

Towards a National Collection: Persistent Identifiers as IRO Infrastructure

Project Launch Webinar, Edinburgh: 6th April 2020

Joseph Padfield (NG)

Working towards Persistent Identifiers in the National Gallery, London.



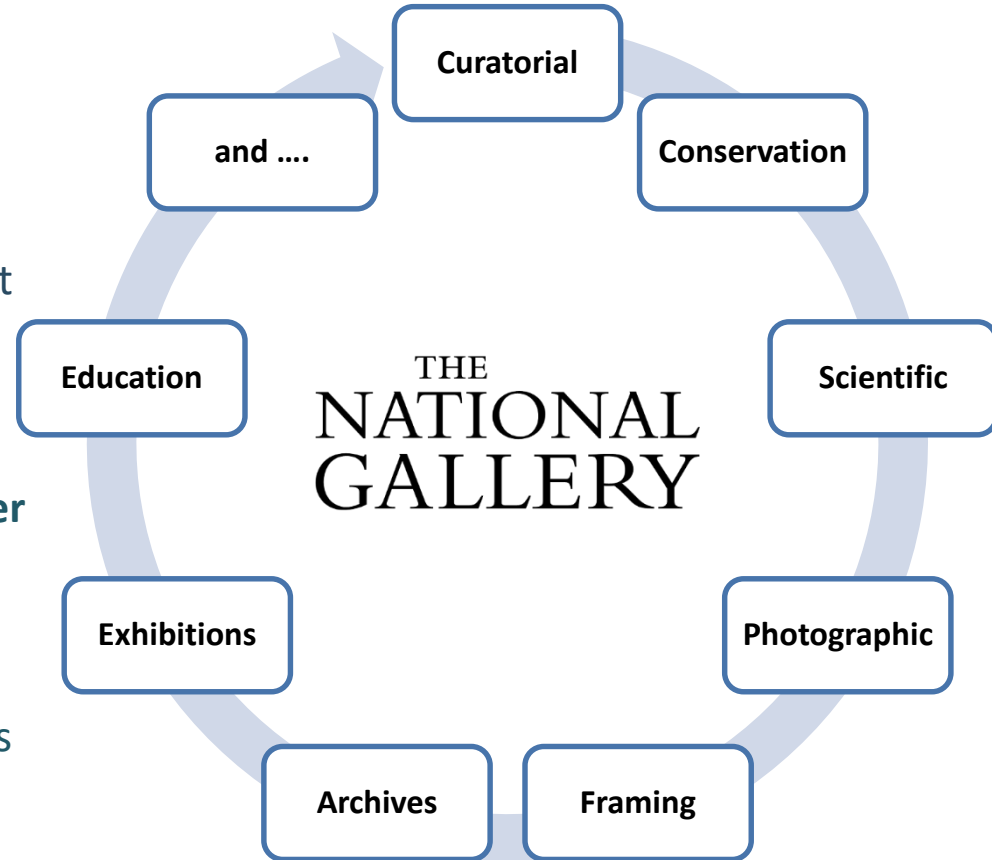
- Over 2,300 main collection works of art in the European Style.
- Ranging from the 13th to the early 20th century.
- Arranged over 66 public Galleries.
- Including many famous works, such as
 - van Eyck's Arnolfini Portrait
 - Velázquez's Rokeby Venus
 - Turner's Fighting Temeraire
 - Van Gogh's Sunflowers.

National Gallery



National Gallery – Research Resources

- **Wide range of resources** of National Gallery research content – everything from bibliographies to images and spectra.
- No single system, but a range of different **systems, resources, people and knowledge**.
- An early question: “**what could be used to connect all of this knowledge together and then potentially connect it to external resources?**”
- **For a number of years** we have been exploring how we might connect systems together and improve access.



**Physical Access to NG Archives has
been common for many years**



ARCHLAB: Physical Access to the Scientific Archive



Archives comprising thousands of unpublished images, data, samples and reports collected over many decades of scientific investigation and conservation of a huge variety of cultural heritage objects and sites

AND

The specialised knowledge at the staff of the ARCHLAB institution to guide the researcher through the archive

ARCHLAB provides EU funded opportunities to explore scientific archives.

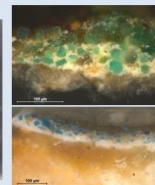


ARCHLAB (NG) - *The Capodimonte Transfiguration: a technical and historical study of a masterpiece by Giovanni Bellini in context*

Angela Cerasuolo, Alessandra Rullo, Museo e Real Bosco di Capodimonte; Helen Glanville, LAMS – CNRS Sorbonne Universités

National Gallery Giovanni Bellini documentation (12 paintings)

X-rays from 1920s onwards
Cross-sections from the 1960s onwards



Macro-XRF scanning in 2018



Gold XRF map

IPERION CH

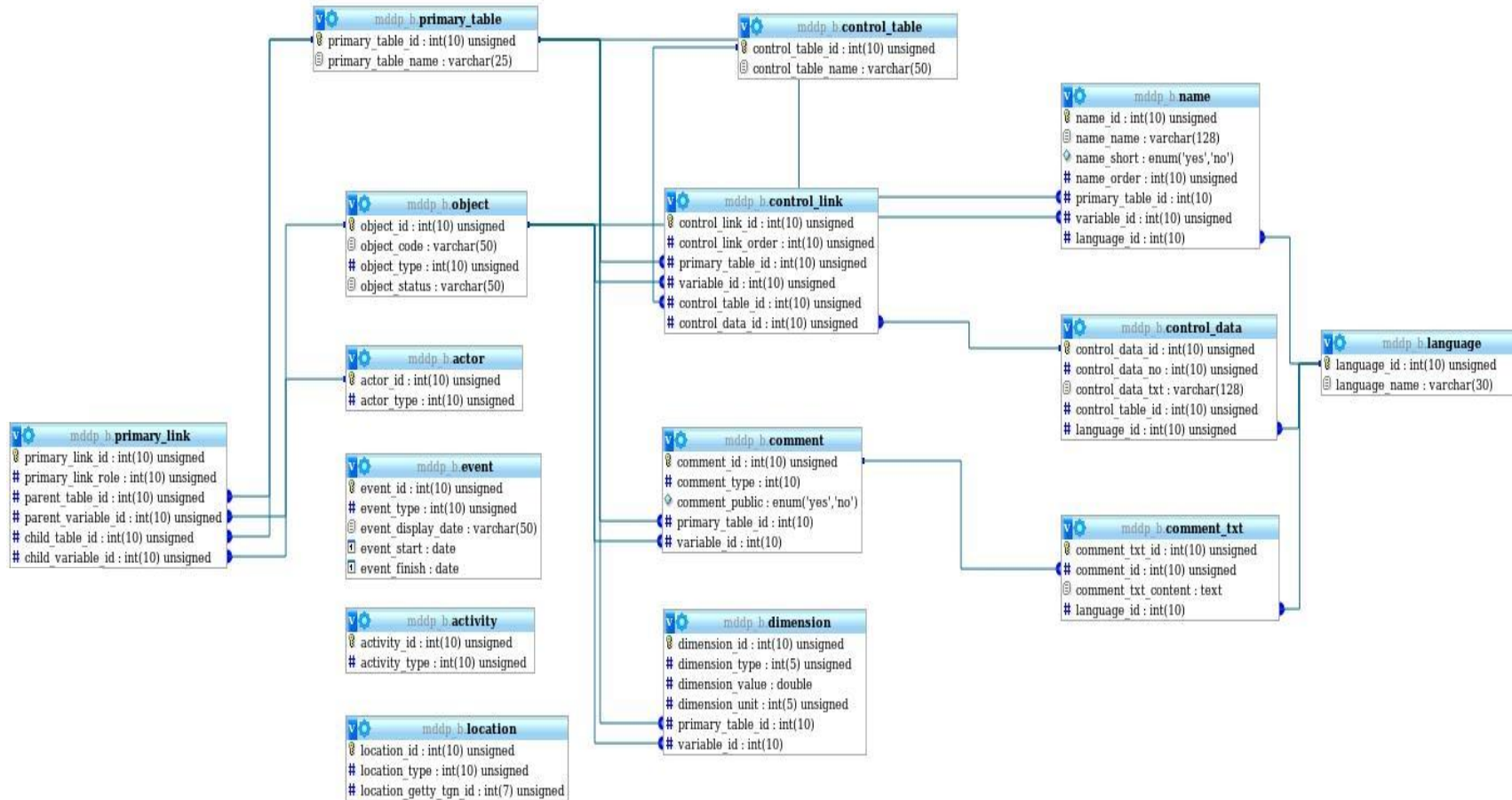


Raphael Project 2007: Database Development

- For this prototype system a MySQL database was developed to store the wide range of data.
- Initial development produced a generic 15+ table schema.

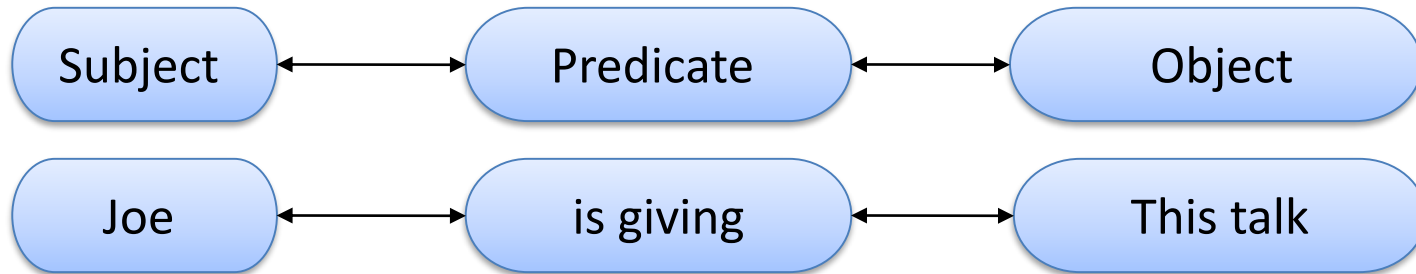


Raphael Research Resource: Initial Scheme



Semantically describing paintings using RDF:

- After further discussion this simplification process led to an alternative way of storing data.
- The RDF data model is based upon the idea of making statements about resources in the form of subject-predicate-object expressions, called triples in RDF terminology.
- The subject denotes the resource, and the predicate denotes traits or aspects of the resource and expresses a relationship between the subject and the object.
- Ideally, each subject, predicate and object require a *unique identifier* that can be *re-used and referenced*.



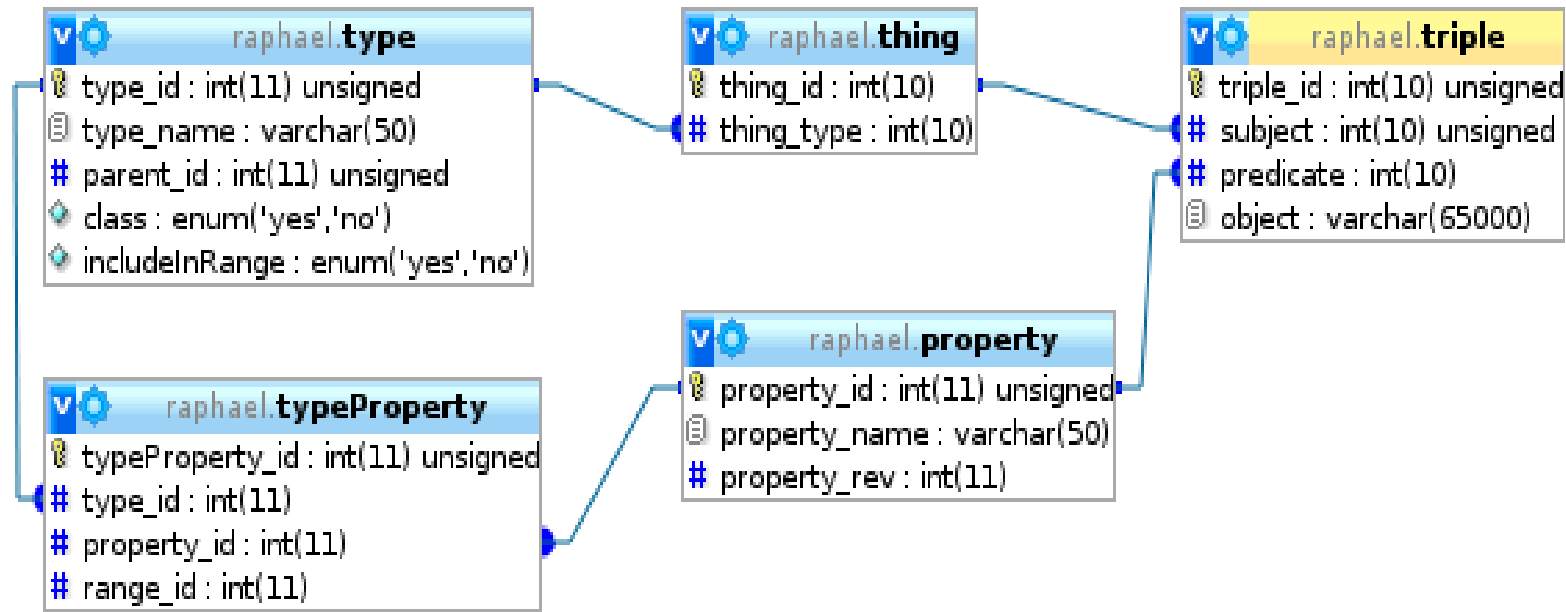
Raphael Project 2007: Database Development

- For this prototype system a MySQL database was developed to store the wide range of data.
- Initial development produced a generic 15+ table schema.
- Experimentation with various Resource Description Framework (RDF) based systems allowed the schema to be simplified even more to 5-6 tables.
- At the time, full migration to an RDF-triple based system was not possible due to time constraints and integration issues with some of the tools used in the graphical user interface.



Raphael Research Resource: Database development

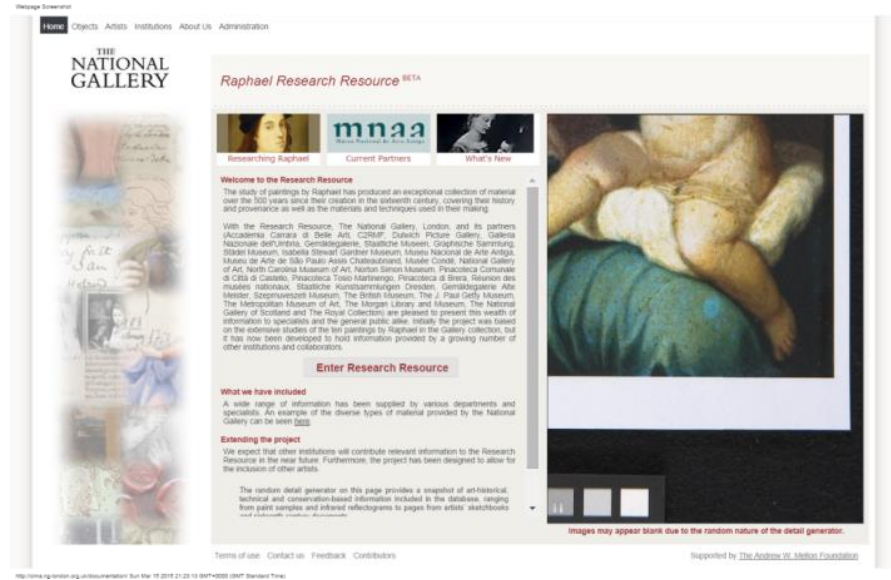
- Within this pilot project it was decided to make use of this different approach to storing data.



Raphael Research Resource

Initially the project was based on the extensive studies of the ten paintings by Raphael in the Gallery collection, but it was extended to hold information provided by a several other institutions and collaborators.

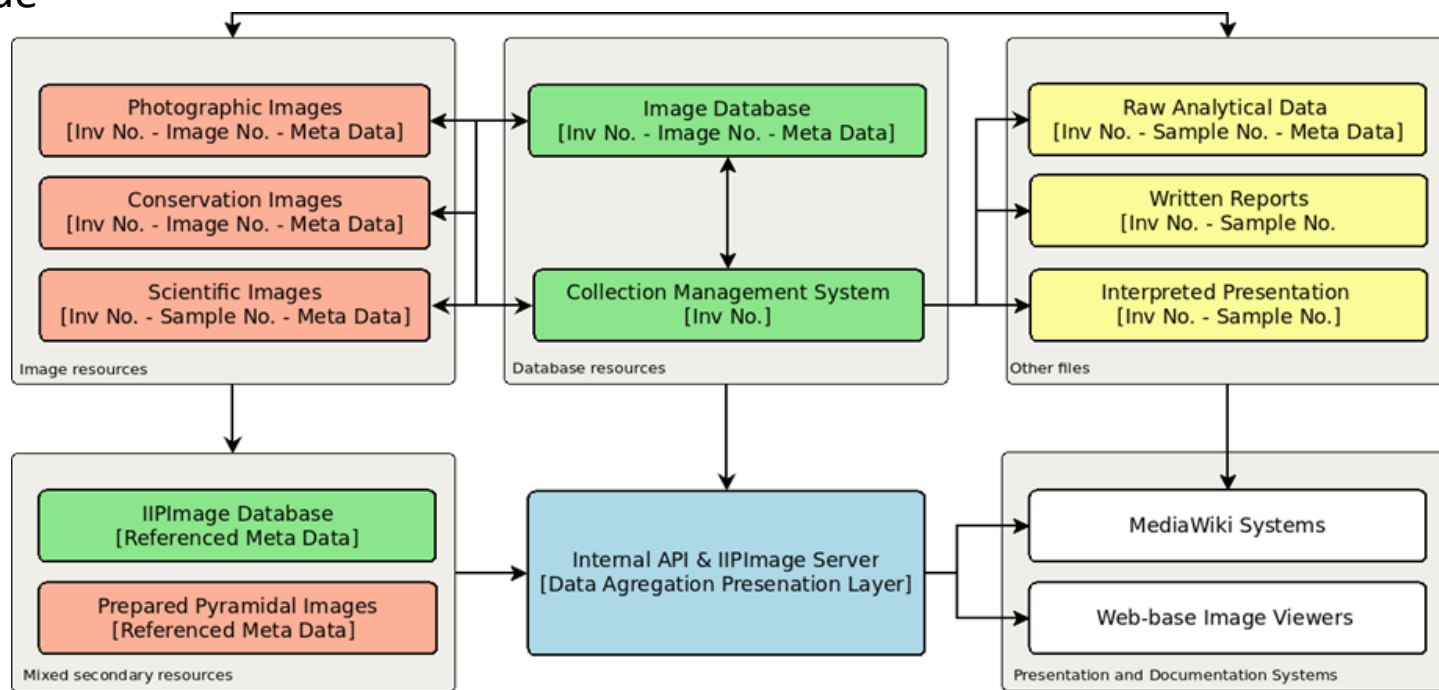
- But the system was designed as a graphical user interface for humans to use.
- It was not possible to reference individual paintings let alone individual data points.
- The system made use of its own internal identifiers which where not designed for re-use.



<http://cima.ng-london.org.uk/documentation>

National Gallery – Connecting Data for Reuse

Over the same period internal naming conventions allowed a number of resources to be identified, classified and automatically linked, via: Painting Inv. No. - Image or Sample No. & Technique



Heritage Digital Identifiers

- **NG Paintings are organised by Inv. No. However** this number relates to a paintings state and what part of the collection a painting is in, so **it is subject to change**.
 - Most digital images are directly named in relation the current Inv. No. – so these are also subject to change.
 - Other image identifiers, often include semantic state information and even meta data - there are also different rules and conventions based on the type and source of an image.
- Other database IDs are directly linked to specific pieces of software – so their use, between systems, can involve a risk if software needs to change.
- More broadly, accession numbers, in museums are also commonly based on the year of acquisition, therefore the use of these simple IDs across multiple institutions becomes difficult.

Designed For Human Re-use

Raphael Project

cima.ng-london.org.uk/documentation/index.php

<https://cima.ng-london.org.uk/documentation>

Home Objects Artists Institutions About Us Administration

THE NATIONAL GALLERY


Select Painting: [NG1171]

Project Categories

- Historical Information
 - Art History
 - Provenance
 - Archive
 - Related Works
 - Drawings
 - Copies
 - Prints
- Conservation
 - Conservation Dossiers
 - Conservation Archive
- Framing
 - Images of Frames
 - Frame Archive
- Materials & Techniques
 - Support and Preparatory Layers
 - Underdrawing Materials
 - Paint Binding Medium
 - Pigments and Layer Structure
 - Study Images
- Microscopy
 - Unmounted Samples
 - Cross Sections
 - SEM Examination
- Infrared Examination
 - Infrared Photography
 - Infrared Reflectography
- X-Ray Examination
 - X-Ray Images
 - Visible Light Examination
 - Visible Light Images
 - Further Details
- Other Images
 - General Bibliography
 - Exhibition and Loan History

The Ansidei Madonna, Raphael (1483-1520), NG1171
1505, 216.80 x 147.60 cm, Drying Oil on Poplar Panel,
The National Gallery, London

Display Options



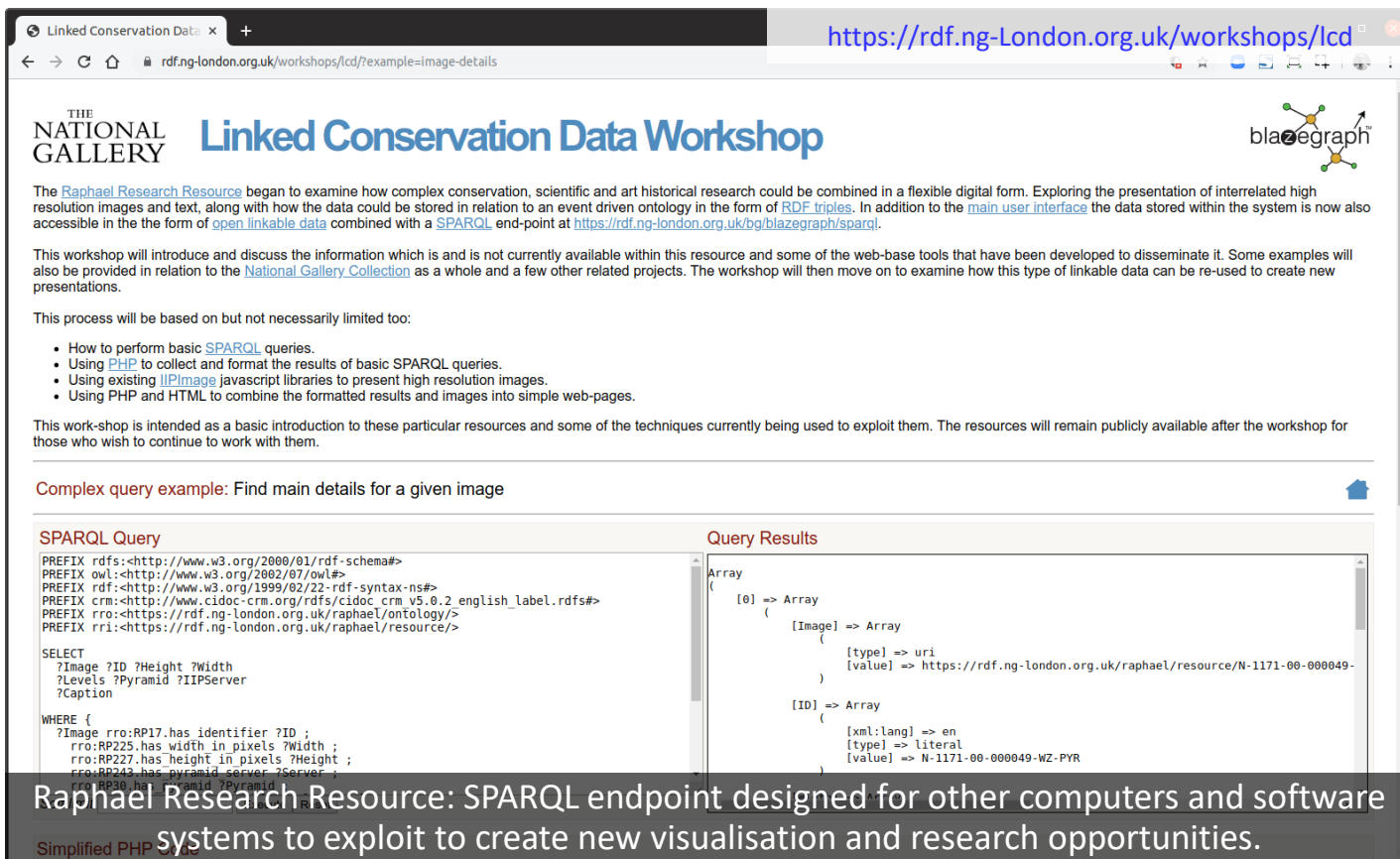
The Madonna and Child with Saint John the Baptist and Saint Nicholas of Bari (The Ansidei Madonna), The National Gallery.
London: The National Gallery, The National Gallery Collection.

Raphael Research Resource: Web interface designed for humans to explore and carry out new research.

Terms of Use

Supported by The Andrew W. Mellon Foundation

Later work: Re-designed For Computer Re-use



Linked Conservation Data Workshop

The [Raphael Research Resource](#) began to examine how complex conservation, scientific and art historical research could be combined in a flexible digital form. Exploring the presentation of interrelated high resolution images and text, along with how the data could be stored in relation to an event driven ontology in the form of [RDF triples](#). In addition to the [main user interface](#) the data stored within the system is now also accessible in the form of [open linkable data](#) combined with a [SPARQL](#) end-point at <https://rdf.ng-london.org.uk/bg/blazegraph/sparql>.

This workshop will introduce and discuss the information which is and is not currently available within this resource and some of the web-base tools that have been developed to disseminate it. Some examples will also be provided in relation to the [National Gallery Collection](#) as a whole and a few other related projects. The workshop will then move on to examine how this type of linkable data can be re-used to create new presentations.

This process will be based on but not necessarily limited too:

- How to perform basic [SPARQL](#) queries.
- Using [PHP](#) to collect and format the results of basic SPARQL queries.
- Using existing [IIPIImage](#) javascript libraries to present high resolution images.
- Using PHP and HTML to combine the formatted results and images into simple web-pages.

This work-shop is intended as a basic introduction to these particular resources and some of the techniques currently being used to exploit them. The resources will remain publicly available after the workshop for those who wish to continue to work with them.

Complex query example: Find main details for a given image

SPARQL Query

```
PREFIX rdfs:<http://www.w3.org/2000/01/rdf-schema#>
PREFIX owl:<http://www.w3.org/2002/07/owl#>
PREFIX rdf:<http://www.w3.org/1999/02/22-rdf-syntax-ns#>
PREFIX crm:<http://www.cidoc-crm.org/rdfs/cidoc_crm_v5.0.2_english_label.rdfs#>
PREFIX rro:<https://rdf.ng-london.org.uk/raphael/ontology/>
PREFIX rri:<https://rdf.ng-london.org.uk/raphael/resource/>

SELECT
  ?Image ?ID ?Height ?Width
  ?Levels ?Pyramid ?IIPServer
  ?Caption
WHERE {
  ?Image rro:RP17.has identifier ?ID ;
  rro:RP225.has width in pixels ?Width ;
  rro:RP227.has height in pixels ?Height ;
  rro:RP243.has pyramid server ?Server ;
  rro:RP30.has pyramid ?Pyramid ;
```

Query Results

```
Array
(
  [0] => Array
    (
      [Image] => Array
        (
          [type] => uri
          [value] => https://rdf.ng-london.org.uk/raphael/resource/N-1171-00-000049-
        )
      [ID] => Array
        (
          [xml:lang] => en
          [type] => literal
          [value] => N-1171-00-000049-WZ-PYR
        )
    )
)
```

Raphael Research Resource: SPARQL endpoint designed for other computers and software systems to exploit to create new visualisation and research opportunities.

Development of the SPARQL end-point highlighted that further work was required to improve the usefulness of this type of structure and begin to consider how it might be used to present the full collection.

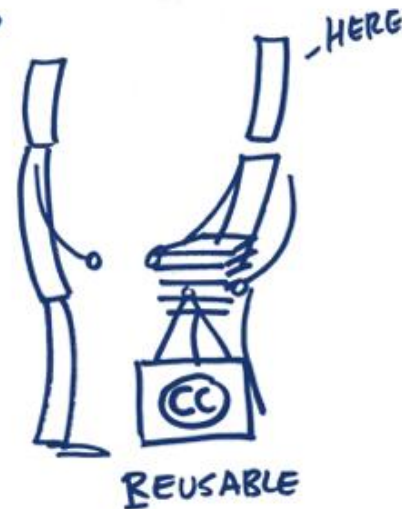
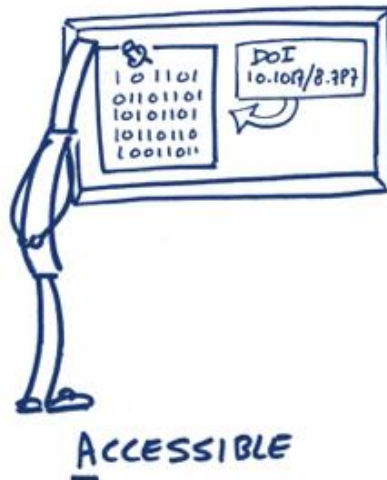
**But beyond this one off project how
could we improve access to digital
data?**



The Standardising Sharing: F.A.I.R. Data Principles

<https://www.go-fair.org/fair-principles/>

FAIR DATA PRINCIPLES



https://www.openaire.eu/images/Guides/FAIRdatapinciples_foster.png

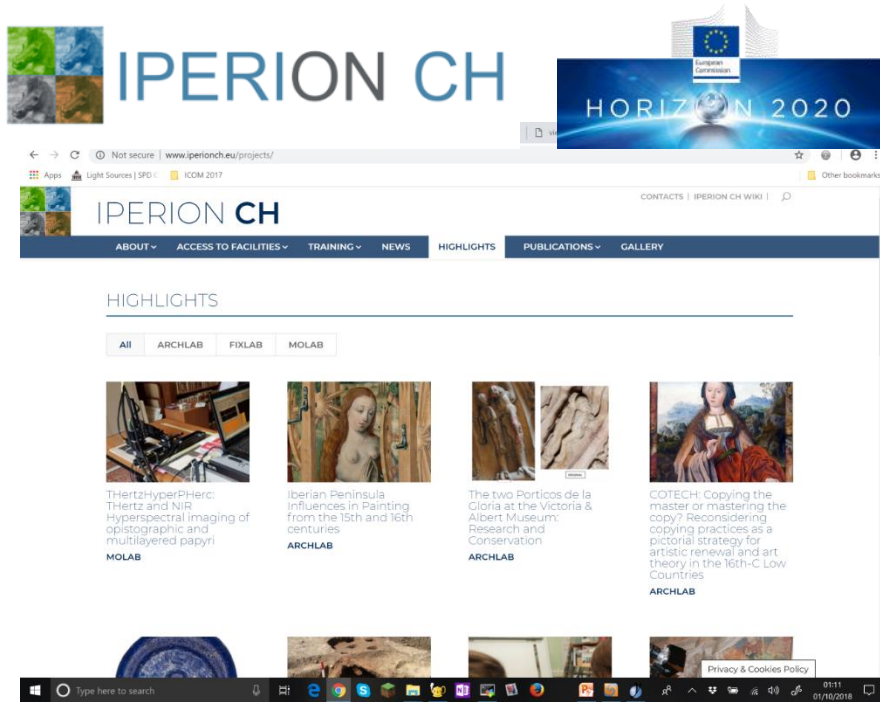


Need:

- Simple PID registry
- Identify available data – painting and artist details, images, etc.
- Build and document an open API, with resolvable URIs, using the CIDOC CRM to map data and IIIF to present images

What was required to make our data accessible

Integrated Platform for the European Research Infrastructure ON Cultural Heritage



<http://www.iperionch.eu/>

- 4 year project, with 24 partners and more than 35 research groups from 12 EU Member States and the USA
- 3 Joint Research Work packages
- 3 Core Accesses: ArchLab, FixLab & MoLab
- One task was specifically exploring developments in digital documentation

- Basic URL Format - NG API
- NG data URLs take the form:
 - **namespace/AAA-AAAA-AAAA**
 - where:
 - The namespace is:
 - <https://data.ng-london.org.uk/resource/>
 - A is any alphanumeric character and together they represent a unique NG PID.
- The remaining characters are arbitrary and just form the rest of the PID.
 - Initially we will be using 8 additional characters: which will allow for 36^8 possibilities per prefix.
 - The system has been built to allow additional sets of 4 characters to be added to scale the number further if required.

In this initial development stage the first set of three characters act as a prefix, indicating what kind of entity is being described by the PID.

- Automated process for incrementing the last used PID using digits 0-9 and upper-case letters A-Z.
- The four character groups are considered from left to right but are incremented right to left.
- If the final 4 character group increments back round to "0000" a new 4 character group will be added on to the right, beginning at "0001".



For example(s):

001-0001-0000 => 001-0002-0000

001-000Z-0000 => 001-0010-0000

001-0019-0000 => 001-001A-0000

001-ZZZZ-00A1 => 001-0000-00A2

001-ZZZZ-ZZZZ => 001-0000-0000-0001

NG - Persistent Identifier (PID) System

Requirements

In order to interlink Gallery digital information which is currently held in multiple systems, and to share its data unambiguously with external users (e.g. research projects), the National Gallery needs to establish a unique, [persistent identifier \(PID\)](#) for every entity referred to by its digital information.

Beyond just supplying another ID, PID systems are typically designed to be actionable, and are generally presented in the form of web based URLs that provide further details about the thing being referenced and links to more information or additional systems.

Whats are PIDs?

A [persistent identifier \(PI or PID\)](#) is a long-lasting generic reference to an image, document, file, web page, or digital description of any physical thing or concept that one might want to describe or discuss.

Many things one might want to discuss or refer to already have IDs within existing local databases or catalogue systems. The purpose of a PID system is to provide unique generic identifiers that can be used and re-used across multiple systems, particularly in relation to publishing information that can be accessed over the Internet.

© The National Gallery 2017

General

Persistent identifiers take the form of Linked (Open) Data dereferenceable URIs.

The National Gallery mints its own PIDs for its own resources, using the namespace <http://data.ng-london.org.uk/resource/>. This system is being built to allocate PIDs and, where relevant, write them into systems which store digital data (e.g. TMS, EOS, CALM, CID, Extensis).

Other PIDs (e.g. ISBNs, DOIs, LDD URIs from other data sources) will also be recorded, where they exist, to ensure that NG data is interoperable.

Basic Layout - NG API

NG PIDs take the form:

namespace/AAA-AAAA-AAAA

where:

- The namespace is:
 - <http://data.ng-london.org.uk/resource/>
- A is any alphanumeric character
- The first set of three characters act as a [prefix](#), indicating what kind of entity is being described by the PID.
 - The remaining characters are arbitrary and just create the unique PID.
 - Initially we will be using 8 additional characters; which will allow for 36⁸ possibilities per prefix.
 - The system has been built to allow additional sets of 4 characters to be added to scale the number further if required.

A separate system will manage the mapping of arbitrary PIDs to human-readable identifiers.

Additional Use - IIIF

PIDs will also be used within the NG IIIF server to present public images. This system will use a different namespace and a variable structure based on application.

PID Prefixes

Code: 000 - Name: Object	14088	2420
Code: 001 - Name: Actors	9219	815
Code: 002 - Name: Events - Objects	14088	2420
Code: 003 - Name: Events - NG	3	8
Code: 004 - Name: Events - External	3	8
Code: 006 - Name: Places	3	84
Code: 005 - Name: Bibliographic - Published	3	8
Code: 007 - Name: Bibliographic - NG Archive	3	8
Code: 008 - Name: Bibliographic - Unpublished	3	8
Code: 009 - Name: Media	3	3480
Code: 00A - Name: Thesaurus terms	3	358
Code: 00B - Name: Periods	3	8
Code: 00C - Name: Appellations	3	2620

PID Sources

Name: TMS	43463
Name: CID	3440
Name: Scientific	8
Name: Conservation	8
Name: NGC	318

PIDs generated and then fed back into NG systems, such as TMS.

- NG1 - [000-03JR-0000](#)
- Duccio - [001-0145-0000](#)
- Room 51 - [006-0000-0000](#)

API - Json Examples

Introduction

The Json formatted data presented by this Beta API is currently under development, this page presents some examples of how the data will be formatted.

The Json formatted data is relatively stable but still might be subject to changes and should only be used for testing purposes.

Object Details: [000-03JR-0000](#)

```
{ "type": "object", "pid": "000-03JR-0000", "no": "NG1", "pdate": "1517-19", "artist": { "display_name": "Sebastiano del Piombo incorporating designs by Michelangelo", "artist_details": { "Sebastiano del Piombo": { "ArtistDisplayDate": "about 1485 - 1547", "birth": { "display": "About 1485", "start": "1483-01-01", "end": "1487-12-31"}, "death": { "display": "1547", "start": "1547-01-01", "end": "1547-12-31"} } } }, "group": "", "fitle": "The Raising of Lazarus", "stitle": "The Raising of Lazarus", "materials": "Oil on canvas, transferred from wood", "medium": ["oil"], "support": ["canvas", "wood"], "height": "381.000", "width": "289.600", "xp": 0, "yp": 0, "credit": "Bought, 1824", "location": { "pid": "006-000C-0000", "name": "Room 8" }, "wtext": "" }
```

The subject of this painting is taken from the New Testament (John: 11). At the request of the sisters Martha and Mary, Jesus visits the grave of their brother Lazarus and raises him from the dead.

This work was painted for Cardinal Giulio de' Medici in Rome in competition with Raphael's 'Transfiguration', now in the Vatican Gallery. It was subsequently taken to the Cathedral of Narbonne. Some of the main figures are based on drawings which Michelangelo supplied for the guidance of Sebastiano.

National Gallery - Beta IIIF Server



Purpose

Welcome to the NG Beta [International Image Interoperability Framework \(IIIF\)](#) Server, which has been set-up to allow direct access to a limited set of National Gallery images.

These web pages have been set up to provide examples of how the system works in a human viewable form, displaying images in the [Project Mirador](#) viewer, but the system is generally designed to be called directly by other computer systems.

A simple search engine has been setup to search for images based on PIDs, names, title, inventory numbers, rooms, keywords, etc.

Search

At this time all of the images displayed via this server are provided under a [Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International License](#).

Basic URL Format - NG IIIF Server

NG IIIF URLs take the form: **namespace/AAA-AAAA-AAAA/iiif-variables**, where:

- The namespace is:
 - <http://media.ng-london.org.uk/iiif/>
- A is any alphanumeric character and together they represent a unique NG [PIDs](#).





<http://media.ng-london.org.uk/iiif/009-0039-0000/full/512,/0/default.jpg>

Accessing simple jpegs

This system has been designed to display images currently held on the National Gallery image server. The system is updated automatically every morning to include new images. For further information about the images displayed, or not displayed here please contact the Photographic Department.

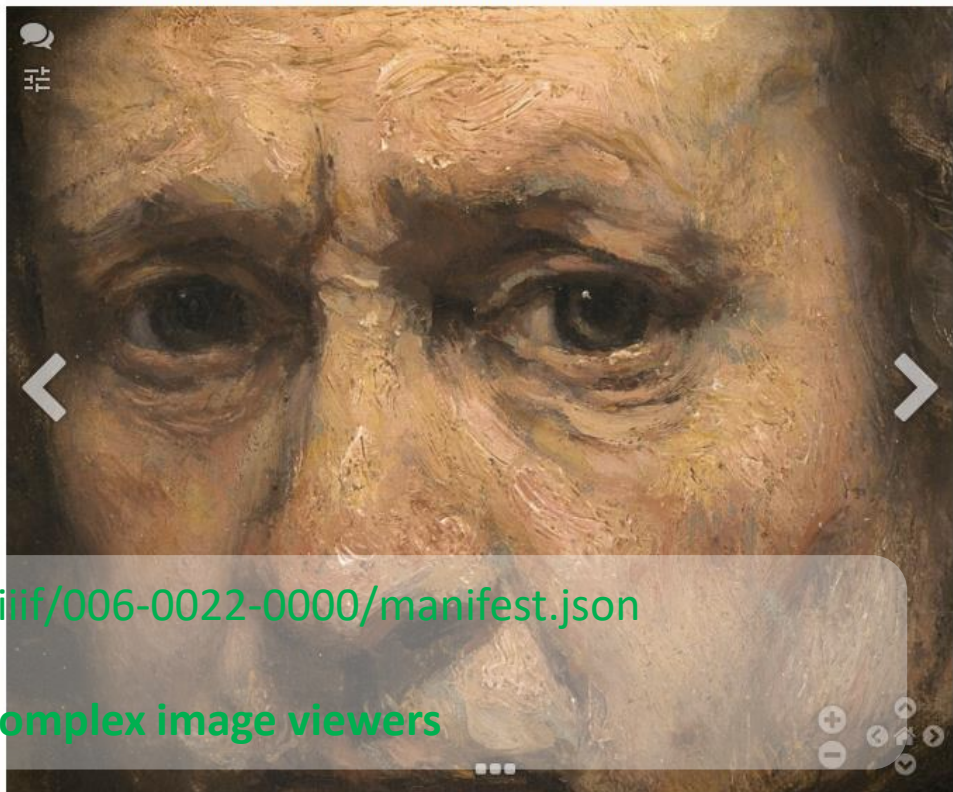
Change Layout

Full Screen

NG672: Rembrandt, Self Portrait at the Age of 34, 16...



National Gallery of Art Collection Highlights



<https://media.ng-london.org.uk/iiif/006-0022-0000/manifest.json>

Presenting images in complex image viewers

Multiple standards based presentations of the same data

NATIONAL GALLERY




Image. See below for a list of paintings in this location

Floorplan: Level 2

Room 30

Spain

Room 29
French Painting 1600-1700


Room 31
Painting in 17th century Italy

Spanish painting flourished during the 17th century principally in the service of God and King. The evolution of a Catholic Counter-Reformation religiosity is revealed in a variety of powerful, individual styles. Not long after El Greco had portrayed the divine with ethereal idealisations of figures, space and light, Diego Velázquez and Francisco de Zurbarán turned to realism to represent the mystical. To make religion more personally relevant, they used naturalistic light to convey divine presence and they depicted the saints as ordinary people, with a vivid physicality and facial expressions. Taste changed after 1650, and Bartolomé Esteban Murillo appealed to popular piety with an ideal style of soft forms and colours, and a sweet and gentle mood.


To make religion more personally relevant, they used naturalistic light to convey divine presence and they depicted the saints as ordinary people, with a vivid physicality and facial expressions. Taste changed after 1650, and Bartolomé Esteban Murillo appealed to popular piety with an ideal style of soft forms and colours, and a sweet and gentle mood.

At the court of Philip IV Velázquez transformed his style of earthly realism in order to express the dignity and splendour of the monarchy. He developed an elegant technique of artful brushwork that calls attention to itself and yet conveys compelling actuality when viewed from a distance.


Paintings in this room



Adoration of the Shepherds



Queen Mariana of Spain in Mourning



Don Adrian Pulido Panja

Formatted Website

```
object {13}

type : location
pid : 006-001M-0000
name : Room 30
title : Spain
description : <p>Spanish painting flourished during the 17th century principally in the service of God and King. The evolution of a Catholic Counter-Reformation religiosity is revealed in a variety of powerful, individual styles. Not long after El Greco had portrayed the divine with ethereal idealisations of figures, space and light, Diego Velázquez and Francisco de Zurbarán turned to realism to represent the mystical.</p><p>To make religion more personally relevant, they used naturalistic light to convey divine presence and they depicted the saints as ordinary people, with a vivid physicality and facial expressions. Taste changed after 1650, and Bartolomé Esteban Murillo appealed to popular piety with an ideal style of soft forms and colours, and a sweet and gentle mood.</p><p>At the court of Philip IV, Velázquez transformed his style of earthly realism in order to express the dignity and splendour of the monarchy. He developed an elegant technique of artful brushwork that calls attention to itself and yet conveys compelling actuality when viewed from a distance.</p>

> objects {21}
  example_object : 000-01D6-0000
> artists {3}
> date_range {2}
> contains {0}
> keywords {63}

license : https://creativecommons.org/licenses/by-nc-nd/4.0/
attribution : This data is licensed under a Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International license (CC BY-NC-ND 4.0)
https://creativecommons.org/licenses/by-nc-nd/4.0/
```

Raw JSON Data

```
<?xml version="1.0" encoding="UTF-8"?>
<rdf:RDF
  xmlns:ng="https://data.ng-london.org.uk/resource/"
  xmlns:xsd="http://www.w3.org/2001/XMLSchema#"
  xmlns:crm="http://www.cidoc-
  crm.org/sites/default/files/cidoc_crm_v6.2.1-2018April.rdf#"/>
  xmlns:owl="http://www.w3.org/2002/07/owl#"
  xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#"
  xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
  xmlns:dce="http://purl.org/dc/elements/1.1/"
  xmlns:cc="https://creativecommons.org/licenses/"
  xml:base="http://data.ng-london.org.uk/resource/" >
  <owl:Ontology/>
  <rdf:Description rdf:nodeID="title_006-001M-0000">
    <rdf:type rdf:resource="crm:E35.Title"/>
    <rdf:label xml:lang="en">Room 30</rdf:label>
    <crm:P2_has_type rdf:resource="00A-000P-0000"/>
  </rdf:Description>
  <rdf:Description rdf:nodeID="subtitle_006-001M-0000">
    <rdf:type rdf:resource="crm:E35.Title"/>
    <rdf:label xml:lang="en">Spain</rdf:label>
    <crm:P2_has_type rdf:resource="00A-000U-0000"/>
  </rdf:Description>
  <rdf:Description rdf:about="000-00A8-0000">
    <crm:P55_has_current_location rdf:resource="006-001M-0000"/>
  </rdf:Description>
  <rdf:Description rdf:about="000-0196-0000">
    <crm:P55_has_current_location rdf:resource="006-001M-0000"/>
  </rdf:Description>
  <rdf:Description rdf:about="000-01AQ-0000">
    <crm:P55_has_current_location rdf:resource="006-001M-0000"/>
  </rdf:Description>
  <rdf:Description rdf:about="000-01AW-0000">
    <crm:P55_has_current_location rdf:resource="006-001M-0000"/>
  </rdf:Description>
  <rdf:Description rdf:about="000-01D6-0000">
    <crm:P55_has_current_location rdf:resource="006-001M-0000"/>
  </rdf:Description>
  <rdf:Description rdf:about="000-0208-0000">
    <crm:P55_has_current_location rdf:resource="006-001M-0000"/>
  </rdf:Description>
  <rdf:Description rdf:about="000-020Z-0000">
    <crm:P55_has_current_location rdf:resource="006-001M-0000"/>
  </rdf:Description>
  <rdf:Description rdf:about="000-02PV-0000">
    <crm:P55_has_current_location rdf:resource="006-001M-0000"/>
  </rdf:Description>
```

CIDOC CRM - RDF XML



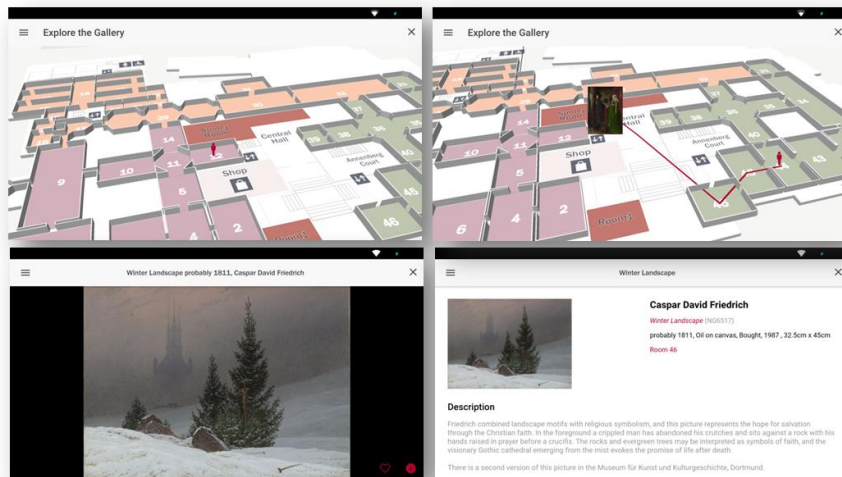
Re-using National Gallery data.



CrossCult – H2020 EU Project – <https://www.crosscult.eu>



Data Re-use in practice: Empowering reuse of digital cultural heritage in context-aware crosscuts of European history

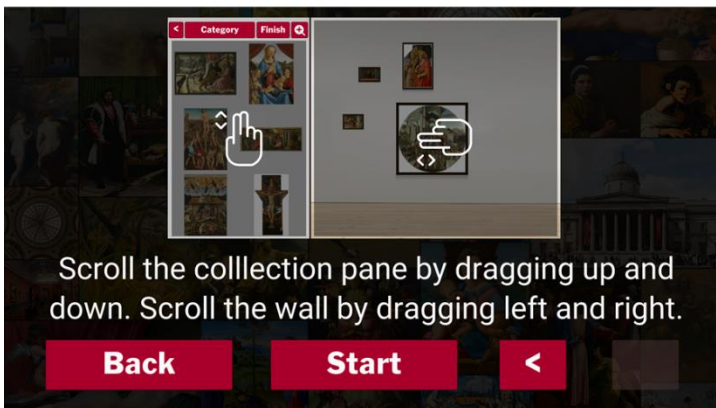


Integrated Platform
with Dedicated Mobile
Apps – Built using re-usable modules

An example research project that dynamically re-used National Gallery data directly via a research API.



The re-use of structured data can lead to multiple benefits



- Currently store location by room
- Required an efficient tool to record the actual position of a painting on a specific wall.
- Enhanced location data useful for:
- Location recommendation
 - Security
 - Visitor flow
 - Preventive Conservation
 - Documenting exhibitions ...



UK Research
and Innovation



Arts and
Humanities
Research Council



Royal
Botanic Garden
Edinburgh

THE
NATIONAL
GALLERY



University
of Glasgow



SCIENCE
MUSEUM
GROUP



What's next?

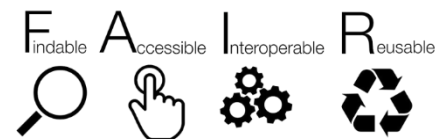


What's next? – Linked Open Data

- Explore how best to increase the awareness of NG published PIDs – **F**indable
- Implement a sustainable supportable middleware system, incorporating IIIF and Persistent Identifiers (PIDs), with standard data end-points/APIs – **A**ccessible
- Integrate CIDOC-CRM and external open thesauri and vocabularies (eg Getty Vocabularies, WikiData) mappings and other external Linked Open Data resources – **I**nteroperable
- Assign and publish standard licences for all of our published data – **R**e-usable



IPERION HS



National Gallery: PID System.

Production Local PIDs:

- Create new, independent IDs for all “things” one wants to discuss or describe.
- namespace/AAAA-AAAA-AAAA-AAAA
 - <https://data.ng-london.org.uk/0F6J-0001-0000-0000> -> Details of NG35

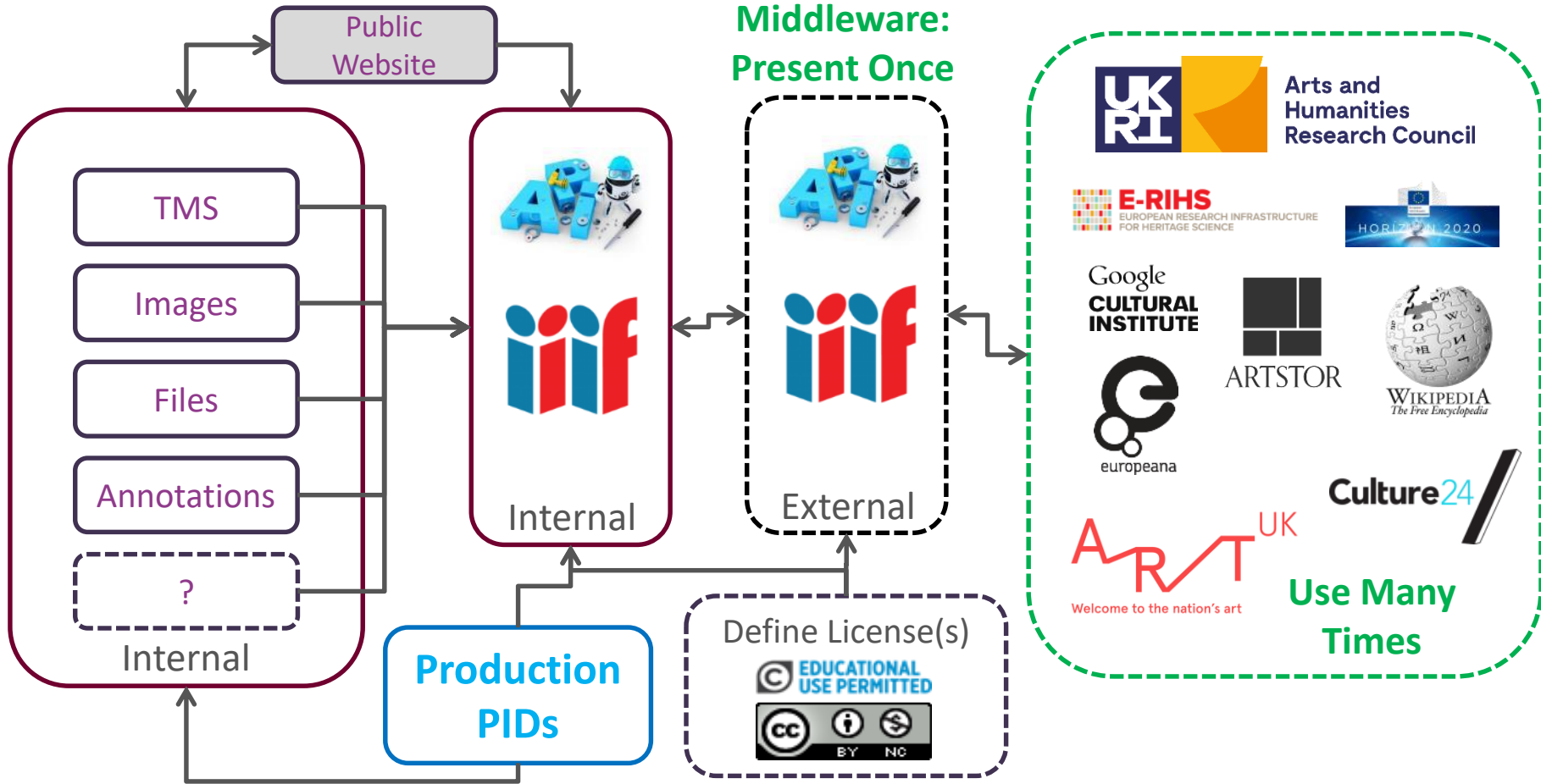
Consider the process of globally registered PIDs:

- Digital Object Identifier (DOI) **doi:10.1186/2041-1480-3-9**
- =handle + added features and rules for persistence, consistency, relationships, semantic interoperability....
- ISO standard, provided by registration agencies, such as <https://datacite.org/>

What will the benefits be from a future combination?

- **Doi:10.XXXX/AAAA-AAAA-AAAA-AAAA**

Building the foundations for a National Collection





Royal
Botanic Garden
Edinburgh

THE
NATIONAL
GALLERY



University
of Glasgow



SCIENCE
MUSEUM
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N
NATURAL
HISTORY
MUSEUM

Towards a National Collection: Persistent Identifiers as IRO Infrastructure
Project Launch Webinar, Edinburgh: 6th April 2020

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Thank you

