Digital Preservation

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Overview

Part 1: Introduction

- What is Digital Preservation?
- What is the OAIS Reference model?
- How do we build a preservation plan?

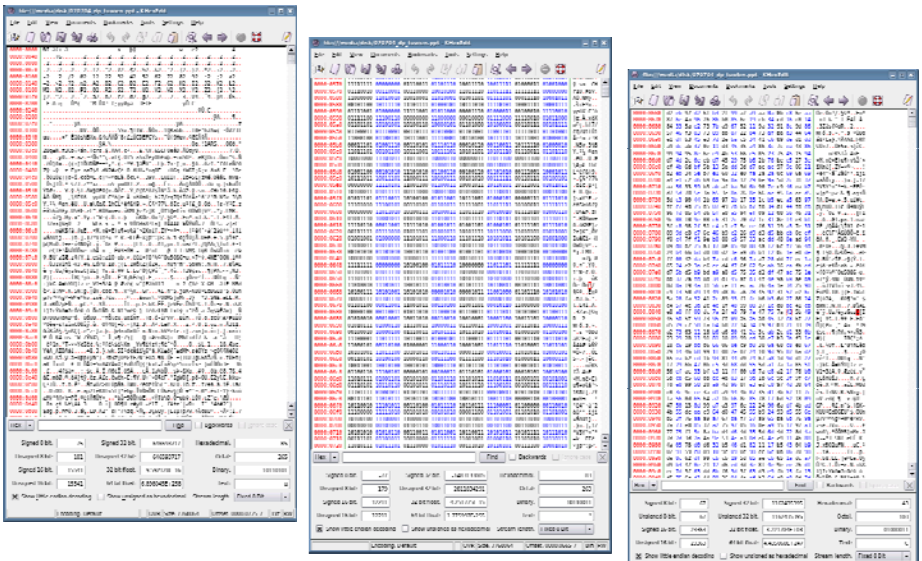
Why do we need Digital Preservation?

Questions / discussion:

- What is *Digital Preservation?*

Why do we need Digital Preservation?

Why do we need Digital Preservation?



Why do we need Digital Preservation?

- Digital Objects require specific environment to be accessible :
  - Files need specific programs
  - Programs need specific operating systems (-versions)
  - Operating systems need specific hardware components
- SW/HW environment is not stable:
  - Files cannot be opened anymore
  - Embedded objects are no longer accessible/linked
  - Programs won't run
  - Information in digital form is lost (usually total loss, no degradation)
- Digital Preservation aims at maintaining digital objects authentically usable and accessible for long time periods.

Why do we need Digital Preservation

- The goal of Digital Preservation is to **maintain digital objects accessible and usable in an authentic manner for a long term** into the future.

Why do we need Digital Preservation?

- Essential for all digital objects
  - Office documents, accounting, emails, …
  - Scientific datasets, sensor data, metadata, …
  - Applications, simulations, business processes, …
- All application domains
  - Cultural heritage data
  - eGovernment, public administration
  - Science / Research
  - Industry
  - Health, pharmaceutical industry
  - Aviation, control systems, construction, …
  - Private data
  - …

Why do we need Digital Preservation?

Questions / discussion:

- What is *digital data*?
- What is *digital storage*?
- What do we mean by
  - *accessible*?
  - *authentic*?
  - *long-term*?

Why do we need Digital Preservation

- 3 levels of threat / preservation
  1. Bit rot – physical preservation / bit preservation
  2. Object formats – logical preservation
  3. Authenticity, interpretability – semantic preservation

Bit-level preservation

- Maintain bit-sequence
- Redundant storage:
  - Lockss: lots of copies keeps stuff safe
  - Cloud
- Distributed storage – physically separated
- Different technologies / platforms / production batches
- Controlled storage conditions
- Regular maintenance: type rewinding, disc spinning, …
- Maintain devices for accessing storage!
- Trade-off capacity, energy, effort

Bit-level preservation

Questions / discussion:

- How long do tapes / CDs / DVDs / HDDs / SSD last?
- What are the costs of bit-level preservation?
- What are the logistic challenges?
- Is a DVD that last for 200 years a solution?
- Distribution and Trust?
- Are we allowed to store redundantly?
  - Copyright
  - Copy protection

Why do we need Digital Preservation

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Logical Preservation

Deja vue:

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Logical Preservation

- Identify objects at risk
- File format no longer supported
- HW / OS platform changes

Strategies for Logical Preservation

Strategies

(grouped according to Companion Document to UNESCO Charter
validity of grouping is questionable - maintained only for structuring reasons)
http://unesdoc.unesco.org/images/0013/001300/130071e.pdf)

- Investment strategies:
  - Standardization, Data extraction, Encapsulation, Format limitations
- Short-term approaches:
  - Museum, Backwards-compatibility, Version-migration, Reengineering
- Medium- / long-term approaches:
  - Migration, Viewer, Emulation
- Alternative approaches:
  - Non-digital Approaches, Data-Archeology
- No single optimal solution for all objects

Standardisierung

- Verwendung von offenen oder de-facto Standards
+ Vereinfacht Preservation Prozess
+ Zahlreiche Tools verfügbar
+ Tools können in Zukunft leichter erstellt werden
- Aufwand zur Standardisierung
- Verlust bei Konvertierung
- Manche Objekte nicht standardisierbar

Datenextraktion und Strukturierung

- Schaffung abstrakter Repräsentation der Daten (z.B. Datenbanken in XML)
+ Unabhängig von spezifischer Infrastruktur
+ Zahlreiche Tools verfügbar
+ Tools können in Zukunft leichter erstellt werden
- Hoher Entwicklungsaufwands für Tools zur Abstraktion und Interpretation
- Interpretationstools limitieren Funktionalität
- Manche Objekte nicht abstrahierbar

Encapsulation

- Daten werden mit Metadaten und Software gekapselt („Zwiebelprinzip“)
+ Vereinfacht das Auffinden oder die Entwicklung einer Preservation-Lösung bei Bedarf
+ Guter Ansatz, der die Anwendung anderer Strategien jederzeit erlaubt
- Löst nicht die Problematik
- Selbst mit gekapselter Information kann die Schaffung einer Lösung unmöglich sein

Formatbeschränkung

- Einschränkung der zur Preservation akzeptierten Dateiformate
+ Reduziert die Problemstellung auf überschaubare Anzahl von Formaten
+ Verfeinerung des Standardisierungsansatzes
- Löst nicht die Problematik
- Schränkt die Art von Material ein, die akzeptiert werden kann
- Konvertierung in Formate kann Datenverlust bedeuten
- Erfordert strikte Kontrolle der Formate

Universal Virtual Computer (UVC)

- Generelle Virtuelle Maschine, Zwischenplattform, die auf jeder Plattform leicht implementiert werden kann
- Zum Preservation-Zeitpunkt wird logische Beschreibung der Daten plus Dekodierungsprogramm für UVC geschaffen

+ Kann sowohl für Dokumente als auch Software funktionieren
+ Einheitliche Zwischen-Plattform reduziert Entwicklungsaufwand
+ Entwickelte Programme bei Erstellung testbar
- Sehr komplex, noch in Entwicklung
- Entwicklungsaufwand zum Archivierungszeitpunkt
- Erfordert Kooperation von Produzenten für Software-Objekte
- Bei notwendiger Abstraktion der Daten Informationsverlust

Strategien zur Langzeitbewahrung

- **Investment Strategien:**
  Standardisierung, Datenextraktion, Encapsulation, Formatbeschränkung, UVC
- **Kurzfristige Ansätze:**
  Museum, Rückwärtskompatibilität, Versionsmigration, Migration, Reengineering
- **Mittel-/langfristig Ansätze:**
  (Migration), Viewer, Emulation, (UVC)
- **Alternative Ansätze:**
  Nicht-digitale Ansätze, Daten-Archäologie

Museum - Technologiebewahrung

- Bewahrung der Hardware (Laufwerke, Rechner,…)
+ Voller Funktionsumfang wird bewahrt
+ Gewinnt Zeit zur Entwicklung alternativer Strategien
+ Erforderliche Dokumentation der HW und SW erlaubt besseres Verständnis für Objekte
+ Einzige Strategie für manche Objekte
- Langzeitverfügbarkeit von Ersatzteilen nicht finanzierbar
- Erfordert umfangreiches „Museum“
- Erfordert umfangreiche technische Expertise

Rückwärtskompatibilität und Versionsmigration

- Aktuelle Software liest ältere Formate und migriert
+ Meist verfügbar
+ Gewinnt Zeit bis zu umfangreicheren Transformationen
+ Oft gleiche (oder bessere) Funktionalität
- Langzeitverfügbarkeit unwahrscheinlich
- Versionsänderung kann unerwünschte Änderungen bewirken, unmittelbar oder über mehrere Migrationsschritte
- Nicht für alle Objekte anwendbar
- Keine Garantie von Seiten der Produzenten

Migration

- Transformation in anderes Format, kontinuierlich oder on-demand (Viewer)
+ Verbreitet im Einsatz
+ Vergleich mit un-migriertem Objekt zum Zeitpunkt der Migration
+ Jederzeit zugreifbar
- Unerwünschte Änderungen unmittelbar oder über mehrere Migrationsschritte
- Nicht für alle Objekte anwendbar
- Kontinuierliche Migration erforderlich

Re-Engineering

- Software Source wird auf neuer Plattform angepasst und kompiliert, Neuentwicklung, oder Reverse-Engineering
+ Anwendbar für Software-Objekte
- Source Code oft nicht verfügbar
- Portierung auf neue Umgebungen oft sehr schwer
- Erheblicher Zeit- und Ressourcenaufwand
- Reverse-Engineering oft illegal

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Viewer

- Migration bei Bedarf, Interpretation durch Viewer-Software
+ Original-Datenstrom wird interpretiert
+ Keine kontinuierliche Migration
+ Keine kumulativen Fehler
- Viewer können nicht alle Teilobjekte darstellen
- Technologische Spanne bei Viewer-Erstellung
- Viewer müssen mit Technologie mitgezogen werden
- Schwer zu evaluieren, ob Viewer das Objekt korrekt wiedergeben

Emulation

- Emulation von Hardware oder Software (Betriebssystem, Applikation)
+ Prinzipien weit verbreitet
+ Zahlreiche Emulatoren verfügbar
+ Potentiell vollständige Funktionalitätsbewahrung
+ *Dokument bleibt unverändert*
- *Dokument bleibt unverändert*
- Komplexe Technologie, Forschungsaufwand
- Erfordert penible Dokumentation des Systems
- Erfordert in Zukunft Erfahrung im Umgang mit derzeitigen Systemen
- Emulatoren müssen ebenfalls migriert/emuliert werden
- Emulatoren potentiell fehlerhaft (Komplexität)

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Nicht-digitale Strategien

- „Ausdruck“ auf Papier, Mikrofilm, Nickel-Platten
+ Erfordert Transformation in lesbare Form – technologieunabhängig
+ Codierung für digitale Daten möglich
+ Erfahrung im Umgang mit analogen Objekten
+ Hohe Stabilität -> Bit-stream Preservation
- Funktionsverlust, Verlust der Vorteile digitaler Technologien
- Nicht für alle Objekte anwendbar
- Kosten für Erhaltung mancher analogen Trägermaterialien sehr hoch

Data-Recovery, Archäologie

- Analyse des bit-streams um Daten zu interpretieren
+ Potentiell einziger Ansatz um andernfalls verlorenes Material wieder zugreifbar zu machen
- Keine Garantie
- Ohne Dokumentation of nur „raten“
- Extrem hohe Kosten pro Objekt
- Nicht abschätzbar ob erfolgreich anwendbar auf bestimmtes Objekt

Logical Preservation

- Changing object, environment
- Loss upon migration / emulation
- Decision of what to preserve → **Significant Properties**!
- Range of strategies available, none is perfect
- Combination of strategies
- No solution forever -> DP is a process!

Logical Preservation

Questions / Discussion:

- What are the problems of logical preservation?
- What is the optimal strategy?
- What is the optimal strategy for a specific object?
- What is a good format / platform (e.g. to migrate to)?
- What are characteristics of good formats/platforms/… ?
- What is the difference between emulation and migration? Are they different? Are they not different?
- What are the significant properties of an object / process?
- "I want to preserve everything" – (how) can we do this?
- How can we find out what we loose with a strategy?

Logical Preservation

Questions / Discussion (2):

- What is the “original object”?
- Is XML the solution to DP?
- What is the complexity of each strategy? Costs? Effort?
- What know-how do we need to decide on a strategy?
- Which objects are most at risk?
- Which objects are most difficult to preserve?
- If we loose significant properties with a strategy, what is the impact on authenticity? Can we use a “changed” object?

Why do we need Digital Preservation

- 3 levels of threat / preservation
  1. Bit rot – physical preservation / bit preservation
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Semantic preservation

- Threats at semantic level
  - meaning of terms change: city names, …
  - measurement scales, sensor sensitivity, …change
  - interpretation of facts change: alcohol levels, …
- Rather long-term, but subtle to notice
- Consider context of objects
  - purpose, setting, limitations, cultural context, related objects, …
- Approaches / solutions:
  - semantic enrichment
  - metadata
  - migration at semantic level
  - documentation of context
  - tracing of metadata

Semantic preservation

Questions / discussion:

- How do we identify need for action?
- What is the risk of missing timely action?
- How do we solidly identify and document context?
- How can we implement semantic enrichment / semantic migration, …?
- Are differences in the communication protocol at an API level a problem of logical or semantic preservation?

Digital Preservation - Summary

- Is a complex task
- Requires a concise understanding of the objects, their intellectual characteristics, the way they were created and used and how they will most likely be used in the future
- Requires a continuous commitment to preserve objects to avoid the „digital dark hole“
- Requires a solid, trusted infrastructure and workflows to ensure digital objects are not lost
- Is essential to maintain electronic publications & data accessible
- Will become more complex as digital objects become more complex
- Needs to be defined in a preservation plan

Digital Preservation

- Reference Models
  - Records Management, ISO 15489:2000
  - OAIS: Open Archival Information System, ISO 14721:2003
- Audit & Certification Initiatives
  - RLG- National Archives and Records Administration Digital Repository Certification Task Force:
    Trustworthy Repositories Audit & Certification: Criteria and Checklist (TRAC)
  - NESTOR:
    Catalogue of Criteria of Trusted Digital Repositories
  - DCC/DPE:
    DRAMBORA: Digital Repository Audit Method Based on Risk Assessment

Digital Preservation

Questions / Discussion:

- At what levels are digital objects threatened?
- What are the time intervals at each level?
- How can we identify objects at risk?
- What can we do to mitigate the risk?
- How can we recover if mitigation fails / is missed?
- How do we organize DP for an organization?
- What competences do we need?
- How would a training/education program look like?
- How do we know if somebody is doing a good job at DP?

Overview

Part 1: Introduction

- What is Digital Preservation?
- Break? - Video?
- What is the OAIS Reference model?
- How do we build a preservation plan?

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OAIS

- NASA: National Space Science Data Center
  - NASA's first digital archive
  - Experienced many technological changes since 1966
- Consultative Committee for Space Data Systems
  - International group of space agencies
  - Developed range of discipline-independent standards
  - Evolved into ISO TC 20/ SC 13 working group around 1990
  - TC20: Aircraft and Space Vehicles
  - SC13: Space Data and Information Transfer Systems

OAIS

- Reference Model for an Open Archival Information System (OAIS), Blue Book, CCSDS 650.0-B-1, January 2002
- ISO 14721:2003
- slides based on Blue Book and:
  - Don Sawyer, Lou Reich: ISO Reference Model for an Open Archival Information System (OAIS) Tutorial Presentation, LOC, June 13 2003
- http://ssdoo.gsfc.nasa.gov/nost/isoas/overview.html

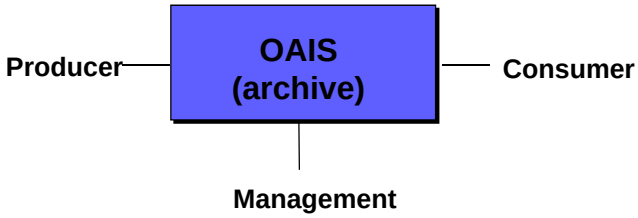
OAIS

- Framework for understanding and applying concepts needed for long-term digital information preservation
  - Long-term: 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’
- alcohol levels
- Framework for comparing architectures and operations of existing and future archives
- 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

OAIS

- OAIS helps understanding / structuring DP
- Is not “perfect”
  - Conflicting models, different views
- Does NOT specify an implementation model !!!
- Difficult balance between high-level structure and detailed guidelines, not consistently solved
- Has to be understood wrt. its time of origin and purpose
- Standards create their own dynamics

OAIS



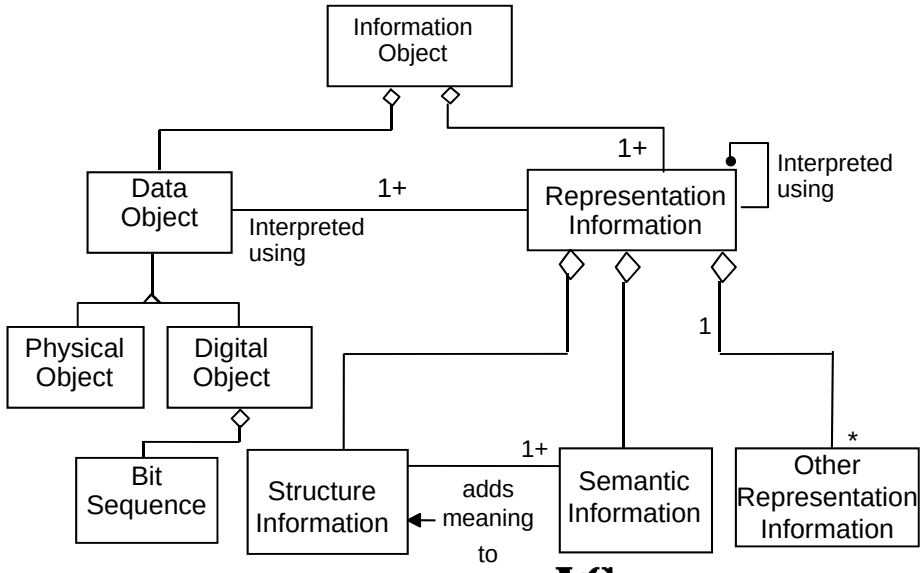
- Producer is the role played by those persons, or client systems, who provide the information to be preserved
- Management is the role played by those who set overall OAIS policy as one component in a broader policy domain
- Consumer is the role played by those persons, or client systems, who interact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

OAIS

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

OAIS

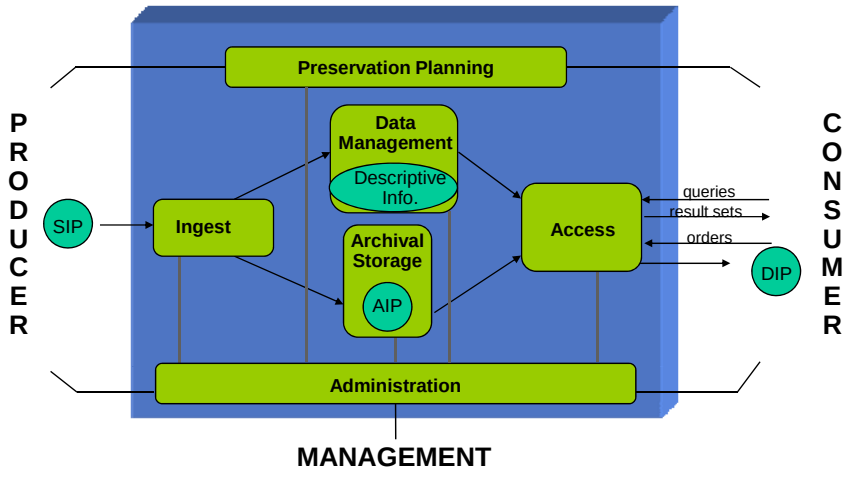


OAIS

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

OAIS

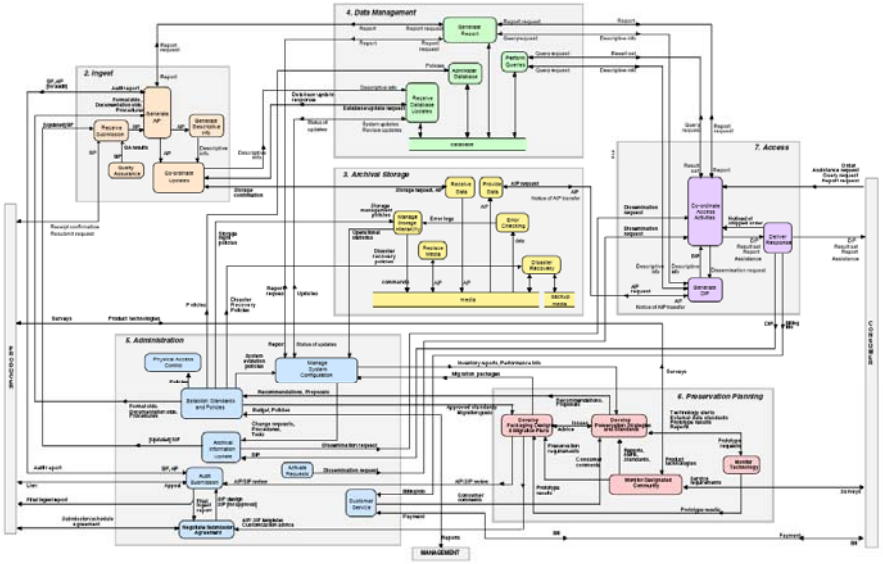


SIP = Submission Information Package

AIP = Archival Information Package

DIP = Dissemination Information Package

OAIS



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Preservation Planning

Why Preservation Planning?

- Several preservation strategies developed
  - For each strategy: several tools available
    - For each tool: several parameter settings available
- How do you know which one is most suitable?
- What are the needs of your users? Now? In the future?
- Which aspects of an object do you want to preserve?
- What are the requirements?
- How to prove in 10, 20, 50, 100 years, that the decision was correct / acceptable at the time it was made?

Preservation Planning

What is Preservation Planning?

- Consistent workflow leading to a preservation plan
- Analyses, which solution to adopt
- Considers
  - preservation policies
  - legal obligations
  - organisational and technical constraints
  - user requirements and preservation goals
- Describes the
  - preservation context
  - evaluated preservation strategies
  - resulting decision including the reasoning
- Repeatable, solid evidence

Digital Preservation

What is a preservation plan?

- 10 Sections
  - Identification
  - Status
  - Description of Institutional Setting
  - Description of Collection
  - Requirements for Preservation
  - Evidence for Preservation Strategy
  - Cost
  - Trigger for Re-evaluation
  - Roles and Responsibilities
  - Preservation Action Plan

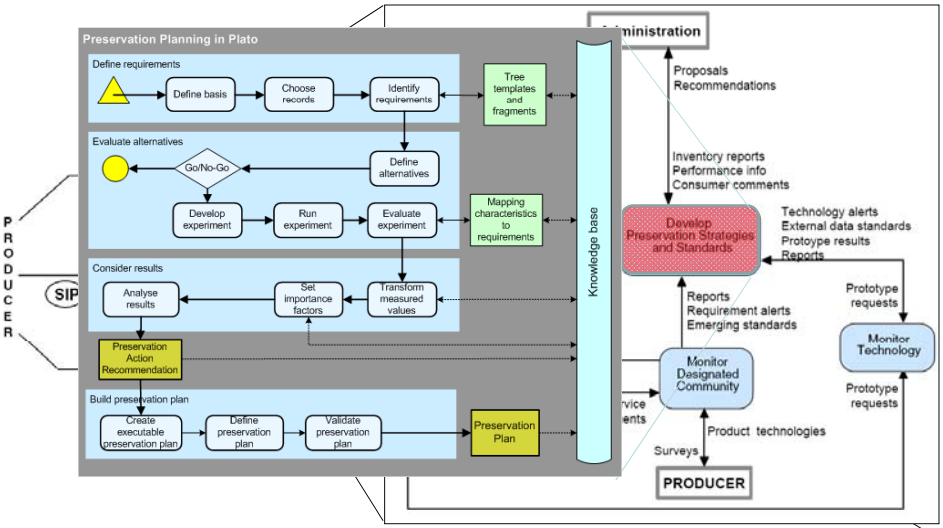
Preservation Plan Template

Preservation Planning

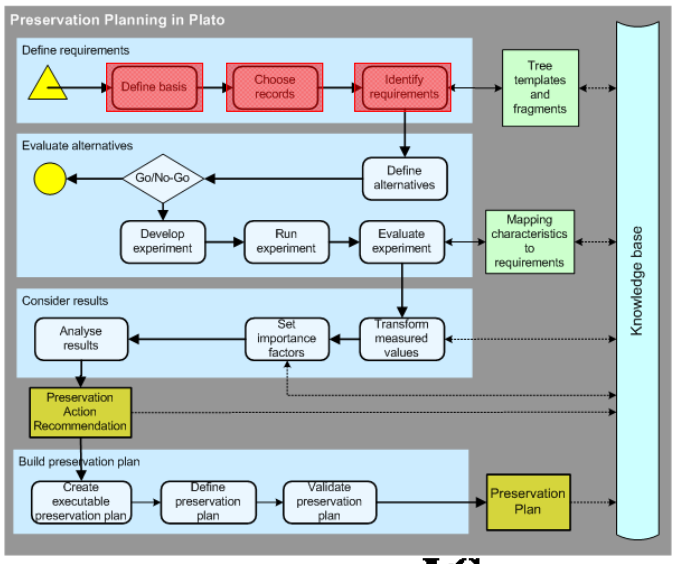
Preservation Planning Workflow

- Originally developed within the DELOS DP Cluster
  now refined and integrated within PLANETS
- Based on
  - Preservation Planning approach based on Utility Analysis, developed at TU Vienna
  - Testbed/lab for evaluation developed at Nationalarchief, The Netherlands
- Follows the OAIS model
- Consistent with requirements specified by ORLC/TRAC and Nestor criteria catalogue

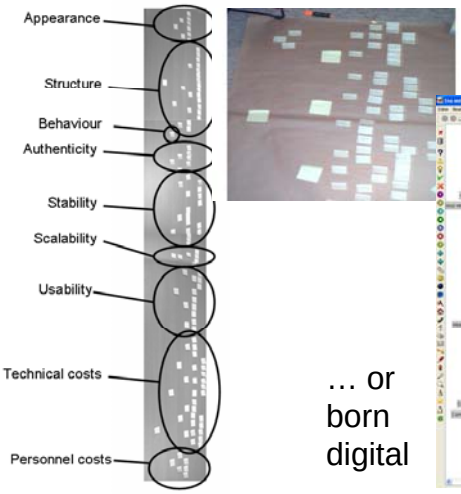
Preservation Planning



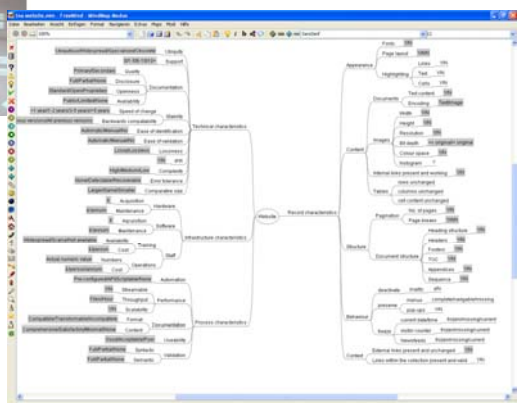
Preservation Planning Workflow



Identify requirements

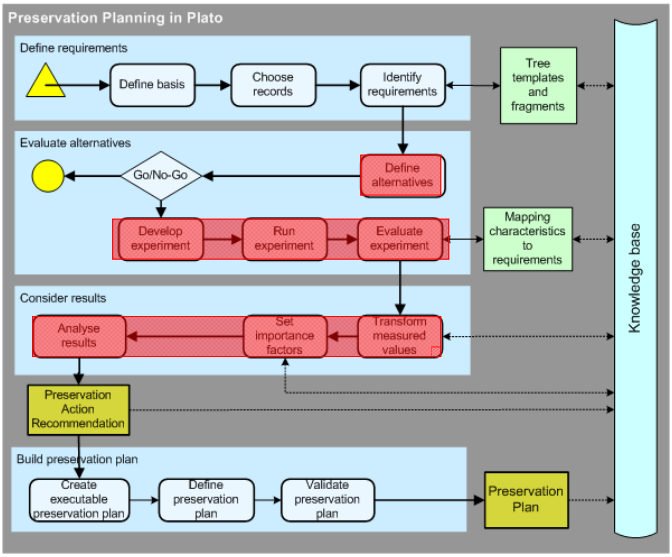


Analog…



… or born digital

Preservation Planning Workflow



Overview

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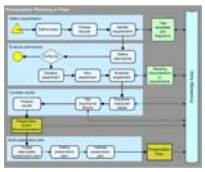
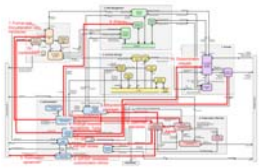
- What is Digital Preservation?
- What is the OAIS Reference model?
- How do we build a preservation plan?
- Other issues in DP?

Current Issues

- Personal & SOHO Archiving
- Web Archiving: DP, IR & Ethics
- Interactive Content
  - Emulation of Computer Games, Multimedia Art
- Context of objects
- Long-term storage: holography, solid-state,…
- Database Preservation
- Security: Signatures, encryption, audit, certification
- Atomic file formats, stability of file formats
- Scalability, Semantics
- Digital forgetting
- Preservation of programs, processes

Thank you!





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