

# **The RAMLET project— Developing a reference model for resource aggregation for learning, education, and training**

**IEEE LTSC CMI Working Group**

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# The RAMLET project— Developing a reference model for resource aggregation for learning, education, and training

## 1. Introduction

The LTSC Computer-managed Instruction (CMI) Working Group has undertaken a project to produce an IEEE standard that will define a reference model for digital aggregates of resources for learning, education, and training applications. The reference model will include a nomenclature and a conceptual model. The standard will facilitate interoperability by enabling the interpretation of external representations of resource aggregates and their properties. It will assume general means and methods for processing resource aggregates and will not address internal compositions, behaviors, or rendering of resources that make up resource aggregates. The project to produce the reference model is known as RAMLET (Resource Aggregation Model for Learning, Education and Training).

*Resource aggregation* is the process of gathering together resources so that the resulting resource aggregate can be used in one or more applications, such as transmission, storage, and delivery to users. Resources of diverse types may be gathered into a *resource aggregate*. Additional information is contained in the resource aggregate for purposes of specifying the categories of and the relations among the aggregated resources. A resource aggregate may be contained in a package or not, and may be self-contained or reference resources held in other locations. A resource aggregate may be disaggregated into its component resources.

Consider a fixed medium, such as a music CD. The CD can be viewed as a container for resources (the digital files that encode the songs) and descriptive metadata (titles of the songs, length of the songs, artists, etc.). The combination of the medium, resources, and metadata is an example of a resource aggregate, except that the containers being discussed in the RAMLET Project are digital, not physical.

Resource aggregates are stored and processed using system formats (*internal representations*), are usually shipped between systems as resources with XML wrappers (*external representations*), and often contain more than just resources and descriptive metadata. The resources may just be references to resources and the resource aggregate may contain processing instructions, rights management information, information about the relationships among resources, and so on.

Different communities, such as the multimedia community, library community, technical documentation community, and learning technology community, have created their own specifications and standards for resource aggregates. More recently, OASIS OpenDocument and similar formats announced by Microsoft also fit into this mould.

Without a common nomenclature and conceptual model to inform the interpretation of these formats and specifications, it is difficult to create applications that can interoperate.

A reference model will facilitate interoperability by providing a common nomenclature and conceptual model that can be used to represent a variety of resource aggregation formats and specifications. Interoperability may be achieved by facilitating the creation of crosswalks among the various aggregation formats and specifications and by enabling the development and evolution of standards and specifications.

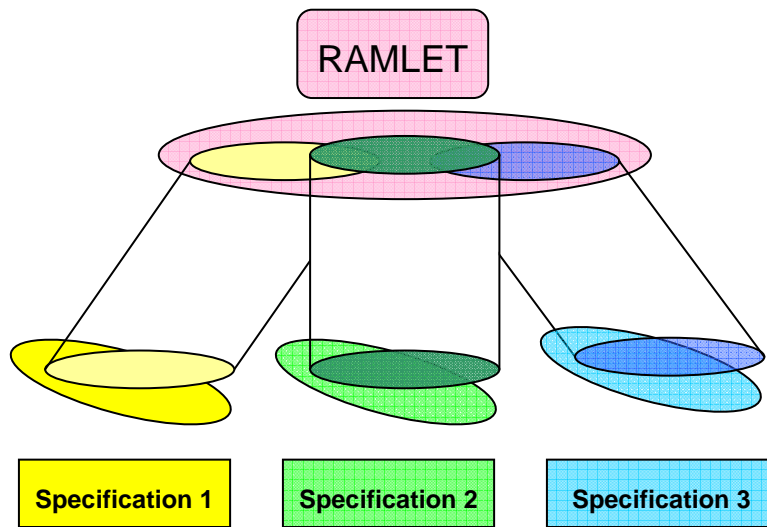
The RAMLET reference model will focus on the structures of the various resource aggregation specifications by analyzing and describing the properties of common structural concepts. For example, consider the common concept of the logical resource aggregate. In IMS CP this concept is represented by the manifest element; in MPEG-21 DIDL by the container element; and in METS by the structMap element.

The RAMLET reference model will not address a generic content model or the functional and informational properties of the content of the resource aggregates. For example, RAMLET will not be concerned with the relationships between sections and chapters or with the interactive properties of different media types. Because overlaps exist between the structural descriptions provided by RAMLET and generic content models, such as that described in the ALOCOM project,<sup>1</sup> software developers and others will need to consider how these different aspects relate in their specific circumstances.

Figure 1 shows the relationship between the RAMLET reference model and examples of other resource aggregation specifications. Significant concepts within RAMLET map to significant concepts of different specifications and standards, thus identifying overlaps and differences among them. Not all concepts within RAMLET may be present in a specification or standard and some details of a specification or standard may not be represented in RAMLET.

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<sup>1</sup> <http://ariadne.cs.kuleuven.ac.be/alocom/>



**Figure 1—The RAMLET reference model and examples of other specifications**

## **2. Proposed structure of the standard**

The working group has defined a tentative table of contents for the standard.

1. Introduction: Scope and purpose.
2. Normative references: References that are needed for the implementation of the standard.
3. Definitions: Terms, abbreviations, and acronyms that are used in the standard.
4. Resource aggregates: A definition of the structures and properties of resource aggregates.
5. Format specification: The RAMLET approach for describing the formats of resource aggregates.
6. Examples: Informative information illustrating the use of RAMLET.

### **3. RAMLET use cases**

The working group has described several use cases to inform its approach to the development of the reference model.

#### **NOTES**

1—Use case support may be limited by the extent that equivalent capabilities exist in different resource aggregation specifications.

2—Direct conversions between different resource aggregation formats are not supported by RAMLET. Support for use cases is limited to interpretation of the resource aggregation formats using the RAMLET reference model.

3—The diagrams in this section are intended to be high-level illustrations of data flows and are not intended to illustrate transactional procedures.

4—Resources, including other resource aggregates, may be imported into a resource aggregate either by inclusion or reference.

#### **3.1 Use case 1**

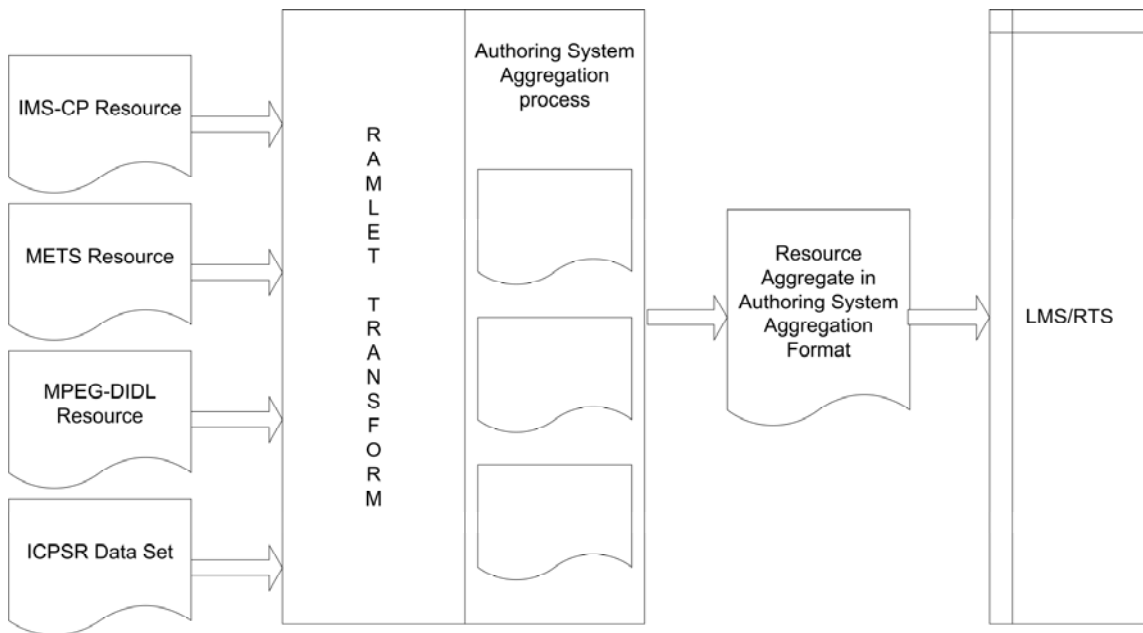
Exchange and reuse of resource aggregates among systems using different specifications. For example, a system using METS might import resource aggregates that use IMS CP, MPEG-21 DIDL, and ICPSR and create a new resource aggregate.

##### **3.1.1 Usage scenario**

A content author in a university is developing a new resource aggregate and wishes to include resources from different sources, including learning resources, reference materials, and research data. The author searches for appropriate materials and retrieves each resource to an authoring system. The resources are exported from their repositories in resource aggregation formats specific to their respective repositories. The authoring system interprets the incoming resource aggregation formats and converts them to its native format.

The author then creates the new resource aggregate, including the imported resources, and makes the new resource aggregate available to the local learning management system (LMS) or run-time system (RTS). The new resource aggregate is in the resource aggregation format used by the authoring system.

Figure 2 illustrates this scenario.



**Figure 2—Use case 1 usage scenario example**

### 3.1.2 3.1.2 Use case summary: retrieve–interpret–aggregate–deploy

This use case addresses *retrieving* resource aggregates from diverse resource repositories that provide resource aggregates in different resource aggregation formats. The retrieved resource aggregates are *interpreted*, and converted into a single format that can be used by an authoring system and then *aggregated* into a new resource aggregate. The new resource aggregate can be *deployed* by an RTS that is limited to a single resource aggregation format.

### 3.1.3 Use case support

RAMLET will support this use case.

## 3.2 Use case 2

Exchange and reuse of the components of resource aggregates among systems using different specifications. For example, a system using METS might import resource aggregates that use IMS CP, MPEG–21 DIDL, and ICPSR and create new aggregates from component resources.

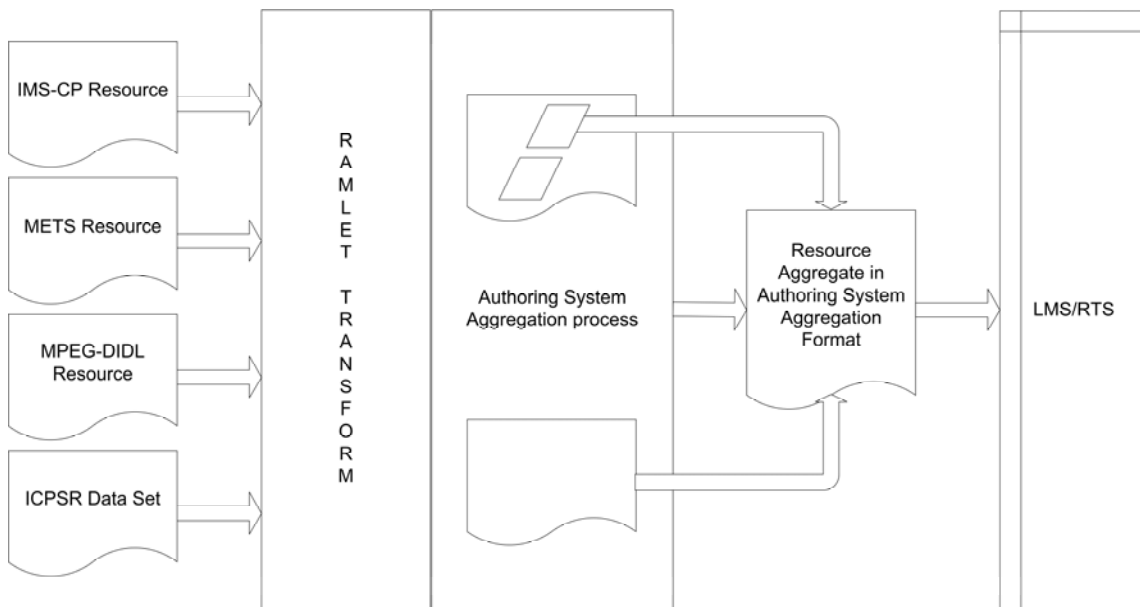
### 3.2.1 Usage scenario

A content author in a university is developing a new resource aggregate and wishes to include resources from different sources, including learning resources, reference materials, and research data. The content author searches for appropriate materials. Some of

these resources are components of resource aggregates, but the author wishes to use the appropriate components only and not the whole resource aggregate. The author retrieves each resource in its resource aggregate to an authoring system. The resources are exported from their repositories in resource aggregation formats specific to their respective repositories. The authoring system interprets the incoming resource aggregation formats and converts them to its native format.

The content author then creates the new resource aggregate, including complete imported resource aggregates and individual component resources disaggregated from their parent resource aggregates. The author makes the new resource aggregate available to the local LMS. The new resource aggregate is in the resource aggregation format used by the authoring system.

Figure 3 illustrates this scenario.



**Figure 3—Use case 2 usage scenario example**

### 3.2.2 Use case summary: retrieve–interpret–disaggregate–aggregate–deploy

This use case addresses *retrieving* resource aggregates from diverse resource repositories that provide resource aggregates in different resource aggregation formats. The retrieved resource aggregates are *interpreted*, and converted into a single format that can be used by an authoring system. Some of the resources are *disaggregated*. Resource aggregates and component resources are then *aggregated* into a new resource aggregate. The new resource aggregate can be *deployed* by an RTS that is limited to a single resource aggregation format.

### 3.2.3 Use case support

RAMLET will support this use case.

## 3.3 Use case 3

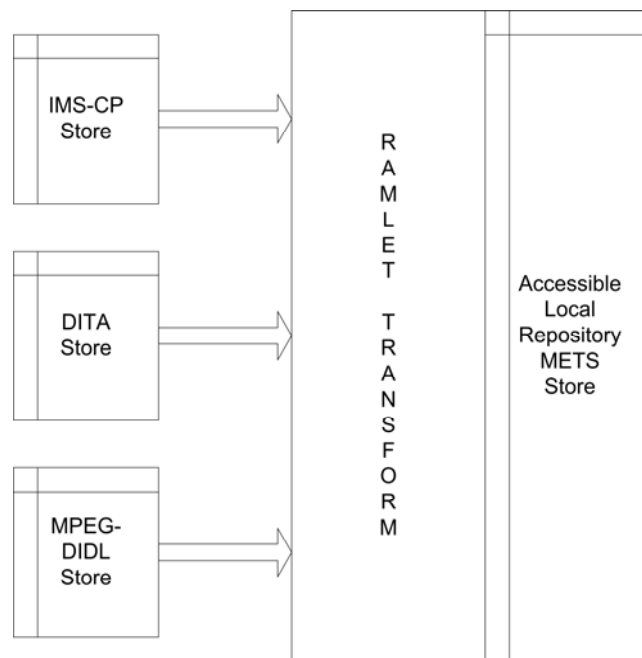
Import, store, and make available resource aggregates from systems using different specifications. For example, a system using METS might import resource aggregates that use IMS CP, DITA, and MPEG-21-DIDL.

### 3.3.1 Usage scenario

A librarian is helping a teacher collect resources that are relevant to the unit he or she is teaching and wishes to store the resources in a local repository for student access. They discover relevant resources in several different repositories and retrieve each resource. The resources are exported from their repositories in resource aggregation formats specific to their respective repositories. The local repository stores resource aggregates in a single resource aggregation format. Upon import to the local repository, the incoming resource aggregation formats are interpreted and the resource aggregates are stored in the resource aggregation format supported by the local repository.

Students are directed to the resources in the local repository by the teacher, and the access system is able to display the material using the resource aggregation format supported by the local repository.

Figure 4 illustrates this scenario.



**Figure 4—Use case 3 usage scenario example**

### **3.3.2 3.3.2 Use case summary: retrieve–interpret–store–provide**

This use case addresses *retrieving* resource aggregates from diverse resource repositories that use different resource aggregation formats, *interpreting* the different formats, *storing* the resource aggregates in a single format, and *providing* the resource aggregates in a single format

### **3.3.3 Use case support**

RAMLET will support this use case.

## **3.4 Use case 4**

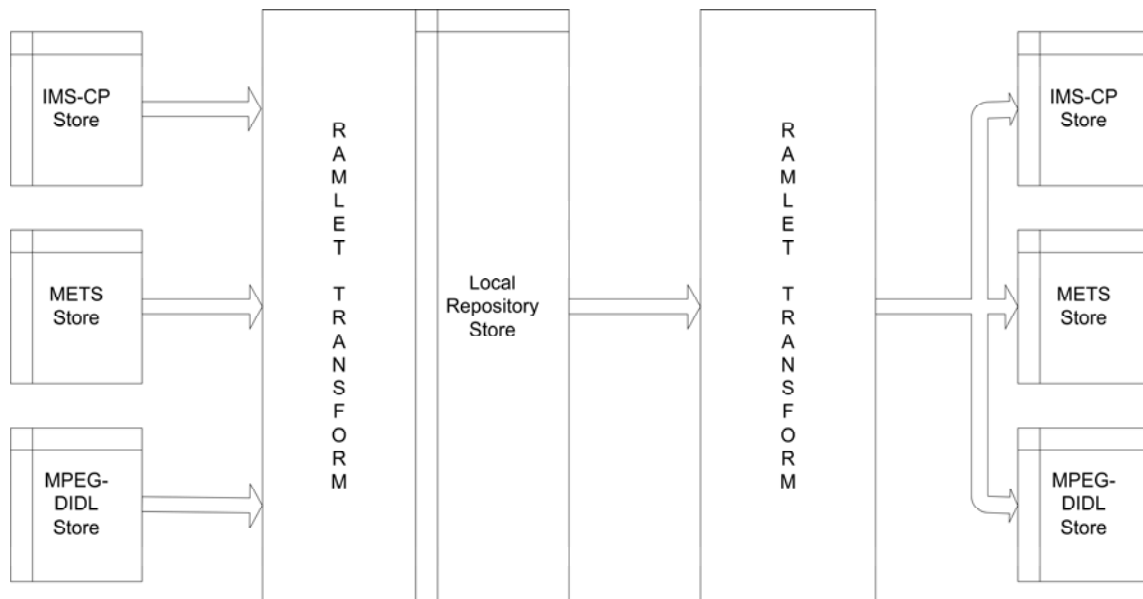
Import, store, and exchange resource aggregates from systems using different specifications. For example, a system using METS might import and export resource aggregates that use IMS CP and MPEG–21-DIDL in addition to METS.

### **3.4.1 Usage scenario**

Resource suppliers provide resources to a resource exchange in the resource aggregation formats that are exported by their respective resource repositories, which may include different formats. Upon import to the resource exchange, the incoming resource aggregation formats are interpreted and converted to the specific resource aggregation format supported by the resource exchange.

Resource consumers search the resource exchange and download resources to their local systems. Upon download, a consumer can specify the resource aggregation format preferred by the consumer's local repository. Upon export, the resource repository converts its resource aggregation format to the format supported by the consumer's repository.

Figure 5 illustrates this scenario.



**Figure 5—Use case 4 usage scenario example**

### 3.4.2 Use case summary: retrieve–interpret–store–interpret–provide

This use case addresses *retrieving* resource aggregates from diverse resource repositories that use different resource aggregation formats, *interpreting* the different formats, *storing* the resource aggregates in a single format, and *providing* the resource aggregates in multiple formats. When a resource aggregate is provided it will either be provided in the repository specific format or *interpreted* and provided in the user’s preferred resource aggregation format.

### 3.4.3 Use case support

RAMLET will support this use case.

## 3.5 Use case 5

A repository stores resources in diverse resource aggregation formats but supports a delivery system that can render only one such format. For example, a repository might store resource aggregates that use IMS CP, S1000D, MPEG–21 DIDL, and the format used by a student-information store and support a delivery system that uses IMS CP, only.

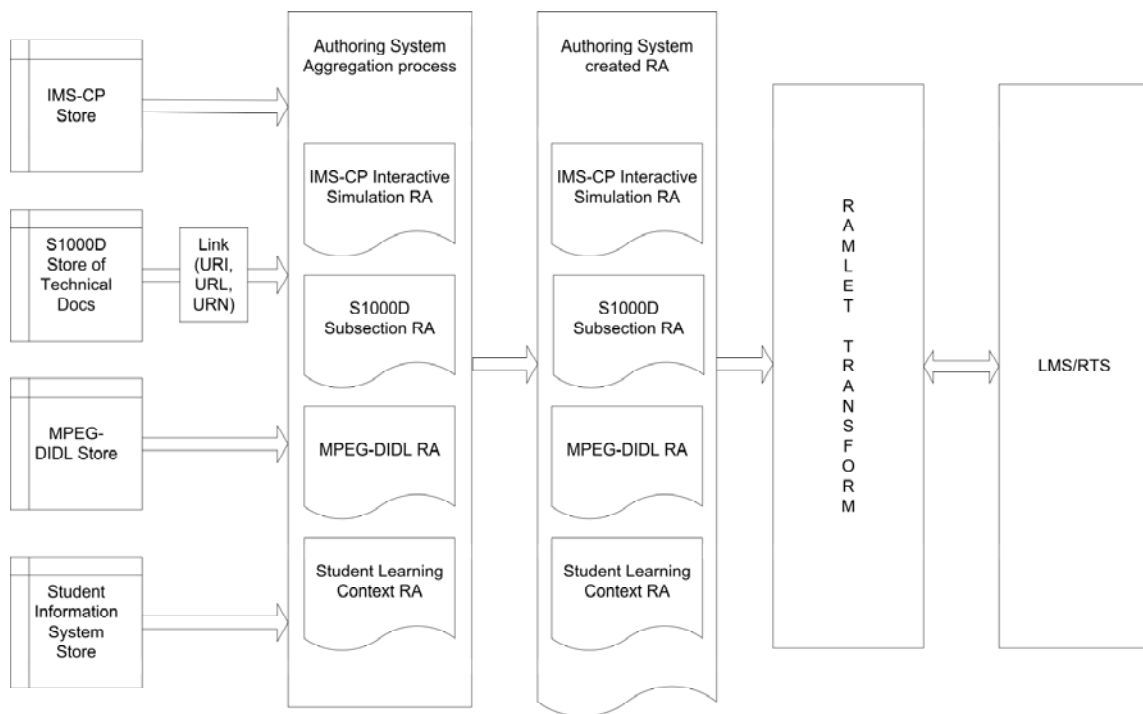
### 3.5.1 Usage scenario

A content author is developing a new resource aggregate in an authoring system for an equipment manufacturer. The new resource aggregate will include several resources from different sources, including simulations, parts of technical manuals, and existing general learning resources (e.g., a resource describing an electrical safety procedure). The author

searches for appropriate materials and retrieves each resource or resource aggregate, or a link to the resource or resource aggregate into the authoring system. A resource or resource aggregate is either exported from its repository in the resource aggregation format used by that repository or is referenced and remains in the original repository in the original format. Imported resource aggregates retain their original resource aggregation formats.

The author creates the new resource aggregate, which includes the imported and referenced resource aggregates, and makes it available to the local LMS. When a student accesses the new resource aggregate in the LMS and uses one of its component resource aggregates, the RTS interprets the component resource aggregation format. The component resource aggregate retains its format from the originating repository.

Figure 6 illustrates this scenario.



**Figure 6—Use case 5 usage scenario example**

### 3.5.2 Use case summary: retrieve–aggregate–interpret–deploy

This use case addresses *retrieving* resources and resource aggregates, either directly or by reference, from diverse resource repositories that use different resource aggregation formats. These resource aggregates are themselves *aggregated* into a new resource aggregate.

gate. They retain their original resource aggregation formats as components of a larger resource aggregate. The component resource aggregates are *interpreted* when they are *deployed* by an RTS that understands the repository's format and the formats used by the component resource aggregates.

This use case is similar to use case 1, but the conversion takes place at run time. The original data is not altered.

### **3.5.3 Use case support**

RAMLET will support this use case subject to feasibility constraints.

NOTES:

1—Mappings between resource aggregation formats may not be lossless.

2—The amount of loss among the mappings may change over time as various resource aggregation specifications evolve. One advantage of run-time interpretation may be that a mapping done at a future time may be able to take advantage of improved mapping features.

3—The resource aggregate may contain only descriptions of resources and links to resources and may not actually contain any resources.

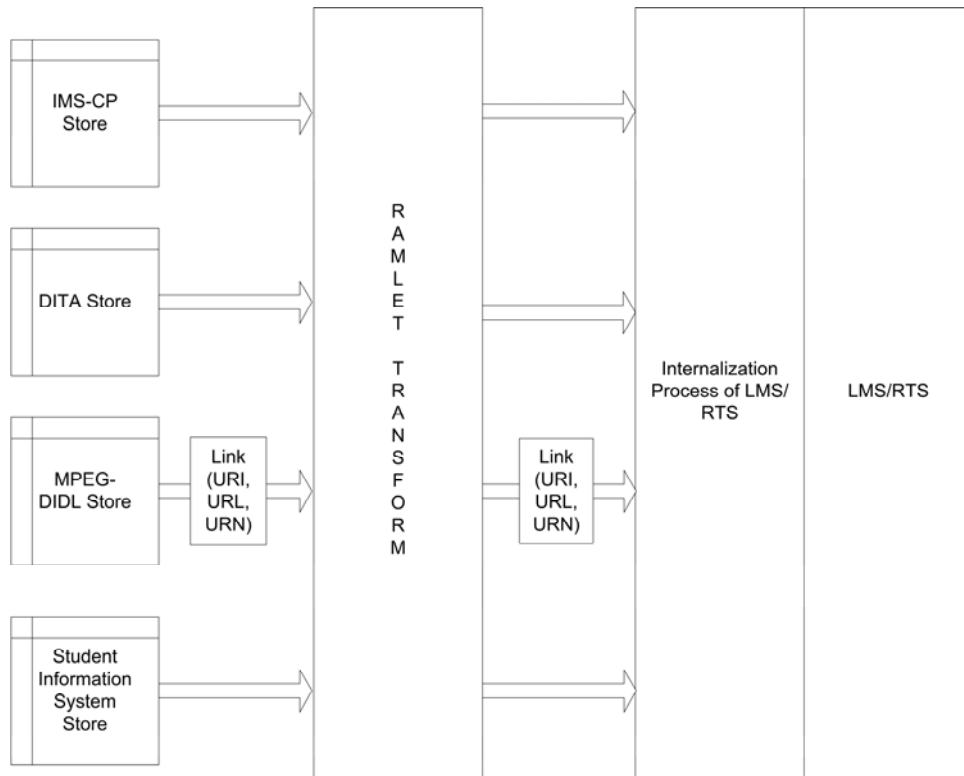
## **3.6 Use case 6**

An LMS creates a resource aggregate just in time and will import, store, and make available resource aggregates from systems using different specifications. For example, a system using its own internal format might import resource aggregates that use IMS CP, DITA, MPEG-21 DIDL, and the format used by a student-information store at the time they are required in the learning path.

### **3.6.1 Usage scenario**

An LMS supports a learner by using and providing learning resources that are appropriate in the respective context of the learning situation and the individual requirements of the learner at a particular time. Such requirements may include accessibility preferences or needs in order to access the material. The LMS retrieves, provides, and aggregates required resources just in time and makes use of different sources that provide resources in different resource aggregation formats.

Figure 7 illustrates this scenario.



**Figure 7—Use case 6 usage scenario example**

### 3.6.2 Use case summary: retrieve–interpret–internalize–deploy

This use case avoids building a complete resource aggregate prior to *deployment*. The RAMLET specification supports the transformation and *interpretation* of *retrieved* resource aggregates in diverse aggregation formats into a single format. The delivery system is able to produce an *internal* representation of the resource aggregate and render the resources.

### 3.6.3 Use case support

RAMLET will support this use case subject to feasibility constraints.

## 3.7 Use case 7

Use of the reference model by system designers to inform an implementation of their internal resource aggregation formats. Their resources and resource aggregates would then be more easily convertible into other formats.

### 3.7.1 Usage scenario

A resource repository system designer is creating an internal resource aggregation format for a resource publisher. The publisher's customers have repositories that use different, repository-specific formats. The publisher's repository will provide a single resource aggregate in different formats depending on the customers' needs. Resources will be included in the resource aggregate by reference, only. Some resources will be held in the publisher's resource repository while others will be held elsewhere on the Internet. By providing a resource aggregate that references resources, the publisher can ensure that the most current versions of the resources managed by the publisher are made available to the customer, include resources managed by third parties in the resource aggregate, and include open-access resources in the resource aggregate.

The designer uses the RAMLET model to inform the design of the internal storage format to facilitate the conversion of resource aggregates from the publisher's internal format to other resource aggregation formats at the time of provision to the customer.

Figure 8 illustrates this scenario.

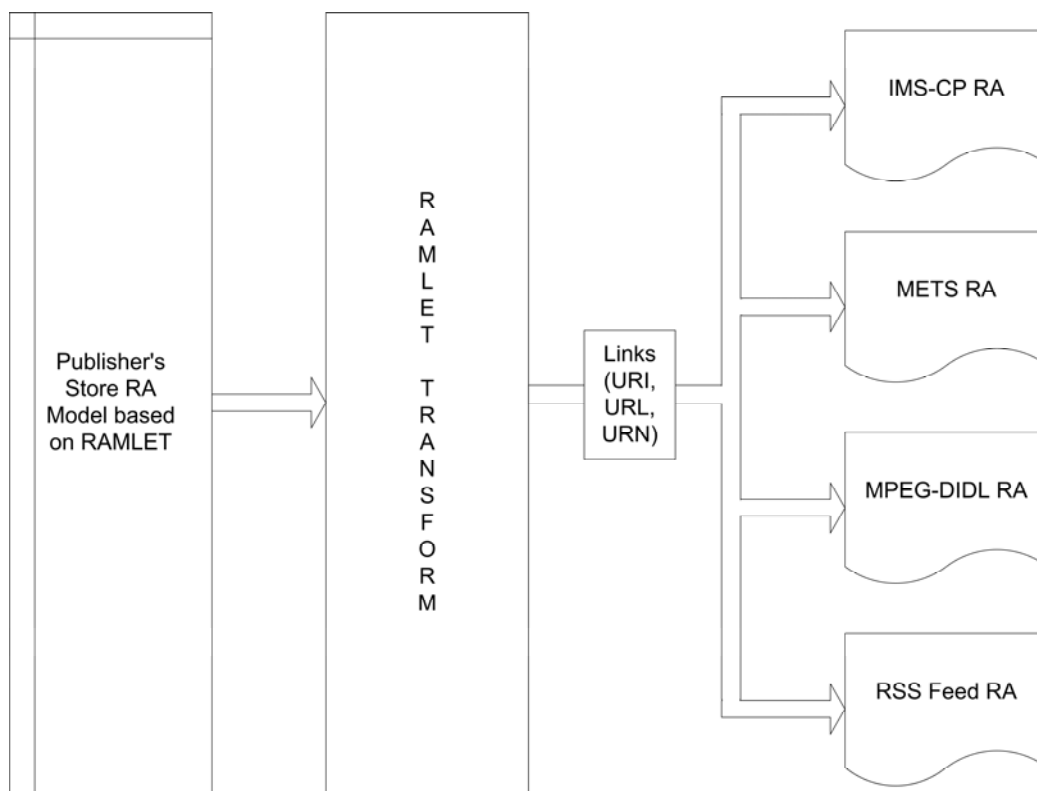


Figure 8—Use case 7 usage scenario example

### 3.7.2 Use case summary: produce–store–provide–retrieve

This use case addresses the design of systems producing resource aggregates that will be provided to diverse repositories each of which may be limited to a resource aggregation format differing from the providing repository. Resource aggregates are *produced* and *stored* in a repository specific format, but *provided* in the resource aggregation formats required by different consumers. Resources are *retrieved* from their home repository as required.

### 3.7.3 Use case support

RAMLET will support this use case.

## 3.8 Use case 8

Extension of the useful scope of a resource aggregate by providing alternatives that adapt to different contexts, such as accessibility requirements or the limitations of individual delivery systems.

NOTES:

1—In all cases, some means of identifying and selecting the most appropriate alternative resource must be provided. This is beyond the scope of RAMLET.

2—Although the usage scenario below focuses on the provision of alternative resources to support the disabled, the ability to provide alternatives to a particular resource has wide application, including the provision of:

- resources in a form suitable to a particular delivery device (e.g., an alternative version suitable for a mobile user accessing resources using a PDA);
- resources in a form suitable to a particular environment, such as an audio equivalent for visual information that can be listened to while driving;
- resources that are “badged” appropriately for users’ contexts (e.g., resources with army or navy badges),
- the same resource in multiple languages; and
- resources that match the access requirements of people with specific limitations or disabilities (e.g., alternative resources for the elderly).

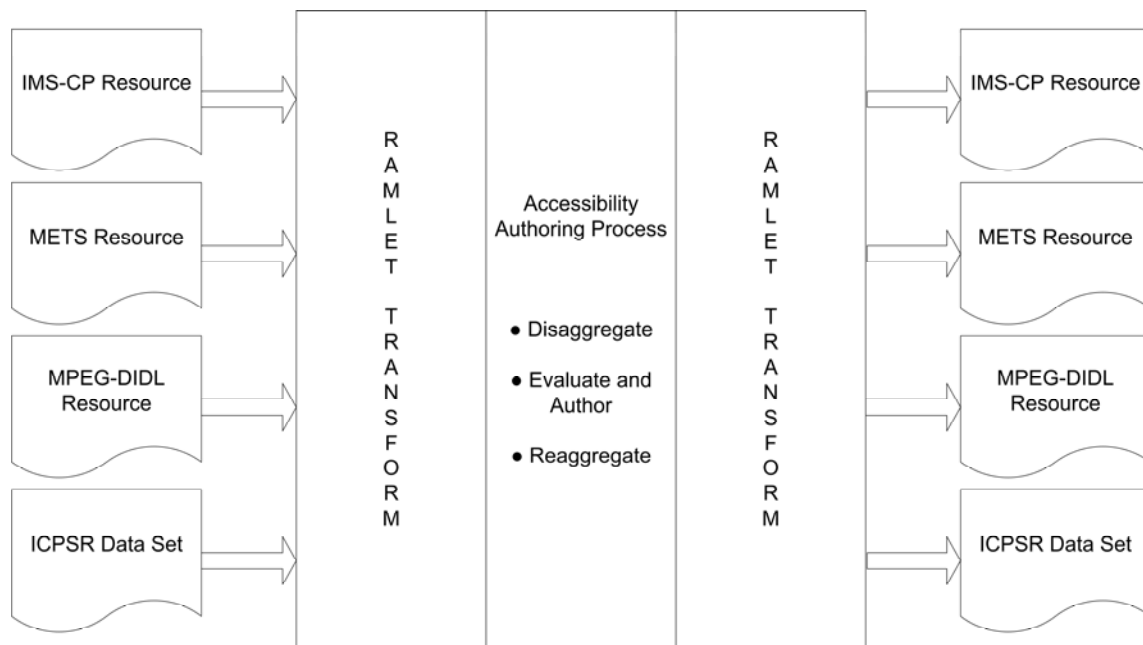
### 3.8.1 Usage scenario

A specialized support teacher for the disabled in a university is working to support specific learners and tutors by improving the accessibility of resources originally created by tutors without specialized accessibility knowledge. The teacher is using a combination of software tools that report on accessibility properties of resources. She then uses human judgement to supply equivalent alternatives for some parts of some resources. The alternatives are being provided for the dual purposes of making the resources accessible to

learners in the local context in which they will be used and of making the resources more generally accessible to meet as wide a variety of contexts.

The resulting outputs can contain multiple alternatives for some resource parts, each suiting different contexts, for example to suit blind users and dyslexic users. The teacher creates some alternatives herself and also searches for and gathers available alternatives from repositories on the Internet. She then creates a new resource aggregate that contains the original resources authored by the tutors, the alternatives she has authored, and the alternatives obtained from repositories. She is careful to use the mechanisms the output resource aggregation format supports to record information that will enable the alternatives she has authored to be re-used in other organizations and contexts and to preserve that same information for the resources she has imported.

Figure 9 illustrates this scenario.



**Figure 9—Use case 8 usage scenario A example**

### 3.8.2 Use case summary: retrieve–interpret–disaggregate–evaluate–author–aggregate

This use case addresses *retrieving* resource aggregates from diverse resource repositories that provide resource aggregates in different resource aggregation formats. The retrieved resource aggregates are *interpreted* and converted into a single format that can be used by an authoring system. Some of the resources are *disaggregated*. After *evaluation* of the

original resources, other resource components are *authored*. Resource aggregates and component resources are then *aggregated* into a new resource aggregate.

### **3.8.3 Use case support**

RAMLET will support this use case.

## **4. Use case contexts**

The use cases discussed above are not exhaustive. The working group is aware that other use cases have not yet been considered. Supported use cases could encompass a wide range of contexts in learning, education, and training including:

- Work-flow-based learning.
- Instructor-led learning.
- Learning that integrates with simulation and vice versa.
- Learning that incorporates reference materials.
- Conventional CBT/CMI (self-paced learning).
- Collaborative learning.
- Referencing of context-dependent metadata, such as learner information.
- Representation of teaching strategies.
- Incorporation of technical publications (S1000D).
- Inclusion of research materials in the resource aggregate.
- Integration of dynamic content resources such as news feeds.

## **5. Contact information**

The LTSC CMI Working Group encourages those working on resource aggregation specifications and their implementations and uses to contribute additional use cases and to participate in the RAMLET project. We anticipate that the project will have a duration of approximately 2 years and will involve weekly meetings by telephone and occasional face-to-face meetings.

To contribute to or participate in the RAMLET project please contact the Chair of the IEEE LTSC CMI Working Group, Kerry Blinco, at [kblinco@powerup.com.au](mailto:kblinco@powerup.com.au).