

Suggested measures for deploying IIF in Swiss cultural heritage institutions

Julien A. Raemy

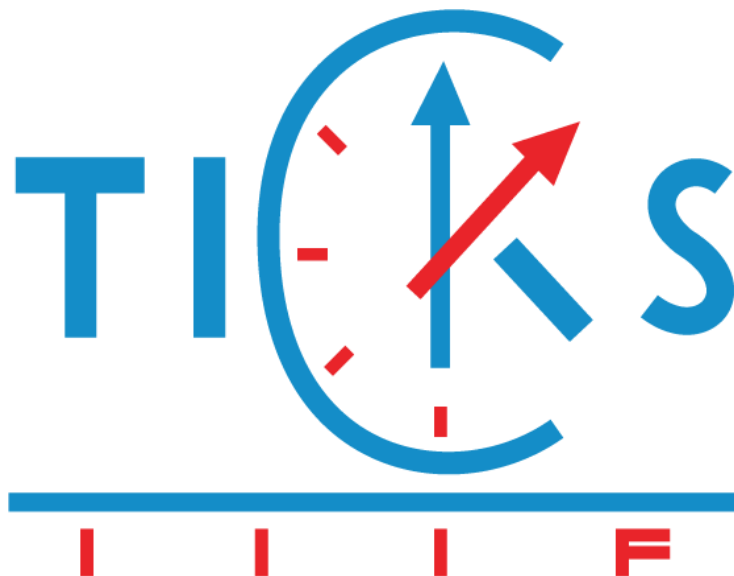
Research and Teaching Assistant in Information Science

 <https://orcid.org/0000-0002-4711-5759>

René Schneider

Full Professor of Information Science

 <https://orcid.org/0000-0003-4897-8561>



This white paper has been published as a component of the Towards IIF-Compliance Knowledge in Switzerland (TICKS) project funded by the Hasler Foundation and carried out at the Haute école de gestion de Genève (HEG-GE), which is part of the HES-SO University of Applied Sciences and Arts Western Switzerland

Acknowledgements

This white paper wouldn't have been realised without the financial support of the **Hasler Foundation** and the **Haute école de gestion de Genève**.

This white paper was largely inspired by works carried out by members of the wider **IIIF community**, especially **Jason Ronallo**, Head of Digital Library Initiatives at North Carolina State University Libraries, as well as **Sara Carlstead Brumfield** and **Ben Brumfield** from Brumfield Labs and both Founders of FromThePage.

Finally, this could not have been done without **a significant number of individuals**. Below are the people that the authors would like to thank for their time, guidance, advice, and who also helped us in reviewing this white paper (they are listed in alphabetical order):

- **William Duba**, Project Manager of Fragmentarium at the University of Fribourg
- **Josh Hadro**, IIIF Managing Director
- **Rebecca Hirsch**, Head of the Digital Services Unit at the Beinecke Rare Book and Manuscript Library, Yale University
- **Andy Irving**, Solutions Architect at the British Library
- **Antoine Isaac**, R&D Manager at Europeana
- **Jeffrey Ke**, Project Lead & Sales Engineer at Veridian
- **Mark A. Matienzo**, Assistant Director for Digital Strategy and Access at Stanford University Libraries
- **Glen Robson**, IIIF Technical Coordinator

We would also like to thank [Pierre-Henri Parisod](#) for designing the TICKS logo.

Note on interests

Julien A. Raemy is an active member of the IIF Community, notably as one of the co-chairs of the IIF Outreach Community Group since January 2018 and a community representative of the IIF Technical Review Committee since February 2019. He has also been a member of several Programme Committees organising some of the latest IIF main events.

Licence

This document is licenced under a Creative Commons Attribution 4.0 International licence (CC BY 4.0) <https://creativecommons.org/licenses/by/4.0/>



Suggested citation

Raemy, Julien A., & Schneider, René (2019). *Suggested Measures for Deploying IIF in Swiss cultural heritage institutions* (White paper). Geneva, Switzerland: HES-SO University of Applied Sciences and Arts Western Switzerland, Haute école de gestion de Genève. 29 May 2019. Retrieved from URL: <http://doi.org/10.5281/zenodo.2640416>

Google Docs short URL: <http://bit.ly/wpticks>

Change Log¹

Date	Description
2019-05-29	Version 1.0 – publication of the white paper on Zenodo (Friedrich Washbar)
2019-05-08	Version 0.9 – release of the white paper to the IIF community for revision purposes (unnamed)
2018-07-10	Version 0.1 – creation of the white paper on Google Docs (unnamed)

¹ The way this change log is done with the naming of stable versions is somewhat akin to the way the IIF APIs are carried out, see for yourself: <https://iif.io/api/presentation/2.1/#q-change-log>

Abstract

This white paper has been written as part of the Towards IIIF-Compliance Knowledge in Switzerland (TICKS) project, conducted at the Haute école de gestion de Genève (HEG-GE) between March 2018 and February 2019, which originated on the acknowledgements that the International Image Interoperability Framework (IIIF) ecosystem was not enough known and deployed in the cultural heritage field in Switzerland.

The white paper starts with the main principles of IIIF, notably indicating the different technical specifications, or application programming interfaces (APIs), produced by the IIIF community as well as the platforms of Swiss projects or institutions that have deployed IIIF. Going from general to specific, a generic IIIF step-by-step graph and six more precise use cases reflecting different needs of the GLAM (Galleries, Libraries, Archives, Museums) sector giving implementation measures have been produced.

Finally, the document contains recommendations for further action as well as some information on the possible reuse of this document for other regions of the world or for other scientific fields.

Table of Contents

Acknowledgements	2
Note on interests	3
Licence	3
Suggested citation	3
Change Log.....	3
Abstract.....	4
Table of Contents.....	5
List of Figures	6
List of abbreviations and acronyms	7
Introduction	8
The IIF ecosystem	11
What? - The technical aspects	11
The IIF APIs.....	11
IIF-compliant software and tools.....	13
Who?.....	14
When and where?	15
IIF-compliant resources from Swiss institutions.....	16
IIF step-by-step	20
Use cases and suggested measures.....	21
Use cases.....	21
Legend.....	22
UC1: A platform of digital surrogates wishing to comply with IIF	23
UC2: A researcher keen on creating her/his own IIF Manifests	25
UC3: Annotation capabilities to enrich digital resources	26
UC4: IIF at the heart of a rich navigation experience for newspapers	28
UC5: Access with control to digitised archival material	30
UC6: Dissemination of audio-visual resources through IIF	32
Further recommendations.....	34
Tips for small institutions.....	34
Discovering the IIF universe.....	34
Persistent identifiers (PIDs)	35
The IIF Cookbook	36
Future work and Conclusion	37
Bibliography	38

List of Figures

Figure 1: IIIF APIs in the client-server model	11
Figure 2: IIIF Client/Server Interaction	13
Figure 3: The IIIF community at large	14
Figure 4: e-codices	16
Figure 5: e-manuscripta	17
Figure 6: e-rara	17
Figure 7: e-newspaperarchives.ch	18
Figure 8: Fragmentarium	18
Figure 9: Bodmer Lab	19
Figure 10: Plume EPFL	19
Figure 11: IIIF step-by-step	20
Figure 12: De divina proportione's document details on e-codices	23
Figure 13: Dr. Lisa Fagin Davis' tweet	25
Figure 14: V&A Manifest Editor	26
Figure 15: Ocean Liners	27
Figure 16: NLW IIIF Fedora 3.3 Implementation	28
Figure 17: Login interaction pattern	30
Figure 18: Click through interaction pattern	31
Figure 19: British Library's overview of the end to end IIIF workflow	32

List of abbreviations and acronyms

API	Application programming interface
A/V	Audio-visual
DH	Digital Humanities
GLAM	Galleries, Libraries, Archives, Museums
HEG-GE	Haute école de gestion de Genève
HTTP(S)	Hypertext Transfer Protocol (Secure)
IIIF ²	The International Image Interoperability Framework
IIIF-C	The International Image Interoperability Framework Consortium
JSON-LD	JavaScript Object Notation for Linked Data
METS	The Metadata Encoding and Transmission Standard
MOU	Memorandum of Understanding
OAIS	Open Archival Information System
TICKS	Towards IIIF-Compliance Knowledge in Switzerland
URL	Uniform Resource Locator
URI	Uniform Resource Identifier
UX	User Experience
RDF	Resource Description Framework
TSG	Technical Specification Group

² IIIF is pronounced 'Triple-Eye-Eff'.

Introduction

The International Image Interoperability Framework (IIIF, pronounced ‘Triple-Eye-Eff’) defines a community-driven initiative created in 2011 by Stanford University, Oxford University and the British Library as well as a set of common application programming interfaces (APIs) serialised in JSON-LD (JavaScript Object Notation for Linked Data) to retrieve, display, manipulate, compare, and annotate digitised and born-digital images³ on the Web. Upon implementation, these technical specifications have offered institutions and end users alike new possibilities.

Organisations participating in the IIIF community consist mainly of research, national and state libraries, museums, cultural aggregators, software firms, and academic departments such as Digital Humanities (DH) centres. In Switzerland, only a handful of institutions and projects have collaborated with the IIIF Community. For instance, e-codices⁴, the Virtual Manuscript Library, was in December 2014 the first Swiss institution to implement the two core IIIF APIs (Image API and Presentation API) to make their collections fully interoperable.

Towards IIIF-Compliance Knowledge in Switzerland (TICKS) has been conceived to help Swiss institutions in implementing IIIF-conform solutions and exposing their digital collections in a more flexible, sustainable and interoperable manner through APIs.

TICKS, a one-year project⁵ which is coordinated at the Haute école de gestion de Genève (HEG-GE), wants to raise awareness and knowledge of IIIF, especially within Swiss institutions in the cultural heritage field - or respectively the GLAM (Galleries, Libraries, Archives, Museums) sector. The following three goals have been considered:

1. Improve uptake of IIIF in Switzerland
2. Enhance the accessibility and interoperability of digital collections throughout Swiss institutions, especially in the cultural heritage field
3. Provide tools and technical recipes with a view to aligning image-based content and their associated metadata to the IIIF APIs

If this white paper is intended to meet the third and last mentioned goal, it is not a full step-by-step IIIF guide, but rather an attempt to provide implementation approaches based on a variety of use cases.

³ Images are to be taken in the broadest sense as IIIF handles any image-based digital resources such as books, photographs, newspapers, manuscripts, scrolls, maps, music scores, artwork pieces, and even audio-visual (A/V) assets (thanks to the ongoing effort of the IIIF A/V Technical Specification Group and the release of the Presentation API 3.0).

⁴ e-codices: <https://www.e-codices.ch/>

⁵ TICKS has been carried out between March 2018 and February 2019.

Rationale

The IIF initiative started on the acknowledgement that delivery of images on the Web within the cultural heritage field was ‘too slow, too disjointed, too complex’ (Snydman, Sanderson, Cramer 2015, pp. 16–17) and decided to tackle these issues in a joint effort. Besides, developing shared APIs have also led to cost savings (Sanderson 2016).

Since its inception in 2011, IIF has become a global network and renowned organisations have joined the community. All potential adopters can benefit from the IIF ecosystem in terms of joining a thriving community, by streamlining their internal operations, and giving their end users the possibility to have access to interoperable collections as well as being able to manipulate, compare, and annotate these resources across the Web.

IIF reduces the friction around information access, it makes research and study easier, and lower the barrier to cross-collection research. Usability studies have also shown that both Mirador and the Universal Viewer, two widely-used and rich IIF-compliant image viewers, received excellent System Usability Scale (SUS) scores and offered a great user experience (UX) to test participants (Raemy 2017, pp. 60–61).

For Europeana, the EU digital platform for cultural heritage, it has even become a protocol which supports them in aggregating datasets from partners that comply with IIF, as compliance makes content easier to crawl (Haskiya 2017). Also, a survey conducted in 2017 estimated that around 335 million images, coming from more than 100 institutions, conformed to the IIF specifications (Warner 2017). Therefore, the IIF APIs have become de facto standards in image delivery for cultural heritage institutions on the Web.

However, too few GLAM institutions in Switzerland are aware of their existence and lack the necessary expertise to deploy a IIF-compliant infrastructure. It is vital to expand IIF knowledge by foraying into the Swiss cultural heritage field. Raising awareness has still a long road to go in this country as Swiss institutions often build their own solution - or silo - to deliver digital content on the Web by, for instance, depending on third-party suppliers.

As part of the TICKS project, an online survey was carried out to provide a (non-exhaustive) landscape review on the use and potential of IIF in Switzerland. It was conducted in three languages (French, German and English) from 13 March to 12 April 2018 and its structure was largely inspired by a similar survey conducted by Europeana in 2017. 52 participants from 45 institutions, mainly libraries and archives, responded⁶. The survey uncovered the following problems:

- Less than half of the survey participants knew what IIF was
- Swiss organisations don’t seem to understand the full potential of IIF
- Swiss organisations haven’t yet understood that IIF will be able to handle A/V resources in the near future through the release of the IIF Presentation API 3.0

It was noted as well that there was a kind of *Röstigraben* around IIF. French-speaking and Italian-speaking Switzerland seem to know IIF less well than German-speaking Switzerland. However, there were proportionately many more responses from the French part, which could constitute a bias. Institutions that implement IIF-compliant solutions in Switzerland collaborate to a limited extent with the IIF community. Swiss cultural and academic organisations often do not ask for help and rarely

⁶ Information and survey data can be downloaded here:
https://campus.hesge.ch/id_bilingue/projekte/ticks/survey_fr.asp

share their feedback. For example, they do not communicate to the IIF community if or when their resources become compliant with their APIs, which undermines true interoperability (Raemy 2018). Based on discussions with the IIF community⁷, adopters and institutions interested in implementing their standards have pointed out some shortfalls to easily deploy IIF:

- Existing workshops don't really give recommendations on which IIF-compliant software to select from.
- The quick start guide that IIF provides is not sufficient⁸.

These are the reasons why this white paper has been specially designed to provide a series of practical measures to Swiss organisations to implement IIF.

Each measure to deploy a IIF-compliant solution is presented in the same way throughout this document:

- A use case linked to one of the target audiences (GLAMs, DH projects, scholars)
- A corresponding success story
- A set of recommendations providing a selection of tools and software to implement
- Some useful links to go more deeply into the process

Lastly, it was finally decided to publish this white paper in English because Switzerland is a multilingual country and the information contained therein may be of interest beyond national borders.



Although this white paper gives recommendations on which IIF-compliant software or recipes to deploy, it is neither an introduction to IIF nor a hands-on workshop. Nevertheless, useful links to material such as introductions and tutorials appear throughout this document in a frame and accompanied by a IIF logo as for this paragraph.

⁷ On their Slack channel, on the IIF-Discuss Google Group or via teleconference calls. Further information can be found on <https://iif.io/community/>.

⁸ The information on the IIF Technical Details webpage (<https://iif.io/technical-details/>) has been improved since the publication of this white paper.

The IIIF ecosystem

What, who, where and when?

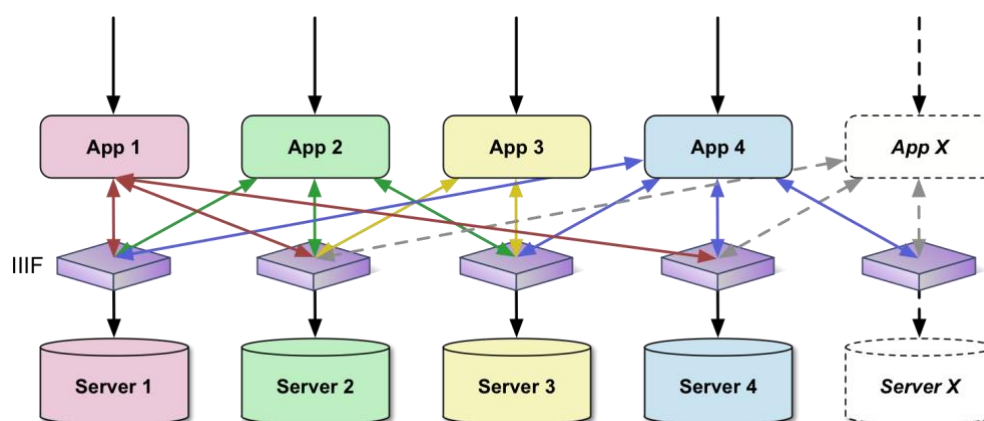
What? - The technical aspects

The IIIF editors are responsible for writing and maintaining the APIs, the annexed documentation (such as the cookbook and notes on specific parts of the specifications) and the Image and Presentation APIs validators. Software and tools have been adapted or built anew by the wider IIIF community (institutions and individuals working closely with IIIF) and vendors to implement the IIIF specifications. These two technical aspects are described below

The IIIF APIs

As depicted in Figure 1, a IIIF API works as an intermediate layer interacting between clients and servers that are IIIF-compliant.

Figure 1: IIIF APIs in the client-server model



(Sanderson 2016)

At the moment, four RESTful APIs serialised in JSON-LD⁹ have been defined and vetted by the IIIF community to provide a consistent way for accessing images and their associated metadata: Image API, Presentation API, Content Search API, and Authentication API. Each API is ‘useful on their own, but more powerful when combined’ (Brumfield Labs 2017). The current IIIF specifications are contained in the table below.

IIIF APIs	Short description and permalink
Image API	Specifies a web service that returns an image in response to a standard HTTP or HTTPS request. The canonical URI can specify the region, size, rotation, quality characteristics and format of the requested image ¹⁰ . The information is encoded in an “info.json” file. Permalink: https://iiif.io/api/image

⁹ JSON-LD is a JSON serialisation pattern for RDF (Resource Description Framework). Further information can be found on <https://json-ld.org/> and <https://iiif.io/api/annex/notes/jsonld/>.

¹⁰ The Image Request URI syntax has the following structure:
{scheme}://{server}/{prefix}/{identifier}/{region}/{size}/{rotation}/{quality}.{format}

	<p>Latest stable version: 2.1.1 Draft specification: 3.0</p>
Presentation API	<p>Provides the information necessary to allow a rich, online viewing environment for primarily image-based objects to be presented to a human user, likely in conjunction with the IIIF Image API. A digital object conform to the Presentation API is called a “IIIF Manifest” and is described within a file called “manifest.json” (this part isn’t necessarily a requirement though).</p> <p>Permalink: https://iiif.io/api/presentation/ Latest stable version: 2.1.1 Draft specification: 3.0 (Integration of audio and video resources)</p>
Content Search API	<p>Gives access and interoperability mechanisms for searching within the textual annotations of a digital object, such as full-text transcription or Optical Character Recognition (OCR).</p> <p>Permalink: https://iiif.io/api/search/ Latest stable version: 1.0</p>
Authentication API	<p>Allows IIIF to be used for access-restricted resources. It supports access based on different credentials and acts as a layer on top of existing authentication infrastructures.</p> <p>Permalink: https://iiif.io/api/auth/ Latest stable version: 1.0</p>

Additional IIIF APIs are in development:

- Change Discovery API (currently 0.3)¹¹: facilitate crawling to build search indexes
- Content State Transfer API (currently 0.2)¹²: Allow description of state of content, to send between systems, as appropriate to user needs (e.g. search results to a IIIF-compliant viewer)



Jason Ronallo’s IIIF Workshop: <http://ronallo.com/iiif-workshop-new/>
Presentation API Validator: <https://iiif.io/api/presentation/validator/service/>
Image API Validator: <https://iiif.io/api/image/validator/>

¹¹ IIIF Change Discovery API: <https://iiif.io/api/discovery/0.3/>

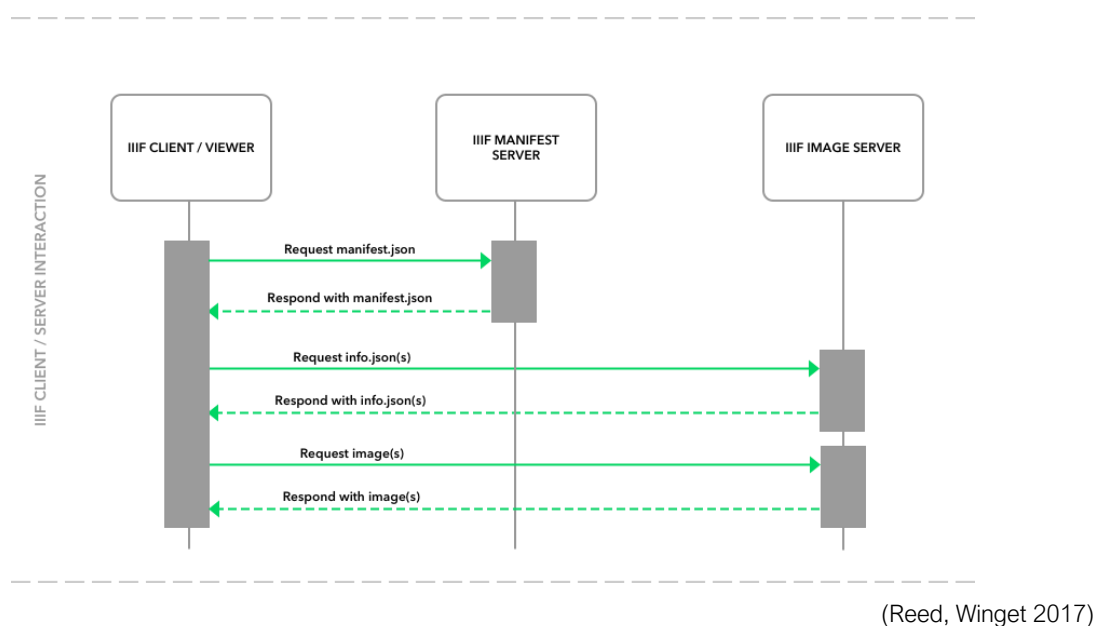
¹² IIIF Content State Transfer API: <https://preview.iiif.io/api/content-state-0.3/api/content-state/0.2/>

IIIF-compliant software and tools

The most common IIIF-compliant software are image and manifest servers as well as image and presentation clients/viewers. A typical IIIF Client/Server interaction (cf. Figure 2) can be broken down in the following three steps (Reed, Winget 2017):

1. The client wants to display a IIIF Manifest of n images and requests the manifest.json from the server.
2. The client parses the manifest.json and requests from the server each info.json related to the images that it wants to display.
3. Finally, the client requests the images and the server responds accordingly.

Figure 2: IIIF Client/Server Interaction



IIIF-compatible software are linked to one or more IIIF APIs (usually the Image and/or the Presentation APIs, which are the core APIs). The two following clients (Universal Viewer and Mirador) are the most popular user interfaces used by the IIIF Community. More information can be found in the links below.

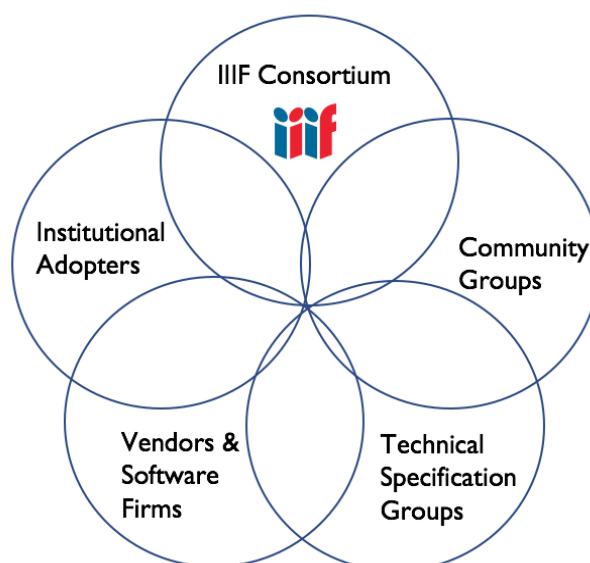
Universal Viewer: <http://universalviewer.io/>

Mirador: <https://projectmirador.org/>

Awesome IIIF: <https://github.com/IIIF/awesome-iiif>

Who?

Figure 3: The IIF community at large



(Rabun, Robson 2017)

As represented on the Figure 3 above, five main entities can be distinguished within the IIF Community landscape:

1. [The IIF Consortium](#) (IIF-C), created in June 2015 to sustain and steer the IIF initiative. IIF-C is currently composed of 53 institutions (Founding and Associate Members) who have signed a Memorandum of Understanding (MOU). IIF currently employs two staff members: The Managing Director and the Technical Coordinator. Since the beginning of 2019, there has also been a Technical Review Committee (TRC) which is *representative of the consortium and the community. Its primary function is to review and ratify or reject proposals to solve technical issues, in an ongoing fashion.*¹³
2. [Community Groups](#): 3D, Archives, Manuscripts, Museum, Newspapers, Outreach, and Software Developers
3. [Technical Specification Groups](#) (TSGs): A/V, Discovery, and Text Granularity. The IIF TSGs are engaged to work on specific goals in relation to the APIs.
4. Vendors and Software Firms (which can also be part of the IIF-C)
5. [Institutional Adopers](#) which are mainly composed of organisations from the cultural heritage sector as well as universities.

¹³Technical Review Committee: <https://iif.io/community/trc/>

When and where?

The first letter of "IIIF" corresponds to "international" and even if there is still at the moment a predominance of organizations from North America and Western Europe, the actors involved in this initiative are global. Events are organized by the various institutions of the cultural and scientific world around the world. Each interest group organises its own calls at regular intervals. It is also worth noting that IIIF organises two major events per year: a conference in the spring and a working meeting in the autumn. In general, if the conference is held in North America for a given year, the working meeting is carried out in Europe, and vice versa.

Communications generally take place via their Slack channel, on the "IIIF-Discuss" mailing list and on Twitter. Quarterly newsletters are released as well on the IIIF website. The management of issues (technical and community-related use-cases) and the maintenance of the APIs and the website is carried out through GitHub.



IIIF Website: <https://iiif.io/>
IIIF Events: <https://iiif.io/event/>
IIIF Call Calendar: <https://iiif.io/community/groups/#iiif-call-calendar>
IIIF Slack Channel: <http://bit.ly/iiif-slack>
IIIF-Discuss mailing list: <https://groups.google.com/forum/#!forum/iiif-discuss>
IIIF News and Announcements: <https://iiif.io/news>
Twitter: [@iiif_io](#) [#iiif](#)
GitHub: <https://github.com/iiif>

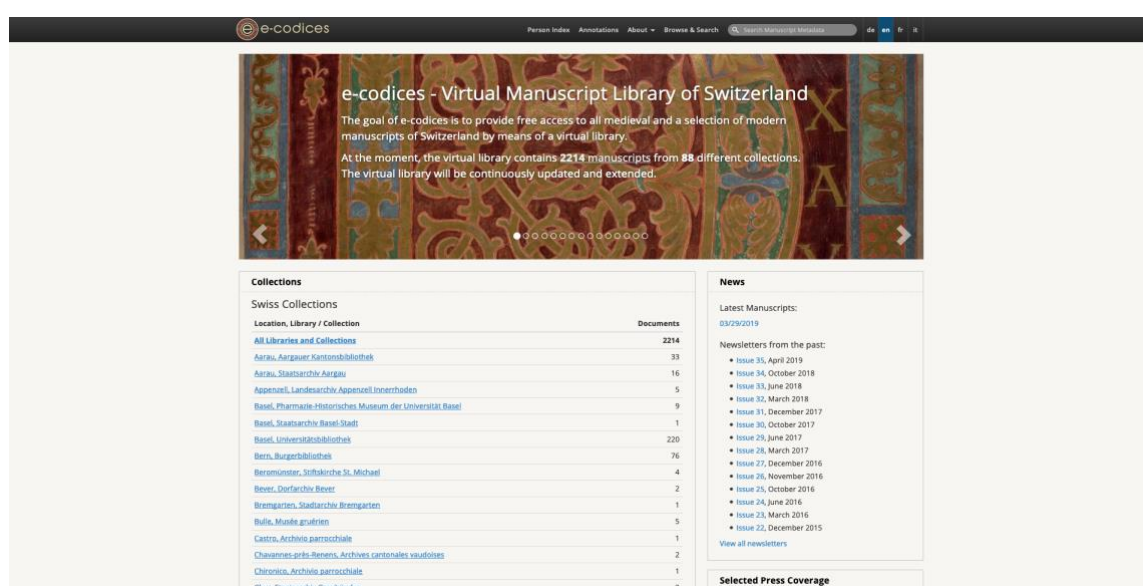
IIIF-compliant resources from Swiss institutions

In this section are (to our knowledge) the systems that have complied with IIIF in recent years. It should be noted that in July 2017, only e-codices had implemented the Image and the Presentation APIs (Raemy 2017). Since then, numerous other groups have adopted IIIF. Indeed, over the course of the TICKS project, IIIF usage has increased dramatically.

Presentation and Image APIs

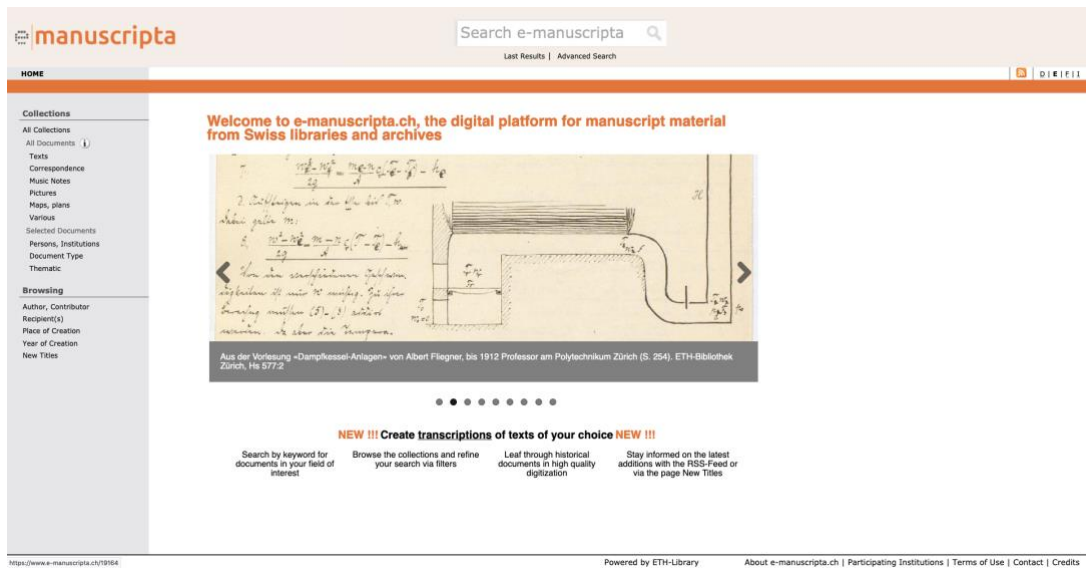
There are currently eight Swiss platforms (or coordinated from Switzerland) that have implemented the two core APIs of IIIF. Some of these collections, however, are only partially IIIF-compliant though. For instance, e-newspapersarchives.ch only displays IIIF manifests for public domain titles, but this could change in the near future.

Figure 4: e-codices



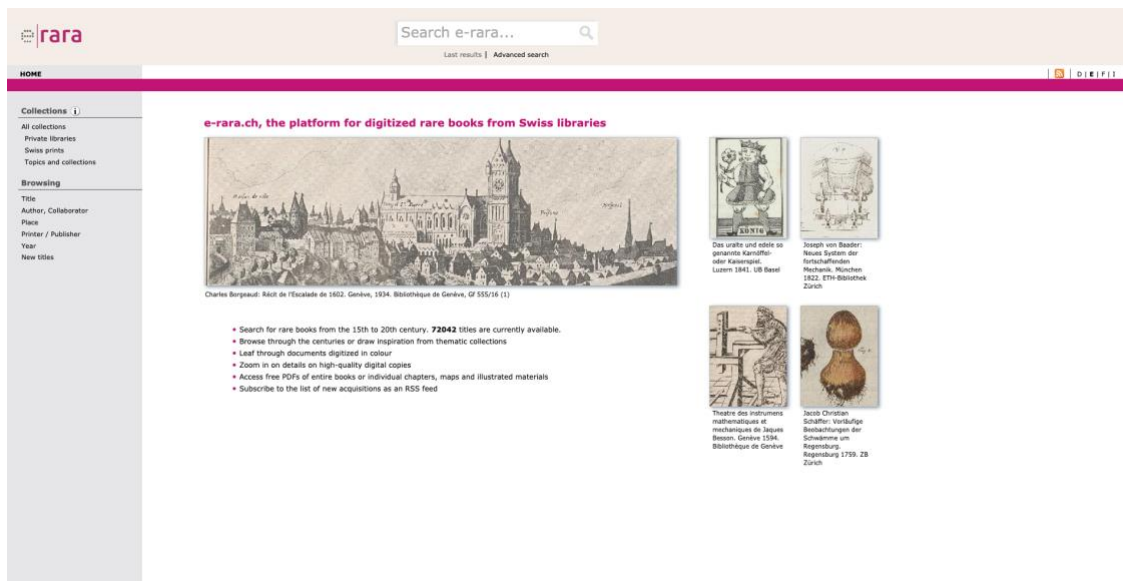
Virtual Manuscript Library of Switzerland - <https://e-codices.ch/>
2214 IIIF Manifests
Top-Level Collection: <https://www.e-codices.ch/metadata/iiif/collection.json>

Figure 5: e-manuscripta



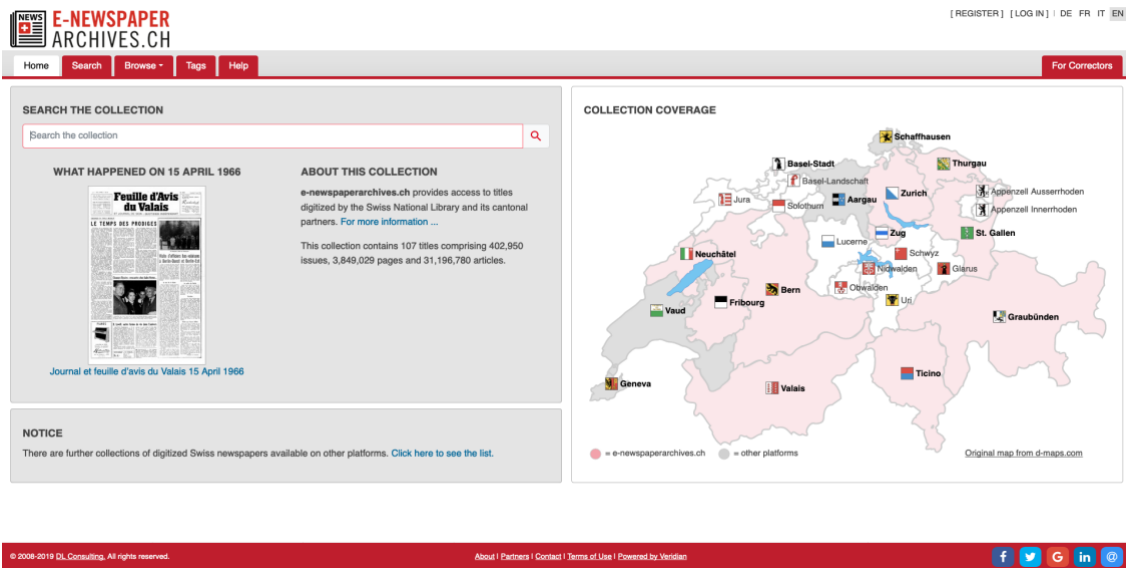
The digital platform for manuscript material from Swiss libraries and archives - <https://www.e-manuscripta.ch/>
More than 75'000 IIF Manifests
Top-Level Collection: <https://www.e-manuscripta.ch/i3f/v21/collection/top>

Figure 6: e-rara



The platform for digitized rare books from Swiss libraries - <https://www.e-rara.ch/>
More than 72'000 IIF Manifests
Top-Level Collection: <https://www.e-rara.ch/i3f/v21/collection/top>

Figure 7: e-newspaperarchives.ch



Collections of digitized Swiss newspapers - <https://www.e-newspaperarchives.ch/>
32 public domain titles (IIIF Collections) comprising 280'000 IIIF Manifests

Figure 8: Fragmentarium



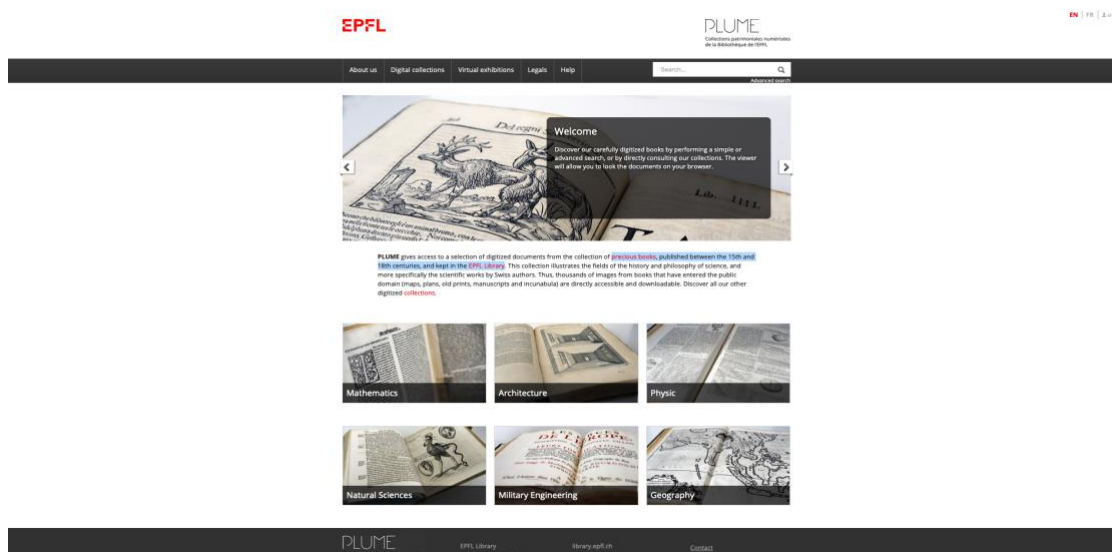
Digital Research Laboratory for Medieval Manuscript Fragments - <https://fragmentarium.ms/>
(Fragmentarium is an international initiative coordinated at the University of Fribourg)
852 IIIF Manifests
Top-Level Collection: <https://fragmentarium.ms/metadata/iiif/collection.json>

Figure 9: Bodmer Lab



Une bibliothèque numérique de la littérature mondiale (project coordinated by the University of Geneva - collections from the Bodmer Foundation) - <https://bodmerlab.unige.ch/>
More than 800 IIF Manifests (manuscripts and printed books)

Figure 10: Plume EPFL



Collections patrimoniales numérisées de la Bibliothèque de l'EPFL (precious books, published between the 15th and 18th centuries, and kept in the EPFL Library) - <https://plume.epfl.ch/>
68 IIF Manifests (in the future about 600 digitised books will be available on the platform)

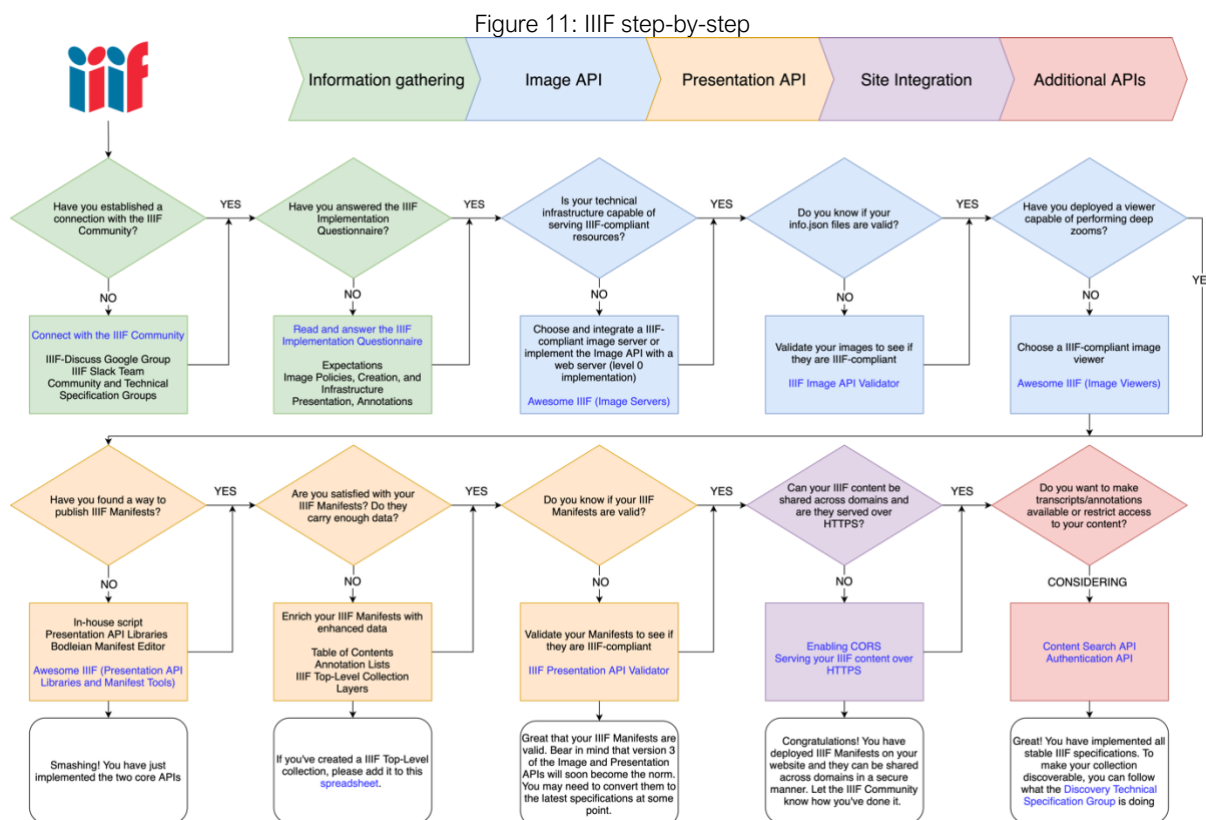
Image API

It is also worth mentioning two websites that have implemented the Image API:

- Bibliothèque numérique du Musée de l'Elysée - <https://photobookselysee.ch/>
- Les Archives du journal Le Temps - <https://www.letempsarchives.ch/>

IIIF step-by-step

The diagram below¹⁴ (cf. Figure 11) has been produced with the help of information contained on the IIIF website¹⁵ and the IIIF Implementation Guide (Brumfield Labs 2017). This gives a generic approach for institutions and projects that want to implement IIIF.



Questions from Jason Ronallo's workshop:

- Who are the users for our image resources?
- What different kinds of users do we have?
- How do users want to be able to use our image resources?
- What kinds of users and uses would we like to serve better?
- How might IIIF enable these uses?

A process flowchart created by Biblissima that goes from JPEG 2000 files to the choice of a IIIF-Compliant viewer : [https://doc.biblissima-fr/sites/doc.biblissima-condorcet.fr/files/iiif/viewers.pdf](https://doc.biblissima.fr/sites/doc.biblissima-condorcet.fr/files/iiif/viewers.pdf)

¹⁴ The step-by-step graph can be downloaded in a higher resolution and in different formats (PNG, SVG, PDF) on the Zenodo repository.

¹⁵ Especially <https://iiif.io/technical-details/>

Use cases and suggested measures

To whom and how?

This white paper has been conceived for those who have just implemented IIIF or wish to do so in the near future. The target audiences may be comprised between one or more of these three different tiers:

- at an institutional level (GLAM-oriented in our examples)
- at a project level (usually related to DH)
- at an individual level (in our case for researchers and students)

Use cases






The following six examples have been selected as use cases and each time a corresponding success story is highlighted.

1. A platform specialised in the description and dissemination of images of ancient books and manuscripts seeking to adapt to IIIF specifications.²³
2. A researcher wanting to create her/his own IIIF manifests with images from various institutions (and publish them on her/his own website).
3. A museum seeking to deploy a IIIF-compliant annotation server to enable their end-users to have a richer experience.
4. A newspaper project seeking to disseminate its journals by allowing users to navigate by publication date or issue number directly on a IIIF-compliant viewer.
5. An archive that needs to publish its digitized resources in accordance with the classification of the collection while restricting access to sensitive resources.
6. A platform mainly dedicated to the diffusion of audio-visual materials showing interest in the IIIF Presentation API 3.0.

The success stories come from organizations and projects that have already deployed IIIF or on the basis of advice from individuals in the field.

Legend

Below is a legend of the icons used to delimit the elements within each use case. The icons come from the IIF website, in particular those used in the homepage (<https://iif.io/>), the Community webpage (<https://iif.io/community/>) and the Technical Details webpage (<https://iif.io/technical-details/>), and have been adapted slightly to the needs of this white paper.

	Context Background Tier Implementation effort APIs to implement
	Success story
	Recommendations
	Useful links
	IIF point of contact such as one of the IIF Community or Technical Specification Groups

It should be noted that the recommendations made in one case study do not exclude those made in another. Some information contained in different use cases may also be complementary.

UC1: A platform of digital surrogates wishing to comply with IIIF

A platform specialised in the description and dissemination of images of ancient books and manuscripts seeking to adapt to IIIF specifications.



Background: They already have high-quality digitized images and want now to comply with the IIIF APIs.

Tier: Institutional or project level

Implementation effort: easy to moderate

APIs to implement: Presentation and Image APIs (2.x or 3.x)

e-codices, the virtual manuscript library of Switzerland, who was the first platform in the world to comply with the two core APIs (Image and Presentation APIs 2.0) in December 2014. The platform uses Loris, OpenSeadragon, Mirador and serves JP2 images - technical information about the e-codices infrastructure can be found here: <https://www.e-codices.ch/en/about/webapplication>



Rafael Schwemmer (text&bytes) about the way they create IIIF Manifest for e-codices:

'I pull all the data from the relational database and create the manifest for each manuscript on the fly. Once it has been created, it is cached until something changes in the database, at which point I delete the cached manifest and it gets recreated on the fly the next time it is requested. The code for this is written in PHP. I basically create *deeply* nested PHP arrays and then use json_encode at the end to generate the JSON.'

The Figure 12 below is an example of how the metadata of a digital surrogate (Genève, Bibliothèque de Genève, Ms. I.e. 210: Luca Pacioli, De divina proportione, <http://dx.doi.org/10.5076/e-codices-bge-le0210>) is displayed on e-codices.

Figure 12: De divina proportione's document details on e-codices

The screenshot shows the e-codices interface for the manuscript 'Genève, Bibliothèque de Genève, Ms. I.e. 210'. The main content area is divided into two columns. On the left, there is a facsimile image of a manuscript page featuring a complex geometric diagram of a dodecahedron with various lines and labels. On the right, the 'Document Details' tab is active, displaying a list of metadata fields and their values. Below the details, there are 'Reference Images and Binding' showing the front and back covers of the manuscript. The interface includes navigation controls at the top, such as search results and page indicators.

Field	Value
Country of Location:	Switzerland
Location:	Genève
Library / Collection:	Bibliothèque de Genève
Shelfmark:	Ms. I.e. 210
Manuscript Title:	Luca Pacioli, De divina proportione
Caption:	Parchment · V + 130 + V ff. · 28.5/28.8 x 20/20.3 cm · Milan · 1498
Language:	Italian, Latin, Ancient Greek
Manuscript Summary:	The <i>De Divina Proportione</i> is a mathematical treatise by the Franciscan friar Luca Pacioli (1445-1517). The Italian text is followed by sixty polyhedra, drawn filled or empty, and influenced by Leonardo da Vinci. Of the three copies written during the author's lifetime, only two remain. This copy, held by the Bibliothèque de Genève, is the presentation copy of the Duke of Milan, Ludovico Sforza, whose coat of arms and motto adorn the manuscript (fol. <i>lr</i> and <i>LXIV</i>). (<i>hoc</i>)
Standard description:	Isabelle Jeger, dans <i>Antologia della Divina Proporzione di Luca Pacioli</i> , 2010, pp. 31-35 - rédigé et complété par Brigitte Roux, e-codices, 2019. Show standard description
DOI (Digital Object Identifier):	10.5076/e-codices-bge-le0210 (http://dx.doi.org/10.5076/e-codices-bge-le0210)
Permanent link:	https://www.e-codices.ch/en/list/one/bge/le0210
IIIF Manifest URL:	https://www.e-codices.ch/metadata/iiif/bge-le0210/manifest.json
How to quote:	Genève, Bibliothèque de Genève, Ms. I.e. 210: Luca Pacioli, De divina proportione (https://www.e-codices.ch/en/list/one/bge/le0210).
Online Since:	02/27/2019
Rights:	Images: (Concerning all other rights see each manuscript description and our Terms of use)



- Find the best solution in terms of image formats (JPEG2000 vs TIFF) and a library to encode and decode images (i.e. Kakadu, OpenJPEG) depending on the deployed server and the available funds. If money is not a problem and system performance is a priority: choose JPEG2000 as image format and get a Kakadu licence.
- Create Manifests from one or more data sources
- Choose the best way to display descriptive metadata alongside a cover image of the digital surrogate or a basic IIIF-compliant viewer (OpenSeaDragon or Leaflet-IIIF)
- Display the IIIF Manifest URL and provide some information on how people should use this logo
- Provide additional description of your digital surrogates such as TEI/XML if available
- Deploy a Mirador as a presentation viewer and provide some information on how the Manifests can be displayed and used in this interface



- Kakadu: <http://kakadusoftware.com/>
- Loris Image Server: <https://github.com/loris-imageserver/loris>
- Metadata transformation from METS files: <https://github.com/jbaiter/demetsiiify>
- Mirador (GitHub): <https://github.com/ProjectMirador/mirador>
- OpenJPEG: <http://www.openjpeg.org/>
- OpenSeaDragon: <https://openseadragon.github.io/>



Manuscripts - <https://iiif.io/community/groups/manuscripts/>

UC2: A researcher keen on creating her/his own IIIF Manifests



A researcher wanting to create her/his own IIIF manifests with images from various institutions (and publish them on her/his own website).

Background: IIIF-compliant resources and the researcher's own images

Tier: individual level

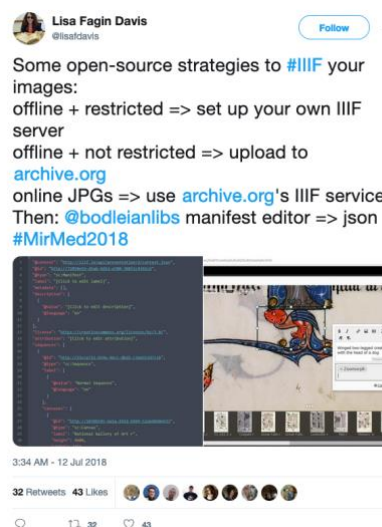
Implementation effort: easy to moderate

APIs to implement: none



This use case is based on a July 2018 tweet written by **Dr. Lisa Fagin Davis** (Cambridge, MA), Executive Director of the Medieval Academy of America and member of the Fragmentarium Editorial Board. Dr. Davis has been regularly giving IIIF workshops to her students and peers in her scientific field. In her tweet, she suggests three types of strategies for people wishing to publish their own IIIF Manifests.

Figure 13: Dr. Lisa Fagin Davis' tweet



<https://twitter.com/lisafdavis/status/1017356422013648896>



- Offline + restricted images : set up your own IIIF-compliant server
- Offline + not restricted images: upload to Internet Archive
- Online images: use Internet Archive's IIIF service and the Bodleian's IIIF Manifest Editor



- Upload an image to the Internet Archive: <https://archive.org/create/>
- Creating a IIIF Manifest: https://iiif.github.io/training/intro-to-iiif/IIIF_MANIFESTS.html
- Bodleian's IIIF Manifest Editor: <https://digital.bodleian.ox.ac.uk/manifest-editor/>
- IIIF Manifest Editor's user manual: <https://github.com/bodleian/iiif-manifest-editor/wiki/User-Manual>
- Creating a Gist that returns JSON: <https://gist.github.com/>



Outreach - <https://iiif.io/community/groups/outreach/>

UC3: Annotation capabilities to enrich digital resources



A museum seeking to deploy a IIIF-compliant annotation server to enable their end-users to have a richer experience.

Tier: Institutional level
Implementation effort: moderate
APIs to implement: Image, Presentation, (Content Search)



In collaboration with **Digirati**, the **Victoria & Albert (V&A) Museum** has deployed storytelling web pages through Annotations and IIIF.

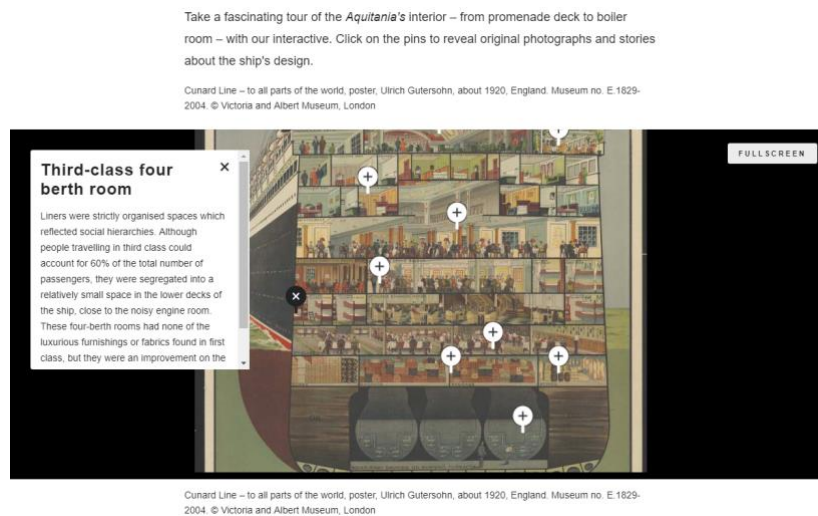
For this purpose, Digirati has designed a Manifest Editor that overrides some of the names of IIIF model elements¹⁶ (cf. Figure 14) that is able to create manifests for multiple images along with annotations (and additional properties). The generated manifest can then be used to display as a slideshow on the responsive website to give a richer experience to the end-user (cf. Figure 15).

Figure 14: V&A Manifest Editor



¹⁶ Tom Crane, Reaching into collections to tell stories: <https://medium.com/digirati-ch/reaching-into-collections-to-tell-stories-3dc32a1772af>

Figure 15: Ocean Liners



If you want to do it in-house:

- Deploy a IIIF Annotation Server such as the Simple Annotation Server or Elucidate
- Use Mirador to create own annotations
- Use the Universal Viewer to display and search the annotations or customise a web page with embedded annotations and parts of images for storytelling purposes



If you want to create Annotations and IIIF with expert companies:

- Cogapp - <http://storiiies.cogapp.com/>
- Digirati - <https://annotation-studio.netlify.com/>
- FromthePage - <https://fromthepage.com/>

- Posts written by Tom Crane (Digirati) about IIIF and Annotations: <https://medium.com/digirati-ch/iiif-annos/home>
- V&A - Inside an ocean liner: the Aquitania: <https://www.vam.ac.uk/articles/inside-an-ocean-liner-aquitania>
- IIIF Open/Web Annotation Extensions: <https://iiif.io/api/annex/openannotation/>
- Simple Annotation Server: <https://github.com/glenrobson/SimpleAnnotationServer>
- Elucidate: <https://github.com/dlcs/elucidate-server>
- North Carolina State University (NCSSU) IIIF-Annotation Library: <https://ncsu-libraries.github.io/iiif-annotation/>
- Local IIIF Annotation Server (front-end: Jekyll with embedded Mirador, back-end: Flask): <https://dnoneill.github.io/annotate/>
- Harvard IIIF Annotation Editor: <http://iiif.harvard.edu/iiif-annotations-editor/>
- HarvardX - CellXplorer: <https://courses.edx.org/courses/course-v1:HarvardX+MCB64.1x+2T2016/d16e07a5cec442eeb7cd9dfcb695dce0/>



Museums - <https://iiif.io/community/groups/museums/>



UC4: IIIF at the heart of a rich navigation experience for newspapers



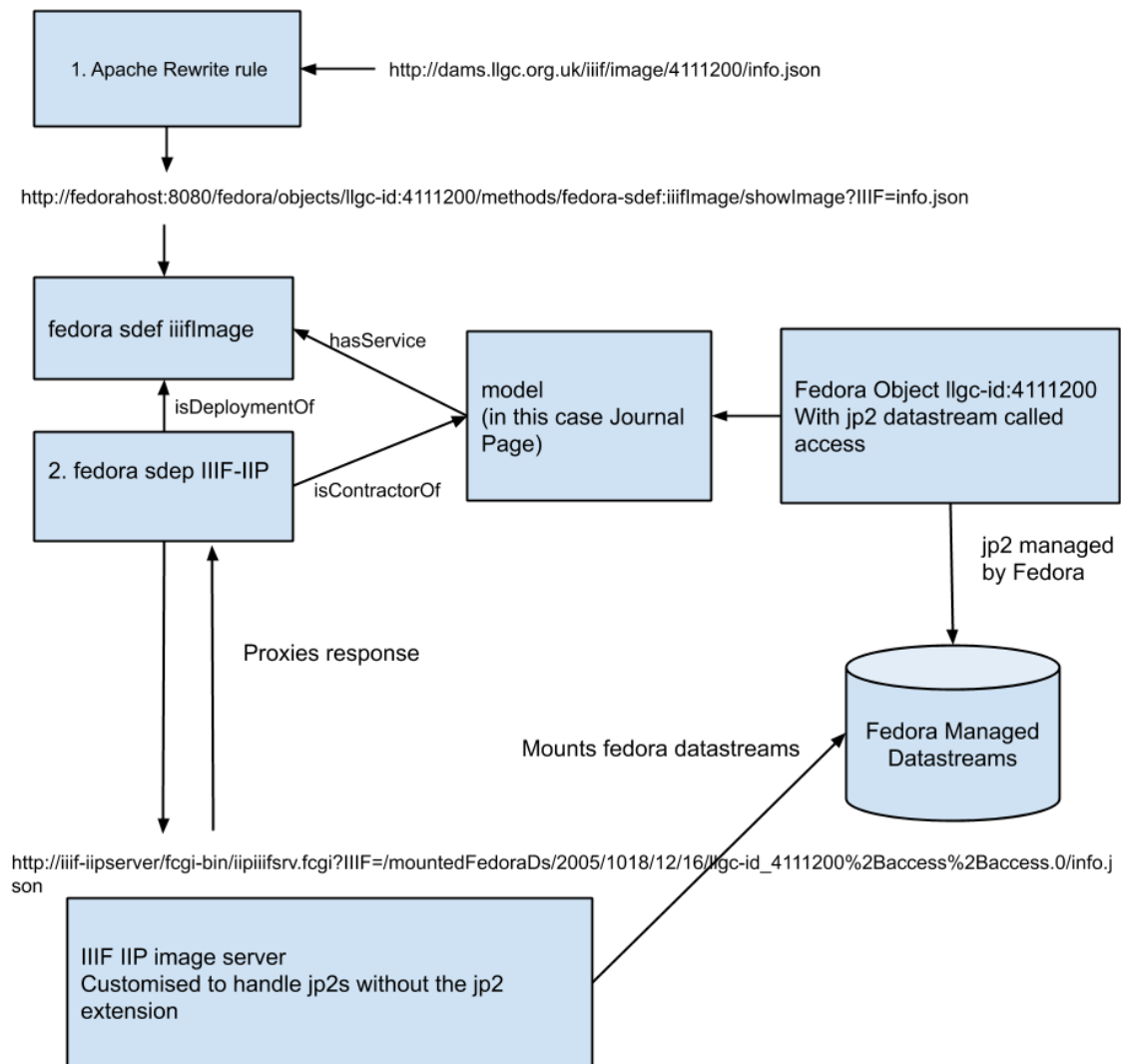
A newspaper project seeking to disseminate its journals by allowing users to navigate by publication date or issue number directly on a IIIF-compliant viewer.

Tier: Project level
Implementation effort: moderate
APIs to implement: Image, Presentation, Content Search



One of the most frequently talked about implementations within the IIIF community in terms of digitised newspapers is the one made by the **National Library of Wales** (NLW). They were of the pioneering institution to achieve a very extensive implementation of IIIF for their newspapers. Below (cf. Figure 16) is the NLW implementation workflow that has been carried out with Fedora 3.3.

Figure 16: NLW IIIF Fedora 3.3 Implementation





- Align the newspapers' structure to the one of IIF
- Add the navDate property to each IIF Manifest to order the resources by date the IIF-compliant viewer
- Deploy the Universal Viewer



- IIF Newspapers Model:
https://docs.google.com/document/d/1UuRRkRnzU0_iUC4OKU7nZ90oci25276Zvic_992nPAE/edit
- Newspapers, IIF, and ALTO: <https://www.slideshare.net/kestlund/newspapers-iiif-and-alto>
- IIF Journals (National Library of Wales' DevWiki):
https://dev.llgc.org.uk/wiki/index.php?title=IIF_Journals
- Universal Viewer (GitHub): <https://github.com/UniversalViewer/universalviewer>



Newspapers - <https://iiif.io/community/groups/newspapers/>

UC5: Access with control to digitised archival material



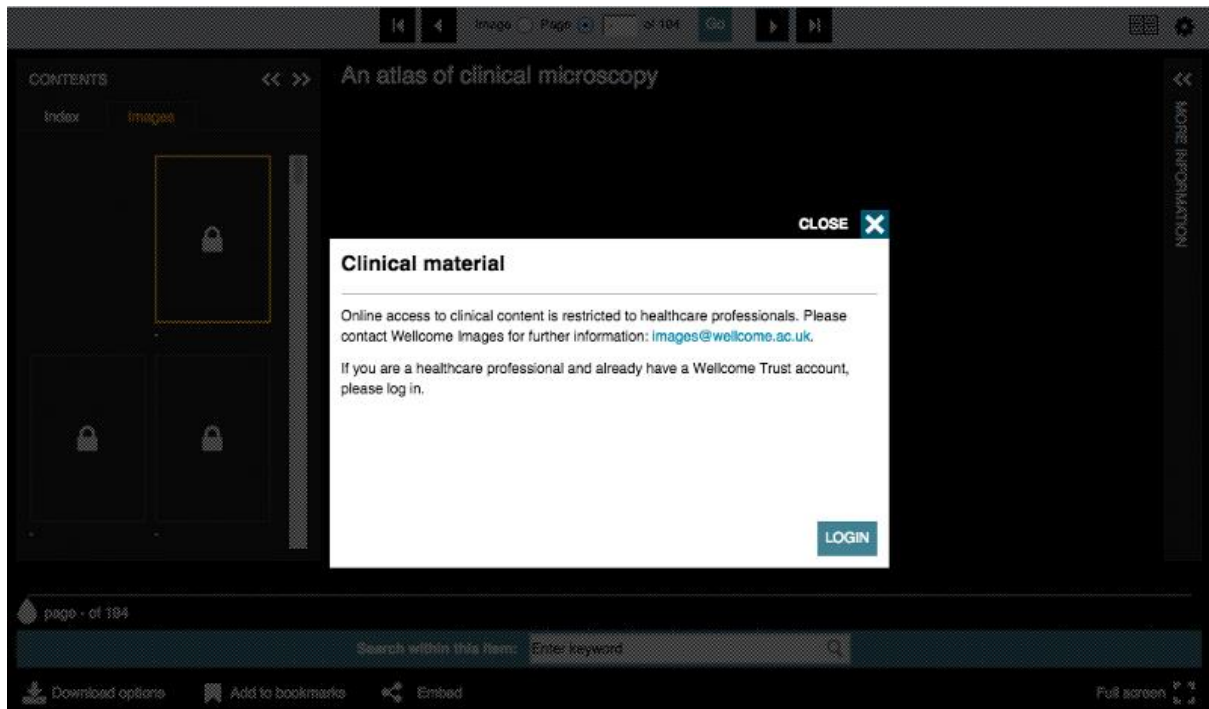
An archive that needs to publish its digitized resources in accordance with the classification of the collection while restricting access to sensitive resources.

Tier: Institutional level
Implementation effort: moderate to challenging
APIs to implement: Image, Presentation, Authentication



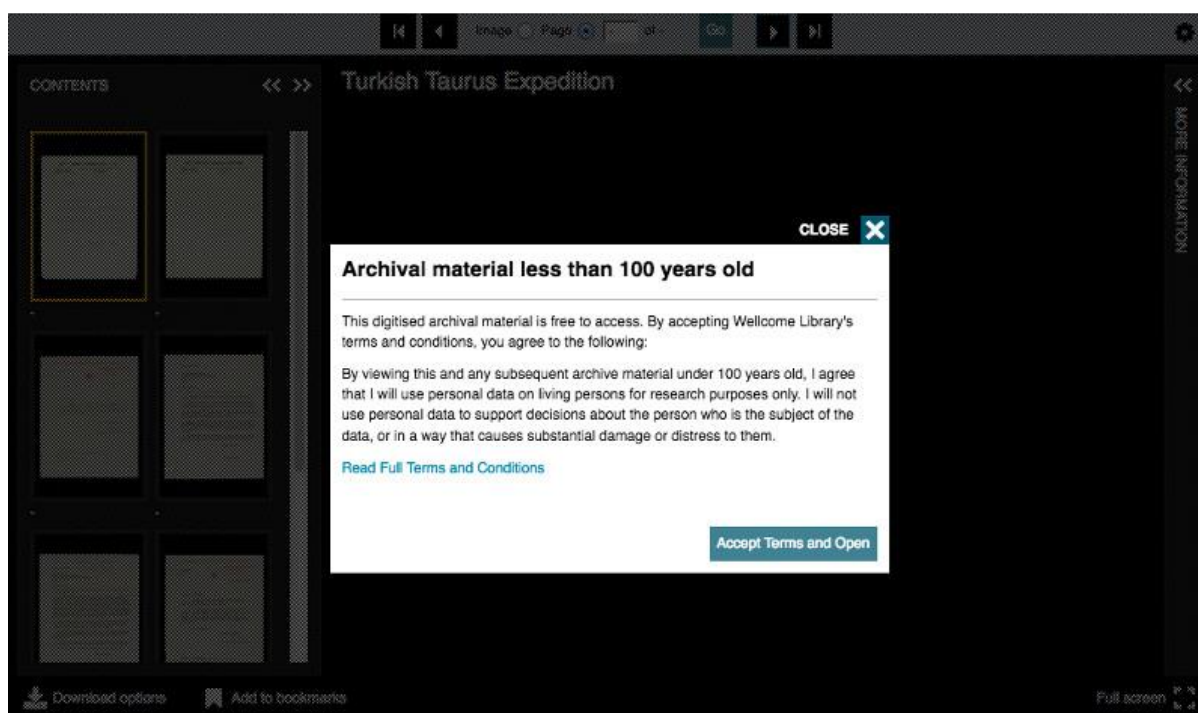
In the IIIF Authentication API, which is designed to allow application of IIIF for access-restricted resources, there are four different interaction patterns for accessing restricted content. These patterns act as a layer on top of existing authentication infrastructures. The **Wellcome Trust** has for instance deployed two of these patterns: login for digital surrogates that have to be restricted to a certain number of people (cf. Figure 17) and the click through for resources that can only be accessed partially because of the sensitive date they contain and thus respect the archival retention periods (cf. Figure 18).

Figure 17: Login interaction pattern



<http://wellcomelibrary.org/item/b16728701>

Figure 18: Click through interaction pattern



<https://wellcomelibrary.org/item/b18170183>

Authentication:

- Model your restricted access resources with one of the interaction patterns proposed by the IIIF Authentication API
- Implement a centralised Single-Sign-On (SSO) or any other systems giving you a login cookie
- Integrate the token service into the IIIF Manifest (or the IIIF Canvas)
- Enable users to authenticate with your own service for the resources that require a login (this can also be done through a third party service like Shibboleth, Google, Twitter, Facebook, etc.)



→ A useful 'trick' given in the Implementation Guide (Brumfield Labs 2017) is to set up two different image servers: one internal with wider access and one external for the public.

Classification of the collection:

- Fonds and sub-fonds = IIIF Collection
- Series = IIIF Collection or IIIF Manifest
- Files = IIIF Manifest
- Item = IIIF Canvas



- IIIF Auth demo by Digirati: <https://digirati-co-uk.github.io/iiif-auth-client/?sources=https://iiifauth.ch.digtest.co.uk/index.json>
- Annotation, Content Search, and IIIF Authentication (Video of a presentation made by Glen Robson at the 2017 IIIF Conference in the Vatican): <https://www.youtube.com/watch?v=nXpeyflipzM>
- Archival IIIF – an open source OAIS-compliant framework to present born digital archives developed by the Swiss Social Archives: <https://archival-iiif.github.io/>
- The Universal Viewer (2.x and upwards) supports the IIIF Authentication API: <http://universalviewer.io/>
- Mirador 3 will support the IIIF Authentication API: <https://projectmirador.org/>



Archives - <https://iiif.io/community/groups/archives/>

UC6: Dissemination of audio-visual resources through IIIF



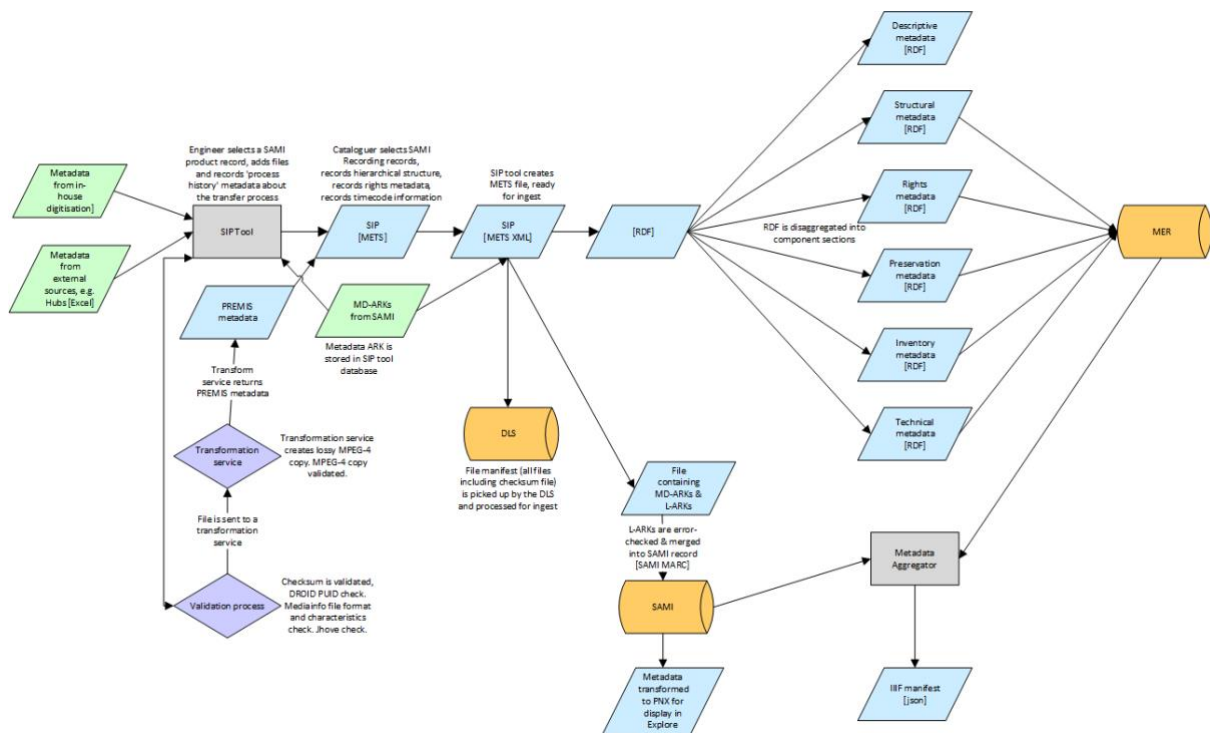
A platform mainly dedicated to the diffusion of audio-visual materials showing interest in the IIIF Presentation API 3.0.

Tier: Project or institutional level
Implementation effort: moderate to challenging
APIs to implement: Image, Presentation (3.x)



Through their Save our Sounds project, the British Library (BL) was able to accelerate the process of integrating A/V resources into the IIIF Presentation API. The BL wanted to conform to the IIIF specifications to disseminate their A/V assets and will be on the pioneers in making it happen in the IIIF universe. Below (cf. Figure 19) is how the BL is producing their IIIF Manifests. They are being created from METS, turned into RDF and then combined with catalogue records through an aggregation process. All of their data (original files as well as access copy) is also stored in their OAIS-compliant preservation system¹⁷.

Figure 19: British Library's overview of the end to end IIIF workflow



- Convert your long-term A/V file formats into web-compatible formats
- Generate the A/V IIIF Manifests from your database (Presentation 3.0 Manifests)
- Deploy the Universal Viewer to display your A/V resources

¹⁷ For a better understanding of this graph and the Save Our Sounds project, please have a look at the Presentation titled 'Unlocking our Sound Heritage: IIIF AV at the British Library' given by Andy Irving at the Bern IIIF Showcase Event on May 15, 2019: https://drive.google.com/open?id=1-1c5yybqfeRANlCx10BcLFAQly2uj7ZPahXt_AJikM



- Media formats for HTML audio and video (Mozilla): https://developer.mozilla.org/en-US/docs/Web/HTML/Supported_media_formats
- Beyond Images: Avalon and IIIF A/V (Video of a presentation made by Chris Colvard, Indiana University, in November 2017: https://media.dlib.indiana.edu/media_objects/3r074z37q)
- Creation of simple A/V Manifests with Edward Silvertown's Build IIIF (biiif)¹⁸: <https://github.com/edsilv/biiif>
- Blog post by Tom Crane, Digirati - A/V and beyond (coming soon): <https://resources.digirati.com/iiif/an-introduction-to-iiif/av-and-beyond.html>



A/V - <https://iiif.io/community/groups/av/>

¹⁸ For the modeling of complex cases, the IIIF Cookbook will surely be required (cf. Page 36).

Further recommendations

Tips for small institutions

Some case studies are more difficult to implement by small institutions that do not have the human resources or extensive technical knowledge. It should be noted that an increasing number of Library Services Platforms (LSPs) and Digital Asset Managements (DAMs) have begun to integrate IIF into their core infrastructure. If you are a small institution, one solution is to ask your software provider if it is possible to upgrade their system to support IIF. In the same spirit, an open letter was sent by the museum community in May 2017. You can also ask any questions you want on the IIF-Discuss mailing list, on IIF Slack, or you can directly email a person working for IIF-C to help you in this process.



Museum Community Letter to Digital Asset Management (DAM) Software Vendors: <https://iif.io/news/2017/05/01/letter-to-dams/>
The email addresses of IIF staff members can be found at the top of the IIF-C webpage: <https://iif.io/community/consortium/>

Discovering the IIF universe

The discoverability issues have not yet been fully addressed by the IIF community. For example, it is not yet possible to perform centralized queries to obtain all IIF Manifests published on the web. There are thematic meta-catalogues or cross-collections search and discovery platforms as well as a register of IIF Top-Level Collections, but this represents only a very small part of what is available through IIF.

This is why the Discovery TSG was created. They have been working on collating use cases, comparing (and/or combining) different standards and technologies (Freire, Isaac, Robson, Brooks, Manguinhas 2017; Freire, Meijers, Voorburg, Isaac 2018), finding best practices on how to make IIF resources discoverable and the best way to model these processes and implement them within new APIs. The Discovery Group has identified four areas of work (Sanderson 2018)¹⁹:

1. Crawling and harvesting of IIF resources
2. Linking to semantic, descriptive content for indexing
3. Notifications between systems
4. Import to viewers of discovered resources

In addition to the Discovery TSG, it should also be noted that a ‘discovery-for-humans’ community group is being created and should be established by 2019-2020.



Discovery Platforms
Biblissima’s Manuscripts & Rare Books: <https://iif.biblissima.fr/collections/>
IIF Discovery in Japan: <http://iif2.dl.itc.u-tokyo.ac.jp/s/iif/page/home>

¹⁹ IIF Technical Specification Group Charter: <https://iif.io/community/groups/discovery/charter/>

Persistent identifiers (PIDs)

To serve IIIF images, URIs must conform to the IIIF Image Request Syntax. Basically, each identifier must be unique.

IIIF Image Request URI Syntax

{scheme}://{server}/{prefix}/{identifier}/{region}/{size}/{rotation}/{quality}.{format}

IIIF Image Information URI Syntax

{scheme}://{server}/{prefix}/{identifier}/info.json

IIIF Recommended URI Patterns (Manifest)

{scheme}://{host}/{prefix}/{identifier}/manifest

Rather than creating your own permalinks for each IIIF resource, it would be more interesting to assign persistent identifiers (PIDs). Some institutions have decided to assign a Digital Object Identifier (DOI) at the IIIF Manifest level. While this remains a good solution to ensure the sustainability of each IIIF-compliant digital object, it is not yet exhaustive and is not meaningful from a granularity point of view. The French National Library (BnF), through Gallica²⁰, has decided to deploy Archival Resource Keys (ARKs) as PIDs. This solution seems to us to be the most effective and is outlined in French on their developer website²¹.

ARK Syntax²²

[http://NMAH/]ark:/NAAN/Name[Qualifier]

ARK + IIIF (BnF)

Image Request:

<https://gallica.bnf.fr/iiif/ark:/12148/btv1b90017179/f15/0,1900,2400,1200/full/0/native.jpg>

Image Information: <https://gallica.bnf.fr/iiif/ark:/12148/btv1b90017179/f15/info.json>

Manifest: <https://gallica.bnf.fr/iiif/ark:/12148/btv1b90017179/manifest.json>

It is important to keep in mind that ARK is a decentralized system and that the sustainability of ARK URIs rests with the institution that have implemented this solution.



IIIF Image Request URI Syntax (Image API): <https://iiif.io/api/image/2.1/#image-request-uri-syntax>

IIIF Image Information URI Syntax (Image API): <https://iiif.io/api/image/2.1/#image-information-request-uri-syntax>

IIIF Recommended URI Patterns (Presentation API):

<https://iiif.io/api/presentation/2.1/#a-summary-of-recommended-uri-patterns>

²⁰ Gallica, the BnF digital library: <https://gallica.bnf.fr/>

²¹ API IIIF de récupération des images de Gallica: <http://api.bnf.fr/api-iiif-de-recuperation-des-images-de-gallica> (only in French) - There is though some information in English on how the Durham University Library deploys ARKs with IIIF here: <https://www.durhampriority.ac.uk/about-the-project/technology/ark-urls/>

²² Archival Resource Key (ARK) Identifiers: https://n2t.net/e/ark_ids.html

The IIIF Cookbook

In parallel to the preparation of the Presentation and Image APIs 3.0, the IIIF community is writing a Cookbook where recipes of different use cases will be highlighted to notably demonstrate how IIIF can be leveraged and help (future) implementers to model complex objects. These recipes are divided into several parts: a definition of the use case, some implementation notes, a JSON snippet as well as links to related recipes. Stay tuned for more information.



IIIF Cookbook (preview): <https://preview.iiif.io/api/image-prezi-rc2/api/cookbook/>
IIIF Cookbook - Simple Manifest Image (preview): <https://preview.iiif.io/api/image-prezi-rc2/api/cookbook/mvm-image/>
IIIF Cookbook's GitHub repository: <https://github.com/IIIF/cookbook-recipes>

Future work and Conclusion

It should first be noted that the information in this document need not be followed to the letter and the recommendations of each case study are suggestions made as part of a research project. There will always be divergent opinions, whether on the choice of image formats or on how to build IIIF Manifests.

Secondly, the number of IIIF-compliant systems in Switzerland should also increase when Image and Presentation APIs 3.x become stable, since it will allow to disseminate audio-visual resources through this medium. It will indeed be interesting to see which organizations will start to take an interest in it and how the IIIF universe can grow.

This white paper should also be updated regularly to keep up with the evolution of the IIIF APIs and the available ecosystem tools, processes and recipes. This white paper focuses on Swiss institutions in the cultural heritage field and should be adapted and/or translated to the needs of other regions and communities. A continuous updating process of this document should be set up with the help of the wider IIIF community. Furthermore, the process should be as transparent as possible for better dissemination and inclusion of the needs of individuals and institutions wishing to implement IIIF or to adapt to new software and specifications.

Bibliography

BRUMFIELD LABS, 2017. IIIF Implementation Guide. *International Image Interoperability Framework* [online]. 3 October 2017. [Accessed 4 May 2019]. Available from: http://iiif.io/assets/acc_implementation_guide_011017.pdf

FREIRE, Nuno, ISAAC, Antoine, ROBSON, Glen, BROOKS, John and MANGUINHAS, Hugo, 2017. A survey of Web technology for metadata aggregation in cultural heritage. *Information Services & Use*. October 2017. Vol. 37, no. 4, p. 425–436. DOI 10.3233/ISU-170859.

FREIRE, Nuno, MEIJERS, Enno, VOORBURG, René and ISAAC, Antoine, 2018. Aggregation of cultural heritage datasets through the Web of Data. *Procedia Computer Science*. 1 January 2018. Vol. 137, p. 120–126. DOI 10.1016/j.procs.2018.09.012.

HASKIYA, David, 2017. Benefits of Institutional Adoption: The Europeana perspective. *2017 IIIF Conference* [online]. Augustinianum, The Vatican City. 7 June 2017. [Accessed 4 May 2019]. Available from: <https://docs.google.com/presentation/d/1ldy8aF7MZfFNR9-frd5oLLOzjfPXR2hebKbJolbM454/>

RABUN, Sheila and ROBSON, Glen, 2017. What is IIIF? [online]. 15 October 2017. [Accessed 4 May 2019]. Available from: <https://docs.google.com/presentation/d/1U3733ZPGtavMFTFxDOzkI8OCTXk3V26KSk5eQUIXaBk/>

RAEMY, Julien A., 2018. The uptake of IIIF in Switzerland and the current state of TICKS: building a IIIF-alignment outreach programme. *2018 IIIF Conference* [online]. Library of Congress, Washington D.C. 24 May 2018. [Accessed 4 May 2019]. Available from: <https://zenodo.org/record/1252084>

RAEMY, Julien A., 2017. *The International Image Interoperability Framework (IIIF): raising awareness of the user benefits for scholarly editions* [online]. Bachelor's thesis. Geneva, Switzerland: Haute école de gestion de Genève. [Accessed 4 May 2019]. Available from: <http://doc.rero.ch/record/306498>

REED, Jack and WINGET, Drew, 2017. Introduction to IIIF. *GitHub* [online]. March 2017. [Accessed 4 May 2019]. Available from: <https://iiif.github.io/training/intro-to-iiif/>

RONALLO, Jason, 2019. IIIF Workshop. *Preliminary Inventory of Digital Collections: incomplete thoughts on digital libraries* [online]. January 2019. [Accessed 4 May 2019]. Available from: <http://ronallo.com/iiif-workshop-new/>

SANDERSON, Robert, 2016. IIIF: The Advantages of APIs. *Access to the World's Images* [online]. Museum of Modern Art, New York. 10 May 2016. [Accessed 4 May 2019]. Available from: <http://www.slideshare.net/azaroth42/iiif-the-advantages-of-apis>

SANDERSON, Robert, 2018. Discovery of IIIF Resources. *2018 IIIF Conference* [online]. Washington D.C. 24 May 2018. [Accessed 4 May 2019]. Available from: https://drive.google.com/file/d/1f4yxihCGRFK9eC9WHIP89ugc7stywoR_/view?usp=sharing

SNYDMAN, Stuart, SANDERSON, Robert and CRAMER, Tom, 2015. The International Image Interoperability Framework (IIIF): A community & technology approach for web-based images. In: *Archiving Conference* [online]. Los Angeles, CA. May 2015. p. 16–21. [Accessed 4 May 2019]. Available from: <https://purl.stanford.edu/df650pk4327>

WARNER, Simeon, 2017. Discovery of IIIF resources. *2017 IIIF Conference* [online]. Augustinianum, The Vatican City. 6 June 2017. [Accessed 4 May 2019]. Available from: https://docs.google.com/presentation/d/12M_oOwwXtOZLfgAeqkJDwFWaOux_0mdmF6doyjYPSzM/edit