Digital Preservation

Block 2:
OAIS Reference Model

Andreas Rauber
Institut für Softwaretechnik und Interaktive Systeme
TU Wien
http://www.ifs.tuwien.ac.at/dp

Überblick

- Prinzipien des OAIS Modells
- Technischer Überblick
- Funktionaler Überblick
- Informationsmodell
- Zusammenfassung

OAIS & Rolle der NASA

- National Space Science Data Center
  - NASA's erstes digitales Archiv
  - hat viele Technologiewechsel seit 1966 durchlebt
- Consultative Committee for Space Data Systems
  - Internationale Gruppe von Space Agencies
  - Entwickelte eine Reihe von Disziplin-unabhängigen Standards
  - Wurde zur Arbeitsgruppe für ISO TC 20/ SC 13 um 1990
    TC20: Aircraft and Space Vehicles
    SC13: Space Data and Information Transfer Systems

Was ist ein Referenz Modell

- Ein Framework
  - um die signifikanten Beziehungen zwischen signifikanten Entitäten in einer Umgebung zu verstehen, und
  - für die Entwicklung von konsistenten Standards oder Spezifikationen zur Unterstützung dieser Umgebungen.
- Ein Referenzmodell
  - basiert auf einer kleinen Anzahl vereinigender Konzepte
  - stellt eine Abstraktion der Kernkonzepte, deren Beziehungen, und deren Schnittstellen sowohl zueinander als auch zur externen Umgebung dar
  - kann als Basis zum Training und zur Erklärung eines Standards dienen.

OAIS

- OAIS ist ein Referenzmodell
- keine Umsetzungsanleitung, kein Datenmodell, keine Spezifikation
- beschreibt jene Elemente, Konzepte, die für das Projekt relevant sind
- Ziel: festzustellen, welche Teilbereiche des Referenzmodells welchen konkreten Systemen, Funktionen und Verantwortlichkeiten in der angestrebten Lösung entsprechen.

OAIS Informationsquellen

- Reference Model for an Open Archival Information System (OAIS), Blue Book, CCSDS 650.0-B-1, January 2002
- Folien basierend auf Blue Book und:
  - Don Sawyer, Lou Reich: ISO Reference Model for an Open Archival Information System (OAIS) Tutorial Presentation, LOC, 13. Juni 2003
  - größtenteils in Originalsprache belassen, um Kernkonzepte im internationalen Sprachgebrauch zu belassen
- http://ssdoo.gsfc.nasa.gov/nost/isoas/overview.html

Überblick

- Prinzipien des OAIS Modells
- Technischer Überblick
- Funktionaler Überblick
- Informationsmodell
- Zusammenfassung:

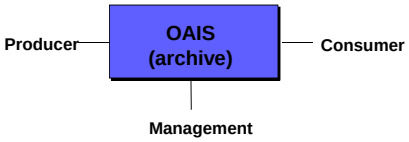
Open Archival Information System (OAIS)

- Open
  - Reference Model standard(s) are developed using a public process and are freely available
- Information
  - Any type of knowledge that can be exchanged
  - Independent of the forms (i.e., physical or digital) used to represent the information
  - Data are the representation forms of information
- Archival Information System
  - Hardware, software, and people who are responsible for the acquisition, preservation and dissemination of the information

Purpose, Scope, and Applicability

- Framework for understanding and applying concepts needed for long-term digital information preservation
  - Long-term is long enough to be concerned about changing technologies
  - Starting point for model addressing non-digital information
- Provides set of minimal responsibilities to distinguish an OAIS from other uses of 'archive'
- Framework for comparing architectures and operations of existing and future archives
- Basis for development of additional related standards
- Addresses a full range of archival functions
- Applicable to all long-term archives and those organizations and individuals dealing with information that may need long-term preservation
- Does NOT specify an implementation

Model View of an OAIS Environment

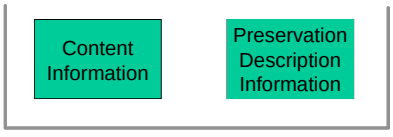


- Producer is the role played by those persons, or client systems, who provide the information to be preserved
- Management is the role played by those who set overall OAIS policy as one component in a broader policy domain
- Consumer is the role played by those persons, or client systems, who interact with OAIS services to find and acquire preserved information of interest

OAIS Information Definition

- Information is always expressed (i.e., represented) by some type of data
- Data interpreted using its Representation Information yields Information
- Information Object preservation requires clear identification and understanding of the Data Object and its associated Representation Information

Information Package Definition

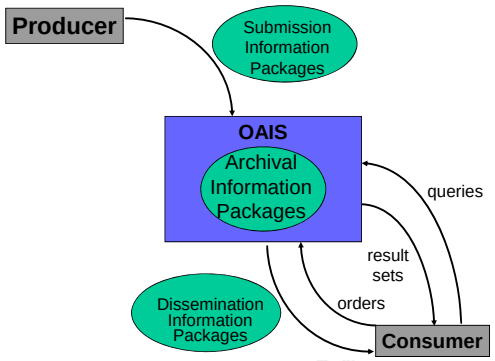


- An Information Package is a conceptual container holding two types of information
  - Content Information
  - Preservation Description Information (PDI)

Information Package Variants

- **SIP**: Submission Information Package
  - Negotiated between Producer and OAIS
  - Sent to OAIS by a Producer
- **AIP**: Archival Information Package
  - Information Package used for preservation
  - Includes complete set of Preservation Description Information (PDI) for the Content Information
- **DIP**: Dissemination Information Package
  - Includes part or all of one or more Archival Information Packages
  - Sent to a Consumer by the OAIS

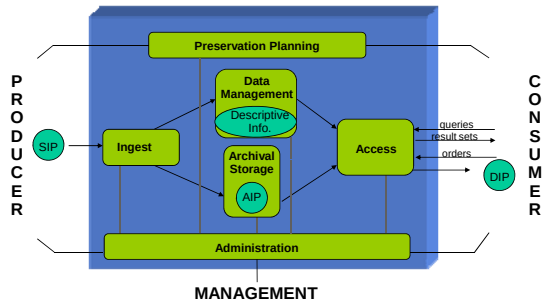
External Data Flow View



Überblick

- Prinzipien des OAIS Modells
- Technischer Überblick
- Funktionaler Überblick
- Informationsmodell
- Zusammenfassung

Open Archival Information System: Six Functional Entities



SIP = Submission Information Package
AIP = Archival Information Package
DIP = Dissemination Information Package

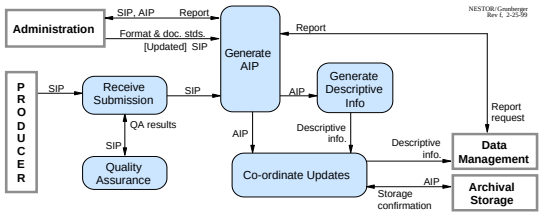
Functional Entities in an OAIS (1/2)

- Ingest: This entity provides the services and functions to accept Submission Information Packages (SIPs) from Producers and prepare the contents for storage and management within the archive
- Archival Storage: This entity provides the services and functions for the storage, maintenance and retrieval of Archival Information Packages
- Data Management: This entity provides the services and functions for populating, maintaining, and accessing both descriptive information which identifies and documents archive holdings and internal archive administrative data.

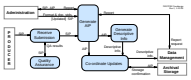
Functional Entities in an OAIS (2/2)

- Administration: This entity manages the overall operation of the archive system
- Preservation Planning: This entity monitors the environment of the OAIS and provides recommendations to ensure that the information stored in the OAIS remain accessible to the Designated User Community over the long term even if the original computing environment becomes obsolete.
- Access: This entity supports consumers in determining the existence, description, location and availability of information stored in the OAIS and allowing consumers to request and receive information products

Ingest Data Functions

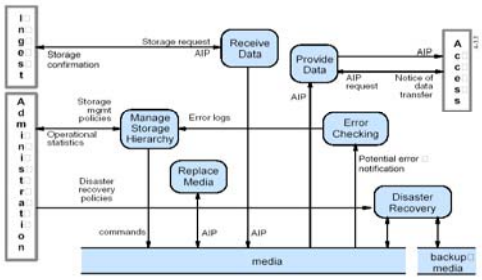


Ingest Data Functions



- Receive Submissions:
  - Zwischenspeicher (Staging Area) für Submissions
  - Bestätigung über Aufnahme in Zwischenspeicher
- Quality Assurance
  - Validierung der Submission (CRC, logs, identity checks,media)
- Generate AIP
  - Transformation von SIPs in AIPs entsprechend den Standards (Transformation, Migration, Umkodierung)
  - Weiterleitung der AIPs an Audit (Administration)
- Generate Descriptive Information
  - Sammlung bzw. Extraktion von deskriptiver Information zum AIP für Data Management und Access Aids
- Coordinate Updates
  - Transfer der AIPs zu Archival Storage
  - Bestätigung -> Deskriptive Information -> Data Management

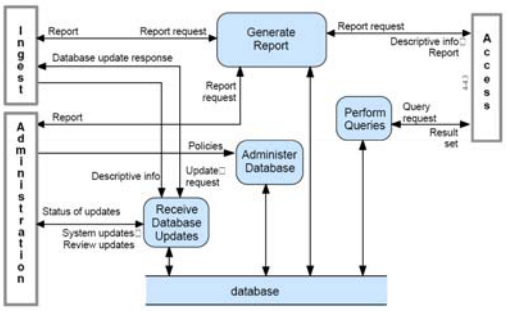
Archival Storage Functions



Archival Storage Functions

- Receive Data:
  - übernimmt Storage Request für AIP
  - entscheidet über Speicherort, Medien
  - retouriert Bestätigungsmeldung
- Manage Storgae Hierarchy
  - Verwaltung entsprechend Policy
  - Überwachung von Fehlermeldungen, operationale Statistiken
- Replace Media
  - Reproduktion von AIPs über die Zeit (keine Änderung von Content oder Preservation Description Information, nur Packaging Information - andere Änderungen: Administration)
- Error Checking
  - PDI Fixity Information (CRCs, error-correcting codes, ...)
- Disaster Recovery
  - Duplizierung des Inhalts of Speichermedien
  - Transport an physisch getrennten Ort
- Provide Data
  - Kopien von AIPs für Access

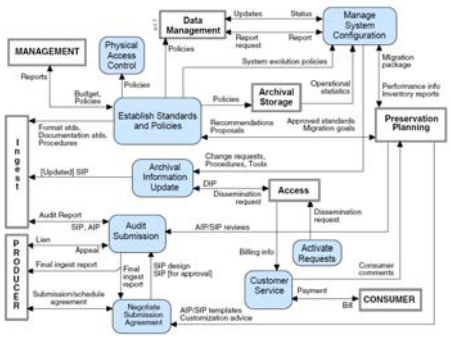
Data Management Functions



Data Management Functions

- Administer Database
  - Integrität der DB für Descriptive Information und Systeminformation
- Perform Queries
  - Bearbeitung von Anfragen durch Access
- Generate Reports
  - Berichte für Ingest, Access, Administration
- Receive DB Updates
  - Fügt hinzu/Löscht/Modifiziert Information in Management DB
  - Ingest: neue AIPs, Administration: updates

Administration Functions



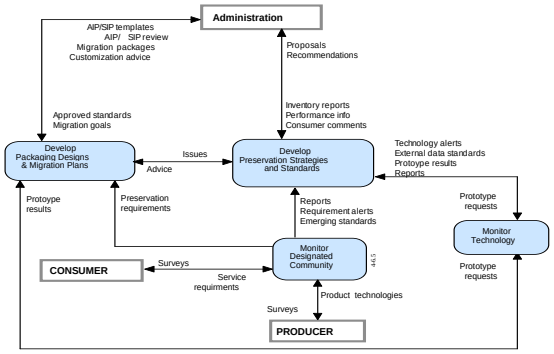
Administration Functions

- Negotiate Submission Agreement
  - Verträge mit Produzenten, Übergabe, Prozedere
- Manage System Configuration
  - Systementwicklung, Überwachung der Funktion
  - Informationen für Policies
- Archival Information Update
  - Aktualisiert den Inhalt des Archivs: Änderung der DIPs und Re-Submission -> Migration
- Establish Standards and Policies
  - Budget, Standards, Policies
- Audit Submission
  - Analyse ob SIPs und AIPs den Vorschriften entsprechen
  - Verifikation der Representation and Package Information

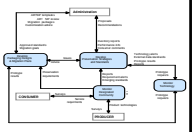
Administration Functions

- Activate Requests
  - Aufzeichnungen über ereignisgesteuerte Abfragen
  - regelmäßige Abfragen an Archiv um Vorhandensein der Daten zu verifizieren
  - Bestellungen auf periodischer Basis
- Customer Service
  - Kundenaccounts
  - sammelt Kosten von Access, erstellt Rechnungen für Kunden

Preservation Planning Functions

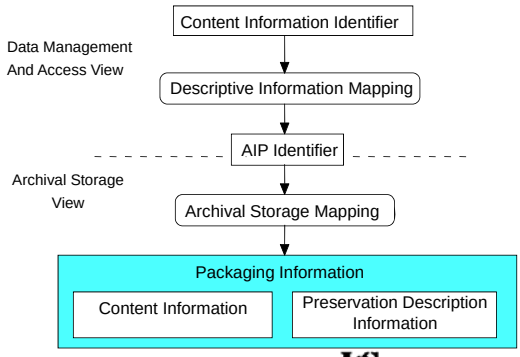


Preservation Planning Functions



- Monitor Designated Community
  - interaktion mit Produzenten und Kunden
- Monitor Technology
  - Technologieentwicklung: HW, SW, Formate
- Develop Preservation Strategies and Standards
  - Strategien, Entwicklungen, Vorhersage von Trends
- Develop Packaging Designs and Migration Plans
  - Migrationspfade, Tools
  - Erstellung von Preservation Description Information

Migration Context



Digital Migration

Digital Migration is defined to be the transfer of digital information, while intending to preserve it, within the OAIS.

- Focus on preservation of the full information content
- New information implementation replaces the old
- OAIS has full control and responsibility over all aspects of the transfer

Migration Motivators

- Motivators driving digital migrations
  - Media Decay
    - Often this is superceded by escalating media drive maintenance costs
  - Increased Cost Effectiveness
    - More cost-effective media types with higher volumes and lower drive maintenance costs
  - New User/Consumer Service Requirements
    - New formats more compatible with user's technology and applications
  - Proprietary software evolution
    - New software versions used to 'upgrade' formats of the information objects being preserved

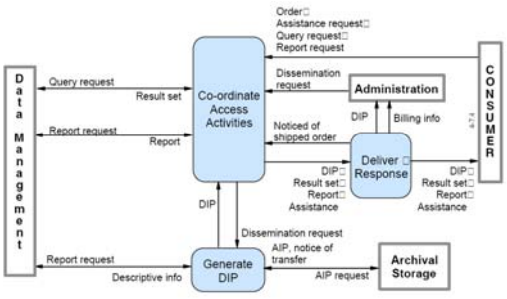
Digital Migration Approaches

- Four primary types of digital migration in response to motivators, ordered by increasing risk of information loss:
  - Refreshment
    - Media replacement with no bit changes
  - Replication
    - No change to Packaging Information or Content Information bits
  - Repackaging
    - Some bit changes in Packaging Information
  - Transformation
    - Reversible: Bit changes in Content Information are reversible by an algorithm
    - Non-reversible: Bit changes in Content Information are not reversible by an algorithm

Digital Migration and AIPs

- Unless migration involves transformation: no new AIP version
- Transformation: new **AIP Version**
- Upgrading or improvement of AIPs: new **AIP Edition**
- Extracting or aggregating from multiple AIPs: **Derived AIP**

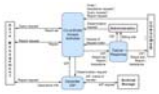
Access Functions



Access Functions

- Coordinate Access Activities
  - Benutzerschnittstelle, Autorisierung
  - 3 Arten von Requests:
    - Anfragen für Data Management mit Result Set
    - Bestellungen für Data Management und Archival Storage
    - Dissemination Requests durch Administration für Archival Information Update
- Generate DIP
  - Holt Daten aus Archival Storag in Staging Area
  - Holt Descriptive Information von Data Management
  - Anwendung von Prozessen zur Transformatin des AIPs in ein geeignetes DIP für die jeweilige Anfrage
- Deliver Response
  - on-line und off-line Anfragen
  - Weiterleitung des Ergebnisses

Access Preservation



- Effective access to digital information requires the use of software
- Application Programming Interfaces (APIs) may be cost-effectively maintained across time by an OAIS when:
  - API is not too complex
  - API is applicable to a wide variety of AIUs
- API source code may be ported to new environments
  - Extensive testing is needed to ensure against information loss
- Preservation of executables by full emulation of underlying hardware is problematic
  - Hard to know what is the information being preserved
  - May not be possible to fully emulate associated devices

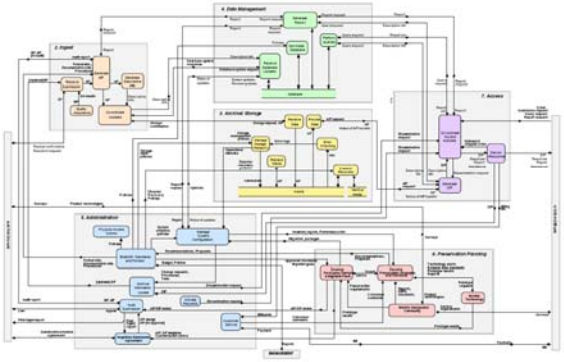
Common Services

- Modern, distributed computing applications assume a number of supporting services
- Examples of Common Services include:
  - inter-process communication
  - name services
  - temporary storage allocation
  - exception handling
  - security
  - file and directory services

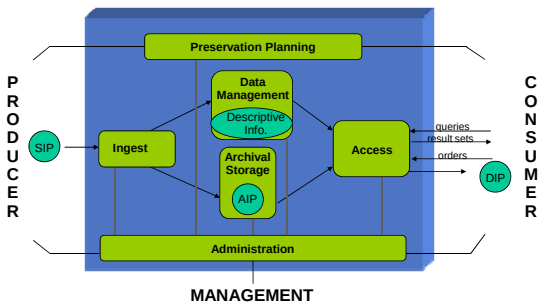
Common Services

- Wichtig:
  - alle Schritte, Aktionen dokumentiert (protokolliert)
  - Reporting
  - Bestätigungen
  - Sind Teil des Archivs

OAIS Composite Functional Entities



Open Archival Information System: Summary

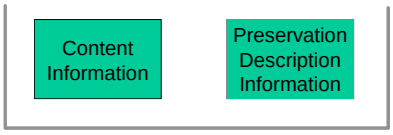


SIP = Submission Information Package
AIP = Archival Information Package
DIP = Dissemination Information Package

Überblick

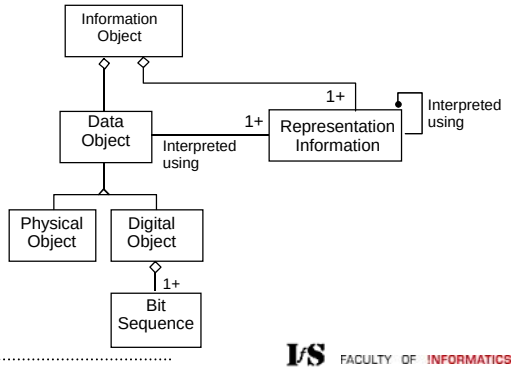
- Prinzipien des OAIS Modells
- Technischer Überblick
- Funktionaler Überblick
- Informationsmodell
- Zusammenfassung

Information Package Definition



- An Information Package is a conceptual container holding two types of information
  - Content Information
  - Preservation Description Information (PDI)

Information Object

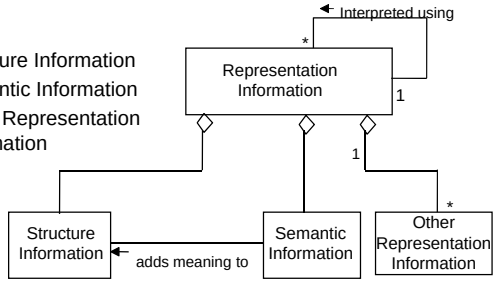


Representation Information

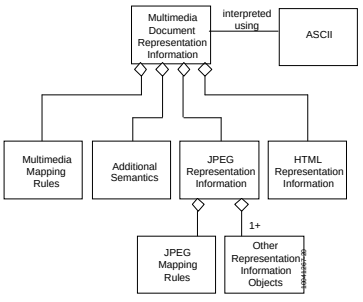
- The Representation Information accompanying a physical object, like a moon rock, may give additional meaning
  - It typically is a result of some analysis of the physically observable attributes of the rock
- The Representation Information accompanying a digital object, or sequence of bits, is used to provide additional meaning.
  - It typically maps the bits into commonly recognized data types such as character, integer, and real and into groups of these data types.
  - It associates these with higher level meanings which can have complex inter-relationships that are also described

Recursive Nature of Representation Information

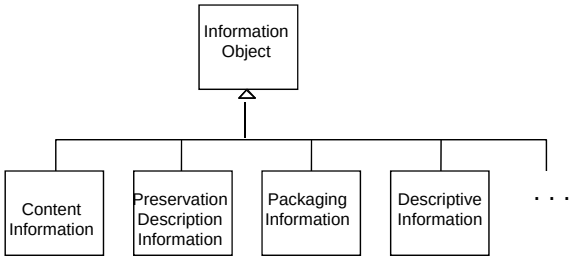
- Structure Information
- Semantic Information
- Other Representation Information



Sample Representation Net



Types of Information Used in OAIS



Content Information

- The information which is the primary object of preservation
- An instance of Content Information is the information that an archive is tasked to preserve.
- Deciding what is the Content Information may not be obvious and may need to be negotiated with the Producer
- The Data Object in the Content Information may be either a Digital Object or a Physical Object (e.g., a physical sample, microfilm)

Preservation Description Information

- Provenance Information
  - Describes the source of Content Information, who has had custody of it, what is its history
- Context Information
  - Describes how the Content Information relates to other information outside the Information Package
- Reference Information
  - Provides one or more identifiers, or systems of identifiers, by which the Content Information may be uniquely identified
- Fixity Information
  - Protects the Content Information from undocumented alteration

PDI Examples

Content Information Type	Reference	Provenance	Context	Fixity
Space Science Data	• Object identifier • Journal reference Mission, instrument, title, attribute set	Instrument description Processing history Sensor description Instrument Instrument mode Decommutation map Software interface specification	Calibration history Related data sets Mission Funding history	CRC Checksum Reed-Solomon coding
Digital Library Collections	Bibliographic description Persistent identifier	For scanned collections: metadata about the digitisation process pointer to master version For born-digital publications: pointer to the digital original Metadata about the preservation process: pointers to earlier versions of the collection item change history	Pointers to related documents in original environment at the time of publication	Digital signature Checksum Authenticity indicator
Software Package	Name Author/Originator Version number Serial number	Revision history License holder Registration Copyright	Help file User guide Related software Language	Certificate Checksum Encryption CRC

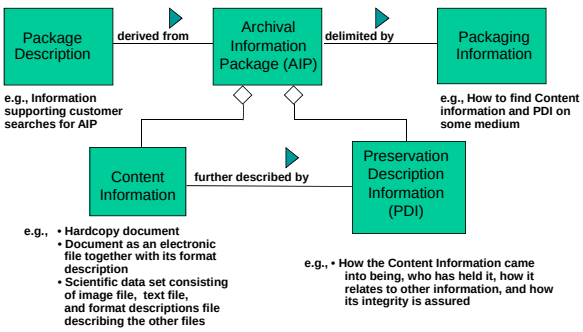
Descriptive Information

- Contain the data that serves as the input to documents or applications called Access Aids.
- Access Aids can be used by a consumer to locate, analyze, retrieve, or order information from the OAIS.

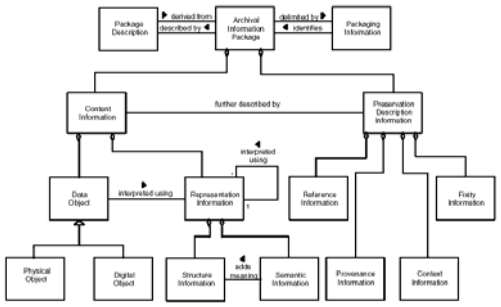
Packaging Information

- Information which, either actually or logically, binds and relates the components of the package into an identifiable entity on specific media
- Examples of Packaging Information include tape marks, directory structures and filenames

OAIS Archival Information Package

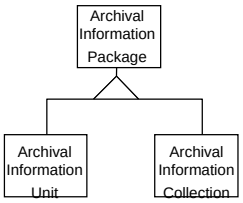


AIP detailed view



AIP Types

- Archival Information Unit (AIU) contains a single Data Object as the Content Object
- Archival Information Collection (AIC) contains multiple AIPs in its Content Object
  - Each member of an AIC is an AIP containing Content Information and PDI
  - The AIC contains unique PDI on the collection process



Package Descriptions and Access Aids

- Package Descriptions are needed by an OAIS to provide visibility and access to the OAIS holdings
- Package Descriptions contain 1 or more Associated Descriptions which describe the AIP Content Information from the point of view of a single Access Aid
- Some example of Access Aids Include:
  - Finding Aids - assist the consumer in locating information of interest
  - Ordering Aids - allow the consumer to discover the cost of and order AIUs of interest
  - Retrieval Aids - enable authorized users to retrieve the AIU described by the Unit Descriptor from Archival Storage

Information Model Summary

- Presented a model of information objects as containing data objects and representation objects
- Classified information required for Long-term archiving into 4 classes: Content Information, PDI, Packaging Information and Descriptive Information
- Described how these classes would be aggregated and related in an AIP to fully describe an instance of Content Information
- Presented information needed for Access, in addition to that needed for Long-term Preservation
- Put the Access oriented structures in the context of the other data needed to operate an OAIS

Zusammenfassung

- OAIS ist ein Referenzmodell
- OAIS ist KEINE Umsetzungsanleitung
- Regelt Sprachgebrauch, Rollen, Aufgabenbereiche, Funktionalitäten
- Anwendbar für alle Archive, Organisationen, Individuen
- Anwendbar für alle Arten von Informationsobjekten