CCSDS

The Consultative Committee for Space Data Systems

Draft Recommendation for
Space Data System Standards

OPEN ARCHIVAL INFORMATION SYSTEM INTEROPERABILITY FRAMEWORK (OAIS-IF) ARCHITECTURE DESCRIPTION

PROPOSED DRAFT RECOMMENDED STANDARD

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FOREWORD

This document is a draft technical Recommended Standard for use in developing and maintaining broader consensus on what is required for an archive to provide permanent, or indefinite long term, preservation of digital information.

This draft Recommended Standard establishes a framework of specifications that forms the basis for the Open Archival Information System (OAIS) Interoperability Framework (IF). OAIS is a long-established Process Framework (PF) to enable digital preservation in trustworthy archives. The OAIS-IF supplements OAIS with interoperable technical specifications that will allow interoperability between users and multiple archives, and between multiple archives. The OAIS-IF is not required for an archive to cite compliance with OAIS.

OAIS provides a basis for further standardization within an archival context. OAIS-IF is an example of that further standardization.

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PREFACE

This document is a draft CCSDS Recommended Standard. Its 'Blue Book' status indicates that the CCSDS believes the document to be technically mature and has released it for formal review by appropriate technical organizations. As such, its technical contents are not stable, and several iterations of it may occur in response to comments received during the review process.

Implementers are cautioned **not** to fabricate any final equipment in accordance with this document's technical content.

DOCUMENT CONTROL

Document	Title and Issue	Date	Status
CCSDS 000.0-W-0	[Document Title], Proposed Draft Recommended Standard, Issue 0	[Month Year]	Current proposed draft

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1 INTRODUCTION

1.1 PURPOSE AND SCOPE

The purpose of this document is to define the CCSDS and International Organization for Standardization (ISO) **Open Archival Information System** (OAIS) Interoperability Framework (IF). An OAIS is an Archive, consisting of an organization, which may be part of a larger organization, of people and systems, that has accepted the responsibility to preserve information and make it available for a **Designated Community**. The OAIS-IF is a supplement to that overarching standard that adds capabilities for system interoperability between users and archives, and between coordinating archives. This document outlines a data system architectural approach and a set of specifications for interfaces required for interoperability and that are visible to Producers and Consumers. This standard is the Architecture Description document that sets the overall architectural framework for the OAIS-IF suite of standards.

The OAIS-IF is an implementable framework for digital repositories that enables international and collaborative research. Its aim is to provide a set of interoperable protocols and interface specifications that will enable the access and re-use of the data, both within and across the operational boundaries of trusted digital repositories. The OAIS-IF is designed to be effectively applied broadly across a spectrum of small, medium, and large use cases and involving a wide variety of stakeholders.

Implementers and system developers that plan to develop systems compliant with the OAIS-IF suite of standards should have a solid grasp of the precepts, concepts and terminology of the Reference Model for an OAIS as described in CCSDS 650.0-M-2.

The information being maintained in these Archives has been deemed to need **Long Term Preservation**, even if the OAIS itself is not permanent. **Long Term** is long enough to be concerned with the impacts of changing technologies, as well as support for new media and data formats, or with a changing Knowledge Base of the Designated Community or changes within the Designated Community or its definition. Long Term may extend indefinitely. Further treatment of the scope of Long Term preservation is in the RM for OAIS, CCSDS 650.0-M-2.-

In terms of scope, this Architecture Description Document is intended to specify normative requirements only for the OAIS-IF components of an OAIS. To describe the overall architecture it also describes components in the client (producer or consumer) systems and in the OAIS Archive "below" the OAIS-IF components. However, these are intended to illuminate the core assumptions behind the architecture design, and not specify any components in the client systems, nor archive components external to the OAIS-IF. The interfaces between the OAIS-IF and external functions are the key assets specified to achieve interoperability across those interfaces. They are fully specified and normative in this document. However, underlying functions below the interfaces within the client or archive systems may be developed differently than this description as long as they support the specified normative functions of the interoperable interfaces.

1.2   APPLICABILITY

Like the OAIS Reference Model in CCSDS 650.0-M-2, this document may be applicable to any Archive that complies with that OAIS standard as well as any archive that wishes to interoperate using the standard. It is specifically applicable to organizations with the responsibility of making information available for the Long Term. This includes organizations with other responsibilities, such as processing and distribution in response to programmatic needs.

This architecture is specifically designed to supplement OAIS Archives. However, this architecture or components of it may be used by archives that are partially or fully non-compliant to the Reference Model for OAIS. The authors of this standard cannot guarantee that these technical approaches will work to fulfill objectives of archives that are not fully OAIS compliant. It is hoped that in these cases partial implementation of the OAIS-IF will encourage greater adoption of the RM for OAIS as archives learn the value of the OAIS practices that enable truly trustworthy Archives for preserving valuable information.

It is intended that the functionality and components in OAIS-IF will exactly mirror the content of the RM for OAIS. However, since these are two separate documents with updates released at different times and different approval cycles, it may be that new functions can be added to OAIS-IF that are not yet in the RM for OAIS. Likewise, there may be new functions in OAIS that are not yet in the OAIS-IF. The intention is to keep the OAIS RM practice and the OAIS-IF specification as closely aligned as possible. However, perfect alignment may not be possible at every given point in time.

These specifications, including the functional and information modeling concepts, are relevant to the comparison and design of facilities which hold information, on a temporary basis, for three reasons:

- When taking into consideration the rapid pace of technology changes or possible changes in a Designated Community, there is the likelihood that facilities, thought to be holding information on a temporary basis, will in fact find that some or much of their information holdings will need Long Term Preservation attention. Stable OAIS-IF standards will help abate the disruption of technology changes.

- Although some facilities holding information may themselves be temporary, some or all of their information may need to be preserved indefinitely. Such facilities need to become active participants in the Long Term Preservation effort and adoption of OAIS-IF will facilitate that transition.

- Regardless of preservation objectives, this architecture enables interoperability for efficiency benefits, preservation benefits, and cross-discipline research benefits.

1.3   OAIS-IF STAKEHOLDERS

In a broad sense, OAIS-IF has applicability to the following stakeholders. This is not an exclusive list, but is intended to illustrate how the document should be of interest to key organization participants.

- **Any organization who has implemented or plans to implement an OAIS-compliant system.** Not all OAIS-compliant systems will have OAIS-IF capabilities. Indeed, as this first version of OAIS-IF is released, none of the OAIS systems in the world will be OAIS-IF compliant. But OAIS implementers should evaluate the benefits to themselves and their customers from implementing an OAIS-IF compliant interoperable archive. Therefore, they have a stake in OAIS-IF.
- **Managers**, who we assume are key decision makers and determine technology adoption and use. We use the Manager stakeholder broadly for anyone who sets overall OAIS policy.
- **Application Software Developers**, who are those responsible for providing software at an application level (i.e. software implementing any of the six functional entities[1] of an OAIS). Application software is likely to be repository-specific.
- **Infrastructure Software Developers**, who are those responsible for providing the underlying software framework or environment which may be used by application software developers. This software is much less likely to be repository specific. The distinction between application and infrastructure is not necessarily exact but the separation from application software is useful in identifying the parts of OAIS-IF that form part of the underling infrastructure and are more likely to be reused from repository to repository.

1.4 RATIONALE

The rationale for OAIS and the Reference Model for OAIS is captured in CCSDS 650.0-M-2.

The rationale for the OAIS Interoperability Framework includes the rationale for OAIS (not repeated here) because it supports OAIS by augmenting it with capabilities for interoperability.

The rationale and vision for OAIS-IF is that in the long-range future it will provide:

- A common user interface experience for users (providers and consumers) of OAIS Archives when accessing many diverse kinds of archives through the OAIS-IF.

- An efficient standardized way for archives to exchange data between archives using the same standardized OAIS-IF interfaces.

- Given broad acceptance of OAIS-IF in the OAIS community, a better chance that long-term preservation will work because future generations can easily find the interfacing resources (plug-ins, etc.) that can be used to access legacy archives.

- Enhanced capabilities for cross-discipline research when many different disciplines use the same interface, and access to a new archive outside of their Designated Community can be accomplished via OAIS-IF.

1.5 CONFORMANCE

An Archive may conform to the Reference Model for OAIS without conforming to the OAIS-IF.

An OAIS Archive that also conforms to OAIS-IF must implement <mark>the normative sections of this document, namely sections 3 and 4.</mark>

While the OAIS Reference Model does not define or require any particular method of implementation, the OAIS-IF must necessarily bound some implementation options in order to insure interoperability. However, the goal of OAIS-IF is to only limit implementation options necessary for interoperability. This is intended to restrict implementation at the interface of systems, but those interfaces are usually characterized to support underlying functionality as required by the OAIS Reference Model. Therefore the definitions at the interfaces and protocols may necessarily imply some underlying <mark>functionality as part of the OAIS-IF suite of standards.</mark> As described in section 1.1, Purpose and Scope, the description of that functionality outside the OAIS-IF is not normative, and may be implemented in different ways, as long as it supports the specified normative functionality for that interface.

A conformant OAIS-IF Archive may provide additional services that are beyond those required of the OAIS-IF standards.

This document does not assume or endorse any specific computing platform, system environment, system design paradigm, system development methodology, database management system, database design paradigm, data definition language, technology, or media required for implementation.

The OAIS-IF is designed as an interoperability framework to support the development of interoperability between archives, both OAIS Archives and non-OAIS archives, using the OAIS-IF standard. As such, it attempts to address all the major activities of an *interoperable* information-preserving Archive in order to define a consistent and useful set of interoperability terms and concepts. A standard or other document that claims to be conformant to the OAIS-IF shall use the terms and concepts defined in the OAIS-IF in the same manner.

1.6   DOCUMENT STRUCTURE

1.6.1   ORGANIZATION BY SECTION

A general description of this document's sections are:
- Section 1 *Purpose and Scope* describes the problem space and rationale for OAIS-IF, and advice on what to expect from the document organization and conventions.
- Section 2 *Overview* provides an informative (non-normative) explanation of the relationships between OAIS-IF components and between them and the environment..
- Section 3 *Interoperability Framework* is a normative description of the requirements on the components of an OAIS-IF architecture. It presents the technical concepts that OAIS-IF uses in order <mark>to perform the functions of an OAIS</mark> in an interoperable way.
- (Add explanation of annexes once they are solidified)

This Blue Book begins with a description of the context for the creation of OAIS-IF in the form of the motivation and rationale for the framework. Further sections in this Blue Book then offer greater levels

of detail about OAIS-IF generated directly from a formal model of the OAIS-IF. This detailed information is presented using the object-oriented paradigm. Each class, attribute, and relationship is formally defined using text and UML diagrams. It is anticipated that these sections will be primarily applicable to system developers but will be of interest to other stakeholders.

It is expected that after this document is approved and published by CCSDS, the model will be made available online by CCSDS. This should be a valuable aid to system developers of OAIS-IF systems.

1.6.2 TYPOGRAPHICAL CONVENTIONS

There are many terms which are used in this framework and which need to have well-defined meanings. These terms are defined in subsection 1.6.2. When first used in the text, they are shown in bold and are capitalized. Subsequent use employs capitalization only. Because of their extensive use in this document, the defined terms 'data' and 'information' will not always be capitalized unless they are part of another defined term. The defined term 'archive' will not be capitalized unless it is used as the equivalent of an 'OAIS Archive'.

Many diagrams are included throughout this reference model, primarily in Sections 4 and 6. In text discussing the diagrams, block names are capitalized and flows are italicized.

1.7 DEFINITIONS

1.7.1 ACRONYMS AND ABBREVIATIONS

AIC   Archival Information Collection

AIP   Archival Information Package

AIU   Archival Information Unit

API   Application Programming Interface

ASCII   American Standard Code for Information Interchange

CCSDS   Consultative Committee for Space Data Systems

CD-ROM   Compact Disk - Read Only Memory

CDO   Content Data Object

CRC   Cyclic Redundancy Check

CSV   Comma Separated Value

DBMS	Data Base Management System
DIP	Dissemination Information Package
DRM	Digital Rights Management
FITS	Flexible Image Transport System
FTP	File Transfer Protocol
HFMS	Hierarchical File Management System
IEEE	Institute of Electrical and Electronics Engineers
IETF	Internet Engineering Task Force
ISBN	International Standard Book Number
ISO	International Organization for Standardization
MPEG	Moving Picture Experts Group
OAIS	Open Archival Information System
PDF	Portable Document Format
PDI	Preservation Description Information
QA	Quality Assurance
RFC	Request For Comment
SIP	Submission Information Package
UML	Unified Modeling Language
VHS	Video Home System
WWW	World Wide Web
XFDU	XML Formatted Data unit
XML	eXtensible Markup Language

1.7.2   TERMINOLOGY

There are many terms which are used in this standard and 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.

This standard is applicable to all disciplines and organizations that do, or expect to, preserve and provide information in digital form, these terms cannot match all of those familiar to any particular discipline (e.g., traditional archives, digital libraries, science data centers). Rather, the approach taken is to use terms that are not already overloaded with meaning so as to reduce conveying unintended meanings. Therefore, it is expected that all disciplines and organizations will find that they need to map some of their more familiar terms to those of the OAIS Reference Model and OAIS-IF. This should not be difficult and is viewed as a contribution, rather than a deterrent, to the success of these standards. For example, archival science focuses on preservation of the 'record'. This term is not used in these standards, but one mapping might approximately equate it with 'Content Data Object within an Archival Information Package'.

TERMS TO BE SUPPLIED (Probably after current OAIS Red Book is published)

1.8   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.

[Only references required as part of the specification are listed in the References subsection. See CCSDS A20.0-Y-4, *CCSDS Publications Manual* (Yellow Book, Issue 4, April 2014) for additional information on this subsection.]

Reference Model for an Open Archival Information System (OAIS). Magenta Book. CCSDS 650.0-M-2 Issue 2. June 2012. (to be changed to Issue 3 when issue 3 is released)

Audit and Certification of Trustworthy Digital Repositories. Magenta Book. Recommended Practice CCSDS 652.0-M-1. September 2011. (to be changed when issue 3 is released)

OTHER REFERENCES TO BE SUPPLIED

2 OVERVIEW

The following concepts set the context for the normative definitions starting in section 3.

2.1 OAIS INTEROPERABILITY FRAMEWORK (OAIS-IF)

An OAIS Archive is an organization that intends to preserve information for access and use by a Designated Community.

An Open Archival Information System (OAIS) is an Archive, an organization that intends to preserve information for access and use by a Designated Community.. It meets a set of responsibilities that allows an OAIS Archive to be distinguished from other uses of the term 'Archive'.

The OAIS Interoperability Framework (OAIS-IF) is a framework based on the concepts presented in the OAIS Reference Model (RM) and augmented with features designed during several decades of digital archive development. The OAIS-IF is designed to be implementable and is an interoperable framework that fosters the acquisition, stewardship, and continuing access to data products, related information resources, and services for a Designated Community.

The environment surrounding an OAIS includes Management, Consumers, and Producers. The resulting environment of the OAIS-IF is illustrated in figure 1.
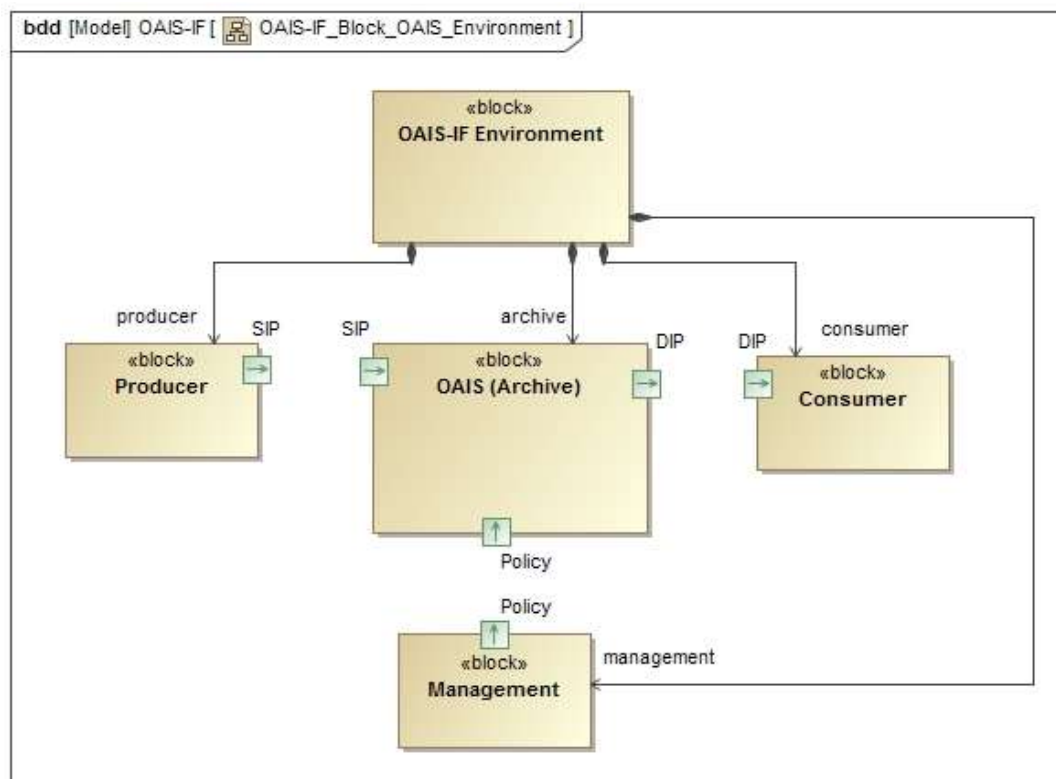
Figure 1 - OAIS Environment

Management is the role played by those who set overall OAIS policy as one component in a broader policy domain, for example as part of a larger organization.

Producer is the role played by those persons or client systems that provide the information to be preserved. This can include other OAISes or internal OAIS persons or systems. A Producer creates a Submission Information Package(s) (SIPs) and submits it to the Archive where it is processed into one or more Archival Information Packages (AIPs).

A Consumer is the role played by those persons, or client systems, who interact with OAIS services to find preserved information of interest and to access that information. A Consumer receives a Dissemination Information Package(s) (DIP) from the Archive.

2.2   OAIS FUNCTIONAL ENTITIES

Within an OAIS (Archive), an OAIS Functional Entity is an entity responsible for an operational function in a specific part of an Open Archive Information System (OAIS). The OAIS functional entities include Access, Administration, Archival Storage, Data Management, Ingest, and Preservation Planning. The OAIS Interoperability Framework, being based on the OAIS Reference Model, has two additional functional entities the Archive Abstraction Layer and the Analytics Platform.
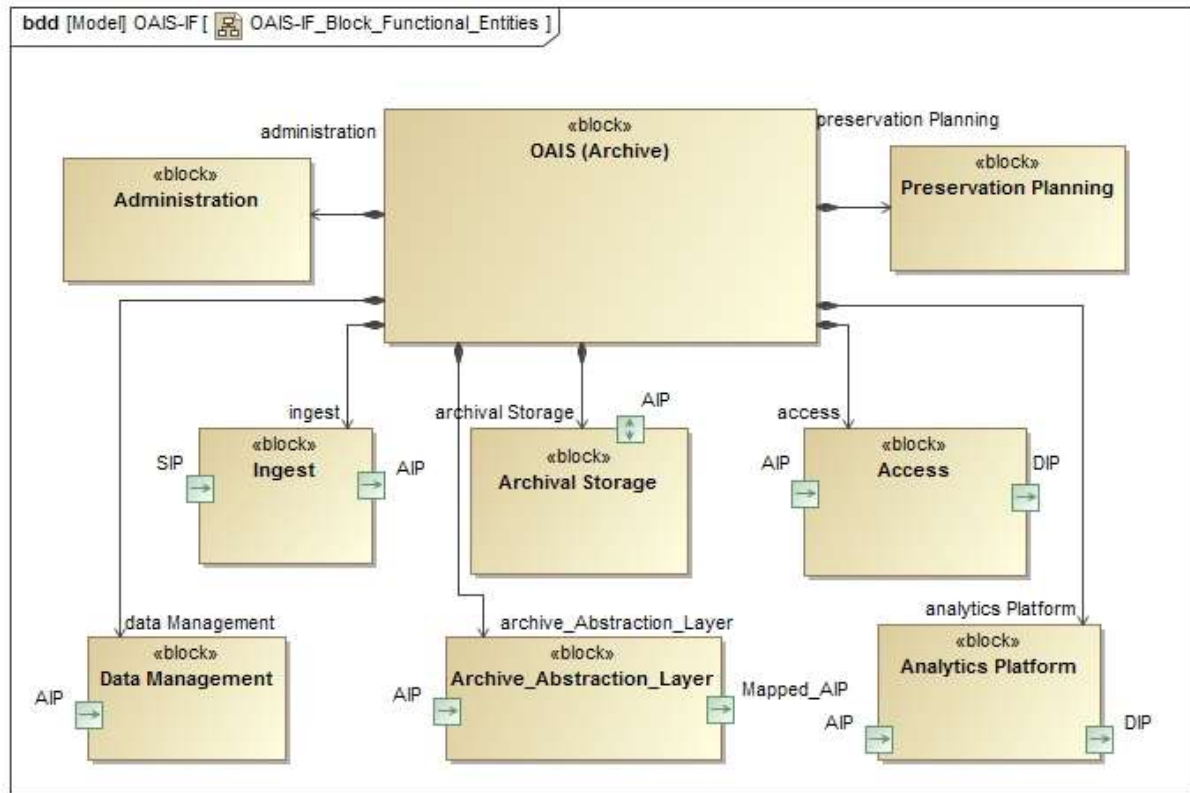
Figure 2 - OAIS Functional Entities

The Access Functional Entity (aka Access) contains the services and functions which make the archival information holdings and related services visible to Consumers. Access generates and provides a DIP to a Consumer, produces a Query Response for a Consumer, and provides Report Assistance to a Consumer.

The Administration Functional Entity (aka Administration) contains the services and functions needed to control the operation of the other OAIS functional entities on a day-to-day basis. For Consumers and Producers Administration sends Information Requests, Bills and Special Request Responses to Consumers. Final Ingest Report and possible liens are sent to a Producer.

The Archival Storage Functional Entity (aka Archival Storage) contains the services and functions used for the storage and retrieval of Archival Information Packages.

The Data Management Functional Entity (aka Data Management) contains the services and functions for populating, maintaining, and accessing a wide variety of information. Some examples of this information are catalogs and inventories on what may be retrieved from

Archival Storage, processing algorithms that may be run on retrieved data, Consumer access statistics, Consumer billing, Event Based Orders, security controls, and OAIS schedules, policies, and procedures.

The Ingest Functional Entity (aka Ingest) contains the services and functions that accept Submission Information Packages from Producers, prepares Archival Information Packages for storage, and ensures that Archival Information Packages and their supporting Descriptive Information become established within the OAIS. Ingest sends Receipt Confirmation to a Producer.

The Preservation Planning Functional Entity (aka Preservation Planning) provides the services and functions for monitoring the environment of the OAIS and provides recommendations and preservation plans to ensure that the information stored in the OAIS remains accessible to, and understandable by, and sufficiently usable by, the Designated Community over the Long Term, even if the original computing environment becomes obsolete. Preservation Planning surveys a Consumer and surveys a Producer.

The Archive Abstraction Layer Functional Entity provides a mapping and possible translation between an object class in the OAIS Information Model and an object class in a non-conforming information model. package. For example a Consumer asking for Provenance Information as defined in in the OAIS Information Model could receive information about a derived product, the source products, and processing software that was grouped and classified as processing history in a non-OAIS information package. This is of course if the Archive Abstraction Layer had definitions of the two information models, how their components were related, and how to translate from one to the other if needed.

The Analytical Platform is a unified data analysis solution designed to address the demands of users beyond the data management infrastructure necessary for maintaining a long-term trusted digital repository. In general it provides contextual analyzed data from across the repository and joins different tools for creating analytics systems.

2.3   OAIS APPLICATIONS

An Application is a computer program designed to perform a group of coordinated functions, tasks, or activities for the benefit of the user. Many of these applications are services, software components that performs work that benefits another. In a service-oriented architecture (SOA) a service is a style of software design where services are provided to the other components by application components, through a communication protocol over a network. The basic principles of service oriented architecture are independent of vendors, products and technologies.

The OAIS-IF Applications are computer programs written for each of the OAIS's Functional Entities outlined in the previous section, for OAIS Consumers or Producers, or for OAIS system services.

The Producer Application class includes applications for users acting as a Producer for an Archive. The Consumer Application class includes applications for users acting as a Consumer of an Archive

An Access Aid is a software program or document that allows Consumers to locate, analyze, order or retrieve information from an OAIS. A Finding Aid is a type of Access Aid that allows a user to search for and identify Archival Information Packages of interest. An Ordering Aid is an application that assists the Consumer in discovering the cost of, and in ordering, AIPs of interest. A Retrieval Aid is an application that allows authorized users to retrieve the Content Information and PDI described by the Package Description.

TBD…

3   INTEROPERABILITY FRAMEWORK

3.1.1   INFORMATION MODEL

An information model is a representation of concepts and the relationships, constraints, rules, and operations to specify data semantics for a chosen domain of discourse. This section is normative.
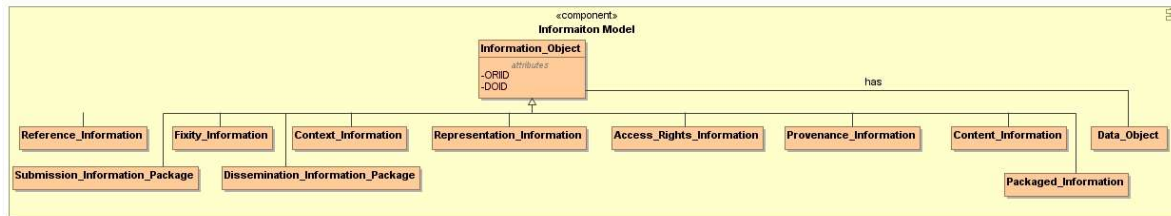

Figure 3 - Information Model

3.1.1.1   Access_Rights_Information

Access Rights Information: The information that identifies the access restrictions pertaining to the Content Information, including the legal framework, licensing terms, and access control. It contains the access and distribution conditions stated within the Submission Agreement, related to both preservation (by the OAIS) and final usage (by the Consumer). It also includes the specifications for the application of rights enforcement measures.

- Subclass of: Information_Object

1. The Information Object is stored in and retrieved from Archival Storage.

2. An Information Object has one Data Object.

3. The class has a getRepresentationInformation method

4. The class has a putRepresentationInformation method

5. The Information Object class is realized by the Information Object Interface.

3.1.1.2   Archival_Information_Package

Archival Information Package (AIP): An Information Package, consisting of the Content Information and the associated Preservation Description Information (PDI), which is preserved within an OAIS.

- Subclass of: Information_Package

> *1. An Archival Information Package is stored in and retrieved from Archival Storage.*
>
> *2. An Information Object has one Data Object.*
>
> *3. The class has a getRepresentationInformation method*
>
> *4. The class has a putRepresentationInformation method*
>
> *5. An Information Package has Content Information.*
>
> *6. The Information Object class is realized by the Information Object Interface.*

3.1.1.3   Content_Information

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.

- Subclass of: Information_Object

> *1. The Information Object is stored in and retrieved from Archival Storage.*
>
> *2. An Information Object has one Data Object.*
>
> *3. The class has a getRepresentationInformation method*
>
> *4. The class has a putRepresentationInformation method*
>
> *5. The Information Object class is realized by the Information Object Interface.*

3.1.1.4   Context_Information

Context Information: The information that documents the relationships of the Content Information to its environment. This includes why the Content Information was created and how it relates to other Content Information objects.

- Subclass of: Information_Object

> *1. The Information Object is stored in and retrieved from Archival Storage.*
>
> *2. An Information Object has one Data Object.*
>
> *3. The class has a getRepresentationInformation method*

4. The class has a putRepresentationInformation method

5. The Information Object class is realized by the Information Object Interface.

3.1.1.5   Dissemination_Information_Package

Dissemination Information Package (DIP): An Information Package, derived from one or more AIPs, and sent by Archives to the Consumer in response to a request to the OAIS.

- Subclass of: Information_Package

1. The Information Object is stored in and retrieved from Archival Storage.

2. An Information Object has one Data Object.

3. The class has a getRepresentationInformation method

4. The class has a putRepresentationInformation method

5. The Dissemination Information Package information object is an element of the Consumer Application Layer component.

6. The Information Object class is realized by the Information Object Interface.

3.1.1.6   Fixity_Information

Fixity Information: The information which documents the mechanisms that ensure that the Content Information object has not been altered in an undocumented manner. An example is a Cyclical Redundancy Check (CRC) code for a file.

- Subclass of: Information_Object

1. The Information Object is stored in and retrieved from Archival Storage.

2. An Information Object has one Data Object.

3. The class has a getRepresentationInformation method

4. The class has a putRepresentationInformation method

5. The Information Object class is realized by the Information Object Interface.

3.1.1.7   Information_Object

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

> *1. The Information Object is stored in and retrieved from Archival Storage.*
>
> *2. An Information Object has one Data Object.*
>
> *3. The class has a getRepresentationInformation method*
>
> *4. The class has a putRepresentationInformation method*
>
> *5. The Information Object class is realized by the Information Object Interface.*

3.1.1.8   Information_Package

Information Package: A logical container composed of optional Content Information and optional associated Preservation Description Information. Associated with this Information Package is Packaging Information used to delimit and identify the Content Information and Package Description information used to facilitate searches for the Content Information.

- Subclass of: Information_Object

> *1. The Information Object is stored in and retrieved from Archival Storage.*
>
> *2. An Information Object has one Data Object.*
>
> *3. The class has a getRepresentationInformation method*
>
> *4. The class has a putRepresentationInformation method*
>
> *5. The Information Object class is realized by the Information Object Interface.*

3.1.1.9   Native_Object

The Native_Object class is a data object in a Native Archive.

3.1.1.10   Provenance_Information

Provenance Information: The information that documents the history of the Content Information. This information tells the origin or source of the Content Information, any changes that may have taken place since it was originated, and who has had custody of it since it was originated. The Archive is responsible for creating and preserving Provenance Information from the point of Ingest; however, earlier Provenance Information should be

provided by the Producer. Provenance Information adds to the evidence to support Authenticity.

- Subclass of: Information_Object

> *1. The Information Object is stored in and retrieved from Archival Storage.*
>
> *2. An Information Object has one Data Object.*
>
> *3. The class has a getRepresentationInformation method*
>
> *4. The class has a putRepresentationInformation method*
>
> *5. The Information Object class is realized by the Information Object Interface.*

3.1.1.11   Reference_Information

Reference Information: The information that is used as an identifier for the Content Information. It also includes identifiers that allow outside systems to refer unambiguously to a particular Content Information. An example of Reference Information is an ISBN.

- Subclass of: Information_Object

> *1. The Information Object is stored in and retrieved from Archival Storage.*
>
> *2. An Information Object has one Data Object.*
>
> *3. The class has a getRepresentationInformation method*
>
> *4. The class has a putRepresentationInformation method*
>
> *5. The Information Object class is realized by the Information Object Interface.*

3.1.1.12   Representation_Information

Representation Information: The information that maps a Data Object into more meaningful concepts. An example of Representation Information for a bit sequence which is a FITS file might consist of the FITS standard which defines the format plus a dictionary which defines the meaning in the file of keywords which are not part of the standard. Another example is JPEG software which is used to render a JPEG file; rendering the JPEG file as bits is not very meaningful to humans but the software, which embodies an understanding of the JPEG standard, maps the bits into pixels which can then be rendered as an image for human viewing.

- Subclass of: Information_Object

> *1. The Information Object is stored in and retrieved from Archival Storage.*
>
> *2. An Information Object has one Data Object.*
>
> *3. The class has a getRepresentationInformation method*
>
> *4. The class has a putRepresentationInformation method*
>
> *5. Representation Information can be interpreted using recursively by Representation Information.*
>
> *6. The Information Object class is realized by the Information Object Interface.*

3.1.1.13   Submission_Information_Package

Submission Information Package (SIP): An Information Package that is delivered by the Producer to the OAIS for use in the construction or update of one or more AIPs and/or the associated Descriptive Information.

- Subclass of: Information_Package

> *1. The Information Object is stored in and retrieved from Archival Storage.*
>
> *2. An Information Object has one Data Object.*
>
> *3. The class has a getRepresentationInformation method*
>
> *4. The class has a putRepresentationInformation method*
>
> *5. The Submission Information Package information object is an element of the Producer Application Layer component.*
>
> *6. The Information Object class is realized by the Information Object Interface.*

3.1.2   COMPONENT

A component in represents a modular part of a system that encapsulates the state and behavior of a number of elements such as attributes or methods. Its behavior is defined in terms of provided and required interfaces, is self-contained, and substitutable. This section is informative.
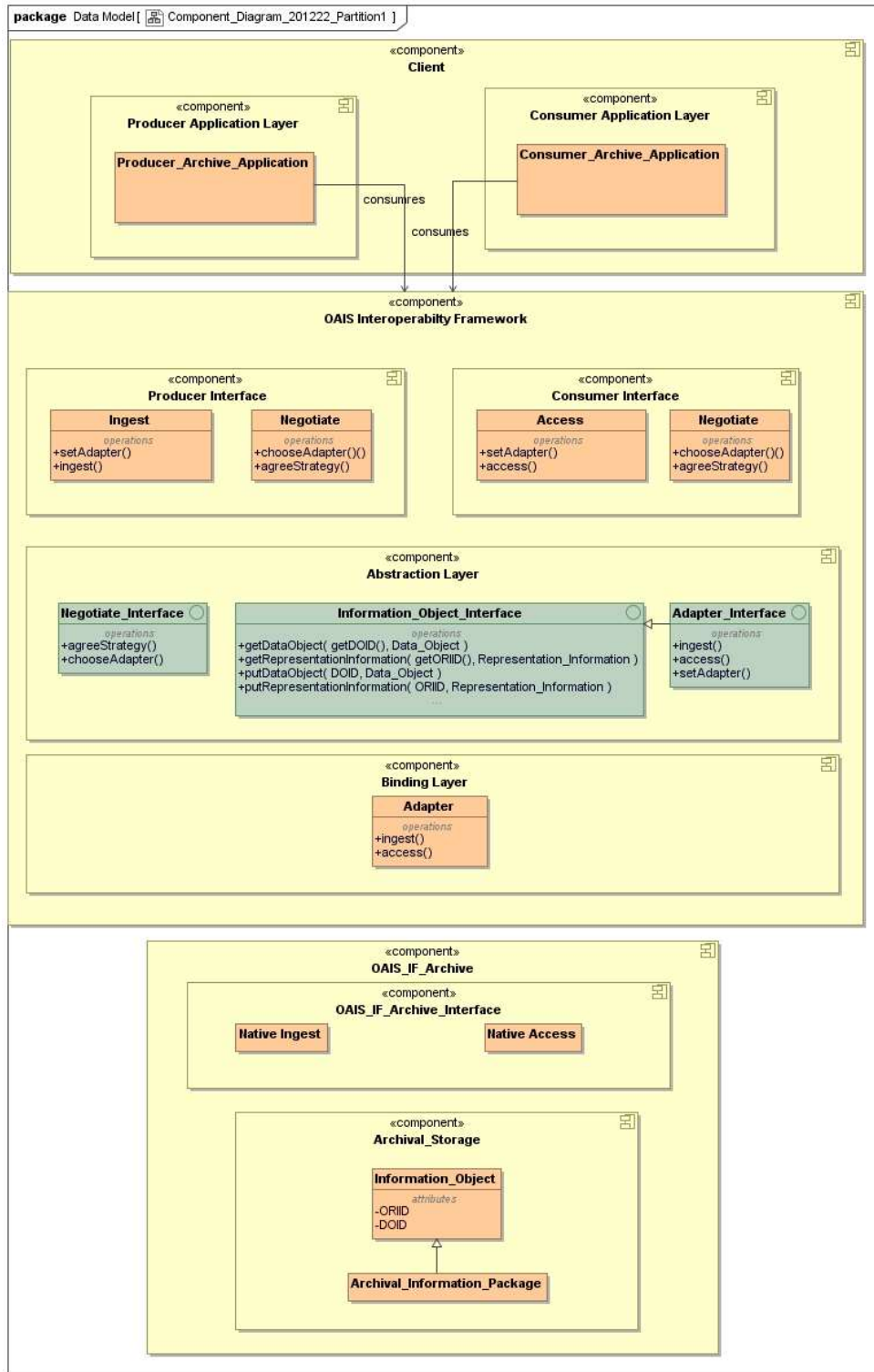
Figure 4 - Component Diagram

3.1.2.1   Abstraction_Layer

The Abstraction_Layer contains the interfaces that define the contracts for the interoperability framework.

- Subclass of: Component

3.1.2.2   Archival_Storage

Archival Storage Functional Entity (aka Archival Storage): The OAIS functional entity that contains the services and functions used for the storage and retrieval of Archival Information Packages.

- Subclass of: Functional_Entity

3.1.2.3   Binding_Layer

The Binding Layer contains 'wrapper' libraries that bridges two programming languages, so that a library written for one language can be used in another language.

- Subclass of: Component

> *1. The Binding Layer component is an element of the OAIS Interoperabilty Framework component.*

3.1.2.4   Client

A Client is a computer system or process that requests a service of another computer system or process (a 'server') using some kind of protocol and accepts the server's responses.

- Subclass of: Component

3.1.2.5   Consumer_Application_Layer

The Consumer Application Layer contains a program or group of programs designed for Consumer.

- Subclass of: Component

> *1. The Consumer Application Layer component is an element of the Client component.*

3.1.2.6   Consumer_Interface

The Consumer Interface provides abstractions of consumer services.

- Subclass of: Component

> *1. The Consumer Interface component is an element of the OAIS Interoperabilty Framework component.*

3.1.2.7   OAIS_Interoperabilty_Framework

The OAIS Interoperabilty Framework is an abstraction based on the OAIS Functional and Information Models in which software providing generic functionality can be selectively changed by additional user-written code to provide application-specific software that interoperates across digital repositories.

- Subclass of: Component

3.1.2.8   Producer_Application_Layer

The Producer Application Layer contains a program or group of programs designed for Producers.

- Subclass of: Component

> *1. The Producer Application Layer component is an element of the Client component.*

3.1.2.9   Producer_Interface

The Producer Interface is an abstraction of producer services.

- Subclass of: Component

> *1. The Producer Interface component is an element of the OAIS Interoperabilty Framework component.*

3.1.3   INTERFACE

An Interface is the abstraction of a service that only defines the operations supported by that service, but not their implementations. This section is normative.
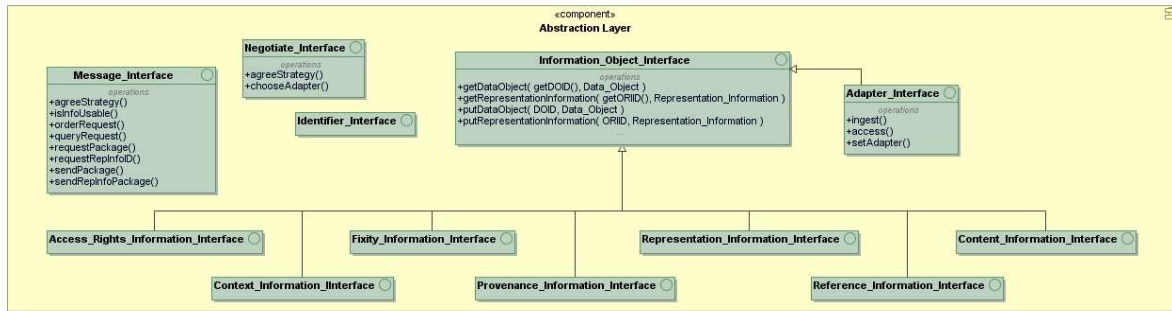
Figure 5 – Interface Layer Diagram

3.1.3.1   Access_Interface

The Access Interface is a well-defined entry point for the Access functional entity and provides a contract for the exchange of information.

- Subclass of: Interface

> *1. The Access Interface is an element of the Abstraction Layer component.*

3.1.3.2   Access_Rights_Information_Interface

The Access Rights Information Interface is a well-defined entry point and contract for accessing Access Rights Information.

- Subclass of: Information_Object_Interface

> *1. The class has a getDataObject method*
>
> *2. The class has a getRepresentationInformation method*
>
> *3. The class has a putDataObject method*
>
> *4. The class has a putRepresentationInformation method*
>
> *5. The Information Object Interface is an element of the Abstraction Layer component.*

3.1.3.3   Adapter_Interface

The Adapter Interface is a well-defined entry point and contract for Bindings.

- Subclass of: Interface

> *1. The class has an accessIO method.*
>
> *2. The class has an ingestIO method.*

3. The class has a setAdapter method.

3.1.3.4   Fixity_Information_Interface

The Fixity Information Interface is a well-defined entry point and contract for accessing Fixity Information.

- Subclass of: Information_Object_Interface

1. The class has a getDataObject method

2. The class has a getRepresentationInformation method

3. The class has a putDataObject method

4. The class has a putRepresentationInformation method

5. The Information Object Interface is an element of the Abstraction Layer component.

3.1.3.5   Information_Object_Interface

The Information Object Interface is a well-defined entry point and contract for accessing an Information_Object.

- Subclass of: Interface

1. The class has a getDataObject method

2. The class has a getRepresentationInformation method

3. The class has a putDataObject method

4. The class has a putRepresentationInformation method

5. The Information Object Interface is an element of the Abstraction Layer component.

3.1.3.6   Ingest_Interface

The Ingest Interface is a well-defined entry point for the Ingest functional entity and provides a contract for the exchange of information.

- Subclass of: Interface

1. The Ingest Interface is an element of the Abstraction Layer component.

3.1.3.7   Message_Interface

The Message Interface is a well-defined entry point and contract for passing messages.

- Subclass of: Interface

> *1. The class has an agreeStrategy method.*
>
> *2. The class has a getReceiver method.*
>
> *3. The class has a getSender method.*
>
> *4. The class has a isInfoUsable method.*
>
> *5. The class has a orderRequest method.*
>
> *6. The class has a queryRequest method.*
>
> *7. The class has a requestPackage method.*
>
> *8. The class has a requestRepInfoIDs method.*
>
> *9. The class has a sendPackage method.*
>
> *10. The class has a sendRepInfoPackage method.*

3.1.3.8   Negotiate_Interface

The Negotiate Interface is a well-defined entry point for negotiating protocols between two entities and provides a contract for the exchange of information during negotiation.

- Subclass of: Interface

> *1. The class has an agreeStrategy method.*
>
> *2. The class has a chooseAdapter method.*
>
> *3. The Negotiate Interface is an element of the Abstraction Layer component.*

3.1.3.9   Provenance_Information_Interface

The Provenance Information Interface is a well-defined entry point and contract for accessing Provenance Information.

- Subclass of: Information_Object_Interface

> *1. The class has a getDataObject method*
>
> *2. The class has a getRepresentationInformation method*

3. The class has a putDataObject method

4. The class has a putRepresentationInformation method

5. The Information Object Interface is an element of the Abstraction Layer component.

3.1.3.10   Reference_Information_Interface

The Reference Information Interface is a well-defined entry point and contract for accessing Reference Information.

- Subclass of: Information_Object_Interface

1. The class has a getDataObject method

2. The class has a getRepresentationInformation method

3. The class has a putDataObject method

4. The class has a putRepresentationInformation method

5. The Information Object Interface is an element of the Abstraction Layer component.

3.1.3.11   Representation_Information_Interface

The Representation Information Interface is a well-defined entry point and contract for accessing Representation Information.

- Subclass of: Information_Object_Interface

1. The class has a getDataObject method

2. The class has a getRepresentationInformation method

3. The class has a putDataObject method

4. The class has a putRepresentationInformation method

5. The Information Object Interface is an element of the Abstraction Layer component.

3.1.4   METHOD

A Method in object-oriented programming (OOP) is a procedure associated with a message and an object. This section is normative.

3.1.4.1   accessIO

accessIO: a method that given an Object Representation Information ID (ORIID), returns the associated Information Object (IO)

- Subclass of: Method

3.1.4.2   agreeStrategy

agreeStrategy: a method that facilitates the creation of a set of OAIS-IF Adapter and Identifier types that enable interoperability between a repository and a user (possibly another repository).

- Subclass of: Method

3.1.4.3   chooseAdapter

chooseAdapter: a method that given an negotiated strategy for interoperation, selects an OAIS-IF Adapter for inclusion into the set of set of adapters to enable interoperability.

- Subclass of: Method

3.1.4.4   getDOID

getDOID: a method that gets the Data Object ID (DOID) for a Data Object.

- Subclass of: Method

3.1.4.5   getDataObject

getDataObject: a method that given a Data Object Identifier (DOID) gets a Data Object.

- Subclass of: Method

3.1.4.6   getORID

getORID: a method that gets the Object Representation Information ID (ORIID) for an instance of Representation Information.

- Subclass of: Method

3.1.4.7   getReceiver

getReceiver: a method that given a message gets the receiver.

- Subclass of: Method

3.1.4.8   getRepresentationInformation

getRepresentationInformation: a method that given a Object Representation Information ID (ORIIID) gets an instance of Representation information.

- Subclass of: Method

3.1.4.9   getSender

getSender: a method that given a message gets the sender.

- Subclass of: Method

3.1.4.10   ingestIO

ingestIO: a method that given an Object Representation Information ID (ORIID), ingests the associated Information Object (IO)

- Subclass of: Method

3.1.4.11   isInfoUsable

isInfoUsable: a method that indicates that an information object is usable.

- Subclass of: Method

3.1.4.12   orderRequest

orderRequest: a method that requests information that has been indicated to be currently available.

- Subclass of: Method

3.1.4.13   putDataObject

putDataObject: a method that given a Data Object Identifier (DOID), puts a data object.

- Subclass of: Method

3.1.4.14   putRepresentationInformation

putRepresentationInformation: a method that given an Object Representation Information ID (ORIID), puts an instance of Representation Information.

- Subclass of: Method

3.1.4.15 queryRequest

queryRequest: a method that returns a list of Object Representation Information IDs (ORIIDs) given a query for finding Information Object(s).

- Subclass of: Method

3.1.4.16 requestPackage

requestPackage: a method that requests an instance of Packaged Information.

- Subclass of: Method

3.1.4.17 requestRepInfoIDs

requestRepInfoIDs: a method that requests Object Representation Information IDs (ORIIDs).

- Subclass of: Method

3.1.4.18 sendPackage

sendPackage: a method that sends an instance of Packaged Information.

- Subclass of: Method

3.1.4.19 sendRepInfoPackage

sendRepInfoPackage: a method that sends Representation information as Packaged Information.

- Subclass of: Method

3.1.4.20 setAdapter

setAdapter: a method that given the Identifer of an Adapter, retrieves and plugs-in the Adapter for use.

- Subclass of: Method

3.1.4.21 setORIID

setORIID: a method that sets the Object Representation Information ID (ORIID) for an instance of Representation Information.

- Subclass of: Method

3.1.5   DATA_STRUCTURE

A Data Structure is a particular way of organizing data in a computer so that it can be used efficiently. This section is informative.

3.1.6   BINDING

A Binding (Adapter) is a wrapper library that bridges two programming languages, so that a library written for one language can be used in another language. The adapter interface is normative. The listed adapters are informative.

3.1.7   APPLICATION

Application software is a program or group of programs designed for end users. This section is informative.
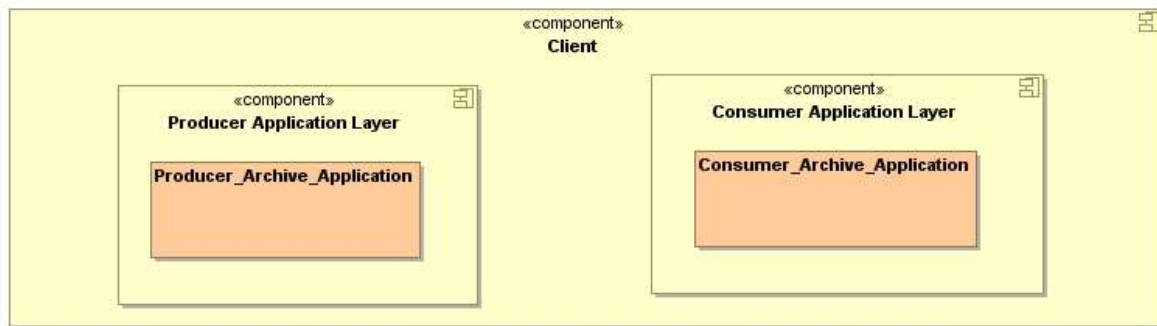

Figure 6 - Application Layer

3.1.7.1   Consumer_Archive_Application

A Consumer_Archive_Application is an application for use by a user performing the role of a consumer for a data archive.

> *1. Consumer_Archive_Application_Receives_Dissemination_Information_Package*
>
> *2. Consumer_Archive_Application_Receives_Information_Package*
>
> *3. The Consumer Archive Application is an element of the Consumer Application Layer component.*
>
> *4. The Consumer Archive Application consumes the OAIS Interoperabilty Framework.*
>
> *5. The Consumer Archive Application negotiates via the Negotiate service.*
>
> *6. The Consumer Archive Application requests through the Access service.*

3.1.7.2   Producer_Archive_Application

A Producer_Archive_Application an application for use by a user performing the role of a producer for a data archive.

> *1. The Producer Archive Application is an element of the Producer Application Layer component.*
>
> *2. The Producer Archive Application consumes the OAIS Interoperabilty Framework.*
>
> *3. The Producer Archive Application negotiates through the Negotiate service.*
>
> *4. The Producer Archive Application produces the Submission Information Package.*
>
> *5. The Producer Archive Application provides SIPs to the Ingest service.*

3.1.8   SERVICE

A service is a software component that performs work that benefits another, primarily by listening for and responding to data requests from other software components. This section is informative.

3.1.8.1   Access

Access Functional Entity (aka Access): The OAIS functional entity that contains the services and functions which make the archival information holdings and related services visible to Consumers.

- Subclass of: Functional_Entity

> *1. The class requests an Archival Information Package*
>
> *2. The Access service is an element of the Consumer Interface component.*
>
> *3. The Access class is realized by the Access Interface.*

3.1.8.2   Functional_Entity

A Functional Entity is an entity responsible for a function that is required to ensure the reliable operation of a specific part of an Open Archive Information System.

- Subclass of: MessagedService

3.1.8.3   Ingest

Ingest Functional Entity (aka Ingest): The OAIS functional entity that contains the services and functions that accept Submission Information Packages from Producers, prepares Archival Information Packages for storage, and ensures that Archival Information Packages and their supporting Descriptive Information become established within the OAIS.

- Subclass of: Functional_Entity

> *1. Ingest sends an Archival Information Package to Archival Storage*
>
> *2. The Ingest service is an element of the Producer Interface component.*
>
> *3. The Ingest class is realized by the Ingest Interface.*

3.1.8.4   Native_Access

The Native_Access class provides an access capability for a Native Archive.

3.1.8.5   Native_Ingest

The Native_Ingest class provides an ingest capability for a Native Archive.

3.1.8.6   Negotiate

The Negotiate function allows a user and the OAIS to negotiate adapters that enable them to interoperate.

- Subclass of: Functional_Entity

> *1. The Negotiate service is an element of the Consumer Interface component.*
>
> *2. The Negotiate service is an element of the Producer Interface component.*
>
> *3. The Negotiate class is realized by the Negotiate Interface.*

3.1.9   OAIS FUNCTIONAL ENTITY

A Functional Entity is an entity responsible for a function that is required to ensure the reliable operation of a specific part of an Open Archive Information System. This section is informative.
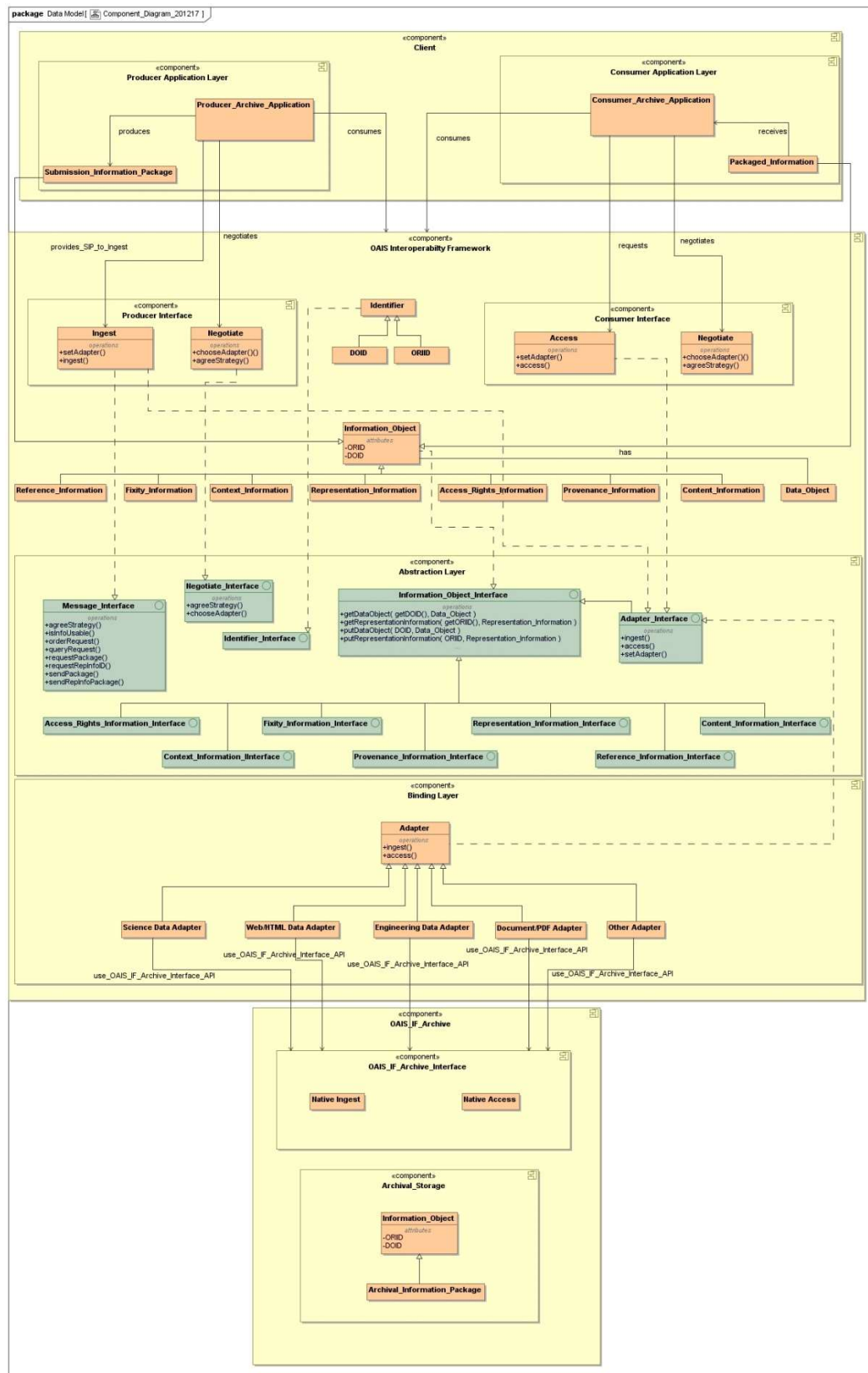
Figure 7 - OAIS Interoperability Framework Component Diagram

ANNEX A

IMPLEMENTATION CONFORMANCE
STATEMENT (ICS) PROFORMA

(NORMATIVE)

A1   INTRODUCTION

A1.1   OVERVIEW

This annex provides the Implementation Conformance Statement (ICS) Requirements List (RL) for an implementation of [Specification]. The ICS for an implementation is generated by completing the RL in accordance with the instructions below. An implementation claiming conformance must satisfy the mandatory requirements referenced in the RL.

A1.2   ABBREVIATIONS AND CONVENTIONS

The RL consists of information in tabular form. The status of features is indicated using the abbreviations and conventions described below.

Item Column

The item column contains sequential numbers for items in the table.

Feature Column

The feature column contains a brief descriptive name for a feature. It implicitly means "Is this feature supported by the implementation?"

Status Column

The status column uses the following notations:

  –   M   mandatory;

  –   O   optional;

  –   C   conditional;

  –   X   prohibited;

  –   I   out of scope;

  –   N/A   not applicable.

<u>Support Column Symbols</u>

The support column is to be used by the implementer to state whether a feature is supported by entering Y, N, or N/A, indicating:

> Y   Yes, supported by the implementation.
>
> N   No, not supported by the implementation.
>
> N/A   Not applicable.

The support column should also be used, when appropriate, to enter values supported for a given capability.

A1.3   INSTRUCTIONS FOR COMPLETING THE RL

An implementer shows the extent of compliance to the Recommended Standard by completing the RL; that is, the state of compliance with all mandatory requirements and the options supported are shown. The resulting completed RL is called an ICS. The implementer shall complete the RL by entering appropriate responses in the support or values supported column, using the notation described in A1.2. If a conditional requirement is inapplicable, N/A should be used. If a mandatory requirement is not satisfied, exception information must be supplied by entering a reference Xi, where i is a unique identifier, to an accompanying rationale for the noncompliance.

A2   ICS PROFORMA FOR [SPECIFICATION]

A2.1   GENERAL INFORMATION

A2.1.1   Identification of ICS

A2.1.1.1   Test

Date of Statement (DD/MM/YYYY)	
ICS serial number	
System Conformance statement cross-reference	

A2.1.2   Identification of Implementation Under Test

Implementation Name	
Implementation Version	
Special Configuration	

Other Information	

A2.1.3 Identification of Supplier

Supplier	
Contact Point for Queries	
Implementation Name(s) and Versions	
Other information necessary for full identification, e.g., name(s) and version(s) for machines and/or operating systems; System Name(s)	

A2.1.4 Identification of Specification

[CCSDS Document Number]	
Have any exceptions been required? NOTE – A YES answer means that the implementation does not conform to the Recommended Standard. Non-supported mandatory capabilities are to be identified in the ICS, with an explanation of why the implementation is non-conforming.	Yes [ ] No [ ]

A2.2 REQUIREMENTS LIST

[See CCSDS A20.1-Y-1, *CCSDS Implementation Conformance Statements* (Yellow Book, Issue 1, April 2014).]

ANNEX B

SECURITY, SANA, AND PATENT CONSIDERATIONS

(INFORMATIVE)

B1   SECURITY CONSIDERATIONS

B1.1   SECURITY CONCERNS WITH RESPECT TO THE CCSDS DOCUMENT

B1.1.1   Data Privacy

B1.1.2   Data Integrity

B1.1.3   Authentication of Communicating Entities

B1.1.4   Control of Access to Resources

B1.1.5   Availability of Resources

B1.1.6   Auditing of Resource Usage

B1.2   POTENTIAL THREATS AND ATTACK SCENARIOS

B1.3   CONSEQUENCES OF NOT APPLYING SECURITY TO THE TECHNOLOGY

B2   SANA CONSIDERATIONS

[See CCSDS 313.0-Y-1, *Space Assigned Numbers Authority (SANA)—Role, Responsibilities, Policies, and Procedures* (Yellow Book, Issue 1, July 2011).]

B3   PATENT CONSIDERATIONS

[See CCSDS A20.0-Y-4, *CCSDS Publications Manual* (Yellow Book, Issue 4, April 2014).]