

# Information Integration: Mapping Cultural Heritage Metadata into CIDOC CRM.

**Lais Barbudo Carrasco** (IESF) - laiscarrasco@hotmail.com

(Instituição - a informar) - manfred.thaller@uni-koeln.de

(Instituição - a informar) - joaquim@uc.pt

## **Resumo:**

*Cultural heritage institutions such as museums, archives, or libraries are confronting a crescent necessity to integrate their system. For this reason, to make cultural resources accessible, it is necessary the use of rich metadata structures, capable to cover the variety of material held in these memory institutions. For those proposes, cultural heritage metadata mappings into an ontology is created to achieve interoperability among sundry digital cultural heritage repositories. The CIDOC Conceptual Reference Model (CRM) is used as the mediated schema to integrate Cultural Heritage metadata sources.*

**Palavras-chave:** *Digital Cultural Heritage Repositories, Metadata, Ontology, Interoperability, Information Integration.*

**Área temática:** *Temática I: Tecnologias de informação e comunicação - um passo a frente*

## Information Integration: Mapping Cultural Heritage Metadata into CIDOC CRM.

### Abstract:

Cultural heritage institutions such as museums, archives, or libraries are confronting a crescent necessity to integrate their system. For this reason, to make cultural resources accessible, it is necessary the use of rich metadata structures, capable to cover the variety of material held in these memory institutions. For those proposes, cultural heritage metadata mappings into an ontology is created to achieve interoperability among sundry digital cultural heritage repositories. The CIDOC Conceptual Reference Model (CRM) is used as the mediated schema to integrate Cultural Heritage metadata sources.

**Key Words:** Digital Cultural Heritage Repositories, Metadata, Ontology, Interoperability, Information Integration.

**Tematic Area:** Temática I: Tecnologias de informação e comunicação – um passo a frente.

## 1 INTRODUCTION

By the fact that Digital Cultural Heritage Repositories - as Libraries, Archives and Museums - use different metadata standards to describe their information resources, the metadata harmonization from the cultural heritage field is a challenge, because the data models are more designed on the community requirements than on requirements of cross-community interoperability.

To examine the similarities and differences between the metadata standards of those three sectors the most prominent modern standards from these fields will be described next. It was selected MARC (Machine-Readable Cataloging)<sup>1</sup>, which is “a *standard for the representation and communication of bibliographic and related information in machine-readable form*”<sup>2</sup>; EAD (Encoded Archival Description)<sup>3</sup>, which project's goal was to create a data standard for describing archives.

EAD stands for Encoded Archival Description, and is a non-proprietary de facto standard for the encoding of finding aids for use in a networked (online) environment. Finding aids are inventories, indexes, or guides that are created by archival and manuscript repositories to provide information about specific

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<sup>1</sup> MARC (Machine-Readable Cataloging) - <http://www.loc.gov/marc/>

<sup>2</sup> MARC (Machine-Readable Cataloging) - <http://www.loc.gov/marc/>

<sup>3</sup> EAD (Encoded Archival Description) - <http://www.loc.gov/ead/>

collections. While the finding aids may vary somewhat in style, their common purpose is to provide detailed description of the content and intellectual organization of collections of archival materials. EAD allows the standardization of collection information in finding aids within and across repositories.<sup>4</sup>

For the field of museums, it was selected LIDO (Lightweight Information Describing Objects)<sup>5</sup>, which has an event-oriented approach compliant with the CIDOC CRM (ISO 21127).

The strength of LIDO lies in its ability to support the full range of descriptive information about museum objects. It can be used for all kinds of object, e.g. art, architecture, cultural history, history of technology, and natural history<sup>6</sup>.

In order to integrate information from heterogeneous sources, ontologies as semantic technologies are already being used, e.g. in the Europeana<sup>7</sup>. CIDOC Conceptual Reference Model (CRM)<sup>8</sup> is a very prominent ontology used for such purposes.

The CIDOC CRM 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. [...] In this way, it can provide the "semantic glue" needed to mediate between different sources of cultural heritage information, such as that published by museums, libraries and archives.<sup>9</sup>

In order to provide information integration semantics mappings can be a solution for it, in this work, mappings derived from the cultural heritage metadata standards, as MARC (Library), EAD (Archive), LIDO (Museum) into CIDOC CRM will be built. Hence, these mappings provide interoperability between those fields of the Cultural Heritage Universe. This mapping of the different metadata schemes into one conceptual reference space primarily supports *conceptual* integration. Therefore, CIDOC Conceptual Reference Model (CRM) is used as the mediated schema to integrate Cultural Heritage metadata sources.

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<sup>4</sup> About EAD (Encoded Archival Description) - <http://www.loc.gov/ead/eadabout.html>

<sup>5</sup> LIDO (Lightweight Information Describing Objects) - <http://network.icom.museum/cidoc/working-groups/data-harvesting-and-interchange/what-is-lido/>

<sup>6</sup> LIDO (Lightweight Information Describing Objects) - <http://network.icom.museum/cidoc/working-groups/data-harvesting-and-interchange/what-is-lido/>

<sup>7</sup> Europeana - <http://www.europeana.eu/>

<sup>8</sup> CIDOC CRM – Conceptual Reference Model - <http://www.cidoc-crm.org/>

<sup>9</sup> CIDOC CRM – Conceptual Reference Model - <http://www.cidoc-crm.org/>

## 2 STATE OF ART

The Library, Archive, and Museums are repositories of collective memory and they have some functions, for example, the maintenance and conservation of collections; the exposure; and provision of the means for the objects or information retrieval.

Storing, cataloging, classifying and exhibiting objects are part of the relationship process of the man with the world, and they are operations that do not arise with the museum, nor with library, and nor with the archive, but with collections.

- **Archive:** Ordained storage of documents, created by a person or institution in the course of its activity, and preserved to achieve their goals, aiming the utility that they may offer in the future, therefore, the archival information is information accumulated by institution to prove or inform, as the institution pursues its purposes/ends, with whom it relates, which rights and duties it represents.

- **Library:** Collection of books, periodicals, audiovisual documents, among others, selected based on their usefulness and arranged to provide access to materials and information, therefore, the organization of the documents in the library reflects the organization given to the area of knowledge (or the subject specifically covered by the documentation center).

- **Museum:** It is a permanent institution, nonprofit organization, in service of society and of its development, open to the public which acquires, conserves, researches, disseminates and exposes the material evidence of people and their environment, for education and delight of society; therefore, the museum, as the instance of the memory representation and social space in which information is considered cultural input, is a fertile ground for the development of studies and actions related to information.

In the last years, facing the phenomena of the digital libraries, a huge volume of data was created on the Internet. All these diversity of informational objects were treated with the use of different types of metadata, because they were from different communities, such as Library, Archive and Museum. It's important to make clear that metadata are data about data. Metadata can be seen as the digital version of catalog cards used in the traditional libraries.

Metadata are forms used to describe, manage, catalog, and classify documents (information objects). In Libraries, they are traditionally used to describe books, in other words, bibliographic data. In addition, in museums, metadata describes artifacts, paintings, and sculptures. On other hand, in Archive, the metadata are used to describe finding aids, charters, and official documents. Therewith, this treated information can be effectively retrieval. The cultural memory institutions aim to treat their information in order to obtain access and retrieval.

However, the metadata harmonization from the cultural heritage field is a challenge, because the data models are more designed on the community requirements than on requirements of cross-community interoperability. Interoperability is important issue discussed nowadays, because it helps to manage heterogeneous environments.

Interoperability is the ability of multiple systems with different hardware and software platforms, data structures, and interfaces to exchange data with minimal loss of content and functionality. Using defined metadata schemes, shared transfer protocols, and crosswalks between schemes, resources across the network can be searched more seamlessly.<sup>10</sup>

Europeana, for example, *“provides a common access point to digital cultural heritage objects across different cultural domains. All these domains, from the library, archives and museum to the audiovisual sectors are using different metadata formats that may be an obstacle to interoperability within Europeana. Practices need to be documented in guidelines, standardized in order to improve the interoperability between the data models and to facilitate works on data quality and enrichment.”*<sup>11</sup>

A way to make metadata interoperate is mapping them into ontology. CIDOC Conceptual Reference Model (CIDOC CRM)<sup>12</sup> is an ontology from the cultural heritage domain, which has been created as a tool for information integration.

### 3 RESULTS

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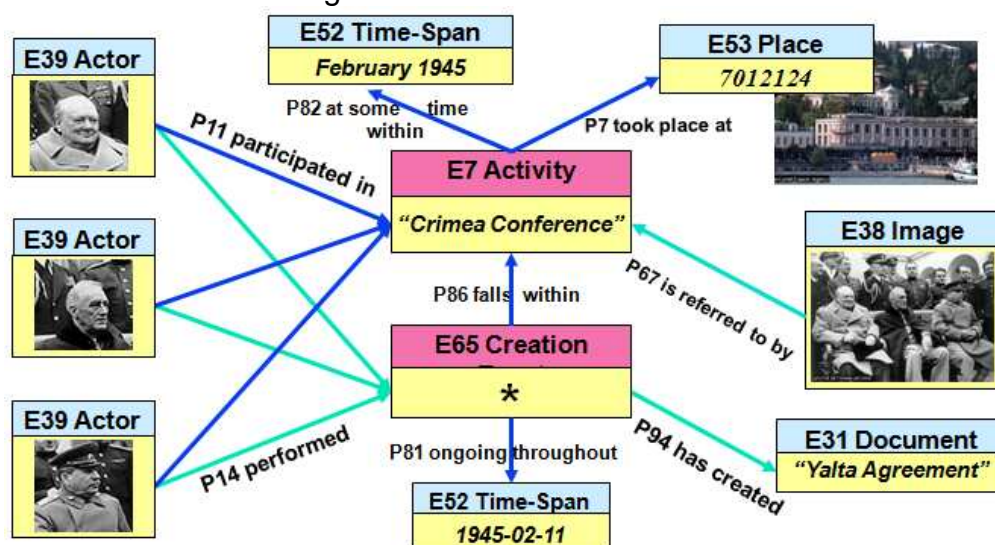
<sup>10</sup> Understanding Metadata – Booklet developed by NISO Press, 2004.

<http://www.niso.org/publications/press/UnderstandingMetadata.pdf>

<sup>11</sup> EDM (The Europeana Data Model) - <http://conference.ifla.org/past/ifla76/149-doerr-en.pdf>

<sup>12</sup> CIDOC CRM (Conceptual Reference Model) - <http://www.cidoc-crm.org/>

Figure 1 – Yalta Conference<sup>13</sup>



Fonte: Doerr, Martin; Stead, Steve. 2008.

The Yalta Conference also known as Crimea Conference, is an activity performed by a group - Allied Powers, Postwar Division – consisting of three person – Churchill, Roosevelt, Stalin – in a place, which can have different names in different languages or a special coordinates/code; in a date – a specific time-span. This episode is reported in a photo and in a written document – e.g. newspaper news. The following draft describes this information in CIDOC CRM categories.

Table 1 – Metadada mappings into CIDOC CRM

CIDOC CRM	MARC	EAD	LIDO
<b>E39 Actor</b>	100 Main entry – personal name (NR)	ead_author	Title
<b>E53 Place</b>	852 Location (R)	ead_origination	namePlaceSet Event Place
<b>E7 Activity</b>	111 Main entry – meeting name (NR)	ead_event	displayEdition
<b>E52 Time-Span</b>	518 Date/time and Place of a event note (R)	ead_date	Event Date
<b>E31 Document</b>	008 All materials	ead_frontmatter	Object
<b>E38 Image</b>	O08 Visual	ead_dao	objectWorkType

<sup>13</sup>Doerr, Martin; Stead, Steve. *The CIDOC CRM, a Standard for the Integration of Cultural Information*. Glasgow, Scotland. January 29, 2008.

[http://www.uniurb.it/sbc/ist\\_bal/seminario/carlo%20meghini/CIDOC%20CRM%20introduction.pdf](http://www.uniurb.it/sbc/ist_bal/seminario/carlo%20meghini/CIDOC%20CRM%20introduction.pdf)

	materials		
<b>E65 Creation</b>	508 Creation	ead_creation	Cultural context

The CIDOC CRM Entity and their connection can be expressed in XML, as follows.

```
<?xml version = "1.0" encoding = "ISO-8859-1"?>  
<?xml-stylesheet type="text/xsl" href="crm.xsl"?>
```

```
<CRMset>  
<CRM_Entity> Yalta Conference
```

```
<in_class> E39: Actor  
<is_identified_by> Churchill </is_identified_by>  
<is_identified_by> Roosevelt </is_identified_by>  
<is_identified_by> Stalin </is_identified_by>  
</in_class>
```

```
<in_class> E74: Group  
<is_identified_by> Allied Leader </is_identified_by>  
<is_identified_by> Allied Power </is_identified_by>  
</in_class>
```

```
<in_class>E53: Place  
<is_identified_by> Yalta  
<has_type> City </has_type>  
</is_identified_by>  
<is_identified_by> Crimea  
<has_type> Region </has_type>  
</is_identified_by>  
<is_identified_by> Ukraine  
<has_type> Country </has_type>  
</is_identified_by>  
<is_identified_by> TGN 7012124  
<has_type> Place identifier/Code </has_type>  
</is_identified_by>  
</in_class>
```

```
<in_class>E5: Event  
<is_identified_by> Yalta Conference  
<has_type> Conference City </has_type>  
</is_identified_by>  
<is_identified_by> Crimea Conference  
<has_type> Conference Region </has_type>  
</is_identified_by>  
<is_identified_by> Allied Leaders at Yalta  
<has_type> Group/ Place </has_type>  
</is_identified_by>
```

```
<is_identified_by> Postwar Division
<has_type> Group </has_type>
<has_type> Organization </has_type>
<has_type> Society </has_type>
</is_identified_by>
</in_class>

<in_class>E50:Date
<has_note> February 1945 <has_note>
<has_note> 1945-02-11<has_note>
</in_class>

<in_class> E65: Conceptual creation
<took_place_on> 1945-02-11 </took_place_on>
</in_class>

<in_class> E31: Document
<documents> Photo
    <has_note> Actors </has_type>
    <has_note> Event </has_type>
</ documents>
<documents> Agreement Text </documents>
</in_class>

<in_class> E38: Image
<is_identified_by> Photo Place
    <has_note> E53 Place </has_type>
</is_identified_by>
< is_identified_by> Photo Event/Actors
    <has_note> E5 Event </has_type>
    <has_note> E39 Actor </has_type>
</ is_identified_by>
</in_class>

</CRM_Entity>
</CRMset>
```

Assumed, that the material for "Yalta" is stored in an information system. This information system displays Churchill. What should the user see on the screen? I.e., besides the picture of Churchill the various links to other resources should also be visible. E.g., as a list of "Events the person has participated in". Such an "event the person has participated in" should than be displayed by its name, its location, possibly an image of the location, etc. and probably also a list of all the people participating in the event. Now the various labels ("Events the person has participated in") exist in English and should be derived exclusively from the CRM



categories, which describe the links/ connections. In order to provide a multilingual description, Portuguese labels were added to the CRM Entities and Properties.

**CHURCHILL** (entity **E39 Actor @ pt E39 Ato**)

P107 was member of @ pt P107 foi membro de

Allied Leader (entity **E74 Group @ pt E74 Grupo**)

P107 had member @ pt P107 teve membro

Roosevelt (entity **E39 Actor @ pt E39 Ato**)

Stalin (entity **E39 Actor @ pt E39 Ato**)

Allied Power (entity **E74 Group @ pt E74 Grupo**)

P107 had member @ pt P107 teve membro

Roosevelt (entity **E39 Actor @ pt E39 Ato**)

Stalin (entity **E39 Actor @ pt E39 Ato**)

P11 participated in, P14 performed @ pt P11 participou em, P14 realizou

Crimea Conference (entity **E7 Activity @ pt E7 Atividade**)

Yalta Conference (entity **E7 Activity @ pt E7 Atividade**)

Conference between Allied Powers (entity **E7 Activity @ pt E7**

*Atividade*)

Allied Leaders at Yalta (entity **E7 Activity @ pt E7 Atividade**)

Postwar Division (entity **E7 Activity @ pt E7 Atividade**)

P82 at some time within @ pt P82 em algum momento dentre

February 1945 (entity **E52 Time-Span @ pt E52 Espaço de Tempo**)

P7 took place at @ pt P7 teve lugar em

Jalta (entity **E53 Place @ pt E53 Lugar**)

P2 has type

City (entity **E55 Type @ pt E55 Tipo**)

Yalta (entity **E53 Place @ pt E53 Lugar**)

P2 has type

City (entity **E55 Type @ pt E55 Tipo**)

Krym (entity **E53 Place @ pt E53 Lugar**)

P2 has type

Region (entity **E55 Type @ pt E55 Tipo**)

Crimea (entity **E53 Place @ pt E53 Lugar**)

P2 has type

Region (entity **E55 Type @ pt E55 Tipo**)

Ukrayina (entity **E53 Place @ pt E53 Lugar**)

P2 has type

Country (entity **E55 Type @ pt E55 Tipo**)

Ukraine (entity **E53 Place @ pt E53 Lugar**)

P2 has type

Country (entity **E55 Type @ pt E55 Tipo**)

7012124 (entity **E53 Place @ pt E53 Lugar**)

P2 has type

TNG (entity **E55 Type @ pt E55 Tipo**)

Photo Place (entity **E53 Place @ pt E53 Lugar**)

## 4 DISCUSSION

The semantic mapping provides interoperability among the cultural heritage systems data, whereas, through the CIDOC CRM they can communicate with each other, i.e. exchange entries. In other words it integrates the ontological representation of the CIDOC CRM with earlier ways to represent metadata.

*The goal of semantic integration is to connect different information systems through their subject metadata - enabling distributed search over several information systems together with the advanced subject access tools provided by the individual databases. Through the mapping of different subject terminologies, a “semantic agreement” for the overall collection to be searched on is achieved. Terminology mapping – the mapping of words and phrases of one controlled vocabulary to the words and phrases of another – enables the seamless switch from a one-database-search to distributed search scenarios in the digital library world.<sup>14</sup>*

Cultural heritage institutions such as museums, archives, or libraries are confronting a crescent necessity to integrate their system. For this reason, to make cultural resources accessible, it is necessary the use of rich metadata structures, capable to cover the variety of material held in these memory institutions.

In this context, ontologies are used as an important tool for achieving information integration, in other words, metadata can be semantically mapped and integrated into an ontology, which has the competence not only to conceptualize specific domains, but also to express their semantics.

*Semantic Integration is the process of using a conceptual representation of the data and of their relationships to eliminate possible heterogeneities. One of the main Semantic Web infrastructure elements, which are an important means in semantic integration scenarios, is ontologies. Their nature allows the sophisticated, extended and rich expression of meanings, and - at the same time - the ability of reasoning.<sup>15</sup>*

In this work, CIDOC CRM ontology was used as a conceptual representation of cultural heritage domain to promote semantic integration between different metadata schemas, such as Encoded Archival Description (EAD), Machine Readable Cataloguing (MARC) and Lightweight Information Describing Objects (LIDO). In

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<sup>14</sup>Mayr, Philipp; Petras, Vivien. *Cross-concordances: terminology mapping and its effectiveness for information retrieval*. <http://www.ib.hu-berlin.de/~mayr/arbeiten/ifla08-2008-04-15.pdf>

<sup>15</sup>Bountouri, Lina; et al. *Ontology-Based Metadata Integration in the Cultural Heritage Domain*. 2007. <http://www.nsl.hcmus.edu.vn:8989/greenstone/collect/icadl/archives/HASH2548.dir/doc.pdf>

addition, semantic mappings from these metadata schemas to CIDOC CRM were made with the intention of achieving semantic interoperability among this data.

## 5 FINAL CONSIDERATIONS

Managing heterogeneous data is a challenge for cultural heritage institutions, archives, libraries, and museums which usually develop collections with heterogeneous types of material, described by different metadata schemas. For example, the Library of Congress, USA, provides EAD metadata for the archives description, MARC 21 records for the description of a wide variety of material, such as books and photographs, Text Encoding Initiative (TEI) for documenting the text of digital reproductions in the American Memory Collection, etc. The wide use of a number of cultural heritage metadata schemas imposes the development of interoperability techniques that facilitate unified access to cultural resources. One of the widely implemented techniques is the Ontology-Based Integration. Ontologies provide formal specifications of a domain's concepts and their interrelations and act as a mediated schema between heterogeneous sources.<sup>16</sup>

We are facing an explosion of varieties of cultural heritage metadata schemas. Cultural Heritage as the safeguard of the memory has heterogeneous materials, and for this reason they are safeguarded, protected and conserved in the Libraries, Archives and Museum. In order to treat these digital object metadata are used. On other hand, how can these three sisters institutions exchange entries?

According to the literature, there are many XML metadata mapping to the CIDOC CRM ontology efforts, since this ontology is considered one of the most appropriate models in integration architectures.

“An ontology is a specification of a conceptualization”<sup>17</sup>. More specially, the CIDOC CRM ontology is the specification of the Cultural Heritage conceptualization. CIDOC CRM has an abstract hierarchy.

Therefore, metadata can be mapped into an ontology to provide interoperability of its data and also to achieve information integration. When the

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<sup>16</sup>Papatheodorou, Christos. *Ontology-based Integration of Cultural Heritage Metadata*.  
<http://iacam.di.uniba.it:8000/ircd12012/data/Invited.pdf>

<sup>17</sup>T. Gruber. A translation approach to portable ontology specifications. *Knowledge Acquisition*,5(2):199{220, 1993.

different kind of metadata are mapped into an ontology the system can interoperate and information access is higher as well as their information retrieval.

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