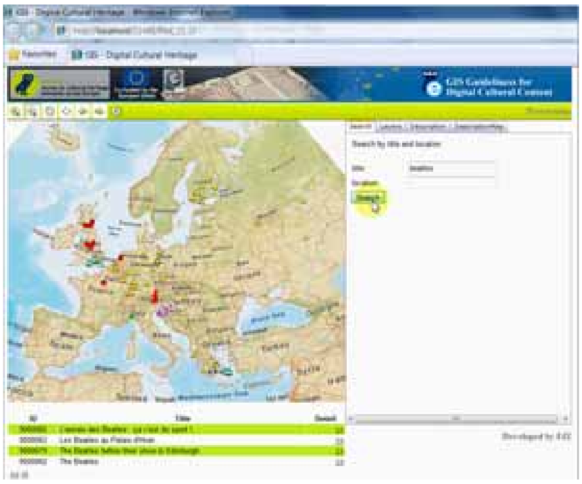
This model is the extension of the previous one »Current«.

In this case the events in someway related to the object are geocoded. Examples include birth place of author, place of production, place of use, current institution, etc. Usually there are more than one event connected to certain object and therefore also more than one coordinate per object.

The LIDO standar appears as an ideal hook to implement this model.

Prototyping

As a prototyping data we use Europena »Beatles« collection describing their tour in Europe. We have geocoded the places by using description field and geoparser.digmap.eu tool. When user browse the map and clicks on it he can see the description and video of their arrival.



Discussion

This model is probably simple enough and powerful on the other side that could be implemented in future as GIS framework in Europeana and other cultural portals.

However the question remains how to combine geoparsing and geoontology when using on line or off line services.

GIS MODEL : IDENTIFY

Concept

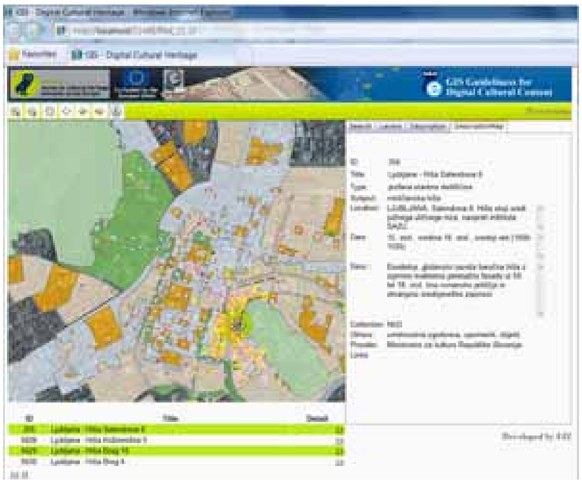
This model is the case for demonstrating the power of geo topological relations among several GIS entities.

When user selects specific location on the map (e.g. point, rectangle, polygon) all GIS entities which are geo-topologically related to this location are identified.

Examples of geo topological relations includes: point in polygon, intersection of polygons and spatial buffer of segment.

Prototyping

As a prototyping data we use samples from Register of cultural heritage of Slovenia.
When user clicks on the map the related polygons are identified and displayed in »onion« structure.



Discussion

This model is usually used in combination with other models.

In order to achieve usable result it is very import that individual GIS layers are geocoded with appropriate accuracy and that unified GIS standards are used in its entirety.

GIS MODEL : HISTORICAL MAPS

Concept

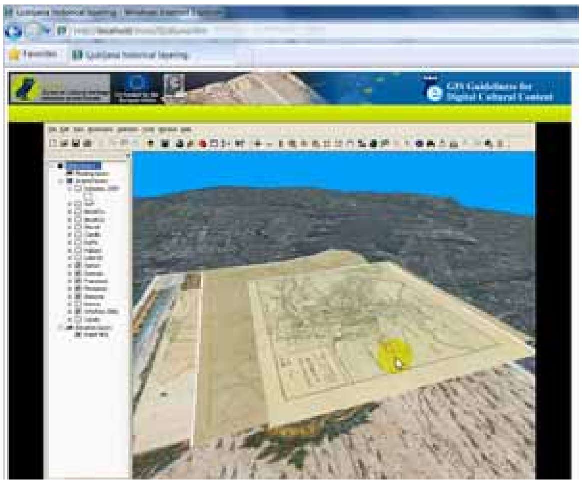
Historical maps offer spatial and temporal information with associated cultural information or attributes. They usually include at least one dynamic map with multiple layers, or multiple maps. They concern specific focus, theme, and/or intended audience. The focus can be either large or small scale in time and space. Information included can be either generalized or complex and detailed.

Historical maps include all the features of the print version but pose new questions about the best ways to represent the information on the internet. Geocoded historical maps can include new functionality enabled by the use of electronic media including:

- interactive viewing and dynamic presentation of the material,
- content searches,
- content filtering,
- spatial and statistical analysis,
- incorporation of larger volumes and more complex data,
- flexibility in integrating content for specific authors goals and intended audiences,
- possibility of online community input of information and feedback.

Prototyping

We use as example the presentation of cadastral and city maps of the City of Ljubljana dating from several different periods.



Discussion

This is a very appropriate approach for the cases when cultural content are historical maps.

The basic georeferencing of historical maps is cost effective.

There are several projects currently running in this area and we may note that there is a need for some practial standardisation on this topics.

GIS MODEL : 3D

Concept

There are a lot of efforts in standardisation, preparation and presentation of three dimensional models of movable (e.g. museum objects) and immovable (e. g. architectural buildings) cultural objects.

In the context of GIS the 3D modeling is more applicable to immovable cultural objects. The so called 3D GIS includes beside x and y coordinates also z coordinate. Models could be:

- simple when geo shapes are only extruded to its proper height,
- real 3 D shapes,
- with detail textures (e.g. facades).

Prototyping

Here we use the presentation of the 3D reconstruction of the city walls of Koper that are visually no longer in the townscape

Discussion

This digital representation of cultural heritage is especially effective when the heritage itself has already been totally or partially dismantled.

6.3 TEN QUICK THOUGHTS

Ten Quick Thoughts are prepared for cultural institutions which consider enriching their digital cultural content with geographical information. They provide quick tips for guidance in the process of modification and extension of their working procedures and action. Quick Thoughts address critical issues and would have beneficial effect in GIS implementation when applied in practice.

1. Act immediately. Think of appropriate geographical reference for your digital cultural content now otherwise your digital cultural content will be lost in global word of digital cultural content.

2. When inventorying or documenting new cultural objects do include geocoding and/or geographical ontology for new object data capture.

3. Download free GIS software. Download immediately to demonstrate the usefulness of GIS among colleagues.

4. Whenever taking photograph of the cultural objects in the field (e.g. natural species) use GPS with appropriate coordinate system and accuracy.

5. Consider encoding your geographical names thesaurus with SKOS standard (»SKOSified« thesaurus) or use automatic geocoding.

6. If historical maps represent your valuable cultural assets then consider geocoding them as first step to your digital georeferencing future.

7. Consider linking your cultural objects to already geocoded immovable cultural heritage.

8. When you are about to enrich your metadata either manually or automatically do everything to achieve as complete and as precise description of geographical data as possible. Pay attention especially when you contribute your metadata to global portals for example to Europeana.

9. When selecting or upgrading new inventory software do check what geographic information system functionalities is it capable of.

10. Monitor what is going on about INSPIRE project in your country. Pay attention especially on developments regarding territorial units layer.

6.4 CURRICULUM OF TRAINING: INTRODUCTION OF GIS

Proposed curriculum of training delineates basics of GIS for potential learners. This introduction to GIS techniques emphasises application of GIS in Historic, Cultural and Archeological Studies.

1. Training Description

Training on GIS is an introduction to the concepts and uses of Geographic Information Systems (GIS). GIS is a system of computer software, hardware, and personnel designed to visualize, manipulate, analyze, and display spatial data. As GIS create "Smart Maps" that links a database to a map, this allows us to view relationships, patterns, or trends that are not possible to see with traditional charts, graphs, and spreadsheets. Topics covered include basic introduction to GIS techniques with the emphasis on Historic, Cultural and Archeological Studies.

2. Training Goals

To provide attendees an understanding of GIS thus establishing a strong foundation to become a successful user of GIS techniques.

- Introduction to GIS
- GIS Data Issues
- Spatial data models
- Geographical databases
- GIS and Spatial Analysis
- Data Sharing and Legal issues
- GIS and modeling.

3. Training Objectives

To gain a basic and practical understanding of GIS concepts, techniques and real world applications:

- Demonstrate an introductory level of understanding GIS.
- Explain how GIS is used in cultural heritage field.
- Search and review existing GIS data and maps.
- Build maps from GIS data.
- Understand the basic data types used within GIS.
- Edit spatial data.

By completing this training the attendee will gain a basic and practical understanding of GIS concepts, techniques and real world applications and understand the basic concepts of geography necessary to use GIS technology efficiently and accurately. Attendee shall understand basic GIS data, concepts of analysis and technical language of GIS.

4. Intended audience

Experts in cultural heritage field.

5. Prerequisites

There are no prerequisites but some background with using computer is helpful.

APPENDICES

APPENDIX 1 GIS Resources and Links

- Laurini, R. and D. Thompson (1992). Fundamentals of Spatial Information Systems. San Diego: Academic Press.

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- Cappellini, V., Maitre, H., Pitas, I., Piva, A (2004) Guest Editorial Special Issue on Image Processing for Cultural Heritage, IP(13), No. 3, March 2004, pp. 273-276.

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- Michael N. DeMers. (2008). Fundamentals of Geographical Information Systems.

- John Wilson, A. Stewart Fotheringham. (2007). The Handbook of Geographic Information Science.

- Arctur, David and Michael Zeiler. (2004). Designing Geodatabases: Case Studies in GIS Data Modeling. Redland: ESRI Press.

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- Maschner, H.D.G. (1996). New Methods, Old Problems: Geographical Information Systems in Modern Archaeological Research. In.: Occassional Paper No. 23. Carbondale Center for Archaeological Investigations: Southern Illinois University.

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- P. Longley and M. Batty, eds. (1997). ***Spatial Analysis: Modelling in a GIS Environment***. Cambridge: GeoInformation International.

- Timothy Foresman. (2007). History of GIS (Geographic Information Systems).

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- Martin Dodge, Rob Kitchin, and Chris Perkins (2009). Rethinking Maps. Routledge.

APPENDIX 2 Detail Answers in ATHENA Survey

Appendix 2.1 Standards for geographic names

The table summarizes the ATHENA Survey on standards for geographic names. Provider, collection name, source for the geographic names and the reference (standards) are listed.

Provider	Collection name	Source for the terms	Source reference
Museum of Romani Culture (Muzeum romské kultury, s.p.o.) Czech Republic	Museum of Romani Cutlure collection (Sbírka Muzea romské kultury)	A published standard	
Musée nationale d'Histoire et d'Art Luxembourg	Luxembourg painters	Developed by the provider	
National Museum of Fine Arts - Heritage Malta Malta	Museum Collection database	A published standard	TGN ULAN AAT
"Stara Sofia" Municipal Enterprise with the Historical Museum of Sofia Bulgaria	Stara Sofia (Old Sofia)	A published standard	http://www.loc.gov/marc/countries/cou_home.html
National Historical Museum Bulgaria	Bulgaria and the Slavic Peoples - 2	A published standard	http://www.loc.gov/marc/countries/cou_home.html
National Historical Museum Bulgaria	Bulgaria and the Slavic Peoples - 1	A published standard	http://www.loc.gov/marc/countries/cou_home.html
Ethnographic Institute with Museum Bulgaria	Folk Applied Arts	A published standard	http://www.loc.gov/marc/countries/cou_home.html
Rybinsk State History, Architecture and Art Museum-reserve Russian Federation	A part of museum collection database	Developed by the provider	
[Ministry for cultural heritage and activities. Directorate general for organisation and innovation]Ministero per i beni e le attività culturali. Direzione generale per l'organizzazione, l'innovazione, la formazione, la qualificazione professionale e le relazioni sindacali	Catalogue Database of all objects of art historical interest located in Italy, both held by museums and hosted in the original location (churches, palaces...), belonging to public and private bodies.	A published standard	ISTAT http://www.istat.it/strumenti/definizioni/

Italy			
Pyal Museums of Art and History Belgium	Museum collection database	Developed by the provider	
National Theatre of Northern Greece Greece	Performances Archive	Developed by the provider	
Historical Archive of the Aegean “Ergani” Greece	Kourtzis Archives	A published standard	Getty Thesaurus of Geographic Names (Getty TGN) http://www.getty.edu/research/conducting_research/vocabularies/tgn/
Museum of Cycladic Art Greece	Ancient Cypriot Art	A published standard	The Getty Thesaurus of Geographical Names (TGN)
Museum of Cycladic Art Greece	Ancient Greek Art	A published standard	The Getty Thesaurus of Geographical Names (TGN)
Museum of Cycladic Art Greece	Cycladic Culture	A published standard	The Getty Thesaurus of Geographical Names (TGN)
Piraeus Bank Group Cultural Foundation Greece	Collection of Marble Crafts-Greece	A published standard Developed by the provider	Getty thesaurus of geographic names (tgn) http://www.getty.edu/research/conducting_research/vocabularies/tgn/
National Museum of Contemporary Art Greece	Contemporary Art Collection	Developed by the provider	
Papafeio Orphanotrophy of Thessalonikh “Meliteys” Greece	Papafi Archive	A published standard	
Państwowe Muzeum Archeologiczne w Warszawie (State Archaeological Museum) Poland	Archaeological Museum collection database (7 digital collections)	A published standard	Commonly and widely available
International Centre for Information Management	Collection of photographs	A published	http://www.nukat.edu.pl/nuk

Systems and Services Poland		standard	at/pl/kaba.phtml?dl=2&id=88&etykieta=151
Murberget, County museum of Västernorrland Sweden	Murberget photo database	A published standard	SCB, Swedish standard geografical names National board of antiquities geografical names
Soprintendenza Speciale per I Beni Archeologici di Napoli e Pompei (Special Superintentency for the Napoli and Pompei Archaeological Heritage) Italy	Heritage Catalogue Database	A published standard	Indirizzario di Pompei, from: L. Esherbach, Gebäudeverzeichnis und Stadtplan der antiken Stadt Pompeji, Köln, 1993
Lusto the Finnish Forest Museum Finland	KANTAPUU Museum collection database	Developed by the provider	
TM - Tampere Museums Finland	Museum collection database	A published standard	YSA - General Finnish Thesaurus www.yso.fi/onto/ysa/ysa_juuri Tampereen virastokartta (Tampere city official map) Published by Tampereen yhdyskuntatuotanto, 1/2007
KMCH - Kuopio Museum of Cultural History Finland	Museum collection database	A published standard Developed by the provider	
Accademia nazionale di Santa Cecilia = St. Cecilia National Academy (foundation) Italy		Developed by the provider	
Soprintendenza per il Polo museale fiorentino = Superintendency to the Museums Pole in Florence Italy	Inventory database of the works located in the State Museums in Florence	Developed by the provider	

Slovenian Museum of Natural History Slovenia	Database of Invertebrate Pictures	A published standard	Country Code: ISO 2-letter code (International Organization for Standardization) As a thesaurus for localities is used ATLAS SLOVENIJE, 4th edition (2005).- Mladinska knjiga, Ljubljana.
National Library of Israel Israel	Audio; Maps; Newspapers; Manuscripts and Transcription; Rare Books; Ketubbot – Jewish Contract Marriages; Talmudic Manuscripts; Treasures of the Library.	Developed by the provider	http://www.oclc.org/bibformats/en/6xx/651.shtm
See list attached to the mail dated March 28th Germany	Many museum collections more without than with specific names	A published standard	German National Library. Subject headings (Schlagwortnormdatei, SWD; licensed, not public) National Statistical Bureau. List of municipalities (Gemeindeverzeichnis; licensed, not public) TGN (licensed; not used at the moment, but in preparation)
Ministry of Culture and Communication (MCC) France	Collections.fr	Developed by the provider	
Ministry of Culture and Communication (MCC) France	Joconde (French museums collection database)	A published standard	INSEE: http://www.insee.fr/fr/metho

			des/nomenclatures/cog/ Getty's Thesaurus of Geographic Names (TGN) (only for archaelogy collections): http://www.getty.edu/vow/TGNHierarchy?find=&place=&nation=&english=Y&subjectid=7029392 Dictionary "Petit Robert".
The Israel Museum	Museum collection online	Developed by the provider	
Museum of Literature Petőfi (PIM) Hungary	Media Collection	Developed by the provider	
Museum of Literature Petőfi (PIM) Hungary	Art Collection	Developed by the provider	
Royal Institute for Cultural Heritage (KIK-IRPA) Belgium	Photographic collection of art objects belonging to the other Belgian participating scientific institutions.	Developed by the provider	
Royal Museum for Central Africa Tervuren Belgium	Photograph collection database	A published standard Developed by the provider	ISO list of short country names (English)
Bristol City Council United Kingdom	Online museum collection database	Developed by the provider	
Royal Albert Memorial Museum and Art Gallery United Kingdom	Online museum collection database	Developed by the provider	
Wiltshire Archaeological and Natural History Society (WANHS) United Kingdom	Online museum collection	Developed by the provider	

Petőfi Literature Museum (PIM) Hungary	Manuscript archive	Developed by the provider	
Victoria and Albert Museum United Kingdom	Online museum collections database	Developed by the provider	
Fitzwilliam Museum United Kingdom	Fitzwilliam Museum Online Catalogue	A published standard Developed by the provider	TGN (used for reference)
English Heritage United Kingdom	ViewFinder	Developed by the provider	
Royal Museums of Art and History Belgium	Museum collection database	Developed by the provider	
Vlaamse Kunstcollectie Belgium	Collection database of three museums of fine art	A published standard	TGN: http://www.getty.edu/research/tools/vocabulary/tgn
S.M.A.K. Belgium	Contemporary art collection	Developed by the provider	
ModeMuseum Provincie Antwerpen – MoMu Belgium	Museum collection database	Developed by the provider	
ModeMuseum Provincie Antwerpen – MoMu Belgium	Museum library database	Developed by the provider	
Stadsarchief Antwerpen (Antwerp City Archives) Belgium	Photo Archive	Developed by the provider	

Appendix 2.2 Standards for geographic co-ordinates

The table summarizes the Survey on standards for geographic co-ordinates. Provider, collection name and source for the geographic co-ordinates are listed.

Provider	Collection name	Standard
“Alt-Soft” Information & Communication Technologies JSC Russian Federation	The united database of the Russian State Archive of Literature and Arts (RGALI)	only for the location of the wholecollection
ModeMuseum Provincie Antwerpen – MoMu Belgium	Museum collection database	Tng Latitude (Lat.) and Longitude (Long.)
8th Ephorate of Byzantine Antiquities Greece	Exhibits of the Byzantine Museum of Ioannina	
Ephorate for Paleoanthropology-Speleology of Northern Greece Greece	FILE OF PHOTOGRAPHS	EPSG:3004
15th Ephorate of Prehistoric and Classical Antiquities	Antiquities included in the Collections System of the National Archive of Monuments «POLEMON» (15th EPCA)	Gauss Boaga
26th Ephorate of Prehistoric and Classical Antiquities Greece	Collection of sculptures from Kalaureia and Troizen	latitude/longitude
33d Ephorate of Prehistoric and Classical Antiquities Greece	Collection of the Arta Arcaheological Museum (selected objects)	Country, X,Y, Z, UTM, location/place
28th Ephorate of Byzantine Antiquities Greece	Gonia Monastery Collection	The following reference systems are used for some records: Lambert 2 extended; Lambert 97
LD’ Ephorate of Prehistoric and Classical Antiquities Greece	“Collection of idols from Archaeological Museum of Karditsa”.	[To be decided in near future dependent on the a JISC project.]

APPENDIX 3: Geographic Information in Standards Concerning Digital Cultural Content

Appendix 3.1 CIDOC CONCEPTUAL REFERENCE MODEL

Information about conservation in museums, libraries and archives is usually heterogenous in its structure and content although some conceptual overlapping occurs in limited cases. Collections and content descriptions varies with regard to following factors:

- Collection type,
- Conservatory approach,
- Subject of discipline,
- Description fragmentation,
- Level of detail in description,
- Structure of descriptive metadata,
- Value of descriptive metadata.

CIDOC Conceptual Reference Model means alternative solution for problem of semantic access to heterogenous cultural heritage information.

CIDOC conceptual reference model is a object oriented ontology for interchange cultural heritage data. It contains technologies for object oriented data modelling which can be used for formalisation of documentation concepts in musem, library and archive. Model aims to facilitate information interchange.

Scope of CRM is defined as integration and exchange of heterogenous information required for systematic documentation of cultural heritage collections. Before we continue we need to clarify some terms.

- Term »heterogenous« denotes that original sources of data are not consistent either in structure or content.
- Term »systematic« denotes that the depth and quality of information can meet requirements of scholarly research.
- Term »cultural heritage collections« denotes any materials collected by museums as defined in ICOM Statute (ICOM 1946-2001).

CRM as object oriented semantic model has several advantages:

- Class hierarchy facilitate coherent integration of related information from different sources and at different level of detail,
- Inheritance of properties means that clasess and properties can be subtypified for specific applications. That makes CIDOC CRM very extendable without reduction of semantic applicability and model integrity. For example CIDOC CRM was extended with multimedia standard MPEG-7 metadata elements for museum multimedia material description.
- CIDOC CRM is elegant, simple and economical viable alternative to relational models which enable equivalent extent of semantical concepts.

Primary role of CRM is therefore enabling **exchange and integration of cultural heritage information**. It aims at providing the semantic definitions and clarifications needed to transform disparate, localised information sources into a coherent global resource. More specifically, it defines and is restricted to the underlying semantics of database schemata and document structures used in cultural heritage and museum documentation in terms of a formal ontology. It does not aim at proposing what cultural institutions should document. Rather it explains the logic of what they actually currently document, and thereby enables semantic interoperability.

The CRM aims to support the following specific functionalities:

- Inform developers of information systems as a guide to good practice in conceptual modelling, in order to effectively structure and relate information assets of cultural documentation.
- Serve as a common language for domain experts and IT developers to formulate requirements and to agree on system functionalities with respect to the correct handling of cultural contents.
- To serve as a formal language for the identification of common information contents in different data formats; in particular to support the implementation of automatic data transformation algorithms from local to global data structures without loss of meaning. The latter being useful for data exchange, data migration from legacy systems, data information integration and mediation of heterogeneous sources.
- To support associative queries against integrated resources by providing a global model of the basic classes and their associations to formulate such queries.
- It is further believed, that advanced natural language algorithms and case-specific heuristics can take significant advantage of the CRM to resolve free text information into a formal logical form, if that is regarded beneficial. The CRM is however not thought to be a means to replace scholarly text, rich in meaning, by logical forms, but only a means to identify related data.

Eide with other authors reports (Eide, 2008) progress on **AMA project**. Project aims at creating powerful mapping application for the creation of mappings from existing datasets. Result of the project was tool for mapping cultural heritage information contained in free text into a CIDOC-CRM compliant data model. They established templates describing relations between the structure of existing archives and CIDOC-CRM. And also they set up semantic framework to store, manage and browse the encoded information providing user-friendly interfaces. The AMA Mapping tool operate on any preliminary, fragmentary or old archaeological format or museum data (both structured and non-structured), and modern datasets, mapping their structure into a single, standardised CRM-compliant system, easily accessible for investigation by means of a web-based interface.

They also report about work on MAD (Managing Archaeological Data) that is a framework originally designed to manage structured and unstructured archaeological excavation datasets encoded using XML syntax, including free text documents marked up in XML. They have added more features that transform the first release into a multipurpose engine able to store and manage ontology encoded information, i.e. data structured in CIDOC-CRM compliant form. The framework can be used to browse and query such data in many powerful ways and to transform and supply semantic data on demand. The second release of the tool was enriched with a set of features devoted to the management of RDF documents encoded using CIDOC-CRM. They have also added some experimental geographic functions. They integrate spatial archaeological information in a spatial context. Fully implementes system will facilitate the creation and distribution of rich geospatial relationships across the Web and the use of geographic data in a Semantic Web scenario. They have also carried out tests using the Geographic Markup Language (GML) to encode geographic data related to archaeological records and to store them in container. Data serialised by the MAD system can be directly transformed in SVG or visualised using map server web applications. The flexibility of GML features will also allow the implementation of complex query-on-map functions to visually query and generate dynamic maps. MAD can also host and serialise KML archaeological files to be used in Google Earth and Google Maps applications.

Table: CIDOC CRM Class Hierarchy

E1	CRM Entity
E2	- Temporal Entity
E3	- - Condition State
E4	- - Period
E5	- - - Event
E7	- - - - Activity
E8	- - - - - Acquisition Event
E9	- - - - - Move
E10	- - - - - Transfer of Custody
E11	- - - - - Modification
E12	- - - - - - Production
E79	- - - - - - Part Addition
E80	- - - - - - Part Removal
E13	- - - - - Attribute Assignment
E14	- - - - - - Condition Assessment
E15	- - - - - - Identifier Assignment
E16	- - - - - - Measurement
E17	- - - - - - Type Assignment
E65	- - - - - Creation
E83	- - - - - - Type Creation
E66	- - - - - Formation
E63	- - - - Beginning of Existence
E67	- - - - - Birth
E81	- - - - - Transformation
E12	- - - - - *Production*
E65	- - - - - *Creation*
1.1.1.1.1	- - - - - - *Type Creation*
E66	- - - - - *Formation*
E64	- - - - End of Existence
E6	- - - - - Destruction
E68	- - - - - Dissolution
E69	- - - - - Death
E81	- - - - - *Transformation*
E77	- Persistent Item
E70	- - Thing
E72	- - - Legal Object
E18	- - - - Physical Thing
E19	- - - - - Physical Object
E20	- - - - - - Biological Object
E21	- - - - - - - Person
E22	- - - - - - Man-Made Object
E84	- - - - - - - Information Carrier
E24	- - - - - Physical Man-Made Thing
E22	- - - - - - *Man-Made Object*

E84 - - - - - - - - 1.1.1.1.1.1.2 Information Carrier
E25 - - - - - - - Man-Made Feature
E78 - - - - - - - Collection
E26 - - - - - - Physical Feature
E27 - - - - - - - Site
E25 - - - - - - - *Man-Made Feature*
E73 - - - - - Information Object
1.1.1.1.1 - - - - - - *1.1.1.1.1.1.4 Design or Procedure*

1.1.1.1.1 - - - - - - *1.1.1.1.1.1.6 Document*

1.1.1.1.1 - - - - - - - *1.1.1.1.1.1.8 Authority Document*

E33 - - - - - - Linguistic Object
1.1.1.1.1 - - - - - - - *1.1.1.1.1.1.10 Inscription*

1.1.1.1.1 - - - - - - - *1.1.1.1.1.1.12 Title*

E36 - - - - - - Visual Item
E37 - - - - - - - Mark
1.1.1.1.1 - - - - - - - - 1.1.1.1.1.1.14 Inscription

E38 - - - - - - - Image
E71 - - - - Man-Made Thing
E24 - - - - - *Physical Man-Made Thing*
E22 - - - - - - *Man-Made Object*
E84 - - - - - - - 1.1.1.1.1.1.15 Information Carrier
E25 - - - - - -
Man-Made Feature
E78 - - - - - -
Collection
E28 - - - - - Conceptual Object
1.1.1.1.1 - - - - - - 1.1.1.1.1.1.17 Information Object

1.1.1.1.1 - - - - - - - 1.1.1.1.1.1.19 Design or Procedure

1.1.1.1.1 - - - - - - - 1.1.1.1.1.1.21 Document

1.1.1.1.1 - - - - - - - - *Authority Document*

1.1.1.1.1 - - - - - - 1.1.1.1.1.1.24 Linguistic Object

E34 - - - - - - - *Inscription*
1.1.1.1.1 - - - - - - - 1.1.1.1.1.1.26 Title

E36 - - - - - - 1.1.1.1.1.1.27 Visual Item
E37 - - - - - - - 1.1.1.1.1.1.28 Mark
1.1.1.1.1 - - - - - - - - 1.1.1.1.1.1.30 Inscription

1.1.1.1.1 - - - - - - - 1.1.1.1.1.1.32 Image

E30 - - - - - Right
E55 - - - - - Type
E56 - - - - - - Language
E57 - - - - - - Material
E58 - - - - - - Measurement Unit
E39 - - Actor
E74 - - - Group
E40 - - - - Legal Body
E21 - - - *Person*
E41 - - Appellation
E42 - - - Object Identifier
E44 - - - Place Appellation
E45 - - - - Address
E46 - - - - Section Definition
E47 - - - - Spatial Coordinates
E48 - - - - Place Name
E49 - - - Time Appellation
E50 - - - - Date
E75 - - - Conceptual Object Appellation
E35 - - - *Title*
E82 - - - Actor Appellation
E51 - - Contact Point
E45 - - - *Address*
E52 - Time-Span
E53 - Place
E54 - Dimension
E59 Primitive Value
E60 - Number
E61 - Time Primitive
E62 - String

The CIDOC Conceptual Reference Model: A Standard for Communicating Cultural Contents

Resources and links:

- CIDOC Conceptual Reference Model (CRM), http://cidoc.ics.forth.gr/

- Encoding Cultural Heritage Information for the Semantic Web. Procedures for Data Integration through CIDOC-CRM Mapping. (2008).

- Eide, A. Felicetti, C.E. Ore, A. D'Andrea and J. Holmen. In: EPOCH Conference on Open Digital Cultural Heritage Systems (2008), pp. 1–7

Appendix 3.2 MUSEUM DOCUMENTATION STANDARD SPECTRUM

Standard SPECTRUM lists **procedures of good practice for museum documentation**. Activities in each procedure and subprocedure have specific requirements for documentation. The operation of a procedure requires recording of various information. These information requirements are listed along with subprocedures and are defined at two levels. First level is unit of information as lowest level of information and may represent data in one field. Second level is defined as information groups which are sets of units brought together to enable the recording of an object, events in the organisation persons, organisations, peoples and places associated with objects and events. Each procedure should achieve minimal standards as specified in its definition.

Standard SPECTRUM defines folowing procedures as follows:

- **Pre-entry**
  The management and documentation of the assessment of potential acquisitions before their arrival at the organisation.
- **Object entry**
  The management and documentation of the receipt of objects and associated information which are not currently part of the collections. Any object which does not currently have an object number assigned by the receiving organisation must be dealt with within this procedure.
- **Loans in**
  Managing and documenting the borrowing of objects for which the organisation is responsible for a specific period of time and for a specified purpose, normally exhibition/display, but including research, conservation, education or photography/publication.
- **Acquisition**
  Documenting and managing the addition of objects and associated information to the collections of the organisation and their possible accession to the permanent collections.
- **Inventory control**
  The maintenance of up-to-date information accounting for and locating all objects for which the organisation has a legal responsibility. This may include objects on loan, unaccessioned or previously undocumented items, temporarily deposited objects and support collections.
- **Location and movement control**
  The documentation and management of information concerning the current and past locations of all objects or groups of objects in the organisation's care to ensure the organisation can locate any object at any time. A location is a specific place where an object or group of objects is stored or displayed.
- **Transport**
  The management and documentation of the transport of objects for which the organisation is partially or fully responsible.
- **Cataloguing**
  The compilation and maintenance of key information, formally identifying and describing objects. It may include information concerning the provenance of objects and also collections management documentation.
- **Object condition checking and technical assessment**
  The management and documentation of information about the make-up and condition of an object, and recommendations for its use, treatment and surrounding environment.

- **Conservation and collections care**
  The documentation and management of information about interventive and preventive conservation activities.
- **Risk management**
  The management and documentation of information relating to potential threats to an organisation's collections and the objects for which it is temporarily responsible. It includes the provision of information enabling preventative measures to be taken as well as documentation supporting disaster planning.
- **Insurance and indemnity management**
  Documenting and managing the insurance needs of objects both in an organisation's permanent collection and those for which it is temporarily responsible.
- **Valuation control**
  The management of information relating to the financial valuations placed on individual objects, or groups of objects, normally for insurance/indemnity purposes.
- **Audit**
  The examination of objects or object information, in order to verify their location, authenticity, accuracy and relationships.
- **Rights management**
  The management and documentation of the rights associated with the objects and information for which the organisation is responsible for, in order to benefit the organisation and to respect the rights of others.
- **Use of collections**
  The management and documentation of all uses of and services based on collections and objects in the organisation.
- **Object exit**
  The management and documentation of objects leaving the organisation's premises.
- **Loans out**
  Documenting and managing the loan of objects to other organisations or individuals for a specific period of time and for a specific purpose, normally exhibition/display, but including research, conservation, photography and education.
- **Loss and damage**
  Managing and documenting an efficient response to the discovery of loss of, or damage to, object(s) whilst in the care of the organisation

Table SPECTRUM information group place

Place association		The way in which a Place is associated with the object.	manufactured; built; used
Place context		A number, code or term identifying physical evidence of an archaeological event, such as a wall, pit or ditch.	34; 56; XXI; kiln stoke-hole; North transept
	Place context date	The date of a context.	8/10/1990
	Place context level	A level within a context.	1; 5; B16; XB
Place coordinates		The precise location of a place expressed according to a chosen system.	AS 3192 6024
	Place coordinates qualifier	The measurement of accuracy of a given for Place coordinates.	+ or - 10; approximate
	Place coordinates type	The locating system used to describe the coordinates of a Place.	LL (Latitude & longitude); NGR (National Grid reference); UTM (Universal Transverse Mercator); Altitude Depth
Place environmental details		Environmental information relevant to an object, such as details about preservation conditions of the surrounding matrix.	waterlogged; carbonized bed
Place feature		The name by which a feature associated with an object is normally known.	Ben Lawers; Beachy Head; Chun Castle
	Place feature date	The date of the Place feature.	8/10/1990
	Place feature type	The nature or category of Place feature recorded.	island; mountain; bay; valley; cliff; castle; tomb
Place name		The name or title by which the Place is normally known.	Shrewsbury; North Sea; West Yorkshire
	Place name type	The nature or category of Place recorded.	baths; chambered tomb; market square; town
Place note		Additional information about Place which has not been recorded elsewhere using controlled terminology.	The site is four miles north of Ambleside
Place owner		The name of the owner of a Place associated with an object.	Can be person, organisation or people.
Place position		A precise position in a Place, usually to record the finding of an object in field collection.	Under a stone at the bottom of the cliff.
Place reference number		A code describing a Place associated with an object, excavation or specimen.	FLG1992
	Place reference number type	The category of Place reference number recorded.	SMR number; Project number; Scheduled monument number;
Place status		A formal administrative or scientific status assigned to a place.	National Trust Area of Outstanding Natural Beauty
Place type system		The classification system from which the Place feature type is taken.	RCHME; CIDOC

Source: SPECTRUM: The UK Museum Documentation Standard, 2009

Resources and links:

- McKenna, G. & Patsatzi, E. (2009). SPECTRUM: The UK Museum Documentation Standard. Cambridge: Collection Trust.

- Gradmann, S. (2009). WP3 Further specification of Functionality and Interoperability: Work Group 3.2 Semantic and Multilingual Aspects, Presentation at Athena meeting

Appendix 3.3. EUROPEANA SEMANTIC ELEMENTS SPECIFICATIONS (ESE)

Set of Europeana Semantic Elements consist of Dublin Core metadata elements and additionally twelve elements created to meet Europeana portal's needs. Descriptions includes metadata elements properties, XML syntax, usage in portal, obligation, occurrence and examples.

Coverage metadata element is used for spatial or temporal subject description of the resource and spatial applicability or jurisdiction. It is used for a named place, a location, a spatial coordinate, a period, date, date range or a named administrative entity. The description of coverage metadata element is included in *Table: Description of Coverage Metadata Element*.

Structure of Europeana Semantic Elements and their refinements are defined as below.

Element	Element Refinement(s)
- title	alternative
- creator	
- subject	
- description	tableOfContents
- publisher	
- contributor	
- date	created; issued
- type	
- format	extent; medium
- identifier	
- source	
- language	
- relation	isVersionOf; hasVersion; isReplacedBy; replaces; isRequiredBy; requires; isPartOf; hasPart; isReferencedBy; references; isFormatOf; hasFormat; conformsTo
- coverage	spatial; temporal
- rights	
- provenance	
- unstored	
- object	
- provider	
- type	
- isShownBy; isShownAt	
- country	
- hasObject	
- language	
- userTag	
- uri	

XML schema

Europeana uses Dublin Core XML schema for »coverage« metadata element.


```
<rdf:Description rdf:about="http://purl.org/dc/terms/coverage">
<rdfs:label xml:lang="en-US">Coverage</rdfs:label>
<rdfs:comment xml:lang="en-US">The spatial or temporal topic of the resource, the spatial
applicability of the resource, or the jurisdiction under which the resource is relevant.</rdfs:comment>
<dcterms:description xml:lang="en-US">Spatial topic and spatial applicability may be a named place
or a location specified by its geographic coordinates. Temporal topic may be a named period, date, or
date range. A jurisdiction may be a named administrative entity or a geographic place to which the
resource applies. Recommended best practice is to use a controlled vocabulary such as the
Thesaurus of Geographic Names [TGN]. Where appropriate, named places or time periods can be
used in preference to numeric identifiers such as sets of coordinates or date
ranges.</dcterms:description>
<rdfs:isDefinedBy rdf:resource="http://purl.org/dc/terms/"/>
<dcterms:issued>2008-01-14</dcterms:issued>
<dcterms:modified>2008-01-14</dcterms:modified>
<rdf:type rdf:resource="http://www.w3.org/1999/02/22-rdf-syntax-ns#Property"/>
<dcterms:hasVersion rdf:resource="http://dublincore.org/usage/terms/history/#coverageT-001"/>
<rdfs:range rdf:resource="http://purl.org/dc/terms/LocationPeriodOrJurisdiction"/>
<rdfs:subPropertyOf rdf:resource="http://purl.org/dc/elements/1.1/coverage"/>
</rdf:Description>
```


Description of Coverage Metadata Element

Element name: coverage					
Namespace	dc				
URI	http://purl.org/dc/terms/coverage				
Label	Coverage				
Definition	The spatial or temporal topic of the resource, the spatial applicability of the resource, or the jurisdiction under which the resource is relevant. This may be a named place, a location, a spatial coordinate, a period, date, date range or a named administrative entity. Refined by <dcterms:spatial> and <dcterms:temporal>				
Europeana note	Coverage is the unqualified spatial or temporal coverage of the original analog or born digital object. Use of the more specific <dcterms:spatial> and <dcterms:temporal> elements is preferred where possible.				
Obligation & Occurrence	Optional (Minimum: 0, Maximum: unbounded)				
Europeana search and display features	Simple search	Facet	Timeline	Advanced search	Full search result display
	X				X (More: Subject Line)

Example	<dc:coverage>1995-1996</dc:coverage> <dc:coverage>Boston, MA</dc:coverage>
Europeana Semantic Elements specifications (2009)	

Example of detailed item from Europeana portal

Title:	Photograph of Minard Castle
Date:	1774-01-01 00:00:00; 1774-12-31 00:00:00; 1774 built
Creator:	Peter Rourke photographer; The Rourke Collection
Description:	Scotland, Argyll, Lochgilphead locality
Language:	en
Format:	image/jpeg
Rights:	The Rourke Collection
Provider:	Scran ; uk
Identifier:	000-000-339-138; 000-000-339-138-R
Subject:	Architecture and Buildings - Castles

Resources and links:

- Europeana Semantic Elements specifications (2009). Retrieved 13. November 2009, from http://group.europeana.eu/c/document_library/get_file?uuid=c56f82a4-8191-42fa-9379-4d5ff8c4ff75&groupId=10602

- Metadata Mapping & Normalisation Guidelines for the Europeana Prototype (2009). Retrieved 13. November 2009, http://version1.europeana.eu/c/document_library/get_file?uuid=58e2b828-b5f3-4fe0-aa46-3dcbc0a2a1f0&groupId=10602

- Dekkers, M. et al. (2009). Europeana Outline Functional Specification. Retrieved 13. November 2009, from http://version1.europeana.eu/c/document_library/get_file?uuid=a9e29cb4-a9b3-462a-a43d-0b480c677088&groupId=10602

Appendix 3.4. DUBLIN CORE METADATA ELEMENT SET (DCMES)

The Dublin Core metadata standard is a simple yet effective element set for describing a wide range of **networked resources**. The semantics of Dublin Core have been established by an international, cross-disciplinary group of professionals from librarianship, computer science, text encoding, the museum community, and other related fields of scholarship and practice.

Descriptive metadata are used for discovery and interpretation of digital object. DCMES is simple descriptive metadata schema suitable for different domains. It consist of fifteen elements.The Dublin Core Metadata Elements are defined in a table below. Dublin Core Metadata Element Set can be used as “simple” or “qualified” Dublin Core. Simple or unqualifilied version use only main 15 elements as simple attribute-value pairs without any "qualifiers" (such as encoding schemes, enumerated lists of values, or other processing clues) to provide more detailed information about a resource. "Qualified Dublin Core" employs additional qualifiers to further refine the meaning of a resource. One use for such qualifiers are to indicate if a metadata value is a compound or structured value, rather than just a string.

Element Name: contributor	
Label:	Contributor
Definition:	An entity responsible for making contributions to the resource.
Comment:	Examples of a Contributor include a person, an organization, or a service. Typically, the name of a Contributor should be used to indicate the entity.
Element Name: coverage	
Label:	Coverage
Definition:	The spatial or temporal topic of the resource, the spatial applicability of the resource, or the jurisdiction under which the resource is relevant.
Comment:	Spatial topic and spatial applicability may be a named place or a location specified by its geographic coordinates. Temporal topic may be a named period, date, or date range. A jurisdiction may be a named administrative entity or a geographic place to which the resource applies. Recommended best practice is to use a controlled vocabulary such as the Thesaurus of Geographic Names [TGN]. Where appropriate, named places or time periods can be used in preference to numeric identifiers such as sets of coordinates or date ranges.
Element Name: creator	
Label:	Creator
Definition:	An entity primarily responsible for making the resource.
Comment:	Examples of a Creator include a person, an organization, or a service. Typically, the name of a Creator should be used to indicate the entity.
Element Name: date	
Label:	Date
Definition:	A point or period of time associated with an event in the lifecycle of the resource.
Comment:	Date may be used to express temporal information at any level of granularity. Recommended best practice is to use an encoding scheme, such as the W3CDTF profile of ISO 8601 [W3CDTF].
Element Name: description	

Label:	Description
Definition:	An account of the resource.
Comment:	Description may include but is not limited to: an abstract, a table of contents, a graphical representation, or a free-text account of the resource.
Element Name: format	
Label:	Format
Definition:	The file format, physical medium, or dimensions of the resource.
Comment:	Examples of dimensions include size and duration. Recommended best practice is to use a controlled vocabulary such as the list of Internet Media Types [MIME].
Element Name: identifier	
Label:	Identifier
Definition:	An unambiguous reference to the resource within a given context.
Comment:	Recommended best practice is to identify the resource by means of a string conforming to a formal identification system.
Element Name: language	
Label:	Language
Definition:	A language of the resource.
Comment:	Recommended best practice is to use a controlled vocabulary such as RFC 4646 [RFC4646].
Element Name: publisher	
Label:	Publisher
Definition:	An entity responsible for making the resource available.
Comment:	Examples of a Publisher include a person, an organization, or a service. Typically, the name of a Publisher should be used to indicate the entity.
Element Name: relation	
Label:	Relation
Definition:	A related resource.
Comment:	Recommended best practice is to identify the related resource by means of a string conforming to a formal identification system.
Element Name: rights	
Label:	Rights
Definition:	Information about rights held in and over the resource.
Comment:	Typically, rights information includes a statement about various property rights associated with the resource, including intellectual property rights.
Element Name: source	
Label:	Source
Definition:	A related resource from which the described resource is derived.
Comment:	The described resource may be derived from the related resource in whole or in part. Recommended best practice is to identify the related resource by means of a string conforming to a formal identification system.
Element Name: subject	
Label:	Subject
Definition:	The topic of the resource.

Comment:	Typically, the subject will be represented using keywords, key phrases, or classification codes. Recommended best practice is to use a controlled vocabulary. To describe the spatial or temporal topic of the resource, use the Coverage element.
1.1.1.1.1.1.33 Element Name: title	
Label:	Title
Definition:	A name given to the resource.
Comment:	Typically, a Title will be a name by which the resource is formally known.
Element Name: type	
Label:	Type
Definition:	The nature or genre of the resource.
Comment:	Recommended best practice is to use a controlled vocabulary such as the DCMI Type Vocabulary [DCMITYPE]. To describe the file format, physical medium, or dimensions of the resource, use the Format element.
Source: Dublin Core Metadata Element Set, version 1.1. Reference description, Dublin Core Metadata Initiative, 14. November 2009	

Dublin Core XML schema for »coverage« metadata element and element refinement »spatial coverage«:

```
<rdf:Description rdf:about="http://purl.org/dc/terms/coverage">
<rdfs:label xml:lang="en-US">Coverage</rdfs:label>
<rdfs:comment xml:lang="en-US">The spatial or temporal topic of the resource, the spatial applicability of the resource, or the jurisdiction under which the resource is relevant.</rdfs:comment>
<dcterms:description xml:lang="en-US">Spatial topic and spatial applicability may be a named place or a location specified by its geographic coordinates. Temporal topic may be a named period, date, or date range. A jurisdiction may be a named administrative entity or a geographic place to which the resource applies. Recommended best practice is to use a controlled vocabulary such as the Thesaurus of Geographic Names [TGN]. Where appropriate, named places or time periods can be used in preference to numeric identifiers such as sets of coordinates or date ranges.</dcterms:description>
<rdfs:isDefinedBy rdf:resource="http://purl.org/dc/terms/"/>
<dcterms:issued>2008-01-14</dcterms:issued>
<dcterms:modified>2008-01-14</dcterms:modified>
<rdf:type rdf:resource="http://www.w3.org/1999/02/22-rdf-syntax-ns#Property"/>
<dcterms:hasVersion rdf:resource="http://dublincore.org/usage/terms/history/#coverageT-001"/>
<rdfs:range rdf:resource="http://purl.org/dc/terms/LocationPeriodOrJurisdiction"/>
<rdfs:subPropertyOf rdf:resource="http://purl.org/dc/elements/1.1/coverage"/>
</rdf:Description>
```

```
<rdf:Description rdf:about="http://purl.org/dc/terms/spatial">
<rdfs:label xml:lang="en-US">Spatial Coverage</rdfs:label>
<rdfs:comment xml:lang="en-US">Spatial characteristics of the resource.</rdfs:comment>
<rdfs:isDefinedBy rdf:resource="http://purl.org/dc/terms/"/>
<dcterms:issued>2000-07-11</dcterms:issued>
<dcterms:modified>2008-01-14</dcterms:modified>
<rdf:type rdf:resource="http://www.w3.org/1999/02/22-rdf-syntax-ns#Property"/>
<dcterms:hasVersion rdf:resource="http://dublincore.org/usage/terms/history/#spatial-003"/>
<rdfs:range rdf:resource="http://purl.org/dc/terms/Location"/>
<rdfs:subPropertyOf rdf:resource="http://purl.org/dc/elements/1.1/coverage"/>
<rdfs:subPropertyOf rdf:resource="http://purl.org/dc/terms/coverage"/>
</rdf:Description>
```

Resources and links:

- Dublin Core Metadata Element Set, Version 1.1 (2009). Retrieved 14. November 2009, from http://dublincore.org/documents/dces/

- The Dublin Core Metadata Initiative (2009). Retrieved 14. November 2009, from http://dublincore.org

Appendix 3.5. SIMPLE KNOWLEDGE ORGANIZATION SYSTEM (SKOS)

The SKOS data model is formally defined in this specification as an **OWL Full ontology**. SKOS data are expressed as RDF triples, and may be encoded using any concrete RDF syntax (such as RDF/XML or Turtle).

The SKOS data model views a knowledge organization system as a concept scheme comprising a set of concepts. These **SKOS concept schemes** and SKOS concepts are identified by URIs, enabling anyone to refer to them unambiguously from any context, and making them a part of the World Wide Web.

SKOS concepts can be labeled with any number of lexical (UNICODE) strings in any given natural language. One of these labels in any given language can be indicated as the preferred label for that language, and the others as alternative labels. Labels may also be "hidden", which is useful where a knowledge organization system is being queried via a text index.

SKOS concepts can be assigned one or more notations, which are lexical codes used to uniquely identify the concept within the scope of a given concept scheme. While URIs are the preferred means of identifying SKOS concepts within computer systems, notations provide a bridge to other systems of identification already in use such as classification codes used in library catalogs.

SKOS concepts can be documented with notes of various types. The SKOS data model provides a basic set of documentation properties, supporting scope notes, definitions and editorial notes, among others. This set is not meant to be exhaustive, but rather to provide a framework that can be extended by third parties to provide support for more specific types of note.

SKOS concepts can be linked to other SKOS concepts via semantic relation properties. The SKOS data model provides support for hierarchical and associative links between SKOS concepts. Again, as with any part of the SKOS data model, these can be extended by third parties to provide support for more specific needs.

SKOS concepts can be grouped into collections, which can be labeled and/or ordered. This feature of the SKOS data model is intended to provide support for node labels within thesauri, and for situations where the ordering of a set of concepts is meaningful or provides some useful information.

SKOS concepts can be mapped to other SKOS concepts in different concept schemes. The SKOS data model provides support for four basic types of mapping link: hierarchical, associative, close equivalent and exact equivalent.

SKOS eXtension for Labels (SKOS-XL) provides more support for identifying, describing and linking lexical entities.

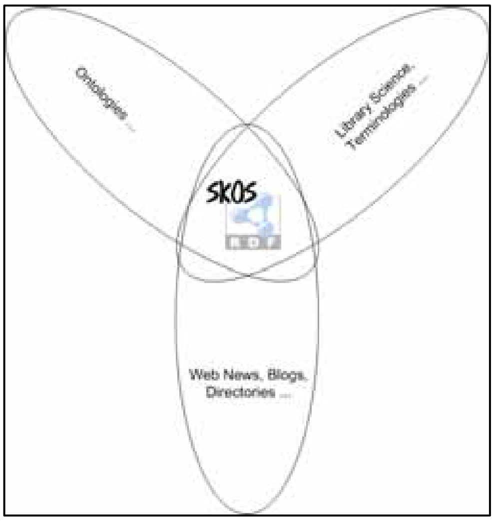
Table below lists URI with their definitions.

URI	Definition
skos:Concept	The class skos:Concept is the class of SKOS concepts. A SKOS concept can be viewed as an idea or notion; a unit of thought. However, what constitutes a unit of thought is subjective, and this definition is meant to be suggestive, rather than restrictive. The notion of a SKOS concept is useful when describing the conceptual or intellectual structure of a knowledge organization system, and when referring to specific ideas or meanings established within a KOS.
skos:ConceptScheme skos:inScheme skos:hasTopConcept skos:topConceptOf	A SKOS concept scheme can be viewed as an aggregation of one or more SKOS concepts. Semantic relationships (links) between those concepts may also be viewed as part of a concept scheme. This definition is, however, meant to be suggestive rather than restrictive, and there is some flexibility in the formal data model stated below.
skos:altLabel skos:hiddenLabel skos:prefLabel	A lexical label is a string of UNICODE characters in a given natural language, such as English or Japanese. The Simple Knowledge Organization System provides some basic vocabulary for associating lexical labels with resources of any type. In particular, SKOS enables a distinction to be made between the preferred, alternative and "hidden" lexical labels for any given resource.
skos:notation	A notation is a string of characters such as "T58.5" or "303.4833" used to uniquely identify a concept within the scope of a given concept scheme. A notation is different from a lexical label in that a notation is not normally recognizable as a word or sequence of words in any natural language.
skos:changeNote skos:definition skos:editorialNote skos:example skos:historyNote skos:note skos:scopeNote	Notes are used to provide information relating to SKOS concepts. There is no restriction on the nature of this information, e.g., it could be plain text, hypertext, or an image; it could be a definition, information about the scope of a concept, editorial information, or any other type of information. There are seven properties in SKOS for associating notes with concepts, defined formally in this section.
skos:broader skos:broaderTransitive skos:narrower skos:narrowerTransitive skos:related skos:semanticRelation	SKOS semantic relations are links between SKOS concepts, where the link is inherent in the meaning of the linked concepts. The Simple Knowledge Organization System distinguishes between two basic categories of semantic relation: hierarchical and associative. A hierarchical link between two concepts indicates that one is in some way more general ("broader") than the other ("narrower"). An associative link between two concepts indicates that the two are inherently "related", but that one is not in any way more general than the other.

skos:Collection skos:OrderedCollection skos:member skos:memberList	SKOS concept collections are labeled and/or ordered groups of SKOS concepts. Collections are useful where a group of concepts shares something in common, and it is convenient to group them under a common label, or where some concepts can be placed in a meaningful order.
skos:broadMatch skos:closeMatch skos:exactMatch skos:mappingRelation skos:narrowMatch skos:relatedMatch	The SKOS mapping properties are used to state mapping (alignment) links between SKOS concepts in different concept schemes, where the links are inherent in the meaning of the linked concepts. The properties skos:broadMatch and skos:narrowMatch are used to state a hierarchical mapping link between two concepts. The property skos:relatedMatch is used to state an associative mapping link between two concepts. The property skos:closeMatch is used to link two concepts that are sufficiently similar that they can be used interchangeably in some information retrieval applications. In order to avoid the possibility of "compound errors" when combining mappings across more than two concept schemes, skos:closeMatch is not declared to be a transitive property. The property skos:exactMatch is used to link two concepts, indicating a high degree of confidence that the concepts can be used interchangeably across a wide range of information retrieval applications. skos:exactMatch is a transitive property, and is a sub-property of skos:closeMatch.

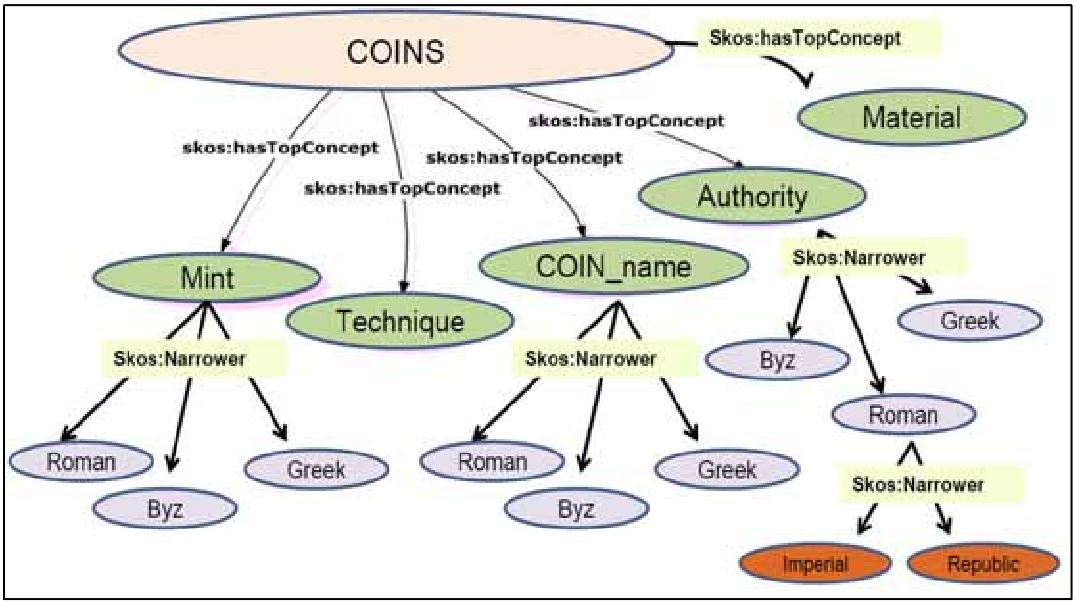
Standard SKOS is seen as connecting link between ontologies, Web resources and classic controlled vocabularies.

Scheme1: SKOS as Connecting Link



Source: Miles, A. et al. (2005).SKOS Core: a language to describe simple knowledge structures for the web.

Scheme 2: Example of Hierarchical Taxonomy of Coins.



Source: D'Andrea, A. (2009). Introduction of SKOS.

Resources and links:

- SKOS Simple Knowledge Organization System Primer (2009). Retrieved 14. November 2009, from http://www.w3.org/TR/skos-primer

- SKOS Simple Knowledge Organization System Reference (2009). Retrieved 14. November 2009, from http://www.w3.org/TR/skos-reference

- Voss, J. (2008). Encoding changing country codes for the Semantic Web with ISO 3166 and SKOS. Retrieved 14. November 2009, from http://arxiv.org/abs/0801.3908v1

Appendix 3.6 ISO/TC 211 GEOGRAPHIC INFORMATION/GEOMATICS

INFRASTRUCTURE FOR GEOSPATIAL STANDARDIZATION	
ISO 19101 Geographic information — Reference model	This International Standard is a guide to structuring geographic information standards in a way that will enable the universal usage of digital geographic information. This reference model describes the overall requirements for standardization and the fundamental principles that apply in developing and using standards for geographic information.
ISO/TS 19103 Geographic information — Conceptual schema language	There are two aspects to this Technical Specification. The first step was to select a CSL that meets the requirements for rigorous representation of geographic information. This Technical Specification identifies the combination of the Unified Modeling Language (UML) static structure diagram with its associated Object Constraint Language (OCL) and a set of basic type definitions as the conceptual schema language for specification of geographic information. Secondly, this Technical Specification provides guidelines on how UML should be used to create geographic information and service models that are a basis for achieving the goal of interoperability.
ISO/TS 19104 Geographic information — Terminology	This Technical Specification provides the guidelines for collection and maintenance of terminology in the field of geographic information. It establishes criteria for selection of concepts to be included in other standards concerning geographic information, which are developed by ISO/TC 211, specifies the structure of the terminological record, and describes the principles for definition writing.
ISO 19105 Geographic information — Conformance and testing	This International Standard specifies the framework, concepts and methodology for testing and criteria to be achieved to claim conformance to the family of ISO geographic information standards. It provides a framework for specifying abstract test suites (ATS) and for defining the procedures to be followed during conformance testing. Conformance may be claimed for data or software products or services or by specifications including any profile or functional standard
ISO 19106 Geographic information — Profiles	The ISO geographic information standards define a variety of models for describing, managing, and processing of geospatial data. Some of these standards create elements, others introduce structures and rules. Different user communities have different requirements for the extent they want to use or implement these elements and rules. Clearly identification and documentation of specific subsets of the ISO

	geographic information standards in a prescribed manner in conformance with these standards profiles are needed
DATA MODELS FOR GEOGRAPHIC INFORMATION	
ISO 19109 Geographic information — Rules for application schema	This International Standard defines rules for creating and documenting application schemas, including principles for the definition of features. An application schema provides the formal description of the data structure and content required by one or more applications. An application schema contains the descriptions of both geographic data and other related data. A fundamental concept of geographic data is the feature.
ISO 19107 Geographic information — Spatial schema	This International Standard provides conceptual schemas for describing and manipulating the spatial characteristics of geographic features. A feature is an abstraction of a real world phenomenon; it is a geographic feature if it is associated with a location relative to the Earth.
ISO 19137 Geographic information — Core profile of the spatial schema	This International Standard defines a core profile of the spatial schema specified in ISO 19107 that specifies, in accordance with ISO 19106, a minimal set of geometric elements necessary for the efficient creation of application schemata.
ISO 19123 Geographic information — Schema for coverage geometry and functions	This International Standard defines a conceptual schema for the spatial characteristics of coverages. Coverages support mapping from a spatial, temporal or spatiotemporal domain to feature attribute values where feature attribute types are common to all geographic positions within the domain. A coverage domain consists of a collection of direct positions in a coordinate space that may be defined in terms of up to three spatial dimensions as well as a temporal dimension.
ISO 19108 Geographic information — Temporal schema	This International Standard defines the standard concepts needed to describe the temporal characteristics of geographic information as they are abstracted from the real world. Temporal characteristics of geographic information include feature attributes, feature operations, feature associations, and metadata elements that take a value in the temporal domain.
ISO 19141 Geographic information — Schema for moving features	This International Standard specifies a conceptual schema that addresses moving features, i.e., features whose locations change over time. This schema includes classes, attributes, associations and operations that provide a common conceptual framework that can be implemented to support various application areas that deal with moving features.
ISO 19111 Geographic	ISO 19111 provides a schema for describing the

information — Spatial referencing by coordinates	coordinate reference systems used to relate the position of geometric primitives to the earth or another object.
ISO 19112 Geographic information — Spatial referencing by geographic identifiers	ISO 19112 provides a general model for spatial referencing using geographic identifiers, as well as specifying the components of a spatial reference system and the essential components of a gazetteer.
GEOGRAPHIC INFORMATION MANAGEMENT	
ISO 19110 Geographic information — Methodology for feature cataloguing	ISO 19110 specifies a methodology for developing catalogues containing definitions of feature types and their property types, including feature attributes, feature associations, and feature operations.
ISO 19115 Geographic information — Metadata	The objective of this International Standard is to provide a structure for describing digital geographic data.
ISO 19113 Geographic information — Quality principles	The objective of this International Standard is to provide principles for describing the quality for geographic data and concepts for handling quality information for geographic data.
ISO 19114 Geographic information — Quality evaluation procedures	This International Standard provides a framework of procedures for determining and evaluating quality that is applicable to digital geographic datasets, consistent with the data quality principles defined in ISO 19113. It also establishes a framework for evaluating and reporting data quality results, either as part of data quality metadata only, or also as a quality evaluation report.
ISO 19131 Geographic information — Data product specifications	This International Standard describes requirements for the specification of geographic data products, based upon the concepts of other ISO 19100 International Standards. It describes the content and structure of a data product specification. It also provides help in the creation of data product specifications, so that they are easily understood and fit for their intended purpose.
ISO 19135 Geographic information — Procedures for item registration	publishing registers of unique, unambiguous and permanent identifiers and meanings that are assigned to items of geographic information. In order to accomplish this purpose, this International Standard specifies elements of information that are necessary to provide identification and meaning to the registered items and to manage the registration of these items.
ISO/TS 19127 Geographic information — Geodetic codes and parameters	This Technical Specification defines rules for the population and maintenance of registers of geodetic codes and parameters and identifies the data elements, in compliance with ISO 19111 and ISO 19135, required within these registers. Recommendations for the use of the registers, the legal aspects, the applicability to historic data, the completeness of the registers, and a mechanism for maintenance are specified by the registers themselves.

ISO/TS 19138 Geographic information — Data quality measures	This Technical Specification defines a set of data quality measures. These can be used when reporting data quality for the data quality subelements identified in ISO 19113. Multiple measures are defined for each data quality subelement, and the choice of which to use will depend on the type of data and its intended purpose. The data quality measures are structured so that they can be maintained in a register established in conformance with ISO 19135.
GEOGRAPHIC INFORMATION SERVICES	
ISO 19119 Geographic information — Services	This International Standard extends the architectural reference model defined in ISO 19101, in which an Extended Open Systems Environment (EOSE) model for geographic services is defined. This International Standard defines the approach to defining services that is used in the ISO 19100 series of standards.
ISO 19116 Geographic information — Positioning services	This International Standard specifies the data structure and content of an interface that permits communication between position-providing device(s) and position-using device(s) so that the position-using device(s) can obtain and unambiguously interpret position information and determine whether the results meet the requirements of the use.
ISO 19117 Geographic information — Portrayal	This International Standard defines a schema for describing the portrayal of geographic information in a form understandable by humans. It includes the methodology for describing symbols and mapping of the schema to an application schema. It does not include standardization of cartographic symbols, and their geometric and functional description.
ISO 19125-1 Geographic information — Simple feature access — Part 1: Common architecture	This part of ISO 19125 describes the common architecture for simple feature geometry. The simple feature geometry object model is Distributed Computing Platform neutral and uses UML notation.
ISO 19125-2 Geographic information — Simple feature access — Part 2: SQL option	The purpose of this part of ISO 19125 is to define a standard Structured Query Language (SQL) schema that supports storage, retrieval, query and update of feature collections via the SQL Call-Level Interface (SQL/CLI) (ISO/IEC 9075-3:2003). A feature has both spatial and non-spatial attributes. Spatial attributes are geometry valued, and simple features are based on 2D geometry with linear interpolation between vertices.
ISO 19128 Geographic information — Web map server interface	This International Standard specifies the behaviour of a Web Map Service (WMS) that produces spatially referenced maps dynamically from geographic information. It specifies operations to retrieve a description of the maps offered by a server to retrieve a map, and to query a server about features displayed on a map. This International Standard is applicable to

	pictorial renderings of maps in a graphical format; it is not applicable to retrieval of actual feature data or coverage data values.
ISO 19132 Geographic information — Location based services — Reference mode	This International Standard defines a reference model and a conceptual framework for location-based services (LBS), and describes the basic principles by which LBS applications may interoperate. This framework references or contains an ontology, a taxonomy, a set of design patterns and a core set of LBS service abstract specifications in UML. This International Standard further specifies the framework's relationship to other frameworks, applications and services for geographic information and to client applications.
ISO 19133 Geographic information — Location based services — Tracking and navigation	This International Standard is a description of the data and services needed to support tracking and navigation applications for mobile clients. The web services views of this International Standard are given in Annex C. This International Standard describes the data types, and operations associated with those types, for the implementation of tracking and navigation services. This International Standard is designed to specify web services that can be made available to wireless devices through web-resident proxy applications, but is not restricted to that environment.
ISO 19134 Geographic information — Location base services — Multimodal routing and navigation	This International Standard provides a conceptual schema for describing the data and services needed to support routing and navigation application for mobile clients who intend to reach a target position using two or more modes of transportation. This International Standard provides a description of a service type to support routing and navigation for a mode that operates either on a fixed route or with a fixed schedule, a description of data type for transfers, and a description of data type for schedule information and route information of a mode with a fixed route and/or schedule.
ENCODING OF GEOGRAPHIC INFORMATION	
ISO 19118 Geographic information — Encoding	This International Standard specifies: requirements for creating encoding rules based on UML schemas, requirements for creating encoding services, an informative XML based encoding rule for neutral interchange of geographic data.
ISO 6709 Standard representation of geographic point location by coordinates	This International Standard is applicable to the interchange of coordinates describing geographic point location. It specifies the representation of coordinates including latitude and longitude to be used in data interchange. It additionally specifies representation of horizontal point location using coordinate types other than latitude and longitude. It also specifies the

	representation of height and depth that may be associated with horizontal coordinates. Representation includes units of measure and coordinate order.
ISO 19136 Geographic information — Geography Markup Language (GML)	The Geography Markup Language (GML) is an XML encoding in compliance with ISO 19118 for the transport and storage of geographic information modelled according to the conceptual modelling framework used in the ISO 19100 series of International Standards and including both the spatial and non-spatial properties of geographic features.
ISO/TS 19139 Geographic information — Metadata — XML schema implementation	This Technical Specification defines Geographic MetaData XML (gmd) encoding, an XML schema implementation derived from ISO 19115.
STANDARDS FOR SPECIFIC THEMATIC AREAS	
ISO/TS 19101-2 Geographic information — Reference model — Part 2: Imagery	This Technical Specification defines a reference model for standardization in the field of geographic imagery processing. This reference model identifies the scope of the standardization activity being undertaken and the context in which it takes place. The reference model includes gridded data with an emphasis on imagery. Although structured in the context of information technology and information technology standards, this Technical Specification is independent of any application development method or technology implementation approach.
ISO 19115-2 Geographic information — Metadata — Part 2: Extensions for imagery and gridded data	The extended metadata are provided for geographic image and gridded datasets which include the geospatial imagery and gridded data and may optionally be provided for aggregations of datasets.
Source: standards guide ISO/TC 211 geographic information/geomatics, 2009-06-01	

Resources and links:

- http://www.iso.org/

Appendix 3.7 OPENGIS: OPEN GEOSPATIAL CONSORTIUM

Table: OpenGIS Standards

OpenGIS Catalogue Service Implementation Specification	The OpenGIS® Catalogue Services Interface Standard (CAT) supports the ability to publish and search collections of descriptive information (metadata) about geospatial data, services and related resources. Providers of resources use catalogues to register metadata that conform to the provider's choice of an information model; such models include descriptions of spatial references and thematic information. Client applications can then search for geospatial data and services in very efficient ways.
City Geography Markup Language (CityGML) Encoding Standard	This document is an OpenGIS® Encoding Standard for the representation, storage and exchange of virtual 3D city and landscape models. CityGML is implemented as an application schema of the Geography Markup Language version 3.1.1 (GML3). CityGML models both complex and georeferenced 3D vector data along with the semantics associated with the data. In contrast to other 3D vector formats, CityGML is based on a rich, general purpose information model in addition to geometry and appearance information. For specific domain areas, CityGML also provides an extension mechanism to enrich the data with identifiable features under preservation of semantic interoperability.
Coordinate Transformation Service	The OpenGIS® Coordinate Transformation Service Standard (CT) provides a standard way for software to specify and access coordinate transformation services for use on specified spatial data. This standard addresses a key requirement for overlaying views of geodata ("maps") from diverse sources: the ability to perform coordinate transformation in such a way that all spatial data are defined relative to the same spatial reference system.
The OpenGIS® Filter Encoding Standard (FES)	Defines an XML encoding for filter expressions. A filter expression logically combines constraints on the properties of a feature in order to identify a particular subset of features to be operated upon. For example, a subset of features might be identified to render them in a particular color or convert them into a user-specified format. Constraints can be specified on values of spatial, temporal and scalar properties. An example of a filter is: Find all the properties in Omstead County owned by Peter Vretanos.
Geographic Objects	The OpenGIS® Geographic Objects Interface Standard (GOS) provides an open set of common, lightweight, language-independent abstractions for describing, managing, rendering, and manipulating geometric and

	geographic objects within an application programming environment. It provides both an abstract object standard (in UML) and a programming-language-specific profile (in Java). The language-specific bindings serve as an open Application Program Interface (API).
Geography Markup Language	The OpenGIS® Geography Markup Language Encoding Standard (GML) The Geography Markup Language (GML) is an XML grammar for expressing geographical features. GML serves as a modeling language for geographic systems as well as an open interchange format for geographic transactions on the Internet. As with most XML based grammars, there are two parts to the grammar – the schema that describes the document and the instance document that contains the actual data.
GeoXACML Implementation Specification	The OpenGIS® Geospatial eXtensible Access Control Markup Language Encoding Standard (GeoXACML) defines a geospatial extension to the OASIS standard "eXtensible Access Control Markup Language (XACML)" [www.oasis-open.org/committees/xacml/]. This extension incorporates spatial data types and spatial authorization decision functions based on the OGC Simple Features[http://www.opengeospatial.org/standards/sfa] and GML[http://www.opengeospatial.org/standards/gml] standards. GeoXACML is a policy language that supports the declaration and enforcement of access rights across jurisdictions and can be used to implement interoperable access control systems for geospatial applications such as Spatial Data Infrastructures. GeoXACML is not designed to be a rights expression language and is therefore not an extension of the OGC GeoDRM Reference Model (Topic 18 in the OpenGIS® Abstract Specification [http://www.opengeospatial.org/standards/as]).
GML in JPEG 2000 for Geographic Imagery Encoding	The OpenGIS® GML in JPEG 2000 for Geographic Imagery Encoding Standard defines the means by which the OpenGIS® Geography Markup Language (GML) Standard [http://www.opengeospatial.org/standards/gml] is used within JPEG 2000 [www.jpeg.org/jpeg2000/] images for geographic imagery. The standard also provides packaging mechanisms for including GML within JPEG 2000 data files and specific GML application schemas to support the encoding of images within JPEG 2000 data files. JPEG 2000 is a wavelet-based image compression standard that provides the ability to include

	XML data for description of the image within the JPEG 2000 data file.
Grid Coverage Service	The OpenGIS® Grid Coverage Service Implementation Specification defines methods that allow interoperability between software implementations by data vendors and software vendors providing grid (raster) analysis and processing capabilities.
KML	Google submitted KML (formerly Keyhole Markup Language) to the Open Geospatial Consortium (OGC) to be evolved within the OGC consensus process with the following goal: KML Version 2.2 has been adopted as an OGC implementation standard. Future versions may be harmonized with relevant OGC standards that comprise the OGC standards baseline.
Location Service (OpenLS)	The OpenGIS® Open Location Services Interface Standard (OpenLS) specifies interfaces that enable companies in the Location Based Services (LBS) value chain to “hook up” and provide their pieces of applications such as emergency response (E-911, for example), personal navigator, traffic information service, proximity service, location recall, mobile field service, travel directions, restaurant finder, corporate asset locator, concierge, routing, vector map portrayal and interaction, friend finder, and geography voice-graphics. These applications are enabled by interfaces that implement OpenLS services such as a Directory Service, Gateway Service, Geocoder Service, Presentation (Map Portrayal) Service and others.
Observations and Measurements	The OpenGIS® Observations and Measurements Encoding Standard (O&M) defines an abstract model and an XML schema [www.w3.org/XML/Schema] encoding for observations and it provides support for common sampling strategies. O&M also provides a general framework for systems that deal in technical measurements in science and engineering. This is one of the OGC Sensor Web Enablement (SWE) [http://www.opengeospatial.org/ogc/markets-technologies/swe] suite of standards.
Sensor Model Language (SensorML)	The OpenGIS® Sensor Model Language Encoding Standard (SensorML) specifies models and XML encoding that provide a framework within which the geometric, dynamic, and observational characteristics of sensors and sensor systems can be defined. There are many different sensor types, from simple visual thermometers to complex electron microscopes and earth observing satellites. These can all be supported through the definition of atomic process models and process chains. Within SensorML, all processes and

	components are encoded as application schema of the Feature model in the Geographic Markup Language (GML) Version 3.1.1. This is one of the OGC Sensor Web Enablement (SWE) [http://www.opengeospatial.org/ogc/markets-technologies/swe] suite of standards. For additional information on SensorML, see http://vast.uah.edu/SensorML.
Simple Feature Access - Part 1: Common Architecture	Part 1 "Common Architecture" supplies the common feature model for use by applications that will use the Simple Features data stores and access interfaces.
OpenGIS Implementation Specification for Geographic information - Simple feature access - Part 2: SQL option	Part 2 provides a standard SQL implementation of the abstract model in Part 1. (Note: The OpenGIS® Simple Features Interface Standards for OLE/COM and CORBA are no longer current and are not provided here.)
Styled Layer Descriptor	The OpenGIS® Styled Layer Descriptor (SLD) Profile of the OpenGIS® Web Map Service (WMS) Encoding Standard [http://www.opengeospatial.org/standards/wms] defines an encoding that extends the WMS standard to allow user-defined symbolization and coloring of geographic feature[http://www.opengeospatial.org/ogc/glossary/f] and coverage[http://www.opengeospatial.org/ogc/glossary/c] data.
Transducer Markup Language (TML)	The OpenGIS® Transducer Markup Language Encoding Standard (TML) is an application and presentation layer communication protocol for exchanging live streaming or archived data to (i.e. control data) and/or sensor data from any sensor system. A sensor system can be one or more sensors, receivers, actuators, transmitters, and processes. A TML client can be capable of handling any TML enabled sensor system without prior knowledge of that system.
Web Coverage Service (WCS)	The OpenGIS® Web Coverage Service Interface Standard (WCS) defines a standard interface and operations that enables interoperable access to geospatial "coverages" [http://www.opengeospatial.org/ogc/glossary/c]. The term "grid coverages" typically refers to content such as satellite images, digital aerial photos, digital elevation data, and other phenomena represented by values at each measurement point.
Web Feature Service (WFS)	The OpenGIS® Web Map Service Interface Standard

Web Map Context Web Map Service (WMS)	(WMS) provides a simple HTTP interface for requesting geo-registered map images from one or more distributed geospatial databases. A WMS request defines the geographic layer(s) and area of interest to be processed. The response to the request is one or more geo-registered map images (returned as JPEG, PNG, etc) that can be displayed in a browser application. The interface also supports the ability to specify whether the returned images should be transparent so that layers from multiple servers can be combined or not.
Web Processing Service	The OpenGIS® Web Processing Service (WPS) Interface Standard provides rules for standardizing how inputs and outputs (requests and responses) for geospatial processing services, such as polygon overlay. The standard also defines how a client can request the execution of a process, and how the output from the process is handled. It defines an interface that facilitates the publishing of geospatial processes and clients' discovery of and binding to those processes. The data required by the WPS can be delivered across a network or they can be available at the server.
Web Service Common	The OpenGIS® Web Services Common (WS-Common) Interface Standard specifies parameters and data structures that are common to all OGC Web Service (OWS) Standards. The standard normalizes the ways in which operation requests and responses handle such elements as bounding boxes, exception processing, URL requests, URN expressions, and key value encoding. Among its uses, this document serves as a normative reference for other OGC Web Service standards, including the OpenGIS Web Map Service (WMS) [http://www.opengeospatial.org/standards/wms], Web Feature Service (WFS) [http://www.opengeospatial.org/standards/wfs], and Web Coverage Service (WCS) [http://www.opengeospatial.org/standards/wcs] standards. Rather than continuing to repeat this material in each such standard, each standard will normatively reference parts of this document.
Source: http://www.opengis.com	

Resources and links:

- http://www.opengeospatial.org/standards/

Appendix 3.8 INSPIRE EU Directive

The INSPIRE Directive addresses spatial data themes as described in the table INSPIRE Data Themes (first priority themes pertaining for digital cultural content are marked with italic font) below.

Coordinate reference systems	*Systems for uniquely referencing spatial information in space as a set of coordinates (x,y,z) and/or latitude and longitude and height, based on a geodetic horizontal and vertical datum.*
Geographical grid systems	*Harmonised multi-resolution grid with a common point of origin and standardised location and size of grid cells.*
Geographical names	*Names of areas, regions, localities, cities, suburbs, towns or settlements, or any geographical or topographical feature of public or historical interest.*
Administrative units	*Units of administration, dividing areas where Member States have and/or exercise jurisdictional rights, for local, regional and national governance, separated by administrative boundaries.*
Addresses	*Location of properties based on address identifiers, usually by road name, house number, postal code.*
Cadastral parcels	Areas defined by cadastral registers or equivalent.
Transport networks	Road, rail, air and water transport networks and related infrastructure. Includes links between different networks. Also includes the trans-European transport network as defined in Decision 1692/96/EC of the European Parliament and of the Council of 23 July 1996 on Community guidelines for the development of the trans-European transport network * and future revisions of that decision.
Hydrography	Hydrographic elements, including marine areas and all other water bodies and items related to them, including river basins and sub-basins.
Protected sites	Area designated or managed within a framework of international, Community and Member States' legislation to achieve specific conservation objectives.
Elevation	Digital elevation models for land, ice and ocean surfaces. Includes terrestrial elevation, bathymetry and shoreline.
Land cover	Physical and biological cover of the earth's surface including artificial surfaces, agricultural areas, forests, (semi-)natural areas, wetlands, water bodies.
Orthoimagery	Geo-referenced image data of the Earth's surface, from either satellite or airborne sensors.
Geology	Geology characterised according to composition and structure. Includes bedrock, aquifers and geomorphology.
Statistical units	Units for dissemination or use of statistical information.
Buildings	Geographical location of buildings.
Soil	Soils and subsoil characterised according to depth, texture, structure and content of particles and organic material, stoniness, erosion, where appropriate mean slope and anticipated water storage capacity.
Land use	Territory characterised according to its current and future planned functional dimension or socio–economic purpose (e.g. residential, industrial, commercial, agricultural, forestry, recreational).
Human health and safety	Geographical distribution of dominance of pathologies

	(allergies, cancers, respiratory diseases, etc.), information indicating the effect on health (biomarkers, decline of fertility, epidemics) or well-being of humans (fatigue, stress, etc.) linked directly (air pollution, chemicals, depletion of the ozone layer, noise, etc.) or indirectly (food, genetically modified organisms, etc.) to the quality of the environment.
Utility and governmental services	Includes utility facilities such as sewage, waste management, energy supply and water supply, administrative and social governmental services such as public administrations, civil protection sites, schools and hospitals.
Environmental monitoring Facilities	Location and operation of environmental monitoring facilities includes observation and measurement of emissions, of the state of environmental media and of other ecosystem parameters (biodiversity, ecological conditions of vegetation, etc.) by or on behalf of public authorities.
Production and industrial facilities	Industrial production sites, including installations covered by Directive 96/61/EC of 24 September 1996 concerning integrated pollution prevention and control * and water abstraction facilities, mining, storage sites.
Agricultural and aquaculture facilities	Farming equipment and production facilities (including irrigation systems, greenhouses and stables).
Population distribution and demography	Geographical distribution of people, including population characteristics and activity levels, aggregated by grid, region, administrative unit or other analytical unit.
Area management/restriction/regulation zones & reporting units	Areas managed, regulated or used for reporting at international, European, national, regional and local levels. Includes dumping sites, restricted areas around drinking water sources, nitrate-vulnerable zones, regulated fairways at sea or large inland waters, areas for the dumping of waste, noise restriction zones, prospecting and mining permit areas, river basin districts, relevant reporting units and coastal zone management areas.
Natural risk zones	Vulnerable areas characterised according to natural hazards (all atmospheric, hydrologic, seismic, volcanic and wildfire phenomena that, because of their location, severity, and frequency, have the potential to seriously affect society), e.g. floods, landslides and subsidence, avalanches, forest fires, earthquakes, volcanic eruptions.
Atmospheric conditions	Physical conditions in the atmosphere. Includes spatial data based on measurements, on models or on a combination thereof and includes measurement locations.
Meteorological geographical features	Weather conditions and their measurements; precipitation, temperature, evapotranspiration, wind speed and direction.
Oceanographic geographical features	Physical conditions of oceans (currents, salinity, wave heights, etc.).
Sea regions	Physical conditions of seas and saline water bodies divided into regions and sub-regions with common characteristics.
Bio-geographical regions	Areas of relatively homogeneous ecological conditions with common characteristics.
Habitats and biotopes	Geographical areas characterised by specific ecological conditions, processes, structure, and (life support) functions that physically support the organisms that live there. Includes terrestrial and aquatic areas distinguished by geographical, abiotic and biotic features, whether entirely natural or semi-

	natural.
Species distribution	Geographical distribution of occurrence of animal and plant species aggregated by grid, region, administrative unit or other analytical unit.
Energy Resources	Energy resources including hydrocarbons, hydropower, bio-energy, solar, wind, etc., where relevant including depth/height information on the extent of the resource.
Mineral Resources	Mineral resources including metal ores, industrial minerals, etc., where relevant including depth/height information on the extent of the resource.
Source: Directive 2007/2/EC of the European Parliament and of the Council of 14 March 2007 establishing an Infrastructure for Spatial Information in the European Community (INSPIRE) 14.03.2007	

Resources and links:

- http://www.inspire.jrc.ec.europa.eu

APPENDIX 4: Elaboration for Implementation of GIS in Digital Cultural Content

Appendix 4.1 LITERATURE ON DATA STRUCTURE SUPPORTED BY GIS

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- Technical Guidelines for Digital Cultural Content Creation ProgrammesVersion 2.0: September 2008, MINERVA eC Project 2008

- The *NOF-digitise Technical Standards and Guidelines* (Version 5, February 2003), UKOLN, University of Bath, The Council for Museums, Archives & Libraries (MLA). <http://www.mla.gov.uk/resources/assets//T/technicalstandardsv1_pdf_7964.pdf>.

- European Museums' Information Institute, *Framework Report* (September 2003), http://www.emii.org/dcf-frame.pdf

- Research Libraries Group Cultural Materials Initiative: Recommendations for Digitizing for RLG Cultural Materials, http://www.rlg.ac.uk/culturalres/prospective.html

- Research Libraries Group Cultural Materials Initiative: Description Guidelines http://www.rlg.ac.uk/culturalres/descguide.html

- Canadian Heritage Standards and Guidelines for Digitisation Projects http://www.pch.gc.ca/progs/pcce-ccop/pubs/ccop-pcceguide_e.pdf

- Working with the Distributed National Electronic Resource (DNER): Standards and Guidelines to Build a National Resource http://www.jisc.ac.uk/index.cfm?name=projman_standards

- JISC Information Environment Architecture Standards Framework http://www.ukoln.ac.uk/distributed-systems/jisc-ie/arch/standards/

Appendix 4.2 GEOCODING

Special meaning and usability in GIS have spatial entities, described with **geocodes** (digital coordinates in 2- or 3- dimensional places on earth surface). ***Geocoding*** is the conversion of spatial textual information into computer-readable form. As such, geocoding, both the process and the concepts involved, determines the type, scale, accuracy and precision of digital maps.

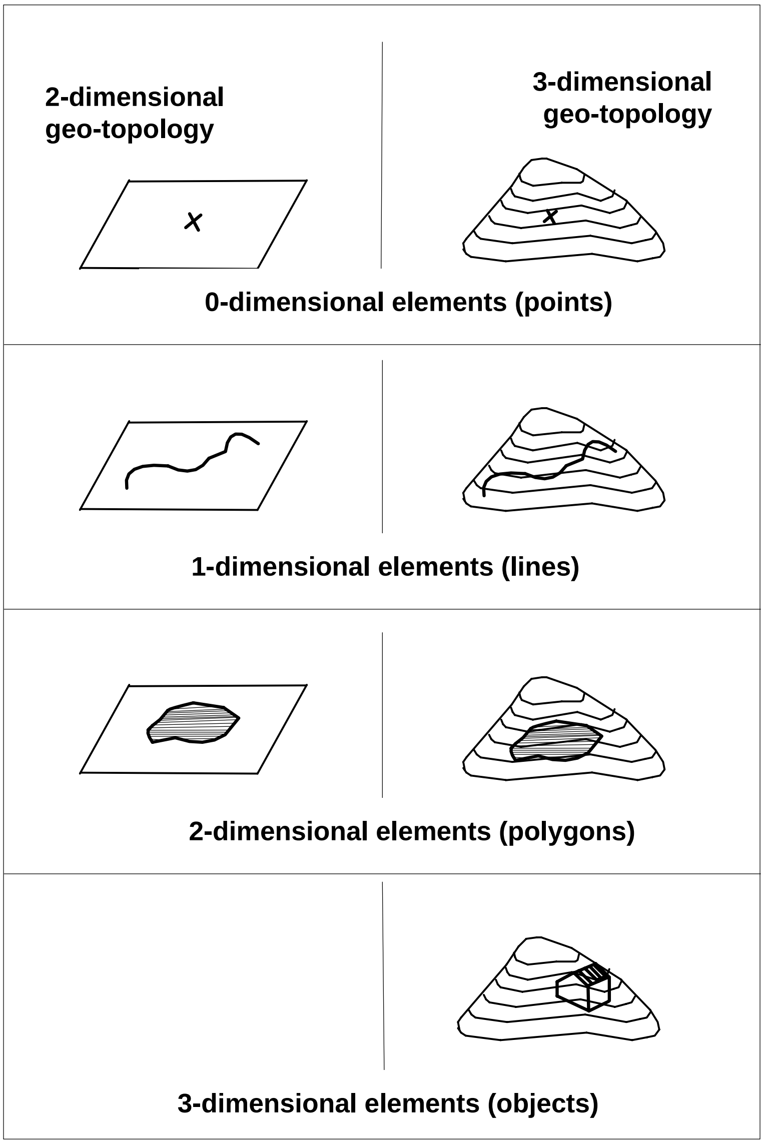
- Geocodes as unified are ideal identificators of other data and are useful for verification of data on the location
- Geocodes do not change over time and therefore enable monitoring changes of the attributes of other entities as cities, regions as border are changing over time.
- Topological rules of plane (topology, metrics) enables »natural« linkage of topological entities and with that indirect connection with other data (for example intersection of areas with different attributes of real world.
- Using geocodes is a base for representing spatial data as maps or inetractive maps.

Informatization of cultural heritage demands **multilayered geocoding** of features, attributes and events:

- Nominal geocodes (e.g. settlement name, street name, building name) describes a place. This description is not accurate and changes over time,
- Ordinal geocodes (e.g. ID of real estate, parcel number) relates to spatial reference, that is maintained by other system.
- Cardinal geocodes (e.g. coordinates of centroid of the museum object provenience, coordinates of the borders of the archeological escavations) are real geographic reference and only this is linked to other entities directly in space.

For example turning a portion of the postal address such as the post code (zip code) into a geographic point or polygon is also part of the geocoding process. However, continuing this line of reasoning presents a slippery slope because a series of fundamental questions arise. What should the point returned as representative of the postal code be? Should it be the center of mass (centroid)? Should it be weighted by the population distribution? Furthermore, if the digital boundary of the postal code is available, why not return it instead of just a single point? Questions such as these are just the beginning. If the postal code can be geocoded, can the city be as well? If so, what is the difference between the geocoder returning a geographic representation of the city and the gazetteer doing the same? And if they are, in fact, performing the same operation, why is it commonly understood that a gazetteer can provide geographic representations for a wide variety of geographic features such as rivers, mountains, and shorelines, while these are seldom thought of as candidates for the geocoding process?

Scheme: 2D/3D Geo-Topology



Resources and links

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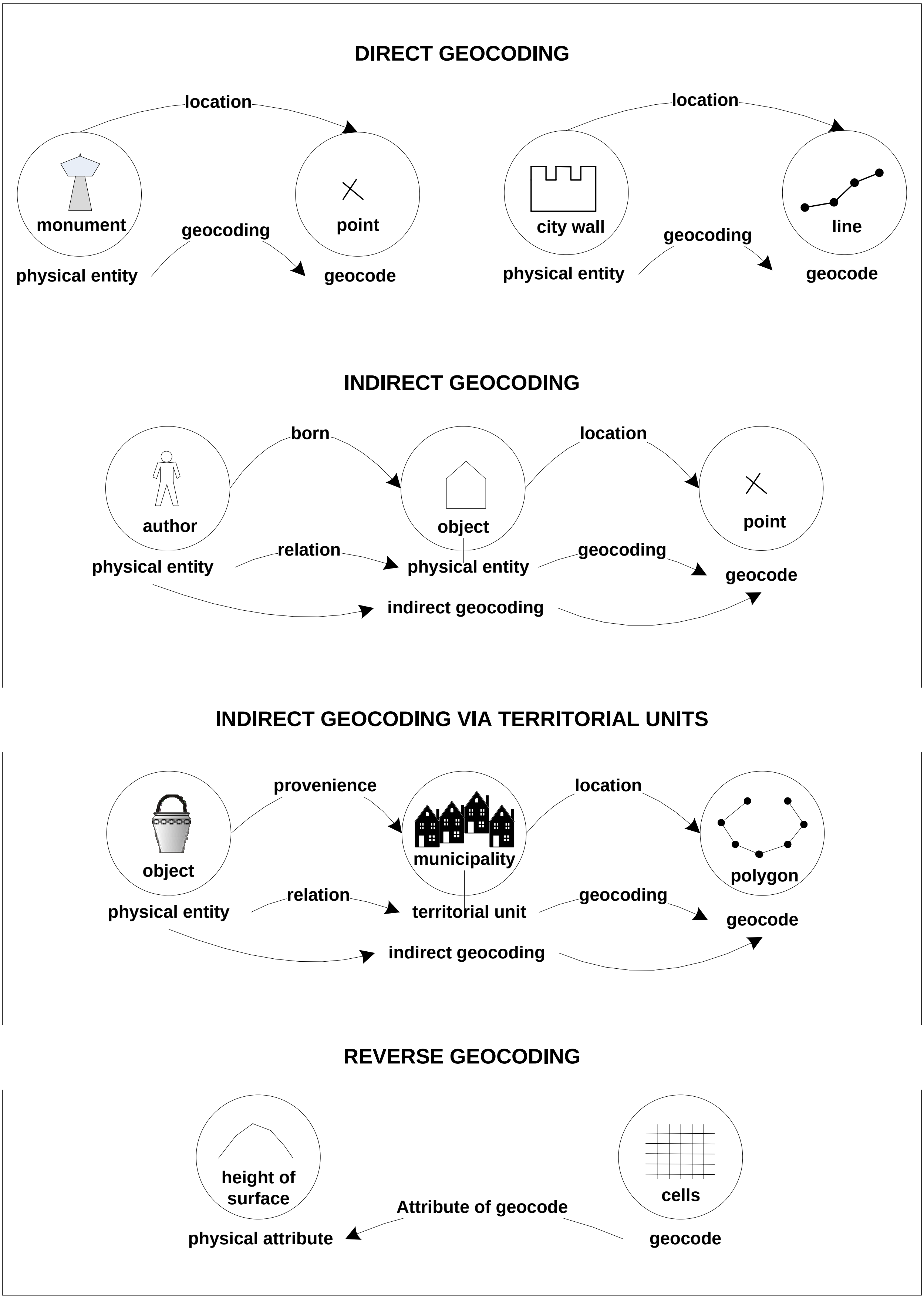
- W3C Semantic Web Activity, http://www.w3.org/2001/sw/

- Web Ontology Language (OWL), W3C, http://www.w3.org/2001/sw/WebOnt/

- OWL Web Ontology Language Reference, W3C, 10 Feb 2004, http://www.w3.org/TR/owl-ref/

Schema: Types of Geocoding



Appendix 4.3 RETRIEVAL WITH ONTOLOGY

Geographical context is required of many information retrieval tasks in which the target of the search may be documents, images or records which are referenced to geographical space only by means of place names. Often there may be an imprecise match between the query name and the names associated with candidate sources of information. There is a need therefore for geographical information retrieval facilities that can rank the relevance of candidate information with respect to geographical closeness of place as well as semantic closeness with respect to the information of interest. Here we present an ontology of place that combines limited coordinate data with semantic and qualitative spatial relationships between places. This parsimonious model of geographical place supports maintenance of knowledge of place names that relate to extensive regions of the Earth at multiple levels of granularity. The ontology has been implemented with a semantic modelling system linking non-spatial conceptual hierarchies with the place ontology. An hierarchical spatial distance measure is combined with Euclidean distance between place centroids to create a hybrid spatial distance measure. This is integrated with thematic distance, based on classification semantics, to create an integrated semantic closeness measure that can be used for a relevance ranking of retrieved objects.

Gazetteers are more than basic place name directories containing names and locations for named geographic places. Most of them contain additional information, including a categorization of gazetteer entries using a typing scheme. Gazetteers can benefit from an ontological approach to typing schemes, providing a formalization that will better support gazetteer applications, maintenance, interoperability, and semi-automatic feature annotation. The table **Comparison of the functionalities of the three gazetteers** reviews three feature type thesauri, the Alexandria Digital Gazetteer, the Getty Thesaurus of Geographic Names and GeoNames.org demonstrate the benefits of a categorization based on ontologies.

Table: Comparison of the functionalities of the ADL, Getty and GeoNames gazetteers

	ADL	Getty	GeoNames
Web interface functionality			
Place name search	i	i	i
Place type restriction	i	i	i
Spatial restriction by nation	i	i	-
Spatial restriction by continent	i	i	i
Spatial restriction via map extent	i	-	-
Temporal restriction	i	i	-
Feature type description lookup	i	-	i
Visualization of results on map	i	-	i
API functionality			
Capabilities descriptions	i	-	-
Query by place type	i	-	i
Geocoding	i	-	i
Inverse geocoding	i	-	i
Query by spatial containment	i	-	i
Place status query	i	-	-
Query by relationship (instance level)	i	-	-
Query for neighbors / nearby features	-	-	i
Source: Janowicz, K. and Keßler, C.(2008). The role of ontology in improving gazetteer interaction, International Journal of Geographical Information Science, 22:10,1129 — 1157			

Table: Online gazetteer services

The table bellow describes some of the gazetteer services currently available in the Web.[1]

Gazetteer Name	Scope	Temporal	Spatial data	Concepts	Names
Alexandria Digital Library Gazetteer	World	Limited	Points or MBRs	4.334.146	
GeoNames	World	Limited	Points	6.603.141	14.592.444
GeoNetPT	Portugal	No	Points or MBRs	431.397	434.539
U.S. Gazetteer	U.S.A.	Limited	Points	92.689	
Gazetteer for Scotland	Scotland	Yes	Very limited	13.471	
Global Gazetteer	World	No	Points		
National Gazetteer of Australia	Australia	No	Points	322.328	
Gazetteer of British Place Names	Britain	Yes	National grid code		50.000
Virginia Gazetteer	Virginia	No	USGS quadrangle	51.000	
Imperial Gazetteer of India	India	Yes	No		
The Fuzzy Gazetteer	World	No	Points		7.205.433
Getty Thesaurus of Geographic Names	World	Yes	Points or MBRs	912.000	1.100.000
W. Hazlit's Classical Gazetteer	World	Yes	No	5.000	
Maplandia Gazetteer	World	No	Polygons	166.000	
Geographical Names of Canada	Canada	No	Points	500.000	
Gazetteer of Tibet and the Himalayas	Tibetan regions in China	Yes	Points		
Old World Trade Routes Gazetteer	Eurasia + Africa	Yes	Points	3.130	12.500
National Gazetteer of Wales	Wales	No	National grid	6.000	
Bulgarian Antarctic Gazetteer	Antarctica	No	Points	97	97
US HomeTownLocator	U.S.A.	No	Points		

[1] Source: e-Perimetron, Vol. 4, No. 1, 2009 [9-24], www.e-perimetron.org

Gazetteer					
Markets/Fairs in England and Wales	England/ Wales	Yes	No	2.400	
Orbis Latinus Gazetteer	World	Limited		16.352	
BSC Latin Place Names File	World	Limited		433	
Gazetteer of names of printing towns	World	Limited			
CERL Thesaurus	World	Limited			
Place Names Data at EKI	Estonia + more	Limited			
Roman place names	World	Limited			
Spanish gazetteer	Spain	No			
World Gazetteer	World		Points		
The Columbia gazetteer of the world	World	Limited	Points and some features		165.000
The Columbia gazetteer of North America	North America		Points/Data		50.000+
Geoscience Australia Place Name	Australia		Points		310.000+
Gazetteer of the Roman world	Roman Empire		Points/Data		
The ancient library	World	Yes	Points		15.000 +
Ordnance gazetteer of Scotland	Scotland		Points/Data		
Gazetteer of Slovakia	Slovakia		Points/Data		
U.S. Board on Geographic Names	U.S.A.		Points		
A gazetteer of Vermont places: real and imagined	Vermont		Points		
East and west Prussia gazetteer	Prussia		Points		
Newfoundland and Labrador Place Name gazetteer	Labrador (Canada)		Points		
NGA GEOnet Names Server	World		Points		7.000.000
Canadian Geographical Names Service	Canada	No	Points	350.000	
National Association of Counties	U.S.A.		Points/Data		
GeoNative	Athens		Points		

The Swedish gazetteer	Swedish		Complete features		57.000 +
Composite gazetteer of Antarctica	Antarctica		Points		36.000 +
CGDI gazetteer interface	Canada	No			47.000
A low-latitude Antarctic gazetteer	Antarctica Ext. Reference s		Points		700 +
Old Hampshire gazetteer	Hampshir e		Points		
Index Mundi	World				
Probert Encyclopaedia	World				70.000 +
Radix – 1882 gazetteer of Hungary	Hungary	Yes	Points		1.000.00 0
earthsearch.net	World		Points		7.400.00 +
German Space Operations Center gazetteer	World		Points		2.000.00 0 +
UK & Ireland gazetteers - GENUKI	U.K.		Points		
NYS gazetteer & GeoData Collection	New York State	No	Points		38.000
PlaceNames – South Australian State Gazetteer	South Australian State		Points		

Resources and links

- http://ecai.org/

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