Open Data Management & Cloud
exam project

Audio music file archiving

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Contents

The presentation is organised as follows:

Introduction

Aim of the project

Investigation of audio file archiving for music.

In particular:

- UML metadata model;
- XSD implementation and XML sample document;
- discussion of data discovery/access and interoperability;
- discussion of (long term) archiving and data preservation.

Data resource

Data resource: not an actual dataset but music files in general.

Great variability:

- File formats;
- Encodings;
- Metadata containers and contents.

Metadata standards for audio files

There is no widely used and standardised metadata model for music audio files.

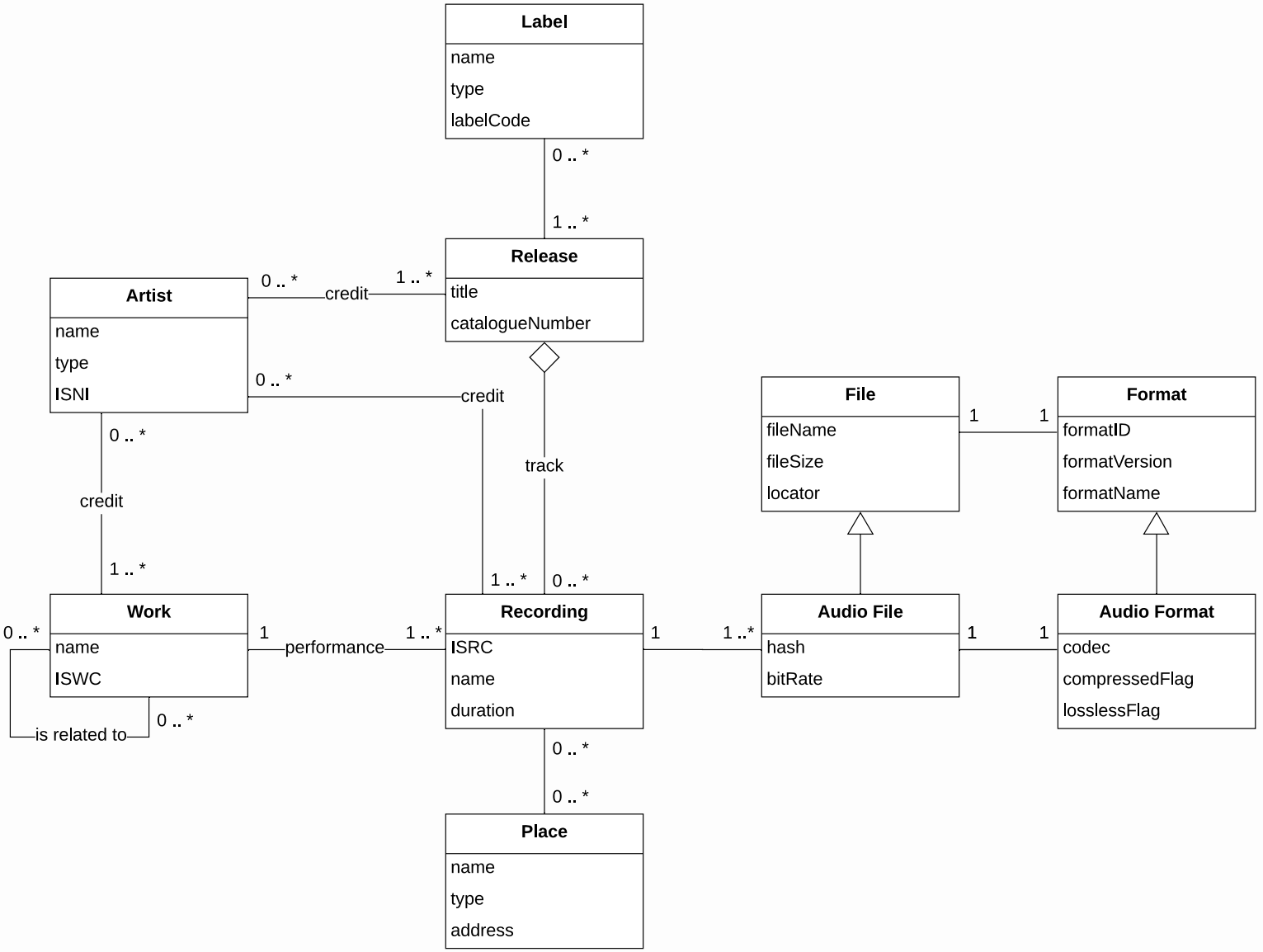
- Dublin Core: simple (15 terms), focus on descriptive metadata;
- EbuCore: detailed DC extension, fine grain technical and administrative metadata for broadcasting;
- METS: handles the structural/hierarchical metadata of a digital library. Open flexibility (no vocabulary).

Model design

What should the data model represent?

- Songs and their different versions;
- Groups of songs (i.e., commercial releases);
- Artists;
- Basic technical metadata (file formats);
- Relationships between songs, releases and artists.

UML


Label
name
type
labelCode
0 .. *
1 .. *
Release
title
catalogueNumber
Artist
name
type
ISNI
0 .. *
credit
1 .. *
0 .. *
credit
0 .. *
credit
track
File
fileName
fileSize
locator
1
1
Format
formatID
formatVersion
formatName
1 .. *
1 .. *
0 .. *
Work
name
ISWC
0 .. *
1
performance
1 .. *
Recording
ISRC
name
duration
1
1 ..*
Audio File
hash
bitRate
1
1
Audio Format
codec
compressedFlag
losslessFlag
0 .. *
is related to
0 .. *
0 .. *
0 .. *
Place
name
type
address

XSD

Choice of implementation:

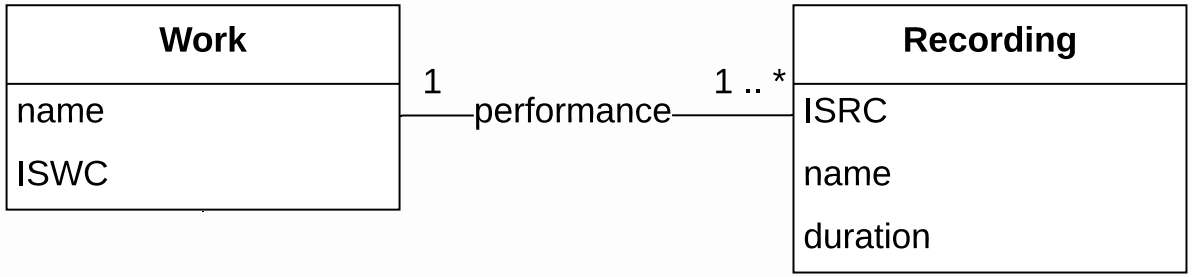
- RDB: easy to enforce constraints (primary/foreign keys), widely used, easy to model relationships, rigid structure;
- **XSD**: flexible, easily handle partial data, more difficult relationship handling.

The proposed XSD implementation should:

- Refine Dublin Core;
- Balance integrity constraints and partial data;
- Model relationships with detail.

The resulting XSD can be retrieved here.

XSD Relationships




```
<xs:complexType name="workType">
  ...
  <xs:element name="hasPerformance" type="odmc:relationType"
      minOccurs="1" maxOccurs="unbounded"/>
  ...
</xs:complexType>

<xs:complexType name="recordingType">
  ...
  <xs:element name="isPerformanceOf" type="odmc:relationType"
      minOccurs="1" maxOccurs="1"/>
  ...
</xs:complexType>
```

XSD Relationships - cont'd

Relationships are implemented using the KEY / KEYREF syntax.

```
<xs:key name="relationId">
  <xs:selector xpath="./odmc:odmcItems/odmc:work/odmc:ISWC"/>
  <xs:field xpath="@id"/>
  </xs:key>
<xs:keyref name="relationIdref" refer="odmc:relationId">
  <xs:selector xpath=".//odmc:relationIdentifier/*"/>
  <xs:field xpath="@idref"/>
</xs:keyref>
```

The XSD structure can be interactively navigated using a web browser using this SVG file.

XML example

Example of an XML document, valid against the proposed XSD.

```
<work>
  <ISWC id="ISWC_T-000.000.000-A"></ISWC>
  <title lang="en">
    <dc:title>Test Work</dc:title>
  </title>
  <hasArtist label="Will Wilson" description="Singer">
  </hasArtist>
  <hasPerformance label="Test Rec." description="Studio Ver.">
    <relationIdentifier>
      <ISRC idref="ISRC_AAAAA0000000"></ISRC>
    </relationIdentifier>
  </hasPerformance>
</work>
```

Difficulties and possible expansions

Difficulties:

- Chosing the right degree of flexibility;
- Handling large XML documents.

Possible expansions:

- Include sort names;
- Include pictures for artists and releases;
- Model inter-document constraints.

Data discovery: search/filter service

The most fundamental service would be a search/filter service.

- Free text queries on the various categories (artist, release, work, recording);
- Queries can be implemented using XQuery;
- Information retrieval techniques to improve results: edit distance and k-gram distance for spelling correction;
- Popularity rank for the results.

Once the resource has been identified: download (lossy and lossless file) and online preview.

Crucial point: XML indexing, trade-off between memory usage and performance.

Data annotation

Metadata can be embed in audio files. **Is it advisable?** A minimal amount, the *catastrophic* metadata is necessary. Most metadata should be saved in external files.

Viable metadata containers:

- ID3: designed for Mp3, highly structured;
- XMP: ISO standard for JPEG images, defined for other formats including Mp3 and WAW;
- BWF `<bext>` chunk: XML administrative metadata for BWF;
- Vorbis comments: unstructured metadata for Vorbis and FLAC.

Conclusion: data annotation heavily depends on file format choice.

Storage and Cloud Solutions

Storing **XML** files:

- XML-native databases are not scalable;
- XML-enabled databases are well established, scalable and can be queried with SQL.

Crucial point: the proposed XSD itself is not scalable.

Audio files can be stored in BLOBs in the database: not flexible.
Alternatively:

- Up to *few* TB: remote filesystem;
- Large archives: distributed DB;
- Cloud solutions: Amazon S3 offers versioning, orphan files handling, redundancy and access control.

Data preservation

A primary concern for an audio archive. The proposed XSD prevent data duplication and limits orphan data.

Most technical and descriptive metadata is **stable** and, in principle, it is not essential to preserve it. Catastrophic metadata is **ephemeral** (e.g., the ISRC for a recording) and must be preserved.

Audio file hashes can be used to check file integrity.

Cloud solutions for **long term preservation**: AWS S3 Glacier and Glacier Deep.

Crucial point: an OAIS implementation could not be *open access* for copyrighted files.

Interoperability

The proposed model strives for semantic interoperability.

- Syntactic interoperability: XML is an open format;
- Semantic interoperability: XSD equips data with meaning, Dublin Core support;
- Standardised and persistent identifiers for the main classes;

A report is associated with the project: it provides ontological information on the model.

Audio file formats

One of the most crucial design choices: obsolete and proprietary file formats make data handling troublesome (*digital dark age*).

(Quasi) open file formats should be used:

- BFW: uncompressed extension of Microsoft WAW, open format;
- FLAC: smaller file size, compressed lossless format, good metadata support;
- MP3: most popular audio file format, very small file size, lossy compression, not a viable alternative for archiving (good for download/preview).

Crucial point: the file format should be well established.

Final considerations

Audio file data management is difficult because:

- Many impactful design choices;
- Lack of metadata standard can make interoperability difficult;
- Practical issues: storage and indexing;
- Cloud solutions to deal with large volumes and concurrent access.