The SCAPE Repository Reference Implementation

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SCAPE Training Event
British Library, September 16-17th 2013

The SCAPE Repository Reference Implementation

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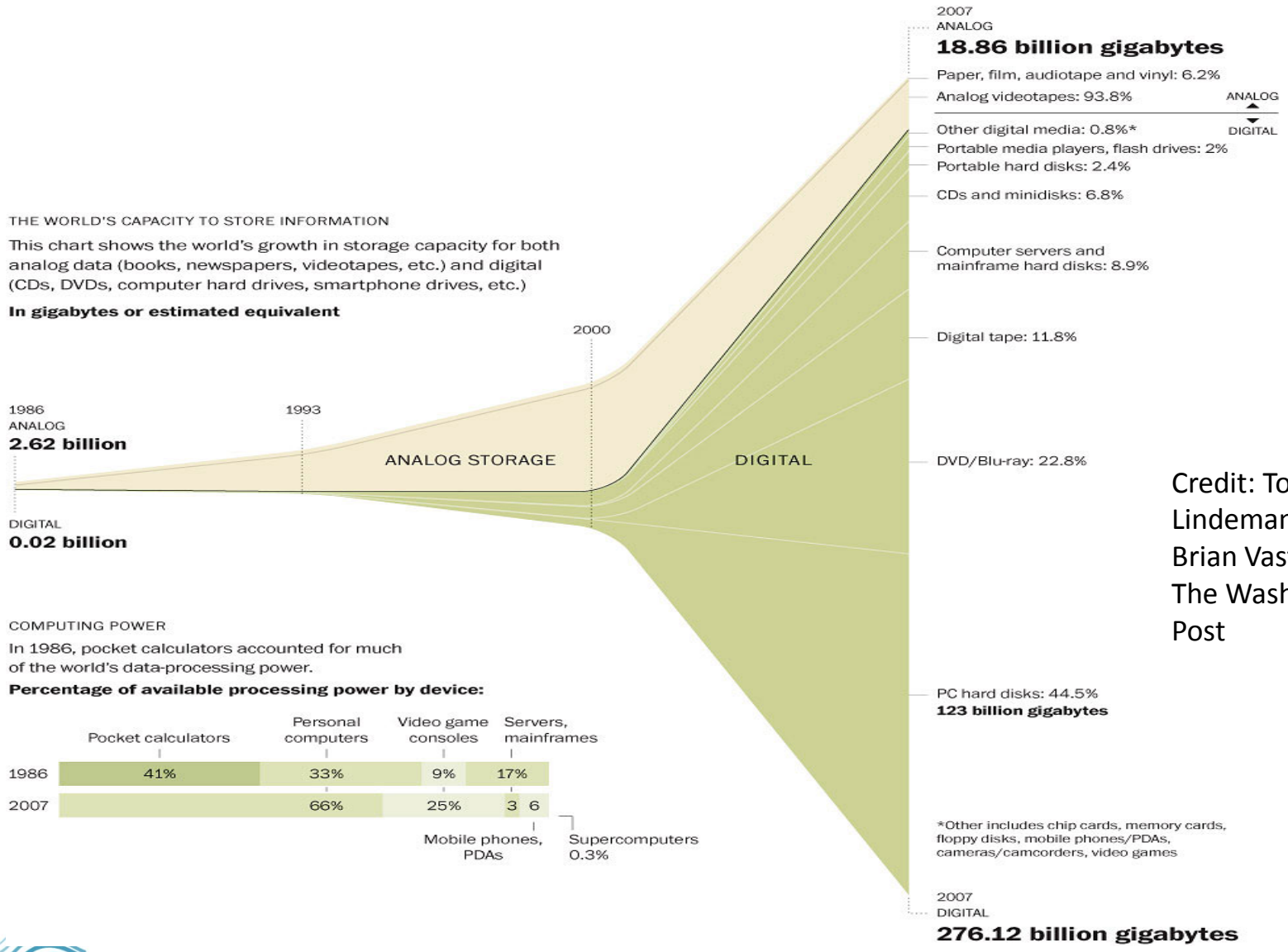
This work was partially supported by the SCAPE Project.
The SCAPE project is co-funded by the European Union under FP7 ICT-2009.4.1 (Grant Agreement number 270137).

Introduction – What's the problem



Credit: Todd Lindeman and Brian Vastag/ The Washington Post

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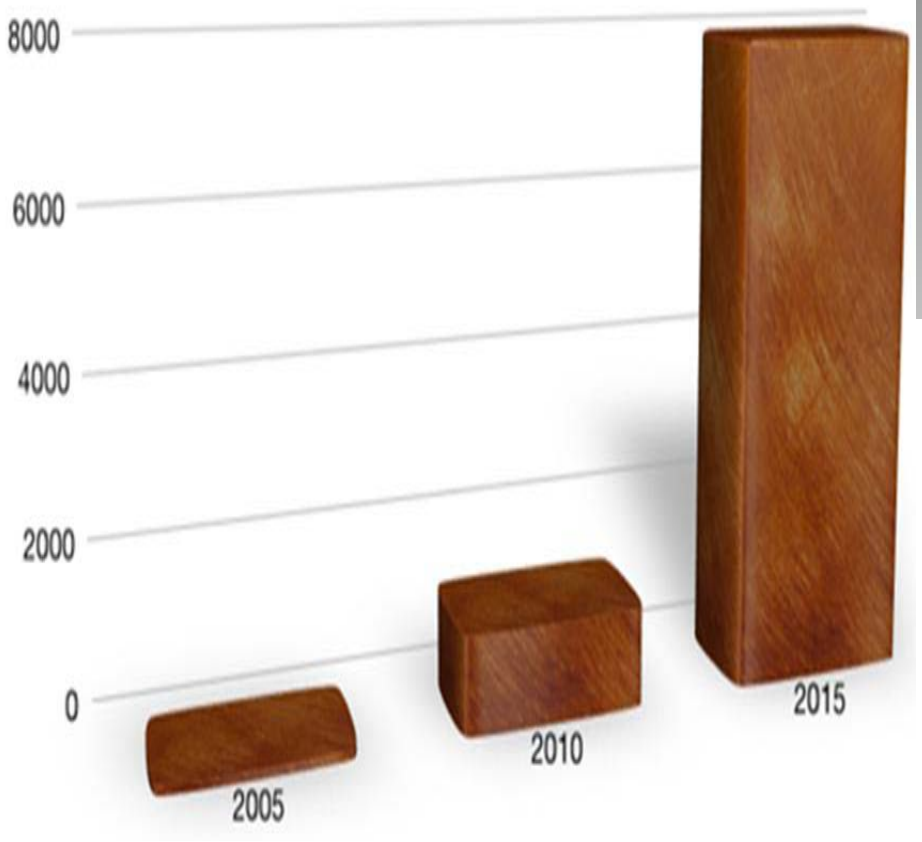
Introduction - It's getting worse…



Global Storage Capacity In Exabytes*

*) 1 Million Terabytes **
**) 1 Million Megabytes

Source: IDC's Digital Universe Study, sponsored by EMC, June 2011

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Introduction - Limits

- Large and complex objects
- Large and heterogenous collections
- Lack of automation, QA and tool support
- Systems don‘t scale

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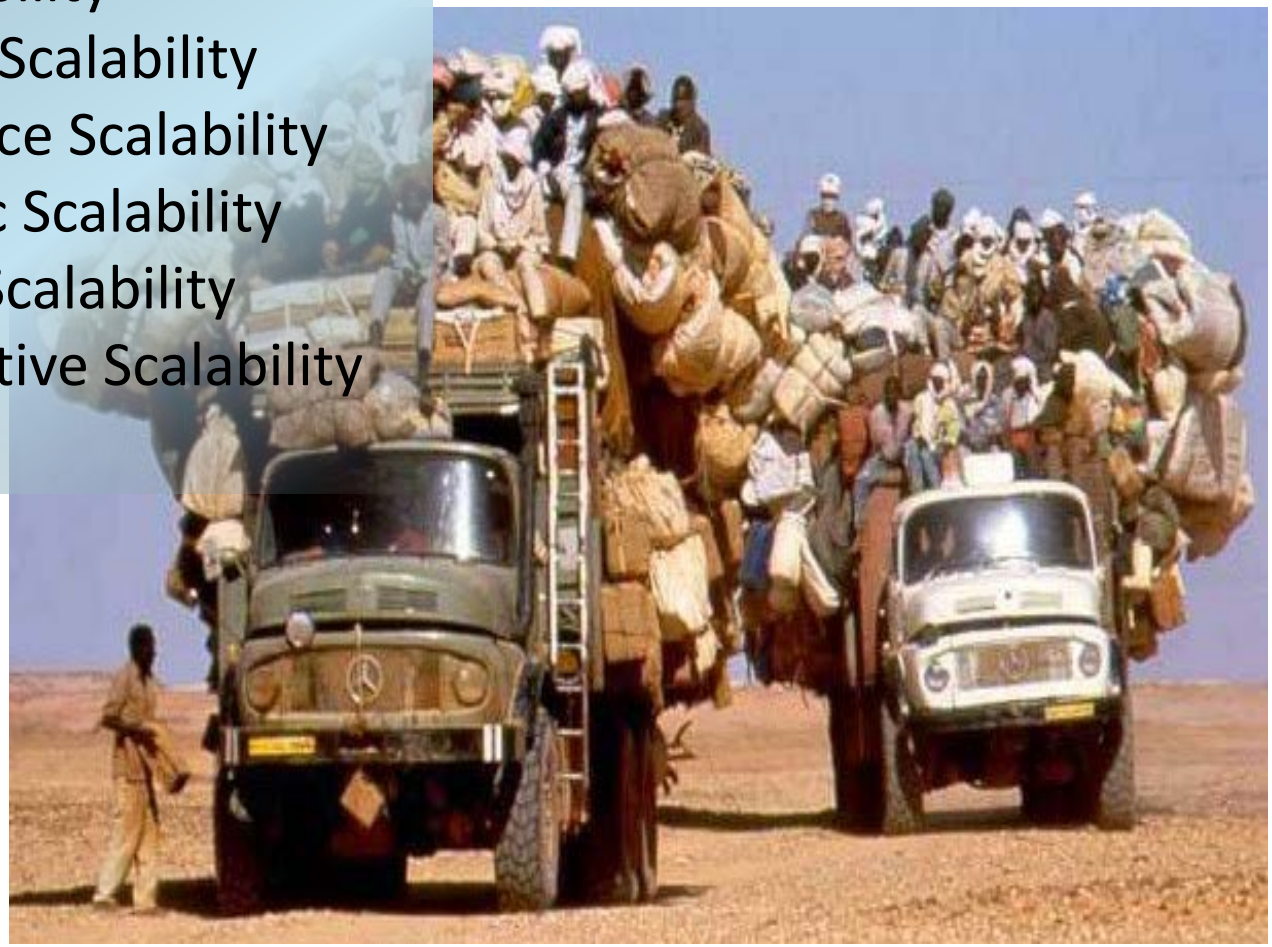
Introduction - Scalability

- Load Scalability
- Functional Scalability
- Maintenance Scalability
- Geographic Scalability
- Economic Scalability
- Administrative Scalability



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Repository Integration - SCAPE

Scalable Preservation Environment

- Interfaces to Workflow execution
- Interfaces to Planning and Watch
- Support of Provenance information
- Interfaces to computation cluster
- Load Scalability tests
- Digital Object Model

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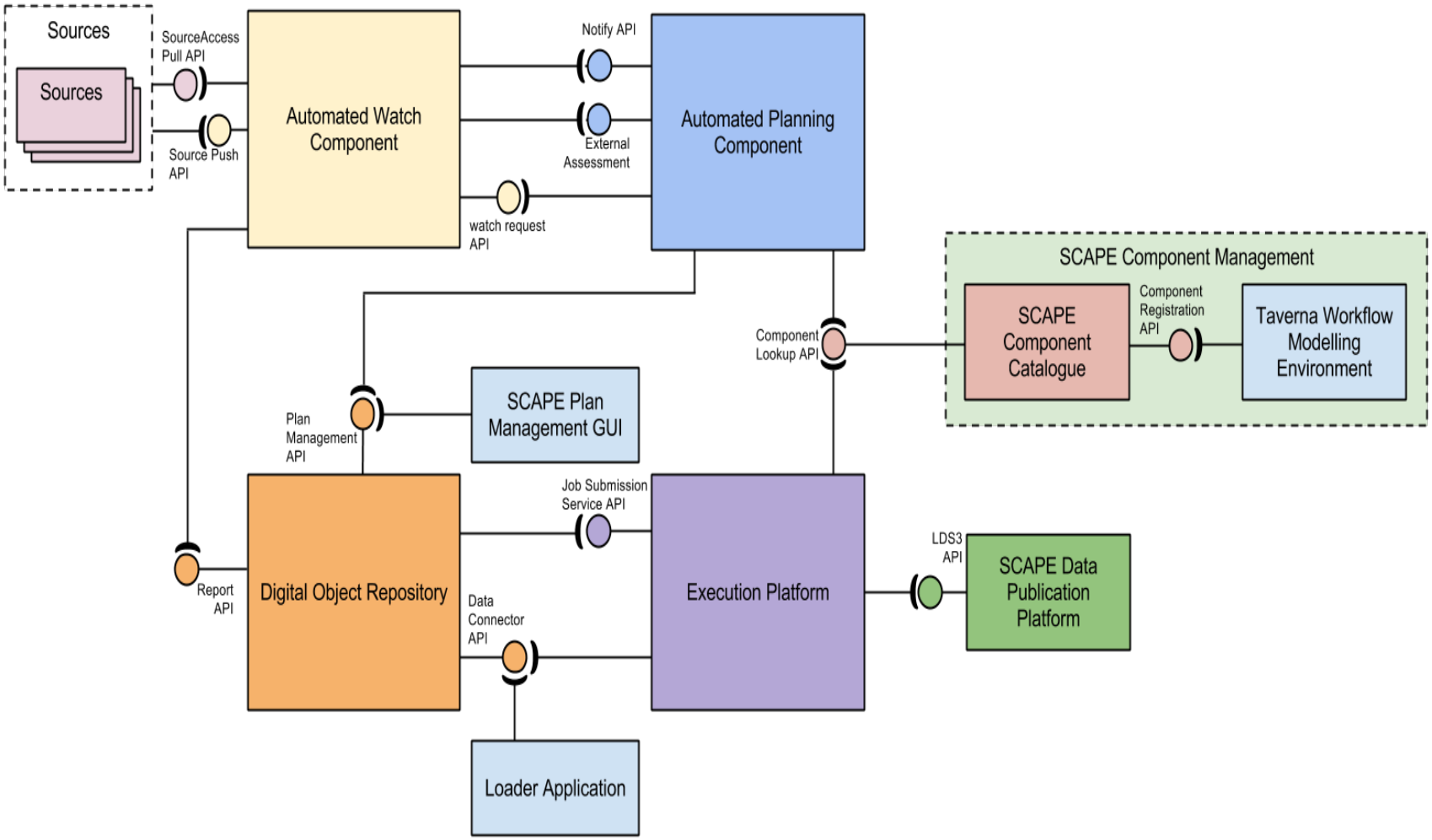
SCAPE Architecture – High Level View



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SCAPE Digital Object Model

- Premis & METS
  - Premis: international standard for metadata to support the preservation of digital objects and ensure their long-term usability.
    - http://www.loc.gov/standards/premis/
    - We are using Version 2.2
  - METS Metadata Extension & Transmission Standard
    - container format to be able to deal with complex objects
    - http://www.loc.gov/standards/mets/

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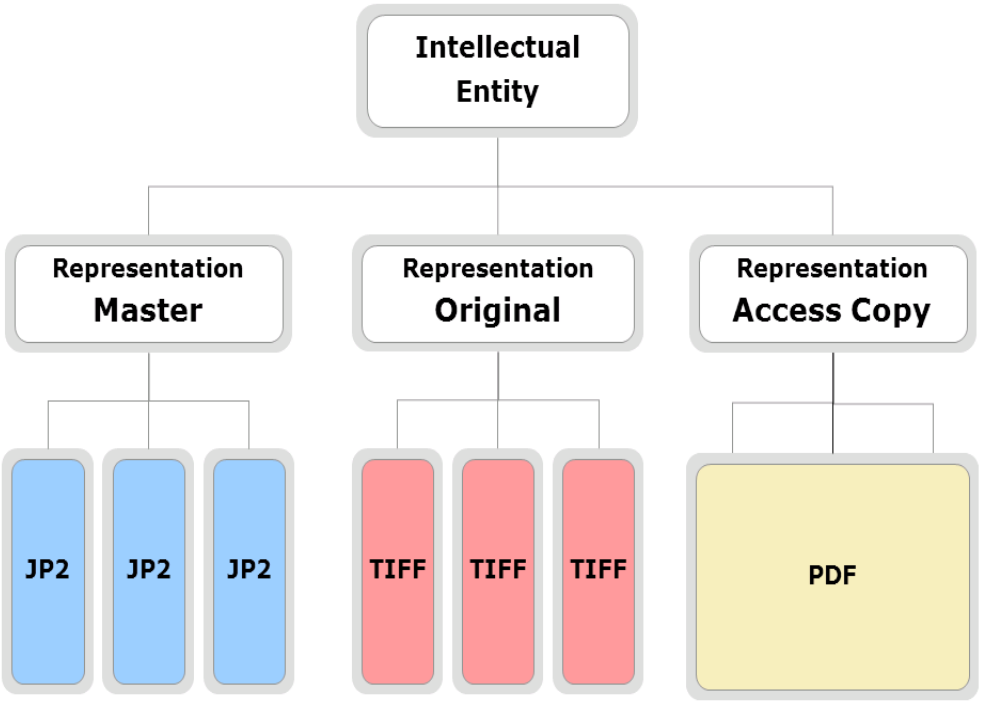
SCAPE Digital Object Model



Intellectual Entity (IE):
Object information – Identifiers, Object Characteristics, etc.
Events – Provenance Events
Rights – Access Rights

Representation:
Object information – Identifier, Object Characteristics, Preservation Level, etc.

File:
Object information – Identifier, significant properties, format, fixity, environment etc.

BitStreams:
Object information – Identifier, significant properties, format, environment etc.

PREMIS Objects

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Building a METS Document

1. Expressing the Structure of complex objects
2. Linking Structure with Content
3. Linking Structure with Descriptive Metadata
4. Linking Structure and Content Files with Administrative metadata

```
<METS:mets>
        <METS:metsHdr />          Header
        <METS:dmdSec />           Descriptive MD
        <METS:amdSec />           Administrative MD
        <METS:fileSec />          File list and groups
        <METS:structMap />        hierarchical structural Map of the object
                                  (e.g. pages of book)
         <METS:structLink />      cross links inside the document
         <METS:behaviourSec />    e.g. applications to view content
</METS:mets>
```

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SCAPE Digital Objects – SCAPE METS

- **Descriptive Metadata**
  - DC
- **Technical Metadata**
  - AudioMD
  - VideoMD
  - TextMD
  - FITS
  - NISO/MIX
- **Provenence**
  - PREMIS
- **Source**
  - DC
- **Rights**
  - PREMIS RIGHTS

```
<mets:mets PROFILE="SCAPE" OBJID="fiz.karlsruhe.09601"
xsi:schemaLocation="http://www.loc.gov/METS/
http://www.loc.gov/standards/mets/mets.xsd">

<mets:dmdSec ID="DC"></mets:dmdSec>

<mets:amdSec>

<mets:techMD ID="object1"></mets:techMD>

<mets:rightsMD ID="rights1"></mets:rightsMD>

<mets:sourceMD ID="source1"></mets:sourceMD>

<mets:digiprovMD ID="event1"></mets:digiprovMD>

…

</mets:amdSec>

<mets:fileSec></mets:fileSec>

<mets:structMap></mets:structMap>

</mets:mets>
```

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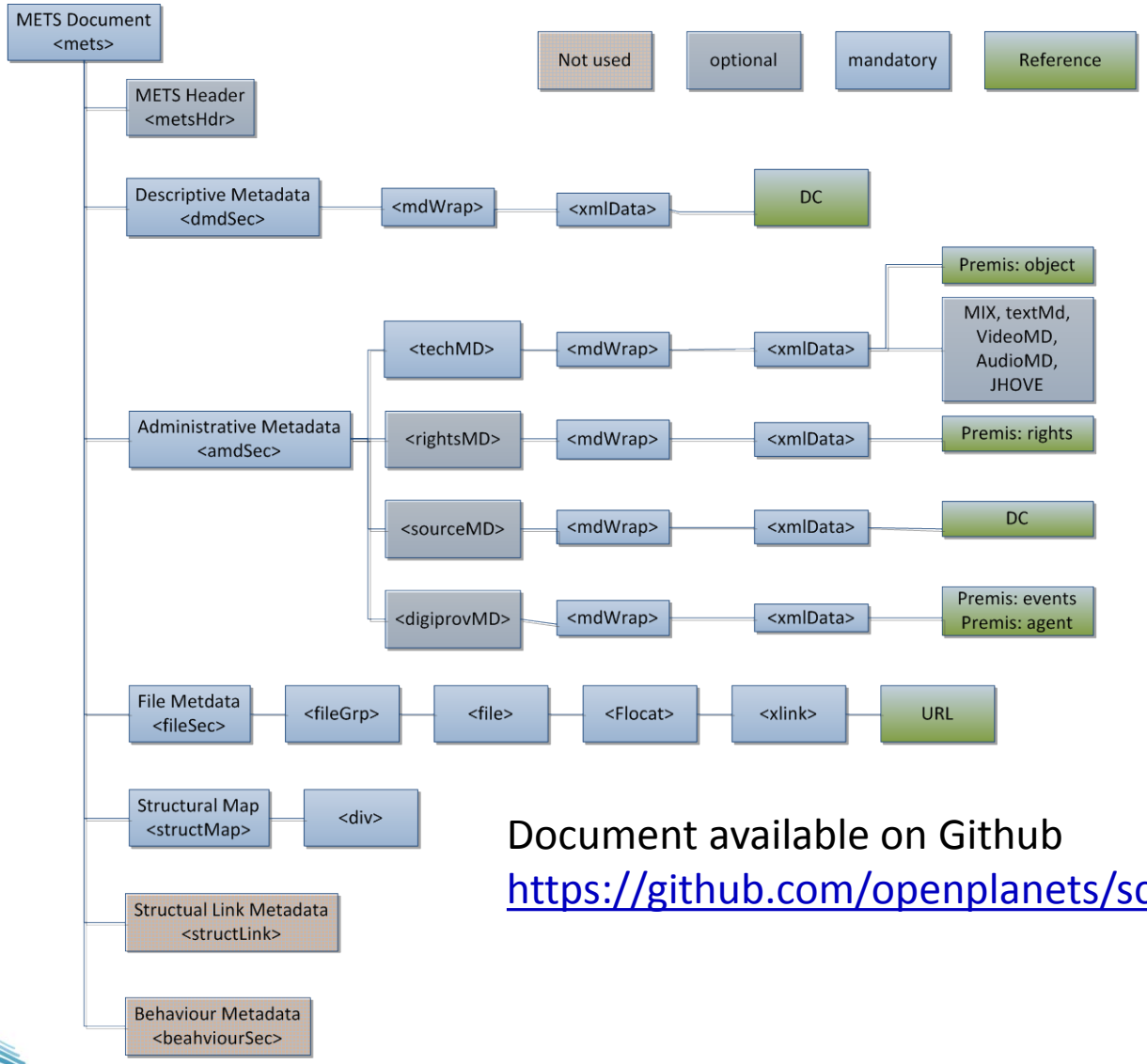
SCAPE Digital Object Model



Document available on Github
https://github.com/openplanets/scape-apis

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Platform Data Model – Code Level

Serialize / Deserialize SCAPE Digital Objects

- Premis: Intellectual Entity - Representation - File - Bitstream as Java Objects.
- Intellectual Entities get serialized/deserialized from/to the METS format
- Representations, Files, Bitstreams get serialized/deserialized by JAX-B directly.

```
HttpGet get = new HttpGet(SCAPE_URL + "/entity/entity-2");
HttpResponse resp = this.client.execute(get);

IntellectualEntity ie = this.marshaller.deserialize(IntellectualEntity.class,
        resp.getEntity().getContent());
```

Code available on Github:

https://github.com/openplanets/scape-platform-datamodel

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Platform Data Model – Code Level

- **ScapeMarshaller.java**
  - takes care of serialization/deserialization of Intellectual entities
  - Takes conversion classes to convert your data into SCAPE Digital Object as IntellectualEntity
  - Whole bunch of Junit Tests can be found at https://github.com/astromatthias/scape-fedora4-test

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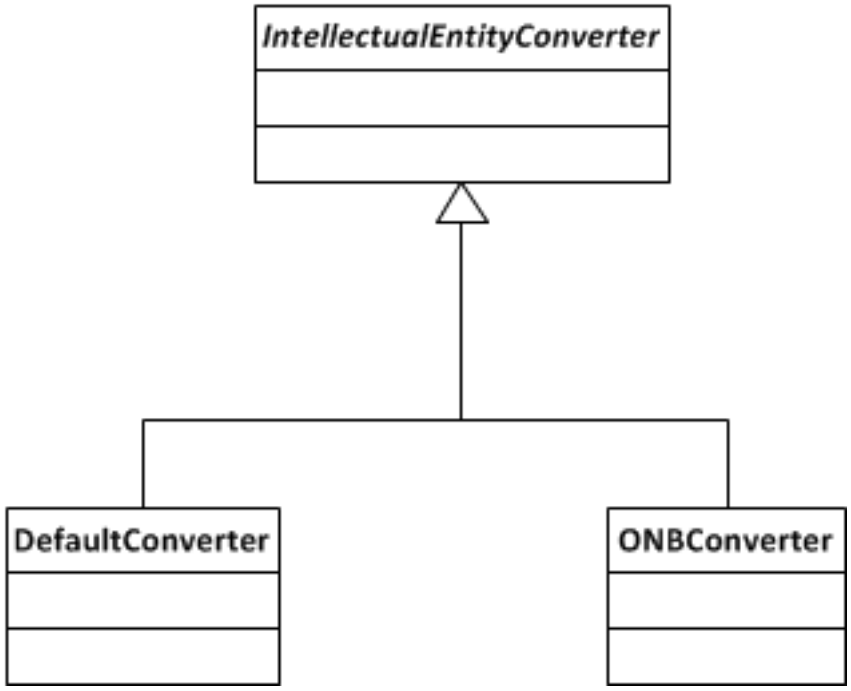
Platform Data Model – Converter

- Conversion into SCAPE Digital Object Model



e.g. covers
google book
scan data

Add your own converter if you want to convert your METS (theoretically any other format) into SCAPE METS Java Objects.

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Platform Data Model – TestUtil

// create entities and post the entity

```
IntellectualEntity ie =
    TestUtil.createTestEntityWithMultipleRepresentations("entity-2");
this.postEntity(ie);
```

The TestUtil class helps you to create an entity with no or multiple representations and can be used to test your SCAPE Connector API implementation.

Refer to
https://github.com/astromatthias/scape-fedora4-test
https://github.com/openplanets/scape-platform-datamodel

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SCAPE Platform Data Model - Demo

- Create a sample set of objects

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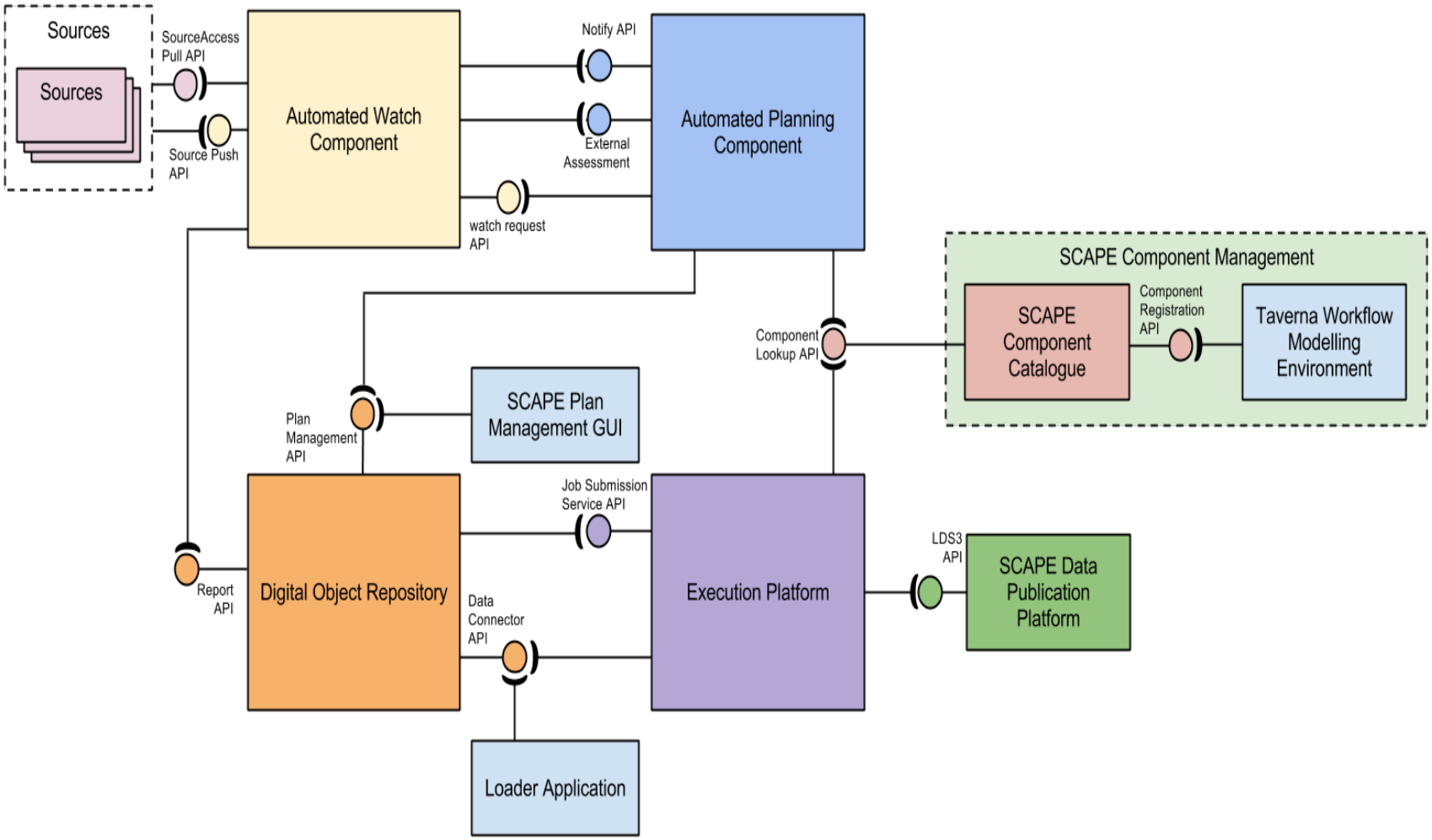
SCAPE APIs



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SCAPE APIs - Connector API

- Connector API
  - The Connector API's purpose in the SCAPE platform is to integrate different repositories with the various SCAPE components
  - The content repository exposes a RESTful API
  - Use Cases
    - **Loader application for batch ingest**
    - **Request Intellectual Entities by the computation cluster**
    - **Update Intellectual Entities with provenance information**
    - **Partially fetching large scale files (e.g. named bitstreams in ARC container)**

Document available on Github
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Connector API - REST Endpoints

- **Ingest an Intellectual Entity**
- **Ingest an Intellectual Entity asynchronously**
- **Retrieve an Intellectual Entity**
- Retrieve a version list for an Intellectual Entity
- **Retrieve a File**
- Retrieve named bit streams
- Retrieve a metadata record
- **Retrieve a set of Intellectual Entities**
- **Retrieve the lifecycle status of an entity**
- Retrieve a Representation
- **Update an Intellectual Entity**
- **Update a Representation of an Intellectual Entity**
- **Update the metadata of an Intellectual Entity**
- Search Intellectual Entities in a collection
- Search Representations in a collection
- Search Files in a collection

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SCAPE APIs - Connector API - Excerpt

Retrieve an Intellectual Entity

Retrieval of entities is done via a GET request. ……The parameter *useReferences* controls wether the response is created using references to the metadata via <mdRef> elements or if the metadata should be wrapped inside <mdWrap> elements in the METS document.

Path:

/entity/<entity-id>/<version-id>?useReferences=[yes|no]

Method:

HTTP/1.1 GET

Parameters:

entity-id: *the id of the requested Intellectual Entity*

version-id: t*he version of the requested entity (optional)*

useReferences: *Wether to wrap metadata inside <mdWrap> elements or to reference the metadata using<mdref> elements. Defaults to yes.*

Produces:

A XML representation of the requested Intellectual Entity version

Content-Type:

text/xml

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SCAPE APIs

- Plan Management API
  - The Plan Management API is a set of HTTP endpoints for serving content in a SCAPE environment. It's purpose is to integrate the various components in the SCAPE platform that handle preservation plans.
  - Use Cases
    - **Deploying new plans in the Repository**
    - **Get state information about plans**
    - **Execute a preservation plan on the Workflow Execution Environment**
    - **Change existing plans**
    - **Get a specific plan based on some criteria**
    - **Reservation of Identifiers**

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SCAPE APIs – Plan Management API - Excerpt

Retrieve a plan

An endpoint for plan retrieval is exposed by the repository. Plans are returned according to the Plato Version 4 XML schema, that is currently in development.

Path

/plan/<id>

Method

HTTP/1.1 GET

Parameter

id *the id of the plan to be fetched from the repository*

Produces

A XML representation of the plan

Available on Github:
https://github.com/openplanets/scape-apis

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Tests of the API - Demo

- Test of the Connector API

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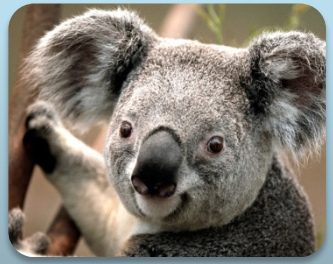
Recap !



SCAPE Integration

- SCAPE Digital Object Model
- SCAPE Platform Model (Code)
- Connector API
- Plan Management API

Other cool stuff

- Akubra HDFS Storage Layer [Fedora 3]
- SCAPE Loader Application [Demo]

Scalability

- Fedora 4

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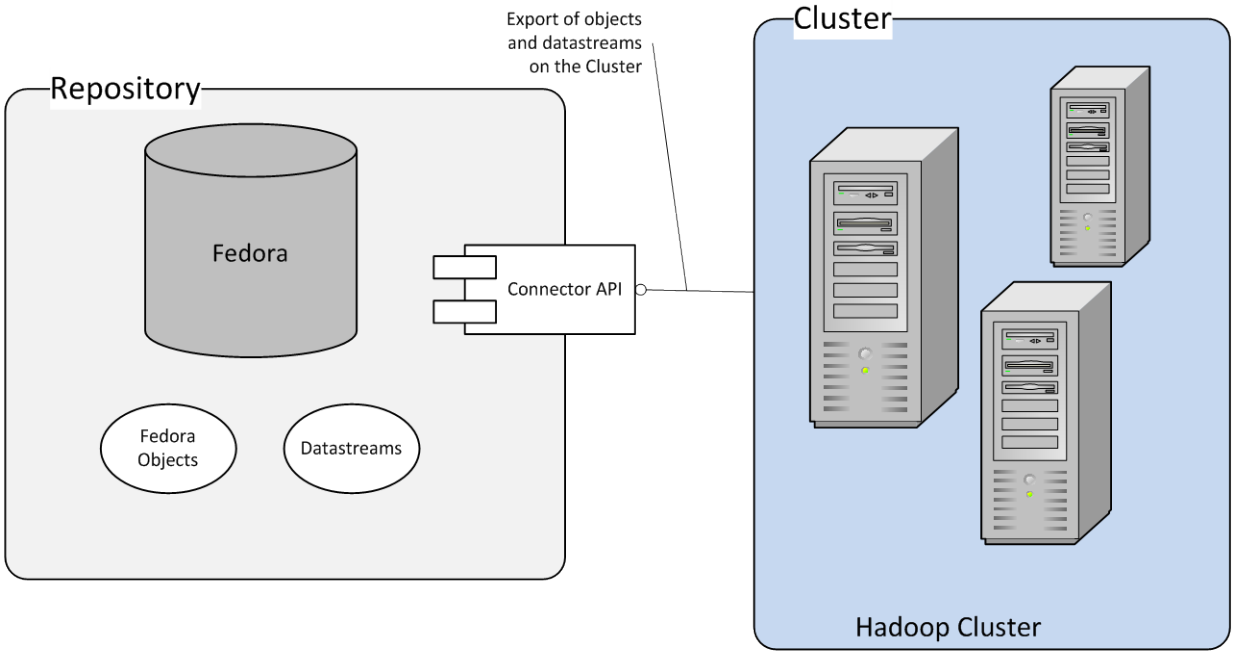
Repositories Storage Layer

Loose Coupling - Export Use Cases

Repository and Hadoop cluster are separated instances. Storage and computation are distinct. Data needs to be exported to the computation cluster via Connector API.



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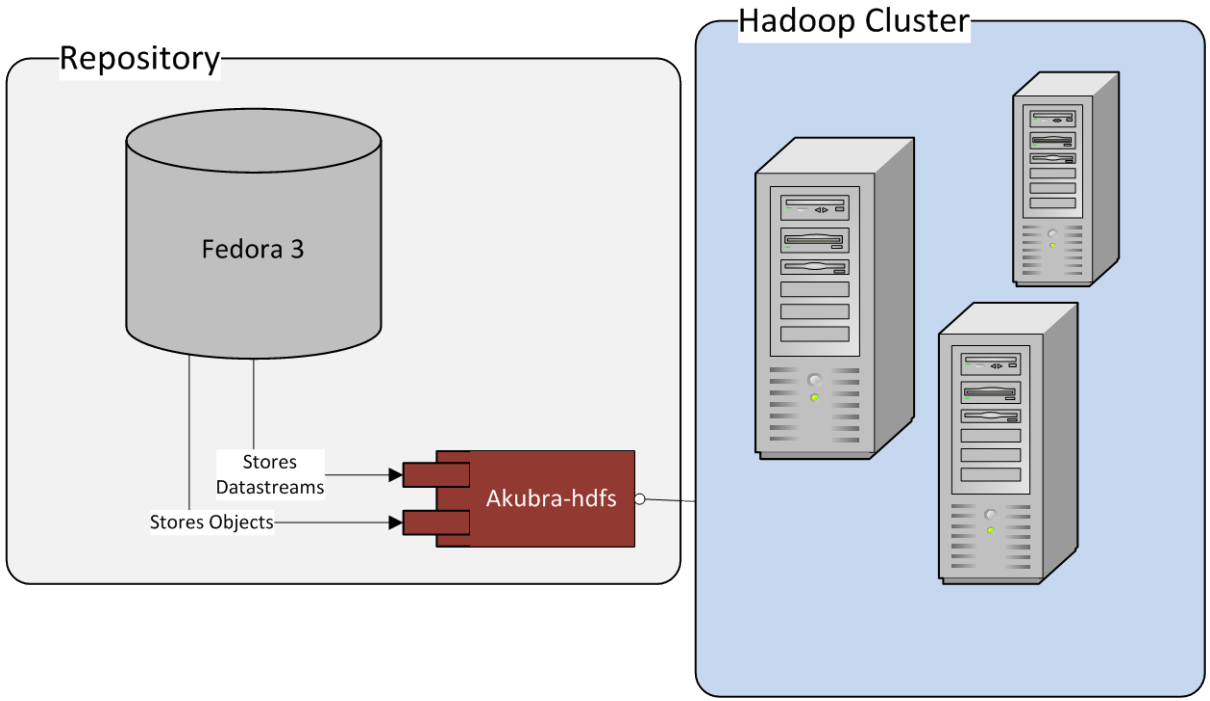
Hadoop as a Storage Backend of Repositories

Repository and Hadoop are wired together via akubra plugins. Repository, computation and storage is just one big infrastructure.



Other Implementations of akubra with iRODS and DELL DX Object Storage exists

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Hadoop as a Storage Layer – Use Cases

- No moving of data to the cluster needed
- Data can be moved very efficiently using Hadoop tools like distcp to another cluster or location on the same cluster.
- Repository can use MapReduce Jobs to monitor / computation tasks direct on the data.
- But HDFS is an immutable file system (write once)
  - Update of files = delete / create cycle
  - Not optimized for random file access
  - Small file problem

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Hadoop Issue – Small File Problem

- **Sequence File**
  - Key (filename)-Value (file content) file
  - Can be slow to create a sequence file of existing data
  - Write data directly into a sequence file better option than packing afterwards.
  - No random access.
  - This file is append-only.

- **HBASE**
  - Random Access
  - realtime read/write access

More:
Akubra HDFS is a storage layer for Fedora 3
http://wiki.opf-labs.org/display/SP/akubra-hdfs

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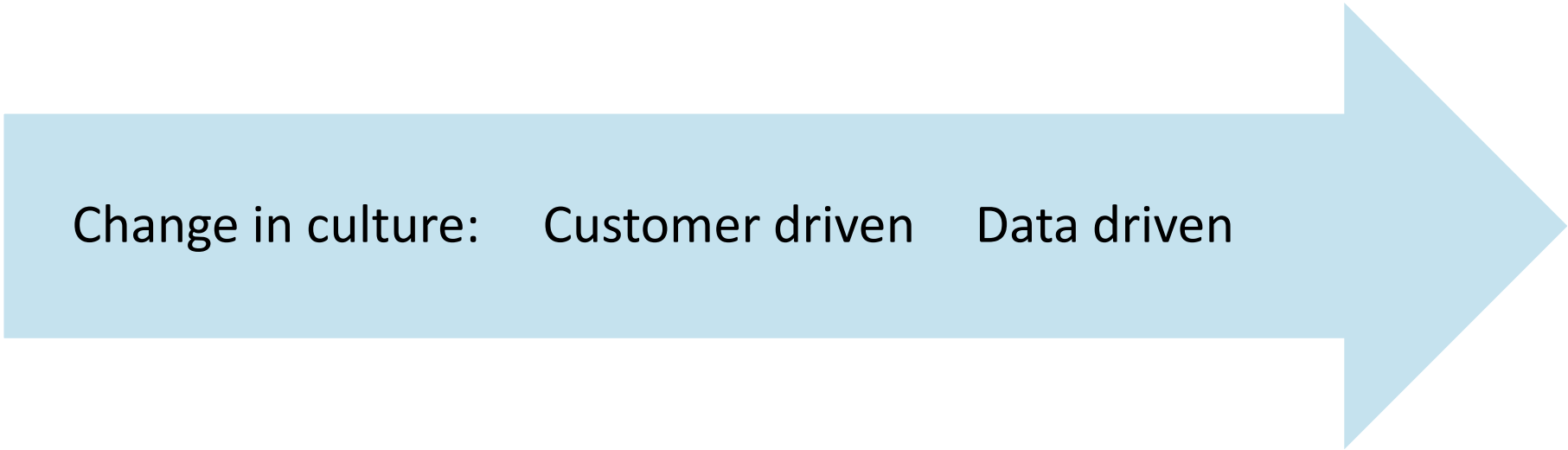
Fedora 3 to 4

- What‘s the problem?
  - A large , aging codebase
  - Declining year-on-year number of developers
  - Declining year-on-year number of commits
  - => slow to develop new features
  - => hard to attract new developers



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Fedora 4 Use Cases

- Repository scales horizontally
- Repository supports storage services (e.g. Amazon Glacier)
- Ingesting large files into the repository
- Policy-driven Storage
  - Separating objects and datastreams into independent stores.
  - Separating large resources and small resources, for some simple definition of "large" and "small", into independent stores.
  - Separating objects and their datastreams into independent stores based on the owner of the object.
- Many more….

https://wiki.duraspace.org/display/FF/Use+Cases

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Fedora 4 – Some Features

Durablility

- Self-Healing
- Transactions
- Clustering for high availibility
- Metric and reporting

Performance

- Batch Operations
- Clustering for Scalability
- File Storage Connector / Projection, aka „instant ingest“

Flexibility

- Eventing, messaging & web hooks
- Policy driven storage
- Sequencer (extract metadata)
- Storage options
- Easy install & deployment

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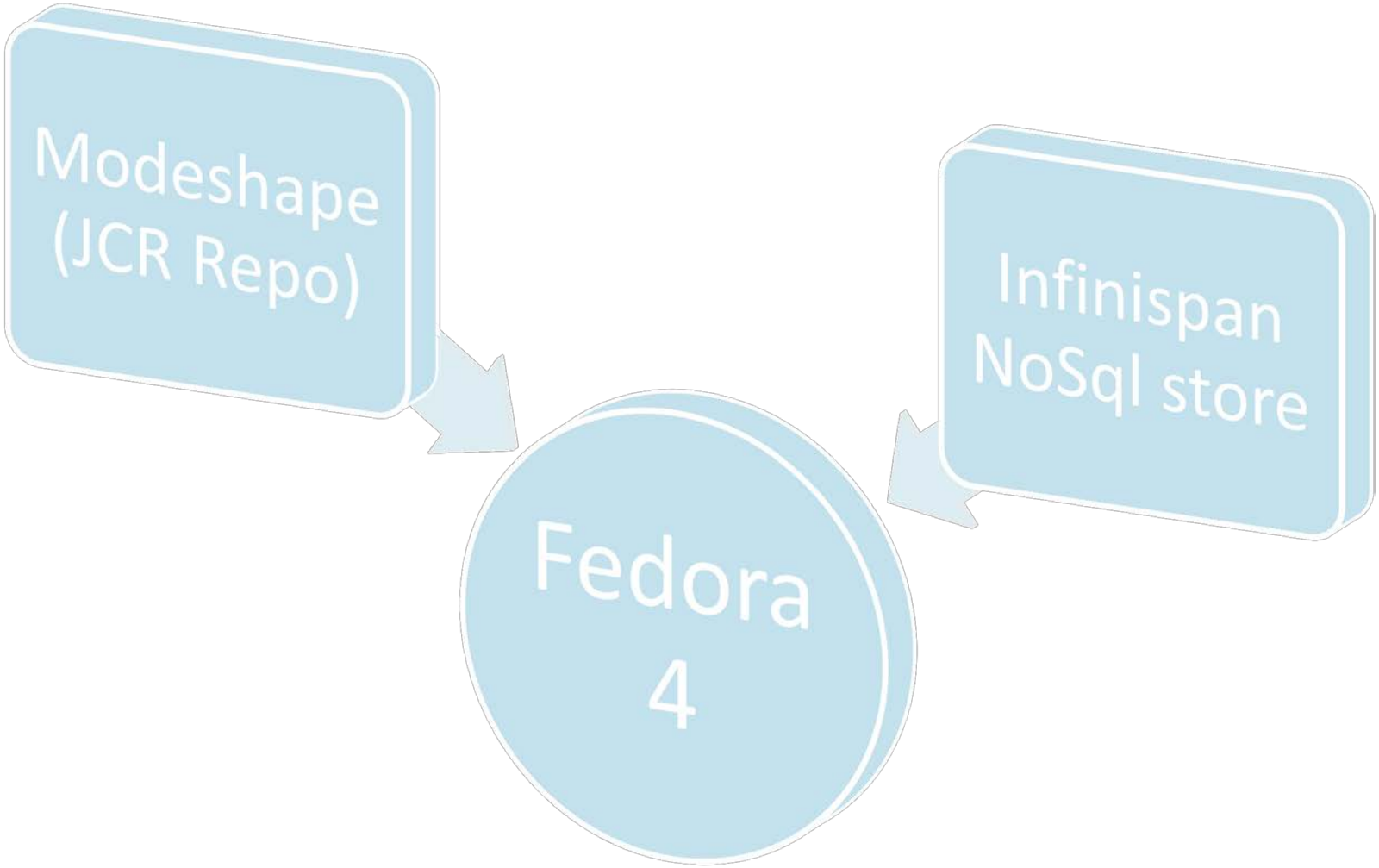
Fedora 4



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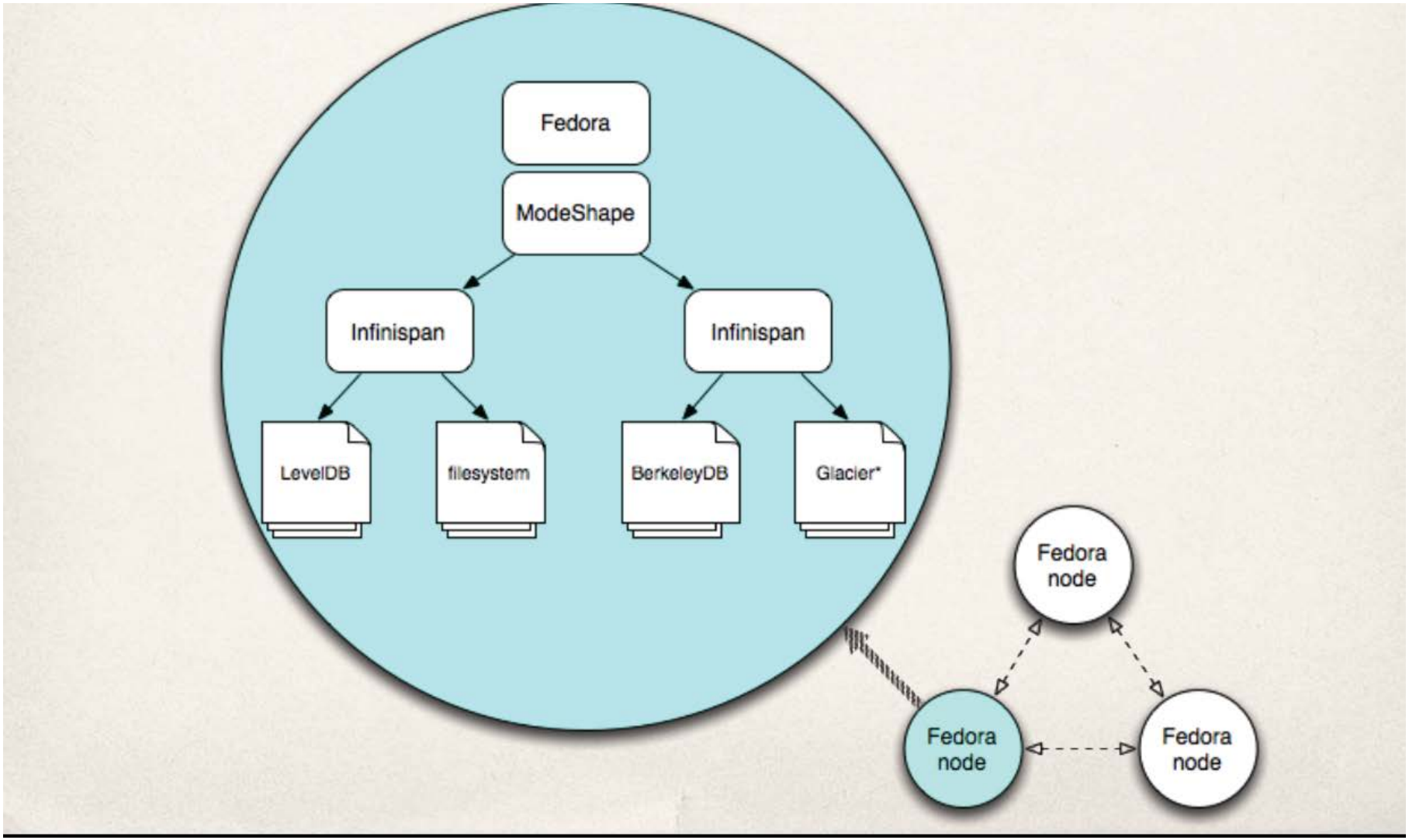
Fedora 4 - Architecture



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Fedora 4

- **Fedora Futures Wiki**
  - https://wiki.duraspace.org/display/FF/Fedora+Futures+Home
- **Fedora Google Tech Group**
  - https://groups.google.com/forum/#!forum/ff-tech
- **Fedora 4 Alpha 1 Release**
  - https://github.com/futures/fcrepo4/releases/fcrepo-4.0.0-alpha-1

- **Fedora 4 SCAPE Connector API iml**
  - https://github.com/openplanets/scape-fcrepo4-connector
- **Fedora 4 SCAPE Plan Management API**
  - https://github.com/openplanets/scape-fcrepo4-planmanagement
- **Fedora 4 SCAPE war file**
  - http://wiki.opf-labs.org/display/SP/Repository+Reference+Implementation

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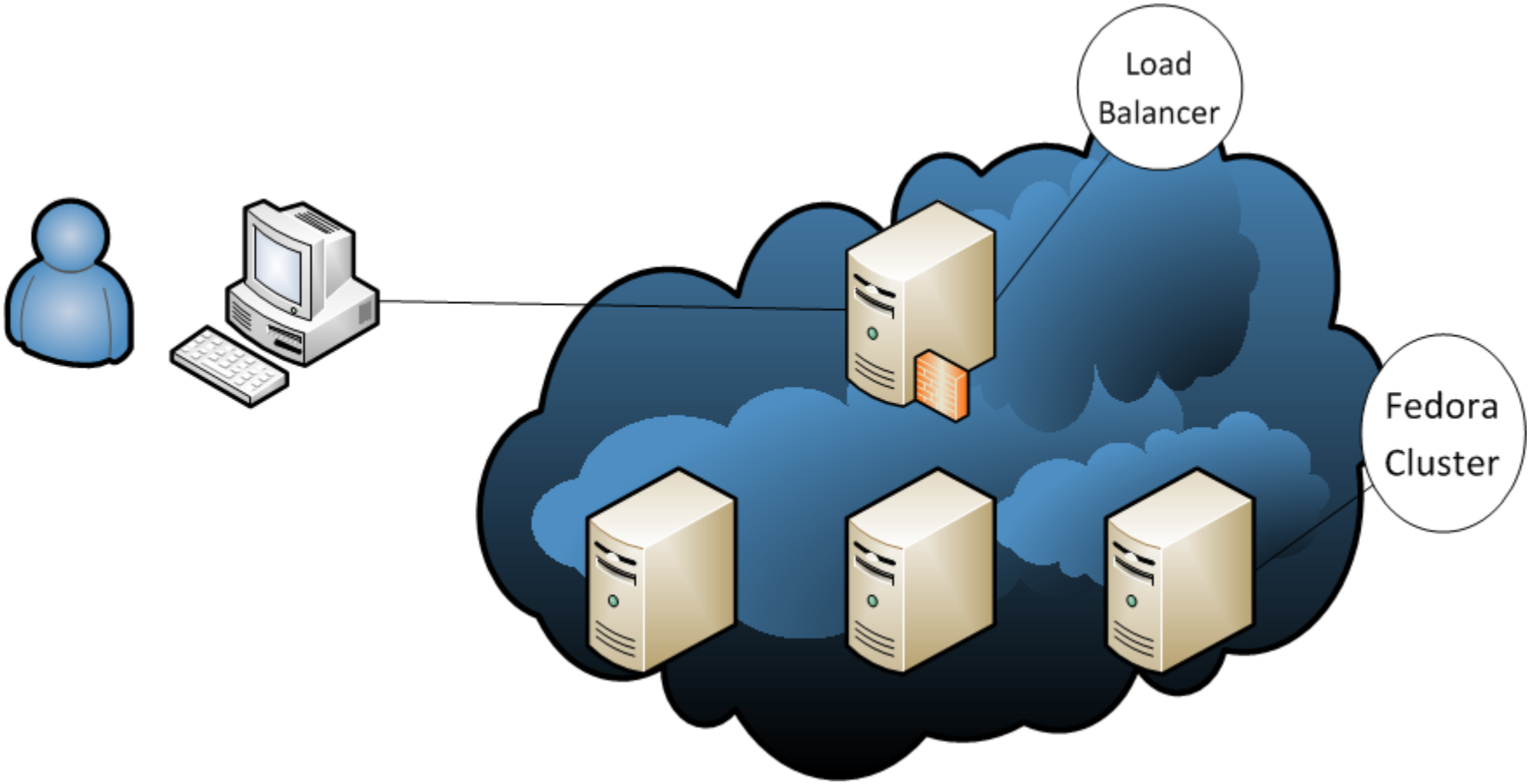
METS Loading Demonstration with Fedora 4



Test Cluster at Steinbuch Center for Computing SCC

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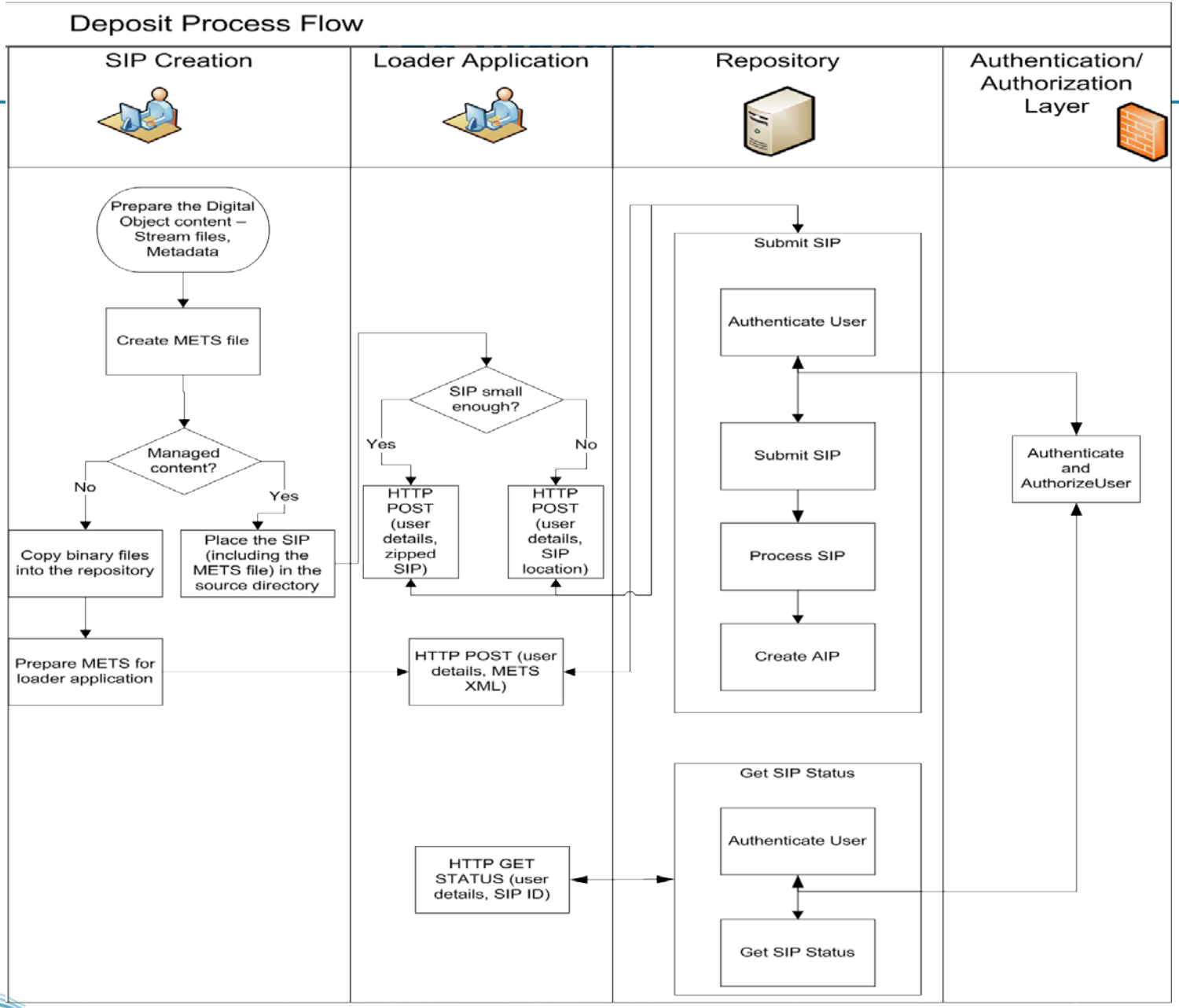

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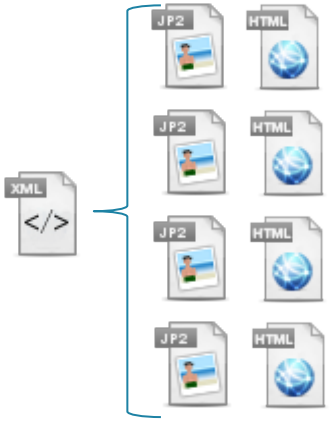
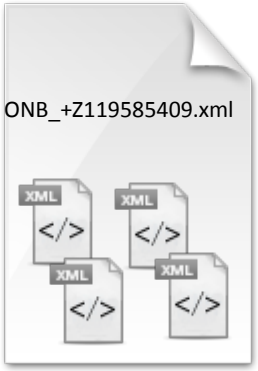
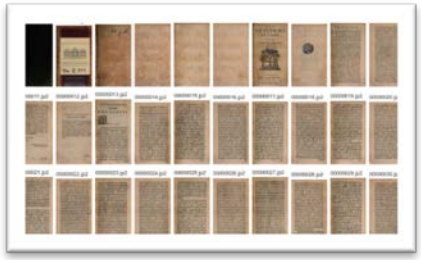
METS Loading at ONB

Structured Digital Book → Sequence File → METS Ingest via Loader App → Creating AIP → Retrieve & Update







METS Container structures digital book object and contains metadata about referenced entities.

All METS files are bundled in a sequence file and stored on HDFS

Loading of METS files into the repository via the Loader App - creation of AIPs by the repository

Digital content can be accessed and managed via Connector API

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The METS Loader Application

- **Loads SIPs [Submission Information Package] into your repository**
- **Reads SIPs from local filesystem, HDFS (from sequence files) or a ZIP file**
- **Reports the ingest lifecycle states periodically**
- **Logs the ingest progress**
- **Easy to configure via command line interface**
- **Can be used by any repository that exposes the Data Connector API (CRU[D] RESTful Service).**
- **source code on Github.**
  https://github.com/shaibe/loader-app

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The Demo

- **The Loader Application registers the METS files for ingest.**
- **The Loader Application posts the METS files to the repository using the REST endpoint for asynchronous ingest.**
- **The SIPs will be queued by the repository for ingest.**
- **The Loader Application recieves from the repository the ID of the Digital Object.**
- **The repository stores and indexes the content – creating AIP [Archival Information Package].**
- **The Loader Application retrieves periodically the lifecycle state of the objects.**

This work was partially supported by the SCAPE Project.
The SCAPE project is co-funded by the European Union under FP7 ICT-2009.4.1 (Grant Agreement number 270137).