TimeSide

Python audio processing framework and server made for the web

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WASABI

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POW

parisson.com

telemeta

cnrs

SORBONNE UNIVERSITÉ

ANR

MINISTÈRE DE LA CULTURE
Liberté
Égalité
Fraternité

Séminaire STMS - 14/10/2020 - IRCAM

Outline

- Introduction
- History
- Core
- Server
- Player
- Perspectives

TimeSide

Context

- digization > big data > platforms > machine learning > users & listeners
- more data sets, databases, formats, algorithm versions, open DSP libraries & communities
- difficulties to port and scale some algorithms on production platforms (DSP at scale)
- computer science need human data, digital humanities needs computers
- collaborative workflows, citizen sciences through the web

Constraints

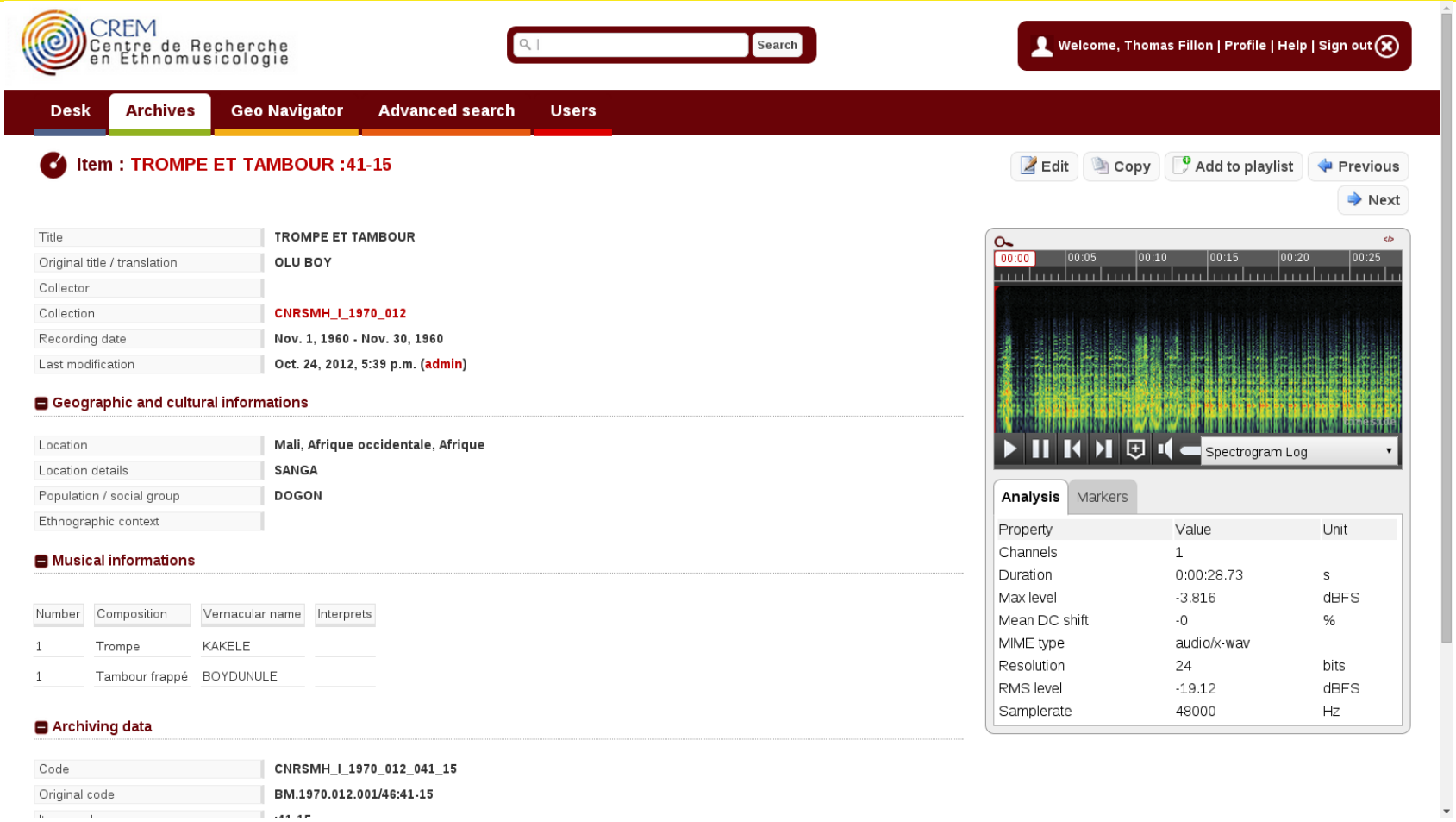
- continuous development, continuous integration
- reproducible research
- sustainable digital archiving
- copyrighted data
- open source and standards
- format evolution and abstraction
- duplicate and version everything
- access everywhere

TimeSide

History

- 2007 : Telemeta developed for the sound archives of the CNRS / Musée de l'Homme
- 2010 : TimeSide separation as a autonomous library and then a framework with a plugin oriented architecture
- 2011 : Telemeta v1.0 released and http://archives.crem-cnrs.fr/
- 2013 : DIADEMS project (ANR) : external plugins
- 2015 : TimeSide server and RESTFul API prototypes
- 2015 : KAMoulox (ANR), DaCaRyh (Labex) projects
- 2016 : WASABI (ANR), CREM-NYU-Parisson projects

Telemeta - CREM



http://archives.crem-cnrs.fr/

Telemeta - CREM

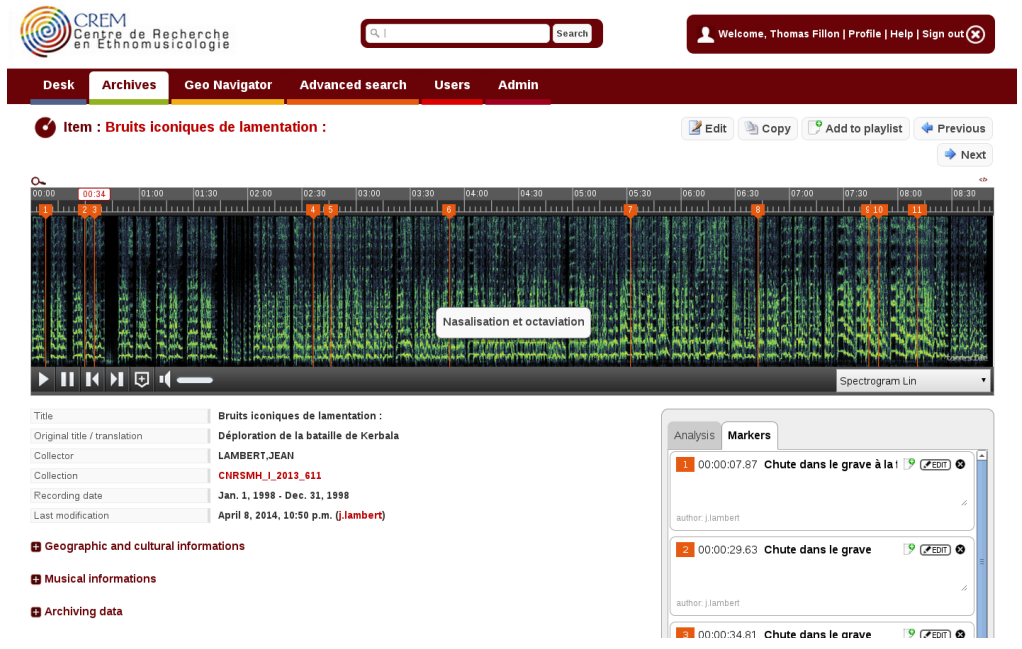
Telemeta / TimeSide integration

Collaborative multimedia asset management system

MIR + Musicology + Archiving = MIRchiving

Ecosystem

- 20 public partners
- 15 historical developers (6000 commits)
- 500 users (CREM)
- and thousands of developers! (open source community)
- mutualized development model



https://github.com/Parisson/Telemeta

WASABI project

Web Audio and SemAntics in the Browser for Indexation

- 42 months from 2016 Q4 to april 2020 Q4
- 750 k€ project granted by the french Research National Agency

Consortium

- INRIA (I3S)
- IRCAM (APM, AnaSyn, POW)
- Parisson
- Deezer R&D
- Radio France

WASABI project

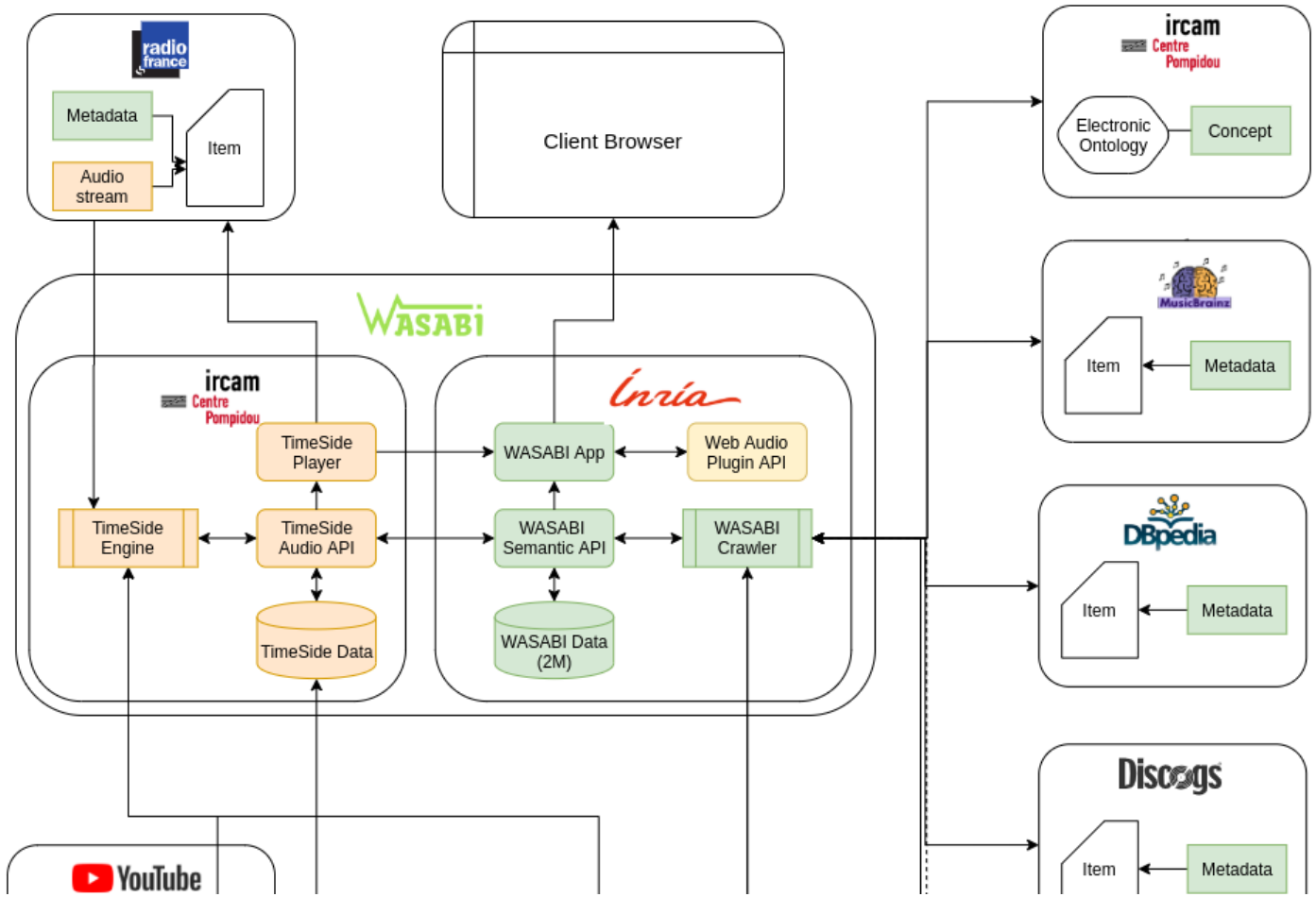
Objectives

- Propose some new methodologies to index music in the web and audio contexts
- Link semantics (linked metadata) + acoustics (MIR data)
- Develop and publish some open source web services through original APIs

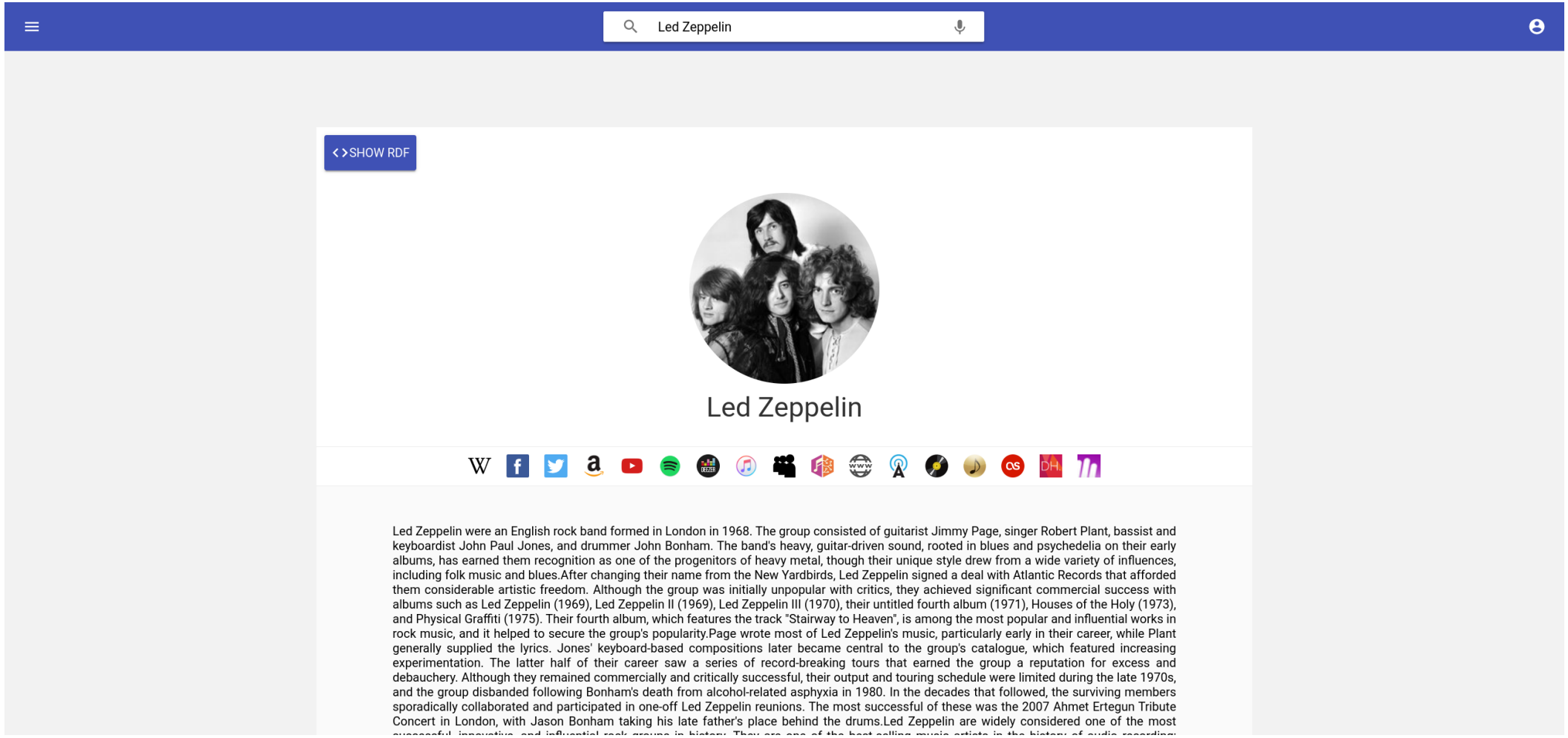
Use cases

- enhanced web music browsing
- computational musicology
- data journalism
- music learning through modular web interfaces (schools)
- lyrics synchronization

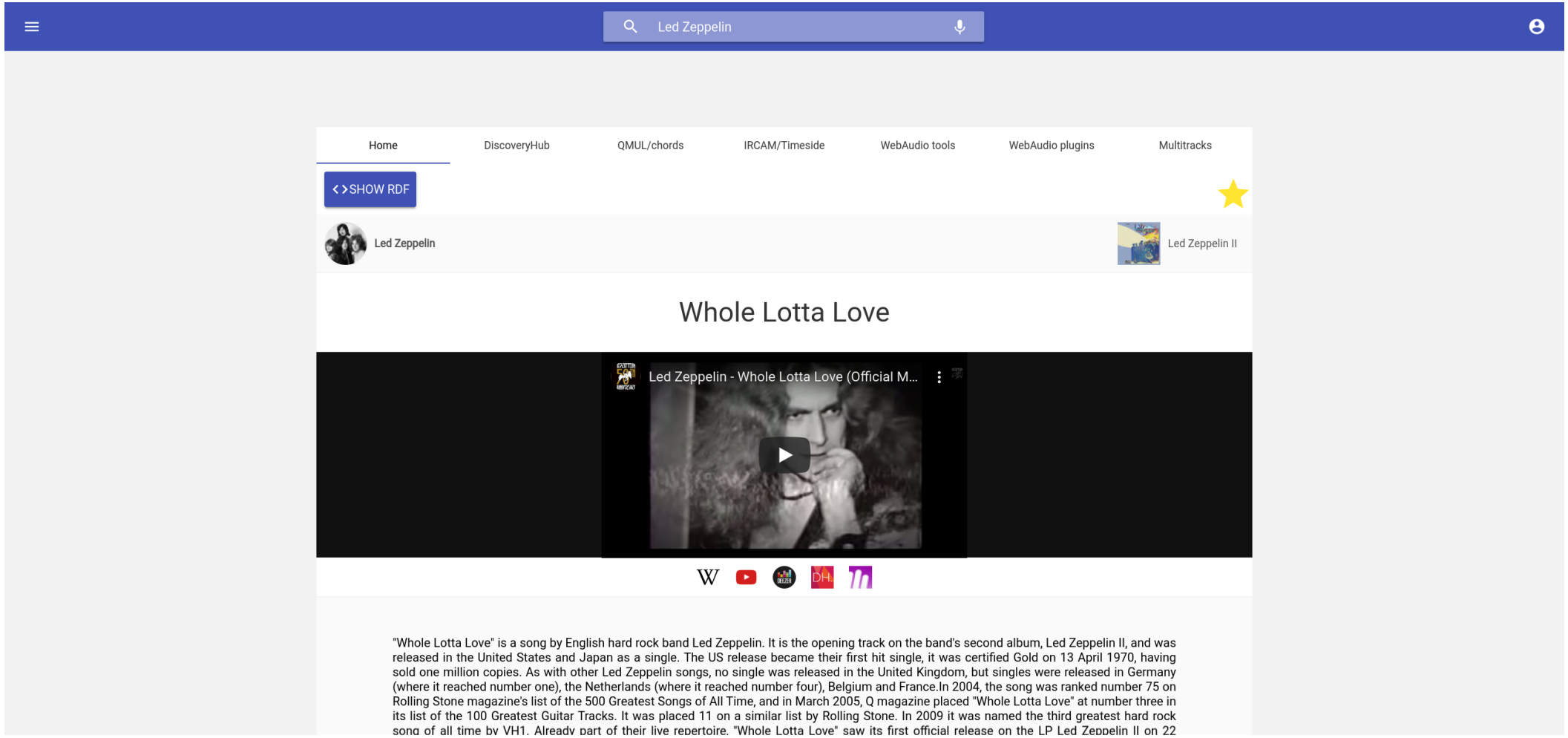
WASABI platform architecture



WASABI platform (link)



WASABI platform (link)



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TimeSide

Python audio processing framework and server made for the web

https://github.com/Parisson/TimeSide

Goals

- **Process** audio fast and asynchronous with **Python**,
- **Decode** audio frames from *any* audio or video media format into **Numpy arrays**,
- **Analyze** audio content with some **state-of-the-art** audio feature extraction libraries like **Aubio, Essentia, Librosa, Yaafe, VAMP** and pure python processors
- **Visualize** audio data with various fancy waveforms, spectrograms and other cool graphers,
- **Transcode** audio data in various media formats and stream them through web apps,
- **Serialize** feature analysis data through various portable formats (XML, JSON, HDF5)
- **Playback** and **interact on demand** through a smart high-level **HTML5 extensible player**,
- **Index**, **tag** and **annotate** audio archives with **cultural and semantic metadata**,
- **Deploy** and **scale** your own audio processing engine flawlessly through any infrastructure with **Docker**

TimeSide

Python audio processing framework and server made for the web

https://github.com/Parisson/TimeSide

Use cases

- Scaled audio processing (filtering, transcoding, machine learning, etc...)
- Audio process prototyping
- Audio dynamic visualization
- Automatic segmentation and labelling synchronized with audio events
- Collaborative annotation
- Audio web services

License: AGPL v2

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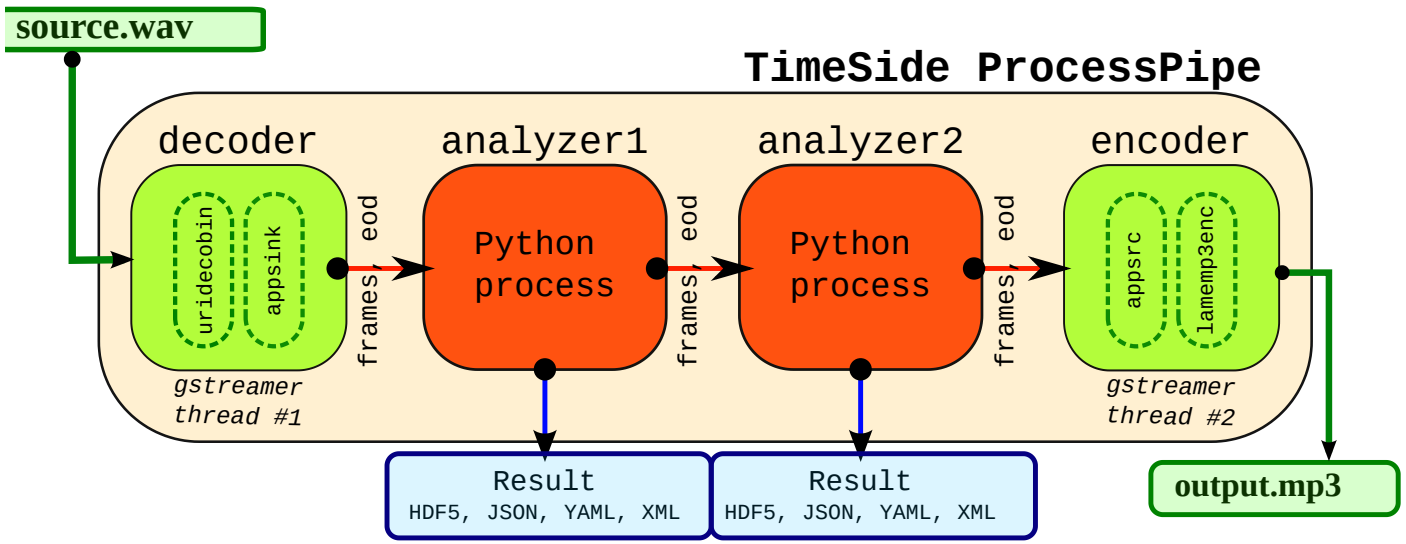
API & architecture

- streaming oriented core engine
- data persistence




```
pipe = (decoder | analyzer1 | analyzer2 | encoder)
```

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API & architecture

- streaming oriented core engine
- data persistence
- processing API
- plugin architecture
- namespace

```
class DummyAnalyzer(Analyzer):
    """A dummy analyzer returning random samples from audio frames"""
    implements(IAnalyzer)

    @interfacedoc
    def setup(self, channels=None, samplerate=None, blocksize=None, totalfram
        super(DummyAnalyzer, self).setup(channels, samplerate, blocksize, tot
        self.values = numpy.array([0])

    @staticmethod
    @interfacedoc
    def id():
        return "dummy"

    @staticmethod
    @interfacedoc
    def name():
        return "Dummy analyzer"

    @staticmethod
    @interfacedoc
    def unit():
        return "None"

    def process(self, frames, eod=False):
        size = frames.size
        if size:
            index = numpy.random.randint(0, size, 1)
            self.values = numpy.append(self.values, frames[index])
        return frames, eod

    def post_process(self):
        result = self.new_result(data_mode='value', time_mode='global')
```

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API & architecture

- streaming oriented core engine
- data persistence
- processing API
- plugin architecture
- namespace
- ~500 unit tests
- docker packaged (Linux, OSX, Windows)

```
import timeside.core
from timeside.core import get_processor
from timeside.core.tools.test_samples import samples

wavfile = samples['sweep.wav']
decoder  =  get_processor('file_decoder')(wavfile)
grapher  =  get_processor('spectrogram')()
analyzer =  get_processor('level')()
encoder  =  get_processor('vorbis_encoder')('sweep.ogg')

pipe = (decoder | grapher | analyzer | encoder)
pipe.run()

grapher.render(output='spectrogram.png')
print('Level:', analyzer.results)
Level: {'level.max': AnalyzerResult(...), 'level.rms': AnalyzerResult(...)}
```

```
$ git clone --recursive https://github.com/Parisson/TimeSide.git
$ docker-compose run app python3 manage.py shell
$ docker-compose up
```

https://timeside.readthedocs.io/en/latest/index.html

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Plugin examples

- FileDecoder, ArrayDecoder, LiveDecoder, AubioDecoder
- VorbisEncoder, WavEncoder, Mp3Encoder, FlacEncoder, OpusEncoder, etc.
- WaveformAnalyzer, SpectrogramAnalyzer
- AubioTemporal, AubioPitch, etc.
- Yaafe wrapper (graph oriented)
- librosa (function oriented)
- VampPyHost
- Essentia bridge
- ...

- Speech detection
- Music detection
- Singing voice detection
- Monophony / Polyphony
- Dissonance
- Timbre Toolbox

https://github.com/DIADEMS/timeside-diadems

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What's new?

0.9.4 > 1.0.0a (released yesterday! 🎉)

- 674 commits, 7 contributors
- Python 2.7 to 3.7
- Drop GStreamer for Aubio as default decoder and encoder
- Regroup all dependencies on pip requirements, drop conda
- Add `Provider` object
- Add Provider plugins `deezer-preview`, `deezer-complete` and `youtube`
- Add loggers
- Improve Docker packaging and image building

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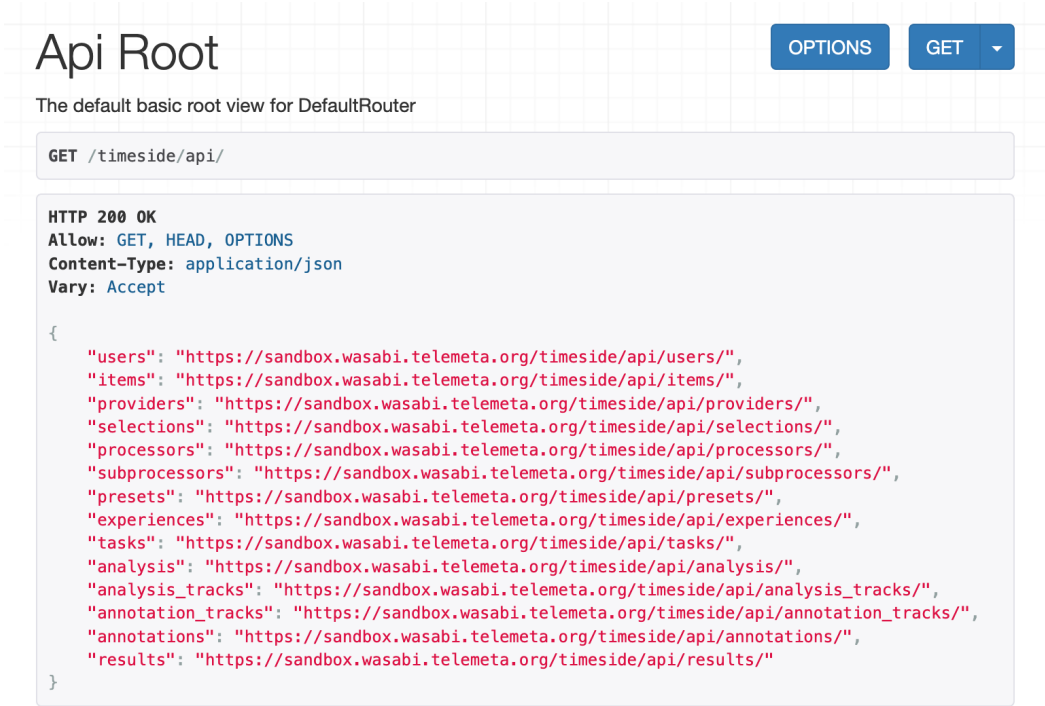
RESTful API built on TimeSide

☞ https://sandbox.wasabi.telemeta.org/timeside/api/

Use cases

- **Upload** audio tracks
- **Retrieve** audio tracks from remote providers
- **Stream** original or transcoded sources
- **Run** on-demand analysis
- **Customize** processors parameters
- **Collect** track's annotation to build audio corpora
- **Deliver** and share several types of results:
  - transcoded audio
  - serialized analysis as JSON or image
- **Export/import** an audio analysis dataset



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RESTful API built on TimeSide

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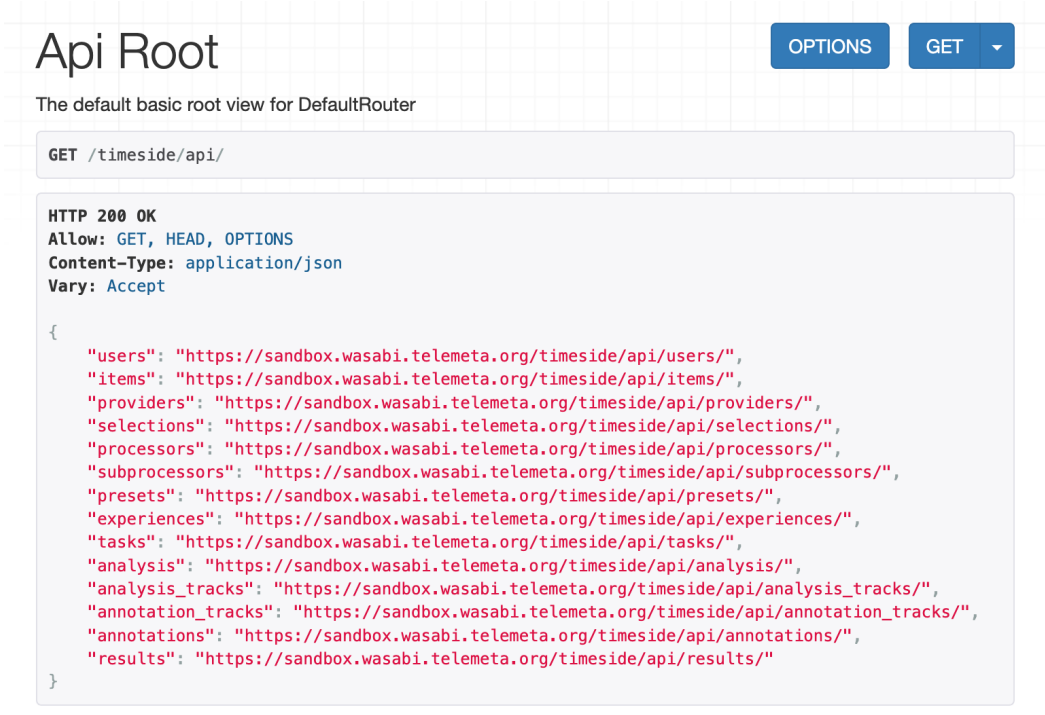
Server design

- Based on Django REST Framework (DRF)
- **Interoperability** between other servers or frontends and TimeSide instance and its data
- Object-relational **database** in order to store music tracks and processing results
- **Models**: define essential fields and behaviors of stored data
- **queue-worker architecture** enables to run tasks asynchronously



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RESTful API built on TimeSide

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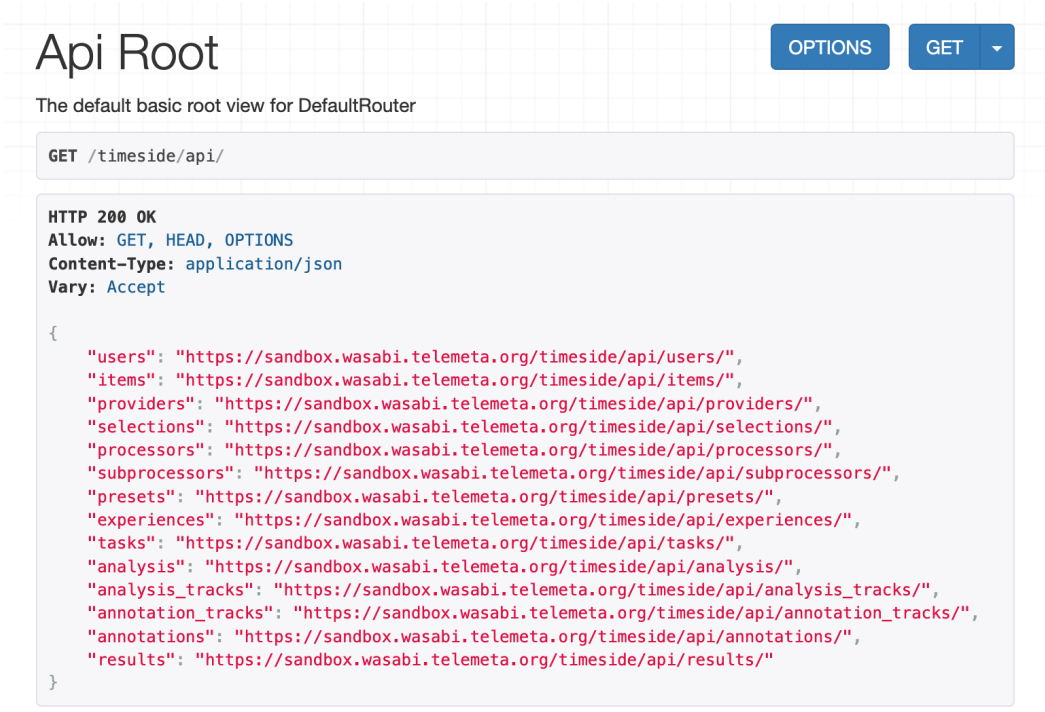
What's new on server?

- Add audio providers (Deezer, Youtube)
- Switch from MySQL to PostgreSQL
- Add a JWT authentication
- Make the API follow the OpenAPI specification
- Build a TypeScript SDK on the REST API
- Add several tools, views, models and serializers
- Improve server unit testing
- Fix few bugs
- Python, Django, DRF and Celery upgrades



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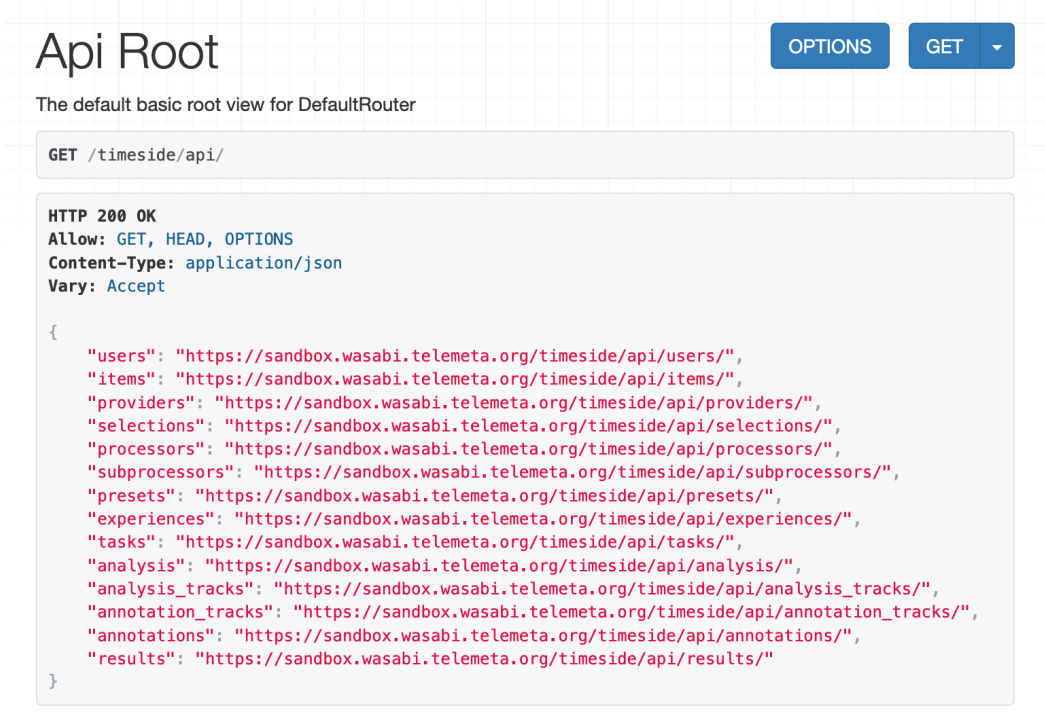
RESTful API built on TimeSide

☞ https://sandbox.wasabi.telemeta.org/timeside/api/

Models

- `Item`: audio content and metadata (external id)
- `Provider`: provide audio from a given plateform
- `Selection`: list of items (corpus)
- `Processor`: plugins with version and default parameters
- `Preset`: processor and a set of parameters
- `Experience`: list of presets forming a pipe (reproductible)
- `Task`: an experience and a selection
- `Result`: transcoded audio or numerical outputs (hdf5 file)
- `Annotation`: label audio file on a given time or segment



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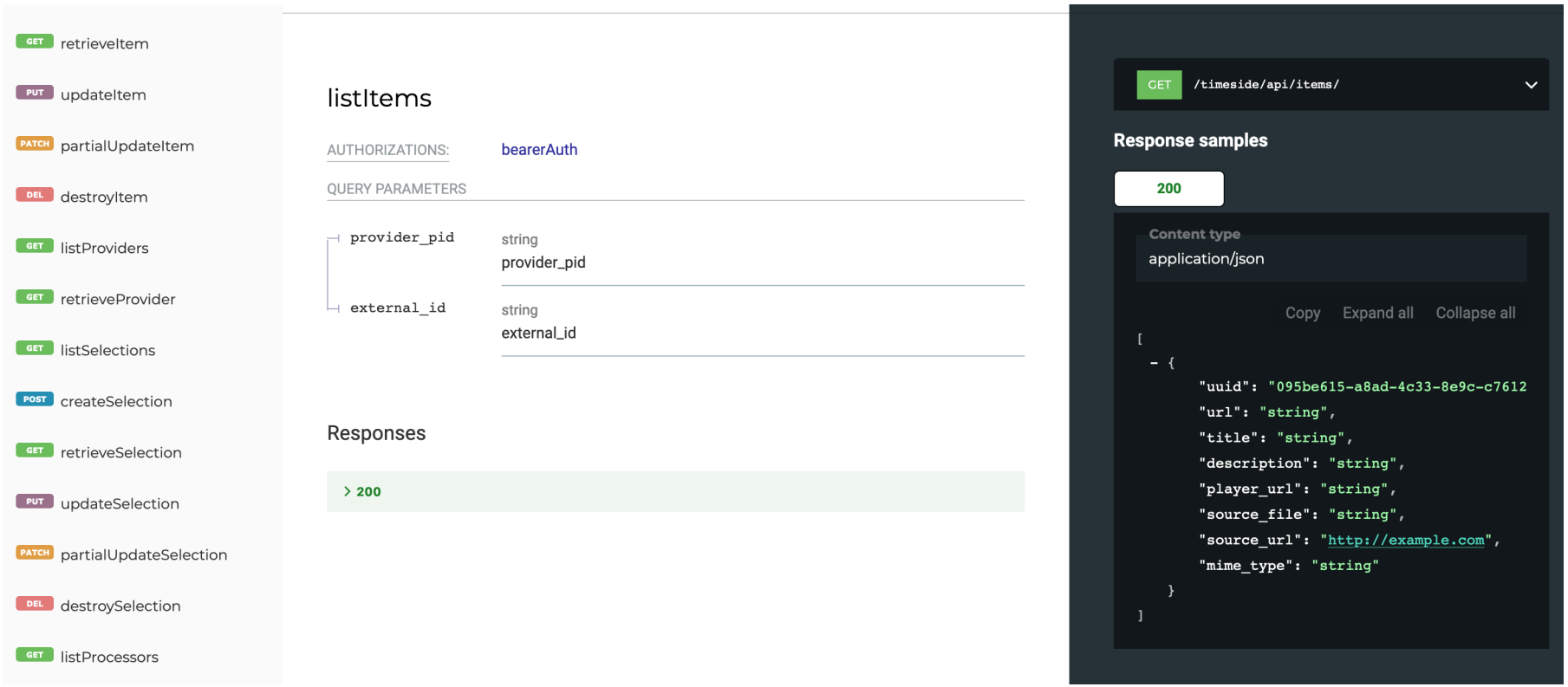
RESTful API documentation

auto-generated thanks to ReDoc on top of OpenAPI 👉 https://sandbox.wasabi.telemeta.org/timeside/api/docs/



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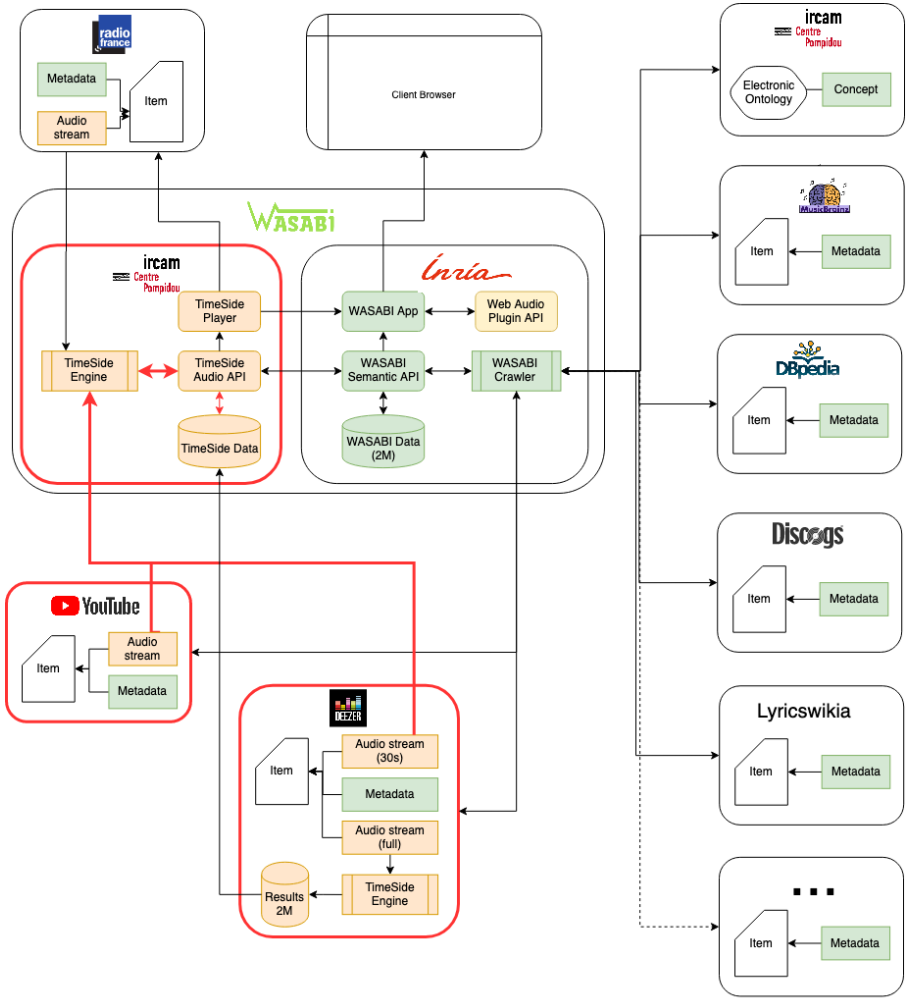
Workflow examples in WASABI Project

With providers

- Youtube
  - based on `youtube-dl`
  - must be adaptable to YouTube's changes
- Deezer 30 seconds long preview
  - consuming Deezer's API
  - find another solution to full contents



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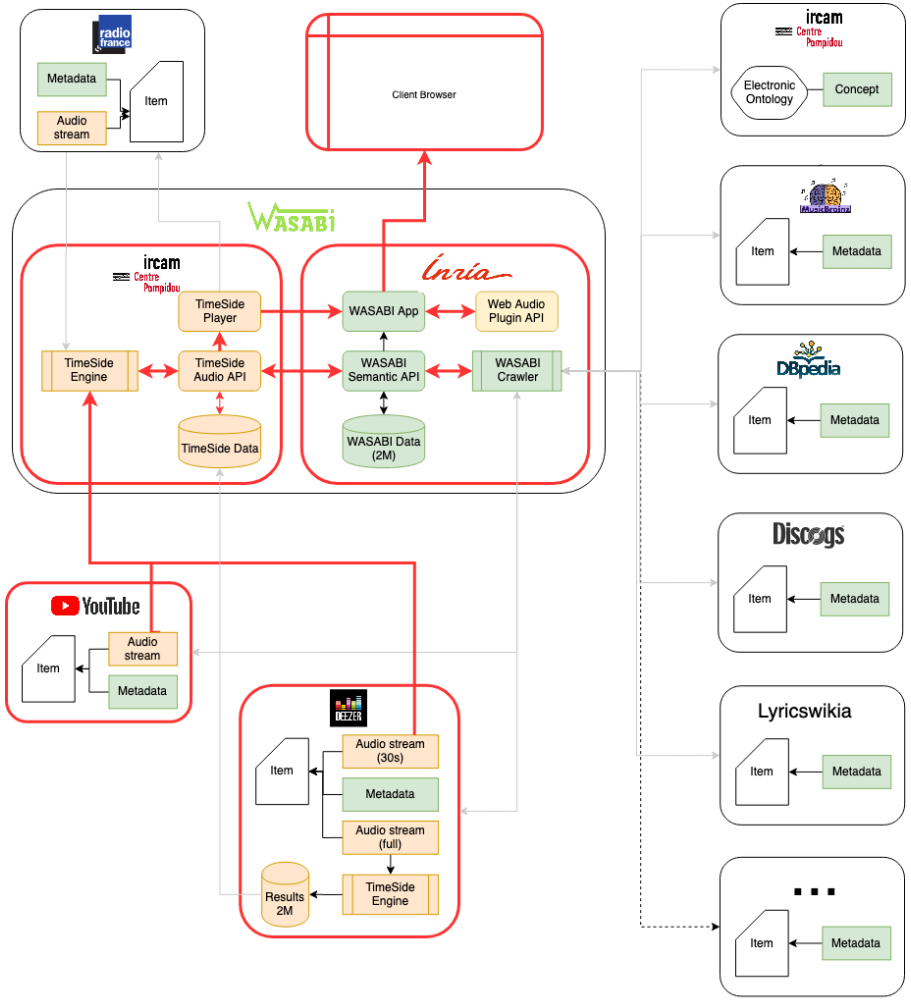
Workflow examples in WASABI Project

With server

POC of a webservice

- delivers audio analysis to another remote server
- enhance its musical metadata with results



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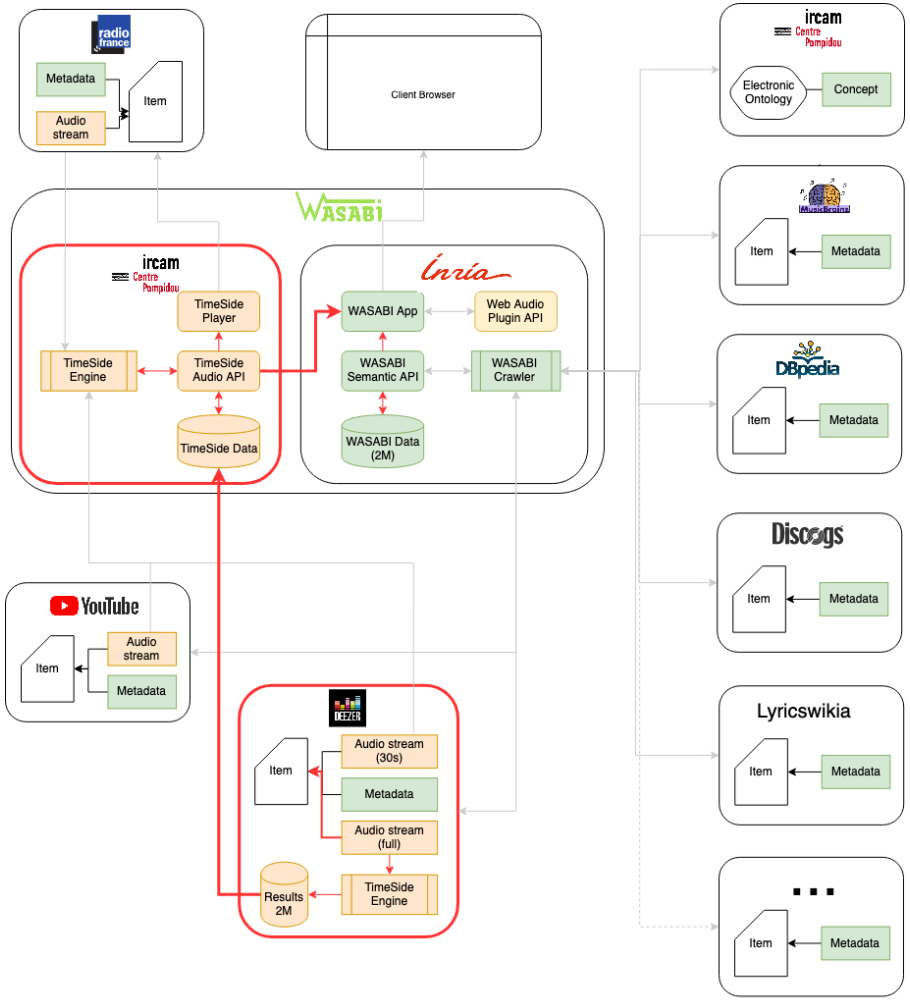
Workflow examples in WASABI Project

Import/export of a run on Deezer's infrastructure

POC of a sharing system of an audio analysis datasets

- easy deployment thanks to docker
- audio does not have to be shared



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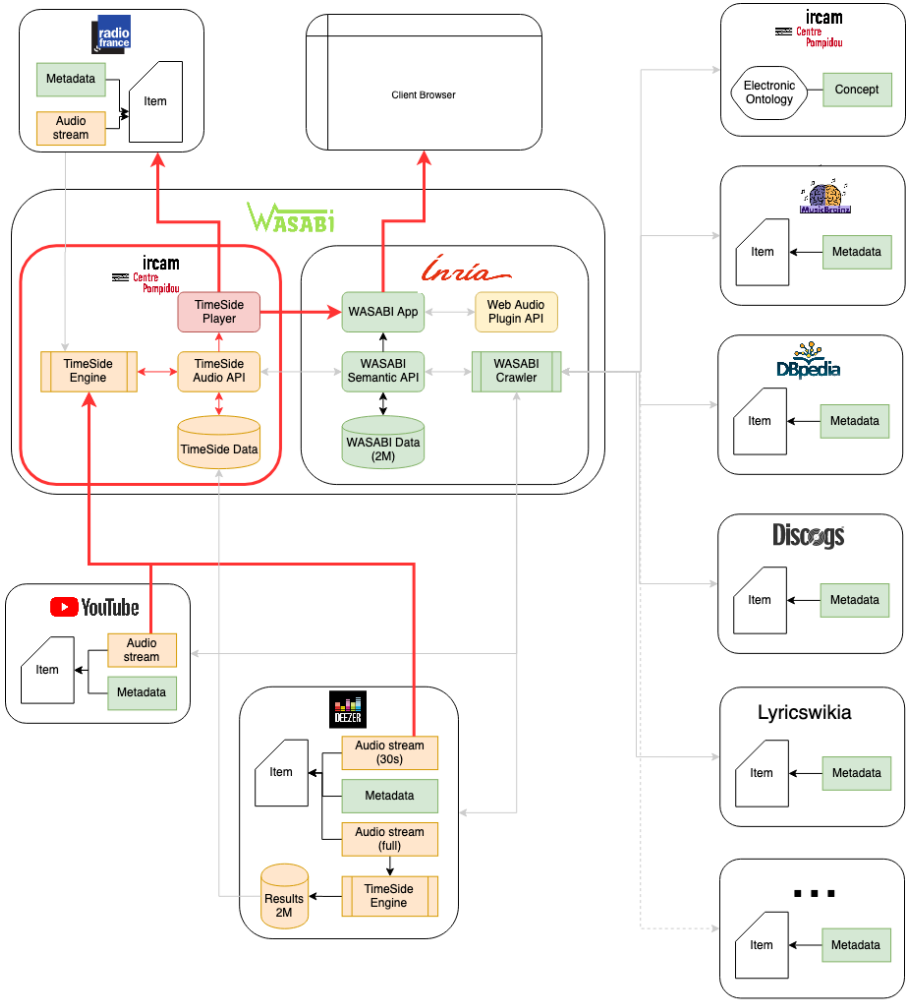
Workflow examples in WASABI Project

With a frontend player

POC of a JavaScript app that consume the Rest API

- serialize data as JSON or image
- deliver analysis track (spectrogram, waveform)
- deliver or get annotations on audio track



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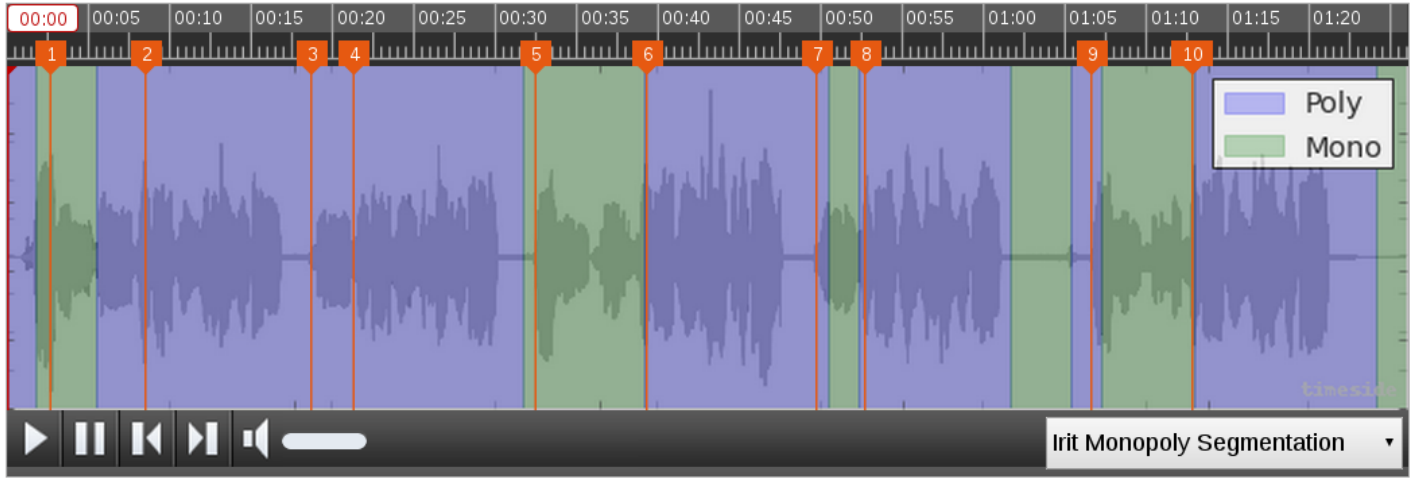
v1 (SoundManager2)

- on demand processing
- simple marker annotation
- bitmap image cache only



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v2

Constraints

- Handling multiple hours audio files
- Multiple user annotations and analysis tracks
- Analysis rendered on the frontend
- Zooming

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API SDK (client library)

- Timeside API: 75 routes
- openapi-generator
  - Typescript
  - Fetch
  - OpenAPI v3 Schemas
- Improve schema support on DRF (PR)
  - Components
  - Customize default names
- Glue code
  - Authentication
  - Initialization on Browser / Node
- Documentation

```
/timeside/api/analysis/:
  get:
    operationId: listAnalysis
    parameters: []
    responses:
      '200':
        content:
          application/json:
            schema:
              type: array
              items:
                $ref: '#/components/schemas/Analysis'
```

- SDK: https://github.com/Ircam-Web/timeside-sdk-js
- Node: https://github.com/Ircam-Web/timeside-scripts

Opportunity: `openapi-generator` also supports Python, C/C++, Ruby, Go, Rust etc...

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Player

🔧 Technologies

- Vue (composition-api): DOM Manipulation, Data reactivity
- D3 (SVG): Render waveform / Analysis
- HTML5 Audio
- Web Animations API
- Resize Observer
- Github Action for continuous test & deployment (npm, gh-page)
- Github: https://github.com/ircam-web/timeside-player

🚀 Usage

- Standalone app
- Web library
  - React
  - Vue
  - HTML

🌐 Tested on Firefox & Chrome

Demo time!

Perspectives

Audio processing web service (SaaS)

TODO

- Clustering and orchestration (Kubernetes, prototype ready)
- Implementing Websocket, ServerEvent or Webhook to avoid task status polling
- Parameters
- Scales
- Split repositories : core / server
- Test some JS MIR librairies
- More documentation, notebooks and tests

Use cases

- MIRchiving (Telemeta 2, CMS embedding, MNHN, UNAM, UNESCO)
- Digitization and media packaging services (VectraCom, VDM, Gecko)
- Metadata enhanced streaming services (Spotify, Deezer, SoundCloud, Netflix)

Dual licencing

- open source community release of the core framework (AGPL)
- proprietary (entreprise) release (SATT Lutech / Parisson / IRCAM Amplify)

Thank you and kudos to all contributors!

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