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LNCS 10058

Digital Heritage

Progress in Cultural Heritage: Documentation, Preservation, and Protection

6th International Conference, EuroMed 2016
Nicosia, Cyprus, October 31 – November 5, 2016
Proceedings, Part I

Springer

Part I

Lecture Notes in Computer Science 10058

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ISSN 0302-9743 ISSN 1611-3349 (electronic)
Lecture Notes in Computer Science
ISBN 978-3-319-48495-2 ISBN 978-3-319-48496-9 (eBook)
DOI 10.1007/978-3-319-48496-9

Library of Congress Control Number: 2016956494

LNCS Sublibrary: SL3 – Information Systems and Applications, incl. Internet/Web, and HCI

Printed on acid-free paper

This Springer imprint is published by Springer Nature
The registered company is Springer International Publishing AG
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

Preface

Welcome to the proceedings of EuromedMed 2016, the biennial scientific event which this year was held in the capital city of Cyprus, the island that has always been a bridge to three continents in the world going back to the origins of civilization. It is a place where the fingerprints of several ancient cultures and civilizations on earth can be found, with a wealth of historical sites recognized and protected by UNESCO.

Several organizations and current EU projects (such as the Marie Sklodowska-Curie Fellowship project on Digital Heritage Marie Sklodowska-Curie FP7-PEOPLE ITN-DCH, the Marie Sklodowska-Curie FP7-IAPP 4D-CH-WORLD, the FP7-CIP ICT-PSP EuropeanaSpace, the H2020 Reflective 7 - INCEPTION, the H2020 CSA Virtual Museums ViMM, the Research Infrastructure DARIAH-EU ERIC and DARIAH-CY) as well as the Innovation in Intelligent Management of Heritage Buildings (i2MHB) decided to join EuroMed2016 and continue cooperating together in order to create an optimal environment for the discussion and explanation of new technologies, the exchange of modern innovative ideas, and in general to allow the transfer of knowledge between a large number of professionals and academics during one common event.

The main goal of the event is to illustrate the programs underway, whether organized by public bodies (e.g., UNESCO, European Union, National States, etc.) or by private foundations (e.g., Getty Foundation, World Heritage Foundation, etc.) in order to promote a common approach to the tasks of recording, documenting, protecting, and managing world cultural heritage. The 6th European-Mediterranean Conference (EuroMed 2016) was definitely a forum for sharing views and experiences, discussing proposals for the optimum approach as well as the best practice and the ideal technical tools to preserve, document, manage, present/visualize and disseminate the rich and diverse cultural heritage of mankind.

This conference was held during the mid-term of the new Framework Programme, Horizon 2020, which is the largest in the world in terms of financial support on research, innovation, technological development, and demonstration activities. The awareness of the value and importance of heritage assets has been reflected in the financing of projects since the first Framework Programme for Research & Technological Development (FP1, 1984–87) and continues into current HORIZON 2020 that follows FP7 (2007–13). In the past 30 years, a large community of researchers, experts, and specialists have had the chance to learn and develop the transferable knowledge and skills needed to inform stakeholders, scholars, and students. Europe has become a leader in heritage documentation, preservation, and protection science, with COST Actions adding value to projects financed within the FP and EUREKA programme and transferring knowledge to practice and supporting the development of SMEs.

The EuroMed 2016 agenda focused on enhancing and strengthening of international and regional cooperation and promoting awareness and tools for future innovative research, development, and applications to protect, preserve, and document the

European and world cultural heritage. Our ambition was to host an exceptional conference by mobilizing also policy makers from different EU countries, institutions (European Commission, European Parliament, Council of Europe, UNESCO, International Committee for Monuments and Sites ICOMOS, the International Committee for Documentation of Cultural Heritage CIPA, the International Society for Photogrammetry and Remote Sensing ISPRS, the International Centre for the study of the Preservation and Restoration of Cultural Property ICCROM, and the International Committee for Museums ICOM), professionals, as well as participants from all over the world and from different scientific areas of cultural heritage.

Protecting, preserving, and presenting our cultural heritage are actions that are frequently interpreted as change management and/or changing the behavior of society. Joint European and international research produce the scientific background and support for such a change. We are living in a period characterized by rapid and remarkable changes in the environment, in society, and in technology. Natural changes, war conflicts, and man-made changes, including climate, as well as technological and societal changes, form an ever-moving and colorful stage and a challenge for our society. Close cooperation between professionals, policy makers, and authorities internationally is necessary for research, development, and technologica advancements in the field of cultural heritage.

Scientific projects in the area of cultural heritage have received national, European Union, or UNESCO funding for more than 30 years. Through financial support and cooperation, major results have been achieved and published in peer-reviewed journals and conference proceedings with the support of professionals from many countries. The European Conferences on Cultural Heritage research and development and in particular the biennial EuroMed conference have become regular milestones on the never-ending journey in the search for new knowledge of our common history and its protection and preservation for the generations to come. EuroMed also provides a unique opportunity to present and review results as well as to draw new inspiration.

To reach this ambitious goal, the topics covered include experiences in the use of innovative technologies and methods and how to take best advantage to integrate the results obtained to build up new tools and/or experiences as well as to improve methodologies for documenting, managing, preserving, and communicating cultural heritage.

In these proceedings we present 105 papers, selected from 504 submissions, which focus on interdisciplinary and multidisciplinary research concerning cutting-edge cultural heritage informatics, physics, chemistry, and engineering and the use of technology for the representation, documentation, archiving, protection, preservation, and communication of cultural heritage knowledge.

Our Keynote speakers, Prof. Dr. Antonia Moropoulou (NTUA and Technical Chamber of Greece), Prof. Dr. Dieter Fellner (Director of FhD/IGD and TU Darmstadt, Germany), Prof. Dr. Wolfgang Kippes (University for Applied Arts Vienna and Donau University Krems, Austria), Prof. Dr. Sarah Whatley (Director of Centre for Dance Research, UK), Prof. Dr. Mustafa Erdik (Bogazici University of Instabul, Turkey), Mr. Jean-Pierre Massué (Senate Member of the European Academy of Sciences and Arts/ COPRNM, France), Mr. Axel Ermert (Institute for Museum Research SMB/PK of Berlin, Germany), Mrs. Rosella Caffo (Director of the Central Institute for the Union

Catalogue of the Italian Libraries (ICCU), Italy), Mr. Vasco Fassina (President of the European Standardization Commission CEN/TC 346: Conservation of Cultural Heritage, Italy), Mrs. Maria P. Kouroupas (Director Cultural Heritage Center, US Department of State), Mrs. France Desmarais (ICOM), Dr. Thomas R. Klein (Counsel, Andrews Kurth LLP), Françoise Bortolotti (Criminal Intelligence Officer, Works of Art Unit, Interpol) and Prof. Dr. Markus Hilgert (Director, Vorderasiatisches Museum im Pergamonmuseum Staatliche Museen zu Berlin - Preußischer Kulturbesitz and Project Leader, ILLICID) are not only experts in their fields, but also visionaries for the future of cultural heritage protection and preservation. They promote the e-documentation and protection of the past in such a way for its preservation for the generations to come.

We extend our thanks to all authors, speakers, and those persons whose labor, financial support, and encouragement made the EuroMed 2016 event possible. The International Program Committee—whose members represent a cross-section of archaeology, physics, chemistry, civil engineering, computer science, graphics and design, library, archive and information science, architecture, surveying, history and museology—worked tenaciously and finished their work on time. The staff of the IT department at the Cyprus University of Technology helped with their local ICT and audio visual support, especially Mr. Filippos Filippou, Mr. Costas Christodoulou, and Mr. Stephanos Mallouris. We would also like to express our gratitude to all the organizations supporting this event and our co-organizers, the European Commission scientific and policy officers of the H2020 Marie Skłodowska-Curie Programme, the director general of Europeana, Mrs. Jill Cousins, the Getty Conservation Institute and World Monuments Fund, the Cyprus University of Technology, the Ministry of Energy, Commerce, Industry, and Tourism. Especially the permanent secretary and Digital Champion Dr. Stelios Himonas and Mr. Nikos Argyris, the Ministry of Education and Culture and particularly Minister Dr. Costas Kadis, the director of Cultural Services Mr. Pavlos Paraskevas, the Department of Antiquities in Cyprus, all the members of the Cypriot National Committee for E-Documentation and E-Preservation in Cultural Heritage, and finally our corporate sponsors, CableNet Ltd., the Cyprus Tourism Organization, the Cyprus Postal Services, the Cyprus Handicraft Center, and Dr. Kyriacos Themistocleous from the Cyprus Remote Sensing Society, who provided services and gifts in kind that made the conference possible.

We express our thanks and appreciation to Dr. Nikos Grammalides from CERTH in Greece and Dr. Sander Münster, the Dresden University of Technology, Germany, as well as the board of the ICOMOS Cyprus Section for their enthusiasm, commitment, and support for the success of this event. Most of all we would like to thank the organizations UNESCO, European Commission, CIPA, ISPRS, and ICOMOS Europa Nostra that entrusted us with the task of organizing and undertaking this unique event.

September 2016

Marinos Ioannides
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Acknowledgments and Disclaimer

The EuroMed 2016 conference was partly supported by the Republic of Cyprus, the Cyprus University of Technology, the Cyprus Tourism Organization, the CableNet Ltd., by CIPA (http://cipa.icomos.org/), ISPRS, ICOMOS, Europa Nostra the EU projects FP7 PEOPLE ITN2013 ITN-DCH and IAPP2012 4D-CH-WORLD, the DARIAH-EU ERIC and DARIAH-CY, the FP7-ICT-2011 i-Treasures, the CIP ICT-PSP EuropeanaSpace and H2020 INCEPTION and H2020-ViMM projects.

However, the content of this publication reflects only the authors' views; the European Commission, the Republic of Cyprus, CIPA, ISPRS, ICOMOS, Europa Nostra, Cyprus University of Technology and the EU projects FP7 PEOPLE ITN2013 ITN-DCH and IAPP2012 4D-CH-WORLD, the DARIAH-EU ERIC and DARIAH-CY, the FP7-ICT-2011 i-Treasures, the CIP ICT-PSP EuropeanaSpace and H2020-INCEPTION and H2020-ViMM are not liable for any use that may be made of the information contained herein.

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The Icons of the Chapel of Saint Jacob

The icon shown on the cover of LNCS 10058 (Part I) depicts the scene of the Enthroned Virgin Mary with Child together with Saint John the Evangelist, while the icon shown on the cover of LNCS 10059 (Part II) illustrates Jesus Christ on a throne together with Saint John the Baptist. The icons are dated back to 1620 A.D. and were painted by the artist Meletios from Crete. These icons were stolen from the iconostasis of the chapel of Saint Jacob in Trikomo (Famagusta district) after the Turkish invasion of 1974. Saint Jacob's chapel had no frescoes but it was decorated with colorful plates of traditional folk art.

The icon illustrating Jesus Christ and Saint John the Baptist is 110 × 128 cm in size and close to the feet of the latter there is the inscription "ΧΕΙΡ ΜΕΛΕΤΙΟΥ ΤΟΥ ΚΡΙΤΟΣ ΑΧΚ(= 1620) Χ(ριστο) Υ. Μ(ηνος) αυγούστου)," which includes the name of the artist as well as the date. The icon of Mary, Mother of Jesus, together with Saint John the Evangelist is 114 × 134 cm in size. Both of them were in the possession of the Russian–Jewish art dealer Alexander Kocinski, until their confiscation by the Swiss Police in Zurich in 2007. The only documentation available to recover these stolen icons from abroad was a paper published in the *Proceedings of the International Cretan Conference* in 1976 by the former director of the Department of Antiquities of Cyprus, Mr. Athanasios Papageorgiou.

The icons were tracked down in 2007 in Christie's Auction House in London, from where they were withdrawn after actions by Kykkos Monastery. Following information by the bishop of Kykkos Monastery, representatives of the monastery traveled to Zurich to meet the owner of the icons; however, it was not possible to persuade him to return the icons to the lawful owners and therefore the authorities of Cyprus were informed. A written complaint by the Byzantinologist of Kykkos Monastery, Dr. C. Chotzakoglou, to the Cypriot Police and to Interpol in Cyprus initiated the repatriation procedure of the icons, eventually leading to their confiscation by the Swiss Interpol.

By means of a new testimony from Dr. C. Chotzakoglou, in addition to a full documentation of the Cypriot origin of the icons and their looting after the Turkish invasion in northern Cyprus, the Supreme Court of Famagusta, based in Larnaca, took legal measures against the owner of the icons, who was convicted. The verdict of the Cypriot Supreme Court was subsequently used in the Swiss Court, leading to the signing of a compromise settlement between the Church of Cyprus and Kocinski for the return of the icons to Cyprus.

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Contents – Part I

Full Paper: Non-destructive Techniques in Cultural Heritage Conservation

Full Paper: Visualisation, VR and AR Methods and Applications

Full Paper: The New Era of Museums and Exhibitions: Digital Engagement and Dissemination

Full Paper: Digital Cultural Heritage in Education, Learning and Training

Project Paper: Data Acquisition, Process and Management in Cultural Heritage

Project Paper: Data, Metadata, Semantics and Ontologies in Cultural Heritage

Project Paper: 3D Reconstruction and 3D Modelling

Project Paper: Heritage Building Information Models (HBIM)

Project Paper: Serious Games for Cultural Heritage

Project Paper: Digital Cultural Heritage in Education, Learning and Training

INCEPTION Standard for Heritage BIM Models

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Abstract. The EU Project INCEPTION will create a platform that is able to exchange content according to state-of-the-art available open BIM standards. This INCEPTION open Heritage BIM platform is not only exchanging data according to existing state-of-the-art standards, but it is based on a new Heritage BIM model using Semantic Web technology. This allows applications to retrieve content according to modern query languages like SPARQL and allows user defined 'on-the-fly' extensions of the standard. This paper describes the structure and development of this new Heritage BIM standard. The Heritage BIM standard is developed by several Semantic Web and BIM standardization specialists in combination with top experts in the field of Cultural Heritage, all of them partners within the INCEPTION project.

Keywords: 3D · BIM · IFC · ifcOWL · GIS · H57 · H-BIM · OWL · OWL2 · Semantic web · RDF · RDFS

1 Introduction

The European Project "INCEPTION - Inclusive Cultural Heritage in Europe through 3D semantic modelling"[1], funded by EC within the Programme Horizon 2020, focuses

[1] The INCEPTION project, Grand Agreement no.: 665220 started the last June 2015, is developed by a consortium of fourteen partners from ten European countries led by the Department of Architecture of the University of Ferrara. More information can be found on [http://www.inception-project.eu/].

M. Ioannides et al. (Eds.): EuroMed 2016, Part I, LNCS 10058, pp. 590–599, 2016.
DOI: 10.1007/978-3-319-48496-9_47

on three main objectives: to create an inclusive understanding of European cultural identity and diversity by stimulating and facilitating collaborations across disciplines, technologies and sectors; to develop cost-effective procedures and enhancements for on-site 3D survey and reconstructions of cultural heritage buildings and sites; to develop an open-standard Semantic Web platform for accessing, processing and sharing inter-operable digital models resulting from 3D survey and data capturing.

This inclusive approach includes open-standard format for cultural Heritage Building Information Modelling (H-BIM) as part of the overall procedure aimed at enriching and enhancing the changing role of 3D representations for knowledge, reconstruction, preservation and exploitation of Cultural Heritage.

The integration of semantic attributes with hierarchically and mutually aggregated 3D digital geometric models is essential for management of heritage information. The development of tools for 3D automatic delineation depending on acquisition technologies, from point clouds to photo-based data, allows to achieve a common standard inter-operable output for BIM environment. Therefore, starting from advanced procedures aimed at handling multi-data point clouds and triangle meshes into BIM software, the INCEPTION procedure advances BIM approach for Heritage knowledge, going a step forward the usual procedure to locate/define 2D or 3D primitive shapes onto the point clouds. INCEPTION develops methodologies and algorithms to recognize these shapes. Results will be constructed in BIM software avoiding the oversimplification of the shapes. When used in models of Cultural Heritage, semantic BIM will be able to be connected to different users (e.g. scholars, technicians, citizens, etc.) in support of the user's needs for interpretation of the cultural heritage model, in addition to the common BIM features of 3D visualization, technical specifications and dataset.

The recent earthquake in central Italy (23 August 2016), causing about 300 victims, almost destroyed the beautiful towns of Accumoli and Amatrice. The last one was inserted in 2015 among the "most beautiful villages of Italy". Both the towns date back to XI–XII centuries and are home to beautiful churches and sanctuaries, heavily damaged by the earthquake. The same fate has befallen many houses of historical interest. Similarly, in 2009, the same region was hit by a big earthquake that fatally wounded the wonderful ancient city of L'Aquila, still undergoing a slow process of architectural recovery, causing 309 victims.

One of the aims of the INCEPTION procedure is protecting the cultural heritage of seismic areas with scopes of classification, prevention and reconstruction.

The paper starts exploring the state of the art within existing open standards, focusing on available H-BIM solutions up to explaining INCEPTION implementations.

2 Existing Open Standards

In the area of BIM, GIS, Cultural Heritage and Semantic Web, a lot of valuable work is already done. INCEPTION has taken existing state-of-the-art open standards and technology as a starting point. In this chapter we will just name a few relevant open standards in the area of BIM and Point Clouds, without being complete in number of standards nor in the areas (for example GIS was removed completely keeping the paper size reasonable). A complete reference can be found in D4.1 from the INCEPTION project.

2.1 Existing BIM Standards

This paragraph will explain the main open BIM standards expected to be used for data providers of BIM.

IFC (ifcXML, ifcOWL, ifczip). The first developments for the IFC format dates back to 1985. The name IFC (Industry Foundation Classes) was first introduced in 1994 led by Autodesk. In 1995 it became a vendor independent standard and had several releases, IFC 151 and IFC 20LF (Long Form) were popular releases for the academic world. Since IFC 2×3 released in 2006 (and later improvements IFC 2×3 Final and IFC 2×3 TC1) it was also becoming more popular for use in real life projects. Nowadays IFC 2×3 TC1 is still the most popular version although for INCEPTION the new version IFC4 (formally known as IFC 2×4) has some important improvements for both 3D representation and scheduling.

IFC is meant to be used by all the disciplines in the Building & Construction industry and the only widely used open standard supporting so many different disciplines. All major CAD vendors and a wide variety of other applications offer support for IFC. Most of the applications supporting IFC are not certified, although most CAD systems with IFC support have a certification from buildingSMART. IFC carries an object-based view of the model, including geometry in 3D (and 2D) as well as properties and interrelationships between objects. It is a well thought through standard with relatively high complexity for software vendors to support. IFC support includes schedule data, quantities and many other construction related data.

The standard exchange format for IFC is STEP/EXPRESS. As serialization support for this format is limited the past few years other serializations are defined also. It started with support for ifcXML, with an alternative ‘simple’ ifcXML format. More recently also ifcOWL serialization is created, this last format is compatible with Semantic Web RDF, RDFS and OWL2 standards. Although there is a small data loss the fast majority of knowledge is kept in these alternative serializations. A different format is ifczip and is nothing more than the zipped version of an original IFC file.

bSDD. Building Smart Data Dictionary is like the semantic extension of the IFC schema. Although IFC in combination with its property sets (and about 3000 properties) has already a lot of semantics in it, to cover the complete Building & Construction industry the semantic definition has to be far larger (numbers differ but we could expect that 100.000 object definitions are required where even the latest IFC schema has less than 1000 entities). bsDD is the standard from Building Smart defining how such extensions of the semantics can be stored and defined.

2.2 Existing Point-Cloud Standards

E57. Most 3D imaging systems for data exchange today takes place using one of three types of file formats: proprietary formats (not an efficient approach to data exchange in the long term), ad-hoc formats (not space or time efficient and no widespread usage), or the LAS format (limited file size and features). The E57 format is intended to overcome these issues, being a more general format that is well-suited for storing data across a variety of application domains. It is able to store point clouds and also other information from 3D scanners like images. The file format is specified by the ASTM, an international standards organization, and it is documented in the ASTM E2807 standard Huber (2011).

Next to the standard a 'reference implementation' is created to make more attractive and easy the use of the standard. The reference implementation is called libE57 and is written in C++ and sources are available [http://www.libe57.org/]. The libE57 application contains an API that can be used by parties that like to import or export files in E57 format.

2.3 Available H-BIM Solutions

Several H-BIM Solutions are already available. One thing we can notice in many of these solutions is use of Semantic Web techniques or use of BIM related standards. For example the vendor specific standard Graphisoft GDL language (Graphical Description Language) allows parametric modelling of components, something very useful in the area of geometry for Cultural Heritage content.

One typical behavior of most currently available H-BIM solutions is that they are clearly focused on one or two areas of the core of a Semantic Web based solution:

- Cultural Heritage
- Semantic Web technology
- BIM /3D /Point Cloud knowledge

3 Semantic Web

3.1 RDF

RDF (Resource Description Framework) supports creating and processing metadata by defining a default structure. This structure can be used for any data, independent of their character. Thus, the application areas of RDF are numerous, e.g., web-based services, peer-to-peer networks, and semantic caching models; they all have in common that huge amounts of data have to be processed when querying RDF data. RDF data can be represented using XML, a triple structure or a graph. Only the graph representation enables the semantic interpretation of the RDF schema.

All of the elements of the triple are resources with the exception of the last element, object, that can be also a literal. Literal, in the RDF sense, is a constant string value such as string or number. Literals can be either plain literals (without type) or typed literals typed using XML Datatypes. These triples together form RDF graph. A normative syntax for serializing RDF is RDF/XML.

3.2 RDF Schema (RDFS)

RDFS extends RDF vocabulary to allow describing taxonomies of classes and properties. It also extends definitions for some of the elements of RDF; for example it sets the domain and range of properties and relates the RDF classes and properties into taxonomies using the RDFS vocabulary.

The RDF schema statements are valid RDF statements because their structure follows the structure of the RDF data model. The only difference to a pure "resource - property - value" - triple is that an agreement about the specific meaning for reserved terms and statements has been made. Next to that, the RDF schema provides a vocabulary for defining the semantics of RDF statements.

3.3 Web Ontology Language (OWL)

OWL is a W3C standard. The abbreviation stands for Web Ontology Language and is a language for processing information on the web. It is built on top of RDF and RDFS. OWL was designed to be interpreted by computers and parsed by applications. It is not meant for being read by people. OWL is written in XML and has three sublanguages - OWL Lite, OWL DL (includes OWL Lite) and OWL Full (includes OWL DL). The Ontology is about the exact description of things and their relationships. For the web, ontology is about the exact description of web information and relationships between web information. The standard OWL is a part of the "Semantic Web Vision", a future web where:

- Web information has exact meaning
- Web information can be processed by computers
- Computers can integrate information from the web

3.4 Web Ontology Language 2 (OWL2)

OWL 2 adds new functionalities with respect to OWL 1. Some of the new features are syntactic sugar (e.g., disjoint union of classes) while others offer new expressivity, including keys, property chains, richer data types, data ranges, qualified cardinality restrictions, asymmetric, reflexive, and disjoint properties, and enhanced annotation capabilities. OWL 2 also defines three new profiles and a new syntax. Some of the restrictions applicable to OWL DL have been relaxed resulting in a slightly larger set of RDF Graphs that can be handled by Description Logics reasoners.

3.5 Reasoning

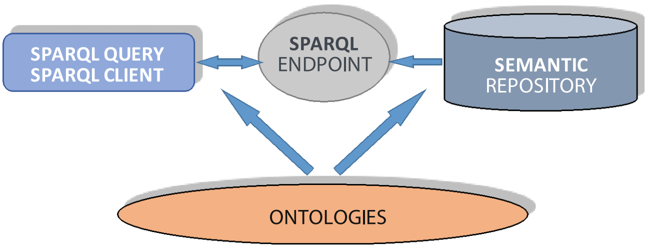
OWL enables "reasoning", as mentioned above. That means it gives the possibility to check the logical correctness of statements and add statements that are implied by other statements

A "semantic reasoner", "reasoning engine", "rules engine", or simply a "reasoner", is a piece of software able to infer logical consequences from a set of asserted facts or axioms. The notion of semantic reasoner generalizes that concept of inference engine, by providing a richer set of mechanisms to work with. The inference rules are commonly specified by means of an ontology language, and often a description language. Many reasoners use first-order predicate logic to perform reasoning; inference commonly proceeds by forward chaining and backward chaining. There are also examples of probabilistic reasoners, including Pei Wang's non-axiomatic reasoning system, and Novamente's probabilistic logic network.

3.6 SPARQL

SPARQL is the reasoning language for Semantic Web. Servers support in many cases out-of-the-box SPARQL queries.

The gate for the access to the Inception ontology will be a SPARQL endpoint. SPARQL 1.1 is a semantic query language and a recommendation of W3C. Its adoption in Inception project is important to access to the CH semantic storage. Multiple programming languages, libraries and semantic repositories implement SPARQL queries. The 1.1 standard also allows to write queries which directly update the RDF graph. Being SPARQL syntax based on graph traversal, it is also easy to visualize SPARQL results graphically. Although repositories could be navigated and examined with different tools, a SPARQL endpoint is one of the powerful tools to open semantic data to main exploitation.



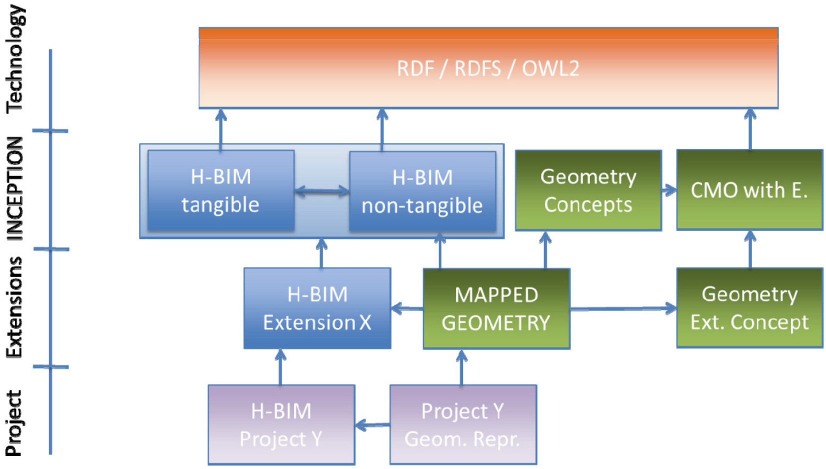
4 H-BIM Ontology

This chapter describes the architecture of the H-BIM Ontology as well as some examples of the content. The H-BIM Ontology is the core of the INCEPTION Platform. The content of the Ontology will be developed together with the specialists that are partners within INCEPTION. By definition the content will however be incomplete; the architecture therefore allows users to extend the H-BIM Ontology either for projects or for larger aggregations, like countries, styles etc.

4.1 Background

The architecture of the H-BIM Ontology is defined to enable storage of semantic information from any cultural heritage object. A clear distinction between tangible and non-tangible content is defined and, in line with the base concepts behind Semantic Web technology, it allows layered extension of the ontology itself. Typical for the H-BIM Ontology is the close connection with existing state-of-the-art BIM standards like IFC/ifcOWL and the link with 3D content defined in Semantic Web (i.e. open standard CMO with Extensions).

4.2 Architecture Overview



4.3 Technology Layer

Within this layer we use the Semantic Web technology as described in Sect. 3. This means use of the RDF, RDFS and OWL2 as top layers of the H-BIM Ontology.

4.4 INCEPTION Layer

The INCEPTION layer of the H-BIM model contains the real knowledge from the specialists within the INCEPTION project. This is knowledge about Cultural Heritage but also knowledge from existing state-of-the-art open BIM and open GIS standards.

One important part of the INCEPTION layer is the difference between tangible and non-tangible results. Since this is a known term in the area of Cultural Heritage and distinction is not always clear, much time and effort is put in defining what is covered by the terms.

4.5 Extensions Layer

As soon as new concepts within the extension layer are defined the queries can be used. Extension could concern new relations between existing content and therefore applied on all existing content, but extensions can also be specific for dedicated content. Some examples:

Example of Extensions Applicable on Existing Content. The INCEPTION H-BIM standard has embedded parts of the semantic structure of IFC (and therefore ifcOWL). This means classes Wall, WallStandardCase and Cur-tainWall exist. Adding a super class Walls and the knowledge that above named classes inherit from this new class Wall is an extension that works on all available content. A SPARQL query can be created to get all instances of new class Walls and it will directly have content for the majority of the Cultural Heritage H-BIM models stored in the INCEPTION platform.

Example of Extensions Applicable on New Content. It is allowed to add a class to the H-BIM model in the extension layer with a new name and no relation to any existing part of the H-BIM model. A query on this class is only relevant for new content incorporating the knowledge that this new class is existing.

4.6 Project Layer

Within the project layer the real content is defined, this content is arranged according to the layers above. All content can be queried according to the SPARQL queries defined on top of the INCEPTION layer. It is also possible to create solution specific queries as well as queries dedicated to certain extensions as defined in the extension layer.

5 Implementation

The INCEPTION standard is the base for the platform that will be developed within INCEPTION. As the INCEPTION standard is developed.

5.1 Server Solutions

The core of the INCEPTION platform will be a server that is able to handle the INCEPTION standard and offer basic functionality like support for SPARQL. During writing of this paper the selection of the server handling this Semantic Web data is not finalized yet, there are several options and the most promising solutions at this moment seem to be RDF4 J and Fuseki 2.

As not only Semantic Web data needs to be stored, but many different file formats including open standard BIM formats as well as point cloud data a file server will be part of the INCEPTION platform also.

Sesame /RDF4J 2.0. The official name is RDF4J and its current release is 2.0, however this solution is best known under its former name OpenRDF Sesame framework. It became part of the Eclipse Foundation and has no official first version at this moment after this important change.

Fuseki 2. Fuseki server is already existing for a while and although especially Fuseki 2 would be of interest for INCEPTION also Fuseki 1 is still actively maintaine. Fuseiki 2 is a server solution on top of Apache and Jena and also called Apache Jena Fuseki. It is a SPARQL server and an open source project.

5.2 SPARQL Queries

Technology choices and implementation will be driven by the accessibility of data through SPARQL queries addressed to a SPARQL endpoint. This means that a running REST web service should respond to data queries and produce as results a set of triples serialized on one of the most used RDF serialization (RDF/XML, Turtle, N3) or an RDF graph. This should include queries both on tangible and non-tangible data and their specific relations.

SPARQL queries are "data-oriented" so there is no inference in the query language itself, all the data manipulation and inferencing has to be done by a layer on storage or on in memory RDF data. Thanks to its structure and many converters present in the market SPARQL queries can be applied not only to native RDF data but also on any data that could be mapped to RDF, like other kind of well-formed relational data.

6 Conclusion

The use of BIM for Cultural Heritage is becoming more and more an effective tool to manage 3D representations at different layers and for multiple purposes, pursuing the common vision, at European level, to apply research, technology and innovation in innovative media to expand understanding and access of the heritage assets.

One of the main challenges is how to manage the complexity of heritage buildings and sites, fostering the collaboration across disciplines through semantic-aware representations, able to solve interoperability issues and avoiding the segmentation of knowledge. The technology of Semantic Web and integration with 3D and BIM are the drivers behind H-BIM Ontology. The H-BIM Ontology in its turn is the core of the INCEPTION H-BIM Platform.

The INCEPTION procedure could be conveniently exploited for protecting the cultural heritage of seismic areas with scopes of classification, prevention and reconstruction.

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Author Index