



Automating Production of Cross Media Content for Multi-channel Distribution

www.AXMEDIS.org

DE3.1.2.2.2

Specification of AXMEDIS Command Manager, first update of DE3.1.2 part B

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Abstract: this part includes the specification of components, formats, databases and protocol related to the AXMEDIS Framework area AXMEDIS Object Model including only details on Command Manager and its usage, the usage of the AXOM

Keyword List: AXOM, AXMEDIS Command Manager, MPEG-21 models, authoring tools and players.

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1 Executive Summary and Report Scope

The full AXMEDIS specification document has been decomposed in the following parts:

DE number	Deliverable title	responsible
DE3.1.2.2.1	Specification of General Aspects of AXMEDIS framework, first update of DE3.1.2 part A AXMEDIS-DE3-1-2-2-1-Spec-of-AX-Gen-Asp-of-AXMEDIS-framework-upA-v1-0.doc	DSI
DE3.1.2.2.2	Specification of AXMEDIS Command Manager, first update of DE3.1.2 part B AXMEDIS- DE3-1-2-2-2-Spec-of-AX-Cmd-Man-upB-v1-0.doc	DSI
DE3.1.2.2.3	Specification of AXMEDIS Object Manager and Protection Processor, first update of DE3.1.2 part B AXMEDIS-DE3-1-2-2-3-Spec-of-AXOM-and-ProtProc-upB-v1-0.doc	DSI
DE3.1.2.2.4	Specification of AXMEDIS Editors and Viewers, first update of DE3.1.2 part B AXMEDIS-DE3-1-2-2-4-Spec-of-AX-Editors-and-Viewers-upB-v1-0.doc	DSI
DE3.1.2.2.5	Specification of External AXMEDIS Editors/Viewers and Players, first update of DE3.1.2 part B AXMEDIS-DE3-1-2-2-5-Spec-of-External-Editors-Viewers-Players-upB-v1-0.doc	EPFL
DE3.1.2.2.6	Specification of AXMEDIS Content Processing, first update of DE3.1.2 part C AXMEDIS-DE3-1-2-2-6-Spec-of-AX-Content-Processing-upC-v1-0.doc	DSI
DE3.1.2.2.7	Specification of AXMEDIS External Processing Algorithms AXMEDIS-DE3-1-2-2-7-Spec-of-AX-External-Processing-Algorithms-v1-0.doc	FHGIGD
DE3.1.2.2.8	Specification of AXMEDIS CMS Crawling Capabilities, first update of part of DE3.1.2 AXMEDIS-DE3-1-2-2-8-Spec-of-AX-CMS-Crawling-Capab-v1-0.doc	DSI
DE3.1.2.2.9	Specification of AXMEDIS database and query support, first update of part of DE3.1.2 AXMEDIS-DE3-1-2-2-9-Spec-of-AX-database-and-query-support-v1-0.doc	EXITECH
DE3.1.2.2.10	Specification of AXMEDIS P2P tools, AXEPTool and AXMEDIS, first update of part of DE3.1.2 AXMEDIS-DE3-1-2-2-10-Spec-of-AXEPTool-and-AXMEDIA-tools-v1-0.doc	DSI
DE3.1.2.2.11	Specification of AXMEDIS Programme and Publication tools, first update of part of DE3.1.2 AXMEDIS-DE3-1-2-2-11-Spec-of-AX-Progr-and-Pub-tool-v1-0.doc	UNIVLEEDS
DE3.1.2.2.12	Specification of AXMEDIS Workflow Tools, first update of part of DE3.1.2 AXMEDIS-DE3-1-2-2-12-Spec-of-AX-Workflow-Tools-v1-0.doc	IRC
DE3.1.2.2.13	Specification of AXMEDIS Certifier and Supervisor and networks of AXCS, first update of part of DE3.1.2 AXMEDIS-DE3-1-2-2-13-Spec-of-AXCS-and-networks-v1-0.doc	DSI
DE3.1.2.2.14	Specification of AXMEDIS Protection Support, first update of part of DE3.1.2 AXMEDIS-DE3-1-2-2-14-Spec-of-AX-Protection-Support-v1-0.doc	FUPF
DE3.1.2.2.15	Specification of AXMEDIS accounting and reporting, first update of part of DE3.1.2 AXMEDIS-DE3-1-2-2-15-Spec-of-AX-Accounting-and-Reporting-v1-0.doc	EXITECH

1.1 This document concerns (DSI)

AXMEDIS Object Manager, so called AXOM, is the outer module exposing functionalities in order to manipulate AXMEDIS Object (or MPEG-21 Digital Items). It hides all the underlying model for representing loading, saving object content and metadata. This module is the keystone to build any AXMEDIS compliant tools since it grants the developer to correctly manages the underlying content model, while also respecting DRM constraints on the AXMEDIS Object. AXMEDIS Object Manager guarantees DRM rules respect on AXMEDIS object manipulations according to the issued licences. AXMEDIS Object Manager is the sole responsible of command execution (i.e. to command an execution of a desired manipulation), because completion of this task requires features of all other modules in specification.

1.2 List of Modules or Executable Tools Specified in this document

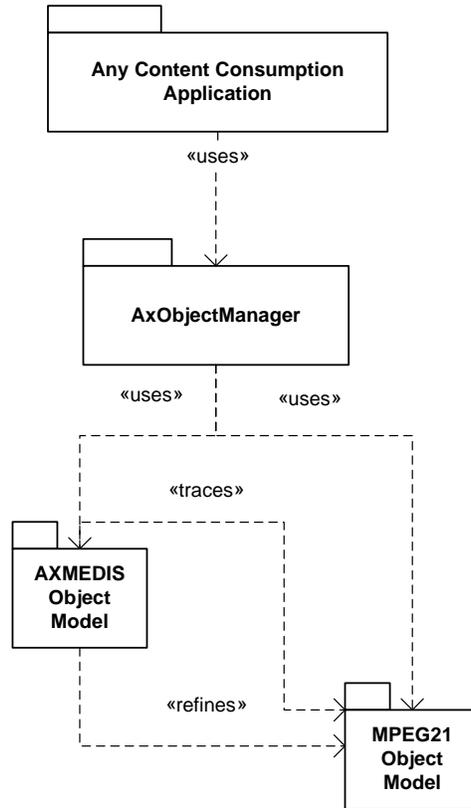
A module is a component that can be or it is reused in other cases or points of the AXMEDIS framework or of other AXMEDIS based solutions.

The modules/tools have to include effective components and/or tools and also testing components and tools.

Module/tool Name	Module/Tool Description and purpose, state also in which other AXMEDIS area is used	Standards exploited if any
AXMEDIS Object Manager	In AXMEDIS Editor, AXMEDIS players, AXMEDIS Content Processing tools, and all tools that use the AXMEDIS object model	MPEG-21 REL/RDD

2 General architecture and relationships among the modules produced

AxObjectManager architecture work in cooperation with many modules involved in manipulating AXMEDIS Objects and to provide at upper level applications useful methods to accomplish all needed tasks in order to manage, modify, and even create, new objects. These interfaces are build in accordance to DRM guidelines and accomplishes all operations enforcing DRM .



This module include several classes . The core is AXMEDIS Object Manager, that coordinates all other classes and expose methods to upper level applications.

AxIndexManager supports indexing of managed elements, providing retrieval functionalities for the entire module.

AxCommand provide a common interface for all the defined commands in the module.

Another concept such as the “event” paradigm, as explained in the Observer design pattern, has been considered and implemented as a part of AxObjectManager package, in order to allow upper layer applications to effectively manage their rendering of the multimedia package Events managed in AxObjectManager provides information about changes in the package structure and notifies modifications in the embedded digital resources or the related metadata. Both AXMEDIS and MPEG-21 models may be subject of those changes , thus two distinct sets of events have been provided.

3 AXMEDIS Object Manager (DSI)

Module/Tool Profile		
AXMEDIS Object Manager		
Responsible Name	Davide Rogai	
Responsible Partner	DSI	
Status (proposed/approved)	Proposed	
Implemented/not implemented	Implemented	
Status of the implementation	90%	
Executable or Library/module (Support)		
Single Thread or Multithread	Multithread	
Language of Development	C++	
Platforms supported	Windows/Unix-Linux	
Reference to the AXFW location of the source code demonstrator	https://cvs.axmedis.org/repos/framework/source/axom	
Reference to the AXFW location of the demonstrator executable tool for internal download	https://cvs.	
Reference to the AXFW location of the demonstrator executable tool for public download		
Address for accessing to WebServices if any, add accession information (user and Passwd) if any		
Test cases (present/absent)		
Test cases location	http://	
Usage of the AXMEDIS configuration manager (yes/no)	Yes	
Usage of the AXMEDIS Error Manager (yes/no)	No	
Major Problems not solved	-- --	
Major pending requirements	-Right Enforcement logic --	
Interfaces API with other tools, named as	Name of the communicating tools References to other major components needed	Communication model and format (protected or not, etc.)
Formats Used	Shared with	format name or reference to a section

Protocol Used	Shared with	Protocol name or reference to a section
Object ID Generation	AXCS	
Object Registration	AXCS	
AXDB Loader	AXDB	
AXDB Saver	AXDB	
Used Database name		
User Interface	Development model, language, etc.	Library used for the development, platform, etc.
Used Libraries	Name of the library and version	License status: GPL. LGPL. PEK, proprietary, authorized or not
libcurl	libcurl-7.15.0	LGPL
gsoap	Gsoap 2.7	LGPL

3.1 General Description of the Module

The AXMEDIS Object Manager (AxObjectManager from now on) has to be used to develop software tools which will handle contents following DRM rules. This module has three main tasks :

- To Provide API to upper layer tools in order to allow AXMEDIS and MPEG-21 DIs object manipulation, also maintaining indexes for the object
- To Assure DRM compliance on any object model related operation, even avoiding direct control from upper layer tools to AXMEDIS and MPEG-21 DIs objects.
- To Establish an Event-Driven communication between Model Layer and Application Layer to cope whit objects structure and content changes.

AXMEDIS Object Model (AXOM from now on) is used to cope with content objects and it is compliant with MPEG-21, extending it with additional features and data structures.

AXOM can be used as foundation to design and develop applications which are able of manipulating both MPEG-21 DIs and AXMEDIS Objects, editing/authoring and playing contents and supporting manipulation/access of a hinged package structure (containing nested levels of packaging, hierarchies organization).

On the other hand one of the most important features of this model is to provide the means to create a trusted environment,, capable,to enforce DRM .

AXOM is capable to guarantee that a tool built on its accessible commands will provide digital right observance Commands are designed to allow only execution of license permitted actions.; different actions on the content model should require different grants (i.e., authorizations). Actions can target the content structure, the resources and the metadata; a unique flow to handle verification of any action performed on the

content has been conceived. Finally a single command may require multiple authorisation to be executed (almost one).

AxObjectManager is the interface among AXOM and upper application layer. Object Manager will provide all base operations (add, change, delete, etc...) which will be needed to manipulate AXMEDIS and MPEG-21 DIs objects,. Moreover, it will maintain the trustness of the object model avoiding direct manipulation of its components from application.

As stated, the AXOM can be used to build a large set of content manipulation applications/systems obtaining trusted behavior encapsulated in a clear use of AXMEDIS/MPEG-21 Objects. The developer can use the API exposed by the AXOM for object loading, browsing and navigation in the object structure, obtaining streams for embedded digital resources according to the rights defined in the licenses. Every action performed on the content is related to a set of rights, which have to be owned at consumption time to enable the action. The result is a transparent DRM-including manipulation of the underlying content package.

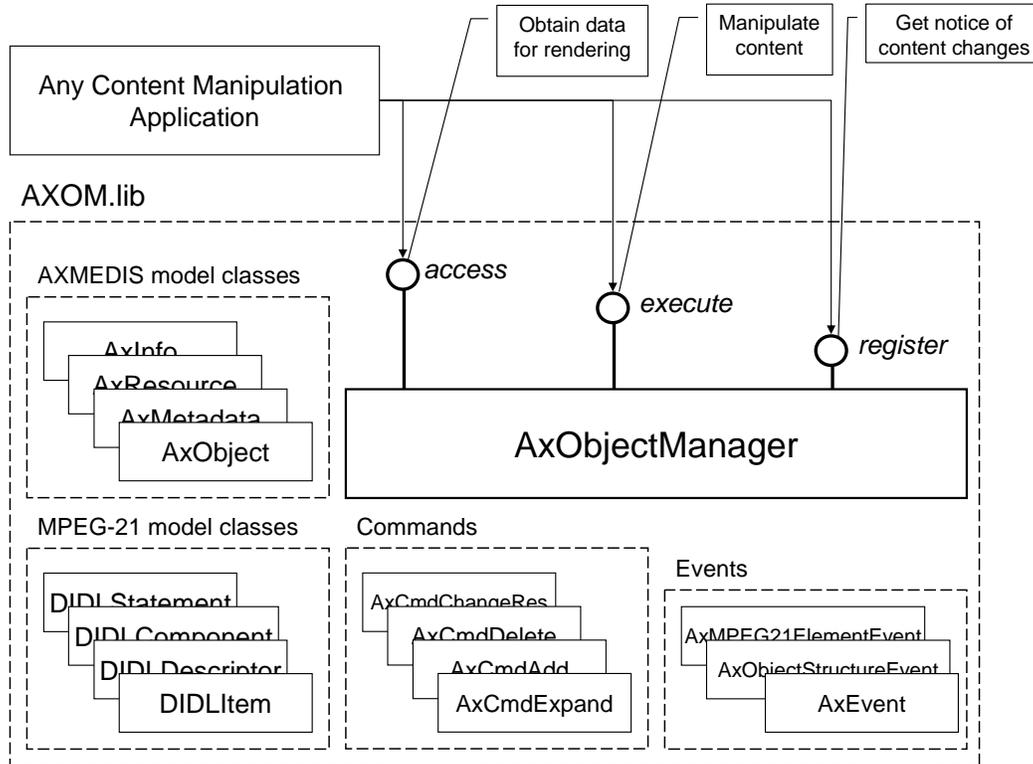
The API is organized in two main subsets:

- Object Model Access – functionalities for browsing and reading content elements; i.e. getting metadata, components, reading content element attributes such as resource descriptors, technical information: MIME-type;
- Object Model Manipulation – functionalities for modifying content package according to DRM rules by using a set of executable commands to add, remove, copy, move content elements such as metadata or resources, to change content elements attribute.

The Object Model Access API covers the basic functionalities to explore and retrieve information from the content package; some of them are listed in the following:

- *getAxObjectElement* – to obtain information about a content element, it provides a clone of the element included in the package;
- *getAxChildIndexes* – to get the list of indexes of the package component when applied to the root level or to an inner sub-package;
- *getAxMetadataIndexes* – to get the list of indexes of the package descriptors;
- *getResourceAsset* – to realize the digital resource extraction, providing a byte stream that can be used for different purposes such as rendering, printing, content processing. This method can used for different purposes: call arguments allow to impose the action to be performed on the resource in terms of rights and related details — e.g., play for 15 minutes;
- *getPublicMetadataTree* – to obtain the complete tree of “public” metadata of the underlying content – i.e. obtaining a full description of it without the need of unprotecting.

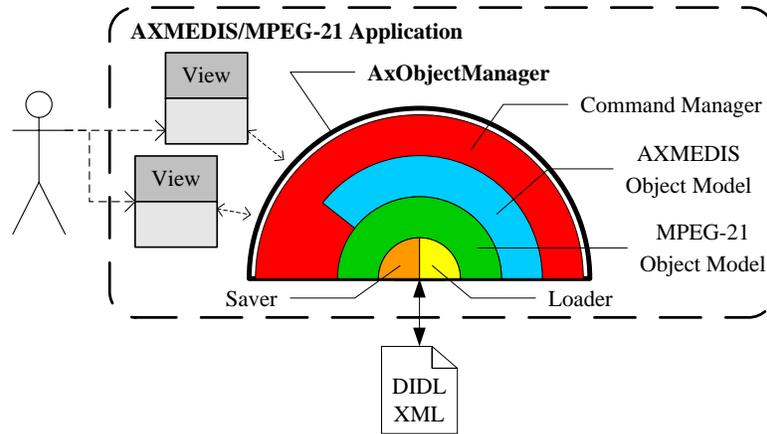
The Object Model Manipulation API has been kept minimal; while an extensible set of elementary command classes have been provided. Thus the content manipulation looks like a sequence of commands targeting the AXMEDIS Object.



- Object Manager works in respect of DRM model, i.e. on every user action it shall invoke the control of user grants on the involved items. That should be possible through the invocation of Protection Processor (see AXMEDIS-DE3-1-2-2-3)
- Object Manager stores information about taken actions, in particular the following information shall be stored:
 - Kind of action and entities involved;
 - Who takes the action;
 - Where the action have been taken (AXMEDIS Editor installation identifier);
 - When the action have been taken (timestamp);

Object Manger provides an interface to permit development of data-manipulation plug-ins by third party developer. This functionality is implemented in ProtectionProcessor. (see AXMEDIS-DE3-1-2-2-3) and exposed in Object Manager.

In order to build a reusable and flexible infrastructure, the AXMEDIS Object Manager has been decomposed in five parts, separating responsibilities of the several elements: MPEG-21 Object Model responsible of managing the MPEG-21 DI allowing content access and manipulation; AXMEDIS Object Model a refinement and an extension of MPEG21 DI, targeting the mentioned requirements and realizing on top of the MPEG-21, the concept of AXMEDIS Data Model.



The part which is described with full details in this document is Command Manager, it is placed at the top of the layers and allows to access and manipulate high-level features in the underlying MPEG-21 structure; The Command Manager allows transparent manipulation of content in respect to DRM rule and directly accessing to the Servers for the acquisition of the License and of Protection Information. It allows to access or to manipulate content with a built-in authorization check on the basis of MPEG-21 REL.

3.1.1 AXMEDIS Object loading

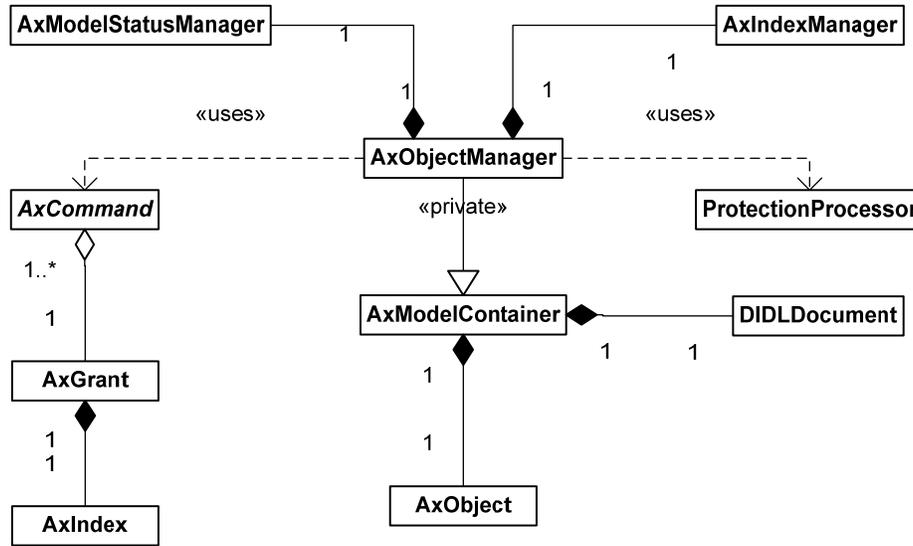
AXMEDIS Object Manager can be created for managing new and existing objects. In case of existing object they can be retrieved by means of different URIs. The supported protocols are:

- **File System:** *file://* protocol or a path can be used to locate an object to be loaded and manipulated via AXOM
- **HTTP download:** *http://* is used when AXMEDIS object have to be retrieved from the Web
- **FTP download:** *ftp://* is used when AXMEDIS object have to be retrieved by using File Transfer Protocol.
- **AXDB checkout:** a special database protocol as been defined with corresponding URI type. The syntax is *axdb://<user>:<passwd>@<host>:<port>/<endpoint>?axoid=<axoid>&ver=<version>*.

To save an AXMEDIS object or to upload on the AXDB specific command have been designed, for this actions are governed by DRM rules.

3.2 Module Design in terms of Classes

AxObjectManager class is composed and is hard linked to a range of classes that implements needed functionalities. Next Class Diagram shows relations between these classes. AxObjectManager is the core class, this class derives from AxModelContainer that offers functionalities to hold AxObjects and MPEG-21 elements. AxIndexManager is in charge to maintain indexing throughout the object model. AxCommand class and his derived children represent allowed commands exposed to the outer environment. AxModelStatusManager controls status of the elements locking and unlocking Objects



The AXMEDIS Object Manager architecture supports extensibility, new types of objects based on MPEG-21 model can be easily managed in MPEG-21 Object Model without changes in present structure. Moreover, only minor changes are needed to process content models that extend MPEG-21 or AXMEDIS elements definitions. Hooks to perform operations on content packages are provided by the upper level layer by means of AxObjectManager and AxCommand set.

These classes offer:

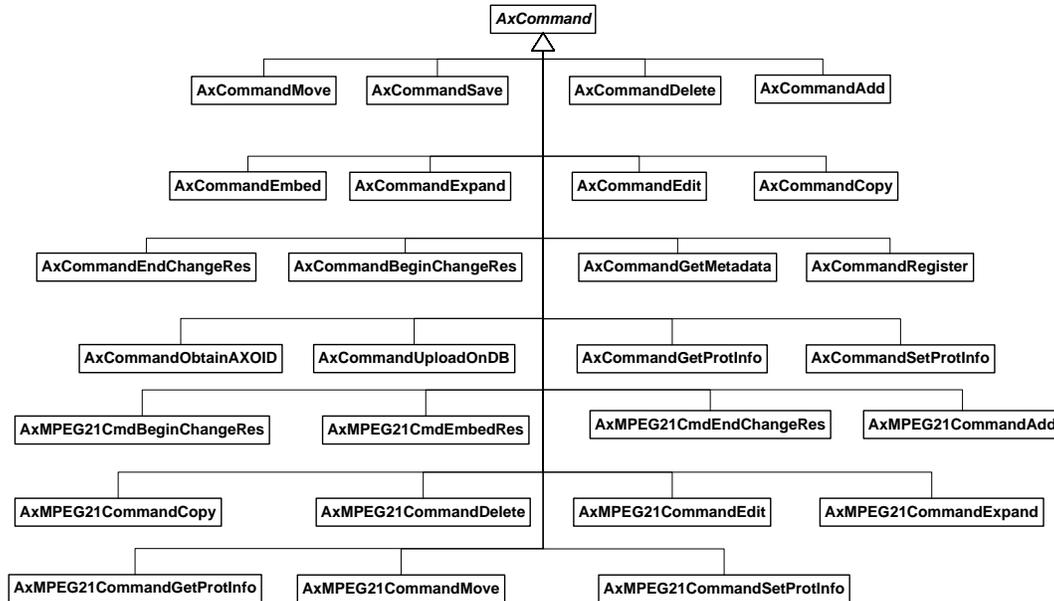
- a range of executable commands targeting the manipulation of both AXMEDIS and MPEG-21 object models,
- coordination of functionalities of lower levels modules to organize a reliable and protected execution flow.

The set of commands is easily extendable to manage future needs of upper level applications as shown in the sequel. Execution of defined commands is performed using class AxObjectManager as shown in the sequel

The “Command Pattern” has been applied to the design of AxObjectManager. The controller is the AxObjectManager which exposes the AXOM API. AxObjectManager is an intermediate layer between the application views and the object models (i.e., the object/package model with resources and descriptors). A view cannot directly manipulate the object model, while it has to issue commands to the AxObjectManager class. The latter is in charge of performing the requested actions on the model. Specifically, each conceivable command has been realized as a class which implements the interface AxCommand. It exposes two main methods: execute and getRequiredGrants. The execute method of AxCommand has to be implemented by each specialized class to actually perform the action on the object model. The command execution method is able to directly access to the data model without any restriction, since the command is executed only if the authorization is obtained. The getRequiredGrants method of AxCommand allows the verification of the requested grants. Thus, the AxObjectManager class is able to handle the request received by the user and the set of conceivable commands can be augmented without any impact on the current architecture.

AxObjectManager class has few control points and the code to verify the commands can be easily inserted in. Indeed AxObjectManager class is not in charge of verifying the grants, while it has been designed in order to provide hooks to easily create control mechanisms. The DRM enforcement is modeled by the declaration of the requested rights which has to be stated by each AxCommand inherited class. In fact, to each command is associated a list of AxGrant, which are the basic arguments for issuing the request to the authorization service. In this way, AxObjectManager is able to generically handle any request issued by the user, respecting governance, delegating authorization service the task of determining if the user has been authorized or not on the basis of the license.

Going deeply we can see how *AxCommand* class is used. From this class derives all allowed commands that could be requested to *AxObjectManager*. These commands share the common interface provided by *AxCommand*, featuring specific methods and data structures to accomplish their tasks.



A typical command will override *AxCommand::execute* method to implement the operation sequence needed to perform represented command task . Other accessory methods could be implemented in the derived command classes.

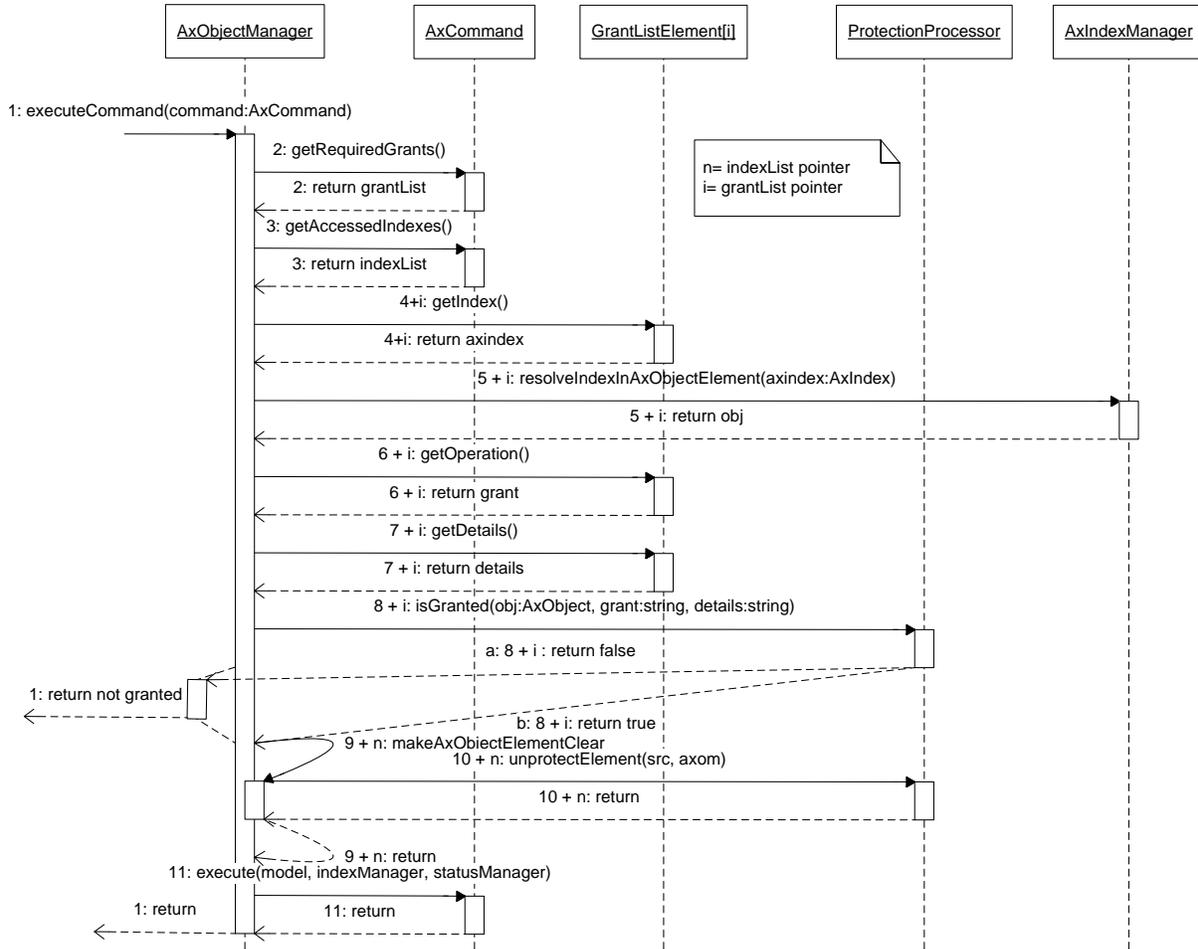
3.2.1 AxObjectManager Capabilities Overview

The *AxObjectManager* exposes functionalities for: creating new content; opening existing content by indicating a URI; browsing content structure; accessing metadata and resources embedded or referred to by the content; manipulating content structure, metadata and resources; saving the content; adding/modifying protection information associated to any content element.

The following pictures shows how the entire module works in terms of sequence diagrams. In the first picture an example of command execution is taken. The command , represented by *AxCommand* class, is passed at *AxObjectManager* by mean of *executeCommand* method.

Next operations involves :

- Getting all grants elements, maintained in *AxCommand*, for command execution
- Getting all indexes of model elements, maintained in *AxCommand*, to unprotect for command execution
- Checking all grants for command execution through *ProtectionProcessor*
- Unprotecting all elements needed for command execution
- Command execution.



By using model encapsulation, a good level of security has been achieved in terms of robustness against developer’s malicious content handling preventing direct manipulation from the views. Thus, views are not allowed to target content elements by using pointers. Command targets have to be indicated using logical references that prevent the access to the physical addresses referring to the digital resources. Thus, the view interacts with the model using instances of the class *AxIndex*. These are used like pointers, while they can be actually resolved only by the *AxObjectManager* which generated them.

The Command Pattern allows to easily extend the set of actions which AXOM is capable to execute (and control) The proposed solution has been designed to speed-up the creation of AXMEDIS-compliant tools, which can easily exploit the provided functionalities and can also extend the command set to their specific need. A custom new command can be defined by taking into account its fundamental aspects: authorization, un-protection and behavior implementation. By specializing from *AxCommand* class the custom command class presents *getRequiredGrants*, *getAccessedIndexes* and *execute* that have to be implemented according to the desired semantics and manipulation logic. The custom action commands classes have to define one or more constructors to give arguments to the manipulation (e.g., target elements) and to introduce specific methods in order to obtain back information after a performed execution.

An example of an extension set of manipulation commands could be one for resource processing. Let us consider a command for processing an image performing a mirror transformation (left to right) and replace the resource with the result of the processing. Command *AxCommandImageMirror* defines a constructor which accepts the target image as an argument. The constructor can be defined as *AxCommandImageMirror(AxIndex imageIndex)*.

The following pseudo-code provides an example about the definition of the command, including the declaration of the required rights and what has to be unprotected.

The method *execute()* sketching the command implementation is also reported.

Each proposed custom command has to be certified and approved to be compliant with the semantics of the rights. This means that the enforcement of the rights into the authoring and player tools has to be performed in accordance to a rights data dictionary – e.g., MPEG-21 RDD – and that defined by Mi3P.

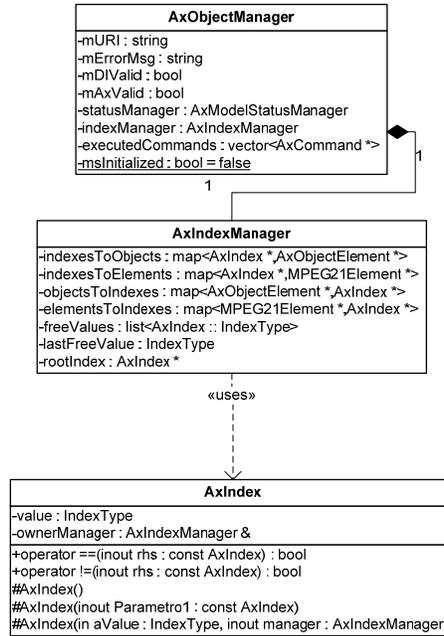
```
class AxCommandImageMirror : public AxCommand
{
private AxIndex targetIndex;
//constructor
AxCommandImageMirror(AxIndex imageIndex)
{
targetIndex = imageIndex;
}
//declaration of required granted rights the operation "modify" has to
// be authorized with details "apply mirror filter"
vector AxGrant getRequiredGrants()
{
return new vector { new AxGrant(targetIndex, "modify",
"apply mirror filter") };
}
//declaration of content elements to be unprotected
//only the target resource has to be unprotected
vector AxIndex getAccessedIndexes()
{
return new vector { targetIndex };
}
void execute(AxModelContainer model,
AxIndexManager indexManager, AxStatusManager s)
{
//since the model has been already unprotected it is possible to
//have direct access to the target resource (located by targetIndex)
AxResource res = (AxResource) indexManager.resolveIndex(targetIndex);
string mime = res.getMIMEType();
//processing
inputstream bytes = res.getAsset().getInputStream();
inputstream mirrorbytes = applyMirrorFilter(mime, bytes);
res.getAsset().setInputStream(mirrorbytes);
}
};
```

Please note that *targetIndex* is used to store the location of the target resource, which is set only at construction time. This index is returned as the unique “accessed index” of the grant authorization. The index is used at command execution time to retrieve the resource in the object model.

3.2.2 AxObjectManager as IndexManager

One of the main tasks AxObjectManager is responsible for is to give support to upper layer application for a direct, in terms of indirection, access to the element managed by AXOM. To maintain separation of the functionalities the class AxIndexManager has been designed to wrap indexing functionalities then any AxObjectManager includes an instance of this class.

AxIndexManager maintains two separated indexes tables: one that refers to MPEG-21 hierarchy and the other refers to AxObjects hierarchy. Another class designed to implement indexing functionalities is AxIndex, representing instances of a single index and used in AxIndexManager as key for indexes tables.

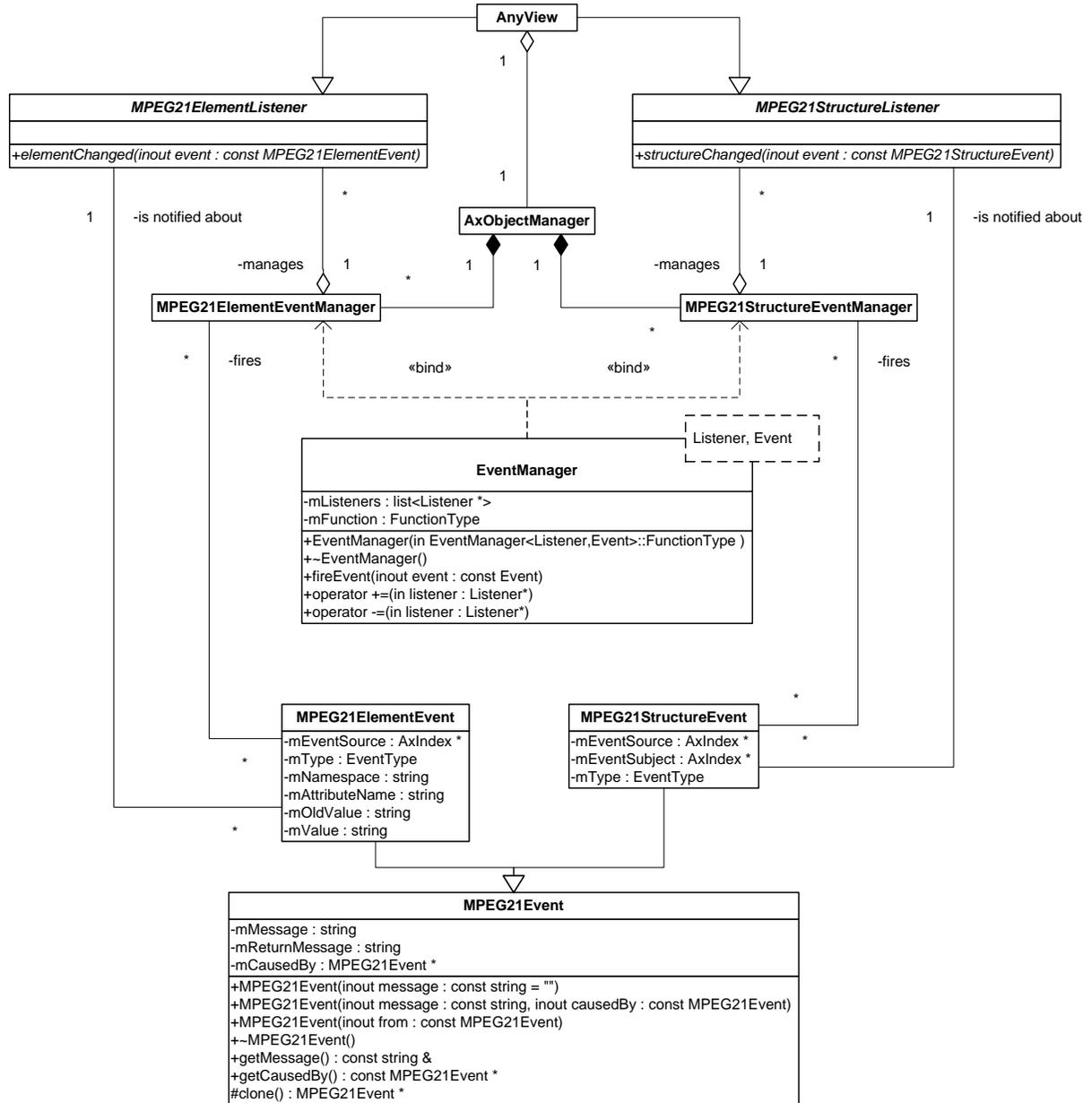


As shown in the class diagram AxIndexManager declares four private maps structure among its own structure. These maps establish legacy among objects and indexes and indexes and objects. Direct access to maps structures is hidden by the implementation through AxObjectManager and AxIndexManager avoiding direct access to referred objects and elements.

3.2.3 AxObjectManager as EventManager

The observer pattern has been implemented in the AxObjectManager (is not the sole case). In the following diagram the main relationships among classes which build the event-driven enabling infrastructure.

The fundamental class is EventManager, since it implements management of event listener once for all in a general manner. In fact it models in a template the common functionality of storing a list of event listeners and firing a certain event on all of them. This template can model, as depicted in the diagram, all the listener/event types.



Please note that MPEG21ElementEvent and MPEG21StructureEvent are examples of the event nature that can be model and it is effectively implemented by AxObjectManager. With this feature AxObjectManager can accept the registration of classes which are conformant to the listener for the event that can be fired. Event are modelled by the following classes:

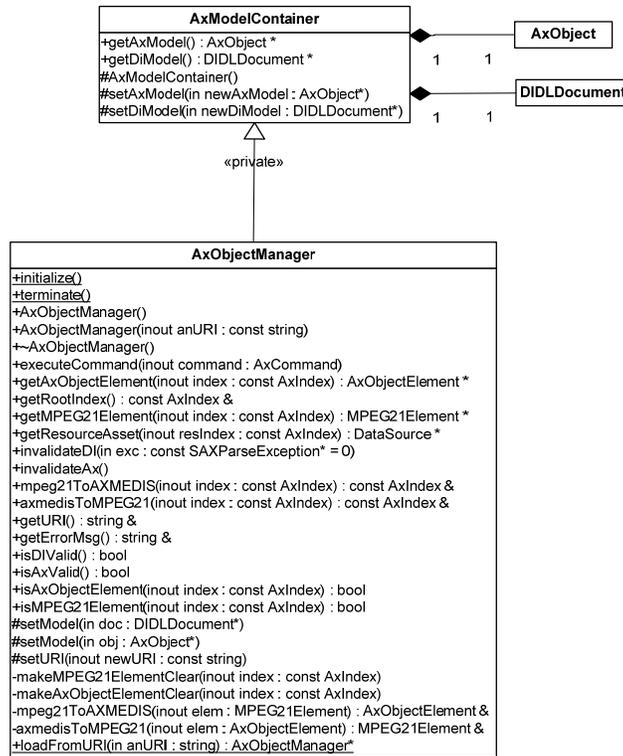
- MPEG21Event;
 - MPEG21ElementEvent: it models a change which has occurred in an MPEG21Element element (e.g. attributes, text);
 - MPEG21StructureEvent: it models a change occurred in the sub-tree starting from a certain MPEG21Element (e.g. a child has been added/removed);
- AxObjectEvent
 - AxObjectElementEvent: it is similar to that defined for MPEG21, while it targets an AxObjectElement
- AxObjectStructureEvent: it is similar to that defined for MPEG21, while it targets an AxObjectElement

A view has to implement a specific method defined by the listener class and it has to register itself to AxObjectManager in order to react to specific changes of the underlying content model.

3.2.4 Class Methods Overview

AxObjectManager - AxModelContainer

Core class of this module, expose methods to interface outer applications to inner classes of the module. As exposed in previous parts of this specification through AxObjectManager ,AxIndexManager, AxCommand and AxModelStatusManager are accessed.



AxObjectManager – Class methods

AxObjectManager -AxObjectManager(const string anURI) - ~AxObjectManager

Class constructor and destructor.

AxObjectManager constructors acts in a two way behaviour. If a class user wants to create a new manager for a target existing AXMEDIS or DIDL object , an input URI string has to be specified in order to retrieve it. Elsewhere a new empty clear object is created along with AxObjectManager new instance.

Initialize – terminate

These two static methods setup and dismiss all needed information and data structures in order to allow usage of AxObjectManager and linked modules. Initialize has to be called as first step when an application has to use Axmedis Object Model or MPEG-21 object model.in any way. Multiple calls of initialize don't cause changes in initialized items. Terminate has to be called whenever an application stops using Axmedis Object Model and MPEG-21 Object Model

executeCommand

Performs operations to allow execution of the input AxCommand., then execute the command

getAxObjectElement – getMPEG21Element - getResourceAsset

Interface to AxIndexManager. Retrieves element related to input AxIndex . Search path is chosen in AxObject or DIDLDocument trees respectively. It returns a clone of the encapsulated object, it has to be destroyed by client code.
getRootIndex
Return index of the root element of AxIndexManager. This index points both AxObject and DIDLDocument roots
invalidateDI, invalidateAX
Make Digital Item tree or AxObject tree invalid
mpeg21ToAXMEDIS – axmedisToMPEG21
Convert MPEG21 element to AxObject element and vice versa. Return index of the converted element
getURI – setURI
Returns an set URI for the manager
isDIValid – isAxValid
Check validity status of the models
isMPEG21Element – isAxObjectElement
Checks if the given index refers an MPEG21Element or an AxObjectElement respectively
setModel
Sets the model root index in AxIndexManager
makeMPEG21ElementClear – makeAxObjectElementClear
Unprotect referred elements through the use of ProtectionProcessor
loadFromURI
a static methods for loading objects from multiple URI has been provided, in order to avoid a constructor which can fail. By calling this static method a pointer to AxObjectManager ready to managed the loaded document.

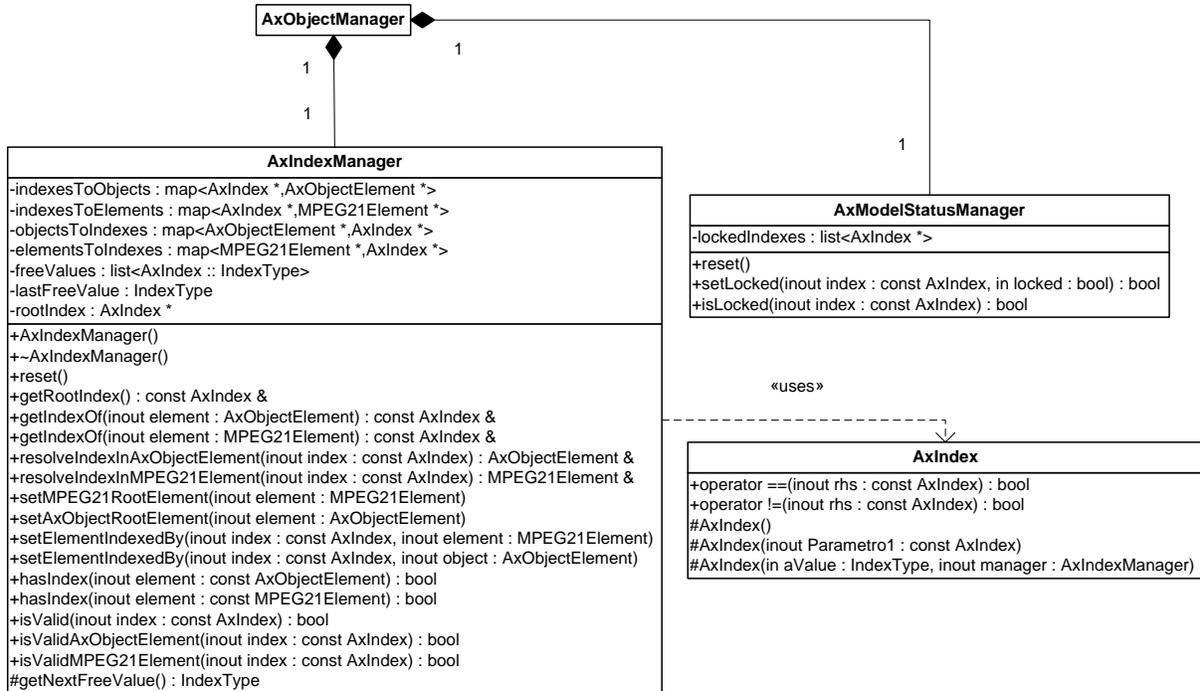
AxModelContainer – Class methods

AxModelContainer
Class constructor
getAxModel – getDIModel
Returns AxModel and DIDLDocument root pointers
setAxModel – setDIModel
Sets AxModel root and DIDLDocument root

AxIndexManager – AxIndex - AxModelStatusManager

These classes support AxObjectManager. AxIndexManager is demanded to manage access to data models maintaining indexes for all the elements. The class maintains two different indexes, one for MPEG21Elements and the other for AxObjectElements.

AxModelStatusManager provide functionalities to control the status of the model.



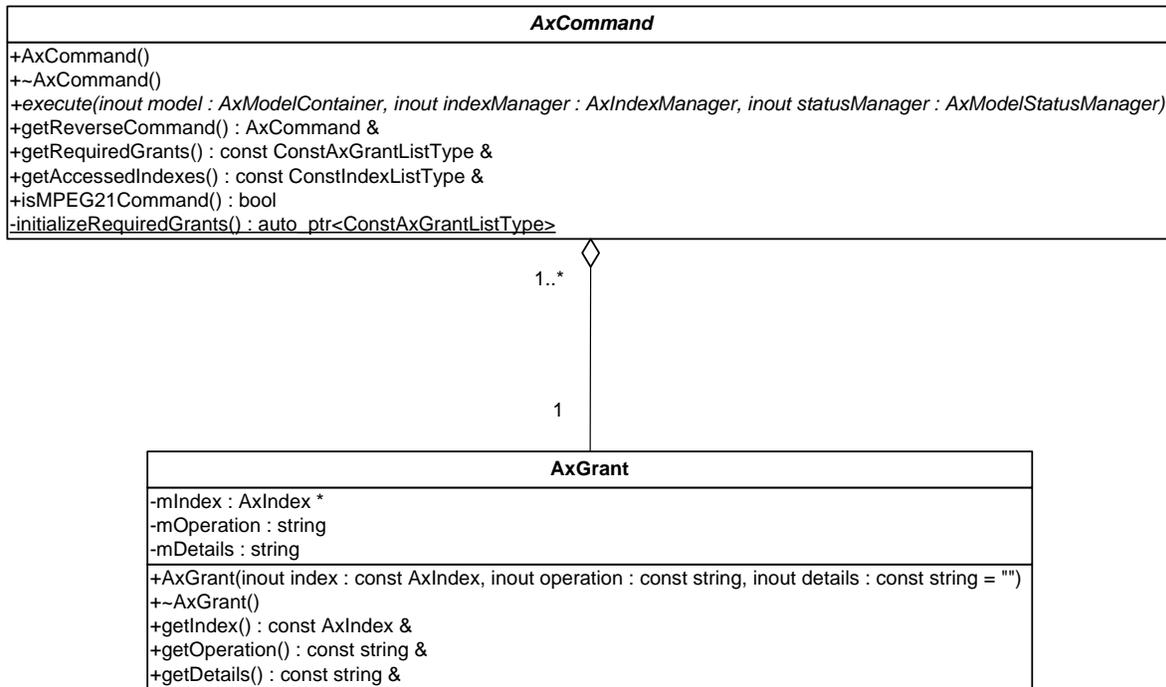
AxIndex Manager – Class methods
AxIndexManager - ~AxIndexManager
Class constructor and destructor
reset
Reset all the element index to an empty value. Delete all AxIndex elements in the index
getRootIndex
Return index of the root element of AxIndexManager.
getIndexOf
Get the AxIndex of input element.
resolveIndexInAxObjectElement – resolveIndexInMPEG21Element
Return element associated with input AxIndex
setMPEG21RootElement – setAxObjectRootElement
Sets root for MPEG21Element index and AxObjectElement index
setElementIndexedBy
Add a new entry in one of two indexes chosen by input element
hasIndex
Checks if the given element has an associated AxIndex
isValid – isValidAxObjectElement – isValidMPEG21Element
Check validity status of the element
getNextFreeValue
Returns next AxIndex number free from element associations

AxIndex– Class methods
AxIndex
Class constructor
operator ==
Checks if two AxIndex are equal
operator !=
Checks if two AxIndex are different

AxModelStatusManager– Class methods
reset
Reset the class to initial state cleaning all locked indexes
setLocked
Lock target element
isLocked
Checks if target element is locked

AxCommand – AxGrant

These classes support commands definitions and execution. AxCommand represent the common interface for all the command defined for the models. AxGrant models grants required for command executions. These grants will be checked by Protection Processor (see DE- 3-1-2-2-3- ProtectionProcessor) .



AxCommand – Class methods
AxCommand - ~AxCommand
Class constructor and destructor
execute
Execute the command in environment defined by input model, indexMannager, statusManager
getReverseCommand
Return the reverse version of this command if a reverse command is supported by the command itself
getRequiredGrants
Returns a list of grants needed for the execution of this command.
getAccessedIndexes
Return a list of AxIndex that refers to all the elements used by the execution of this command
isMPEG21Command
Checksif the command operates on an MPEG21Element

initializeRequiredGrants
Initialize the grant list for the command

AxGrant – Class methods
AxGrant - ~AxGrant
Class constructor and destructor
getIndex – getOperation –getDetails
Returns index , operation name and details for the grant

AxCommands

A list of all implemented command classes is now showed

AxCommandAdd: add a new AxObject to the tree. The object which is passed as an argument to the addition is cloned with deep option set to true.

AxCommandAdd
+execute(inout model : AxModelContainer, inout indexManager : AxIndexManager, inout statusManager : AxModelStatusManager)
+AxCommandAdd(inout theNewElement : AxObjectElement, inout theParentIndex : const AxIndex)
+AxCommandAdd(inout theNewElement : AxObjectElement, inout theParentIndex : const AxIndex, inout theReferenceIndex : const AxIndex, in insertbefore : bool)
+getIndexOfAddedElement() : const AxIndex &
+getRequiredGrants() : constConstAxGrantListType&

AxCommandAdd – Class methods
AxCommandAdd - ~AxCommandAdd
Class constructor and destructor
Execute
Execute the command in environment defined by input model, indexMannager, statusManager
getIndexeOfAddedElement
Return the index of added element
getRequiredGrants
Return grants needed to command execution

AxCommandBeginChangeRes: Change the AxResource content. This command returns an output stream where the modified resource can be written. The action has to be finalized with AxCommandEndChangeRes.

AxCommandBeginChangeRes
+execute(inout model : AxModelContainer, inout indexManager : AxIndexManager, inout statusManager : AxModelStatusManager)
+AxCommandBeginChangeRes(inout contentContainerIndex : const AxIndex)
+~AxCommandBeginChangeRes()
+getOutputStream() : ostream &
+getRequiredGrants() : constConstAxGrantListType&

AxCommandBeginChangeRes– Class methods
AxCommandBeginChangeRes - ~AxCommandBeginChangeRes
Class constructor and destructor
Execute
Execute the command in environment defined by input model, indexMannager, statusManager
getOuputStream
Return the output stream of Resource to be changed
getRequiredGrants
Return grants needed to command execution

AxCommandCopy: copy a target AxObject element to a destination

AxMPEG21CommandCopy
+execute(inout model : AxModelContainer, inout indexManager : AxIndexManager, inout statusManager : AxModelStatusManager)
+AxMPEG21CommandCopy(inout theSourceIndex : const AxIndex, inout theDestParentIndex : const AxIndex)
+getNewElementIndex() : const AxIndex &
+getRequiredGrants() : constConstAxGrantListType &

AxCommandCopy – Class methods
AxCommandCopy - ~AxCommandCopy
Class constructor and destructor
Execute
Execute the command in environment defined by input model, indexMannager, statusManager
getNewElementIndex
Return the index of new element
getRequiredGrants
Return grants needed to command execution

AxCommandDelete: delete a target AxObject element

AxCommandDelete
+execute(inout model : AxModelContainer, inout indexManager : AxIndexManager, inout statusManager : AxModelStatusManager)
+AxCommandDelete(inout toDeleteIndex : const AxIndex)
+getRequiredGrants() : constConstAxGrantListType&

AxCommandDelete – Class methods
AxCommandDelete
Class constructor
execute
Execute the command in environment defined by input model, indexMannager, statusManager
getRequiredGrants
Return grants needed to command execution

AxCommandEdit: edit an element of the AxObject, this command can be used to modify the attribute of any element in the AxObject (e.g. to modify the mime-type of a resource).

AxCommandEdit
+execute(inout model : AxModelContainer, inout indexManager : AxIndexManager, inout statusManager : AxModelStatusManager)
+AxCommandEdit(inout theEditIndex : const AxIndex, inout theDataElement : AxObjectElement)
+getRequiredGrants() : constConstAxGrantListType&

AxCommandEdit – Class methods
AxCommandEdit
Class constructor
execute
Execute the command in environment defined by input model, indexMannager, statusManager
getRequiredGrants
Return grants needed to command execution

AxCommandEmbed: embed a new asset in an AxResource. Similar to the command for changing a resource, this command modify at once all the resource asset. The main difference is that allows to pass an input stream where the command will extract the content.

AxCommandEmbed
+execute(inout model : AxModelContainer, inout indexManager : AxIndexManager, inout statusManager : AxModelStatusManager)
+AxCommandEmbed(inout axResourceIndex : const AxIndex, inout assetFileName : const string)
+AxCommandEmbed(inout axResourceIndex : const AxIndex, inout assetStream : istream)
+~AxCommandEmbed()
+getRequiredGrants() : constConstAxGrantListType&

AxCommandEmbed – Class methods
AxCommandEmbed - ~AxCommandEmbed
Class constructor and destructor
execute
Execute the command in environment defined by input model, indexMannager, statusManager
getRequiredGrants
Return grants needed to command execution

AxCommandEndChangeRes: terminate an AxResource change operation. Finalize the changes of a given resource. It has to be call when a resource modification process (beginning with a AxCommandEndChangeRes) is terminates. After its execution the new resource will be embedded as an asset.

AxCommandEndChangeRes
+execute(inout model : AxModelContainer, inout indexManager : AxIndexManager, inout statusManager : AxModelStatusManager)
+AxCommandEndChangeRes(inout contentContainerIndex : const AxIndex)
+~AxCommandEndChangeRes()
+getRequiredGrants() : constConstAxGrantListType&

AxCommandEndChangeRes – Class methods
AxCommandEndChangeRes - ~AxCommandEndChangeRes
Class constructor and destructor
execute
Execute the command in environment defined by input model, indexMannager, statusManager
getRequiredGrants
Return grants needed to command execution

AxCommandExpand: Returns indexes of target element’s children. This command is used to browse the AxObject level by level.

AxCommandExpand
+execute(inout model : AxModelContainer, inout indexManager : AxIndexManager, inout statusManager : AxModelStatusManager)
+AxCommandExpand(inout expandIndex : const AxIndex)
+~AxCommandExpand()
+getChildrenIndexes() : const vector<AxIndex *> &
+getRequiredGrants() : constConstAxGrantListType&

AxCommandExpand – Class methods
AxCommandExpand - ~AxCommandExpand
Class constructor and destructor
execute
Execute the command in environment defined by input model, indexMannager, statusManager
getChildrenIndexes
Return indexes to children of expanded node
getRequiredGrants
Return grants needed to command execution

AxCommandGetMetadata: return metadata indexes. This command is used to obtain the list of metadata, which are associated to a given AxObject.

AxCommandGetMetadata
+execute(inout model : AxModelContainer, inout indexManager : AxIndexManager, inout statusManager : AxModelStatusManager)
+AxCommandGetMetadata(inout getMetadataIndex : const AxIndex, inout ns : const string = "")
+~AxCommandGetMetadata()
+getMetadataIndexes() : const vector<AxIndex *> &
+getRequiredGrants() : constConstAxGrantListType&

AxCommandGetMetadata – Class methods

AxCommandGetMetadata - ~AxCommandGetMetadata

Class constructor and destructor

execute

Execute the command in environment defined by input model, indexMannager, statusManager

getMetadataIndexes

Return the indexes of retrived metadata

getRequiredGrants

Return grants needed to command execution

AxCommandGetProtInfo: returns Protection Information for target AxObject

AxCommandGetProtInfo

```
+execute(inout model : AxModelContainer, inout indexManager : AxIndexManager, inout statusManager : AxModelStatusManager)
+AxCommandGetProtInfo(inout index : const AxIndex)
+~AxCommandGetProtInfo()
+getToolList() : const ConstToolListType &
+getRequiredGrants() : constConstAxGrantListType&
```

AxCommandGetProtInfo – Class methods

AxCommandGetProtInfo - ~AxCommandGetProtInfo

Class constructor and destructor

execute

Execute the command in environment defined by input model, indexMannager, statusManager

getToolList

Return a list ot tool types used to process element’s protection information

getRequiredGrants

Return grants needed to command execution

AxCommandMove: Move an AxObject element to a destination

AxCommandMove

```
+execute(inout model : AxModelContainer, inout indexManager : AxIndexManager, inout statusManager : AxModelStatusManager)
+AxCommandMove(inout theSourceIndex : const AxIndex, inout theDestParentIndex : const AxIndex)
+AxCommandMove(inout theSourceIndex : const AxIndex, inout theDestParentIndex : const AxIndex, inout theDestRefIndex : const AxIndex, in beforeafter : bool)
+getRequiredGrants() : constConstAxGrantListType&
```

AxCommandMove – Class methods

AxCommandMove - ~AxCommandMove

Class constructor and destructor

execute

Execute the command in environment defined by input model, indexMannager, statusManager

getRequiredGrants

Return grants needed to command execution

AxCommandObtainAxoid: It contact the suitable service in orded to obtain an AXOID. Inthis way it can be uniquely identified in the AXMEDIS. This is a mandatory step before the publication/distribution.

AxCommandObtainAXOID

```
+execute(inout model : AxModelContainer, inout indexManager : AxIndexManager, inout statusManager : AxModelStatusManager)
+AxCommandObtainAXOID(inout index : const AxIndex)
+~AxCommandObtainAXOID()
+getAXOID() : const string &
+getRequiredGrants() : constConstAxGrantListType&
```

AxCommandObtainAXOID – Class methods

AxCommandObtainAXOID - ~AxCommandObtainAXOID

Class constructor and destructor

execute
Execute the command in environment defined by input model, indexMannager, statusManager
getAXOID
Return Axmedis Object ID (AXOID)
getRequiredGrants
Return grants needed to command execution

AxCommandRegister: Register the object. This is a mandatory step before the publication/distribution.

AxCommandRegister
+execute(inout model : AxModelContainer, inout indexManager : AxIndexManager, inout statusManager : AxModelStatusManager)
+AxCommandRegister()
+~AxCommandRegister()
+getRequiredGrants() : constConstAxGrantListType&

AxCommandRegister – Class methods

AxCommandRegister - ~AxCommandRegister
Class constructor and destructor
execute
Execute the command in environment defined by input model, indexMannager, statusManager
getRequiredGrants
Return grants needed to command execution

AxCommandSave: save the object in a output file

AxCommandSave
+execute(inout model : AxModelContainer, inout indexManager : AxIndexManager, inout statusManager : AxModelStatusManager)
+AxCommandSave(inout destFileName : const string = "")
+getState() : SaveStateType
+getMessage() : const string &
-generateTmpFileName() : string
+getRequiredGrants() : constConstAxGrantListType&

AxCommandSave – Class methods

AxCommandSave
Class constructor
execute
Execute the command in environment defined by input model, indexMannager, statusManager
getState
Return state of saving process
getMessage
Return information about command execution errors
getRequiredGrants
Return grants needed to command execution

AxCommandSetProtInfo: set protection info for the object

AxCommandSetProtInfo
+execute(inout model : AxModelContainer, inout indexManager : AxIndexManager, inout statusManager : AxModelStatusManager)
+AxCommandSetProtInfo(inout ttp : const AxIndex, inout tools : const ConstToolListType)
+~AxCommandSetProtInfo()
+getRequiredGrants() : constConstAxGrantListType&

AxCommandSetProtInfo – Class methods
AxCommandSetProtInfo - ~AxCommandSetProtInfo
Class constructor and destructor
execute
Execute the command in environment defined by input model, indexMannager, statusManager
getRequiredGrants
Return grants needed to command execution

AxCommandUploadOnDB: save the object in a AXDB

AxCommandUploadOnDB
+execute(inout model : AxModelContainer, inout indexManager : AxIndexManager, inout statusManager : AxModelStatusManager)
+AxCommandUploadOnDB()
+AxCommandUploadOnDB(in saverEndPoint : string, in ftpPath : string, in user : string, in passwd : string)
+getState() : UploadStateType
+getMessage() : const string &
+getRequiredGrants() : constConstAxGrantListType&

AxCommandUploadOnDB– Class methods
AxCommandUploadOnDB
Class constructor and destructor
execute
Execute the command in environment defined by input model, indexMannager, statusManager
getState
Return state of saving process
getMessage
Return information about command execution errors
getRequiredGrants
Return grants needed to command execution

Note: the default constructor will target the “default database” (location will be retrieved by the current configuration). If the extended constructor will be used, the target database is located by the proper information.

AxMPEG21CmdBeginChangeRes: Changes a Resource asset in the MPEG-21 DI. See corresponding command on the AXMEDIS Object.

AxMPEG21CmdBeginChangeRes
+execute(inout model : AxModelContainer, inout indexManager : AxIndexManager, inout statusManager : AxModelStatusManager)
+AxMPEG21CmdBeginChangeRes(inout contentContainerIndex : const AxIndex)
+~AxMPEG21CmdBeginChangeRes()
+getOutputStream() : ostream &
+getRequiredGrants() : const ConstAxGrantListType &

AxMPEG21CmdBeginChangeRes – Class methods
AxMPEG21CmdBeginChangeRes - ~AxMPEG21CmdBeginChangeRes
Class constructor and destructor
execute
Execute the command in environment defined by input model, indexMannager, statusManager
getOutputStream
Return output stream related to new Resource
getRequiredGrants
Return grants needed to command execution

AxMPEG21CmdEmbedRes: load resource asset content in an MPEG-21 DI

AxMPEG21CmdEmbedRes
+execute(inout model : AxModelContainer, inout indexManager : AxIndexManager, inout statusManager : AxModelStatusManager)
+AxMPEG21CmdEmbedRes(inout contentContainerIndex : const AxIndex, inout streamToBeEmbedded : istream)
+~AxMPEG21CmdEmbedRes()
+getRequiredGrants() : const ConstAxGrantListType &

AxMPEG21CmdEmbedRes – Class methods

AxMPEG21CmdEmbedRes - ~AxMPEG21CmdEmbedRes

Class constructor and destructor

Execute

Execute the command in environment defined by input model, indexMannager, statusManager

getIndexeOfAddedElement

Return the index of added element

AxMPEG21CmdEndChangeRes: End changes of the resource. To be called at the end of a Resource editing which has been started by AxMPEG21CmdBeginChangeRes.

AxMPEG21CmdEndChangeRes
+execute(inout model : AxModelContainer, inout indexManager : AxIndexManager, inout statusManager : AxModelStatusManager)
+AxMPEG21CmdEndChangeRes(inout contentContainerIndex : const AxIndex)
+~AxMPEG21CmdEndChangeRes()
+getRequiredGrants() : const ConstAxGrantListType &

AxCmdEndChangeRes – Class methods

AxMPEG21CmdEndChangeRes - ~AxMPEG21CmdEndChangeRes

Class constructor and destructor

execute

Execute the command in environment defined by input model, indexMannager, statusManager

getRequiredGrants

Return grants needed to command execution

AxMPEG21CommandAdd: add a target MPEG-21 element to an MPEG-21 DI

AxMPEG21CommandAdd
+execute(inout model : AxModelContainer, inout indexManager : AxIndexManager, inout statusManager : AxModelStatusManager)
+AxMPEG21CommandAdd(inout theNewElement : MPEG21Element, inout theParentIndex : const AxIndex)
+AxMPEG21CommandAdd(inout theNewElement : MPEG21Element, inout theParentIndex : const AxIndex, inout theReferencelIndex : const AxIndex, in beforeafter : bool)
+getIndexOfAddedElement() : const AxIndex &
+getRequiredGrants() : constConstAxGrantListType &

AxMPEG21CommandAdd – Class methods

AxMPEG21CommandAdd - ~AxMPEG21CommandAdd

Class constructor and destructor

execute

Execute the command in environment defined by input model, indexMannager, statusManager

getIndexeOfAddedElement

Return the index of added element

getRequiredGrants

Return grants needed to command execution

AxMPEG21CommandCopy: Copy target MPEG-21 Element

AxMPEG21CommandCopy
+execute(inout model : AxModelContainer, inout indexManager : AxIndexManager, inout statusManager : AxModelStatusManager)
+AxMPEG21CommandCopy(inout theSourceIndex : const AxIndex, inout theDestParentIndex : const AxIndex)
+getNewElementIndex() : const AxIndex &
+getRequiredGrants() : constConstAxGrantListType &

AxMPEG21CommandCopy – Class methods

AxMPEG21CommandCopy - ~AxMPEG21CommandCopy

Class constructor and destructor
execute
Execute the command in environment defined by input model, indexMannager, statusManager
getNewElementIndex
Return the index of copy element
getRequiredGrants
Return grants needed to command execution

AxMPEG21CommandDelete: Delete target MPEG-21 Element

AxMPEG21CommandDelete
+execute(inout model : AxModelContainer, inout indexManager : AxIndexManager, inout statusManager : AxModelStatusManager)
+AxMPEG21CommandDelete(inout toDeleteIndex : const AxIndex)
+getRequiredGrants() : constConstAxGrantListType &

AxMPEG21CommandDelete – Class methods

AxMPEG21CommandDelete
Class constructor
execute
Execute the command in environment defined by input model, indexMannager, statusManager
getRequiredGrants
Return grants needed to command execution

AxMPEG21CommandEdit: Edit target MPEG-21 Element. It changes the attribute of the element with no impact on the structure.

AxMPEG21CommandEdit
+execute(inout model : AxModelContainer, inout indexManager : AxIndexManager, inout statusManager : AxModelStatusManager)
+AxMPEG21CommandEdit(inout theEditIndex : const AxIndex, inout theDataElement : const MPEG21Element)
+getRequiredGrants() : constConstAxGrantListType &

AxMPEG21CommandEdit – Class methods

AxMPEG21CommandEdit
Class constructor
execute
Execute the command in environment defined by input model, indexMannager, statusManager
getRequiredGrants
Return grants needed to command execution

AxMPEG21CommandExpand: Return indexes of target element’s children

AxMPEG21CommandExpand
+execute(inout model : AxModelContainer, inout indexManager : AxIndexManager, inout statusManager : AxModelStatusManager)
+AxMPEG21CommandExpand(inout expandIndex : const AxIndex)
+~AxMPEG21CommandExpand()
+getChildrenIndexes() : const vector<AxIndex *> &
+getRequiredGrants() : constConstAxGrantListType &

AxMPEG21CommandExpand – Class methods

AxMPEG21CommandExpand- ~ AxMPEG21CommandExpand
Class constructor and destructor
execute
Execute the command in environment defined by input model, indexMannager, statusManager
getChildrenIndexes
Return indexes to children of expanded node
getRequiredGrants
Return grants needed to command execution

AxMPEG21CommandGetProtInfo: Returns protection info for target MPEG-21 element

AxMPEG21CommandGetProtInfo
+execute(inout model : AxModelContainer, inout indexManager : AxIndexManager, inout statusManager : AxModelStatusManager)
+AxMPEG21CommandGetProtInfo(inout index : const AxIndex)
+~AxMPEG21CommandGetProtInfo()
+getToolList() : const ConstToolListType &
+getRequiredGrants() : constConstAxGrantListType &

AxMPEG21CommandGetProtInfo – Class methods

AxMPEG21CommandGetProtInfo - ~AxMPEG21CommandGetProtInfo
Class constructor and destructor
execute
Execute the command in environment defined by input model, indexMannager, statusManager
getToolList
Return a list of tool types used to process element’s protection information
getRequiredGrants
Return grants needed to command execution

AxMPEG21CommandMove: Move target MPEG-21 element to destination

AxMPEG21CommandMove
+execute(inout model : AxModelContainer, inout indexManager : AxIndexManager, inout statusManager : AxModelStatusManager)
+AxMPEG21CommandMove(inout theSourceIndex : const AxIndex, inout theDestParentIndex : const AxIndex)
+AxMPEG21CommandMove(inout theSourceIndex : const AxIndex, inout theDestParentIndex : const AxIndex, inout theDestRefIndex : const AxIndex, in beforeafter : bool)
+getRequiredGrants() : constConstAxGrantListType &

AxMPEG21CommandMove – Class methods

AxMPEG21CommandMove - ~AxMPEG21CommandMove
Class constructor and destructor
Execute
Execute the command in environment defined by input model, indexMannager, statusManager
getRequiredGrants
Return grants needed to command execution

AxMPEG21CommandSetProtInfo: Set protection informations for MPEG-21 target element

AxMPEG21CommandSetProtInfo
+execute(inout model : AxModelContainer, inout indexManager : AxIndexManager, inout statusManager : AxModelStatusManager)
+AxMPEG21CommandSetProtInfo(inout ttp : const AxIndex, inout tools : const ConstToolListType)
+~AxMPEG21CommandSetProtInfo()
+getRequiredGrants() : constConstAxGrantListType&

AxMPEG21CommandSetProtInfo – Class methods

AxMPEG21CommandSetProtInfo - ~AxMPEG21CommandSetProtInfo
Class constructor and destructor
Execute
Execute the command in environment defined by input model, indexMannager, statusManager
getRequiredGrants
Return grants needed to command execution

3.3 Examples of usage

In the following, a subset of the commands which are at disposal in the AXOM is presented. Each command models a specific manipulation on the content package. The important aspects of each class, inherited by *AxCommand*, are the constructors, which are needed for setting the operation parameters, and additional methods defined in order to get the execution results. The results typically may contain additional information not directly accessible in the modified package.

- *AxCommandAdd*– this command class has been defined to add *AxObject* elements. It presents constructors to impose the entry point of the addition: *AxCommandAdd(AxObjectElement newElement, AxIndex parentIndex)* to add an element at the end of the list of descriptors or components; *AxCommandAdd(AxObjectElement newElement, AxIndex parentIndex, AxIndex referenceIndex, bool insertBefore)* to insert a new content element before or after a given element in the list *AxIndex getIndexOfAddedElement()* to obtain after the execution the logical reference of an added new element
- *AxCommandDelete* – command class defined to reduce the content package by deleting descriptions, digital resources or inner packages. A constructor is needed in order to select the target element to be removed: *AxCommandDelete(AxIndex deleteIndex)*
- *AxCommandEdit* – command class defined to edit the attributes included in the content elements of the package: *AxCommandEdit(AxObjectElement dataElement, AxIndex editIndex)* change the attributes of the target element by copying them from *dataElement*;

The usage of AXOM functionalities is quite simple. For the manipulation of content package the creation of a new command and its execution are needed. The AXOM is responsible of providing indexes for the root level or for any sub-tree of the package hierarchy.

In the following a simplified version of AXOM usage is reported by using a pseudo-code and adding comments, this highlight the semantic meaning of the performed actions.

```
// creating a manager to manipulate a new AXMEDIS object
AxObjectManager myEmptyObject = new AxObjectManager();
// creating a resource element targeting to a digital resource URL (a jpeg image)
AxResource myDigitalRes = new AxResource();
myDigitalRes.load("bar.jpg");
// performing the addition of the created resource in the empty object
// step1: creation of the suitable command object
AxCommandAdd addCmd = new AxCommandAdd(myDigitalRes, myEmptyObject.getRootIndex());
// step2: execution of the command
myEmptyObject.executeCommand(addCmd);
// step3: (optional) gathering of the results: the index of the added element
AxIndex addedResIndex = addCmd.getIndexOfAddedElement();
```

The usage of the AXOM hides the DRM verification of grants which can be needed to authorize the manipulations. The AXOM is capable of controlling the execution of the above mentioned commands, delegating to them the specification of the grants needed and the accesses to the content elements. On the other hand, only the AXOM can (i) request the grant authorization from the Authorization Service, and can (ii) unprotect the content package.

It is important to specify that any operation call in *AxObjectManager* requires the class initialized. Two static methods, *initialize* and *terminate*, have to be called at the start and at the end of any chunk of code that involve use of *AxObjectManager*. Classes initialized by this methods are lower model static factories, loaders and writers.(see DE-3-1-2-2-3)

```
AxObjectManager::initialize();
...Any Code...
AxObjectManager::terminate();
```

This chunk of code shows an example of *Object Manager's* command execution.. We suppose that *initialize* is already executed.

```

AXObjectManager myAXOM;
//build a new object
AXObject *myObject=new AXObject;
myObject->setContentID("example_object_id");
AxmlMetadata *myMetadata = new AxmlMetadata();
myMetadata->setMetadataID("example_metadata");
myObject->addMetadata(myMetadata);
//build a command to add the object
AxmlCommandAdd *myCommand=new AxmlCommandAdd(*myObject,myAXOM.getRootIndex());
myAXOM.executeCommand(*myCommand);
AXObject *theSameObject =
    dynamic_cast<AXObject *> (myAXOM.getAxmlObjectElement(myCommand->getIndexofAddedElement()));
delete theSameObject;
//build a new resource
AxmlResource *myResource=new AxmlResource();
myResource->setMimeType("video/mp4");
myResource->setRef("http://myvideos.com/test.mp4");
myResource->setContentID("mp4");
//build a command to add the resource before the object
AxmlCommandAdd* cmdAddResource=new AxmlCommandAdd(*myResource, myAXOM.getRootIndex());
myAXOM.executeCommand(*cmdAddResource);
AxmlResource *theSameResource =
    dynamic_cast<AxmlResource *> (myAXOM.getAxmlObjectElement(cmdAddResource->getIndexofAddedElement()));
delete theSameResource;
AXObject *theObject = dynamic_cast<AXObject *> (myAXOM.getAxmlObjectElement(myAXOM.getRootIndex()));
AxmlCommandExpand *checkExpand = new AxmlCommandExpand(myAXOM.getRootIndex());
myAXOM.executeCommand(*checkExpand);
AxmlResource *againResource =
    dynamic_cast<AxmlResource *> (myAXOM.getAxmlObjectElement(* (checkExpand->getChildrenIndexes() [1])));
delete againResource;
AxmlCommandDelete* cmdDelete=new AxmlCommandDelete(cmdAddResource->getIndexofAddedElement());
myAXOM.executeCommand(*cmdDelete);
theObject = dynamic_cast<AXObject *> (myAXOM.getAxmlObjectElement(myAXOM.getRootIndex()));
delete theObject;
AxmlCommandExpand *checkExpand2 = new AxmlCommandExpand(myAXOM.getRootIndex());
myAXOM.executeCommand(*checkExpand2);
theObject = dynamic_cast<AXObject *> (myAXOM.getAxmlObjectElement(* (checkExpand2->getChildrenIndexes() [0])));
delete theObject;
    
```

Please note that after obtaining an object from the AxmlObjectManager (e.g. an AxmlResource) it has to be destroyed, since it is a clone of the node (and only it) which is inside the object model.

In the following is also reported a simple example on how is possible to open a digital resource which has been embedded in an AXMEDIS object, for rendering.

```

DataSource* loadedAsset=axom->getResourceAsset(index);
std::istream& embeddedStream = loadedAsset->getInputStream();
ResourceDecoder *decoder = new ResourceDecoder(embeddedStream,
encoding=="base64");
load(decoder->getInputStream(), mimeType);
delete decoder;
delete loadedAsset;
    
```

In this example the load function model the action of extracting the digital asset file and process them w.r.t. the suitable format (based on mime-type information).

3.4 Errors reported and that may occur

Error code	Description and rationales
0	Invalid Index: input index don't refers expected element
1	Invalid input resource
2	Unable to unprotect the input element

4 AXOID Assignment (DSI)

See AXMEDIS – DE – 3-1-2-2-13 section 7

5 Object Registration (DSI)

See AXMEDIS – DE – 3-1-2-2-13 section 7