



Project Number	IST-2006-033789
Project Title	Planets
Title of Deliverable	Evaluation of Preservation Planning within OAIS, based on the Planets Functional Model
Deliverable Number	PP7-D6.1
Contributing Sub-project and Work-package	PP 7
Deliverable Dissemination Level	External Public
Deliverable Nature	Report
Contractual Delivery Date	1-4-2010
Actual Delivery Date	12-05-2010
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Abstract

This report gives an overview of the Planets Functional Model and relates it to the Planets deliverables. It also gives a set of recommendations for the OAIS model.

Keyword list

Planets Functional Model, OAIS, Preservation Planning

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Revision History

Issue	Author	Date	Description
1.0	B.Sierman, P. Wheatley	13/04/2010	Initial draft version for review
1.1	B.Sierman, P. Wheatley	27/05/2010	Document Issue

EXECUTIVE SUMMARY

By implementing preservation processes and services and then trialing them on real digital collections, Planets has been able to gain a greater understanding of the corresponding higher level functions required within a digital repository for preservation purposes. This understanding has been captured in the Planets Functional Model and associated descriptions found in this report. A comparison of this functional model has been made with the OAIS model. This analysis resulted in a set of recommendations for the OAIS model, which will be send to the OAIS Committee.

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1 Introduction

1.1 Overview

By implementing preservation processes and services and then trialing them on real digital collections, Planets has been able to gain a greater understanding of the corresponding higher level functions required within a digital repository for preservation purposes. This understanding has been captured in the Planets Functional Model and associated descriptions found in this report.

The Planets Functional Model describes the functions and processes of a preservation planning component of a digital repository, according to the developments and experiences of the Planets Project. This includes a high level view of the Functional Model (see section 2.1), a breakdown of these components into Sub Functions (see section 2.3) and a series of Scenarios that describe common preservation processes (see section 3).

The developments of the Planets Project have provided a detailed implementation of the preservation functions of an OAIS compliant digital repository. Section 4 shows how the tools and services developed by the Planets Project fulfil key preservation functions as described by the Planets Functional Model.

Section 5 provides a mapping of Planets to OAIS and OAIS to Planets, with notes on any discrepancies or issues arising. This analysis and mapping activity has helped to demonstrate the compatibility of OAIS and Planets and has elicited omissions or areas for clarification in both Planets and OAIS (see section 6). Many of these have been identified and addressed already, since the first iteration of this work was published as PP7-D1¹. This has enabled a contribution to OAIS review activities to be made and has also helped to shape developments within the Planets Project. Revisions to the Planets Functional Model, the mapping work and the conclusions are presented in this final deliverable for the PP7 work package.

1.2 Terminology

Managing utilised terminology effectively, ensuring consistency and avoiding terminology clashes is typically a challenging issue and one with which the authors of this report have continued to grapple with throughout the Planets Project. Where possible the terminology used within OAIS has been closely followed, and many of these terms have been confirmed within section 2.4. Inevitably there have been some terms used within Planets that have different meanings within OAIS and vice versa. Terms where issues have been identified are:

- **Preservation Planning.** This is used within OAIS to describe primarily information gathering, analysis, investigative work and planning of

¹ "Report on Comparison of Planets with OAIS", http://www.planets-project.eu/docs/reports/Planets_PP7-D1_ReportOnComparisonOfPlanetsWithOais.pdf

preservation activities. The Planets definition (specifically with regard to the Functional Model) is a little tighter and refers to an evaluative and planning process which is specified sufficiently tightly, so it can be formally modelled and supported by tools based on this model.

- **Knowledge Base.** This has a specific meaning with OAIS, referring to the understanding of a Designated Community. This is different from the meaning of Knowledge Base used within this report, which equates the Knowledge Base with the OAIS meaning of a Representation Information Registry as well as registries of a host of related preservation information (such as preservation plans and risk registers).
- **Designated Community / User Community.** Early feedback on this work observed that the OAIS concept of Designated Community had been ignored. This was not the intention of the authors, but explanation had not been given on the use of the alternate and more general term: User Community. The primary focus of the Planets work has been on ensuring that digital information of all kinds can be rendered or used by users over time in spite of a changing technical environment (eg. rendering a spreadsheet object, revealing rows of numbers to the user). The additional need for users to then be able to understand rendered digital information (eg. ensuring a user can understand the meaning of the numbers in a spreadsheet as a budget in 1000s of euros for a particular department within an organisation) may well be important in ensuring long term preservation and access, but was not an activity addressed by Planets². Designated Community defines a group of users with a particular understanding which may need to be augmented to facilitate the understanding of a particular digital object. This is therefore less relevant to Planets, where the critical issue is not the knowledge of the users but the computer hardware and software they have available which correspondingly may need to be augmented to enable a digital object to be rendered. For this reason, Designated Community was felt to be less relevant within the Planets work, if not incompatible. At the same time, typical Library and Archive users experienced by the Planets Project partners tend to be less easy to categorise than the Designated Communities envisaged by OAIS, again making the term less relevant. For these reasons, the more general term of User Community has been used.

1.3 Scope

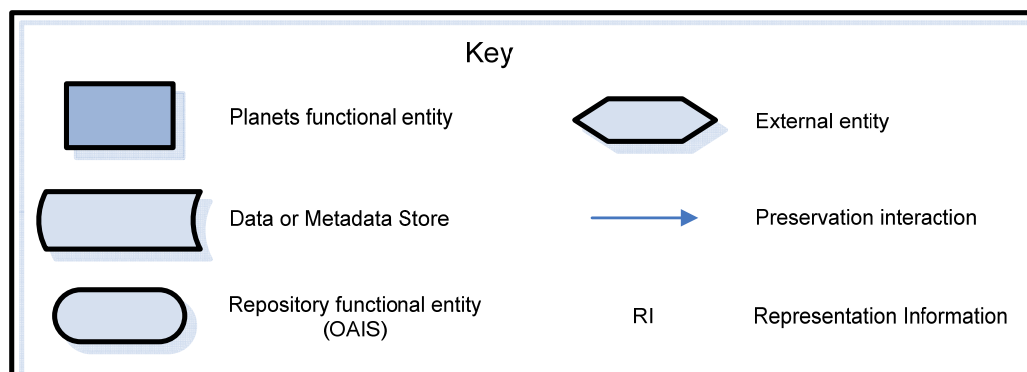
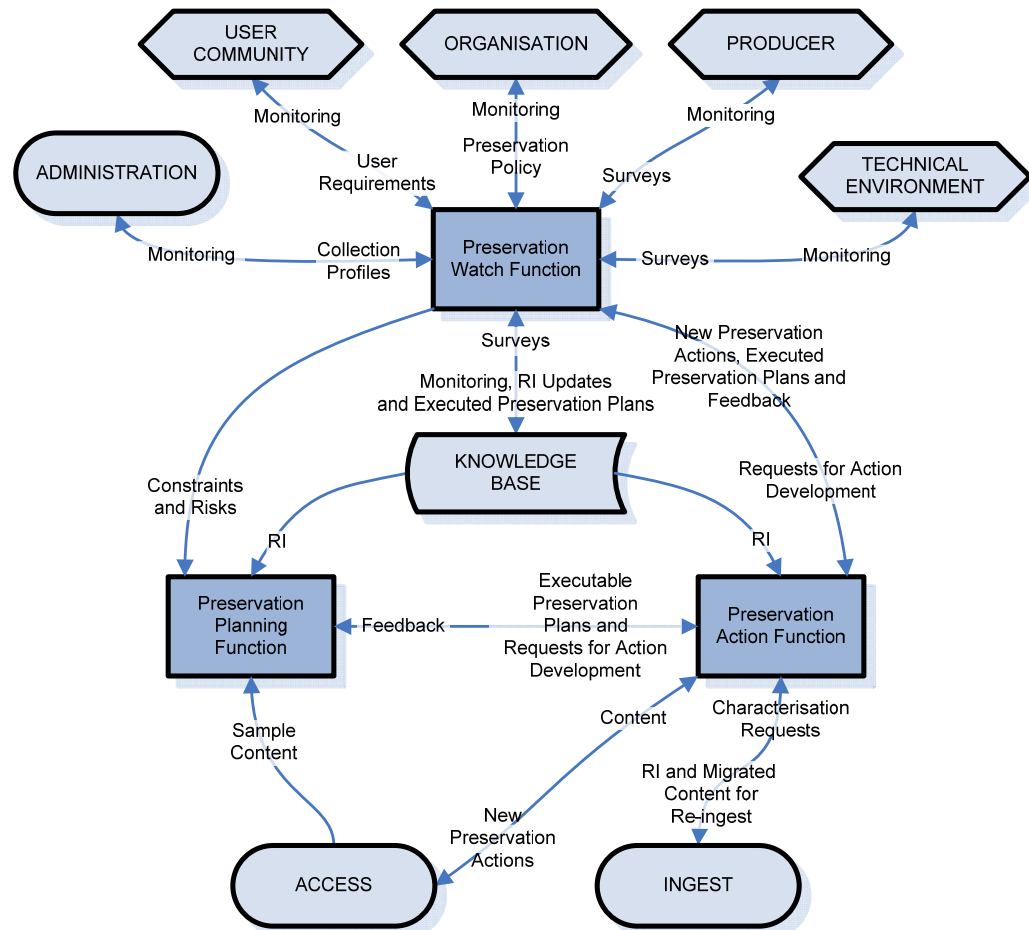
The PP7 work was initially tasked with comparing the Preservation Planning elements of Planets with those of OAIS but it quickly became evident that a wider assessment of all preservation relevant functions in Planets and OAIS would be more useful. It should therefore be noted that although Preservation Planning was the main focus, the implementation of the planning activities as well as a number of other preservation activities were considered.

² This function was a key area addressed by the CASPAR Project, also supported by the EU under Framework 6, <http://www.casparpreserves.eu/>

The primary focus of the mapping exercise from Planets to OAIS and vice versa was on the Functional Model in OAIS and the Functional Model in Planets. The Functional Model was considered the most relevant part of OAIS for consideration. This does not in any way indicate issues with or exclusion of other elements of the OAIS Model such as the Information Model (which is considered to be broadly compatible with Planets developments).

2 The Planets Functional Model

2.1 Planets Functional View (final)



2.2 The 3 Planets Functions

The model identifies 3 key preservation functions: Preservation Watch, Preservation Planning and Preservation Action. All functions are described briefly here, and further detail is provided in section 3.

Preservation Watch monitors a variety of internal and external entities, including the content³ preserved in the digital repository itself (via ADMINISTRATION). Where potential changes in the entities are identified (e.g. a new tool is available, a platform is no longer supported, or a new use case becomes popular), the resulting preservation risk is assessed. Critical or imminent risks are passed to Preservation Planning for further analysis and planning of subsequent action. Information gathered from the entities and analysed in the Testbed is used to provide Representation Information Updates to the KNOWLEDGE BASE⁴. For example, the addition of a KNOWLEDGE BASE entry describing a new tool and its capabilities.

Preservation Planning assesses Constraints and Risks received from Preservation Watch. It evaluates available preservation options (informed by Representation Information from the KNOWLEDGE BASE) and then trials them on Sample Content. It assesses the results of those trials and identifies the most appropriate options. Plans for implementing the selected preservation options are then created and passed to Preservation Action for implementation.

Preservation Action performs actions on Content to ensure its continued accessibility and sends appropriate feedback to Preservation Watch (including Executed Preservation Plans). Where Preservation Planning requires that a migration be performed, a Preservation Plan is passed to Preservation Action, describing the required process. The Content is passed from Access. As part of the preservation plan a Characterisation of the Content will be performed, both before and after the action. The appropriate tools and services to perform the action are identified from the KNOWLEDGE BASE and will be deployed in the appropriate environment (see section 2.3.3 Deploy Action). The preservation action will then be executed and evaluated.

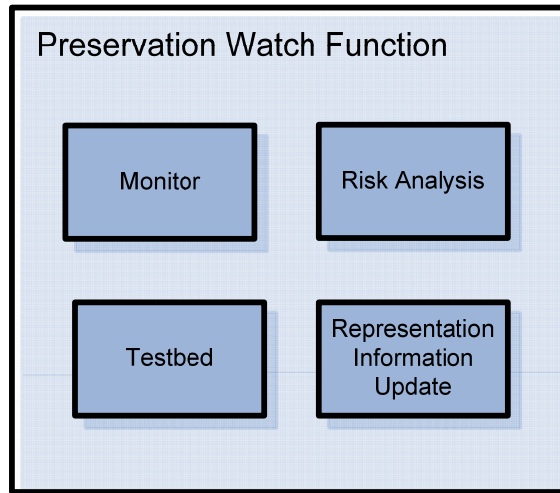
³ The term “content” refers to digital objects that are the focus of preservation.

⁴ The KNOWLEDGE BASE is an umbrella term, representing various repositories for preservation metadata. This will include Representation Information about formats, tools and environments; Testbed experiment results data; and risk register data (see for a more detailed description 2.4)

2.3 The Planets Sub-Functions

This section of the document provides descriptions of the Planets Sub-Functions.

2.3.1 Breakdown of the Preservation Watch Function



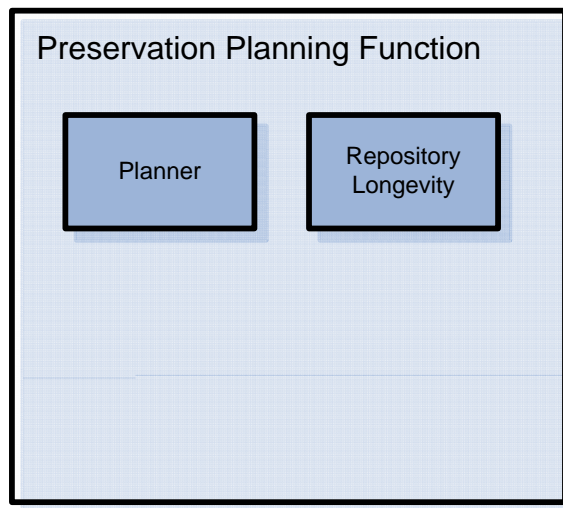
Monitor provides the role of collating preservation related information from a variety of internal and external entities. Monitoring can be scheduled on a regular basis but might also be triggered by alerts from Technology Watch services or other sources..

Risk Analysis provides an assessment of this information, relaying critical risks to Preservation Planning. For example a particular tool becomes obsolete, leaving content in the digital repository without a rendering mechanism. A further Preservation Planning exercise would then be triggered, to consider remaining alternatives.

Representation Information Update provides updates to Representation Information in the KNOWLEDGE BASE, enriching information describing file formats, tools or environments as well as recording Risks and Executed Preservation Plans.

The Testbed provides a controlled environment for studying the operation of tools and services on content in controlled experiments, thereby facilitating the assessment of the capability of the tools and services for preservation purposes. Results are stored in the KNOWLEDGE BASE and these will inform the Preservation Planning activities.

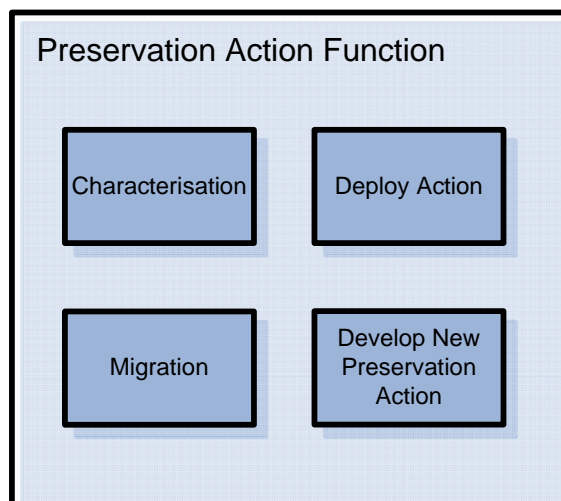
2.3.2 Breakdown of the Preservation Planning Function



The Planner is the decision analysis function within Preservation Planning which analyses and selects appropriate preservation solutions for the preservation of digital objects and packaging designs.

Repository Longevity provides a focus on review and necessary action to ensure longevity of the OAIS repository itself. This includes a focus on areas such as repository technologies and preservation of the KNOWLEDGE BASE and other databases.

2.3.3 Breakdown of the Preservation Action Function



A Preservation Action can take several forms and may even combine several stages or techniques and so might be represented in more than one of the boxes above. Migration transforms digital objects from format to format before they are re-ingested to the digital repository or served on demand to the user. Emulation (as an example in the sub function Deploy Action) mimics the original environment in which the digital object was created at the point of access for the user. The techniques can also be combined to extend the life of obsolete migration tools via emulation.

Characterisation identifies particular properties within content and extracts their values. These value-property pairs (called characteristics) can then be utilised to perform particular preservation processes⁵. Characteristics can be interpreted in order to construct a Content Profile of preservation relevant characteristics of content (such as file format) which will in turn support activities such as: the monitoring of content (via Preservation Watch); the selection of content in a digital repository on which to perform Preservation Actions; and the selection of compatible preservation tools (eg. that perform rendering, migration). Characterisation can also be performed to support the validation of a Preservation action, for example, by extracting characteristics before and after a Migration and then comparing them for evidence of loss.

Deploy Action provides the ability to deploy specific preservation tools and services within the Open Archival Information System environment, as well as performing preparatory activities necessary to preservation action at the point of execution (for example building an emulator image).

Develop New Preservation Action focuses on developing new Preservation Action tools or services.

⁵ "Modelling Organizational Preservation Goals to Guide Digital Preservation", Dappert,A, Farquhar,A, <http://www.ijdc.net/index.php/ijdc/article/view/123>

2.4 Digital repository and external functional entities

The text above references a number of digital repository functions. These are described below:

Functional entities	Description
INGEST	The function which manages ingest of content into the digital repository (as described in the OAIS Model).
KNOWLEDGE BASE	<p>The KNOWLEDGE BASE is used here as an umbrella term for a repository of a variety of key information which will inform preservation processes conducted within the Digital repository. It provides the information required to understand and make use of a particular digital object, including information about how to render, interpret or re-use the digital object (which broadly equates to the concept of a Representation Network described in the OAIS Model).⁶</p> <p>It may also contain a variety of other preservation information including risk registers for the organisation and the results of experiments or other evaluative activities on content or tools,</p>
ACCESS	Provides access to content from the archival store (see the OAIS Model).
ORGANISATION	The ORGANISATION that is the custodian of the content being preserved. This organisation might also act on behalf of other content owners as a service provider.
USER COMMUNITY	The community or communities of external actors that are expected to be users of the content.
TECHNICAL ENVIRONMENT	An abstract entity representing the technical environment that the ORGANISATION, the PRODUCERS and the USER COMMUNITY operate within. Key elements are computing platforms, application software and file formats.
PRODUCER	The Producers of the content being preserved. This might represent the actual creator and/or the actor supplying the content

⁶ For more information, see A. Brown: White Paper: Representation Information Registries, Planets, PC3/D7, 2008 at http://www.planets-project.eu/docs/reports/Planets_PC3-D7_ReplInformationRegistries.pdf

	to the repository.
ADMINISTRATION	The services and functions needed to manage the operation of the other functional entities on a day-to-day basis.

3 Scenarios

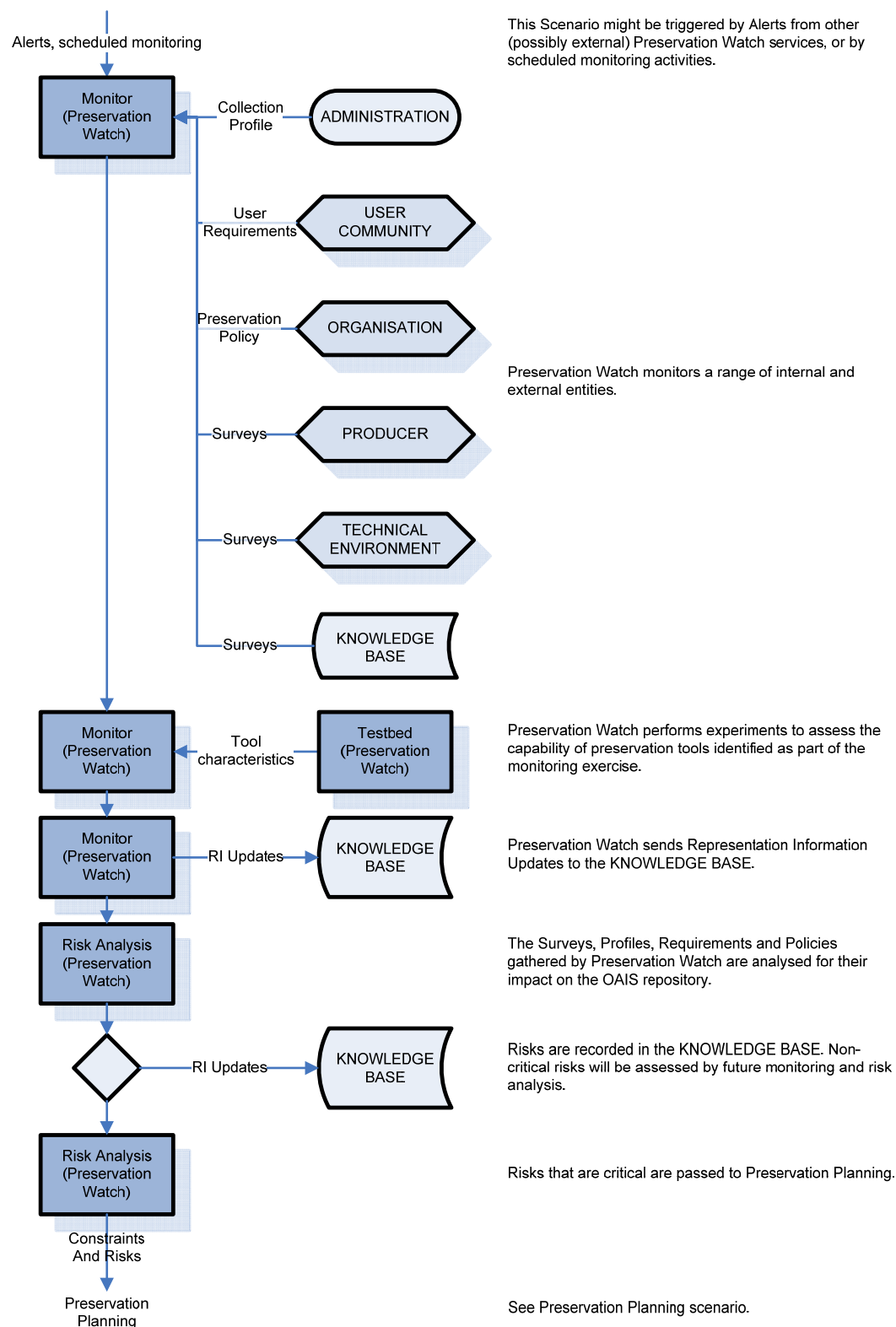
3.1 Introduction and aims

Three Scenarios describing key preservation processes were produced with the aim of communicating the role of preservation functions and facilitating discussion across the Planets Project.

PP/7 has attempted to draw out key high level characteristics which have been developed with the benefit of the hands on work performed by Planets, while at the same time, not allowing low level detail to cloud the critical functions and relationships present.

The Scenarios offered a means of communicating the work of PP/7 and in particular a means of validating the Planets Functional Model and ensuring its relevance and accuracy to work across the Planets Project.

3.2 Preservation Watch Scenario: Monitoring and Risk Analysis



The Preservation Watch Scenario represents an ongoing monitoring process. Based on certain rules, translated into a pre-arranged schedule, monitoring activities are conducted. Monitoring might also be triggered by alerts from an external service, such as a Technology Watch Service.

Monitor will survey various internal and external entities and will gather a variety of information which will inform preservation activities. This might for example include a change to the TECHNICAL ENVIRONMENT, such as a new preservation tool becoming available, or an existing tool or platform reaching the end of its life and no longer being supported by the author or producer. Gathered surveys may trigger further investigation into a particular preservation issue or perhaps a particular file format or preservation tool. The Testbed function is able to conduct this research and experimentation, returning results to Monitor.

Information gathered as part of Surveys or subsequent experiments may be suitable for updating the KNOWLEDGE BASE, and this is conducted by the Representation Information Update function. Such updates might include more detail on a particular file format, the addition of a new rendering tool for a particular file format, or a change in the Designated Community which requires an update to the information describing it.

The Risk Analysis function analyses information from gathered Surveys and assesses it for impact on the digital repository. Critical risks are recorded in the KNOWLEDGE BASE and are then passed on to Preservation Planning for further assessment and preparation of a plan for the treatment of at risk content. Non-critical risks are recorded in the KNOWLEDGE BASE for continued monitoring.

3.2.1 Additional Information

Entities monitored by the Monitor sub function include:

- ADMINISTRATION

Information on Collection Profiles.

- ORGANISATION

Changes in its own organization, like a change in a collection profile, might lead to different preservation policies. Apart from its own organization, the Preservation Watch function might monitor an external organization in case parts of the digital repository are outsourced, or the repository is a service provider for other repositories.

- KNOWLEDGE BASE

Preservation Watch Function monitors periodically the information in different registries regarding the file formats and for example significant properties stored in the digital archive and decides whether there is a risk. The KNOWLEDGE BASE might contain information on earlier identified risks, information on experiments with tools and services of other organisations (Testbed) etc. The KNOWLEDGE BASE could be internal and / or external.

- USER COMMUNITY

Preservation Watch Function monitors the USER COMMUNITY and identifies possible risks, like for example a change in the expected DIP format.

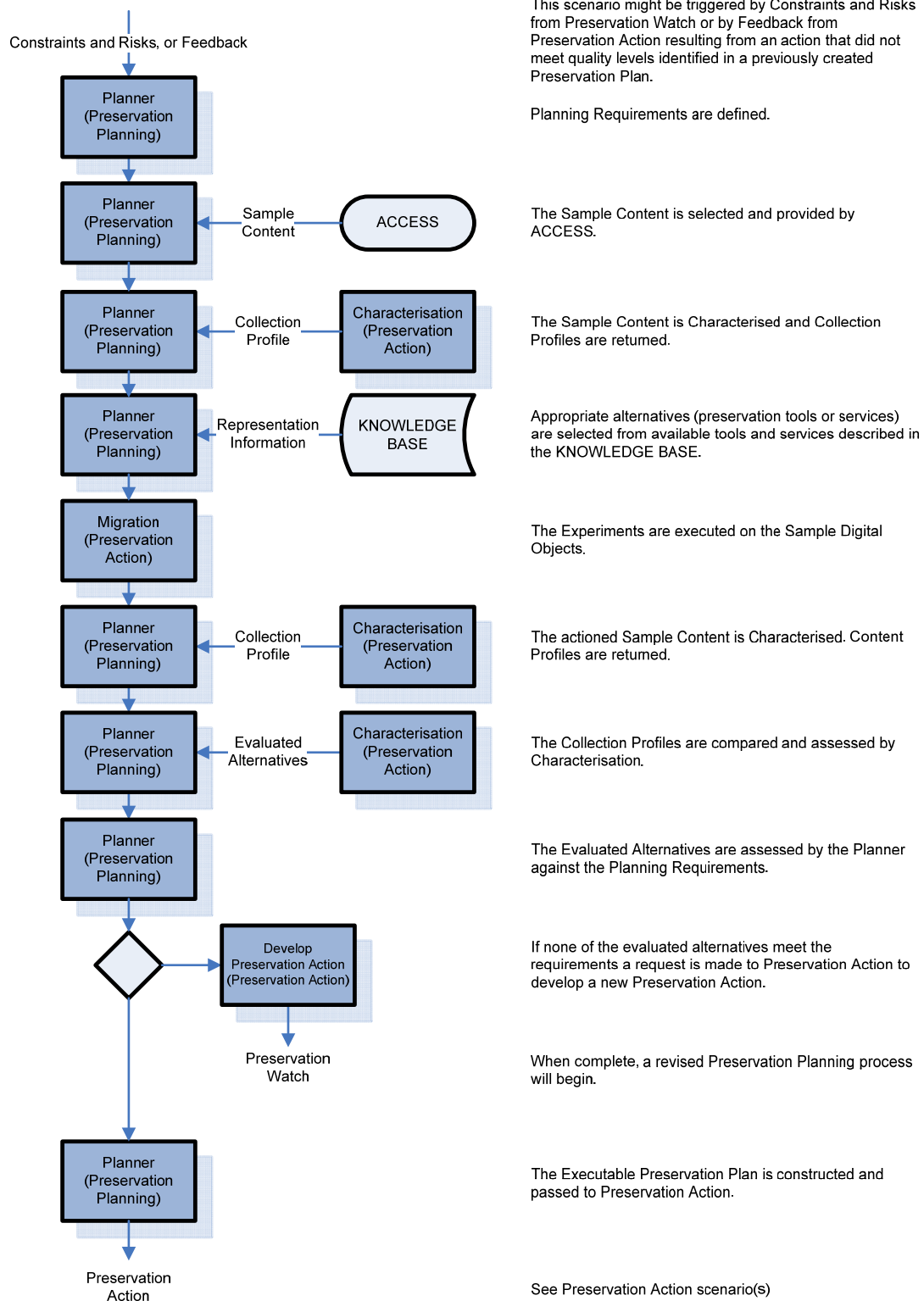
- PRODUCER

Preservation Watch Function monitors the PRODUCER, these are all organizations depositing material into the digital archive. Changes in this area might offer a risk or at least require adaptation.

- TECHNICAL ENVIRONMENT

Preservation Watch Function monitors the TECHNICAL ENVIRONMENT in general: developments in the technical area, that might lead to new file formats, new digital object formats, new publishing methods.

3.3 Preservation Planning Scenario: Planning and Creation of Preservation Plan



Preservation Planning receives a notification from Preservation Watch, describing critical risks and constraints for further assessment. Planning Requirements are then defined and the background and context to the planning exercise is captured. Appropriate Sample Content are selected and obtained from ACCESS. The Sample Content is characterised to produce a Collection Profile. Preservation alternatives are selected, utilizing information (including Testbed results) from the KNOWLEDGE BASE. These alternatives will be explored in experiments conducted on the Sample Content. The experiments are then executed. Content produced as output from the experiments is re-characterised and compared with the original Content Profiles. These results are then assessed by the Planner against the original requirements for the planning exercise. If the results satisfy the requirements, an Executable Preservation Plan is created and passed to Preservation Action for execution. If the requirements are not satisfied, further assessment may be required and a request to Preservation Action to develop a new action may be necessary.

Preservation Planning may also be triggered by Feedback from Preservation Action resulting from an action that did not meet quality levels identified in a previously created Preservation Plan.

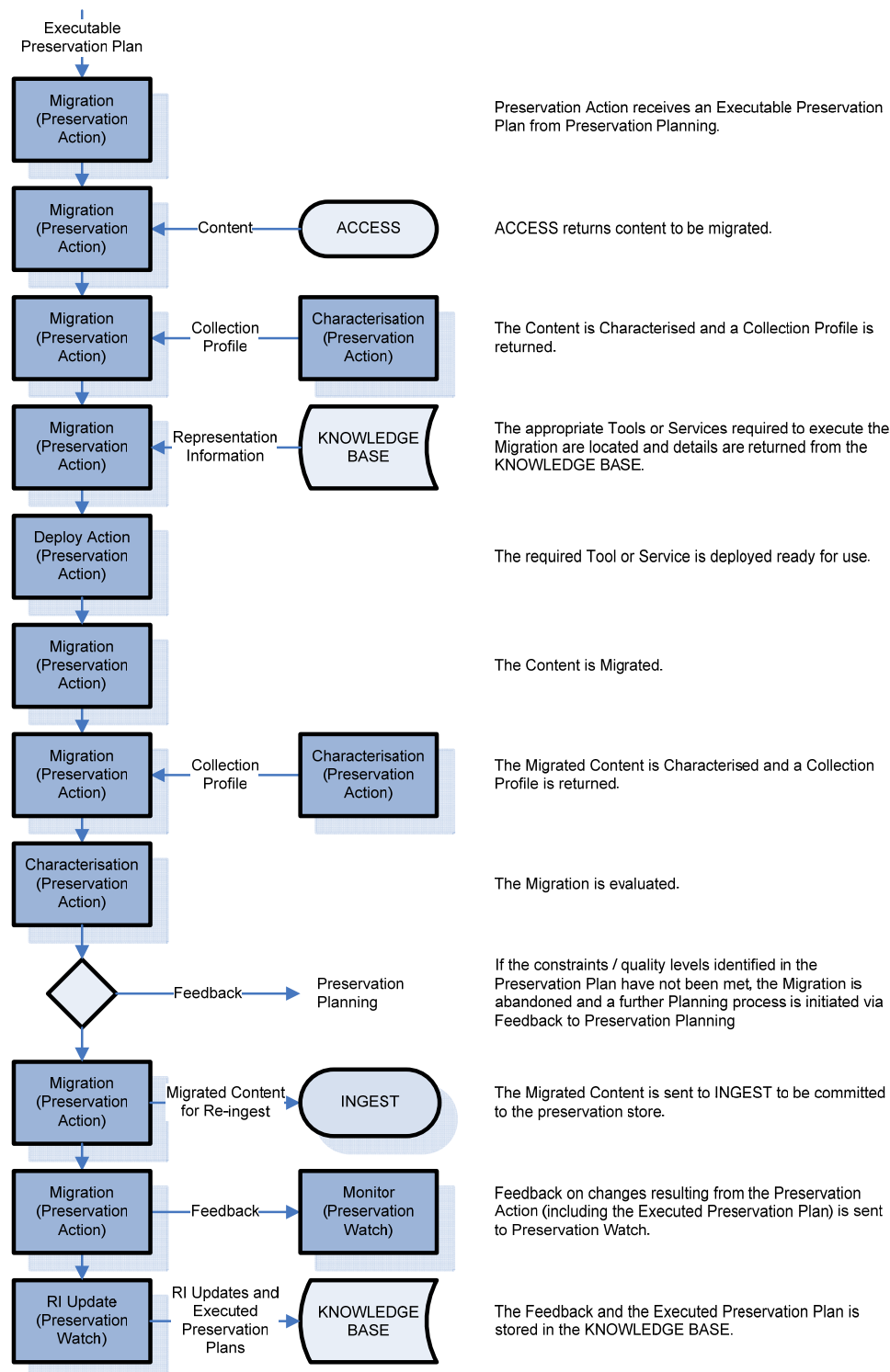
3.3.1 Additional Information

The Constraints and Risks passed from Preservation Watch to Preservation Planning might include a wide range of information that will guide the planning process. Details including related preservation policies, an indication of the affected objects (this will help to create a representative subset of sample content) and additional constraints such as restrictions on the costs of the planned Preservation Action may be present.

The planning process shown in this scenario is likely to involve a number of cycles as detail is laid out and earlier stages need to be revised. This is not shown in the diagram to ensure clarity of communication of the core process.

In future it might be expected that organisations will be supported in creating preservation plans guided by existing templates in which common requirements and processes are made easily repeatable, perhaps with minor modifications. This will be one of the goals of Plato, the Preservation Planning tool of Planets.

3.4 Preservation Action Scenario: Migration



Preservation Action receives an Executable Preservation Plan from the Preservation Planning Function. In this case a Migration is planned. The Preservation Action Function obtains the set of objects identified in the Plan from ACCESS. The Content is then characterised and a Content Profile is generated. The Tools or Services required to execute the Migration are located and are deployed ready for use. The Content is then migrated and a further Content Profile is generated. This is compared and evaluated against acceptable quality levels. If these have not been met a further Preservation Planning process is required. Otherwise, the migrated Content is passed to INGEST in order to be re-ingested into the preservation store. Feedback (including the Executed Preservation Plan) is sent to Preservation Watch and is stored in the KNOWLEDGE BASE.

4 Mapping of Planets Functional Model to Planets Results

This section provides a mapping of the Planets Functional Model to the developed results of the Planets Project. A cross mapping was produced from functions to Planets results and vice versa, in order to ensure as complete a coverage as possible. This mapping aims to show how the Planets Functional Model (see page 8), developed in PP7, is implemented by actual Planets results. No consideration is given to the status or completeness of the referenced results.

Planets Functional Model		Planets Results that fulfill the corresponding function
Function	Sub-Function	
Preservation Watch	Monitor	<p>Monitoring of collections (via ADMINISTRATION and KNOWLEDGE BASE) provided by:</p> <ul style="list-style-type: none"> Collection Profiling tool (PP6-D4). Context Aware Objects in (PA6-D7). <p>Monitoring of ORGANISATION and capture of Preservation Policy provided by:</p> <ul style="list-style-type: none"> Model and machine interpretable model (incorporated in Plato tool) in (PP2-D3). Survey of memory institutions in (DT7-D4). <p>Monitoring of USER COMMUNITY and capture of User Requirements provided by:</p> <ul style="list-style-type: none"> The Planets Conceptual Model (PP3-D2). <p>Monitoring of TECHNICAL ENVIRONMENT and provision of technology Surveys provided by:</p> <ul style="list-style-type: none"> The Planets Conceptual Model (PP2-D3). Planets Core Registry (KNOWLEDGE BASE) (PC3-D20). <p>Monitoring / interaction with the PRODUCERS:</p> <ul style="list-style-type: none"> Not covered in detail by Planets products.
Preservation	Risk Analysis	Identification and assessment of risks

Watch		<p>provided by:</p> <ul style="list-style-type: none"> • The Conceptual Model in (PP2-D3). • Triggers for a new Preservation Planning process are described in Becker 2009⁷. • Various PP6 deliverables (under development at the time of writing).
Preservation Watch	Testbed	<p>Assessment of capabilities of tools and services provided by:</p> <ul style="list-style-type: none"> • Planets Testbed (Aitken 2009⁸). • Testbed Corpora (TB/3-D7).
Preservation Watch	Update Representation Information	<p>Recording of Testbed results in Experiments Database (KNOWLEDGE BASE) provided by:</p> <ul style="list-style-type: none"> • Planets Testbed (Aitken 2009). <p>Recording of Representation Information in Planets Core Registry (KNOWLEDGE BASE) provided by:</p> <ul style="list-style-type: none"> • Planets Core Registry (PC3-D20).
Preservation Planning	Planner	<p>Preservation Planning provided by:</p> <ul style="list-style-type: none"> • Plato and the associated Preservation Planning workflow, (Becker 2009).
Preservation Planning	Repository Longevity	<p>Repository Longevity:</p> <ul style="list-style-type: none"> • not covered in detail by Planets products (and out of Planets scope).
Preservation Action	Characterisation	<p>Content Profiling:</p> <ul style="list-style-type: none"> • see Preservation Watch, above. <p>Validation of Migration Preservation Actions provided by:</p> <ul style="list-style-type: none"> • Extractor and Comparator and associated extraction languages, (PC4-D6). <p>Validation of Emulation Preservation Actions:</p>

⁷ "Systematic planning for digital preservation: Evaluating potential strategies and building preservation plans", Christoph Becker, Hannes Kulovits, Mark Guttenbrunner, Stephan Strodl, Andreas Rauber, and Hans Hofman. International Journal on Digital Libraries (IJDL), December 2009.

⁸ "The Planets Testbed: Science for Digital Preservation", Brian Aitken, Petra Helwig, Andrew Jackson, Andrew Lindley, Eleonora Nicchiarelli, Seamus Ross, Code4Lib, <http://journal.code4lib.org/articles/83>

		<ul style="list-style-type: none"> Approaches to emulation testing (PA/5-D1).
Preservation Action	Deploy Action	<p>Deployment of Preservation Actions provided by:</p> <ul style="list-style-type: none"> Preservation Workflows (IF5-D1). Interoperability Framework (IF2/4/5-D9). GRATE (PA/5-D7). UVC (PA5-D5). Dioscuri (PA5-D6). Validation Framework (PP5-D3)
Preservation Action	Migration	<p>New and wrapped Preservation Actions provided by:</p> <ul style="list-style-type: none"> Overview of wrapped tools (IF6-D1). SIARD MS Office conversion (PA4-D6). Validation Framework (PP5-D3)
Preservation Action	Develop New Preservation Action	<p>Process for developing and wrapping new Preservation Actions provided by:</p> <ul style="list-style-type: none"> Blueprint for the development of new PA tools in (PA4-D2a). Service Developer Guidelines (IF6-D3).
Entity		Description
KNOWLEDGE BASE		<p>KNOWLEDGE BASE provided by:</p> <ul style="list-style-type: none"> Planets Core Registry (PC3-D20). Planets Testbed, Experiments Database (Aitken 2009). Ontology (PC3-D23) IF Tools Registry (IF5-D1).

Note: many Planets deliverables are not mentioned in the above table. These deliverables provide supporting infrastructure to the functions described above rather than providing the functionality themselves (eg. Many of the IF components).

5 Mapping Planets to OAIS

This section provides a mapping of key functions in the Planets Functional Model to the Functional Model of OAIS and vice versa. It is a revision of a similar process described in PP7-D1. Consideration has been given to subsequent developments within Planets, changes in the Planets Functional Model and changes in OAIS proposed in the Pink Book revision⁹.

Planets Function	Planets Sub Function	OAIS Function	Observations
Preservation Watch	Monitor	Monitor Technology, Monitor Designated Community	Planets and OAIS use slightly different structures to capture the monitoring of key entities but are broadly equivalent in aim. Planets emphasizes the need to monitor further entities which are not specifically referred to in the OAIS Functional Model.
Preservation Watch	Risk Analysis	Develop Preservation Strategies and Standards	<p>Risk management is referenced within OAIS following changes within the Pink Book revision. Both Planets and OAIS have placed greater emphasis on assessing and acting on identified risks during the lifetime of the Planets Project.</p> <p>The Planets Model describes a clear process for monitoring, analyzing, (where appropriate) acting on identified risks and recording the outcome. This is integral to the core preservation processes within Planets. Risk analysis is not as clearly embedded within OAIS, although the Pink Book revisions have improved on this aspect.</p>
Preservation Watch	Testbed	Monitor Technology	The Planets Testbed concept maps quite closely to the OAIS concept of Prototyping. Through its implementation work Planets has now realized this concept in considerable detail. A lack of description of the focus and results

⁹ <http://public.ccsds.org/sites/cwe/rids/Lists/CCSDS%206500P11/CCSDSAgency.aspx>

			of the OAIS Prototyping concept makes further comparison difficult.
Preservation Watch	Representation Information Update	Not specifically identified in the Functional Model.	Planets has realized the process of capturing and recording RI in the KNOWLEDGE BASE as a particular function. This activity is implied within other OAIS functions, but is perhaps not given sufficient emphasis.
Preservation Planning	Planner	Develop Preservation Strategies and Standards, Develop Packaging Designs and Migration Plans	<p>Although articulated in a different structure, the Planner Function is also present in OAIS, although it specifically references development of Migration plans with no reference to emulation.</p> <p>Planets describes the preservation planning concept in greater detail than in OAIS, as would be expected when drawing from the experiences of implementing this function in the Library and Archive domain.</p>
Preservation Planning	Repository Longevity	Develop Preservation Strategies and Standards, Develop Packaging Designs and Migration Plans	<p>Planets has separated preservation aspects relating to the OAIS Repository from those relating to the preservation of digital objects. This function maps clearly to aspects of Develop Preservation Strategies and Standards and Develop Packaging Designs and Migration Plans.</p> <p>OAIS is more comprehensive on this function, which has not been a major focus of development within Planets.</p>
Preservation Action	Characterisation	OAIS describes the activity of extraction or recording of Descriptive Information (section 4.1.1.2), but this does not encompass technical characteristics	<p>OAIS does not identify Characterisation as a specific activity within the functional model and as a consequence may not place enough emphasis on this critical activity. This appears to be an issue given the OAIS emphasis given to the extraction of descriptive information in the Generate Descriptive Information sub-function.</p> <p>Planets identified Characterisation</p>

		<p>or RI.</p> <p>OAIS describes the need to validate transformations (in particular: reversible and non-reversible transformations section 5.1.3.4).</p> <p>The Pink Book revision introduces the concept of Information Property Description which expands on the issue of validating preservation actions (section 5.1.3.4 and section 5.2.2.2).</p>	<p>as an integral part of Preservation Action, although it also has a role in supporting a number of other activities including INGEST, Preservation Planning and Preservation Watch. This includes the generation or extraction of metadata to facilitate the selection of digital objects to which a particular risk applies (for example objects created by a particular application) as well as the need to characterize before and after preservation action to facilitate validation.</p>
Preservation Action	Deploy Action	<p>OAIS describes many of the issues around RI and the use of Access Software to render digital objects (section 4.2.1.3.2) and specifically on emulation (section 5.2.2.2). This has been expanded in the Pink Book Revision.</p>	<p>This is a complex process that Planets has identified within its functional model. This function might be considered to be too low level for inclusion in OAIS.</p>
Preservation Action	Migration	<p>Archival Information Update in Administration (section 4.1.1.5)</p>	<p>Both models align reasonably closely. OAIS places migration within the Administration function. Feedback from resulting actions to Preservation Planning is considered critical within Planets.</p>
Preservation	Develop New	Develop	<p>This function is closely</p>

Action	Preservation Action	Preservation Strategies and Standards	represented in OAIS and Planets.
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OAIS Function	Planets Function	Issues / Omissions
Develop Preservation Strategies and Standards	Preservation Planning, Preservation Watch	System evolution and related activities were included in the second iteration of the Planets Functional Model, although have not been a focus of development for the Planets Project.
Develop Packaging Designs and Migration Plans	Preservation Planning, Preservation Watch, Preservation Action	-
Monitor Designated Community	Preservation Watch	-
Monitor Technology	Preservation Watch	-

6 Recommendations on OAIS

6.1 Introduction to Recommendations

This section considers a variety of developments from within the Planets Project, and this work package in particular, with the aim of drawing out specific recommendations for improvements to the OAIS Model.

As was indicated in some early Planets work that compared the Planets Preservation Planning process with OAIS¹⁰, it was felt that Planets and OAIS were compatible and that the Preservation Planning process is compliant with the OAIS Model. Subsequent work, culminating in this report, has added weight to this conclusion and has shown how the Planets technology is able to implement the high level functionality of OAIS. This is a reinforcement of the preservation aspects of the OAIS Model which have been realized and tested in an actual preservation system implementation by Planets. It also reveals that the design and implementation of the Planets services, and in particular the Preservation Planning process, is comprehensive in its support for the key activities identified within OAIS.

A substantial difference between the OAIS and Planets models is the way in which similar concepts are articulated in different ways. A valuable outcome of the Planets developments is a set of informative terminology that clearly expresses the function of the key preservation components. In particular, the Preservation Watch, Planning and Action terms have helped to communicate complex concepts in an understandable manner and have begun to be adopted by the wider digital preservation community¹¹. An opportunity exists to take advantage of the Planets terminology in this area, and incorporate within the OAIS Model.

Further recommendations to further clarify functions, to communicate complex concepts more clearly and in a few areas to increase the emphasis given to critical activities, are provided below.

6.2 Specific Recommendations on OAIS

1. The Planets Preservation Watch function is broadly similar in aims and composition to the OAIS monitoring functions (Monitor Technology, Monitor Designated Community) but provides a stronger representation of these key activities in a number of ways:
 - a. Preservation Watch articulates a more comprehensive function that monitors the USER COMMUNITY and TECHNICAL ENVIRONMENT as well as the ORGANISATION, PRODUCER, ADMINISTRATION (collection objects and the OAIS repository itself) and the KNOWLEDGE BASE. It was identified that it was

¹⁰ "How to Choose a Digital Preservation Strategy: Evaluating a Preservation Planning Procedure", Strodl, S, Becker, C, Neumayer, R, Rauber, A, Proceedings of the ACM IEEE Joint Conference on Digital Libraries (JCDL'07), Vancouver, British Columbia, Canada, June 2007. <http://www.ifs.tuwien.ac.at/~strodl/paper/FP060-strodl.pdf>

¹¹ As evidenced by use in training materials for digital repository managers produced by the KeepIt Project, <http://eprints.ecs.soton.ac.uk/21029/>

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- critical to monitor and consider data gathered from all of these entities in order to inform effective preservation planning.
- b. Preservation Watch brings similar activities together into one functional entity. Risks identified in an entity may have an impact on constraints defined by another. It is therefore helpful to combine the analysis of these different entities in one place. By combining similar functions in one location, redundancy is removed and the resulting model has a greater clarity.
 - c. **Recommendation: Combine the two monitoring functions within Preservation Planning. The single resulting function should be named "Preservation Watch". This function is then responsible for monitoring the variety of entities noted in (a) above.**
 - d. **Re-phrase "recommending the migration of current archive holdings" (section 4-2) to "initiating preservation plans for necessary preservation actions"**
2. OAIS now identifies Risk Management as a useful methodology but it is not embedded in the Preservation Planning function in a comprehensive manner.
- a. Risk Management is an integral part of the Planets preservation planning process and acts as a driver for the preservation activities that must be undertaken and the resulting evaluation of mitigating actions. Preservation Watch identifies risks which may be parked for further monitoring or passed to Preservation Planning for further analysis when they are judged to become critical. Mitigating action chosen by Preservation Planning is implemented by Preservation Action, and feedback is passed to Preservation Watch where the status of the risk is updated.
 - b. The Pink Book revision of OAIS now identifies Risk Management as an appropriate methodology, within the Develop Preservation Strategies and Standards functional entity. However, it is not embedded within the OAIS Preservation Planning function in a comprehensive manner. Develop Preservation Strategies and Standards now generates Risk Analysis Reports which are sent to ADMINISTRATION. It is then unclear what the resulting action would be, and how feedback is communicated to Develop Preservation Strategies and Standards.
 - c. **Recommendation: The new Preservation Watch function (see above) should encompass a new activity of risk analysis. Critical risks identified will then trigger preservation planning activities within Develop Preservation Strategies and Standards, rather than Risk Analysis Reports being passed to ADMINISTRATION.**
3. OAIS does not emphasize the recording and maintenance of Representation Information sufficiently within the Functional Model.

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- a. The Planets Preservation Watch function contains a Testbed facility used to evaluate technologies. As well as informing the identification of preservation risks, results are recorded as Representation Information in the KNOWLEDGE BASE. This is performed by a dedicated sub function: Representation Information Update.
 - b. Monitor Technology contains a Prototyping capability which is described as providing a function for evaluating emerging technologies. The results from Prototyping are passed to the other Preservation Planning entities. It may be beneficial to emphasize the recording of these results as Representation Information, as this activity is not formally recognized in the OAIS Functional Model.
 - c. **Recommendation: Formalise the capture and recording of Representation Information in appropriate location within Preservation Planning.**
 - d. **Revise the narrow definition of Representation Information (section 1-14 Pink Book) to reflect the notion of rendering as well as interpreting and understanding, which is already described elsewhere in OAIS and in Planets.**
4. Despite some revisions in the Pink Book, OAIS still presents a pessimistic view of emulation and does not sufficiently recognize its presence in the Functional Model. Planets includes functions associated with emulation and on-access strategies but could also provide more emphasis and detail on the emulation approach.
- a. The Planets Functional Model includes functions dedicated to the migration process and to the deployment of on-access services such as emulation. The addition of an on-access scenario would assist with the articulation of an alternate preservation process to migration.
 - b. The OAIS Functional Model focuses exclusively on Migration (primarily Re-Packaging and Transformation) rather than emulation.
 - c. OAIS states in 5.2.2.2 that emulation should be considered when the preservation of look and feel is a mandatory requirement. Emulation could in fact be applied in order to meet other requirements beyond simply the look and feel. This was noted in Planets in PP7-D1¹², and encapsulated in the Planets preservation planning process.
 - d. **Recommendation: Thoroughly review and revise OAIS text on migration and emulation in order to present a balanced**

¹² "Framework and Workflow for testing tools for different technical environments"
http://www.planets-project.eu/docs/reports/Planets_PA5-D1-TestingToolsForTechnicalEnvironments-Final_v2_public.pdf

view on the array of preservation actions that might be applicable to a particular situation. In particular:

- i. Amend 5.2.2.2 to indicate that preservation solutions should be chosen to match the requirements identified in the preservation planning process.**
 - ii. Remove or replace the language specific to migration within the functional model (4.1.1.6) and rename this function as Preservation Action.**
- 5. OAIS does not give enough emphasis to the process of characterization in the Functional Model. This could be addressed by identifying appropriate functions for the extraction of relevant preservation characteristics within the Functional Model.
 - a. Planets identifies the use of characterisation in two key roles which are represented in the Functional Model as a sub function of Preservation Action:
 - i. The extraction of digital object characteristics which are used to inform preservation processes including the monitoring of content, the selection of content in a digital repository on which to perform Preservation Actions and the selection of compatible preservation tools.
 - ii. The extraction of digital object characteristics before and after a Preservation Action in order to support the validation of the action's success.
 - b. OAIS identifies a function within INGEST dedicated to the extraction of Descriptive Information (Generate Descriptive Information). A similar function is not present for extracting the technical characteristics (which are closely related to but are not wholly a part of Representation Information) used to inform the processes described above. Implementation experience from the Planets Project indicates that characterization of technical properties is a considerably more complex and substantial task than that of extracting Descriptive Information. This reinforces the need for consideration of this issue within OAIS.
 - c. Similarly, the OAIS Functional Model devotes little detail to the validation of preservation actions. Section 5.1.3.4 does however provide a methodology for validation, with reference to reversible or non-reversible transformations. This has been extended in the Pink Book to include the concept of Transformational Information Properties which identify particular characteristics that are required to be preserved.
 - d. Recommendation: Rename and expand the Generate Descriptive Information function to cover the extraction of non-descriptive metadata. Expand on and emphasize the need to validate preservation actions, ideally with representation in the functional model.**

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6. The majority of changes made to OAIS in the Pink Book have provided clarification and further explanation, but a small number of issues were identified:
- a. The information flows in Figure 4-6 are not consistent with the respective explanatory text.
 - b. The new concept of Transformational Information Properties is not described in a clear and understandable manner.
 - c. **Recommendation: Revise Figure 4-6 and respective text to ensure consistency. Clarify the text on Transformation Information Properties which is currently unclear.**