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Space data and information transfer systems — Information preparation to enable long term use

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International Standard

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Space data and information transfer systems — Information preparation to enable long term use

Systèmes de transfert de données et d'informations spatiales — Préparation des informations pour permettre une utilisation à long terme

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Foreword

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1 INTRODUCTION

1.1 PURPOSE AND SCOPE

There is a well-recognized need to capture digital information associated with a great variety of endeavours in virtually all areas of society. However, it is widely recognized that many such endeavours are not able, for one reason or another, to leave a sufficient legacy of information so others can reuse and fully leverage the effort that has gone into the endeavour. Such reasons include the focus on hardware by those involved in earlier stages of a project, which means that they may not always think about collecting and saving information about design decisions and calibrations needed for analysis of the data the hardware will collect or create; lack of understanding that there must be a budget allocation to fund the collection of such information; uncertainty about what information to collect at various stages, which often means that very little is collected; and limits on data collection such that information may not be collected if it is not needed for the primary use of the data collected, which means that alternative uses are limited.

The purpose of this Recommended Practice is to provide guidance for projects about the metadata (the term Additional Information is used below because the term 'metadata' is too unspecific and its use can cause confusion) that needs to be captured and/or generated and retained in order to ensure that the information created by the project, either as part of its main objectives or as a by-product of achieving those objectives, can be exploited over the short, medium, and long term.

This Recommended Practice deals with the aspects of a project, in particular the terminology used. Many of these terms are already used with various definitions within the target communities for this practice, for example, space, science, life sciences, libraries, records management, and archival communities. It is expected that other communities can easily map this terminology to the terminology used within those communities. The *Reference Model for an Open Archival Information System (OAIS)* provided a starting point and inputs from a variety of other sources were used to arrive at the terms used within this standard.

This Recommended Practice accomplishes the following:

- identifies the Additional Information to be collected or improved at various points;
- forms a basis for the specification of Data Management Plans (DMPs);
- forms a basis for the identification and/or development of additional standards and implementation guides, including those that address particular concerns in more detail.

1.2 CONTEXT

This Recommended Practice was inspired by the approach taken by the widely used *Project Management Book of Knowledge (PMBOK) Guide* (reference [1]) and the related *Data Management Body of Knowledge (DMBOK)* (references [2] and [3]).

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The PMBOK defines a project as an endeavour which is temporary, that is, having a beginning and an end, undertaken to create a unique product, service, or result, and focusses on the information and techniques required to manage the project so that it achieves its objectives. The DMBOK focuses on all aspects of data management within such an activity, while noting that '*Data, and information created from data, are now widely recognised as enterprise assets*', and furthermore, '*Data has value only when it is actually used, or can be useful in the future*'.

This document is focussed on the Additional Information that needs to be captured and/or generated and retained in order to ensure that the information created by the project, either as part of its main objectives or as a by-product of achieving those objectives, can be exploited over the short, medium, and long term. It is expected that, by ensuring this Additional Information is collected as fully as possible, projects can significantly improve their information legacy to the benefit of the wider community.

At various times in the project, and for various reasons, data is captured or created. There is Additional Information associated with this data that also needs to be captured. The types of Additional Information are informed by the *Reference Model for an Open Archival Information System (OAIS)* (reference [4]) that provides a conceptual view of long-term information preservation in an archive.

This Recommended Practice fits into the overall context defined by a number of other standards. Some relationships between the documents are illustrated in figure 1-1.

The Additional Information required for the information to be preserved will be collected/created by individuals and teams not necessarily involved with the archive which will undertake the preservation. Therefore, this document is needed as a guide for those individuals and teams so that adequate information is available for those that do use the *Producer-Archive Interface Methodology Abstract Standard (PAIMAS)*, the *Producer-Archive Interface Specification (PAIS)*, OAIS, and Audit and Certification. If insufficient Additional Information is created/collected, then this will limit the ability of any archive to undertake long-term preservation of the information.

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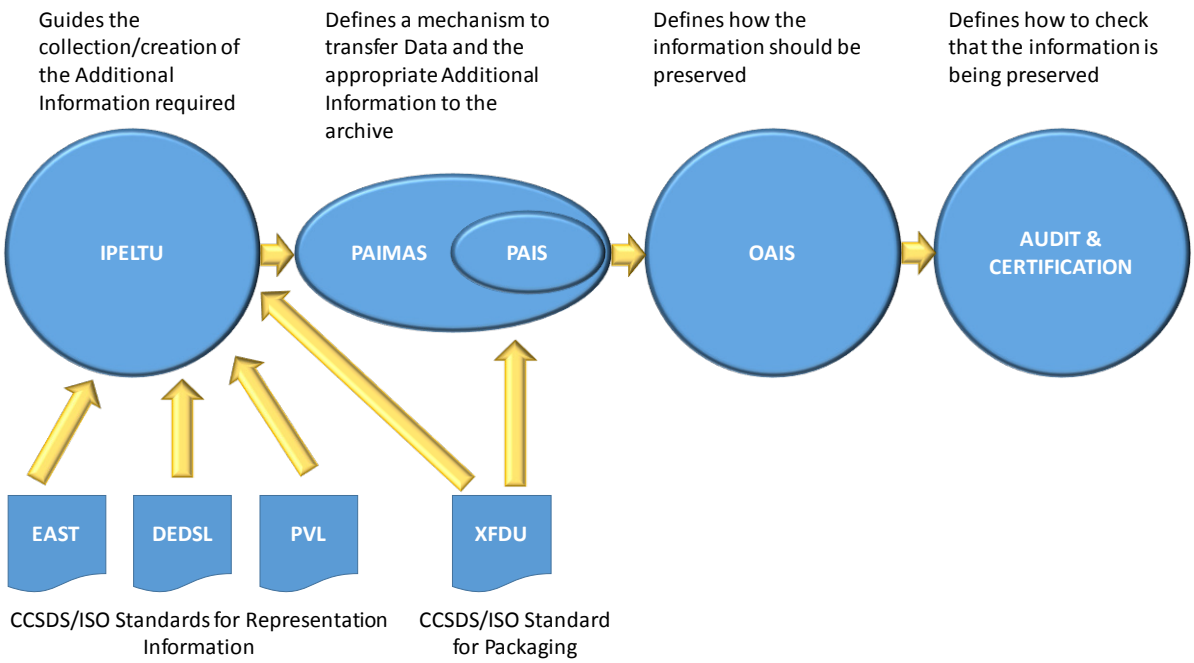

Figure 1-1: Relationship between CCSDS Standards

OAIS is one of the most widely recognized and applied archival standards available today. An OAIS is an archive, consisting of an organization of people and systems, that has accepted the responsibility to preserve information and make it available for a Designated Community.

PAIMAS (reference [5]) defines a methodology for transferring data from an Information Producer to an Archive based on the four following phases: Preliminary, Formal Definition, Transfer, and Validation. Required activities during each phase are identified.

PAIS (reference [6]) provides the abstract syntax and an XML implementation of descriptions of data to be sent to an archive. These descriptions are negotiated agreements between the data Producer and the Archive and facilitate production of agreed-upon data by the Producer and validation of received data by the Archive. The negotiation is required in order to ensure that the correct level of detail of description is produced. The Recommended Standard includes an abstract syntax and one possible concrete implementation for the packages.

The *Audit and Certification of Trustworthy Digital Repositories* Recommended Practice (reference [7]) provides metrics for use in assessing the trustworthiness of digital repositories or archives.

In addition, there are other CCSDS/ISO standards that may be used to create Representation Information (the *Parameter Value Language (PVL)*, reference [8]; *the Data Description Language EAST Specification*, reference [9]; and the *Data Entity Dictionary Specification Language (DEDSL)*, reference [10]; and also to package information the *XML Formatted Data Unit (XFDU)*, reference [11]). There are many other techniques for creating Additional Information, but these are outside the scope of this document.

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1.3 APPLICABILITY

While this Recommended Practice originates in the space community, it is being designed in a generic way and should be applicable to any science domain, such as life sciences, and to the wider library, records management, and archival communities. It is applicable to information created by an individual, in an individual project, or by an organisation as a whole. It is applicable to projects in which the data already exists as well as projects in which data is to be created in the future. It is also applicable to projects in which the associated data is not the main focus of the project.

This document should be of use to funders and information creators, a role which may be played by multiple actors such as researchers or manufacturers, archive managers and end-users. It will be of use by helping to increase the effectiveness of preservation activities and the exploitation of information, and by informing the practices and standards these users define in their communities.

This guidance can form the basis on which plans, including DMPs, can be constructed, updated, and monitored, to achieve the objectives noted above.

1.4 RATIONALE

Data that is collected or created must have Additional Information associated with it if it is to be independently understandable, usable, and trusted as being authentic. The amount and content of the Additional Information change over time, as hardware, software, the general environment, and users' tacit knowledge change. OAIS uses the terms Representation Information and Preservation Description Information (PDI) for the associated information which is important for preservation. But other types of Additional Information which may help future long-term exploitation are needed. All these must be accumulated over the life of the project. For example, Provenance Information (part of PDI) should originate at data creation and will accumulate over time, recording the things that have happened to the data.

In the case of information created by individual projects, funders are increasingly asking that DMPs accompany any request for project funding. However, these tend not to evolve with the project and are difficult to monitor. This standard encourages the active management of these plans to continue to address the communities' needs and uses for the data. These DMPs can also be captured as part of the Additional Information.

Many project models have been proposed. However, they do not focus on the activities needed at each stage that will help to ensure that the data can be optimally exploited over the long term.

There are a small number of generally applicable groups of activities, within larger project phases in a project where Additional Information should be collected (Collection Groups). These are typically where the responsibility is handed on from one individual or team to another. Each of those individuals or teams has specific knowledge about the information which subsequent individuals or teams may not possess. There is a need to specify the

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information to be captured within and at the interfaces between each of those Project Phases. Improvements or changes to the Additional Information must be considered as the work proceeds. Therefore, there is a need for guidance as to what Additional Information should be captured or improved through the various Project Phases.

This document should help to enable:

- the Producer to capture and record the relevant information in a timely manner;
- the Archive to be assured that it will receive adequate information to enable it to perform preservation activities and support exploitation (e.g., reuse or secondary use) of the information;
- the user to reuse information more easily;
- the funder/sponsor to be assured that the resources that they contribute to the creation of the information will have suitable pay-back.

1.5 CONFORMANCE

Conformance to this recommended practice requires that Additional Information is collected as described in sections 4 and 5.

1.6 DOCUMENT STRUCTURE

Section 2 gives an overview of the document concepts and the way in which activities in projects can be grouped. These are expanded in the following sections. The overlapping activities that occur throughout a project or phases in projects are described in more detail in Section 3. Section 4 defines the areas about which information should be collected and identifies the major pieces of information related to eventual reuse and exploitation which need to be collected. Section 5 shows a Framework for the way in which that minimum useful information that should be captured may evolve through the project.

The annexes provide supporting information. Annex B provides more details from PMBOK and DMBOK, from which a number of concepts are drawn. A brief comparison of other ways to break down projects is in annex C. Checklists specific for space projects are given in annex D. Examples of Frameworks, in less detail, are provided for a broader set of domains in annex E. Security considerations are discussed in annex A.

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1.7 DEFINITIONS

1.7.1 ACRONYMS AND ABBREVIATIONS

AIP	Archival Information Package
CCSDS	Consultative Committee for Space Data Systems
CRC	Cyclic(al) Redundancy Check
CRIS	Current Research Information System
CRO	contract research organization
DAMA	Data Management Association International
DEDSL	Data Entity Dictionary Specification Language
DMBOK	Data Management Body of Knowledge
DMP	Data Management Plan
DOI	Digital Object Identifier
EO	Earth Observation
ESDIS	Earth Science Data and Information System
FITS	Flexible Image Transport System
GDPR	General Data Protection Regulation
GxP	good practice
IIIF	International Image Interoperability Framework
ISAAR	International Standard Archival Authority Record
ISAD	international standard archival description
LTDP	Long-Term Data Preservation
MDR	Medical Devices Regulation
OAIS	Open Archival Information System
OPAC	Online Public Access Catalogue
PAIMAS	Producer-Archive Ingest Methodology Abstract Standard
PAIS	Producer-Archive Ingest Specification
PDI	Preservation Description Information
PMBOK	Project Management Book of Knowledge
PVL	Parameter Value Language
RIN	Representation Information Network
SDLC	Systems Development Lifecycle
SDO	Standards Development Organization
SIP	Submission Information Package
XFDU	XML Formatted Data Unit
XML	Extensible Markup Language

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1.7.2 TERMINOLOGY

There are many terms used in this document which need to have well-defined meanings. These terms are defined in this subsection. When first used in the text, they are shown in bold and are capitalized. Subsequent use employs capitalization only. They should eventually be available online at http://www.sanaregistry.org/r/terms/terms.html.

Apart from the extra terms below, the definitions provided by the *Reference Model for an Open Archival Information System (OAIS)* (reference [4]) and the other standards described in 1.2 are used; these terms are normally capitalized, following the OAIS convention. It is assumed that the reader has some familiarity with OAIS.

NOTE – For convenience, a number of selected definitions from OAIS are included here:

Activity: A distinct, scheduled portion of work performed during the course of a project (from PMBOK).

Additional Information Area: A complete set of concepts, terms, and activities that make up the Additional Information that is needed to support long-term exploitation of data.

Additional Information: The information which should accompany Data to ensure that it can be preserved and exploited. This will include Representation Information and PDI, as defined by OAIS.

Collection Groups: types of Activities in which Additional Information may be collected. The Collection Groups are:

- **Initiating**—justification for creating the data and initial definition of the data project.
- **Planning**—planning for the data creation and encoding.
- **Executing**—creating/collecting/encoding the data. At each point, there may be deviations from the planned results, including instrument effects and unexpected influences.
- **Closing**—completing the data creation/collection/encoding to satisfy the requirements of the project, phase or contractual obligations, and, at the end of the project, turning the information over to the long-term preservation organization.
- **Control**—track, review, and orchestrate the progress and performance of the activities.

Content Information: A set of information that is the original target of preservation or that includes part or all of that information. It is an Information Object composed of its Content Data Object and its Representation Information.

Data: A reinterpretable representation of information in a formalized manner suitable for communication, interpretation, or processing.

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Data Management Plan, DMP: A document that describes how Data will be handled throughout the project and what will happen to it when the project ends. There may be several different Data Management Plans, of various scope and timescale, throughout the project.

Data Object: Either a Physical Object or a Digital Object.

Deliverable: Any unique and verifiable product, result, or capability to perform a service that is required to be produced to complete a process, phase, or project (from PMBOK).

Designated Community: An identified group of potential Consumers who should be able to understand a particular set of information in ways exemplified by the Preservation Objectives. The Designated Community may be composed of multiple user communities. A Designated Community is defined by the Archive, and this definition may change over time.

Digital Object: An object composed of a set of bit sequences.

Information Object: A Data Object together with its Representation Information.

Information Package: A logical container composed of optional Information Object(s). Associated with this Information Package is Packaging Information used to delimit and identify the Information Object and optional Package Description information used to facilitate searches for the Information Object.

Information: Any type of knowledge that can be exchanged. In an exchange, it is represented by data.

Long Term: A period of time long enough for there to be concern about the impacts of changing technologies, including support for new media and data formats, and of a changing Designated Community or changes to the Designated Community's Knowledge Base, on the information being held in an OAIS. This period extends into the indefinite future.

Physical Object: An object (such as a moon rock, bio-specimen, or microscope slide) with physically observable properties that represent information that is considered suitable for being adequately documented for preservation, distribution, and independent usage.

Preservation Description Information, PDI: The information, which, along with Representation Information, is necessary for adequate preservation of the Content Data Object and which can be categorized as Provenance Information, Context Information, Reference Information, Fixity Information, and Access Rights Information.

Preservation Objective: A specific achievable aim which can be carried out using the Information Object.

Project Phase: A collection of logically related project activities that culminates in the completion of one or more outputs (from PMBOK).

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Project: A temporary endeavour undertaken to create a unique product, service, or result (from PMBOK).

Representation Information: The information that maps a Data Object into more meaningful concepts so that the Data Object may be understood in ways exemplified by Preservation Objectives. It is a type of Information Object.

1.8 NOMENCLATURE

1.8.1 NORMATIVE TEXT

The following conventions apply for the normative specifications in this Recommended Practice:

a) the words 'shall' and 'must' imply a binding and verifiable specification;

b) the word 'should' implies an optional, but desirable, specification;

c) the word 'may' implies an optional specification;

d) the words 'is', 'are', and 'will' imply statements of fact.

NOTE – These conventions do not imply constraints on diction in text that is clearly informative in nature.

1.8.2 INFORMATIVE TEXT

In the normative sections of this document, informative text is set off from the normative specifications either in notes or under one of the following subsection headings:

– Overview;

– Background;

– Rationale;

– Discussion.

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1.9 REFERENCES

The following publications contain provisions which, through reference in this text, constitute provisions of this document. At the time of publication, the editions indicated were valid. All publications are subject to revision, and users of this document are encouraged to investigate the possibility of applying the most recent editions of the publications indicated below. The CCSDS Secretariat maintains a register of currently valid CCSDS publications.

[1] *A Guide to the Project Management Body of Knowledge (PMBOK® Guide)*. 5th ed. Newtown Square, Pennsylvania: PMI, 2013.

[2] *The DAMA Guide to the Data Management Body of Knowledge (DAMA-DMBOK Guide)*. 1st ed. Bradley Beach, New Jersey: Technics Publications, 2009.

[3] *DAMA-DMBOK: The DAMA Guide to the Data Management Body of Knowledge*. 2nd ed. Bradley Beach, New Jersey: Technics Publications, 2017.

[4] *Reference Model for an Open Archival Information System (OAIS)*. Issue 3. Recommendation for Space Data System Practices (Magenta Book), CCSDS 650.0-M-3. Washington, D.C.: CCSDS, December 2024. [Equivalent to ISO 14721.]

[5] *Producer-Archive Interface Methodology Abstract Standard*. Issue 1. Recommendation for Space Data System Practices (Magenta Book), CCSDS 651.0-M-1. Washington, D.C.: CCSDS, May 2004. [Equivalent to ISO 20652:2006.]

[6] *Producer-Archive Interface Specification (PAIS)*. Issue 1. Recommendation for Space Data System Standards (Blue Book), CCSDS 651.1-B-1. Washington, D.C.: CCSDS, February 2014. [Equivalent to ISO 20104:2015]

[7] *Audit and Certification of Trustworthy Digital Repositories*. Issue 2. Recommendation for Space Data System Practices (Magenta Book), CCSDS 652.0-M-2. Washington, D.C.: CCSDS, December 2024. [Equivalent to ISO 16363.]

[8] *Parameter Value Language Specification (CCSD0006 and CCSD0008)*. Issue 2-S. Recommendation for Space Data System Standards (Historical), CCSDS 641.0-B-2-S. Washington, D.C.: CCSDS, (June 2000) June 2000. [Equivalent to ISO 21962:2003.]

[9] *The Data Description Language EAST Specification (CCSD0010)*. Issue 3. Recommendation for Space Data System Standards (Blue Book), CCSDS 644.0-B-3. Washington, D.C.: CCSDS, June 2010. [Equivalent to ISO 15889:2011.]

[10] *Data Entity Dictionary Specification Language (DEDSL)—XML/DTD Syntax (CCSD0013)*. Issue 1. Recommendation for Space Data System Standards (Blue Book), CCSDS 647.3-B-1. Washington, D.C.: CCSDS, January 2002. [Equivalent to ISO 15889:2011.]

[11] *XML Formatted Data Unit (XFDU) Structure and Construction Rules*. Issue 1. Recommendation for Space Data System Standards (Blue Book), CCSDS 661.0-B-1. Washington, D.C.: CCSDS, September 2008. [Equivalent to ISO 13527:2010.]

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2 OVERVIEW

Following the terminology discussed in annex B, a **Project** may be divided into any number of **Project Phases** (see, for example, annex C to annex E). A Project Phase is a collection of logically related project **Activities** that culminates in the completion of one or more **Deliverables**. The Project Phases may be sequential or overlapping.

There are many system lifecycle descriptions which describe the stages or phases of systems. Those in annex B use a more flexible approach of describing groups of activities which appear repeatedly in these various stages or phases.

The basic method descibed here and eloborated in this document is to identify a framework in the form of a matrix of groupings of activities/processes for a number of areas (this document uses the term Additional Information Areas). In this document, the Areas are about collections of activities for which information is needed in order to support long-term exploitation of data.

The aim is to fill in the cells in the table below to show that for a given area there should be some specific Activity. This will act as a checklist to help to ensure that data is useable over the long term.

Activities→ Areas↓	Activity 1	Activity 2			Activity n
Area 1	Expected activity of type 'Activity 1' in 'Area 1'	…	…	…	…
Area 2	…	…	…	…	…
Area …	…	…	…	…	…
Area m	…	…	---	---	Expected activity of type 'Activity n' in 'Area m'

Subsection 2.1 describes the groupings of activities while 2.2 describes the areas.

2.1 GROUPINGS OF ACTIVITIES

2.1.1 GENERAL

PMBOK and DMBOK described in annex B use slightly different groupings and terminology; the former uses the term Process Groups, described in B1, while the latter uses the term Activity Groups, described in B2. This document uses the term Collection Groups, which best fits the requirements of this document and is described in 2.1.2.

Each data management activity fits into one or more data management activity groups.

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2.1.2 COLLECTION GROUPS

This document uses the term Collection Groups because the concern is to collect Additional Information about the data being created. The Collection Groups identify types of Activities in which Additional Information may be collected and is a specialization of the PMBOK terminology described in annex B, in particular including 'Closing' because when the process to create data closes, steps must be taken to ensure its usability after the end of that process. The Collection Groups are:

- **Initiating**—justification for creating the data and initial definition of the data project.
- **Planning**—planning for the data creation and encoding.
- **Executing**—creating/collecting/encoding the data. At each point there may be deviations from the planned results, including instrument effects and unexpected influences.
- **Closing**—completing the data creation/collection/encoding to satisfy the requirements of the project, phase, or contractual obligations, and, at the end of the project, turning the information over to the long-term preservation organization.
- **Control**—track, review, and orchestrate the progress and performance of the activities.

These will be discussed in detail in section 3.

2.2 AREAS

2.2.1 GENERAL

The areas identify general headings which are or should be used in most projects most of the time. Annex B provides lists of these areas in general terms. PMBOK uses the term **Knowledge Areas**, described in B3 while DMBOK currently uses the term **Functions**, described in B4. This document uses the term **Additional Information Areas**, described in 2.2.2.

2.2.2 ADDITIONAL INFORMATION AREAS

The Additional Information Areas have a strong relationship to the PMBOK and DMBOK Knowledge Areas/Functions. PMBOK and DMBOK deal with all aspects of a project, but this document is concerned only with those aspects which ensure long-term usability of the data.

The Metadata Management function (see B4) clearly is of particular significance, but for the purpose of this document, it is important to provide finer granularity by using the concepts provided by the OAIS Information Model. OAIS defines the information required for Long-Term Preservation. All or part of the Information required by these Information Objects must therefore be created/collected through the project. These are largely the areas of information

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which are required to create an Archival Information Package, supplemented by a number of other areas which are not covered by OAIS.

The Additional Information Areas are

- Content Information:
  - Content Data Object,
  - Representation Information;
- PDI:
  - Reference Information,
  - Provenance Information,
  - Context Information,
  - Fixity Information,
  - Access Rights Information;
- Package Description;
- Packaging Information;
- Issues Outside OAIS Information Model:
  - Publications,
  - Related Data Set,
  - Potential uses of the data,
  - Potential Designated Community/Knowledge Base,
  - Potential Transformational Information Properties.

These are discussed in more detail in section 4.

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3 COLLECTION GROUPS

3.1 OVERVIEW

Subsection 3.2 outlines the Collection Groups. Subsection 3.3 provides a brief description of each of the Collection Groups.

3.2 OVERVIEW OF COLLECTION GROUPS

The Collection Groups, following in the style of PMBOK's Knowledge Areas, are illustrated as follows. The groups are linked by the outputs they produce; they are overlapping activities that occur throughout a project or phases of a project. They are not expected to be either one time or discrete events.

Figure 3-1 illustrates these Collection Groups in a project with three phases.

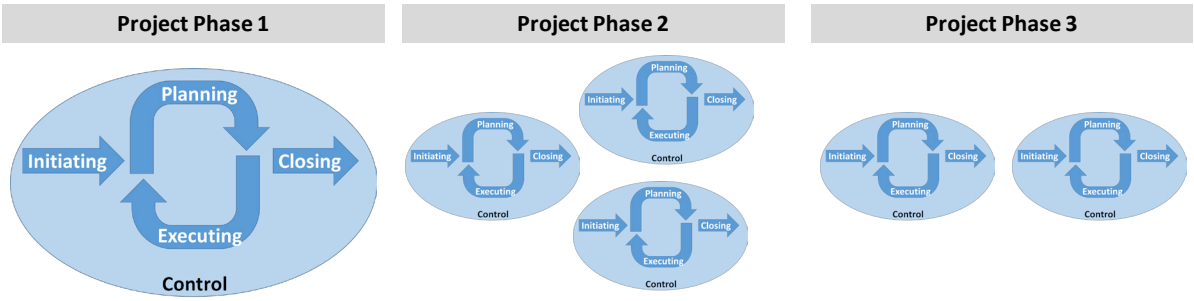

Figure 3-1: Example Collection Groups within a Project with Three Phases

3.3 DETAILS OF THE COLLECTION GROUPS

3.3.1 OVERVIEW

In the following subsections, the focus is on the Information created by the project, including the project management information, which may need to be retained and preserved as Additional Information so that the data (created or collected by the project) will remain understandable and usable. Important types of information are identified in section 4, and a number of checklists are provided in annex D and annex E; these objects should be considered for Long Term Preservation. But the variety of potential projects and their documents means that only general guidelines can be given.

3.3.2 THE INITIATING COLLECTION GROUP

The Initiating Collection Group consists of processes performed to justify the data collection and to define a new project, or new phase of an existing project, by obtaining authorization to start the project or phase.

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