PREMIS Final Report

This excerpt from

Data Dictionary for Preservation Metadata:
Final Report of the PREMIS Working Group

Contains Sections 1 and 4-7. It does not include the Data Dictionary itself or the Examples, both of which are also available as separate excerpts from the full report. For the complete report, see www.oclc.org/research/projects/pmwg/premis-final.pdf

May 2005

PREMIS Preservation Metadata: Implementation Strategies
A Working Group Jointly Sponsored By OCLC and RLG

OCLC Online Computer Library Center, Inc.
6565 Frantz Road, Dublin, Ohio, 43017-3395 USA

RLG
2029 Stierlin Court, Suite 100, Mountain View, California, 94043-4684 USA

CONTENTS

ACKNOWLEDGMENTS

PREMIS members
Priscilla Caplan, Florida Center for Library Automation, *co-chair*
Rebecca Guenther, Library of Congress, *co-chair*
Robin Dale, *RLG liaison*
Brian Lavoie, *OCLC liaison*
George Barnum, U.S. Government Printing Office
Charles Blair, University of Chicago
Olaf Brandt, Göttingen State and University Library
Mikki Carpenter, Museum of Modern Art
Adam Farquhar, British Library
David Gewirtz, Yale University
Keith Glavash, MIT/DSpace
Andrea Goethals, Florida Center for Library Automation
Cathy Hartman, University of North Texas
Helen Hodgart, British Library
Nancy Hoebelheinrich, Stanford University
Roger Howard, J. Paul Getty Museum
Sally Hubbard, Getty Research Institute
Mela Kircher, OCLC
John Kunze, California Digital Library
Vicky McCargar, Los Angeles Times
Jerome McDonough, New York University/METS
Evan Owens, Ithaka-Electronic Archiving Initiative
Erin Rhodes, U.S. National Archives and Records Administration
Madi Solomon, Walt Disney Corporation
Angela Spinazze, ATSPIN Consulting
Stefan Strathmann, Göttingen State and University Library
Günter Waibel, RLG
Lisa Weber, U.S. National Archives and Records Administration
Robin Wendler, Harvard University
Hilde van Wijngaarden, National Library of the Netherlands
Andrew Wilson, National Archives of Australia and British Library
Deborah Woodyard-Robinson, British Library and Woodyard-Robinson Holdings Ltd.

Advisory committee
Howard Besser, University of California, Los Angeles
Liz Bishoff, OCLC
Gerard Clifton, National Library of Australia
Gail Hodge, CENDI
Steve Knight, National Library of New Zealand
Maggie Jones, Digital Preservation Coalition
Nancy McGovern, Cornell University
Cliff Morgan, John Wiley & Sons, Ltd.
John Perkins, CIMI Consortium
Richard Rinehart, University of California, Berkeley

Special thanks

These individuals contributed their expertise to help with special topics and/or comment on drafts:

Stephen Abrams, Harvard University
Reinhard Altenhöner, Die Deutsche Bibliothek
Caroline Arms, Library of Congress
Kevin Bradley, National Library of Australia
Thomas Fischer, Lower Saxony State and University Library, Göttingen
Carl Fleischhauer, Library of Congress
Mahnaz Ghaznavi, Getty Research Institute/InterPARES
Corey Harper, University of Oregon
Lori Lindberg, SLIS Cal State San Jose/InterPARES
Justin Littman, Library of Congress
Sean Martin, British Library
Quyen Nguyen, U.S. National Archives and Records Administration
Tobias Steinke, Die Deutsche Bibliothek
Robert Tansley, Hewlett-Packard
Andrew Waugh, Public Record Office, Victoria

PREMIS WEB SITES AND E-MAIL

PREMIS working group Web site: www.oclc.org/research/projects/pmwg/.

PREMIS maintenance activity Web site: www.loc.gov/standards/premis/.

Please send comments and questions to premis@loc.gov.

INTRODUCTION

In 2003 OCLC and RLG established Preservation Metadata: Implementation Strategies (PREMIS), an international working group. This report and the PREMIS Data Dictionary version 1.0 are the culmination of nearly two years of effort by PREMIS members.

The Data Dictionary defines and describes an implementable set of core preservation metadata with broad applicability to digital preservation repositories. This report is intended to put the Data Dictionary into context, explain the underlying assumptions and data model, and provide additional information about the meaning and use of semantic units defined in the Data Dictionary.

The charge of the PREMIS working group was to:

- define an implementable set of “core” preservation metadata elements, with broad applicability within the digital preservation community;
- draft a Data Dictionary to support the core preservation metadata element set;
- examine and evaluate alternative strategies for the encoding, storage, and management of preservation metadata within a digital preservation system, as well as for the exchange of preservation metadata among systems;
- conduct pilot programs for testing the group’s recommendations and best practices in a variety of systems settings; and
- explore opportunities for the cooperative creation and sharing of preservation metadata.

A draft of this report and the Data Dictionary were completed in February 2005 and circulated to the PREMIS Advisory Committee and a small number of other invited reviewers. The working group received a great deal of valuable feedback from this initial review period, and spent considerable time considering each comment and making revisions. Both documents benefited immensely from this review.

With this release of the PREMIS Data Dictionary version 1.0, immediate next steps will likely focus on implementation and interoperability. Operating repositories can use PREMIS as a checklist against which to compare their own preservation metadata specifications. Repositories in development can serve as testbeds for implementing PREMIS-conformant semantics and feed their experience into future revisions of the Data Dictionary. XML bindings for the Data Dictionary are being developed to represent PREMIS-conformant metadata in the exchange of archival information packages between preservation repositories.

The working group wants to stress that the Data Dictionary is not intended to be fixed and final but to provide a starting point for improvements and enhancements based on community experience and feedback. A mechanism is being established for the ongoing maintenance and oversight of the PREMIS Data Dictionary and associated XML schemas; see www.loc.gov/standards/premis/. The PREMIS Web site at www.oclc.org/research/projects/pmwg/ should be consulted for current information about ongoing activities.

Introduction

Background

PREMIS was established to build on the earlier work of another initiative sponsored by OCLC and RLG, the Preservation Metadata Framework working group. In 2001–2002 that group outlined the types of information that should be associated with an archived digital object. Their report, *A Metadata Framework to Support the Preservation of Digital Objects* (the *Framework*), proposed a list of prototype metadata elements.[1] However, additional work was needed to make these prototype elements implementable. The PREMIS working group aimed to take the previous group's work a step further: to develop a Data Dictionary of core metadata elements to be applied to archived objects, give guidance on the implementation of that metadata element set in preservation systems, and suggest best practice for populating those elements.

As PREMIS had a practical rather than theoretical focus, members were sought from institutions known to be running or developing preservation repository systems within the cultural heritage and information industry sectors. Diverse perspectives were also sought. The working group consisted of representatives from academic and national libraries, museums, archives, government, and commercial enterprises in six different countries. In addition, PREMIS called upon an international advisory committee of experts to review progress.

To accomplish as much of the charge as possible in a reasonable timeframe, the working group divided into two subgroups. The Implementation Strategies Subgroup examined various strategies for encoding, storing, and managing preservation metadata within digital preservation systems. The Core Elements Subgroup took responsibility for selecting the core preservation metadata elements and drafting the Data Dictionary. Both subgroups conducted their work almost entirely by weekly conference calls. The Core Elements Subgroup also held two face-to-face meetings.

To find out how preservation repositories were actually implementing preservation metadata, in November 2003 the Implementation Strategies Subgroup surveyed about 70 organizations thought to be active in or interested in digital preservation. The survey provided an opportunity to explore the state of the art in digital preservation generally, and questions were drafted to elicit information about policies, governance and funding, system architecture, and preservation strategies, as well as metadata practices. The subgroup contacted 16 of 48 respondents by telephone for more in-depth interviews. In December 2004 the PREMIS working group published its report based on the survey of digital repositories, *Implementing Preservation Repositories for Digital Materials: Current Practice and Emerging Trends in the Cultural Heritage Community* (the *Implementation Survey Report*).[2]

The Implementation Strategies Subgroup had also been charged with developing pilot implementations of the PREMIS core elements. This will likely be addressed as a follow-on activity to PREMIS's work. Testing of the Data Dictionary will likely require significant effort and independent funding and will benefit from being organized as a separate activity.

Core preservation metadata elements and the Data Dictionary

The Core Elements Subgroup developed the Data Dictionary of core elements needed to support digital preservation, including implementation details such as repeatability, obligation, and examples. The Implementation Strategies Subgroup annotated the Data Dictionary with notes about the creation and use of the metadata elements.

Both the earlier *Framework* and the PREMIS Data Dictionary build on the Open Archival Information System (OAIS) reference model (ISO14721).[3] The OAIS information model provides a conceptual foundation by providing a taxonomy of information objects and packages for archived objects and the structure of their associated metadata. The *Framework* can be viewed as an elaboration of the OAIS information model, explicated through the mapping of preservation metadata to that conceptual structure. The PREMIS work can be viewed as a translation of the *Framework* into a set of implementable semantic units in the Data Dictionary. However, it should be noted that PREMIS and OAIS use some terminology differently, as noted in the Glossary. Differences usually reflect the fact that PREMIS semantic units require more specificity than the OAIS definitions provide, which is to be expected when moving from a conceptual framework to an implementation.

Drafting the Data Dictionary required agreement on working definitions of "preservation metadata," "core," and "implementable." These working definitions provided criteria for evaluating potential semantic units.

PREMIS defines "preservation metadata" as *the information a repository uses to support the digital preservation process.* Specifically, the group looked at metadata supporting the functions of maintaining viability, renderability, understandability, authenticity, and identity in a preservation context. Preservation metadata thus spans a number of the categories typically used to differentiate types of metadata: administrative (including rights and permissions), technical, and structural. Particular attention was paid to the documentation of digital provenance (the history of an object) and to the documentation of relationships, especially relationships among different objects within the preservation repository.

The group considered a number of definitions of "core." In one view, core describes any metadata absolutely required under any circumstances. In another, core means that metadata is applicable to any type of repository implementing any type of preservation. PREMIS uses this practical definition: *things that most working preservation repositories are likely to need to know in order to support digital preservation.* The words "most" and "likely" were chosen deliberately. Core does not necessarily mean mandatory, and some semantic units were designated as optional when exceptional cases were apparent.

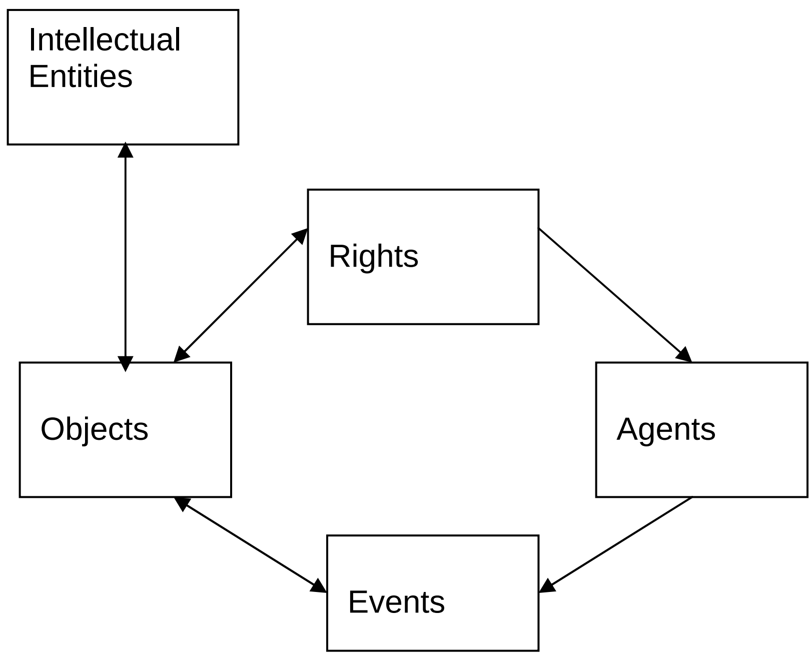
The idea of "implementability" also generated some discussion. Most preservation repositories will be dealing with large quantities of data. Therefore, a key factor in the implementability of preservation metadata is whether the values can be automatically supplied and automatically used by the repository. Whenever possible the group defined elements that do not require human intervention to supply or analyze. For example, coded values from an authority list are preferred over textual descriptions.

The group decided that the Data Dictionary should be wholly implementation independent. That is, the core elements define information that a repository needs to know, regardless of how, or even whether, that information is stored. For instance, for a given identifier to be usable, it is necessary to know the identifier scheme and the namespace in which it is unique. If a particular repository uses only one type of identifier, the repository would not need to record the scheme in association with each object. The repository would, however, need to know this information and to be able to supply it when exchanging metadata with other repositories. Because of the emphasis on the need to know rather than the need to record or represent in any particular way, the group preferred to use the term “semantic unit” rather than “metadata element.” The Data Dictionary names and describes semantic units, the properties of entities.

An implementable metadata scheme needs to define each semantic unit as rigorously as possible and relate it to the type of entity it describes. This was a guiding principle for the group as it compiled the Data Dictionary.

1. THE PREMIS DATA MODEL

To facilitate the logical organization of the PREMIS metadata elements, the group developed a simple model of five types of entities involved in digital preservation activities: Intellectual Entities, Objects, Events, Rights, and Agents.[4] In the data model diagram, entities are drawn as boxes while the relationships between them are drawn as lines. The direction of the arrow shows the direction of the relationship link defined in the Data Dictionary; for example, the arrow from Rights to Agents means the metadata defined for Rights includes semantic units to identify the related agent(s). A double-headed arrow means reciprocal links are defined.



An **Object**, or Digital Object, is a discrete unit of information in digital form.[5]

An **Intellectual Entity** is a coherent set of content that is reasonably described as a unit, for example, a particular book, map, photograph, or database. An Intellectual Entity can include other Intellectual Entities; for example, a Web site can include a Web page, a Web page can include a photograph. An Intellectual Entity may have one or more digital representations.

An **Event** is an action that involves at least one object or agent known to the preservation repository.

An **Agent** is a person, organization, or software program associated with preservation events in the life of an object.

Rights, or Rights Statements, are assertions of one or more rights or permissions pertaining to an object and/or agent.

A **relationship** is a statement of association between instances of entities. "Relationship" can be interpreted broadly or narrowly, and any relationship fact can be expressed in many different ways. That object A is of format B could be considered a relationship between A and B. The PREMIS model, however, treats format B as a property of object A. PREMIS reserves "relationship" for associations between two or more Object entities or between entities of different types, such as an Object and an Agent.

Semantic units are the properties of an entity (the thing being described). Semantic units have values; for example, the semantic unit *size* is a property of an Object entity. For a particular object the value of *size* might be "843200004."

In most cases a particular semantic unit is clearly a property of only one type of entity. The size of an object is clearly a property of the Object entity. In some cases a semantic unit applies equally to two or more different types of entity. For example, events have outcomes. If a migration event creates a file that has lost some important feature, the loss of that feature might be considered a sort of outcome (and so a property of the Event entity) or it might be considered an attribute of the new file (and so a property of the Object entity). When a semantic unit applies equally to different types of entities, the semantic unit is associated with only one type of entity in the Data Dictionary. The model relies upon links between the different entities to make these relationships clear. In the example above, the loss of the feature is treated as a detailed outcome of the Event, where the Event contains the identifier of the Object involved. What is important is that this association is arbitrary and is not meant to imply that a particular implementation is required.

In some cases a semantic unit is an umbrella or **container** that groups a set of related semantic units. For example, a semantic unit *identifier* groups the two semantic units *identifierType* and *identifierValue*. The grouped subunits are called **semantic components** of the semantic unit.

Objects

The Object entity has three subtypes: file, bitstream, and representation.

A **file** is a named and ordered sequence of bytes that is known by an operating system. A file can be zero or more bytes and has a file format, access permissions, and file system statistics such as size and last modification date.

A **bitstream** is contiguous or non-contiguous data within a file that has meaningful common properties for preservation purposes. A bitstream cannot be transformed into a standalone file without the addition of file structure (headers, etc.) and/or reformatting the bitstream to comply with some particular file format.

A **representation** is the set of files, including structural metadata, needed for a complete and reasonable rendition of an Intellectual Entity. For example, a journal article may be complete in one PDF file; this single file constitutes the representation. Another journal article may consist of one SGML file and two image files; these three files constitute the representation. A third article may be represented by one TIFF image for each of 12 pages plus an XML file of structural metadata showing the order of the pages; these 13 files constitute the representation.

Files, bitstreams, and filestreams

A file in the PREMIS data model is similar to the idea of a computer file in ordinary usage: a set of zero or more bytes known to an operating system. Files can be read, written, and copied. Files have names and formats.

A bitstream as defined in the PREMIS data model is a set of bits embedded within a file. This differs from common usage, where a bitstream could in theory span more than one file. A good example of a file with embedded bitstreams is a TIFF file containing two images.

According to the TIFF file format specification a TIFF file must contain a header containing some information about the file. It may then contain one or more images. In the PREMIS data model each of these images is a bitstream and can have properties such as identifiers, location, inhibitors, and detailed technical metadata (e.g., color space).

Some bitstreams have the same properties as files and some do not. The image embedded within the TIFF file clearly has properties different from the file itself. However, in another example, three TIFF files could be aggregated within a larger tar file. In this case the three TIFF files are also embedded bitstreams, but they have all the properties of TIFF files.

The PREMIS data model refines the definition of bitstream to include only an embedded bitstream that cannot be transformed into a standalone file without the addition of file structure (e.g., headers) or other reformatting to comply with some particular file format specification. Examples of these bitstreams include an image within a TIFF 6.0 file, audio data within a WAVE file, or graphics within a Microsoft Word file.

Some embedded bitstreams can be transformed into standalone files without adding any additional information, although a transformation process such as decompression, decryption, or decoding may have to be performed on the bitstream in the extraction process. Examples of these bitstreams include a TIFF within a tar file, or an encoded EPS within an XML file.

In the PREMIS data model these bitstreams are defined as "filestreams," that is, true files embedded within larger files. Filestreams have all of the properties of files, while bitstreams do not. In the Data Dictionary, the column for "File" applies to both files and filestreams. The column for "Bitstream" applies to the subset of bitstreams that are not filestreams and that adhere to the stricter PREMIS definition of bitstream. The location (*contentLocation* in the Data Dictionary) of a file would normally be a location in storage; while the location of a filestream or bitstream would normally be the starting offset within the embedding file.

Representations

The goal of many preservation repositories is to maintain usable versions of intellectual entities over time. For an intellectual entity to be displayed, played, or otherwise made useable to a human, all of the files making up at least one version of that intellectual entity must be identified, stored, and maintained so that they can be assembled and rendered to a user at any given point. A representation is the set of files required to do this.

1. The PREMIS Data Model

PREMIS chose the term "representation" to avoid the term "manifestation" as it is used in the *Functional Requirements for Bibliographic Records* (FRBR).[6] In FRBR a manifestation entity is "all the physical objects that bear the same characteristics in respect to both intellectual content and physical form." In the PREMIS model a representation is *a single digital instance of an intellectual entity held in a preservation repository*.

A preservation repository might hold more than one representation for the same intellectual entity. For example, the repository might acquire a single image (say, "Statue of a horse") as a TIFF file. At some point the repository creates a derivative JPEG2000 file from the TIFF and keeps both files. Each of these files would constitute a representation of "Statue of a horse."

In a more complicated example, "Statue of a horse" might be a part of an article consisting of that TIFF image and a file of SGML-encoded text. If the repository created a JPEG2000 version of the TIFF, it would hold two representations of the article: the TIFF and the SGML files would make up one representation, while the JPEG2000 and the SGML files would make up another representation. How those representations are stored is implementation specific. A repository might chose to store a single copy of the SGML file, which would then be shared between representations. Alternately, the repository could choose to duplicate the SGML file and store two identical copies of it. The two representations would then consist of the TIFF and SGML copy 1, and the JPEG2000 and SGML copy 2.

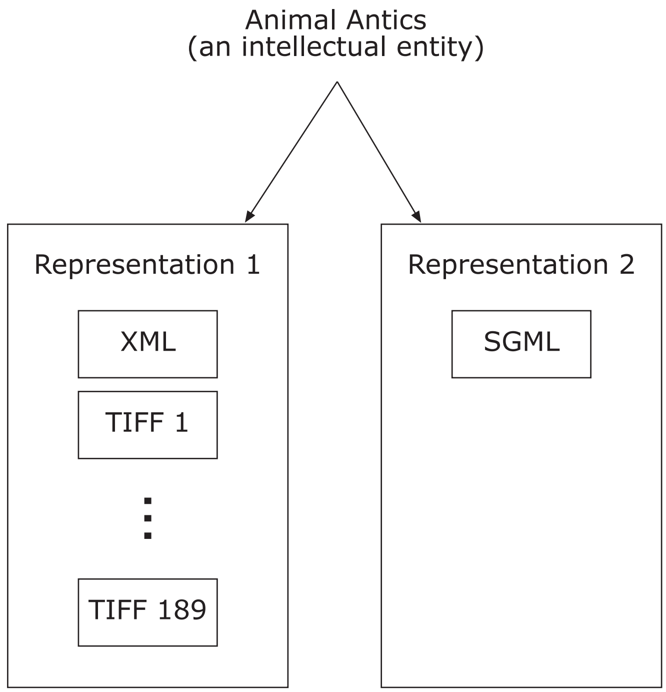
Not all preservation repositories will be concerned with representations. A repository might, for example, preserve file objects only and rely on external agents to assemble these objects into usable representations. If the repository does not manage representations, it does not need to record metadata about them.

Intellectual Entities and Objects

The relationship between Intellectual Entities and Objects can be illustrated by a couple of examples:

Example 1, *Animal Antics*: The book *Animal Antics* was published in 1902. A library digitized *Animal Antics*, creating one TIFF file for each of 189 pages. As structural metadata, it created an XML file showing how the images are assembled into a complete book. The library then performed OCR on the TIFF images, ultimately creating a single large text file that was marked up by hand in SGML. The library submitted 189 TIFF files, one XML file, and one SGML file to a preservation repository.

To the repository *Animal Antics* is an Intellectual Entity: it is a reasonable unit that can be described as a whole, with properties such as an author, a title, and a publication date. The repository has two representations, one consisting of 189 TIFF files and an XML file, and the other consisting of one SGML file. Each representation could render a complete version of *Animal Antics*, albeit with different functionalities. The repository will record metadata about two representation objects and 191 file objects.



Example 2, *Welcome to U*: *Welcome to U*, submitted to a preservation repository as an AVI (Audio Video Interleaved) file, is a 10-minute movie introducing new students to a university campus.

Welcome to U is an Intellectual Entity. The repository has one representation, which consists of a single AVI file. The repository's preservation strategy requires that it manage the audio bits of the AVI file separately from the video bits. The repository will record metadata about one representation object, one file object, and two bitstream objects.

Events

The Event entity aggregates metadata about actions. A preservation repository will record events for many reasons. Documentation of actions that modify (that is, create a new version of) a digital object is critical to maintaining digital provenance, a key element of authenticity. Actions that create new relationships or alter existing relationships are important in explaining those relationships. Even actions that alter nothing, such as validity and integrity checks on objects, can be important to record for management purposes. For billing or reporting purposes some repositories may track actions such as requests for dissemination or reports.

It is up to the repository which actions to record as Events. Some actions may be considered too trivial to record, or may be recorded in other systems (as, for example, routine file backups may be recorded in storage management systems). It is also an implementation decision whether to record events that occur before an object is ingested into the preservation repository, for example, derivation from an earlier object, or changes of custody. In theory, events following the deaccessioning of an Intellectual Entity could also be recorded. For example, a repository might first deaccession an Intellectual Entity, then delete all file Objects associated with that entity, and record each deletion as an Event.

In the data model Objects are associated with Events in two ways. If an Object is related to a second Object through (because of) an Event, the Event identifier is recorded in the *relationship* container as the semantic component *relatedEventIdentification.* If the Object simply has an associated Event with no relationship to a second Object, the Event identifier is recorded in the container *linkingEventIdentifier*. (For more information on relationships, see page 1-8.)

For example, assume a preservation repository ingests an XML file (object A) and creates a normalized version of it (object B) by running a program (event 1). In the metadata for object B, this could be recorded in *relationship* as follows:

relationshipType = “derivation”
relationshipSubType = “derived from”
relatedObjectIdentification
  relatedObjectIdentifierType = “local”
  relatedObjectIdentifierValue = “A”
  relatedObjectSequence = “not applicable”
relatedEventIdentification
  relatedEventIdentifierType = “local”
  relatedEventIdentifierValue = “1”
  relatedEventSequence = “not applicable”

Continuing with this example, assume that after object B is created it is validated by running another program (event 2). In this case event 2 pertains only to object B, not to the relationship between B and A. The link to event 2 would be recorded as *linkingEventIdentifier*:

linkingEventIdentifierType = “local”
linkingEventIdentifierValue = “2”

A given Object can be associated in these two ways with any number of Events.

All events have outcomes (success, failure, etc.). Some events also have outputs; for example, the execution of a program creates a new file object. The semantic units *eventOutcome* and *eventOutcomeDetail* are intended for documenting qualitative outcomes. For example, if the event is an act of format validation, the value of *eventOutcome* might be a code indicating the object is fully valid. Alternatively, it might be a code indicating the object is not fully valid, and *eventOutcomeDetail* could be used to describe all anomalies found. If the program performing the validation writes a log of warnings and error messages, a second instance of *eventOutcomeDetail* could be used to store or point to that log.

If an event creates objects that are stored in the repository, those objects should be described as entities with a complete set of applicable metadata and associated with the event by links.

Agents

Agents are clearly important but are not the focus of the Data Dictionary, which defines only a means to identify the agent and a classification of agent type (person, organization or software). While more metadata is likely to be necessary, this is left to other initiatives to define.

The data model diagram shows an arrow from the Agent entity to the Event entity, but no arrow from Agent to the Object entity. Agents influence Objects only indirectly through Events. Each Event can have one or more related Objects and one or more related Agents. Because a single Agent can perform different roles in different Events, the role of the Agent is a property of the Event entity, not of the Agent entity.

Rights

Many efforts are concerned with metadata related to intellectual property rights and permissions, from rights expression languages to the <indecs> framework. However, only a small body of work addresses rights and permissions specifically related to digital preservation. The working group surveyed the literature, reviewed the *Implementation Survey Report*, and solicited use cases.

To keep the scope of the discussion manageable, the working group agreed to concentrate on rights and permissions concerned with preservation activities, leaving aside those concerned with access and/or distribution. To further narrow the scope it was proposed that only two expressions were required: “Agent A holds this right to Object B” and “Agent A grants [the repository] this permission related to Object B.”

Finally, this was narrowed to the single case, “Agent A grants this permission for Object B.” It could be inferred from this that the agent held the right to grant the permission. “Permission” was defined as *an agreement between the rights holder and the repository, allowing the repository to undertake some action*.

Another issue was the appropriate level of granularity for the definitions of the various aspects of permission. For example, if a repository is allowed to make up to three backup copies, this could be expressed as a single statement of permission:

permission = make up to three backup copies

Or it could be expressed as a more granular set of terms:

act = copy
purpose = backup
condition = none
quantity limit = three
time limit = none
geographic limit = none
(and so on)

The working group decided to divide these into only three semantic units: one for the allowed act, one for the expiration date of the permission, and one for all other terms, conditions, restrictions and/or limitations. The dates of the term of the grant were separated out because dates are best represented in a structured format; other restrictions were combined largely for the sake of simplicity of implementation. Finally, a note was added to allow additional or related information to be recorded. Expressing permission for three backup copies in the final structure for the *permission* semantic unit would take this form:

act = make a copy
restriction = up to three; for the purpose of backup only
termOfGrant
  startDate = 20050101
  endDate = none
permissionNote = none

Repositories requiring more granularity are free to develop their own typologies of restrictions.

The semantic units defined in the Data Dictionary should be considered only a start, focused on a very narrow need. A great deal of work remains to be done when the community has more implementation experience in this area.

Relationships

Relationships between Objects

The group began its exploration of this topic by collecting examples from existing preservation metadata projects. It found a wide range of metadata facts expressed as relationships—for example, "is migrated from," "is keyed text of," "is thumbnail of." In some cases these relationship statements combine more than one fact (e.g., "is keyed text of" combines "is a keyed text" and "is derived from"). The group also reviewed the element refinements for the Dublin Core Relation element (IsPartOf, IsFormatOf, IsVersionOf, etc.) and concluded that most relationships among objects appear to be variants of these three basic types: structural, derivation, and dependency.

Structural relationships show relationships between parts of objects. The structural relationships between the files that constitute a representation of an Intellectual Entity are clearly essential preservation metadata. If a preservation repository can't put the pieces of a digital object back together, it hasn't preserved the object. For a simple digital object (e.g., a photograph) structural information is minimal: the file constitutes the representation. Other digital objects such as e-books and Web sites can have quite complex structural relationships.

Derivation relationships result from the replication or transformation of an Object. The intellectual content of the resulting Object is the same, but the Object's instantiation, and possibly its format, are different. When file A of format X is migrated to create file B of format Y, a derivation relationship exists between A and B.

Many digital objects are complex, and both structural and derivation information can change over time as a result of preservation activities. For example, a digitized book represented by 400 TIFF page images might after migration become four PDF files each containing 100 pages.

A structural relationship among objects can be established by an act of derivation before the objects were ingested by the repository. For example, a word-processing document could have been used to create derivative files in PDF and XML formats. If only the PDF and XML files are submitted to the preservation repository, these objects are different representations of the same Intellectual Entity with parent-child relationships to the source word-processing file. They do not have derivation relationships with each other, but do have a structural relationship as siblings (children of a common parent).

There is no one way to model all possible structural or derivation information. Rather than specify a particular approach, the group identified essential information that must be captured. The PREMIS Data Dictionary describes this in the semantic components of the semantic unit *relationship*. Structural and derivative relationships link Objects; the Objects must be identified. The type of relationship must be identified in some way (e.g., “is child of”) and the relationship may be associated with an Event that created that relationship. Implementers will likely choose approaches that best suit the content to be preserved by using, for example, the METS structMap or the Dublin Core Relation refinements.

A dependency relationship exists when one object requires another to support its function, delivery, or coherence of content. An object may require a font, style sheet, DTD, schema, or other file that is not formally part of the object itself but is necessary to render it. The Data Dictionary handles dependency relationships as part of the environment information, in the semantic units *dependency* and *swDependency*. In this way requirements for hardware and software are brought together with requirements for dependent files to form a complete picture of the information or assets required for the rendering and/or understanding of the object.

Relationships between entities of different types

The data model diagram uses arrows to show relationships between entities of different types. Objects are related to Intellectual Entities, Objects are related to Events, Agents are related to Events, etc. The Data Dictionary expresses relationships as linking information by including in the information for entity A a pointer to the related entity B. Every entity in the data model has a unique identifier for use as a pointer. So, for example, the Object entity has arrows pointing to Intellectual Entities and Events. These are implemented in the Data Dictionary by the semantic units *linkingIntellectualEntityIdentifier* and *linkingEventIdentifier*.

The 1:1 principle

In digital preservation it is common practice to create new copies or versions of stored objects. For example, in forward migration file A in format X may be input to a program which outputs file B in format Y. There are two ways to think about files A and B. One might think of them as a single Object, the history of which includes the transformation from X to Y, or one could think of them as two distinct Objects with a relationship created by the transformation Event.

The 1:1 principle in metadata asserts that each description describes one and only one resource. As applied to PREMIS metadata, every Object held within the preservation repository (file, bitstream, representation) is described as a static set of bits. It is not possible to change a file (or bitstream or representation); one can only create a new file (or bitstream or representation) that is related to the source Object. In the example above, therefore, files A and B are distinct Objects with a derivative relationship between them. The Data Dictionary has a semantic unit for the creation date of an Object (*dateCreatedByApplication*) but not for the modification date of an Object, because an Object, by definition, cannot be modified.

When new objects are derived from existing objects the event that created the new object should be recorded as an Event, which will have a date/time stamp. The relationship(s) among the objects should be recorded using the *relationship* semantic unit associated with the Object entity. The semantic component *relatedEventIdentification* should be used to make the association with the Event.

See separate document: premis-dd.pdf

See separate document: premis-examples.pdf

4. SPECIAL TOPICS

As it compiled the Data Dictionary, the PREMIS working group felt several topics were important but too detailed for the Data Dictionary itself. The discussion here provides background information about semantic units and illustrates the thinking of the working group.

Format information

The working group discussed format at length, finding a need to come to agreement on some fundamental questions before specific semantic units could be defined. These issues included:

- What is a format?
- What types of objects have format?
- How does one identify a format?
- Is there a difference between a format and a profile?

The concept of format seems almost intuitive, but given the importance of format information to digital preservation the group wanted to be very specific about its meaning. In discussion the defining feature of a format emerged as the fact that a format has to correspond to some formal or informal specification; it cannot be a random or undocumented layout of bits. The definition in the Wikipedia, “a particular way to encode information for storage in a computer file,” does not seem to emphasize this feature sufficiently.[7] The group drafted its own definition: *a specific, preestablished structure for the organization of a digital file or bitstream.*

Format is obviously a property of files, but it can also apply to bitstreams. For example, an image bitstream within a TIFF file may have a format that is defined within the TIFF file format specification. For this reason PREMIS avoids the term “file format” for the more generic “format.”

A preservation repository must record format information as specifically as possible. Ideally, formats would be identified by a direct link to the full format specification. In real implementations an indirect link such as a code or string that can in turn be associated with the full format specification is more practical. The group saw format name as a somewhat arbitrary designation that could be used as this indirect link. However, two complications arose when the group attempted to define the semantic unit(s) to be used as this link.

First, format designations in common use, such as MIME types and filetype extensions, are not granular enough to be used in this way without the addition of version information. There was some discussion of whether the semantic unit defined for format name should include both format and version (e.g., “TIFF 6.0”) or whether two semantic units should be defined, one for name and one for version. To allow existing authority lists such as MIME type to be used the group decided on two semantic units. In the Data Dictionary *formatDesignation* has two components: *formatName* and *formatVersion*.

Second, centrally maintained format registries are expected to be the best way to get detailed format information in the future.[8] In the PREMIS model the format name provides an indirect link to the format specification. In the registry environment not one but two things must be known: what registry is being used, and what identifies the specification within the registry. The group discussed whether to combine all format identification into a single set of semantic units, or define different containers for registry and non-registry environments. A good argument for a single set is that a repository that uses its own authority list of format names to associate digital objects with specifications is, in essence, maintaining its own format registry, where the identification of the registry itself is simply assumed. However, with major format registries still under development the group was reluctant to make assumptions about what would be needed to use them. Ultimately, two containers were defined: *formatDesignation* and *formatRegistry*. In case different registries might emerge to provide different types of information, *formatRegistry* was made repeatable.

It is not uncommon for particular implementations of formats to be specified, often called profiles. For example, GeoTIFF (for geographic images), TIFF/EP (for digital cameras), and TIFF/IT (for prepress images) are compatible with the TIFF specification, but narrow it by requiring certain options, or extend it by adding tags. Because of this it is possible for a file to have more than one format, for example, both TIFF and GeoTIFF. The group discussed various options to accommodate this, such as making the format designation repeatable or defining format profile as a separate semantic unit. Instead the decision was to recommend recording the most specific format designation that applies. A repository (or formats registry) may use multipart format names (e.g., “TIFF_GeoTIFF” or “WAVE_MPEG_BWF”) to achieve this specificity.

The group recognized that the most specific designation is a matter of opinion and will be implementation specific. For example, for a METS document (that is, an XML instance conforming to the METS schema) one repository may consider XML to be the most specific format, while another may consider METS to be the most specific format.

Environment

Digital materials are distinctly different from analog materials because a complex technical environment is interposed between user and content. Application software, operating systems, computing resources, and even network connectivity allow the user to render and interact with the content. Separating digital content from its environmental context can make the content unusable. Therefore, careful documentation of the technical environment associated with an archived digital object can be an essential component of preservation metadata.

Since digital environments are made up of components that can be broken down into smaller and smaller components, their descriptions can easily become extremely complex. It is also possible that these descriptions will tend to be the same for entire classes of digital objects, for example, for all files of a particular format. Both of these factors suggest that the most efficient model for collecting and maintaining environment metadata is a centralized registry. While the development of the PREMIS *environment* container did not presuppose the existence of such a registry, it might best be interpreted as a template for the types of information an environment registry might maintain, rather than what a repository is likely to record locally.

The semantic units associated with the *environment* container represent the PREMIS working group’s recommendation of what a repository needs to know about an archived object’s environment. How this information is known—through a central registry, through locally recorded metadata, or both—is an implementation issue that must be resolved by the repository.

The working group decided to limit its scope to environment metadata associated with objects currently in the repository. Strategies for recording changes to the environment over time is an implementation issue and therefore beyond the scope of the Data Dictionary.

Sometimes multiple environments support a single digital format. The Data Dictionary acknowledges this possibility by making the *environment* container repeatable, but this is in no way intended to suggest that a repository should attempt to account for every possible software/hardware combination compatible with a particular archived object. Documented environments should, however, include the semantic unit *environmentCharacteristic*, populated by an appropriate value such as “minimum,” “recommended,” “known to work,” etc. The working group generally agreed that at least a “minimum” environment should be specified. Specification of an environment that is “known to work” may be necessary in cases where it is important to preserve certain significant properties of the object—aspects of the object’s original look, feel, and functionality. In these circumstances, it is useful to document an environment that is known to render these attributes faithfully.

The working group considered whether environment metadata can usefully apply to representations, files, and bitstreams. Although in most cases it does not apply to bitstreams, since software operates on known file formats, or in the case of compound objects, on aggregations of known file formats, it could have apply to bitstreams in some situations. For instance, it is possible for a single AVI file to be used as the common container for video streams each requiring the use of specialized rendering software. In an AVI file encapsulating heterogeneous bitstreams, each of the bitstreams may require a substantially unique preservation workflow. Setting the environment at the bitstream level maintains the important association that a particular bitstream requires a particular environment. If the environment were set at the file level, this association would be lost, complicating preservation efforts that require the disaggregation of the file.

However, in other cases a file format may contain two or more discrete bitstreams with wholly different semantics, but software designed to support the format may be able to correctly interpret and/or render any bitstream appearing within the file. For example, a TIFF viewer rendering an image knows to skip past the header information (a bitstream within the file) to reach the image data (a second bitstream within the file). It is not always necessary to detail separate environment information for each of these bitstreams if they are both handled by any rendering application compatible with the TIFF format specification.

Note that environment metadata may differ at the representation and file levels for a particular Object. For example, a browser is appropriate for rendering a multimedia Web page consisting of text, static images, animation, and sound components, but each component rendered separately would require different environments than the one for the compound object as a whole.

The working group decided not to recommend supplying separate environment information for both the preservation and the dissemination versions of an Object (where the dissemination version is the version made available to users in a Dissemination Information Package or DIP). If dissemination versions are stored by the repository separately from preservation masters, these are stored objects and can be described by all metadata applicable to Object entities. If dissemination versions are generated “on the fly” from stored preservation masters, the environment to support them is not strictly a preservation issue. While environment information for dissemination versions may in some cases be useful, it is not core in the sense of being necessary to support the preservation process. (See also the discussion of dissemination format, page 4-10.)

Another point of discussion was whether the mechanism(s) by which archived objects are delivered from the repository to the user (i.e., over a network, on CD, on DVD, etc.) should be part of the environment metadata. The argument in favor of this is that the rendering environment must support the requirements implied by the delivery mechanism—if content is delivered on CD-ROM, the rendering environment must include a CD-ROM drive. However, the group decided that knowledge of the delivery mechanism was not essential to support the preservation process and therefore not core. Moreover, the usefulness of a delivery mechanism description will likely vary from repository to repository, depending on local dissemination policies.

Despite the critical importance of environment metadata for ensuring that digital materials remain accessible and usable over the long term, the working group reluctantly decided to make the entire *environment* container optional. The group could not assert categorically that every preservation strategy that exists or might be developed would require a knowledge of environment information. However, the fact that the *environment* container is currently optional does not indicate that the working group considers this metadata unimportant. Well-documented environments for access and use are an essential component of most digital preservation strategies. Much work remains to be done, however, to establish practical mechanisms for collecting, storing, and updating this metadata.

Object characteristics and composition level: the “onion” model

When an object is compressed or encrypted, the format of the object is determined by the compression or encryption scheme. At the same time, the object has an underlying format that is different. Objects such as these pose the problem of how to describe complex layers of encodings and encryptions so that they can be reversed correctly. The group arrived at the metaphor of an onion: a digital object can be wrapped in layers of encodings that need to be “peeled off” in a particular sequence. The onion model is implemented by treating each layer as a “composition level,” and organizing metadata into sets of values pertaining to each layer.

The simplest example is a single file with no encoding or encryption. In this case there would be one instance of the semantic unit *objectCharacteristics* with *compositionLevel* value of 0 (zero). The object characteristics of a simple PDF, for example, might include a message digest, a size of 500,000 bytes, a format of PDF 1.2, inhibitors such as no printing allowed, and creating application of Adobe Acrobat. If a compressed version of that PDF file were created using the UNIX gzip utility and stored in the repository, the compressed file would be described with two *objectCharacteristics* blocks. The first, with *compositionLevel* zero, would be the same as for the simple PDF, and the second with *compositionLevel* 1, would record another message digest, a smaller size, and a format of gzip. This could continue for as many layers as necessary to describe the object completely.

To extract the content object, one works backwards through the composition levels from highest to lowest, using an application appropriate to the format of the layer. In the example above, to get to the PDF one applies a tool that understands the gzip format. Having un-gzipped the content, it can be compared to the size and fixity information previously stored to determine that the correct object has been extracted. (In practice, some of the encodings have checking mechanisms built in.)

Note that this model assumes that the object is being stored with the composition layers preserved. If the archive has already removed the layers and is storing the base object, the information about the removal of the layers is Event data rather than composition data. That is, if a decompressed version of object A is created and called object B, A is related to B by a derivation relationship (*sourceOf*) with a related decompression event.

Bitstreams and filestreams are not composition layers. If an archive chooses to manage bitstream or filestream objects, they are separate objects whose storage location is at an offset inside a file, which is itself a separate object with characteristics and metadata and its own storage location. Each of these may have composition layers including encryption and encodings. The level-zero composition layer of the file would be the file without encryption or encoding; that a bitstream inside that file is a managed object is a separate issue (and object) distinct from the layers of encodings of the file.

Formats such as tar and ZIP that can bring together ("package") several files into one file present a related but not identical problem. If the package consists of only one object, one could treat the package as yet another composition layer; for example, a file that is encrypted, then zipped would have three composition levels. If the package contains more than one file, however, it should be treated as a separate object that provides the storage location for the contained objects so that there can be distinct metadata records for each of the contained objects. For example, a ZIP file containing two PDF files should be treated as three objects: the ZIP file with a base composition format of ZIP, and two other objects whose storage location is inside the ZIP file. As with bitstreams, the objects inside the ZIP file object are logically distinct from the containing object. They each may have completely different sets of metadata and indeed may have additional composition layers as well. One could imagine an encrypted ZIP file containing two files that are themselves each separately encrypted. There would then be three objects, each with two composition levels.

Fixity, integrity, authenticity

In the process of defining core elements for preservation the working group gave considerable attention to the concepts of fixity, integrity, and authenticity of digital objects. Objects that lack these features are of little value to repositories that have the mission to protect evidentiary value or indeed to preserve the cultural memory.

In the PREMIS Data Dictionary the information needed to verify fixity (that an object is unchanged since some earlier point in time) is described by a set of semantic components under the semantic unit *objectCharacteristics*. Running a fixity check program on an object to detect unauthorized changes to it is detailed as an Event. In the analog world acts of publication and production serve to fix an object in time. In the digital domain hash algorithms that create a message digest can be used to implement a fixity check for an object. If the message digest created by an algorithm at one point is identical to the message digest created by the same algorithm at a later point, this indicates the object did not change during the interim. In fact, recommended practice is to create and test at least two message digests using two different algorithms to be certain that an object is fixed.

While this procedure can indicate with some confidence that an object has not changed over time, it does not address the object's integrity or authenticity. In the PREMIS model, verifying the integrity of an object is considered an Event. Format identification and validation are key indicators of the integrity of a file. Software technology such as JHOVE can verify that a format is what its file extension claims as well as determine the level of compliance to a particular format specification.[9] The integrity of a representation may have to be verified by special programs that understand the structure of the representation. If the representation includes structural metadata, the structural metadata can be used to test that all files are present and appropriately named.

The authenticity of a digital object is the quality of being what it purports to be. As the Digital Preservation Coalition (DPC) explains, "In the case of electronic records, [authenticity] refers to the trustworthiness of the electronic record as a record…Confidence in the authenticity of digital materials over time is particularly crucial owing to the ease with which alterations can be made."[10]

Authentication, or the demonstration of authenticity, is multifaceted, and includes both technical and procedural aspects. Technical approaches may include the maintenance of detailed documentation of digital provenance (the history of the object), the preservation of a version of the object that is, bit-wise, identical to the content as submitted, and the use of digital signatures. PREMIS metadata supports the documentation of provenance by defining semantic units associated with events and allowing linking between Object entities and Event entities. Fixity can be tested against stored message digest information and the testing itself recorded as an event. Digital signatures are discussed next.

Digital signatures

Preservation repositories use digital signatures in three main ways:

- For submission to the repository, an agent (author or submitter) might sign an object to assert that it truly is the author or submitter.
- For dissemination from the repository, the repository may sign an object to assert that it truly is the source of the dissemination.
- For archival storage, a repository may sign an object so that it will be possible to confirm the origin and integrity of the data.

The first and second usages are common today as digital signatures are used in the transmission of business documents and other data. Typically, validation takes place shortly after signing and there is no need to preserve the signature itself over time. In the first case the repository may record the act of validation as an Event, and save related information needed to demonstrate provenance in the event detail. In the second case the repository might also record the signing as an Event but the use of the signature is the responsibility of the receiver. Only in the third case, where digital signatures are used by the repository as a tool to confirm the authenticity of its stored digital objects over time, must the signature itself and the information needed to validate the signature be preserved.

Just as with a pen-and-ink signature or seal, reliable digital signatures require that:

- The process of producing a signature, such as a person's physical signature, is considered to be unique and uncopyable.
- The signature is related to the content of the document that was signed.
- The signature can be recognized by others to be the signature of the person or entity that produced it.

To create a digital signature, first a secure hash algorithm (SHA) is applied to content (a file or bitstream) and used to produce a short message digest from that content. The message digest is then encrypted using asymmetric cryptography. Asymmetric cryptography is based on using a pair of keys: a private key to encrypt and a public key to decrypt. The private key must be held secretly and securely by the signer, ideally in secure hardware. This accomplishes the goal of a unique and uncopyable signature. Since the message digest that is encrypted is tied directly to the content this also accomplishes the goal of relating the signature to the content. The signature can be verified by decrypting the signature with the signer's public key and comparing the now-decrypted digest with a new digest produced by the same algorithm from the same content. If the content had been changed, the comparison would fail.

The goal of connecting the signature to the signer is based on establishing trust. For example, agent A ought to trust a signature by agent B if a third party trusted by A asserts that the signature is truly B's. This principle governs notarization of written signatures. The same approach is used in digital signatures, where a trusted third party certifies that a particular key is indeed the public key of the signer. This extends to a chain of trust, whereby the trusted body trusts an intermediary which in turn certifies the signer's public key. This process is typically, but not necessarily, implemented using X.509 certificates, or certificate chains.

This is important for preservation, because the standard current mechanisms for establishing trust in a certificate relies on a set of services that are not likely to be available for the long term. For preservation widely sharing and safely storing the public key as a formal document may be a more suitable approach. For example, a university might regularly publish its public key in its annual report and make it available on its Web site.

Digital signature metadata

For a preservation repository to later validate a digital signature the repository will need to store:

- The digital signature itself.
- The name of the hash algorithm and encryption algorithm used to produce the digital signature.

- The parameters associated with these algorithms.
- The chain of certificates needed to validate the signature (if a certificate model is used to relate the signer and the signer's public key).

It is recommended that a repository also store the definitions of the algorithms and relevant standards (e.g., for encoding the keys) so that these methods could be reimplemented if necessary.

The W3C's *XML-Signature Syntax and Processing* (*XML Signatures*) is a de facto standard for encoding digital signatures that provides a clear functional model for them.[11] PREMIS adopted the names and structure of semantic units from that specification where applicable. However, *XML Signatures* is both too generalized and too specific to be applied directly in this context. It is too generalized because it allows multiple data objects (files and/or bitstreams in the PREMIS model) to be signed together, while in the PREMIS model a digital signature is a property of a single object. It is too specific because it prescribes a particular encoding and validation methodology that is not universally applicable.

The Data Dictionary defines the following structure:

signatureInformation
- signatureInformationEncoding
- signer
- signatureMethod
- signatureValue
- signatureValidationRules
- signatureProperties
- keyInformation

The digital signature itself is the *signatureValue*. The hash and encryption algorithms used are recorded in *signatureMethod*; for example, "DSA-SHA1" would indicate the encryption algorithm is DSA and the hash algorithm is SHA1. The parameters associated with these algorithms are recorded in *keyInformation*, and if X.509 certificates are used to validate the signature they are also placed in *keyInformation*. Information about the generation of the signature, such as date and time, is stored in *signatureProperties.*

The semantic units discussed above have analogs in the *XML Signatures*. Three semantic units were added: *signatureInformationEncoding, signer,* and *signatureValidationRules.* The semantic unit *signatureInformationEncoding* indicates the encoding of the values of the subsequent semantic units; this is not included in *XML Signatures* because that document mandates a particular encoding, which cannot be assumed in a broader context. The name of the signer can be extracted from the signer's certificate, but isolating this in *signer* makes it easier to access. Documentation of the process to be used in validating the signature is stored or pointed to in *signatureValidationRules.*

Non-core metadata

The working group decided not to include some metadata concepts in the Data Dictionary. Unless otherwise noted this does not imply that these semantic units are not necessary or important in other contexts. For specific implementations there may be legitimate reasons to record this information in some form.

Aggregation: Aggregation means the embedding of objects into a larger object (rather than a collection of discrete objects). The property of being an aggregate can be inferred from the presence of multiple files and/or bitstreams, which will be documented in *objectCharacteristics*. That semantic unit makes no distinction between an aggregation that is ingested and an aggregation that is created by the preservation repository for storage or other purposes; however, this distinction was not felt to be core.

Quirks and anomalies: The *Framework* defines "quirks" as "any loss in functionality or change in the look and feel of the Content Data Object resulting from the preservation processes and procedures implemented by the archive." The working group used "anomalies" to describe aspects of an object that do not meet the specification for the object. The discussions of quirks and anomalies centered on whether they should be defined as the outcomes of Events or classified as properties of Objects.

The argument for treating these as outcomes of events is that quirks by definition result from an event, and anomalies are discovered through the event of validation. If treated this way, an anomaly would be recorded as part of the description of a validation event; the semantic unit *eventOutcome* would indicate problems, and the semantic unit *eventOutcomeDetail* would record the known anomalies.

An argument for treating quirks and anomalies as properties of an object is that this appears to elevate them in importance and gives them a direct as opposed to indirect association with the object.

The decision is arbitrary. The Data Dictionary treats quirks and anomalies as outcomes of events, recorded in *eventOutcomeDetail*.

Byte order: Byte order determines whether numbers of more than eight bits are stored from most to least significant ("big-endian") or from least to most significant ("little-endian"). Byte order is hardware dependent and can cause problems when data is shared between different types of computers. However, it does not pertain to all formats. For example, it is irrelevant for encodings such as ASCII, where one byte equals one character, and UTF-8, which is byte-order independent. The working group decided that byte order might better be treated as format-specific technical metadata, and noted that NISO/AIIM Z39.87 (Technical metadata for digital still images) includes byte order as technical metadata for images.[12]

Character encoding: This element is important, but it is format-specific technical metadata, useful only for text files and files that can include text.

4. Special Topics

Dissemination format: A great deal of discussion centered on whether dissemination format was in scope. The working group concluded that the "preservation format" is the object of preservation activity, which may or may not be the same as the dissemination format. Whether or not the preservation format is immediately renderable or is transformed for dissemination is an implementation choice. For example, if the preservation format is a TIFF image, one preservation repository might create a dissemination version (say a JPEG image) on the fly for user access, while another repository might deliver the TIFF master. A third repository might store and process both the TIFF master and the JPEG access copy.

The Data Dictionary does not address the creation of metadata objects that are not stored in a preservation repository. Although the group agreed that dissemination format is important to a repository operationally, it is not core to preservation processes.

Embedded metadata: One implementation used a metadata flag to indicate whether a file object contained embedded metadata. The group agreed to leave this indicator out of the Data Dictionary for now, with the understanding that this will probably have to be revisited in the next several years as more and more formats include embedded metadata. For the time being if embedded metadata is extracted and stored elsewhere, there is no need to note the existence of embedded metadata in the file.

The group also discussed the distinction between standard embedded metadata defined by a file format and locally defined metadata that might be inserted into a file header. Any local divergences from standard formats will likely need to be documented as anomalies.

Event type: The semantic unit *eventType* is core, but not all types of events were considered core, and some were deliberately omitted from the list of suggested values provided in the Data Dictionary. Among these, the group agreed that microfilming (preservation reformatting), moving a file offline, and media refreshment were not core events. Events likely to be handled by a storage system, such as mirroring or the creation of backup copies, would probably be recorded in a system log and are not raised to the level of an event that has metadata associated with it.

Event next occurrence: Many actions taken by a preservation repository are performed periodically, for example, daily or weekly monitoring actions. It could be useful to record an action date or "tickler" for the next scheduled occurrence of an event. This was considered a matter of repository policy and implementation, and not a core property of Events.

File pathname/URI: This element was seen as both implementation specific and system dependent. It was not seen as information that would be explicitly recorded in a repository. Often the pathname or location of an object is not known in a content management system; only the unique object identifier of the asset is known and needed for retrieval. Alternatively, in some systems such as the Handle system, the *objectIdentifier* alone is usually sufficient for retrieving the file. Therefore, a broader, less system-dependent semantic unit was defined: *contentLocation* can be interpreted narrowly (a value could be an exact path or a "fully qualified" path or filename) or broadly (any information needed to retrieve a file from a storage system, which may include information used by a resolution system such as the Handle system).

Global identifier: The *Framework* included a “Global Identifier” defined as an identifier known outside of the repository system. The group did not consider the distinction between an externally known identifier and an internally known identifier to be significant. An internal identifier could easily become known outside of the repository and then would be a global identifier. The issue was raised whether internal identifiers would be sufficiently unique in an external context to function as a global identifier. However, as the *objectIdentifier* always includes an identifier type as well as value, the combination of type and value would be unique even if the type were some local repository scheme.

The *Framework* also implied that a Global Identifier would be a standard identifier such as ISBN or ISSN. However, because these schemes designate an abstract bibliographic entity or set of items, not the specific content data object in the preservation repository, they are really descriptive metadata rather than preservation metadata. ISBNs, ISSNs, and similar standard identifiers are likely to refer to many different representations held in many different preservation repositories, with no way to distinguish between them. Therefore, the identifier used by the repository must in practice be the “global” identifier.

MIME type: The Internet Media Type and SubType (commonly called “MIME type”) was subsumed under *formatIdentification*. Format identification is intended to be more granular and precise than MIME type and includes multiple format identification schemes, of which MIME type can be one. A MIME type alone is not rigorous enough to identify formats for digital preservation—not all formats have MIME types, it is too coarse a typing mechanism, it is not necessarily current, and it provides no versioning information. Good practice is to include format name and version and use MIME type only if no other data is available.

Modification date: The PREMIS data model asserts that metadata describes only one object at any given time. If an object is changed or modified, a new object is created that is related to the previous one. Each object then has its own set of metadata, and the relationship between the two is also described. The model does not allow for modifying an object and keeping a set of metadata that describes a history of changes about that object. Therefore, there would be no modification date of an object, only a creation date for the new object. The act of modification (e.g., migration, normalization) is documented as an Event and is linked to the object that is created as a result of these processes. Modification date was considered by the group in the context of an Event record that is associated with an Object, rather than a date associated with a history of changes to the metadata associated with an object.

Object type: The group discussed the desirability of having a semantic unit for a genre or media type that would classify objects on a much higher level than format. There is such an element in the METS schema, but currently there is no controlled vocabulary defined for its value. The group argued that object type is useful information to know at the system level (for example, for performing preservation actions on an entire class of materials) and possibly for categorizing objects in terms of how they are rendered in certain environments. High-level object typing is probably more useful for exchange and access to objects than for preservation purposes. However, developing a universally acceptable list of object types is beyond the PREMIS’s scope and, without an authority list of types, this element would not be entirely useful outside of the repository. This element might be recorded in descriptive metadata.

4. Special Topics

Permanence levels: The group discussed how the National Library of Medicine's Permanence ratings intersected with PREMIS work.[13] The permanence-level rating appeared to be less a property of an Object entity than a property of an entity defining business rules. The group had already decided that business rules were out of scope.

Profile conformance: A "profile" can be seen as a subtype or refinement of a format; for example, the GeoTIFF specification can be seen as a profile of TIFF. There was a question of whether profile conformance should be seen as something separate from format validation. The decision to recommend recording only a single format at the most specific level obviated the need to define a separate semantic unit for profile conformance.

Reason for creation: This metadata element was defined in the *Framework*. The working group concluded that for objects created by the preservation repository (e.g., a normalized version of a file) the reason for creation could be recorded as part of the *eventDetail* for the event of creation. However, the group did not consider at length events or processes that occur before ingest and was not convinced that these were core knowledge for a preservation repository. Some of the context surrounding object creation may be documented in relation to the Object entity in *creatingApplication*. The group expressed some reservations about the life-cycle model used by the *Framework* (origin, pre-ingest, ingest, archival retention, etc.) as being too restrictive.

Sibling relationships: The group discussed whether sibling relationships (children of the same parent) should be made a separate category of relationship. It was agreed that sibling relationships always have a structural relationship (and may possibly also have a derivation relationship), and should therefore fall under these relationship categories. What renders them potentially confusing is that the parent is not always stored within the repository system. For example, a report created using Microsoft Word might be processed to create a PDF version for printing and an HTML version for online display. If both of these representations were stored in the preservation archive without the original Word file, it might not be obvious that the two representations have a sibling relationship.

5. METHODOLOGY

The Core Elements Subgroup began by analyzing the Preservation Description Information recommendations of the earlier Preservation Metadata Framework working group. In OAIS, Preservation Description Information includes reference information (identifiers and bibliographic information), context information (how objects are related to each other), provenance information (the history of digital content), and “fixity” information. Members of the subgroup from institutions actively running or developing preservation repositories mapped elements from the *Framework* to those in use in their own systems. The subgroup also reviewed published specifications from organizations and projects that did not have representatives on the PREMIS working group.

It became clear that the prototype elements detailed in the *Framework* did not always correspond to elements implemented in practice. However, the exercise provided a common denominator for diverse implementations; the group discussed each element in conference calls to discover commonality in usage. Widely used elements formed the beginning of a set of core elements, which were then mapped to appropriate entity types as the data model evolved.

In the OAIS and the *Framework*, technical metadata is considered Representation Information rather than Preservation Descriptive Information. Because there are few technical metadata elements in the *Framework*, the working group compiled a list of potential technical metadata based on specifications for the proposed Global Digital Format Registry (GDFR), supplemented by data elements used in the repository systems of members’ institutions.[14] Each element on the list was then discussed at some length, and any element that was format specific or implementation specific was regarded as non-core. In some cases outside experts were asked to help with particularly difficult areas, including formats, hardware and software environment information, and digital signatures.

The process for determining which semantic units were core involved analysis and discussion of a selection of elements from various sources and a determination of whether they were in scope. In general, the working group excluded these candidates from the Data Dictionary:

- Metadata elements that could be grouped into broader categories.
- Format-specific, implementation-specific, or policy-driven elements.
- Elements outside the PREMIS scope.
- Elements for which information could be obtained easily and reliably from the object itself or other sources.

This page intentionally blank.

6. IMPLEMENTATION CONSIDERATIONS

PREMIS conformance

PREMIS conformance requires a preservation repository to follow the specifications outlined in the Data Dictionary. For example, if the repository claiming to be PREMIS-conformant implements a metadata element sharing the name of a semantic unit in the Data Dictionary, it is expected that the repository's metadata element will also share the definition of the semantic unit. Metadata not defined in the Data Dictionary may certainly be used, but non-PREMIS elements should not conflict with or overlap with PREMIS semantic units. In other words, local metadata can be used to extend but not modify the PREMIS semantic units. Data constraints and applicability guidelines in the Data Dictionary must also be adhered to. For repeatability and obligation, PREMIS conformance permits more stringent but not more liberal application. That is, a semantic unit defined in the Data Dictionary as repeatable can be treated as not repeatable within a repository, but not vice versa.

The PREMIS Data Dictionary designates some semantic units as mandatory when describing representations, files, and/or bitstreams. The mandatory semantic units represent the minimum amount of information 1) necessary to support the long-term preservation of digital objects, and 2) that must accompany a digital object as it is transferred from the custody of one preservation repository to another. There is no prescribed strategy for collecting, storing, or managing the mandatory semantic units within the repository's internal systems. Nor is there a minimum level of information that must be explicitly recorded and maintained locally by the repository. In general, the mandatory semantic units of the Data Dictionary represent the information that a preservation repository must be able to associate with any archived digital object in its possession. The specific means of association (e.g., local metadata storage, shared registries, etc.) are implementation issues and outside the scope of the Data Dictionary.

When a digital object is exchanged between two preservation repositories, the repository sending the object must be able to extract from its systems or from other sources the information needed to populate the semantic units marked mandatory in the Data Dictionary. This information must conform to the specifications in the Data Dictionary and must be packaged with the digital object before its transfer to the second repository. The PREMIS working group believes that this information represents the minimum amount for the second repository to accept custody of the digital object and assume responsibility for its long-term preservation.

Some PREMIS semantic units are equivalent to metadata elements in other metadata schemas. If metadata is taken from other schemas to populate PREMIS semantic units, care must be taken to ensure that this information conforms to the requirements and constraints associated with the corresponding semantic unit in the PREMIS Data Dictionary. Harmonizing the PREMIS Data Dictionary with other metadata schemas in cases where they overlap would help minimize conformance issues. For example, the Z39.87 metadata standard (Technical Metadata for Digital Still Images) revised some of its elements to harmonize them with equivalent semantic units in the PREMIS Data Dictionary.

6. Implementation Considerations

Sometimes a preservation repository exchanges digital objects with parties that are not themselves preservation repositories. When a party submits an object to a preservation repository for archival retention, it is unlikely that the submitter will be in a position to supply the full range of information needed to populate the mandatory semantic units. Instead, it will supply a subset of this information whose extent, ideally, is determined by prior arrangement between the submitter and the repository. Whatever the extent of this subset, any information supplied by the submitter should conform to the Data Dictionary. The repository's ingest process would then supply the rest of the information for the mandatory semantic units.

When a repository disseminates an archived digital object to a user, it is unlikely that the user will be interested in the full range of mandatory semantic units associated the archived object. Instead, the user would be provided with a subset of these semantic units. As in the case of submission, whatever the extent of this subset, any information supplied by the repository should conform to the Data Dictionary.

Achieving interoperability across a network of preservation repositories and other stakeholders requires a shared view of the metadata needed to support long-term preservation, formalized as an implementable schema. PREMIS conformance and the mandatory semantic units are intended to fill this need.

Implementation of the data model

The PREMIS data model is meant to clarify the meaning and use of the semantic units in the Data Dictionary. It is not intended to prescribe an architecture for implementation.

The working group believed that most preservation repositories will need to deal in some way with conceptual entities Objects, Agents, Events, and Rights, and found it useful to distinguish between the properties of subclasses of objects, such as files and filestreams, bitstreams, and representations. A particular repository implementation, however, may need to be more or less granular or define different categories of entity altogether. PREMIS recommends that any data model used be clearly defined and documented, and that metadata decisions be consistent with the data model.

Sets of semantic units may be grouped and related indirectly to particular entities. For example, *environment* is a property of Objects. Logically, each file has one or more associated environments. However, in many cases the environment is determined by the file format; that is, all files of a particular format will have the same environment information. This could be handled in many different ways by different implementations. Three examples:

- Repository 1 uses a relational database system for metadata. It has a file table with a row describing each file object; one column in the file table is format. A format table has a row for each file format; columns in the format table store environment information associated with that format.

- Repository 2 also uses a relational database system. It has a file table with a row for each file object, and an environment table with a row for each unique set of environment information.

The file table has a column for a pointer to the appropriate environment information for each file.

- Repository 3 uses a system that models representations as containers and files as objects within those containers. Each object consists of a set of property/typed value pairs. Properties define roles for values. Property and type descriptions are themselves objects whose identifiers are drawn from the same namespace as other object identifiers. A file object may include a format property. Because format description is also an object, it could include an environment property, which in turn would point to an environment description object. Alternatively, a file object could include an environment property directly.

Storing metadata

The survey by the Implementation Strategies Subgroup showed that repositories have implemented several different architectures for storing metadata. Most commonly, metadata is stored in relational database tables. It is also common to store metadata as XML documents in an XML database, or as XML documents stored with the content data files. Other methods include proprietary flat file formats and object-oriented databases. Most respondents were using two or more of these methods. (For more information, see the *Implementation Survey Report*.)

Storing metadata elements in a database system has the advantages of fast access, easy update, and ease of use for query and reporting. Storing metadata records as digital objects in repository storage along with the digital objects the metadata describes also has advantages: it is harder to separate the metadata from the content, and the same preservation strategies that are applied to the content can be applied to the metadata. Recommended practice is to store critical metadata in both ways.

Supplying metadata values

Most preservation repositories will deal with large quantities of materials, so it is desirable to automate the creation and use of metadata as much as possible. The values of many PREMIS semantic units can be obtained by parsing files programmatically, or can be supplied as constants by repository ingest programs. In cases where human intervention might be unavoidable, the group tended to pair a semantic unit requiring a coded value with a second semantic unit allowing a textual explanation.

When information is supplied by the individual or organization submitting the objects to the repository, recommended practice is for the repository to attempt to verify this information by program whenever possible. For example, if a filename includes a file type extension, the repository should not assume the file extension necessarily indicates the format and should attempt to verify the format of the file before recording this as metadata.

To facilitate automatic processing, the use of controlled vocabularies is recommended whenever applicable. PREMIS assumes that repositories will adopt or define controlled vocabularies useful to them; only a small number of semantic units require values defined in the Data Dictionary. However, the use of many different vocabularies will impede interoperability. Recommended practice is for a repository to note the source of each controlled vocabulary used when exporting metadata for exchange. The group expects that as more experience is gained in digital preservation, and as repositories begin to exchange PREMIS-conformant metadata some dominant vocabularies may emerge.

In Resource Description Framework (RDF), use of resource URIs as property values is encouraged, and many XML Schemas require attribute values to be URIs.[15] For example, in the *XML Signatures*, the value of the signature method algorithm must be a URI, such as “http://www.w3.org/2000/09/xmldsign#dsa-sha1”.

In general, resource URIs are allowable as values for semantic units in the PREMIS Data Dictionary, unless some noted constraint would disallow this. However, the working group was wary of recommending this practice for preservation. Resolution of URIs depends on a protocol that while currently ubiquitous is outside the control of the preservation repository. Also, the group felt strongly that any information needed for long-term preservation should be stored within the repository itself. If this information is stored as a preservation object, it is best referenced by the repository’s *objectIdentifier*. Information stored otherwise should still be under the direct control of the repository. Therefore, most examples in the Data Dictionary are names of values rather than resource URIs. The equivalent of the example above might be simply “DSA-SHA1,” which should be assumed to be a constant whose meaning is known to the repository through some table or other documentation under the control of the repository organization.

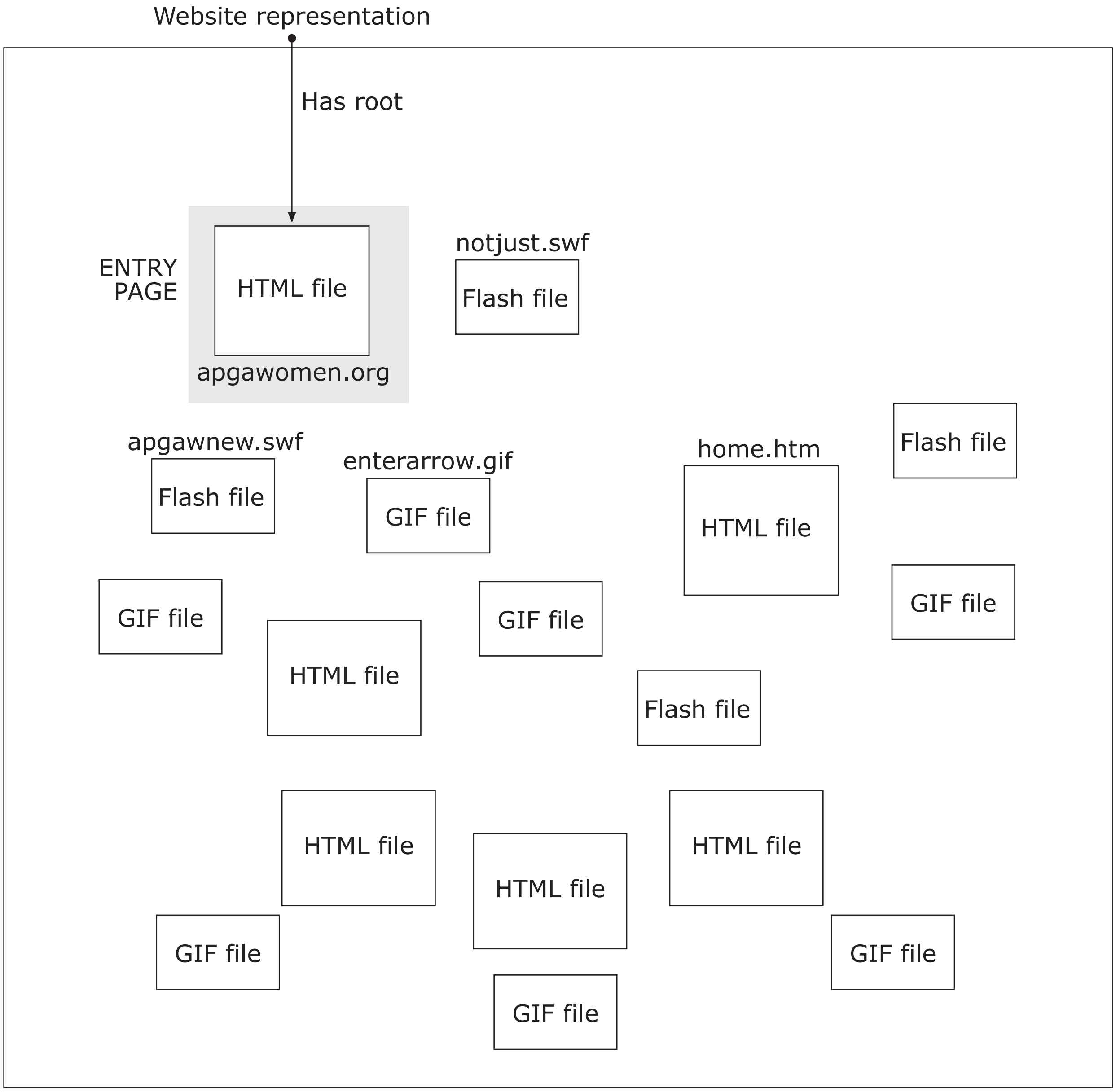
Preservation metadata for Web sites and Web pages

The PREMIS working group had several discussions about the peculiarities of Web sites and Web pages that are archived for preservation purposes. Many of the current projects archiving Web sites have dealt with them in terms of access rather than preservation, so there is little experience in applying preservation metadata. A particular problem with Web sites and Web pages is the difficulty viewing them in an implementation-neutral way.

- **Objects:** Since Web sites are complex, with many layers of component objects and relationships, there are various interpretations of what really constitutes a site or page as an object of preservation. Some harvesters aggregate objects into larger files. For example, the harvester used by the Internet Archive aggregates objects into an “.arc” or “.warc” file. One of these files may contain page components from more than one Web site, and pages from one Web site may be spread over multiple .arc files. In this case an additional tool is needed to bring together all the pieces of a logical Web page. With this situation the repository must decide whether it considers its object of preservation to be the .arc file or the conceptual Web site. This is an implementation decision, similar to that made about other file types that package filestreams together, like ZIP files. The working group thought it may be advantageous to consider the object of preservation the conceptual Web site. Web harvesting programs will undoubtedly evolve, and any particular container format is not likely to have a long life span.

- **Relationships among components:** There are several ways to model the relationships between the components of a Web site, even leaving aside the complexities of multiple captures. Assume a Web site consists of a finite number of pages that in turn consist of one or more files; for example, one page may be simply a PDF file, while another may be an HTML file, several images, and a Flash animation. At one extreme, a repository could designate one file as the parent for each page and describe the others as ordered or unordered children, duplicating relationship information stored internally within files as metadata. At the other extreme, the Web site as a whole could be described as a representation, and the many files that make up the site could be described as file Objects having an "is part of" relationship to the Web site representation (see page 6-6). Alternately, the repository could consider each page a representation as well, with the file Objects composing each page having an "is part of" relationship to the page, and the representation Object for each page having an "is part of" relationship to the Web site representation (see page 6-7) Working with a representation of the whole Web site means the repository does not need to maintain more hierarchical relationship information because linking information is contained within the files themselves. All three models, however, require the designation of one file as the root file, the file you go to first in order to reassemble the representation.

Website representation
internal relationships
option 1



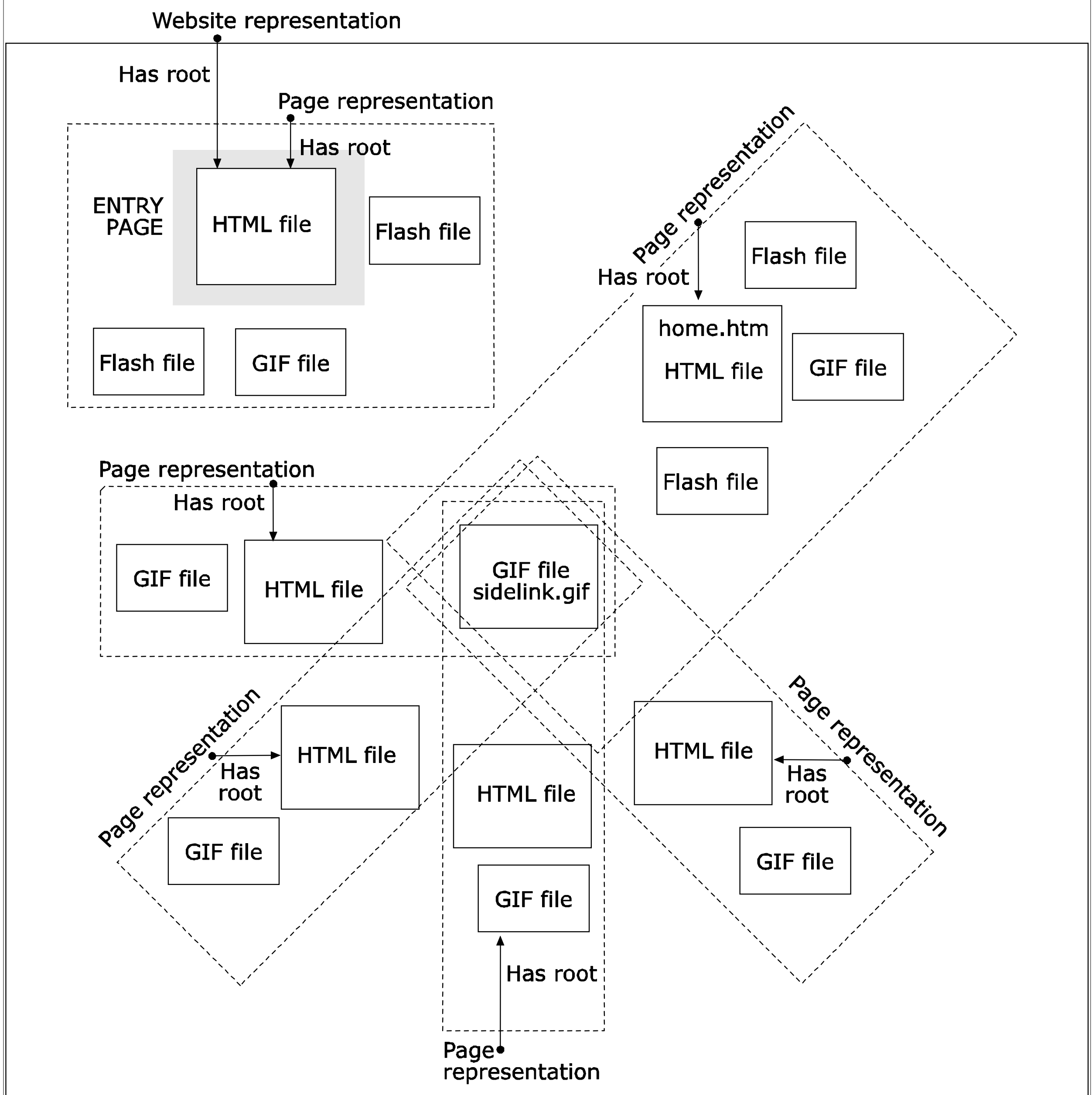
Notes:

1) Only relationship information is that all are part of the website representation

2) All objects have "Is part of" relationship to the website representation

3) HTML file serving as entry page is designated as root file

Website representation
internal relationships
option 2



Notes:

1) Relationships: All objects are part of representation.

2) Separate representations for each page (all files)

3) HTML designated "root" for each

4) Each object has "Is part of" relationship to its page

5) One GIF file (sidelink.gif) has "Is part of" relationship to each page representation in site

6. Implementation Considerations

- **Relationships among captures:** There appears to be no widely accepted model for representing the relationships between different captures of a Web site. If different time-dependent captures of a Web site or Web page are treated as formally different Intellectual Entities, like different editions of a work, the metadata describing these relationships would formally be descriptive metadata and outside the scope of PREMIS. However, a repository might prefer to treat all captures of a Web site or Web page as Objects related temporally. Implementers of this approach might consider recording temporal as well as structural and derivative relationships as metadata.

- **Capture date:** Another point of discussion was how to treat the date the Web site or Web page was captured. Since different captures could be considered different Intellectual Entities, the date captured could be considered descriptive metadata and therefore out of scope for PREMIS. On the other hand there is a semantic unit for recording the date that an application created an object (*dateCreatedByApplication*) that would pertain to an aggregate created by the harvester, like the Internet Archive's .arc files. If the harvested files were altered in any way by the harvester (that is, if they are not exact copies of the source files), this element should be used for the date of capture, since the harvester is literally the creating application of the harvested files. This creates another problem: where to record the creating application and create date of the source files. In any case, the act of capture can be recorded as a pre-ingest event.

The PREMIS working group thought it would most flexible to provide a few alternatives for describing the complex relationships between files that constitute Web sites. Best practices are likely to emerge after some further experimentation.

7. GLOSSARY

Early in its work, the PREMIS working group realized the need for a glossary, since a common vocabulary seemed to be lacking in discussions about preservation metadata. This glossary defines a number of terms used in this report; the working group recognizes that in some cases other groups may have given different meanings to some of these terms. Terms were selected for inclusion in the glossary on the basis of their relative importance or frequency of occurrence in the report and Data Dictionary, and/or the potential for ambiguity or confusion in their interpretation.

Terms that are capitalized are defined elsewhere in the glossary.

Actionable: Property of a Semantic Unit indicating that the Semantic Unit is recorded/coded in such a way as to be machine processable.

Agent: Actor (human, machine, or software) associated with Events occurring over the course of a Digital Object's life cycle.

Anomaly: Property of a Digital Object that does not meet the specification for the Digital Object.

Authenticity: Property that a Digital Object is what it purports to be.

Bit-Level Preservation: Preservation strategy in which the sole objective is to ensure that a Digital Object remains fixed (unaltered) and viable (readable from media). No effort is made to ensure that the Digital Object remains renderable or interpretable by contemporary technology.

Bitstream: Contiguous or non-contiguous data within a file that has meaningful common properties for preservation purposes. A Bitstream cannot be transformed into a standalone File without the addition of file structure (headers, etc.) and/or reformatting the Bitstream in order to comply with some particular Format. Note that this definition is more specific than the common definition of "bitstream" used in computer science.

Business Rules: Policies and other restrictions, guidelines, and procedures governing the administration and operation of a Preservation Repository.

Byte: A component in the machine data hierarchy usually larger than a bit and smaller than a word; now most often eight bits and the smallest addressable unit of storage. A byte typically holds one character. (From FOLDOC: foldoc.doc.ic.ac.uk/foldoc/foldoc.cgi?query=byte)

Capture: Process by which a Preservation Repository actively obtains Digital Objects for long-term retention, for example, a harvesting program that collects Web sites. Note that the Capture process precedes the Ingest process.

Complex Object: See Compound Object.

7. Glossary

Compound Object: Digital Object composed of multiple Files, for example, a Web page composed of text and image files.

Compression: Process of coding data to save storage space or transmission time. Although data is already coded in digital form for computer processing, it can often be coded more efficiently (using fewer bits). For example, run-length encoding replaces strings of repeated characters (or other units of data) with a single character and a count. There are many compression algorithms and utilities. Compressed data must be decompressed before it can be used. (From FOLDOC: foldoc.doc.ic.ac.uk/foldoc/foldoc.cgi?query=compression)

Container: In the Data Dictionary, a Semantic Unit used to group other related Semantic Units. A container Semantic Unit takes no value of its own.

Core Preservation Metadata: Semantic Units that most Preservation Repositories will need to know in order to support the digital preservation process. Core Preservation Metadata should be independent of factors such as specific preservation strategy, type of archived content, and institutional context.

Data File: See File.

Data Object: See Digital Object.

Deaccession: Process of removing a Digital Object from the inventory of a Preservation Repository.

Decompression: Process of reversing the effects of data Compression. (From FOLDOC: foldoc.doc.ic.ac.uk/foldoc/foldoc.cgi?decompress)

Decryption: Process of employing any procedure used in cryptography to convert ciphertext (encrypted data) into plaintext. (From FOLDOC: foldoc.doc.ic.ac.uk/foldoc/foldoc.cgi?decryption)

Deletion: Process of removing a Digital Object from repository storage.

Dependency Relationship: Relationship where one Digital Object requires another Digital Object to support its function, delivery, or coherence of content.

Derivation Relationship: Relationship between Digital Objects where one Object is the result of a Transformation performed on the other Object.

Descriptive Metadata: Metadata that serves the purposes of discovery (how one finds a resource), identification (how a resource can be distinguished from other, similar resources), and selection (how to determine that a resource fills a particular need, for example, for the DVD version of a video recording). (From Caplan, *Metadata Fundamentals for All Librarians*, ALA Editions, 2003)

Digital Migration: See Migration.

Digital Object: Discrete unit of information in digital form. A Digital Object can be a Representation, File, Bitstream, or Filestream. Note that the PREMIS definition of Digital Object differs from the definition commonly used in the digital library community, which holds a digital object to be a combination of identifier, metadata, and data.

Digital Provenance: Documentation of processes in a Digital Object's life cycle. Digital Provenance typically describes Agents responsible for the custody and stewardship of Digital Objects, key Events that occur over the course of the Digital Object's life cycle, and other information associated with the Digital Object's creation, management, and preservation.

Digital Signature Validation: Process of determining that a decrypted digital signature matches an expected value when the correct keys, algorithms, and parameters have been used. Validation confirms the originator and Fixity of the signed Digital Object.

Dissemination: Process of retrieving a Digital Object from the Preservation Repository's archival storage and making it available to users. In the context of OAIS, Dissemination involves transforming one or more Archival Information Packages (AIP) into a Dissemination Information Package (DIP) and making it available in a form suitable for the Preservation Repository's Designated Community.

Emulation: Preservation strategy for overcoming technological obsolescence of hardware and software by developing techniques for imitating obsolete systems on future generations of computers. (From DPC: www.dpconline.org/graphics/intro/definitions.html)

Encryption: Process of employing any procedure used in cryptography to convert plaintext into ciphertext (encrypted message) in order to prevent any but the intended recipient from reading that data. Schematically, there are two classes of encryption primitives: public-key cryptography and private-key cryptography; they are generally used complementarily. Public-key encryption algorithms include RSA; private-key algorithms include the obsolescent Data Encryption Standard, the Advanced Encryption Standard, as well as RC4. (From FOLDOC: foldoc.doc.ic.ac.uk/foldoc/foldoc.cgi?query=encryption)

Entity: Abstraction for a set of "things" (agents, events, etc.) described by the same properties. The PREMIS data model defines five types of Entities: Intellectual Entities, Objects, Agents, Rights, and Events.

Event: Action that involves at least one Digital Object and/or Agent known to the Preservation Repository.

File: Named and ordered sequence of Bytes that is known by an operating system. A File can be zero or more Bytes, has access permissions, and has file system statistics such as size and last modification date. A File also has a Format.

Filestream: Embedded Bitstream that can be transformed into a standalone File without adding any additional information, for example, a TIFF image embedded within a tar file, or an encoded EPS within an XML file.

7. Glossary

Fixity: Property that a Digital Object has not been changed between two points in time.

Fixity Check: Process of verifying that a File or Bitstream has not been changed during a given period. A common Fixity Check method is to compute a message digest (“hash”) at one point and recalculate the message digest at a later point; if the digests are identical, the object has not been altered.

Format: Specific, preestablished structure for the organization of a File, Bitstream, or Filestream.

Format Migration: See Migration.

Forward Migration: See Migration.

Granularity: Relative size, scale, level of detail, or depth of penetration that characterizes an object or activity. “Level of granularity” is often used to refer to the level of focus in a hierarchy; for example, in a hierarchy of entity types from largest to smallest, collection, intellectual entity, representation, and file would be different levels of granularity. In the context of preservation metadata specifically and metadata generally, granularity is important in defining at what level a particular metadata element or Semantic Unit applies, for example, to a Representation, to a File, or to a Bitstream.

Ingest: Process of adding objects to a Preservation Repository’s storage system. In the context of OAIS, Ingest includes services and functions that accept Submission Information Packages (SIP) from Producers, and transforms them into one or more Archival Information Packages (AIP) for long-term retention.

Inhibitor: Feature of a Digital Object intended to inhibit access, copying, Dissemination, or Migration. Common Inhibitors are Encryption and password protection.

Intellectual Entity: Coherent set of content that is described as a unit, for example, a book, a map, a photograph, a serial. An Intellectual Entity can include other Intellectual Entities; for example, a Web site can include a Web page, a Web page can include a photograph. An Intellectual Entity may have one or more Representations.

Media Migration: Form of Replication, in which a Digital Object is copied onto a different type of digital storage medium because the original medium is in danger of obsolescence.

Media Refreshment: Form of Replication, in which a Digital Object is copied onto a different unit of storage of the same or similar medium as the original. Note: Media Refreshment is used in preference to the definition of “refreshment” in the *OAIS Reference Model*. OAIS defines refreshment as a “Digital Migration where the effect is to replace a media instance with a copy that is sufficiently exact that all Archival Storage hardware and software continues to run as before.”

Message Digest Calculation: Process by which a message digest ("hash") is created for a Digital Object residing in a Preservation Repository. See also Fixity Check.

Migration: Preservation strategy in which a Transformation creates a version of a Digital Object in a different Format, where the new Format is compatible with contemporary software and hardware environments. Ideally, Migration is accomplished with as little loss of content, formatting and functionality as possible, but the amount of information loss will vary depending on the Formats and content types involved. Also called "format migration" and "forward migration."

Note: Migration and Media migration are used in preference to the definition of "digital migration" in the *OAIS Reference Model*. OAIS defines digital migration as the "transfer of digital information, while intending to preserve it, within the OAIS. It is distinguished from transfers in general by three attributes: 1) a focus on the preservation of the full information content; 2) a perspective that the new archival implementation of the information is a replacement for the old; and 3) an understanding that full control and responsibility over all aspects of the transfer resides with the OAIS."

Namespace: Set of names in which all names are unique. (From FOLDOC: foldoc.doc.ic.ac.uk/foldoc/foldoc.cgi?namespace)

Normalization: Form of Migration in which a version of a Digital Object is created in a new Format with properties more conducive to preservation treatment. Normalization is often implemented as part of the Ingest process.

Object: See Digital Object.

Permission: Agreement between a rights holder and a Preservation Repository, allowing the Preservation Repository to undertake some action.

Pre-Ingest: Period in the life cycle of a Digital Object *before* it is Ingested into a Preservation Repository.

Preservation Metadata: Information a Preservation Repository uses to support the digital preservation process.

Preservation Repository: Repository that, either as its sole responsibility or as one of multiple responsibilities, undertakes the long-term preservation of the Digital Objects in its custody.

Profile: Specification for a particular implementation of a Format. For example, GeoTIFF is a profile of TIFF.

Quirk: Any loss in functionality or change in the look and feel of a Digital Object resulting from the preservation processes and procedures implemented by a Preservation Repository. (See also the definition supplied by the National Library of Australia www.nla.gov.au/preserve/pmeta.html#14)

7. Glossary

Refreshment: See Media Refreshment.

Relationship: Statement about an association between instances of Entities.

Render: To make a Digital Object perceptible to a user, by displaying (for visual materials), playing (for audio materials), or other means appropriate to the Format of the Digital Object.

Replication: Process of copying a Digital Object so that the copy is bit-wise identical to the original. Media Migration and Media Refreshment are specific types of Replication.

Representation: Digital Object instantiating or embodying an Intellectual Entity. A Representation is the set of stored Files and structural metadata needed to provide a complete and reasonable rendition of the Intellectual Entity.

Rights: Assertions of one or more rights or permissions pertaining to a Digital Object and/or an Agent.

Root: The File that must be processed first in order to render a Representation correctly.

Semantic Component: Semantic Unit grouped with one or more other Semantic Units within a Container. A Semantic Component may itself be a Container.

Semantic Unit: Property of an Entity. Note: The PREMIS Data Dictionary makes a distinction between a Semantic Unit and a metadata element. A Semantic Unit is information that a Preservation Repository needs to know; a metadata element is how that information is actually recorded. So in practice there could be a one-to-one relationship between a Semantic Unit and its associated metadata element; a one-to-many relationship; or even a many-to-one relationship. Ultimately, the translation of a set of Semantic Units into a corresponding set of metadata elements is an implementation issue.

Simple Object: Digital Object consisting of a single File, for example, a technical report complete in one PDF file.

Store: Write a File to some non-volatile storage device such as disk, tape, or DVD.

Structural Relationship: Relationship between parts of a Digital Object.

Technical Metadata: Information describing physical (as opposed to intellectual) attributes or properties of Digital Objects. Some Technical Metadata properties are Format specific (that is, they pertain only to Digital Objects in a particular Format, for example, color space associated with a TIFF image), while others are Format independent (that is, they pertain to all Digital Objects regardless of Format, for example, size in bytes).

Transformation: Process performed on a Digital Object that results in one or more new Digital Objects that are not bit-wise identical to the source Digital Object. Examples of Transformation include Migration and Normalization.

Validation: Process of comparing a Digital Object with a standard or benchmark and noting compliance or exceptions. For example, a File can be validated against a file format specification or profile; a Representation can be validated against criteria for completeness.

Viability: Property of being readable from media.

Virus Check: Process of scanning a File for malicious programs designed to corrupt Digital Objects and systems.

Web Page: “Page” of the World Wide Web, usually in HTML/XHTML format (the file extensions are typically .htm or .html) and with hypertext links to enable navigation from one page or section to another. Web pages often use associated graphics files to provide illustration, and these too can be clickable links. (From Wikipedia: en.wikipedia.org/wiki/Web_page)

Web Site: A collection of Web Pages, that is, HTML/XHTML documents accessible via HTTP on the Internet; all publicly accessible Web Sites in existence comprise the World Wide Web. The pages of a Web Site will be accessed from a common root URL, the home page, and usually reside on the same physical server. The URLs of the pages organize them into a hierarchy, although the hyperlinks between them control how the reader perceives the overall structure and how the traffic flows between the different parts of the Web Site. (From Wikipedia: en.wikipedia.org/wiki/Web_site)

This page intentionally blank.

NOTES

[1] *A Metadata Framework to Support the Preservation of Digital Objects* (Dublin, Ohio: OCLC Online Computer Library Center, 2002), www.oclc.org/research/projects/pmwg/pm_framework.pdf.
[2] *Implementing Preservation Repositories for Digital Materials: Current Practice and Emerging Trends in the Cultural Heritage Community* (Dublin, Ohio: OCLC Online Computer Library Center, 2004), www.oclc.org/research/projects/pmwg/surveyreport.pdf.
[3] *Reference Model for an Open Archival Information System (OAIS)* (Washington, DC: Consultative Committee for Space Data Systems, 2002), ssdoo.gsfc.nasa.gov/nost/wwwclassic/documents/pdf/CCSDS-650.0-B-1.pdf.
[4] Other preservation metadata initiatives have developed other models. The National Library of New Zealand defines four types of entity: objects, files, processes, and metadata modification. *Metadata Standards Framework—Preservation Metadata (Revised)* (Wellington: National Library of New Zealand, June 2003), www.natlib.govt.nz/files/4initiatives_metaschema_revised.pdf.
[5] Note that the PREMIS definition of an Object entity differs from the definition of digital object commonly used in the digital library community, which holds a digital object to be a combination of identifier, metadata, and data. This is not intended to be a conflict. The Object entity in our model is an abstraction defined only to cluster attributes (semantic units) and clarify relationships.
[6] IFLA, *Functional Requirements for Bibliographic Records* (Munich: K.G. Saur, 1998), www.ifla.org/VII/s13/frbr/frbr.pdf.
[7] Wikipedia, the free encyclopedia, en.wikipedia.org/wiki/Main_Page.
[8] See, for example, the proposed Global Digital Format Registry at hul.harvard.edu/gdfr/.
[9] JHOVE - JSTOR/Harvard Object Validation Environment, hul.harvard.edu/jhove/.
[10] Digital Preservation Coalition Handbook, www.dpconline.org/graphics/intro/definitions.html.
[11] *XML-Signature Syntax and Processing: W3C Recommendation 12 February 2002*, www.w3.org/TR/xmldsig-core/.
[12] *Data Dictionary—Technical Metadata for Digital Still Images*, NISO Z39.87-2002/AIIM 20-2002, www.niso.org/standards/resources/Z39_87_trial_use.pdf.
[13] Margaret Byrnes, *Assigning Permanence Levels to NLM's Electronic Publications* (presented at 2000 Preservation: An International Conference on the Preservation and Long Term Accessibility of Digital Materials), www.rlg.org/en/page.php?Page_ID=244.
[14] Global Digital Format Registry (GDFR) Data Model v.3, hul.harvard.edu/gdfr/DataModel_v3.doc.
[15] Resource Description Framework (RDF), www.w3.org/RDF/.