Models and tools for aggregating and annotating content on ECLAP

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Abstract— In the area of cultural heritage there is a strong push on aggregating content metadata from institutions (such as museums, university, archives, library, foundations, etc.) to make them widely accessible. This action is going to reduce fragmentation, allows aggregation and integrates valuable collections in a unique place. For example, Europeana (the so called European digital library) collects only metadata, while content files are referred via some URL. These URLs refer to the original content owner and/or to the Content Aggregator, facilitating the collection. That model leaves space to the Content Aggregator to provide additional services on their enriched models. The proposed Content Aggregation model attempts to satisfy specific requirements with a semantic model and tools providing support for executable aggregations such as: playlists, collections, e-learning courses, and media annotations/synchronizations. The produced aggregations may also be provided by mapping semantic concepts to Europeana. The paper also performs an analysis of semantics models mentioned and of their difficulties including some comments about the adoption of linked open data and media model. The results have been produced in the project ECLAP ICT PSP founded by the European Commission, http://www.eclap.eu .

Keywords: media aggregation, executable aggregations, playlists, collections, audio visual annotationa, semantic mapping, social networking.

I. INTRODUCTION

In the last years, the society of information has been permeated by new ways of fruition of multimedia contents on the web. The attention of users is more focused on content oriented web sites, and in most of them several forms of content aggregation are offered in the context of social and best practice networks. More recently, several web portals and social services that collect metadata of content (articles, video, etc.), indexing citations, indexing cultural heritage content are growing as *indexing portals/engines*. Those portals and services are facilitators for content access, while the real content items, the digital essences, are accessible only on the original portal of the content provider because they are referred. This may happen in the digital libraries of IEEE and ACM, which in some cases index metadata and refer other collections via URLs.

Among *indexing portals*, Europeana [11] (i.e., the European Digital Library, http://www.europeana.org) collects cultural heritage metadata coming from several institutions, universities, foundations, museums, schools of art, representing a cultural heritage of the huge European history. Europeana portal collects only metadata, while content files are referred via some URL. These URLs refer to the original content owner and/or to the Content Aggregator, facilitating the collection. Despite to difficulties in reaching resource files, the *indexing portals*, as well as Europeana, have a strong validity for educational purposes.

In this paper, some executable content aggregation models are analyzed to better understand their capabilities about their export and share among portals and digital archives. The solutions proposed in this paper have been developed for ECLAP (European Collected Library of Artistic Performance) ICT PsP project of the European Commission (http://www.eclap.eu). ECLAP models and tools would support the Content Aggregation process collecting and aggregating content for Europeana. To this end, ECLAP defined an executable semantic model and tools for playlists, collections, e-learning courses, and media annotations/synchronizations. The semantics of the aggregation can be difficultly mapped into the new semantic model of Europeana, the Europeana Data Model, EDM [12].

The paper is organized as follows. In Section II, a short overview of ECLAP project is provided. Section III puts in evidence the requirements for Content Aggregation. In Section IV the ECLAP Semantic Aggregation Model is presented. Section V describes and comment the semantic models for the different aggregation models raging from: collection, playlists, annotations, synchronizations and experiences. The presentation and analysis is referred to the ECLAP implementation of the Aggregations Models. In Section VI, the mapping of the ECLAP aggregation model with EDM is reported and discussed. Section VII describes the problems of Content Aggregators in exploiting remotely located content into aggregations. Conclusions are drawn in Section VIII.

II. ECLAP OVERVIEW

ECLAP e-library for performing art portal and service has been created for ECLAP ICT PsP project (European Collected Library of Artistic Performance) of the European Commission (http://www.eclap.eu). ECLAP is analyzing problems and finds solution to aggregate content for Europeana. ECLAP is establishing a set of tools for content aggregation, automated content ingestion and adaptation, semantic modelling, IPR management and wizard, semantic enrichment and content aggregation moving co ntent toward EDM. ECLAP is collecting content coming from about 15 European cultural and educational institutions. The provided content has to be semantically enriched for creating aggregations. The enriched content is provided in

terms of metadata to Europeana portal, and used by the institutions for educational aspects, research and accessing to integrated/aggregated cultural heritage material in general.

ECLAP provides to registered users a set of functionalities and facilities, such as:
(i) social service support with registration, discussion groups, mailing and forums, recommendations; (ii) search, retrieve and play cross media and multilingual content; (iii) semantically enrich and contextualize, annotate, aggregate content; (iv) upload and share multilingual content for professional and User Generated Content; (v) comment, annotate, rate and vote on content; (vi) Wizard tools to solve and manage IPR issues; (vii) distribution and access to content via different devices such as PCs, tablets and smartphones; (viii) publication of metadata and aggregation performed to Europeana; (ix) usage and exploitation of e-learning facilities for the content providers and in general for registered users.

In this paper, the aggregation capabilities developed in ECLAP are presented and discussed, focusing the attention on playlists, collections, courses, non linear annotation, synchronizations of media and record of narrative experiences explaining why these aspects can represent a new better way to provide technologies for e-learning environments.

III. CONTENT AGGREGATION REQUIREMENTS

According to above described situation, the following requirements have been collected regarding the executable aggregation facilities of ECLAP, based on: playlists, collections, courses, annotations, and audiovisual synchronizations. These aggregations are finally exported towards Europeana as aggregations and their corresponding single entities, via a mapping and a simplification.

On this regard, the ECLAP users (teachers and students) have to be mainly capable of:
(i) creating and sharing playlists, collection and courses with their own classification metadata, while the single content item has to preserve its own classification and identification, (ii) creating playlists as a sequence of segments/sub-segments of audio and/or video content or timed images without modifying the content sources, and thus that may be located on different servers, (iii) executing playlists with a semantics presenting them in a time sequence comprised a combination of: segments of video identified from the whole video file, segments of audio identified from the whole audio file, presentation of images for a defined number of seconds, (iv) synchronizing video/audio segments and images, for example defining time relationships among them and the possibility of passing from one resource to another, via a non linear navigation, (v) recording the navigation experiences of the users among the synchronizations of video, audio and images defined in the previous point, (vi) rating, commenting, promoting single content items, playlists, collections and courses, (vii) managing the e-learning course as a sequence of activities including, a set of content items, text for presenting and gluing them. Content items can be: audio, video, slide, documents, collections, playlists, excel files, tools questionnaires, polls, etc.

In addition, the teachers can organize their courses in lesson units. Each lesson unit may contain contextual text and a set of digital resources including collection, playlists, annotations, etc.

IV. ECLAP SEMANTIC AGGREGATION MODEL

This section is focused on presenting an overview of the ECLAP semantic model, with a specific accent on the aggregations: playlists, collections, annotations, synchronizations and e-learning courses. The ECLAP semantic model is reported in Figure 1. Moreover, several other kinds of concepts and data are modeled ranging from content to users and their relationships. The different kinds of contents are classified with a thematic SKOS [6]: genre, performing art type, historical period, subjects, etc. Also the user profile includes such a classification to allow users to express their preferences about content theme, and to exploit that information for suggestions and/or recommendations. Content in ECLAP can be: image, document, video, audio, epub, MPEG-21, html, archive, animations, etc., but also the aggregation as playlists, collections, web pages, annotations, comments, etc., and considered content as well.

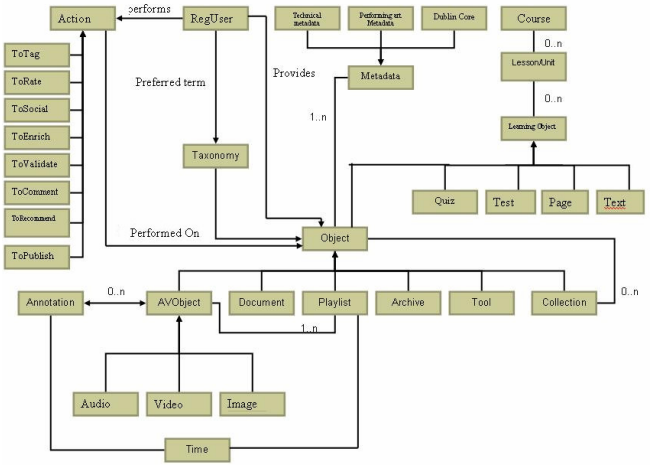

Figure 1. ECLAP Semantic model (a part)

V. AGGREGATIONS MODELS AND TOOLS

A. *Content Collections*

According to the ECLAP model of Figure 1, a Collection is a set of contents: audio, video, images, documents, pdf, playlists, zip files, etc. The collections can be created on the Portal and may be published or kept private by the users: *Unpublished*: the collection will be visible only to the creator in a draft form; *Published*: the collection has been uploaded as new a content item (also indexed, etc.) and can be shared with other users and published toward Europeana, for example.

In order to keep separate temporary collected objects and collections, the system creates different xml descriptions on server for each user. Once a content is on the temporary list, it may be added to a personal collections, to be published later. The descriptive xml structure is the reported as in the

following example (where the AXOID is an UUID (Universally Unique IDentifier)):

```
<collection xmlns="http://…">
   <Record>
      <DrupalNode>3452</DrupalNode>
      <Media>
         <Title>mask</Title>
         <MediaType>Image</MediaType>
         <Axoid>urn:axm:…7fb6ce0</Axoid>
         <Ext>.gif</Ext>
      </Media>
   </Record>…
   <Record>
      <DrupalNode>3451</DrupalNode>
      <Media>
         <Title>Theatre curtain</Title>
         <MediaType>Video</MediaType>
         <Axoid>urn:axm:00000:obj:e2e24d4b-22ab-
                  48ec-a461-98250f283b55</Axoid>
         <Ext>.flv</Ext>
      </Media>
   </Record>
</collection>
```

The descriptors of the elements collected into the Collection can be recovered by using the DrupalNode id and/or the UUID coded as AXOID into the system.

The collection may include classification and technical information to be shared according to LOD (Linked Open Data) [2] [4] model. When a user publishes a collection, classification and technical metadata have to be assed. In ECLAP, also the association to taxonomy and groups is requested. The definition of metadata information keeps unchanged the multimedia objects composing the collection, but completes and produces an additional semantic descriptor to the collection created. This information is indexed, shared and accessible, so that it can be used to make queries for searching collection objects on the ECLAP Portal.

In ECLAP, a set of operative functionalities are available to manage collection such as: *list* of resources, add/delete resource, creation and editing, saving and publication of a collection, assigning metadata, updating of a collection already published. The collection can be used as the primary source for producing courses. The user may create its own thematic collections for creating a repository of content for the composition of its own lessons/courses. In many cases, Collections may be published and exported on Europeana as described in the following. For example when the collection represent an added value: the pictures in a room, the set of picture of the same opera, the set of content used to prepare the opera, the different camera views of the same theatrical representation, etc.

In Figure 2, four resources have been selected and are present in a *temporary list* (e.g., 'Theater curtain', 'i-theatre annotate', etc.), while three of them have been grouped in the 'Theater' collection, by selecting them and adding them to the collection. Once a user has created an unpublished collection (i.e., private) he/she can publish on the Portal. Already published collections can be also updated without changing the metadata.

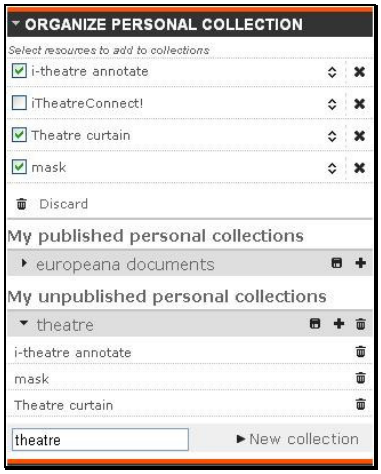

Figure 2. Bblock for managing personal collections. In the upper side the temporary collection, in the second part published and unpublished collections are visible.

In general, the concept of Collection does not have an executable semantics, in the sense that the playback of a collection is not bringing to the frontal reproduction of the single content of the collection. As limit case, the collection would have an ordering of content elements, but only in some specific cases. In the next section, a more sophisticated model of collection is presented. It is typically proposed and called as PlayList.

B. Content Playlist

In most cases, the concept of playlist is used by the users to create specific collections of ordered audiovisual content, e.g., a set of audio tracks, a set of videos. The playlist execution consists in the sequential play of the single content objects. The executable semantic of play along the time can be easily applied to audiovisual content such as image and audio tracks.

In ECLAP, the play list model also support the inclusion of images and audiovisual segments of the media. According to the model of Figure 1, a playlist can be a set of audiovisual contents. The same media can be included in several playlists or some different temporal segments of it can be inserted in a single playlist. The order or execution and their timeline for each playlist and object can be user defined. Playlists are a way of playing an ordered series of multimedia contents.

Therefore, the playlist model of ECLAP is not the classical play list of many social networks. In ECLAP the user may put in the play list even a small segment of video and audio, without the modification of their corresponding files. This permits to create e-learning units without the need to cutting the audiovisual pieces. The semantic of playlist allows to play the audiovisual content according to the identified segments and sequence only once or in a continue loop (images, audio, and video).

From the operative point of view, a user can take from the portal any audiovisual segment to compose its own playlist. The operation is performed on a specific audiovisual flash player in which one can select a start and (|-) an end (-|) of the audiovisual segment.

In the case of images included in the ECLAP playlist, a duration time of their permanence on screen has to be defined by the user. A duration of default is set to 5 seconds.

Once a play list is complete, the user may decide to publish and share it on ECLAP. In this case, specific metadata are requested, plus taxonomical information. The published playlist can be aggregated in Collection and into Courses as basic elements. Please note that the association of metadata keeps unchanged the multimedia objects composing the playlists, and gives a semantic on the playlist created, assigning the order to included media segments to be played.

The XML descriptor of the playlist may be accessible from ECLAP to the playlist player on the client side to keep available all the information for the system during the playback phase. A reduced number of information regarding the playlist may also be passed to Europeana. In this case, the executable semantics of ECLAP playlists is lost mapping the information to EDM.

C. *Audio Visual Annotations and Synchronizations*

The possibility of creating annotations on audiovisual is provided on several portals by using several different kind of tools and solutions, see [8][9][10]. In most cases, the annotations are textual or semantic descriptions of the scene, e.g.: Carl is talking with Peter, a table with two chairs, Sausalito beach. In addition to this requirement, there is the need of synchronizing audiovisual media. For example, to show the video and slides synchronized each other, to see at the same time different synched views of the same scene (may be taken from different points of views) in a theatre (see this example on ECLAP portal).

The integration of classical annotations and synchronization functionalities is an important feature to be accessible in the educational environments.

Therefore, in order to satisfy these requirements, the model and tool enforced in ECLAP has been derived by the MyStoryPlayer [1]. With MyStoryPlayer a user may annotate an audiovisual content segment (image, video, audio) with another audiovisual content segment (see Figure 3). This allows to define synchronizations and to associate to those segment also textual and/or descriptive annotations. These annotations are saved into an RDF [5] model located to the server, and partially sent to the on demand player according to contextualized SPARQL queries.

So that, on ECLAP a user can perform annotations on any audio, video or image located on the portal. This activity is performed by using a simple on-line tool. Then the annotations performed may be played/executed by the MyStoryPlayer tool.

Moreover, according to the MyStoryPlayer model, there is no difference between a media and a annotation. The annotation can be also a media. A media can be at the same time a resource for an annotation and an annotation. This leads to build an annotative structure in which a user can navigate among several annotations. An annotation, according to the semantic model, can involve one or two media. It is based on a starting and ending time, involving two media.

As for the other features like play lists and collections, no alteration is done on the original file. When two media are annotated and/or synchronized each other. The model is based on a set of RDF triples to code the relation, saving it in the semantic database, in order to allow searching for annotations on users profile.

D. *Navigation and User Experiences on MyStoryPlayer*

The MyStoryPlayer allows to prepare a lesson synchronizing slides and videos in the same environment, or adding some pictures or audios examples that can better explain the concepts of his lesson. Another application can be the creation of synchronized presentations of many multimedia objects of the same event, for example taken from different point of views, relating them each other and play them synchronously and in parallel on the same player.

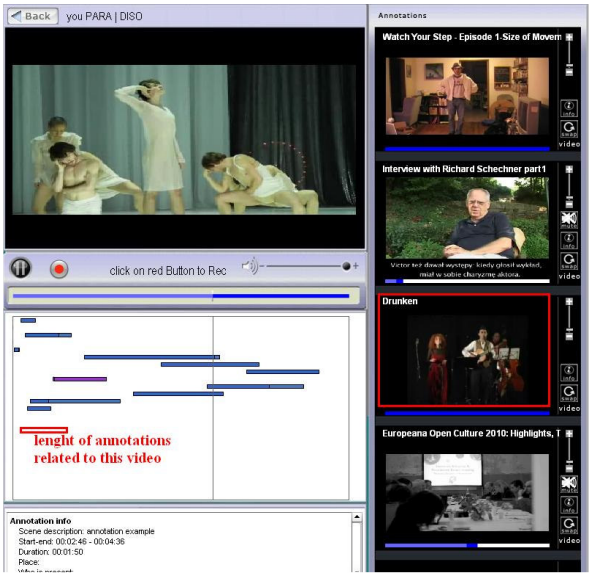

Figure 3. MyStoryPlayer screenshot. The rectangles below the temporal line represent the length of annotations respect to the media duration. The media aside are playing synchronously with the main media

Media are connected with the main video for the time represented by the length of the rectangles, afterwards they disappear. During the time they are active, the user is granted with many choices: he can keep on viewing the main video or can click on the other video represented by a side annotation. This latter action introduces a swap between the two videos, while new contents are loaded in association with the new main media. Every time a swap action is executed, user can go back to previous step simply by clicking on the *Back* button, just like it occurs with any web browser.

The solution allows the users to add annotations on media content and/or relating audiovisual segments each other. Moreover, there is another feature, the so called User

Experience, in which a user, for example a teacher, may record his personal experience navigating on MyStoryPlayer annotations. Then the teacher can save and share this experience with students, stimulating the attention on a particular aspect following a leit-motif through the annotated media. This feature is provided to give the user the chance of recording every step he/she takes along his personal experience on MyStoryPlayer, in order to share and make it available for other users.

E. E-learning courses

The e-learning support of ECLAP allows users to compose and/or publish aggregations and educational content and to exploit the advantages provided by the use of a complete and effective tool for creation and management of on-line courses in an integrated manner. The ECLAP Portal provides support for e-learning activities to the registered users. This integration system allows the teachers to create the courses using an augmented Moodle [3] with ECLAP content and aggregation facilities. Thus the user has the possibility of composing courses also by using the audiovisual content of ECLAP and created aggregations as: Collections, Playlist, Annotations, etc. Each lesson may be composed by different learning objects which are content types, such as: quiz, test, text, web pages, objects, audiovisual contents, and thus collections, playlists.

VI. AGGREGATION TO EUROPEANA

Recently, the new Europeana Data Model (EDM) [12] for metadata ingestion and management has been proposed. The new model is based on well defined semantic web standards as ORE, Dublin Core [7] and SKOS [6]. Noticeable requirements for the EDM model were (i) distinction between "provided object" (painting, book, movie, archaeology site, archival file, etc.) and digital representation, (ii) distinction between object and metadata record describing an object, (iii) multiple records for the same object should be allowed, containing potentially contradictory statements about an object, (iv) support for objects that are composed of other objects, (v) compatibility with different abstraction levels of description, (vi) EDM provides a standard metadata format that can be specialized and (vii) EDM provides a standard vocabulary format that can be specialized.

One of the main goals of EDM is to allow the integration of the different data models used in Cultural Heritage data, in order to collect and connect through higher-level concepts all original descriptions coming from several Content Aggregators.

Analysing the EDM model in the context of Aggregation, two basis classes of resources provided to Europeana are identified: the "provided object" itself and a (set of) digital accessible representation of it. This permits to distinct between "works", which are expected to be the focus of users' interest, and their digital representations, which are the elements manipulated in information systems like Europeana. According to the ORE approach through the ore:Aggregation class , the provided object and its digital representation, given by one provider, form an aggregation. Each instance of ore:Aggregation is related to one resource standing for the provided object, through ens:aggregatedCHO property, and one or more resources that are the digital representations of the provided object through the ens:hasView property.

The present version of EDM integrates the former model of Europeana called Europeana Semantic Elements, ESE, by re-contextualizing each element in the more structured context of EDM.

In particular, in the context of EDM deployment, the values of ESE properties that are currently given as simple strings could be given, in a typical RDF [5] form, as pointers to fully-fledged (RDF) resources standing for concepts, agents or places (to name a few) that would be provided with complete description and linkage to other resources. This applies in particular to both Dublin Core properties (e.g., dc:creator) and to ESE-specific ones (e.g., ens:isShownAt).

As EDM supports the delivery of aggregated content, ECLAP can use Collections as a kind of aggregated content that may be provided to Europeana.

Moreover, ECLAP can use the extensibility of EDM to define specific specialization for some properties to provide more detailed information on a content. For example custom properties can be defined in the following way:

eclap:director *rdfs:subPropertyOf* dc:creator.
eclap:lightDesigner *rdfs:subPropertyOf* dc:contributor.
eclap:dateOfPerformance rdfs:subPropertyOf dc:date.

Where director property is defined as sub property of Dublin Core creator, lightDesigner as sub property of contributor and date of performance as sub property of date.

The example of an aggregated content is the following (using the turtle syntax):

eclap:Collection *rdfs:subClassOf* ore:Aggregation;
rdfs:subClassOf eclap:Content.
<urn:axmedis:0000:obj:abc…> a eclap:Content;
dc:title "you PARA | DISO"@en;
dc:creator "emio greco & pc";
eclap:dateOfPerformance "2010/07/15";…
<urn:axmedis:0000:obj:0123…> a eclap:Content;
dc:title "Divina Commedia, Paradiso"@it;…
eclap: aggregation_10231 a ore:Aggregation;
dc:creator "ECLAP";
ens:aggregatedCHO <urn:axmedis:0000:obj:a1b2…>.
<urn:axmedis:0000:obj:a1b2…> a eclap:Collection;
dc:title "Paradise from past to future"@en;
ore:aggregates <urn:axmedis:0000:obj:abc…>;
ore:aggregates <urn:axmedis:0000:obj:0123…>.

Where <urn:axmedis:0000:obj:a1b2…> is a collection aggregating the two contents <urn:axmedis:0000:obj:abc…> and <urn:axmedis:0000:obj:0123…>, while aggregation_10231 is the aggregation among the provided object and its digital representations.

According to the present EDM model, some aggregated content present in ECLAP cannot be fully exported to Europeana. In fact, by following the aggregation schema allowed by EDM the information about (i) the temporal segments of media involved in playlists, (ii) semantic information related to annotations and synchronizations

modelled in MyStoryPlayer, (iii) the full courses; cannot be directly mapped into EDM. On the other hand, they continue to be additional features of ECLAP Content Aggregator with respect to the Europeana model and service. ECLAP also present the management of social network and thus the several relationships with users.

VII. PROBLEMS OF AGGREGATING REMOTE CONTENT

According to the concepts of LOD (Linked Open Data) and Linked Open Media one should access to metadata and content without the need of aggregating the effective content file on a unique service provider. On the other hand, as discussed in the following, the exploitation of executable content aggregation models exploiting content remotely located in the http servers of the original providers presents a set of drawbacks, among them:

A. Access problems

It would be not suitable for a content aggregator to base its service in providing content on the basis of content coming from third party servers. They may have poor performance, and out of service out of direct control. Moreover, the provider could have or change without notification access protection protocol that the aggregator need to support.

B. Content format problems

The third party providers may provide content in a format that is not directly suitable for the content aggregator. This happens mostly with video content due to the current babel of video formats. Due to this problem, the provider should provide content in a variety of formats. However providing content in multiple formats is a cost that the provider may not decide to pay. Please note that the audio videos have to be of the right format to be played with annotations, to allow the fine seeking of timeline, to add annotations, etc. Moreover, content providers are typically producing video in multiple formats to satisfy multiple devices: different resolutions and codecs.

C. Seeking problems

If the aggregator needs to provide to the user direct access to a fragment of the content (mostly for audio/video content) problems come on how to achieve this without downloading the whole content. This is achievable only if the provider supports this kind of access. This problem is also related with the content format problem as frequently specific format parameters need to be set to allow direct content access.

To overcome these problems a caching service on the aggregator site may be used, this caching service may be used to adapt content if needed however in this case copyrights problems may be present.

VIII. CONCLUSIONS

In this paper, the main requirements and models for content aggregation have been identified and analysed,e-learning courses, annotations, synchronization media, playlists, collections. The analysis has been exploited to develop the semantic model of ECLAP portal and service for content aggregation toward Europeana. The ECLAP portal is freely accessed. The important aspects of the proposed models and tools reside in the fact that new ways of fruition of multimedia contents are provided and thanks to the aggregations system, no alteration are done on the contents, but these are enriched with metadata, for a better indexing, searching and sharing contents. All of these aspects are related to the edutainment, entertainment and infotainment, bringing new solutions in this topic. Playlists allow to reproduce in a specified sequence many audiovisual objects or segments of them, annotations. The MyStoryPlayer allows users to annotate and synchronize media and record and save experience in the annotated structure. Collections are simple set of objects used to preparing lessons or courses on educational portal. Only a part of these semantic aggregations can be exported as aggregated content on Europeana EDM.

In future, these aggregation tools will be developed and enriched with more functionality, in order to satisfy and keep the user as more as possible comfortable in educational environment.

ECLAP ICT PsP project (European Collected Library of Artistic Performance) of the European Commission (http://www.eclap.eu) Grant Agreement N° 250481.
The authors would like to thanks to all ECLAP partners.

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