

# Proposal for Multimedia Ontologies:

## ISO/FDIS 21127

*Martin Doerr, ISC-FORTH, Heraklion, Greece*

*martin@ics.forth.gr*

*Dolores Iorizzo, ICSTM, London, UK*

*d.iorizzo@imperial.ac.uk*

*, Paul Lewis, Kirk Martinez, Matthew Addis, University of Southampton, UK*

*[pass,phl,km]@ecs.soton.ac.uk, mja@it-innovation.soton.ac.uk*

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## Introduction

Multimedia objects are characterized by a complex structure and a complex creation process. By far more than texts, digital visual and audio objects frequently represent other things. This is why they are often regarded as “digital surrogates”, even though this term may be more misleading than helpful. E.g., a digital library keeps a digitized image of an 18<sup>th</sup> century engraving of the Sphinx in Gizeh, Egypt, with the nose intact. A study may *comprise images* of the Sphinx at different times and describe *processes*, such as deteriorations, destructions, reconstructions and interpretations. More than in traditional media, content *relationships* such as *different views* of the same item, views of *parts*, views of changes over *time*, documentation of *events* and processes play a major role in the understanding and processing of multimedia objects.

The idea of a digital surrogate frequently misleads documentalists to ignore the relevance of the *derivation* history and *composition processes* for the successful automated *integration, correlation* and *reuse* of multimedia *assets* and *objects*. There is a need for *integrated representation* of *relationships* of the ***content and context of creation***. For instance, a journalist recording a war scene is part of the event itself.

## ISO21127

The CIDOC CRM or ISO/FDIS 21127 is a core ontology and Final Draft ISO standard for the semantic integration of cultural information and more with library, archive and other information. It has been developed and is supported by the International Committee for Documentation CIDOC of the International Council of Museums ICOM from 1996 on. The CIDOC CRM concentrates on the definition of relationships, rather than classes, in order to capture the underlying semantics of multiple data and metadata structures. This led to a compact model of 80 classes and 130 relationships, easy to comprehend and suitable to serve as a basis for mediation of cultural and library information and thereby provide the semantic 'glue' needed to transform today's disparate, localised information sources into a coherent and valuable global resource. It comprises the concepts characteristic for most museum, archive and library documentation. Its central idea is the explicit modelling of events, both for the representation of metadata, such as creation, publication, and use, as well as for content summarization and the creation of integrated knowledge bases. It has been formulated in RDFS and OWL.

Its approach to event modelling is generic enough to describe not only cultural materials but also the basic documentation of experiments and observations carried out in sciences. There is a successful on-going collaboration of committees ICOM and IFLA on the harmonization of ISO21127 with latest expression of the conceptualization of the libraries world, FRBR. It could be demonstrated, that ISO21127 subsumes all relevant FRBR concepts. Jane Hunter describes a merge of MPEG7 concepts with the CIDOC CRM. The ontology enjoys a rapidly increasing take up by information systems designers all around the world.

## Requirements

### *Scope and usage*

We propose to consider the CIDOC CRM (see <http://cidoc.ics.forth.gr>) as *part of a core ontology* for Multimedia Objects.

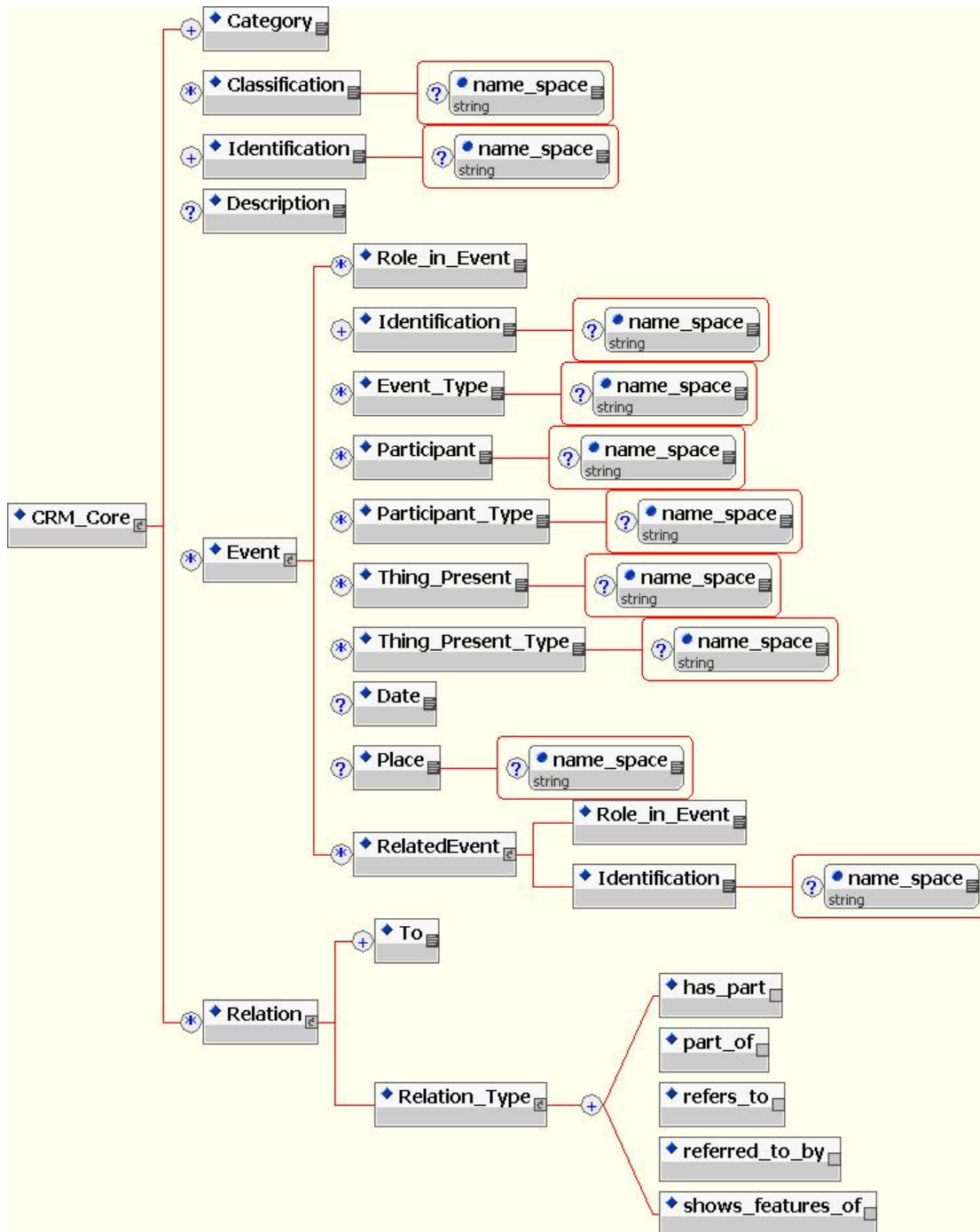
The particular power of the CRM lies in the fact that thousands of potential relationships can be reduced to four fundamental principles:

1. Participation in an event (e.g. creator, contributor, publisher, birth date, birth place, creation date, place of find, designer, project leader etc.)
2. Part-whole relation
3. Reference (e.g. subject, “aboutness”, representation)
4. Classification

The CIDOC CRM is a powerful global model to integrate, mediate and transform metadata and content summarizations. It is nearly unique, because it elaborates on the relationships that connect our knowledge rather than on individual concepts or vocabularies. As such, it closes a huge gap in the ontologies landscape. We regard that a harmonization of other MM ontologies with the CIDOC CRM offers the following benefits:

1. Wide compatibility with documentation formats of Archives Libraries and Museums and potential to cover larger parts of other scientific documentation.
2. Coherent representation of core relationships about the context of complex MM object creation and content summarization.
3. A back-bone for the alignment and harmonization of various MM ontologies.

## CRM Core



**Figure 1** A graphical representation of the CRM Core DTD

The **CRM Core** is a recent proposal of CIDOC for a highly condensed set of metadata elements which basically reduces the CIDOC CRM to the above principles and still is ISO21127 compatible. It is Dublin Core compatible, but more than Dublin Core, it can be used to describe large meaningful networks of knowledge which allow for querying *meaningful deep data paths* of properties, such as “the organizations X with which partners of contract Y had already contracts before”.

The design of CRM Core is so that it enables the construction of networks, as the Hoagland example in Appendix A demonstrates. This is a novel requirement to metadata elements, previously seen just as finding aids, but not as means to relate information. Of course, one can produce a multitude of such metadata structures from the CIDOC CRM, at different levels of sophistication. The CRM Core is an extraordinary simple one.

These days, many researchers concentrate on ontologies used as categorical data, i.e. formally defined terminological systems of individual concepts, rather than relationships. They often oversee the completely different character of core ontologies describing schema semantics. The latter are the ones employed in the database integration experiments in the nineties, such as TSIMMIS, Infosleuth etc. They are small and dominated by relationships. It is often argued, that IsA hierarchies of a domain terminology “structure” a domain. This might be, but they do not structure information itself. The internal structure of information units is given by relations (or attributes) connecting particulars, and not by individual classes or terms. If information units are integrated, again it is the relationships that provide structure. In conceptual models, classes mainly govern the consistent application of the relationships. Classification of information does not integrate information in the narrower sense. It aggregates it and divides it up. It cannot describe any complementary information.

The CRM Core as an XML DTD is provided in Appendix A to illustrate the basic idea of the CIDOC CRM. We will use the examples of information modelled in CRM Core in the rest of the document.

## Annotation

The Sphinx scenario described in the introduction illustrates the complexity of the information modelling problem in the cultural heritage domain. Through the simple examples in this section we demonstrate the requirements for cultural heritage annotation of multimedia objects, and how the CIDOC CRM supports these. A more complete example is presented in Appendix A.

### A digital photo depicting a person

[http://en.wikipedia.org/wiki/Image:Beckham\\_Euro2004.jpg](http://en.wikipedia.org/wiki/Image:Beckham_Euro2004.jpg)

David Beckham at Euro 2004

Image © <http://soccer-europe.com>

QuickTime™ and a  
TIFF (Uncompressed) decompressor  
are needed to see this picture.

This example simply illustrates how to represent a person depicted in a digital photo. The image is hosted on the Wikipedia site, and thus its URL is used as the record identifier. The subject (David Beckham) is modelled as being a participant of an event that the image represents.

```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE CRM_Core SYSTEM "CRM_Core.dtd">
<CRM_Core>
  <Category>E38.Image</Category>
  <Classification name_space="http://www.getty.edu/research/conducting_research/vocabularies/aat/"
    >digital images</Classification>
  <Identification>http://en.wikipedia.org/wiki/Image:Beckham_Euro2004.jpg</Identification>
  <Description>David Beckham at Euro 2004</Description>
  <Event>
    <Role_in_Event>P138F.represents</Role_in_Event>
    <Identification name_space="http://cidoc.ics.forth.gr/crm_core/demo">David Beckham at Euro 2004</Identification>
    <Event_Type name_space="http://cidoc.ics.forth.gr/rdfs/cidoc_v4.2.rdfs">E7.Activity</Event_Type>
    <Event_Type name_space="http://www.iptc.org/NewsCodes/">soccer</Event_Type>
    <Participant>
      <Identification>http://en.wikipedia.org/wiki/David_beckham</Identification>
      <Participant_Type name_space="http://www.iptc.org/NewsCodes/">soccer</Participant_Type>
      <Participant_Type name_space="http://www.iptc.org/NewsCodes/">celebrity</Participant_Type>
    </Participant>
    <Date>2004</Date>
    <Place name_space="http://www.getty.edu/research/conducting_research/vocabularies/tgn/">Portugal (nation)</Place>
  </Event>
</CRM_Core>
```

## A photo of an event – the Yalta Conference

[http://en.wikipedia.org/wiki/Image:Yalta\\_Conference.jpg](http://en.wikipedia.org/wiki/Image:Yalta_Conference.jpg)

Yalta summit 1945 with Churchill, Roosevelt, Stalin.

Here is a more complex example involving a photo of Churchill, Roosevelt and Stalin at the Yalta Conference.

Again, the subjects of the photo are modelled through a representation event with several participants. This event references a sub event of the Yalta Conference, the creation of the “Protocol of Proceedings of Crimea Conference “ document (following page).

QuickTime™ and a  
TIFF (Uncompressed) decompressor  
are needed to see this picture.

### The image on Wikipedia:

```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE CRM_Core SYSTEM "CRM_Core.dtd">
<CRM_Core>
  <Category>E38.Image</Category>
  <Classification name_space="http://www.getty.edu/research/conducting_research/vocabularies/aat/"
    >photographs</Classification>
  <Identification>http://en.wikipedia.org/wiki/Image:Yalta_Conference.jpg</Identification>
  <Description>Yalta summit in 1945 with Winston Churchill, Franklin Roosevelt and Josef Stalin</Description>
  <Event>
    <Role_in_Event>P138F.represents</Role_in_Event>
    <Identification name_space="http://cidoc.ics.forth.gr/crm_core/demo">Crimea Conference</Identification>
    <Event_Type name_space="http://cidoc.ics.forth.gr/rdfs/cidoc_v4.2.rdfs">E7.Activity</Event_Type>
    <Participant>
      <Identification>http://en.wikipedia.org/wiki/Churchill</Identification>
      <Participant_Type name_space="http://www.getty.edu/research/conducting_research/vocabularies/aat/"
        >politicians</Participant_Type>
    </Participant>
    <Participant>
      <Identification>http://en.wikipedia.org/wiki/Franklin_Delano_Roosevelt</Identification>
      <Participant_Type name_space="http://www.getty.edu/research/conducting_research/vocabularies/aat/"
        >politicians</Participant_Type>
    </Participant>
    <Participant>
      <Identification>http://en.wikipedia.org/wiki/Stalin</Identification>
      <Participant_Type name_space="http://www.getty.edu/research/conducting_research/vocabularies/aat/"
        >politicians</Participant_Type>
    </Participant>
    <Date>1945</Date>
    <Place name_space="http://www.getty.edu/research/conducting_research/vocabularies/tgn/">Yalta (inhabited place)</Place>
    <RelatedEvent>
      <Role_in_Event>P9F.is_composed_of</Role_in_Event>
      <Identification name_space="http://cidoc.ics.forth.gr/crm_core/demo">Creating Yalta Agreement</Identification>
    </RelatedEvent>
  </Event>
</CRM_Core>
```

## Record for the Protocol of Proceedings of Crimea Conference:

```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE CRM_Core SYSTEM "CRM_Core.dtd">
<CRM_Core>
  <Category>E31.Document</Category>
  <Identification>http://www.taiwandocuments.org/yalta.htm</Identification>
  <Description>Protocol of Proceedings of Crimea Conference.</Description>
  <Event>
    <Role_in_Event>P94B.was_created_by</Role_in_Event>
    <Identification name_space="http://cidoc.ics.forth.gr/crm_core/demo">Creating Yalta Agreement</Identification>
    <Event_Type name_space="http://cidoc.ics.forth.gr/rdfs/cidoc_v4.2.rdfs">E65_Creation</Event_Type>
    <Participant>
      <Identification>http://en.wikipedia.org/wiki/Churchill</Identification>
      <Participant_Type name_space="http://www.getty.edu/research/conducting_research/vocabularies/aat/"
        >politicians</Participant_Type>
    </Participant>
    <Participant>
      <Identification>http://en.wikipedia.org/wiki/Franklin_Delano_Roosevelt</Identification>
      <Participant_Type name_space="http://www.getty.edu/research/conducting_research/vocabularies/aat/"
        >politicians</Participant_Type>
    </Participant>
    <Participant>
      <Identification>http://en.wikipedia.org/wiki/Stalin</Identification>
      <Participant_Type name_space="http://www.getty.edu/research/conducting_research/vocabularies/aat/"
        >politicians</Participant_Type>
    </Participant>
    <Date>1945</Date>
    <Place name_space="http://www.getty.edu/research/conducting_research/vocabularies/tgn/">Yalta (inhabited place)</Place>
    <RelatedEvent>
      <Role_in_Event>P9B.forms_part_of</Role_in_Event>
      <Identification name_space="http://cidoc.ics.forth.gr/crm_core/demo">Crimea Conference</Identification>
    </RelatedEvent>
  </Event>
</CRM_Core>
```

## Provenance information of cultural heritage object

[http://en.wikipedia.org/wiki/Image:Mona\\_Lisa.jpg](http://en.wikipedia.org/wiki/Image:Mona_Lisa.jpg)

The Mona Lisa

Source: <http://www.louvre.fr/img/photos/collec/peint/grande/inv0779.jpg>

Here is a more typical cultural heritage scenario.

We have a digital image of a painting, the Mona Lisa, hosted by Wikipedia. The image refers to the actual work of art at the Louvre in Paris.

We can then describe information about that work of art, such as details about the creation that link to another record about the artist.

QuickTime™ and a  
TIFF (Uncompressed) decompressor  
are needed to see this picture.

### The image on Wikipedia:

```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE CRM_Core SYSTEM "CRM_Core.dtd">
<CRM_Core>
  <Category>E38.Image</Category>
  <Classification name_space="http://www.getty.edu/research/conducting_research/vocabularies/aat/"
    >digital_images</Classification>
  <Identification>http://en.wikipedia.org/wiki/Image:Mona_Lisa.jpg</Identification>
  <Relation>
    <To name_space="http://www.louvre.fr">INV. 779</To>
    <Relation_Type>
      <refers_to/>
    </Relation_Type>
  </Relation>
</CRM_Core>
```

### The painting in the Louvre:

```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE CRM_Core SYSTEM "CRM_Core.dtd">
<CRM_Core>
  <Category>E84.Information_Carrier</Category>
  <Classification name_space="http://www.getty.edu/research/conducting_research/vocabularies/aat/"
    >paintings</Classification>
  <Identification name_space="http://www.louvre.fr">INV. 779</Identification>
  <Description>Portrait of Lisa Gherardini, wife of Francesco del Giocondo</Description>
  <Event>
    <Role_in_Event>P108B.was_produced_by</Role_in_Event>
    <Identification name_space="http://cidoc.ics.forth.gr/crm_core/demo">Painting of Mona Lisa</Identification>
    <Event_Type name_space="http://cidoc.ics.forth.gr/rdfs/cidoc_v4.2.rdfs">E12.Production</Event_Type>
    <Participant>
      <Identification name_space="http://www.getty.edu/research/conducting_research/vocabularies/ulan/"
        >Leonardo da Vinci</Identification>
      <Participant_Type name_space="http://www.getty.edu/research/conducting_research/vocabularies/aat/"
```

```
        >artists</Participant_Type>
    </Participant>
    <Date>1503-1506</Date>
    <Place name_space="http://www.getty.edu/research/conducting_research/vocabularies/tgn/"
        >Florence (World, Europe, Italy, Tuscany, Firenze province)</Place>
</Event>
</CRM_Core>
```

### Record for the artist, Leonardo da Vinci:

```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE CRM_Core SYSTEM "CRM_Core.dtd">
<CRM_Core>
    <Category>E21.Person</Category>
    <Classification name_space="http://www.getty.edu/research/conducting_research/vocabularies/aat/"
        >artists</Classification>
    <Identification
        name_space="http://www.getty.edu/research/conducting_research/vocabularies/ulan/">Leonardo
        da Vinci</Identification>
    <Event>
        <Role_in_Event>P98B.was_born</Role_in_Event>
        <Identification name_space="http://cidoc.ics.forth.gr/crm_core/demo">Leonardo birth</Identification>
        <Event_Type name_space="http://cidoc.ics.forth.gr/rdfs/cidoc_v4.2.rdfs">E67.Birth</Event_Type>
        <Date>1452</Date>
        <Place name_space="http://www.getty.edu/research/conducting_research/vocabularies/tgn/"
            >Vinci (Firenze province, Tuscany, Italy) </Place>
    </Event>
    <Event>
        <Role_in_Event>P100B.died_in</Role_in_Event>
        <Identification name_space="http://cidoc.ics.forth.gr/crm_core/demo">Leonardo death</Identification>
        <Event_Type name_space="http://cidoc.ics.forth.gr/rdfs/cidoc_v4.2.rdfs">E69.Death</Event_Type>
        <Date>1519</Date>
        <Place name_space="http://www.getty.edu/research/conducting_research/vocabularies/tgn/"
            >Amboise (Indre-et-Loire, Centre region, France) </Place>
    </Event>
</CRM_Core>
```

## Multiple views of the same object

[http://www.vam.ac.uk/collections/furniture/object\\_stories/lawson/index.html](http://www.vam.ac.uk/collections/furniture/object_stories/lawson/index.html)

It is often not possible to capture a complex physical object using a single item of media. It may be necessary to use a set of photographs representing multiple views of the same physical object. A series of photographs may also be used to capture the same physical object in different locations, for example the various locations within the Victoria and Albert Museum in which The Three Graces has been exhibited.

This example shows the records for the Lawson Cabinet at the Victoria & Albert Museum in London.

### Record for the cabinet:

```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE CRM_Core SYSTEM "CRM_Core.dtd">
<CRM_Core>
  <Category>E84.Information_Carrier</Category>
  <Classification name_space="http://www.getty.edu/research/conducting_research/vocabularies/aat/"
    >cabinets (case furniture)</Classification>
  <Identification>http://www.vam.ac.uk/collections/furniture/object_stories/lawson/index.html</Identification>
  <Description>The cabinet was made in about 1700 to commemorate the marriage of Margaret Trotter
    to George Lawson. The couple's monograms can be seen on the outer doors, while the arms of
    the two families can be found on the door of the inner cupboard.</Description>
  <Event>
    <Role_in_Event>P94B.was_created_by</Role_in_Event>
    <Identification name_space="http://cidoc.ics.forth.gr/crm_core/demo"
      >Making_the_Lawson_Cabinet</Identification>
    <Event_Type name_space="http://cidoc.ics.forth.gr/rdfs/cidoc_v4.2.rdfs">E12.Production</Event_Type>
    <Participant>
      <Participant_Type name_space="http://www.getty.edu/research/conducting_research/vocabularies/aat/"
        >cabinetmakers</Participant_Type>
    </Participant>
    <Date>Circa 1700</Date>
    <Place name_space="http://www.getty.edu/research/conducting_research/vocabularies/tgn/"
      City of London (World, Europe, United Kingdom, England, Greater London, London)</Place>
  </Event>
</CRM_Core>
```

## Images of the cabinet:

```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE CRM_Core SYSTEM "CRM_Core.dtd">
<CRM_Core>
  <Category>E38.Image</Category>
  <Classification name_space="http://www.getty.edu/research/conducting_research/vocabularies/aat/">photographs</Classification>
  <Identification>http://www.vam.ac.uk/images/image/3689-popup.html</Identification>
  <Description>Lawson Cabinet</Description>
  <Relation>
    <To>http://www.vam.ac.uk/collections/furniture/object_stories/lawson/index.html</To>
    <Relation_Type>
      <refers_to/>
    </Relation_Type>
  </Relation>
</CRM_Core>
```

```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE CRM_Core SYSTEM "CRM_Core.dtd">
<CRM_Core>
  <Category>E38.Image</Category>
  <Classification name_space="http://www.getty.edu/research/conducting_research/vocabularies/aat/">photographs</Classification>
  <Identification>http://www.vam.ac.uk/images/image/3692-popup.html</Identification>
  <Description>Lawson Cabinet Door</Description>
  <Relation>
    <To>http://www.vam.ac.uk/collections/furniture/object_stories/lawson/index.html</To>
    <Relation_Type>
      <refers_to/>
    </Relation_Type>
  </Relation>
</CRM_Core>
```

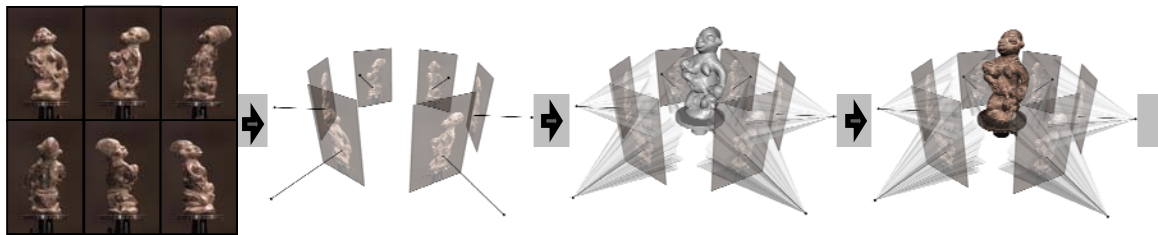
```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE CRM_Core SYSTEM "CRM_Core.dtd">
<CRM_Core>
  <Category>E38.Image</Category>
  <Classification name_space="http://www.getty.edu/research/conducting_research/vocabularies/aat/">photographs</Classification>
  <Identification>http://www.vam.ac.uk/images/image/3696-popup.html</Identification>
  <Description>Detail of Lawson Cabinet draws</Description>
  <Relation>
    <To>http://www.vam.ac.uk/collections/furniture/object_stories/lawson/index.html</To>
    <Relation_Type>
      <refers_to/>
    </Relation_Type>
  </Relation>
</CRM_Core>
```

We have used these examples to illustrate some of the complexities of modeling information in the cultural heritage domain, and how the CIDOC CRM can be used to capture the information. Further examples in the cultural heritage domain that we have encountered include:

- Views within a certain image. For instance in objects depicting many people one should be able to associate regions of a image to individuals and events. The same applies to multimedia representations of cultural events, such as videos.
- Event modelling – issues with temporal modelling: historical events as meetings, deposition events as meetings, information events as meetings, time uncertainty, certainty and duration
- A geographical map used to present information on roman coins including where they were made, where they were discovered, and where they are now housed in collections that can be viewed. This scenario shows how a multimedia map (potentially interactive, c.f. Google earth) can be used to present multiple physical objects in different contexts.
- A timeline presenting the works of art of one or more artists. The construction, degradation, and restoration of a work of art can also be shown as a time series. This scenario shows how multiple images represent the temporal events/states of a physical object.
- A set of tableware (knives, forks, plates, bowls, serving dishes) presented as an animated and interactive model to show how a table might have been laid, the type of food that might have been served, and the order in which the utensils were used. This shows how a single multimedia item can represent multiple physical objects and the temporal use of those objects.
- Different scientific images (UV, IR, x-ray etc.) are sometimes presented alongside the original artwork in museums and galleries, along with explanations of how to interpret them and what they reveal, e.g. to show how conservation has been done on an oil painting, the underdrawings, the paint layers, and the brush strokes. This scenario shows how different types of images can show different characteristics of the same physical object.
- Interesting scenarios arise where a particular artist creates several different works of art of the same subject (e.g. ‘virgin of the rocks’) that are located in different venues (e.g. The National Gallery London and The Louvre) and the multimedia images are presented side-by-side with the physical objects in these venues.
- Physical objects (e.g. <http://www.vam.ac.uk/collections/sculpture/stories/bashaw/index.html>) are often found co-located in a gallery or museum and multimedia (either temporarily or permanently) and a representation (e.g. QT movie or VRML) is often used to capture this in digital form. Conversely, virtual environments

may be created digitally that co-locate multiple real-world objects that are physically geographically distributed.

- It is not uncommon for artists to create portraits of themselves or other artists, for example <http://www.artandarchitecture.org.uk/fourpaintings/rubens/index.html>. In this scenario, a photograph represents a painting created by an artist that also depicts that artist and other people related to them.



- The creation of one multimedia object may involve the processing of other multimedia objects, for example a series of 2D photographs can be used to make a set of 2D silhouettes, which in turn were used to create a 3D model and texture map. Multiple media objects are created using a particular process with both the starting point and end result describing a particular physical object.

### ***Links to Domain Vocabularies***

The CIDOC CRM defines the underlying semantics of cultural heritage information in terms of a formal ontology. It does not specify any of the terminology appearing typically as data in the respective data structures. However, it foresees the characteristic relationships for its use.

In the cultural heritage domain there are various existing domain vocabularies that are widely used. These include English Heritage, HEREIN, AAT, ICONCLASS and SHIC. Outside of the cultural heritage domain there are a wide variety of vocabularies that can be used. Some of the examples presented here use the IPTC news codes. It is important that associations to domain vocabularies are handled through the identifiers in the vocabulary, as opposed to simply using free text labels.

This approach can be applied to link existing domain vocabularies and ontologies to deal with terminology outside of the cultural heritage domain. A useful resource in this area is the SKOS ontology for modeling knowledge organization systems.

For identifying real world people the use of standard controlled lists, such as ULAN, should be used as much as possible.

The proper application of spatial information is incredibly useful in cultural heritage. The way that place metadata is structured is crucial as it enables browsing and retrieval based on an exact spatial location rather than text based retrieval on place names. There are other considerations particular to the cultural heritage domain, such as historical documentation referring to historical place names that needs to be modeled. Being able to link to a standard gazetteer is important, such as the Getty

Thesaurus of Geographic Names (TGN), but there should also be the ability to define well structured place information for a particular application.

### ***Languages and Tools***

The full version of the CIDOC CRM is available in XML, RDFS and OWL. The CIDOC CRM Core is work in progress, and to date is only available as XML DTD. It will be possible to express the model as RDFS or OWL.

The Sculpteur SRW [6],[7] exposes data structured according to the CIDOC CRM structure. In the eCHASE project we are investigating the use of CIDOC CRM Core to provide interoperability between different museum institutions.

### ***Concepts and Resources - characteristics to be represented***

We are proposing that the CIDOC CRM should be used as part of the core ontology for multimedia. As such, we suggest that the CRM Core concepts should be considered as requirements so that information related to and regarding multimedia objects can be structured and modelled accurately.

We have not gone into much detail on the particular characteristics for the multimedia objects themselves, as we believe that other members of the community are better suited for specifying such requirements. However, from the perspective of the cultural heritage domain, there are some particular multimedia formats and characteristics that we would like to describe to ensure they are not overlooked.

We have described that being able to specify regions in multimedia objects, including temporal multimedia, is important.

In the MIAKT project [8] an ontology was used to integrate various imaging modalities in breast cancer diagnosis to the medical case notes. Tools were provided for delineating regions so that automatic analysis of those regions could be used to generate textual descriptors that were in the ontology. Hence you could get from instance in the ontology to images with those particular characteristics and use the information in the reasoning and classification processes.

There are specific requirements for more unusual multimedia representations in the cultural heritage domain. These include:

- multispectral images for art conservation with appropriate colour calibration
- 3D scanning and fotogrammetry of objects
- performing arts recording
- 3D objects
- ethnographic or historical scenes,
- aerial and satellite images for evaluation of sites and their changes,

alignment of related images, annotation of VR models.

### ***Harmonisation***

Core ontologies are not just arbitrary formulations of a domain. They are carefully selected, fundamental concepts and relationships that together allow for the description of the most relevant information in an optimal way for designated functionalities. Further, they provide a suitable coverage of general concepts and

relationships to be highly extensible without compromising the logic and expressive power of the core model. For example, in the CIDOC CRM a new relationship implying the participation of an Actor in an Event, such as “transported by charter flight”, must be modelled as a subproperty of the CIDOC CRM property “participated in”, so that queries for the latter property will imply the case of the new property by virtue of the extended model. Similarly, any relationship implying an event must be expandable into a full path making the event explicit, in order to be CRM compatible.

For these reasons, multiple core ontologies cannot be simply mapped or “articulated”. The integrated model would not fulfil the functional requirements. Rather, they must be “harmonized”, so that the transition from one model to the other can be made without comprising the functionality. E.g., the CIDOC CRM aims at information integration and at aggregation of alternative opinions about things existing, the immediate and distant past. It favours concepts and relationships which correspond to the units in which knowledge about the past is normally acquired and which tend to be monotonic under natural increase of knowledge.

The CIDOC CRM Special Interest Group has long term experience in the harmonisation process. There was a successful harmonization of the CIDOC CRM with the ABC Harmony Model, as described in [1], and the harmonisation of IFLA’s FRBR with the CIDOC CRM is in progress.

The harmonisation process is an iterative process, starting with a first alignment of classes and properties, and then working through the conflict cases in a bottom-up manner. Each conflict case is analyzed in terms of examples and the intended functionality. The combined models are first defined in a graphical way in small functional units corresponding to a “frame” of the intended reality. In the sequence, the classes are integrated into hierarchies, and then the properties are integrated into hierarchies. Both processes lead in general to revisions at all levels. Both models may change, if insight is gained that a slight change of definition preserves functionality, increases genericity or solves inherent inconsistencies in the original model.

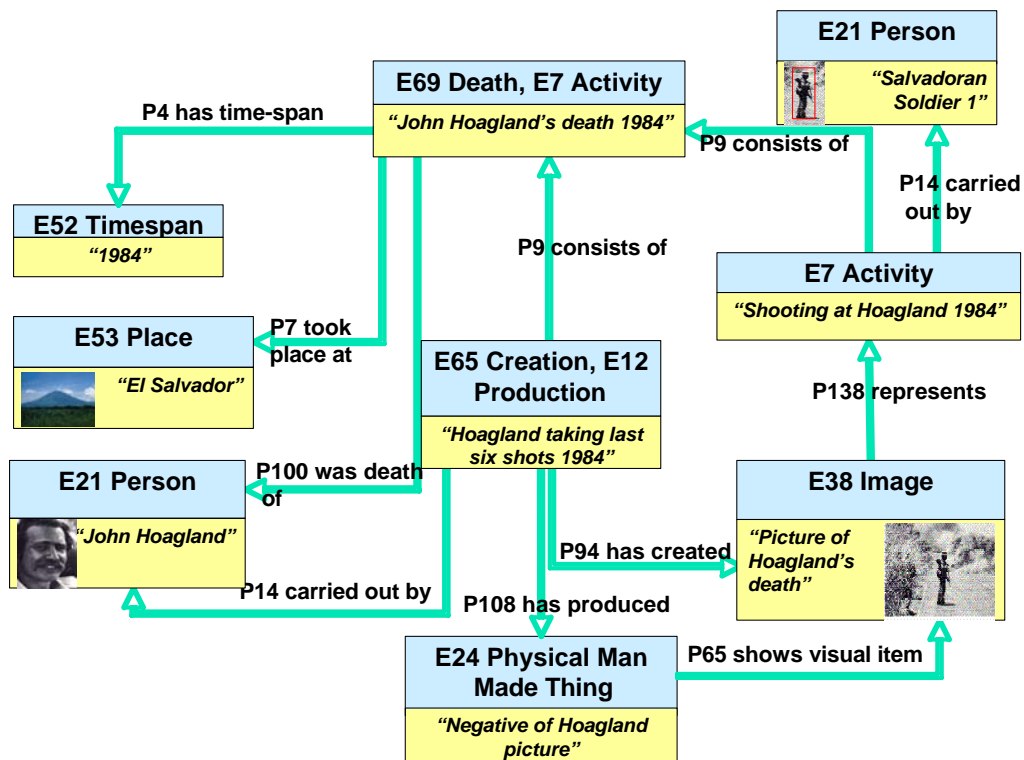
In case of compatible functionality, a complete merge can be the result. There are a series of ontological modelling principles to be applied, such as those referred in [1],[2][3],[4],[5]. The experience of the CIDOC CRM SIG shows that by applying those principles, an interdisciplinary expert team can substantially resolve the conflicts between modelling alternatives and come to an optimal solution for the intended purpose rather than to a set of compromises.

The advantages of harmonized core ontologies for related application areas are immense. Rather than fuzzy “cross-walks”, real, precise semantic interoperability can be supported. We therefore recommend the harmonization of the relevant core ontologies in the multimedia application areas.

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- [2] Oltramari, A., Gangemi A., Guarino N., Masolo C. 2002. Restructuring WordNet's Top-Level: The OntoClean approach. To appear in *Proceedings of LREC2002 (OntoLex workshop)*. Las Palmas, Spain  
<http://www.ladseb.pd.cnr.it/infor/Ontology/Papers/Oltramari2.pdf>.

- [3] Welty, C., Guarino, N. 2001. Supporting Ontological Analysis of Taxonomic Relationships. *Data and Knowledge Engineering*39(1), pp. 51-74.
- [4] Thomas R. Gruber, "Toward Principles for the Design of Ontologies Used for Knowledge Sharing", in: *Formal Ontology in Conceptual Analysis and Knowledge Representation*, edited by Nicola Guarino, Roberto Poli, Kluwer, 1994,
- [5] Doerr M., "The CIDOC CRM – An Ontological Approach to Semantic Interoperability of Metadata", *AI Magazine*, 4, issue 1 (2003),
- [6] Addis, M., Boniface, M., Goodall, S., Grimwood, P., Kim, S., Lewis, P., Martinez, K. and Stevenson, A. (2003) [SCULPTEUR: Towards a New Paradigm for Multimedia Museum Information Handling](#). In *Proceedings of Semantic Web ISWC 2870*, pages 582 -596.
- [7] Sinclair, P. A. S., Goodall, S., Lewis, P. H., Martinez, K. and Addis, M. J. (2005) [Concept browsing for multimedia retrieval in the SCULPTEUR project](#). In *Proceedings of The 2nd Annual European Semantic Web Conference* (in press), Heraklion, Crete.
- [8] N. Shadbolt, P. Lewis, S. Dasmahapatra, D. Dupplaw, B. Hu, and H. Lewis. MIAKT: Combining Grid and Web Services for Collaborative Medical Decision Making. e-Science All Hands Meeting 2004. Nottingham, UK 2004.

## Appendix A - John Hoagland



One of the victims of the war was photojournalist John Hoagland (1947-84). His photographic career had started in 1970, videoing the Chicano Moratorium anti-war movement in Los Angeles and he moved to El Salvador in 1979, working for the French Gamma agency and Newsweek, for which he had five cover pictures. Together with Susan Meiselas he had a lucky escape in 1981 when his car ran over a land mine. Hoagland and Meiselas escaped with injuries but the third person in the car, Ian Mates, died. After a period covering the war in Beirut in 1983-4 he returned to El Salvador, marrying a Salvadoran.

His work in El Salvador was a clear and sometimes devastating account of what was happening, showing the bodies left on the ground by the death squads, a mother holding the body of her dead son and other horrific scenes. On the evidence of the work on the web he was a highly competent photographer who was seriously involved in recording the war and giving a truthful account of how he saw it. His last six frames, found in his camera, record his own death, and were analysed by Richard Astle for 'Wasted Space'. They show Hoagland a few yards from a pair of Salvadoran soldiers on an empty road. One turns towards him and apparently sees he is taking pictures. The next to last frame, shot as he was falling shows the tip of his show and the last picture 'is of the Salvadoran soil, his adoptive country.'

## Record for article describing Hoagland's last six frames recording his own death:

```
<?xml version="1.0" encoding="UTF-8"?>
<!--Sample XML file generated by XMLSpy v2005 rel. 3 U (http://www.altova.com)-->
<!DOCTYPE CRM_Core SYSTEM "CRM_Core.dtd">
<!-- Example created by Athina Kritsotaki and Martin Doerr 20-01-2006 -->
<CRM_Core>
  <Category>E31.Document</Category>
  <Classification name_space="http://www.getty.edu/research/conducting_research/vocabularies/aat/">articles</Classification>
  <Identification>http://www.wastedspace.com/best/astle.html</Identification>
  <Description>This article analyzes Hoagland's last six frames recording his own death.</Description>
  <Event>
    <Role_in_Event>P94B.was_created_by</Role_in_Event>
    <Identification name_space="http://cidoc.ics.forth.gr/crm_core/demo">Astle_writing_1985</Identification>
    <Event_Type name_space="http://cidoc.ics.forth.gr/rdfs/cidoc_v4.2.rdfs">E65.Creation</Event_Type>
    <Participant>
      <Identification name_space="http://cidoc.ics.forth.gr/crm_core/demo">Richard Astle</Identification>
      <Participant_Type name_space="http://www.getty.edu/research/conducting_research/vocabularies/aat/"
        >journalists</Participant_Type>
    </Participant>
    <Date>1985</Date>
  </Event>
  <Event>
    <Role_in_Event>P67F.refers_to</Role_in_Event>
    <Identification name_space="http://cidoc.ics.forth.gr/crm_core/demo">John Hoagland's death 1984</Identification>
    <Event_Type name_space="http://cidoc.ics.forth.gr/rdfs/cidoc_v4.2.rdfs">E69.Death</Event_Type>
    <Event_Type name_space="http://cidoc.ics.forth.gr/rdfs/cidoc_v4.2.rdfs">E7.Activity</Event_Type>
    <Participant>
      <Identification name_space="http://cidoc.ics.forth.gr/crm_core/demo">John Hoagland</Identification>
      <Participant_Type name_space="http://www.getty.edu/research/conducting_research/vocabularies/aat/"
        >photojournalists</Participant_Type>
    </Participant>
    <Thing_Present>
      <Identification name_space="http://cidoc.ics.forth.gr/crm_core/demo"
        >Hoagland_taking_last_six_shots_1984</Identification>
      <Thing_Present_Type name_space="http://cidoc.ics.forth.gr/rdfs/cidoc_v4.2.rdfs">E38.Image</Thing_Present_Type>
    </Thing_Present>
    <Date>1984</Date>
    <Place name_space="http://www.getty.edu/research/conducting_research/vocabularies/tgn/">El Salvador (nation)</Place>
    <RelatedEvent>
      <Role_in_Event>P9B.forms_part_of</Role_in_Event>
      <Identification name_space="http://cidoc.ics.forth.gr/crm_core/demo"
        >Hoagland_taking_last_six_shots_1984</Identification>
    </RelatedEvent>
    <RelatedEvent>
      <Role_in_Event>P9B.is_composed_of</Role_in_Event>
      <Identification name_space="http://cidoc.ics.forth.gr/crm_core/demo">Shooting at
        Hoagland 1984</Identification>
    </RelatedEvent>
  </Event>

```

```

    </RelatedEvent>
</Event>
<Event>
  <Role_in_Event>P129F.is_about</Role_in_Event>
  <Identification name_space="http://cidoc.ics.forth.gr/crm_core/demo"
    >Hoagland_taking_last_six_shots_1984</Identification>
  <Event_Type name_space="http://cidoc.ics.forth.gr/rdfs/cidoc_v4.2.rdfs">E65.Creation</Event_Type>
  <Participant>
    <Identification name_space="http://cidoc.ics.forth.gr/crm_core/demo">John Hoagland</Identification>
    <Participant_Type name_space="http://www.getty.edu/research/conducting_research/vocabularies/aat/"
      >photojournalists</Participant_Type>
  </Participant>
  <Thing_Present>
    <Identification name_space="http://cidoc.ics.forth.gr/crm_core/demo">Negative_of_Hoagland_picture</Identification>
    <Thing_Present_Type name_space="http://www.getty.edu/research/conducting_research/vocabularies/aat/"
      >negatives</Thing_Present_Type>
  </Thing_Present>
  <Date>1984</Date>
  <Place name_space="http://www.getty.edu/research/conducting_research/vocabularies/tgn/">El Salvador (nation)</Place>
</Event>
<Event>
  <Role_in_Event>P129F.is_about</Role_in_Event>
  <Identification name_space="http://cidoc.ics.forth.gr/crm_core/demo">Shooting at Hoagland
    1984</Identification>
  <Event_Type name_space="http://cidoc.ics.forth.gr/rdfs/cidoc_v4.2.rdfs">E7.Activity</Event_Type>
  <Participant>
    <Identification name_space="http://cidoc.ics.forth.gr/crm_core/demo">John Hoagland</Identification>
    <Participant_Type name_space="http://www.getty.edu/research/conducting_research/vocabularies/aat/"
      >photojournalists</Participant_Type>
  </Participant>
  <Participant>
    <Identification name_space="http://cidoc.ics.forth.gr/crm_core/demo">Salvadoran Soldier 1</Identification>
    <Participant_Type name_space="http://www.getty.edu/research/conducting_research/vocabularies/aat/"
      >soldiers</Participant_Type>
  </Participant>
  <Date>1984</Date>
  <Place name_space="http://www.getty.edu/research/conducting_research/vocabularies/tgn/">El Salvador (nation)</Place>
</Event>
<Relation>
  <To name_space="http://www.wastedspace.com/index.html">wasted space</To>
  <Relation_Type>
    <has_part/>
    <part_of/>
    <refers_to/>
    <referred_to_by/>
    <shows_features_of/>
  </Relation_Type>
</Relation>
</CRM_Core>

```

## Record for John Hoagland:

```
<?xml version="1.0" encoding="UTF-8"?>
<!--Sample XML file generated by XMLSpy v2005 rel. 3 U (http://www.altova.com)-->
<!DOCTYPE CRM_Core SYSTEM "CRM_Core.dtd">
<!-- Example created by Athina Kritsotaki and Martin Doerr 20-01-2006 -->
<CRM_Core>
  <Category>E21.Person</Category>
  <Classification name_space="http://www.getty.edu/research/conducting_research/vocabularies/aat/"
    >photojournalists</Classification>
  <Identification name_space="http://cidoc.ics.forth.gr/crm_core/demo">John Hoagland</Identification>
  <Description>Born in San Diego, California, the oldest child of Helen and Al Hoagland, a career
    officer in the Navy and a combat air veteran of World War Two... </Description>
  <Event>
    <Role_in_Event>P100B.died_in</Role_in_Event>
    <Identification name_space="http://cidoc.ics.forth.gr/crm_core/demo">John Hoagland's death 1984</Identification>
    <Event_Type name_space="http://cidoc.ics.forth.gr/rdfs/cidoc_v4.2.rdfs">E69_Death</Event_Type>
    <Event_Type name_space="http://cidoc.ics.forth.gr/rdfs/cidoc_v4.2.rdfs">E7.Activity</Event_Type>
    <Participant>
      <Identification name_space="http://cidoc.ics.forth.gr/crm_core/demo">Salvadoran Soldier 1</Identification>
      <Participant_Type name_space="http://www.getty.edu/research/conducting_research/vocabularies/aat/"
        >soldiers</Participant_Type>
    </Participant>
    <Date>1984</Date>
    <Place name_space="http://www.getty.edu/research/conducting_research/vocabularies/tgn/">El Salvador (nation)</Place>
    <RelatedEvent>
      <Role_in_Event>P46F.is_composed_of</Role_in_Event>
      <Identification name_space="http://cidoc.ics.forth.gr/crm_core/demo"
        >Hoagland_taking_last_six_shots_1984</Identification>
    </RelatedEvent>
    <RelatedEvent>
      <Role_in_Event>P46F.is_composed_of</Role_in_Event>
      <Identification name_space="http://cidoc.ics.forth.gr/crm_core/demo">Shooting at Hoagland 1984</Identification>
    </RelatedEvent>
  </Event>
</CRM_Core>
```

## Record for images of John Hoagland's death

```
<?xml version="1.0" encoding="UTF-8"?>
<!--Sample XML file generated by XMLSpy v2005 rel. 3 U (http://www.altova.com)-->
<!DOCTYPE CRM_Core SYSTEM "CRM_Core.dtd">
<!-- Example created by Athina Kritsotaki and Martin Doerr 20-01-2006 -->
<CRM_Core>
  <Category>E38.Image</Category>
  <Classification name_space="http://www.getty.edu/research/conducting_research/vocabularies/aat/"
    >photographs</Classification>
  <Identification>http://thedagger.com/archive/elsal/lastsix.gif</Identification>
  <Description>This image shows how one of Salvadoran soldiers turns towards the camera and spots
    Hoagland "shooting" him.</Description>
  <Event>
    <Role_in_Event>P94B.was_created_by</Role_in_Event>
    <Identification name_space="http://cidoc.ics.forth.gr/crm_core/demo"
      >Hoagland_taking_last_six_shots_1984</Identification>
    <Event_Type name_space="http://cidoc.ics.forth.gr/rdfs/cidoc_v4.2.rdfs">E65_Creation</Event_Type>
    <Participant>
      <Identification name_space="http://cidoc.ics.forth.gr/crm_core/demo">John Hoagland</Identification>
      <Participant_Type name_space="http://www.getty.edu/research/conducting_research/vocabularies/aat/"
        >photojournalists</Participant_Type>
    </Participant>
    <Thing_Present>
      <Identification name_space="http://cidoc.ics.forth.gr/crm_core/demo">Negative_of_Hoagland_picture</Identification>
      <Thing_Present_Type name_space="http://www.getty.edu/research/conducting_research/vocabularies/aat/"
        >negatives</Thing_Present_Type>
    </Thing_Present>
    <Date>1984</Date>
    <Place name_space="http://www.getty.edu/research/conducting_research/vocabularies/tgn/">El Salvador (nation)</Place>
    <RelatedEvent>
      <Role_in_Event>P9B.consists_of</Role_in_Event>
      <Identification name_space="http://cidoc.ics.forth.gr/crm_core/demo">John Hoagland's death 1984</Identification>
    </RelatedEvent>
  </Event>
  <Event>
    <Role_in_Event>P138F.represents</Role_in_Event>
    <Identification name_space="http://cidoc.ics.forth.gr/crm_core/demo">Shooting at Hoagland 1984</Identification>
    <Event_Type name_space="http://cidoc.ics.forth.gr/rdfs/cidoc_v4.2.rdfs">E7.Activity</Event_Type>
    <Participant>
      <Identification name_space="http://cidoc.ics.forth.gr/crm_core/demo">John Hoagland</Identification>
      <Participant_Type name_space="http://www.getty.edu/research/conducting_research/vocabularies/aat/"
        >photojournalists</Participant_Type>
    </Participant>
    <Participant>
      <Identification name_space="http://cidoc.ics.forth.gr/crm_core/demo">Salvadoran Soldier 1</Identification>
      <Participant_Type name_space="http://www.getty.edu/research/conducting_research/vocabularies/aat/"
        >soldiers</Participant_Type>
    </Participant>
  </Event>
</CRM_Core>
```

```
</Participant>
<Date>1984</Date>
<Place name_space="http://www.getty.edu/research/conducting_research/vocabularies/tgn/">El Salvador (nation)</Place>
<RelatedEvent>
  <Role_in_Event>P9B.consists_of</Role_in_Event>
  <Identification name_space="http://cidoc.ics.forth.gr/crm_core/demo">John Hoagland's death 1984</Identification>
</RelatedEvent>
</Event>
</CRM_Core>
```

## Appendix B – CRM Core DTD

```
<?xml version='1.0' encoding='UTF-8' ?>
<!--Generated by Turbo XML 2.3.1.100.-->
<!-->
<!--#DOCUMENTATION:Represents the described CRM Entity. Corresponds to Dublin Core resource.-->
<!ELEMENT CRM_Core (Category+ , Classification* , Identification+ , Description? , Event* , Relation*)>
<!--#DOCUMENTATION:One of the CIDOC CRM Classes, or a mapping to/from DCMI Type Vocabulary. General term to characterize the
nature of the described item.
Compatibility: DC.Type, CIDOC CRM class system.
-->
<!ELEMENT Category (#PCDATA)>
<!--#DOCUMENTATION:Any category classifying the described item. Preferrably from controlled vocabularies.
Compatibility: CIDOC CRM P2 has type. E55 Type. Includes: DC.Format, DC.Language
-->
<!ELEMENT Classification (#PCDATA)>
<!ATTLIST Classification name_space CDATA #IMPLIED >
<!--#DOCUMENTATION:Any name or identifier used for the particular item described.
Compatibility: DC.Title and DC.Identifier. CIDOC CRM P1 is identified by: E41 Appellation
-->
<!ELEMENT Identification (#PCDATA)>
<!ATTLIST Identification name_space CDATA #IMPLIED >
<!--#DOCUMENTATION:An account of the nature or content of the described item.
Compatibility: DC.Description, CIDOC CRM P3 has note: E62 String
-->
<!ELEMENT Description (#PCDATA)>
<!--#DOCUMENTATION:Any Event the described item was present at. (In generalization any period the object existed in ?)
Compatibility: CIDOC CRM E5 Event
Allows for expressing DC.Creator, DC.Publisher, DC.Contributor, DC.Date, DC.Coverage
-->
<!ELEMENT Event (Role_in_Event* , Identification+ , Event_Type* , Participant* , Thing_Present* , Date? , Place? , RelatedEvent*)>
<!--#DOCUMENTATION:Role of the described Item in the Event:
Compatibility: Any subproperty of CIDOC CRM P12B was present at.
Allows for connecting DC.Creator, DC.Contributor, DC.Publisher, DC.Coverage DC.Date.
-->
<!ELEMENT Role_in_Event (#PCDATA)>
<!--#DOCUMENTATION:Classification of the Event, e.g. Publication, Production, Creation, Finding, Use)
Compatibility: subclasses of CIDOC CRM E5 Event, and compatible E55 Type
```

```
-->
<!ELEMENT Event_Type (#PCDATA)>

<!ATTLIST Event_Type name_space CDATA #IMPLIED >
<!--#DOCUMENTATION:Any Actor participating or being present in the Event.
Compatibility: DC.Creator,DC.Publisher,DC.Contributor, DC.Relation if an Agent is referred.
CIDOC CRM P12B was present at: E39 Actor
-->

<!ELEMENT Participant (Identification*, Participant_Type*)>

<!--#DOCUMENTATION:Any kind of Actor participating or being present in the Event. This expresses incomplete knowledge.
Compatibility: CIDOC CRM P12B was present at: E39 Actor. P2 has type: E55 Type
-->
<!ELEMENT Participant_Type (#PCDATA)>

<!ATTLIST Participant_Type name_space CDATA #IMPLIED >
<!--#DOCUMENTATION:Any Stuff being present in the Event.
Compatibility: DC.Relation
CIDOC CRM P12B was present at: E70 Stuff
-->
<!ELEMENT Thing_Present (Identification*, Thing_Present_Type*)>
<!--#DOCUMENTATION:Any kind of Stuff being present in the Event.
Compatibility: DC.Relation
CIDOC CRM P12B was present at: E70 Stuff
-->
<!ELEMENT Thing_Present_Type (#PCDATA)>

<!ATTLIST Thing_Present_Type name_space CDATA #IMPLIED >
<!--#DOCUMENTATION:A time date range constraining the event related to the described item.
Compatibility: CIDOC CRM P4 has time-span:E52 Time-Span.P82 at some time within: E61 Time Primitive.
Includes: DC.Date, DC.Coverage depending on the role of the item in the Event (Role_in_Event)
-->
<!ELEMENT Date (#PCDATA)>

<!--#DOCUMENTATION:A time date range constraining the event related to the described item.
Compatibility: CIDOC CRM P7 took place at E53 Place.
Includes: DC.Coverage depending on the role of the item in the Event (Role_in_Event)
-->
<!ELEMENT Place (#PCDATA)>

<!ATTLIST Place name_space CDATA #IMPLIED >
<!--#DOCUMENTATION:Any not event-mediated relation. Restricted to: part of, reference, similarity for which causal events are not
established.
Compatibility: subset of DC.Relation
-->
<!ELEMENT Relation (To+ , Relation_Type)>

<!ELEMENT To (#PCDATA)>
```

```
<!ATTLIST To name_space CDATA #IMPLIED >
<!ELEMENT Relation_Type (has_part | part_of | refers_to | referred_to_by | shows_features_of)+>

<!ELEMENT refers_to EMPTY>

<!ELEMENT referred_to_by EMPTY>

<!ELEMENT part_of EMPTY>

<!ELEMENT has_part EMPTY>

<!ELEMENT shows_features_of EMPTY>

<!ELEMENT RelatedEvent (Role_in_Event , Identification)>
```