A Novel Metadata Standard for Multimedia Preservation

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ABSTRACT

This paper introduces the motivation and describes the model of a novel metadata standard for the exchange of preservation metadata of multimedia content. The model is being standardised as the MPEG Multimedia Preservation Application Format (MP-AF), addressing the specific issues related to the preservation description information of audiovisual contents. Several standards for expressing metadata in digital preservation are available and have been taken into consideration in the paper and in the work done in MPEG. However, none of them is able to cover all the needed aspects related to the preservation of audiovisual content. Audiovisual files are in most cases containers and are usually made up of several tracks carrying audio data, video data and specific time-based metadata. In order to be able to perform the opportune preservation actions (among others planning and format migration), several kinds of information must be kept alongside the audiovisual contents. Within this context a standardised representation for these structures and metadata is needed. Information such as quality description or fixity at frame level is required for ensuring long term access to visual content. Without using a standardised interface it is hard to guarantee a faithful rendering of encoded information while exchanging contents between different repositories, either internally or with external institutions. This paper describes the work done so far within MPEG for defining a standard metadata model which covers the identified missing parts and gaps regarding the acquisition of digital preservation description information.

General Terms

Preservation strategies and workflows, specialist content type, case studies and best practice.

Keywords

Digital Preservation, Multimedia Metadata, Preservation Description Information, OAIS, Audiovisual Content Preservation, Standard.

1. INTRODUCTION

In the last decade, many research projects at national as well as international level have investigated solutions for preserving audiovisual content. Projects such as the Presto family starting in 1999 have deeply studied the preservation and storage of professional audiovisual contents. Special attention has been given to broadcasting environments that suffer from the obsolescence of audiovisual contents, wrappers and carriers [1,2,3,4]. Even if many formats were available for describing general purpose information, it was clear that many others were left out of the standards and kept in custom structures [3]. As an example, the quality information acquired during the digitisation process (conversion from the analogue audio visual carrier towards a digital representation and support) have been stored in specific structures by broadcasters and audiovisual archives [3].

Many organisations collecting various types of multimedia content, such as archives, libraries, museums, etc. already have digital preservation systems in place. These organisations often have the need to exchange multimedia assets and related metadata, for example:

- to exchange assets between preservation systems/repositories within the organization or with related organizations,
- to change/upgrade their preservation systems,
- to exchange content with service providers, or to
- provide preservation services for other organisations.

When they exchange multimedia assets, they need to include preservation metadata that enables the receiving organisation both to assess the integrity and fidelity of the assets it receives and to establish a baseline for its own curation and use of the assets. In addition to the metadata described above, the receiving organisation also needs information about any preservation processes the assets have undergone, including descriptions of the outcome of such preservation processes. The description may include metadata about content, structure, and quality, as well as technical, historical and editorial information, and information about property and use rights and conditions. A standard is needed that defines the content and format of multimedia preservation description information (MPDI), in order to facilitate interoperability between preservation systems, ensure accurate understanding of the resources' exchanges, and reduce the risks of corruption both in the exchange and thereafter.

These issues have been strongly pointed out in the UNESCO Vancouver declaration, written during the UNESCO conference "Memory of the World in the Digital age: Digitization and Preservation" held in Vancouver in 2012 [5]. The overall document stresses the need and the importance of digital preservation. The following quotation taken from the last part of the document reinforces the need of a metadata standard for multimedia preservation:

"Recommendations to industry: ...

a. ensure long-term accessibility to digital information;

b. adhere to descriptive standards and recognized metadata standards to enable the creation of trusted digital repositories. ..." [5]

We can easily recognise that the work presented in this paper responds to what (b) is motivating and UNESCO is stressing the importance of metadata standards for preservation in order to enable the creation of preservation archives, or more precisely, the trusted digital repositories.

This paper describes the work on a metadata model for multimedia preservation metadata within the standards ecosystem of MPEG [6]. MPEG is an ISO/IEC working group defining standards for coding moving pictures and audio. Over the years the work of MPEG has broadened to include metadata over the lifecycle of multimedia items. Thus a standard for preservation description information of multimedia items complements these efforts. Within MPEG, the work on multimedia preservation is done in the context of application formats, which are standards composed of subsets of different MPEG technologies targeting a specific application scope, and extending them with existing technology from outside MPEG or new technology if needed. The preservation metadata standard is thus named Multimedia Preservation Application Format (MP-AF).

The metadata model proposed by MP-AF is presented in this paper, which is organised as follows: Section 2 introduces the motivation and foundation of the work done while Section 3 discusses related work. Section 4 presents the Multimedia Preservation Description Information (MPDI), in accordance to the OAIS model and definitions [7]. The metadata model describing the multimedia preservation metadata is presented in Section 5, and its relation to other data models is discussed. Section 6 wraps up the conclusion of this work and points out upcoming activities.

2. MOTIVATION

There is a range of different organisations that are in charge of preserving multimedia content, from dedicated audiovisual archives with a mission for preserving the collection over archives of broadcasters or media production companies, for which the archive must primarily serve their production workflows, to libraries or museums that may only have some multimedia items among their collection. All of them have the need to perform processes such as digitisation or migration of the multimedia content. These processes are increasingly automated within large organisations or outsourced to service providers by organisations that cannot afford to have the infrastructure and knowledge in-house. Performing and documenting these preservation workflows requires the ability to represent detailed preservation description information in an interoperable way.

The use cases addressed by MP-AF include (partial) preservation workflows where metadata created or needed in the preservation process is exchanged between different systems or organisations. One example is a preservation workflow including regular fixity, integrity and quality checks of broadcast content, performed by different systems. Another example is a migration process outsourced to a service provider, which includes determining the need for migration to another format, choosing the parameters of the target format and performing quality checks to ensure that the result of the migration is free or errors and is a complete representation of the source. Another use case involves content being exclusively licensed to another company (under certain restrictions, e.g. territorial) and making sure to identify the versions affected by the contract, including different technical formats for different distribution channels.

A different group of use cases addresses cases where content is deposited with an archive for preservation. For example, a national library may have the mission to preserve all music recordings, and receives the masters from the record companies, including the metadata for each song and the collection, as well as further artwork related to the production. The carrier may become obsolete and digitised/migrated to another carrier or file storage, keeping the grouping of the different objects in the submission and their relations.

PREMIS is nowadays the (de facto) standard which is used by many national libraries and archives for aggregating and preserving metadata required for ensuring long term access to digital content. Key concerns are related to the renderability, understandability and identity of digital objects with the passing of time. Repositories that store the digital items related metadata, must ensure their consistency over time. The standard makes no assumptions about the preservation strategies, technologies and storage systems. It is meant to be used on any type of digital content in any available encoding (i.e. file format). PREMIS defines the dictionary of preservation metadata elements, but not the structure of the description resp. the metadata container. It thus needs to be embedded in some container structure, for example, METS or MPEG-21 DID. This way, one can aggregate more complex archiving structures related to book collections, movie series, photo exhibitions, etc. (cf. [8]).

When using the PREMIS standard in a concrete application scenario, it is soon observed that different enhancements are required to address particular needs of a given preservation context [8]. In particular, the following issues have been recognised in the context of preservation metadata for audiovisual content.

Compatibility with standards in use. MPEG standards are widely used by broadcasters and audiovisual archives. The information relevant for preservation purposes is partly covered by descriptive and technical metadata standards already in use. Compatibility with these formats eliminates the overhead required for mapping and transforming existing metadata to PREMIS representation and may ease acquisition of preservation related metadata during content creation (e.g., collection of timing and location metadata with digital cameras, metadata acquisition at digitisation time). These compatibility issues do not only concern metadata formats, but also container formats like the MPEG Professional Archive Application Format (PA-AF) [9].

Enhanced support for modelling hierarchical, complex structures and descriptions. A collection is a common unit of work in digital libraries and archives. Collections may be aggregated in hierarchical structures by using different criteria. Multimedia content is often the result of a long and complicated creation process, reusing material from a multitude of sources, each with their specific properties, provenance and rights. For example, it is popular nowadays to have long TV series organised in seasons and episodes, including versions translated in different languages. Motion pictures may be released in a number of localised and age versions, with different audio formats, in different 3D technologies etc. Moreover, the file formats for

encoding this content is a container itself carrying bitstreams of different types of data: audio, video, subtitles, etc. Over its lifetime, the content may need to be migrated due to obsolescence of the original formats. For ensuring the long term access to the content by respecting copyrights and ownership, it is mandatory to preserve descriptive and technical metadata at each level of aggregation.

Support for time-based metadata. The existence of a temporal dimension is an inherent property of audiovisual content. For many types of metadata, it is crucial to have them on a detailed temporal granularity, for example, per shot. This includes descriptive and technical information, which may differ as the shots may be recorded with different technologies. In types of productions that rely heavily on the reuse of material (e.g., news), each shot may come from a different source, having its specific provenance and rights metadata. Due to the potentially long duration of a content item and its large file size, it is also important to have quality and fixity metadata on a fine temporal granularity in order to locate and potentially repair problems in later steps of a preservation workflow.

Defining the metadata container. The PREMIS standard does per se not specify the metadata container, for example, for the creation of submission, archival and dissemination packages as defined in the OAIS standard. As the choice of the container is left to the implementation, there are no built-in mechanism for ensuring the referential and data integrity of the package. Consequently in the case of broken packages there is no mechanism defined for verifying which parts of the package are not corrupted and can still be used properly in preservation processes.

MP-AF aims to address these issues by defining a specification that provides solutions for these gaps. Compatibility with PREMIS has been taken into account in the design of the standard, and mapping is intended to be straight forward for overlapping parts of the specifications. Moreover, the MP-AF representation takes into account additional issues related to the encoding the metadata in different languages using alternative scripting variants and extendable semantics of the core elements by using controlled vocabularies. By standardising the format of the metadata container and referencing within of the information package a better support for implementation of preservation workflows and outsourcing of preservation services can be provided.

3. RELATED WORK

While an abundance of metadata standards and formats for describing multimedia content exists, this is not the case for the description of material properties, tools and processes for preservation of audiovisual content. Preservation metadata is a relatively new concept, and preservation metadata models emerged quite recently in the digital library domain. The most important of these models is PREMIS, a model proposed by the US Library of Congress [10]. It defines a high-level data model and a set of properties for each of the entities in the model. There are five semantic units (classes) in PREMIS as shown in Figure 1. An XML representation exists and an OWL (Web Ontology Language) representation has recently been proposed [11].

One issue related to the modelling of multimedia content is the assignment of rights to an Agent, which is different from general the licenses or contracts related to the object or intellectual entity. There is a second issue, as the digital object and the intellectual entity are considered at the same level. Furthermore, rights represented as an association class between object and agents are expressing the “access control” instead a full “contract” that is usually applied in multimedia environments. Subclasses of Object are File, Bitstream and Representation that are suitable for multimedia content as well. However, the typical hierarchy of representing levels of multimedia content between the work and a specific bitstream (as e.g. commonly used in the broadcasting domain, see the description of EBU CCDM below) are not directly supported. This concerns in particular the issue that a multitude of versions of multimedia contents exist, and regular migration between different technical formats (potentially as a lossy process) is a common issue.

The National Library of New Zealand (NLNZ) has defined a metadata model largely based on PREMIS [12] by adding extensions and addressing some implementation issues. The AIP is made up of the digital object, the technical metadata required for technical preservation of the object (using Rosetta DNX) and the descriptive metadata required for discovery and asset management.

Another approach to represent the provenance of digital objects, related events and agents was recently proposed within the provenance model developed by the W3C [13]. This has evolved in the context of open data initiatives, in order to track the activities that created and modified data published on the web. The core of this data model is represented in Figure 2, where three elements were identified, namely the Agent, Entity and Activity. In addition to the data model, the PROV family of specification defines different serializations of the model, including XML and RDF/OWL.

A model for the authentication of digital resources and representing the steps in the process that impact authenticity has been proposed on [14] and later refined in [15]. When dealing with multimedia content, the implementation of PREMIS elements in MPEG-21 Digital Item Declaration (DID) containers has been proposed in [16]. However, the link between the PREMIS descriptors and the MPEG-21 structures is rather loose, not fully leveraging the potential of both technologies. A similar approach is used by D2D, which is another MPEG-21 based representation for preservation metadata [17]. The core of the model is based on MPEG-21 DIDL and a set of specific descriptors was defined, which hold the various types of preservation metadata. Many of the descriptors are specified in a very generic way, using a key/value representation.

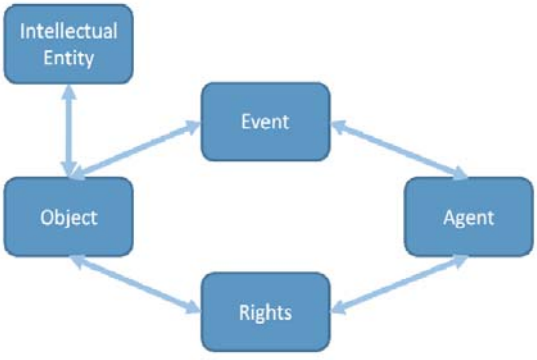

Figure 1: Data Model of PREMIS (from [10]).

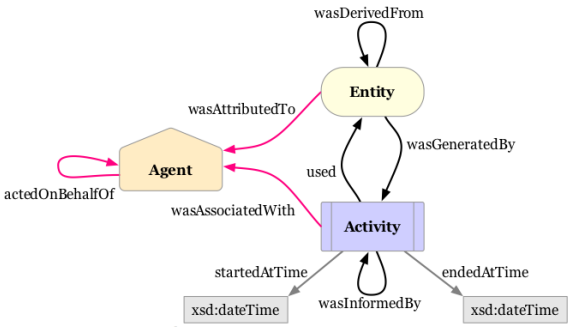

Figure 2: The conceptual overview of the PROV data model and related properties (as presented in [18]).

Within the PrestoPRIME project, a specific data model has been defined in order to set up an OAIS archive of audiovisual contents [19,3]. PrestoPRIME faced the problem of managing AV contents on a long term basis, therefore the OAIS specifications had to be adapted to deal with specificities of multimedia contents. In the PrestoPRIME model, the EditorialEntity has one or more Representations which have associated Files made up of Bitstreams. This data model is quite powerful and covers several requirements of MP-AF. The model uses METS as wrapper and includes elements from DublinCore, PREMIS, MPEG-7 and MPEG-21, as well as some custom extensions, such as DNX.

EBU CCDM [20] is a conceptual data model for audiovisual content and related entities from the broadcasting domain. The main entities are Intellectual Property Rights, the Production Order, the Sales Order, the Editorial Objects, the Asset (EditorialObject with associated IPR), the Manufacturing Object, the Publication Event, the Media Resource Object. Although not specifically designed for preservation, several entities overlap with preservation metadata models.

The same holds for the MPEG-7 Detailed Audiovisual Profile (AVDP [21]), which is part a MPEG-7 metadata standard defined for applications in production and archiving of audiovisual content. This standard covers technical and descriptive metadata, including quality analysis results, but lacks other aspects needed for a preservation metadata model.

Another related technology from the multimedia area is the MPEG Professional Archive Application Format (PA-AF) [9]. Like MP-AF, it is an application format combining different MPEG technologies for use in the archival domain. However, its focus is on specifying a virtual structure for packaging multiple items into a single file in order to preserve them together in a platform independent way. The resulting file conforms to the MPEG-21 file format, while providing only very basic metadata support. It is thus complementary technology to MP-AF and the two technologies can be used together, as described in Section 5.4.

4. THE MULTIMEDIA PRESERVATION DESCRIPTION INFORMATION (MPDI)

The data structures laying behind the definition of the preservation objects are presented in Section 5.1. In the following we present the most important concepts formalizing the representation of the information used for multimedia preservation purposes. These concepts were identified within the scope of the MPDI requirements document, but a revised definition is used within the proposed standard. The model is partly inspired by the PREMIS and partly by the related work in preservation projects (see also Section 3). However, it takes advantage from the complete representation of the preservation information package and includes semantic elements attached to each level in the hierarchical structures.

The following MPDI concepts define elements relevant for multimedia preservation and used in preservation processes.

Provenance documents the chronology of events regarding the creation, modification, ownership and custody of resources, such as who produced it and who has had custody since its origination. It provides information on the history of the multimedia content (including processing history).

Context describes the circumstances that resulted in the production of the resource and how the preserved resource relates to other relevant resources. For example, it may describe why and how the resource was created, it may indicate from which resources the current one was derived, or it may specify the relationship to other resources available in the package.

Reference represents the information that is used for identifying and addressing the multimedia content and related resources. It uses one or more identifiers, or systems of identifiers, by which the resources may be uniquely and persistently identified. Reference information supports the linkage of identical or related resources that might be stored in separate repositories. These repositories may use different mechanisms for identifying resources (e.g. using different standards for representing local identifiers).

Quality encompasses information related to the qualitative or quantitative measurements describing a given resource. It supports reasoning and evaluation of how good the resources have been preserved. The quality assessment should document any modification or transformation applied to the content, as well as the processes that produced them.

Fixity encompasses the information ensuring that resources (as described by their properties) are not altered in an undocumented manner. This information is also used to verify the integrity of digital items.

Integrity represents the state of an entity (e.g. digital item) indicating the quality of being complete. It can be proven by verifying the presence of all required parts/components in an unaltered (i.e. not modified) state.

Authenticity encompasses information that enables an agent to verify if an object is correctly identified and free from (intentional or accidental) corruption (i.e. it is capable of delivering its original message). The agents that issue statements about authenticity must also be correctly identified. While integrity is only on a technical level, authenticity is concerned with the object not being tampered with. Assessment of authenticity may require information related to different representations of the same work, while integrity refers to a specific representation. For example, the digitisation of an analogue copy cannot be automatically checked for integrity but is still preserves the authenticity of the content. Similarly, transformations from SIP to AIP or from AIP to DIP preserve authenticity, but not necessarily integrity.

Rights encompass information concerning legal, regulatory or contractual provisions that affect ownership, control, access or use of resources insofar as they impact the long term preservation (e.g. intellectual property, copyrights, privacy, etc.). Actions or events in the preservation of resources need to respect such rights.

5. MP-AF DATA MODEL

The MP-AF data model represents metadata for the preservation of a variety of media, such as images, graphics, video, animation, sound and text, and combinations of these. The definition of these elements/classes follows the goal of maximizing interoperability and maintaining compatibility with existing preservation data models. This should facilitate the adoption of MP-AF model among organizations that already use compatible models, at least for data exchange purposes, such as the migration between preservation systems (for software or hardware upgrade for example) or for exchange between repositories.

The MP-AF data model is defined for representing the Multimedia Preservation Description Information (MPDI) needed for discovering, accessing and delivering multimedia resources.

The specification of MP-AF contains three main components. The first is a high-level data model, specifying the top-level entities and their relations. The second part concerns the specific metadata structures for the different types of preservation metadata covered by MP-AF, modelled as descriptors. Whenever possible, these definitions make use of existing metadata standards, i.e., the specification reuses parts of MPEG-7, MPEG-21 and also defines extensions to existing metadata standards (e.g., MPEG-7). The third part (not described in detail in this paper) defines a core set of technical and descriptive metadata that is required to ensure minimum interoperability between preservation systems. A serialisation of the MP-AF data model using XML Schema has been specified.

5.1 Data Model Overview

The central entities in the model are those representing multimedia content. They are designed to be compatible with the MPEG-21 Digital Items, which hold metadata and references to the actual essence. In order to align the proposed model with other ones uses in the media industry four levels of specialisations are defined.

A Preservation Object combines information describing the intellectual and artistic attributes of a Work together with Digital Items that encode the Work. It includes technical, descriptive and preservation metadata and any other information needed to ensure consistent and reliable access to the Digital Item(s) over time. An Asset is a specialisation of Preservation Object aggregating a description of the owner and the owner's rights. These rights are exploitation rights that are different from the usage rights of a Digital Item. This is aligned with the definition of an Asset by the Society of Motion Picture and Television Engineers (SMPTE), which defines assets as being content with associated rights. Preservation Objects may be recursively nested in order to express groups of objects, which constitute a Preservation Object themselves (e.g., tracks of an audio CD vs. the entire CD). In contrast, Groups are explicitly containers of Preservation Objects and not an Preservation Objects themselves (i.e. it a logical grouping such as a broadcasting series).

A Representation is a specific and complete manifestation of the Work. Representations may differ in terms of technical or descriptive properties while sharing the same intellectual and/or descriptive attributes of the Work (e.g. different performances of the same Work, low vs. high definition representations of a movie). A Representation aggregates the whole set of Essences plus any additional metadata needed for a complete presentation of a Work.

Essence is a manifestation of a Work or part of a Work. It refers to the metadata needed for correctly rendering media content including all associated Components.

The Component is the entity holding specific technical metadata supporting the handling of the media resource referenced by a Media Locator (reference or identifier of a storage media volume, Item or part of an Item). Components can be Files or Bitstreams.

Operators are persons, organisations or systems that can be instantiated in form of Agents (persons, organizations) or Tools (hardware devices, software applications). They are involved in a certain Activity with a specific role. Different Agents may have relations to each other. An Activity is a preservation action performed on at least one Digital Item or Component. The activity is carried out by one or more Operators known to the preservation system.

The complete data model is shown in Figure 3. The relations in this diagram are of the following types: inheritance (the entity is a specialization of a more general type inheriting the parent's attributes), composition/aggregation (the entity aggregates other entities) or associations.

The data model contains entities marked with the <<Metadata>> stereotype, which correspond to the metadata types specified in the MP-AF requirements. These entities might correspond to a single or a set of the descriptors in a concrete representation of the model. The use of the metadata types on specific entities of the MP-AF data model is listed in Table 1.

Table 1: Overview indicating the relations of preservation information concepts to content entities.

	Preservation Object	Representation	Essence	File/ Bitstream
Provenance	Yes	Yes	Yes	
Context	Yes			
Reference	Yes	Yes	Yes	
Quality	Yes	Yes	Yes	Yes
Integrity	Yes	Yes	Yes	
Authenticity	Yes	Yes	Yes	
Fixity	Yes	Yes	Yes	Yes
Rights	Yes	Yes	Yes	

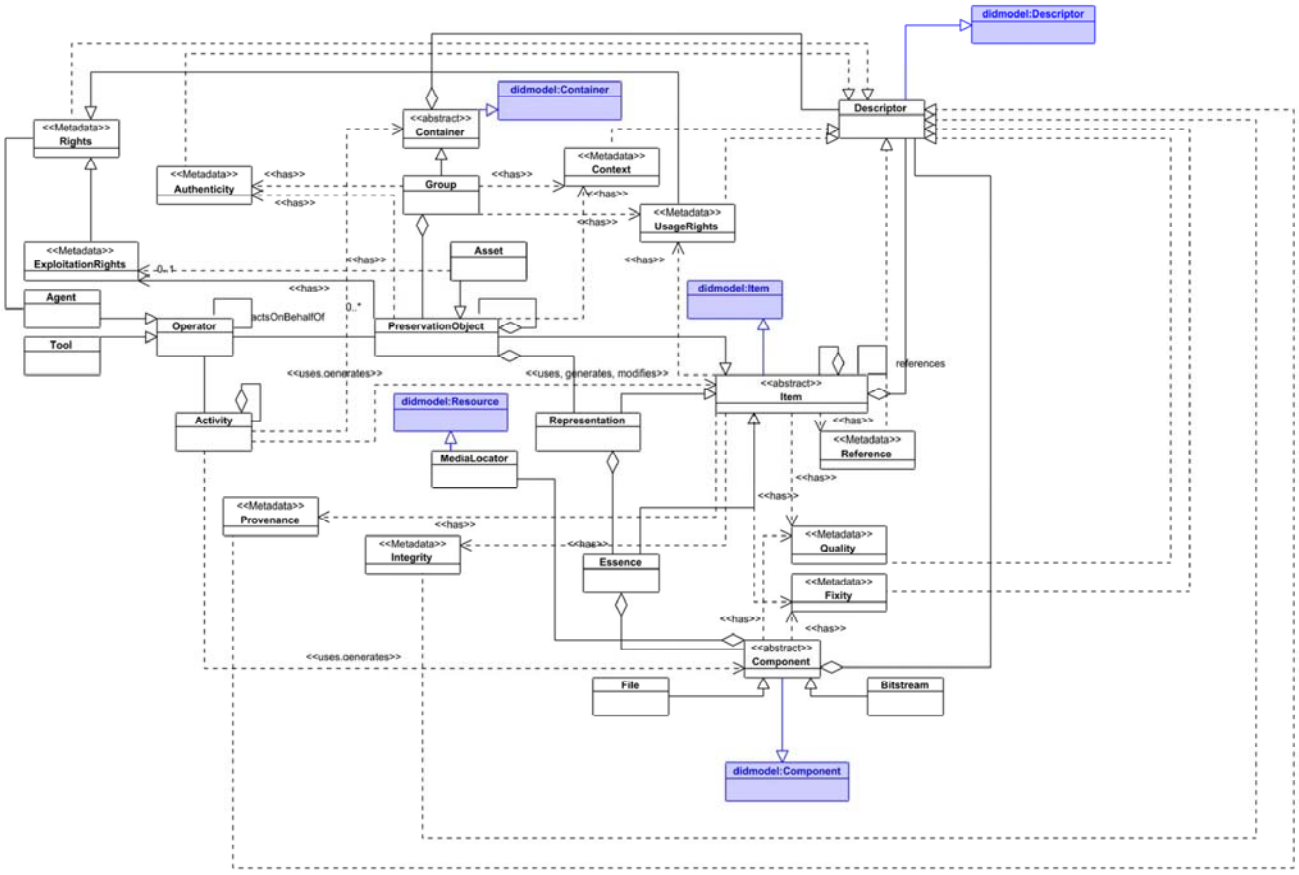

Figure 3: Core MP-AF data model. Entities from MPEG-21 DID are highlighted.

5.2 Structures for Specific Metadata Types

This section describes the concrete representations used for the specific types of preservation metadata. Provenance metadata, item identification and description are supported by MPEG-21 DII and DID. The structure based on MPEG-21 provides sufficient capabilities for item identification, supporting multiple identifiers, qualified by type.

Basic support for structural relationships between the items is provided by the Digital Item structure. Relationships are used to specify alternative identifiers of digital items and their nature/type (e.g., ISBN vs. barcode vs. bookshelf ID). MP-AF adopts MPEG-21 Digital Item Semantic Relationships [22] for expressing relations between Digital Items.

The preservation processes applied to Digital Items and Groups, the Activity and Operator entities are defined as part of the core MP-AF data model. These entities have been defined to ensure maximum compatibility with the corresponding entities in PREMIS, W3C PROV and BPMN (see also Section 4 for further details).

As part of the preservation metadata of multimedia asset, the history of creation and processing steps applied, as well as their parameters are described. This representation thus differs from process model representations including branching and options. The processing log describes what actually happened with a Digital Item, i.e., it is a linear sequence of activities, with the option to add a hierarchy for grouping activities. The descriptions of activities in the model use a set of specific types (e.g., digitisation), with possible further specialisations (e.g., film scanning), in order to improve interoperability between preservation systems. In a similar way, types of tools/devices being operators in these activities are identified. In addition, parameters of tools/devices are represented in a key/value structure, with a set of defined key for the most important properties are specified.

The definition of reference vocabularies is out of scope of MP-AF. However, preferred vocabularies of terms are recommended in an annex of the MP-AF specification where applicable (e.g., the set of quality items being defined by the EBU Quality Control group [12]).

Context can represent information about the purpose of preservation (e.g. project and preservation program). Relationships represent relations between different Digital Items, while Context includes relations to any type of related resource.

For fixity metadata temporally fine-grained checksums are supported. This enables better localization (and thus more efficient repair) of errors in bitstreams.

Integrity metadata comprises of information to index a set of content items, a set of identifiers to be checked and a list of dependencies on other preservation information packages (e.g. collection, and packages of individual episodes). Component-level fixity information as well as fixity of metadata documents/fragments may be included. Format validation results

can be represented using the quality descriptors, performing wrapper or bitstream layer checks.

MP-AF can include metadata to support checking of authenticity but cannot ensure the authenticity of the preservation object. MP-AF supports the following information for checking authenticity: information provided by the submitter of the object to the archive (descriptive, rights and provenance metadata), a complete log of the activities related to the preservation object, including technical, organisational and legal activities (based on the process description model) and metadata for comparing representations of the Preservation Object (e.g. fingerprints). As this information can be represented in different descriptors of MP-AF, no specific authenticity descriptor is provided.

MP-AF provides means to represent metadata related to (semi-) automatic quality control of multimedia data. The quality metadata description framework specified in ISO/IEC 15938-5:2003/Amd 5 is used for this purpose.

The description is compatible with the data model defined by the EBU QC group. It is recommended that the metadata refers to the taxonomy of quality control items defined in [12].

For rights metadata, both MPEG-21 Rights Expression Language (REL, part 5) and MPEG-21 Contract Expression Language (CEL)/Media Contract Ontology (MCO) will be supported (MPEG-21 CEL, part 20, and MCO, part 21, are semantically equivalent, but with XML and RDF/OWL representation respectively). REL can be used if it is sufficient to represent the rights situation, i.e., if only usage rights need to be represented. In more complex cases, if media-related contracts need to be documented or when a documentation of the history of the rights situation is needed, CEL or MCO can be used.

5.3 Descriptive and Technical Metadata

The common core set of metadata represents basic information needed to support digital preservation. It includes descriptive metadata by which a Digital Item can be unambiguously identified. It also includes technical metadata (e.g. describing the format) associated with one or more specific Representations, Essences or Components of the corresponding Preservation Object. The common core metadata set should be seen as a baseline profile, which enables a minimal set of knowledge acquisition by the receiver of an MP-AF instance. Additional metadata can be inserted into the MP-AF structure at any place that allows MPEG-21 compliant descriptors.

The common core metadata set is modelled as two specific descriptor types. Descriptive metadata contains a basic set of descriptive metadata elements, represented either as MPEG-7 Creation Information, EBU Core or Dublin Core descriptor. Technical metadata defines basic technical information (for different media types), represented as MPEG-7 Media Information or EBU Core Format descriptors.

5.4 Relation to Other Data Models

The interoperability with other existing data models related to digital preservation has been adopted as a core design principle. The purpose of MP-AF is not to provide yet another metadata standard, but the most interoperable and complete metadata standard for describing the preservation information needed in professional audiovisual domains. Three data models have been selected as the most adopted in the current practice of audiovisual archives, and therefore as mapping targets: PREMIS [10], W3C PROV [13] and EBU CCDM [20]. These mappings for MP-AF to already implemented data models are useful for understanding its context and allowing a further adoption. For the representation of processes and agents, also the compatibility with Business Process Model and Notation (BPMN) [23] has been taken into account. In particular archives closely linked to media production institutions (e.g., broadcast archives, stock footage libraries) increasingly use service oriented architectures modelled using business processes.

While MP-AF has been defined in the context of MPEG, its use is not strongly linked to the use of other MPEG technologies for the content being preserved. For example, in the broadcasting domain, SMPTE MXF [24] has become the most widely used file container, and MP-AF can be used for representing preservation information of MXF files, whether the contained bitstreams are encoded using MPEG formats or not. Also, as described above, MP-AF allows for the inclusion of descriptive and technical metadata in different formats.

In the following paragraphs, a description of the relations to the three mentioned data models is reported, as displayed in Figure 4. In the figure, every element coming from other models is labelled with the corresponding prefix (i.e. premis, prov, ccdm) in order to disambiguate terms and avoid name mangling. Associations (connected lines with different symbols) are written following the UML2 [25] notation with the more general meaning (i.e. where it was not possible to define more precise relationships, a simple dependency with dashed lines has been adopted).

5.4.1 PREMIS

The compatibility of the MP-AF data model with the Object-Event-Agent structure in PREMIS is important in order to support organisations holding some amounts of audiovisual content, but which is not their main asset (e.g. National Libraries may preserve some audiovisual content, but their core assets are the book collections). Moreover the interoperability increases with the changes planned for the upcoming version 3 of PREMIS. As shown in Figure 4, the central element of the data model is the premis:IntellectualEntity that in MP-AF is the PreservationObject i.e. the entity that the model is describing with preservation metadata. In Figure 4 an UML dependency (dashed arrow) has been depicted connecting the two elements. Actually the PreservationObject is a child of the abstract element Item that in PREMIS can be considered as a child of premis:Object. The MP-AF Representation, File, Bitstream and UsageRights have quite straightforward PREMIS counterparts: the premis:Representation, premis:File, premis:Bitstream and premis:Rights. Concerning the latter, the MP-AF is more expressive because it can express usage rights (the rights expressed in premis:Rights) but can also express the ExploitationRights, i.e. much more complex rights (such as contracts) that can prevent many operations on the PreservationObject and must be captured as well.

The MP-AF Operator has the related element premis:Agent. In this case, MP-AF has decided to discriminate between human beings and machines, that is not directly possible in PREMIS. Hence the MP-AF Operator is a superclass of Agent for human beings and of Tools for software or other virtual actors. It follows that the premis:Agent had to be mapped to the more general parent class Operator. The MP-AF Activity, which is quite general, can be mapped to the premis:Event, that is associated to the premis:Agent performing or involved in the event as well as the Activity is associated to the Operator in MP-AF.

5.4.2 W3C PROV

The MP-AF data model is fully compatible with the Entity-Activity-Agent structure in the recently completed W3C Provenance data model [13]. The PROV data model is much smaller but actually the MP-AF element Item can be mapped to the prov:Entity. That means that all the MP-AF sub-elements of Item such as PreservationObject, Representation, Essence and Bitstream are mapped to prov:Entity as well. The prov:Activity performed on the prov:Entity can be mapped to the MP-AF Activity, with more or less the same semantic. The prov:Agent (as described in PREMIS) can be mapped to the MP-AF Operator. The MP-AF Group of several PreservationObject is represented in PROV as prov:Collection.

As with PREMIS, a direct mapping of MP-AF Asset does not exist, and only the more general PreservationObject can be mapped.

5.4.3 EBU CCDM

A mapping between the main entities in MP-AF and the EBU Class Conceptual Data Model (CCDM) has been established, aligning the model with a set of metadata models and formats implementing CCDM. The core element of CCDM is the ccdm:EditorialObject which is straight forwardly mapped to the MP-AF central element PreservationObject. CCDM, compared to the previous data models, is the closest to the audiovisual professional domains (EBU) and have more corresponding elements in the MP-AF model. For that reason we have immediate correspondence of MP-AF Asset (child of PreservationObject) to the ccdm:Asset, the Essence to the ccdm:Essence, the Group to the ccdm:Group, the Agent to the ccdm:Agent, the MediaLocator to the ccdm:Locator. Since Essence is a parent of the MP-AF Bitstream, it can also be considered mapped to the ccdm:Essence as well. Concerning the Rights, CCDM is able to represent complex rights, actually IPRights and the element ccdm:IPRights is closer to the MP-AF ExploitationRights rather than the simpler UsageRights. MP-AF Representation can considered the counterpart of ccdm:MediaResource.

5.4.4 Packaging MP-AF and Content

MP-AF does not specify a format for packaging metadata together with content, as different types of organisations preserving audiovisual content have different needs concerning the package format. The MP-AF implementation guidelines, which are currently being developed, describe how MP-AF can be embedded in some common container formats. Those include the MPEG Professional Archive Application Format (PA-AF), the Material Exchange Format (MXF [24]) and the Archive Exchange Format (currently under standardisation, to become SMPTE ST 2034).

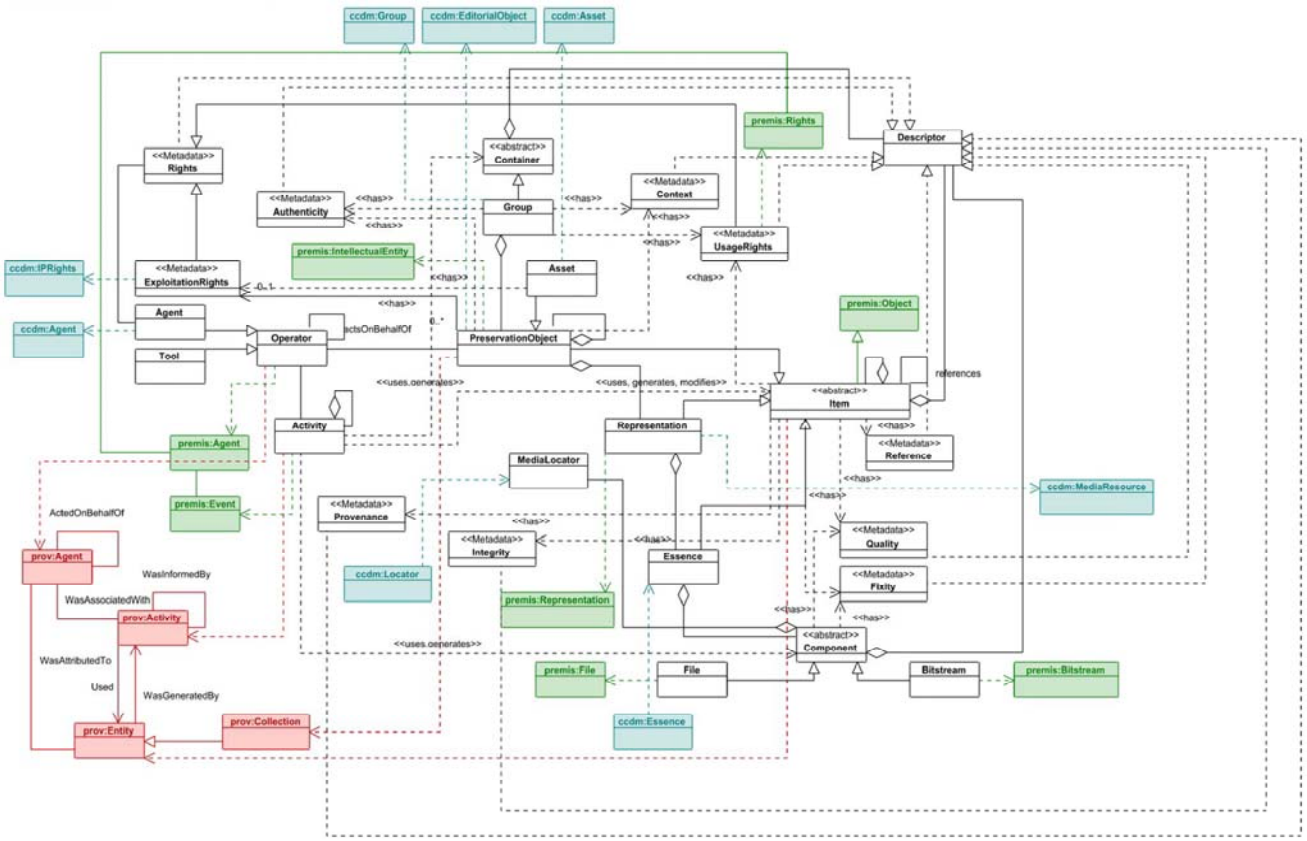

Figure 4: Visualisation of mapping of MP-AF entities to PREMIS, W3C PROV and CCDM.

6. CONCLUSION AND FUTURE WORK

This paper presents the work on a novel metadata MPEG standard specifying information needed for preservation of multimedia content, named Multimedia Preservation Application Format (MP-AF). The standardisation process is currently ongoing on committee level. The standard is expected to be completed in 2015 [26].

The presented model is able to fix the gaps already identified for representing preservation metadata of audiovisual contents and is sufficiently flexible to support various preservation workflows without imposing constraints on preservation environments or demanding changes of current models. It enables full interoperability between widely adopted preservation metadata schemas, various content structures and process models.

In next months the MPEG Multimedia Preservation group will evaluate the effectiveness of MP-AF in managing the multimedia preservation information in operative environments and use cases, in order to include samples and guidelines and allows an easy adoption in several different contexts.

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