LINKED HERITAGE
best practice
NETWORK:
achievements,
RESULTS
and outputs

ICTPSP

europeana
project group
member

LINKEDHERITAGE

Coordination of standards
and technologies
for the enrichment
of EUROPEANA

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КАЛЕВАЛА

ФИНСКІЙ НАРОДНЫЙ ЭПОСЪ.

1. Executive Summary

The Linked Heritage project facilitated and delivered large-scale, long-term enhancement of Europeana and its services. This has been achieved by:

- The contribution of 2.7 million additional metadata records, linking to 7.5 million new digital items.
- Providing of key enabling technologies for diverse content providers to contribute to Europeana
- Delivering pragmatic technological solutions to the problem of non-standard descriptive terminologies; this enhances Europeana in terms of metadata richness, re-use potential, and uniqueness.
- Demonstrating the use of persistent identifiers in digital cultural heritage and their use in linked data.

- Simplifying the provision of private-sector metadata to Europeana, and demonstrating the benefits of private sector interoperability to Europeana.

The achievements have been underpinned by bringing together ministries and government agencies, content providers and aggregators, leading research centres, publishers and SMEs, from throughout Europe in a best practice network of 38 beneficiaries, 10 affiliated partners and 12 additional external content providers..
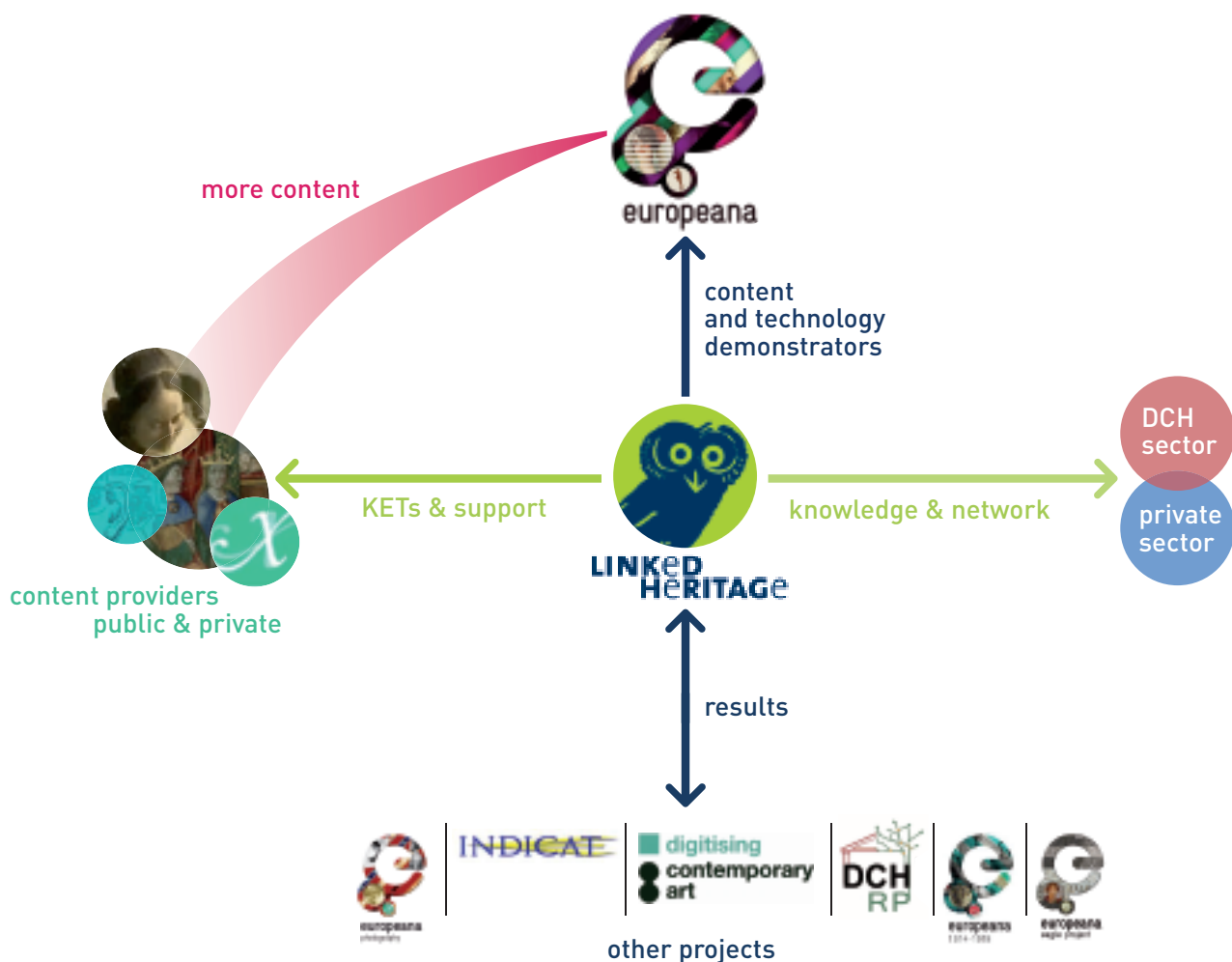
2. Project Context and Objectives

Linked Heritage is a member of the Europeana ecosystem – a family of projects dedicated to providing content to the Europeana portal and research and development of new technologies to enhance the Europeana platform.
The project contributes to Europeana along two axes – (a) the provision of **new metadata** and (b) the use of **new technology**.

Linked Heritage addresses several key **technical** issues for Europeana: interlinking with third party data sources via **linked data**, stability of resource location/retrieve using **permanent identifiers**, standardisation of **terminologies** across content providers and language/national boundaries, access to **private-sector** metadata, technical support.

On a broader sectoral level, Linked Heritage has established a **lasting collaborative network** of organisations and individuals who are committed to the further development of digital cultural heritage in Europe.

Objectives

The aims of the project were:

- To deliver large quantities of **new content** to Europeana, from both the public and private sectors
- To deliver the **key enabling technologies** for the delivery of large amounts of new **multi-source metadata** to Europeana, with optimal **quality assurance** and **intellectual property** management
- To **support** and stimulate existing and new **content providers** around Europe to contribute to Europeana
- Engagement with the **private sector** (especially publishers), identification of appropriate partnership models and input of their metadata to Europeana.
- To **enhance the search** experience and improve the **quality of metadata** through standardisation of **terminologies**.
- To demonstrate the use of **linked data** to support more expressive semantic processing within Europeana, as well as making Europeana information available to third parties.
- To explore the use of **persistent identifiers** and their use for preventing duplicate records and broken links.
- **Outreach, dissemination and training**, to maximise the impact and value of the project's work.
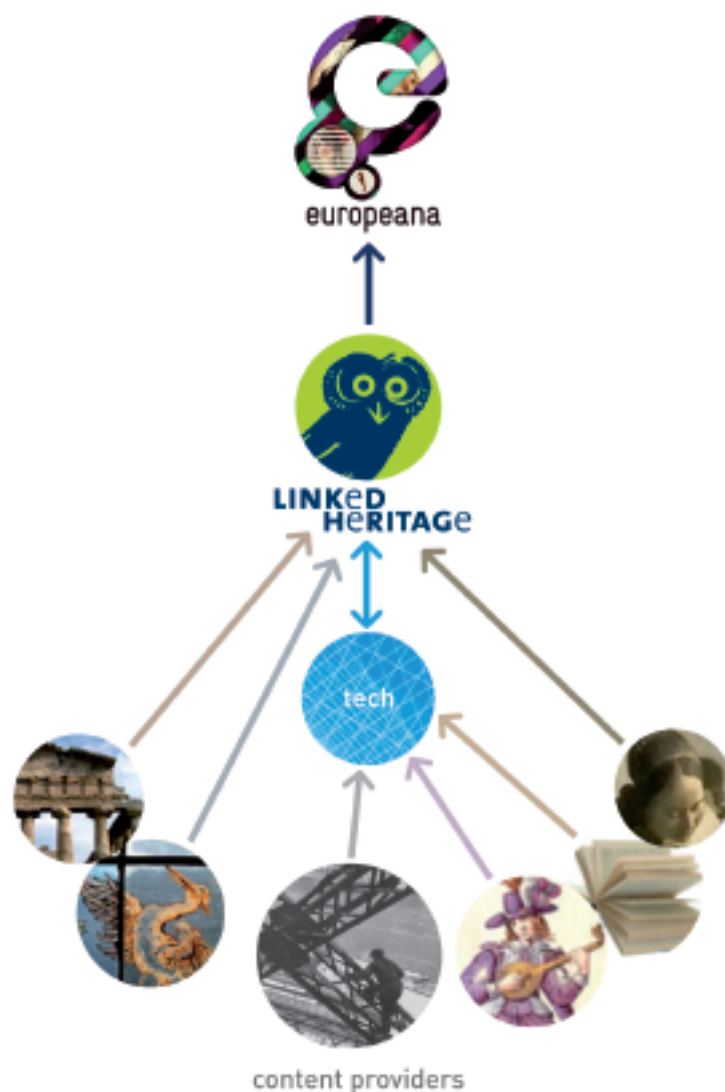
Consortium

The Linked Heritage consortium includes representatives of all the **key stakeholder groups from 20 EU countries**, together with Israel and Russia. These include ministries and responsible **government agencies**, **content providers** and aggregators, leading **research centres**, **publishers** and **SMEs**. Several partners participate in other projects of the Europeana group; this guarantees alignment with Europeana's evolution. In addition, new organisations have contributed content for the first time to Europeana, through Linked Heritage.

Linked Heritage focuses on **areas where, up to now, no clear and agreed solution has been identified,** as outlined above. By developing broad consensus, and by building on the work of other projects within the Europeana ecosystem, Linked Heritage has identified and validated solutions that will enjoy maximum endorsement and "take-up" across the ecosystem and across the European cultural heritage community.

Best Practice Network

The establishment of the Linked Heritage **best practice network** has been a fundamental building block for the achievement of our aims. The network includes the project partners, plus experts and stakeholders from across Europe who have an interest in the work of the project and of Europeana. In order to maximise the network benefit, two categories of working groups were established: Thematic Working Groups were set up at **European** level, focusing on specific pan-European challenges (and supporting work-packages with similar points of focus) and thematic or interdisciplinary **National** Working Groups set up in partner countries have worked on the same topics at national level. The best practice network has enabled the project to benefit from the input of a wide population of experts, over and above the consortium members.

3. Work Undertaken and Key Results

3.1 Overview

The project was delivered as a portfolio of interconnected work-packages (WPs), each of which addressed a specific set of objectives. These are presented below. The **overall flow of the project** was as follows:

One work-package (WP1) focused on the **coordination** of the large consortium, the orchestrating of our efforts and the effective collaboration between teams at national and international levels. It applied a typical project management model, with Project Ccoordinator, Technical Coordinator, WP leaders, etc. Six work-packages addressed the core **research challenges** of the project.

- **WP2** examined **linked data**, the increasingly important automatable linking of online resources by using RDF triples and specialised software, and the potential of **permanent identifiers** to underpin improvements in interoperability, search and long term preservation.

- **WP3** addressed the issue of **terminologies**, and how different organisations and nations have different names for the same thing. An innovative terminology management (TMP) platform was developed.

- **WP4** examined a key business topic – how to attract **private-sector content** onto Europeana, what obstacles exist and how to overcome them. While excellent metadata mapping results were achieved, the conflict between commercial drivers and the DEA appears intractable

- **WP5** delivered the **key enabling technology** for large-scale aggregation of public and private-sector data and (most importantly) its automated **quality control** and submission to Europeana.

- **WP6** **supported** our large population of content providers (which grew by 12 during the project) in the use of this technology and the contribution of content to Europeana.

- Finally, **WP7** **disseminated** the work and results of the project to key target audiences in the cultural heritage sector and beyond, as well as creating a substantial **training** resource to help to build capacity and expertise in the sector.

3.2 Key Enabling Technologies

Challenge: Metadata exists in a multitude of formats and levels of detail. Organisational policies for the re-use of such metadata vary considerably. Europeana requires the best possible quality of metadata, available under a consistent intellectual property model.

Aim: **Linked Heritage WP5** aimed to provide the technology required to map all content providers' metadata records to the Europeana metadata format (ESE) and then publish it to Europeana. This included integration with the terminology system (WP3), support for different models of intellectual property rights, and quality assurance of the metadata.

Work carried out: The team extended the service-oriented MINT platform, originally developed in ATHENA and enhanced in other Europeana ecosystem projects. The platform enables any XML schema to be mapped, using a graphical interface, to the LIDO intermediate metadata standard; from LIDO an existing service generated Europeana-compliant ESE metadata records, which were published using OAI-PMH. The MINT system was enhanced in several important ways:

- by integration of enriched terminologies from the terminology management platform
- by adding an **OAI-PMH** server with OAI-DC and improving **scalability** for large collections of metadata records
- by adding a **linked data** server to enable publication of a subset of Linked Heritage metadata as linked data
- by adding support for multiple levels of **intellectual property management** – this allowed users to specify what license/IP model to apply to their metadata
- by adding **quality verification** and checklists to underpin the submission of high-quality metadata by Linked Heritage to Europeana
- by enhancing the **preview** capabilities and thus adding confidence in the end result of the publication process

These are in addition to the existing MINT system's powerful metadata mapping, publishing and preview/visualisation functions. The system was used successfully by all content providers, and acted as the conduit for Linked Heritage metadata to Europeana.

LIDO – a critical building block

LIDO (lightweight information describing objects) is an XML harvesting schema which was specifically designed to facilitate the contribution of metadata and digital objects to portals and union resources. LIDO is particularly powerful at describing museum objects, but is also broadly applicable to capturing rich metadata schemas from a range of cultural heritage domains. It is compliant with CIDOC-CRM and has been used in a series of EU-funded projects in the Europeana ecosystem, notably ATHENA. The MINT system is a toolkit for converting arbitrary XML schemas to LIDO, thus enabling their further conversion to a range of destination metadata models, including those used by Europeana. For more, see http://network.icom.museum/cidoc/working-groups/data-harvesting-and-interchange/resources/

3.2.1 Key Results

The metadata mapping, quality control and submission/publication system was implemented and maintained for all partners. Significant upgrades were carried out to the system, which remains available for third parties and other Europeana-feeder initiatives to use.

3.2.2 Impact

MINT now represents an appealing avenue for content providers at all levels of technical sophistication
to contribute material to Europeana. In particular, it supports the filtering of content so that different intellectual property models can be applied, and also supports quality assurance of metadata records.
By delivering a pipeline all the way from native XML to ESE (via LIDO), the system greatly facilitates content provision to Europeana, most of all by smaller and local memory institutions.

3.3 Supporting Content Providers

Challenge: Content providers were often not familiar with the details of Europeana's technical and legal requirements. The MINT system, though powerful, could be challenging for new users to use to its full potential.

Aim: **Linked Heritage WP6** was entirely focused on supporting all partners throughout the process of provision, preparation and submission of their content. This facilitated the contribution of the maximum amount and quality of metadata to Europeana.
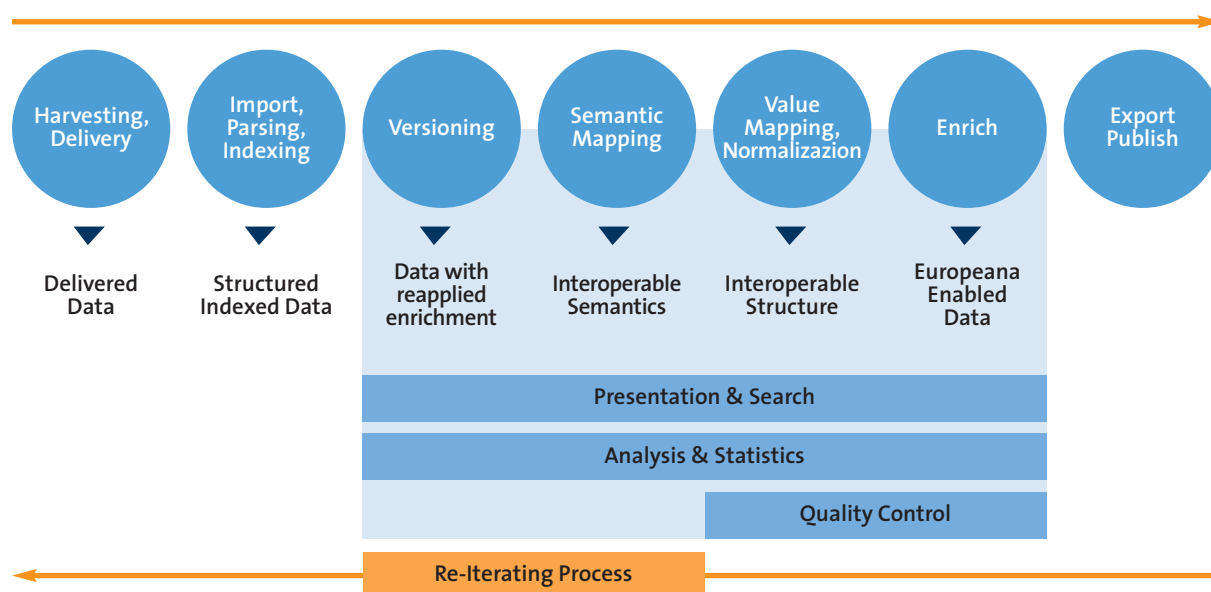
Work Carried Out
An **ingestion plan** was drawn up, which verified that the proposed content was still available for ingestion and set a schedule. Content providers were then given **training** on the use of the MINT technology, and familiarised with ESE, LIDO and other relevant background information. The **training materials** remain useful for present and future MINT users. An ingestion **helpdesk** was established and maintained throughout the project; this helped content providers to map and publish their metadata, and to understand and comply with the Europeana legal model.

This work-package collected **feedback** from content providers on the ingestion process and on the legal and process framework. This helped to inform the refinement of the MINT technical platform. **Monitoring** and feedback per content provider also informed the support process itself.

The evolution of the Europeana Data Exchange Agreement (DEA) during the lifetime of this project caused some issues for content providers. A **DEA task force** was established to discuss the problem and come up with a solution. This led to new functionality in the key enabling technology tools enabling fine-grained control of IP by content providers. By providing full-time support for all aspects of data ingestion, and also for key policy and IP issues, content providers were greatly facilitated in contributing to Europeana.

THE AGGREGATION WORKFLOW THROUGH MINT

Harvesting, Delivery	Import, Parsing, Indexing	Versioning	Semantic Mapping	Value Mapping, Normalizazion	Enrich	Export Publish
▼	▼	▼	▼	▼	▼	
Delivered Data	Structured Indexed Data	Data with reapplied enrichment	Interoperable Semantics	Interoperable Structure	Europeana Enabled Data	

Presentation & Search

Analysis & Statistics

Quality Control

Re-Iterating Process

3.3.1 Key Results

- An ingestion **helpdesk**, which supported our numerous content providers
- The delivery **of 2.7M metadata records to Europeana, representing some 7.5M digital objects**.
- The Linked Heritage network grew to **26 countries, with 38 Linked Heritage beneficiaries, 10 affiliated partners and 12 additional external content providers** who joined the project during the project execution.

Higher quality metadata submitted to Europeana, thanks to the quality control processes implemented in WP5 and operationalised in WP6.

3.3.2 Impact

By providing a support service to the content providers, this work-package ensured that issues or questions were rapidly resolved. For future initiatives with a similar goal, there is little doubt of the value of such a service. Feedback from end users helped in the specification, design and refinement of the technology.

3.4. Engagement with the Private Sector

Challenge: Relatively little private-sector content can be found on Europeana. This reflects a more general disconnect between the traditionally public-sector cultural heritage community and the commercial publishing world. The business and intellectual property rights models to underpin public-private partnership in cultural heritage metadata have not been fully explored.

Aim: **Linked Heritage WP4** aimed to overcome the obstacles to private-sector collaboration with the heritage sector in general, and with Europeana in particular. This included analysis of the business context in private sector, verifying metadata interoperability, exploration of rights agreements, and the validation of these results.

Work carried out: a comprehensive review of commercial sector best practice and standards in metadata management, legal frameworks and business models was carried out. This was analysed in the light of the DEA. The benefits offered by inclusion in Europeana were evaluated from the perspective of commercial metadata owners.

A commercial evaluation of applications and APIs to cultural heritage data was carried out. To date, few have made the transition to significant commercial products. Further development of this theme focused on the potential for commercial licensing of the digital objects themselves, with Europeana acting as a facilitator for the licensing of *content* (as opposed to *metadata* describing the content).

Proof-of-concept commercial data sets passed through the Linked Heritage work-flows, demonstrating the applicability of Linked Heritage technology to private-sector metadata transformation and contribution to Europeana. No data was actually ingested, however, due to IP issues.

3.4.1 Key results

The Europeana DEA is a major obstacle to commercial-sector partnership. Commercial entities need to be offered **clear commercial benefits**, while IP models **must not disrupt** mission-critical commercial data services. This requires licensing models **not based on a CC0** rights waiver.

Publication on Europeana offers few benefits to companies which already have high profiles, established business models, outlets and customer bases. This contrasts with the value (in terms of visibility and distribution) that Europeana offers 'typical' cultural heritage players. An alternative approach, involving the commercial licensing of cultural heritage **materials,** identified via (and possibly licensed through) Europeana, showed good potential.

LIDO was found to be able to capture almost the entire richness of the ONIX for Books 3.01 metadata standard. Initial results for music, film and TV metadata were positive. This opens doors to further interoperability of metadata standards across the public-private boundary.

3.4.2 Impact

The Linked Heritage outputs provide a uniquely informative overview of the interface between commercial and public-sector business models, metadata and services.

Additional work by the team has significantly contributed to Thema, a new international subject categorisation standard being coordinated by EDItEUR, with valuable input from several other partners.

A new project, **RDI**, will use MINT for media rights management. This can help to underpin new public-private partnerships based on shared metadata. Interaction with **Europeana Creative** is anticipated.

3.5. Improved search and higher-quality metadata through terminology management

Challenge: The Linked Heritage project connects data from cultural heritage organizations from many European countries. Hence, the controlled vocabularies used to describe collections come in **various languages and forms**. Incompatible terminologies impede effective searching by end users and are an obstacle for web services that rely on consistent metadata. In order to overcome problems of language and format, data must be made accessible following the principles of the semantic web: publishing in SKOS/RDF, mapping vocabulary concepts, enhancing vocabulary control etc..

Aim: **Linked Heritage WP3** addressed this challenge by creating an **open source tool** where **terminologies** can be uploaded or created from scratch in SKOS/RDF. The terminologies can be managed and exported in the desired format. Concepts from various terminologies are mapped using SKOS-mapping properties. This will allow better search results on the web and in Europeana.
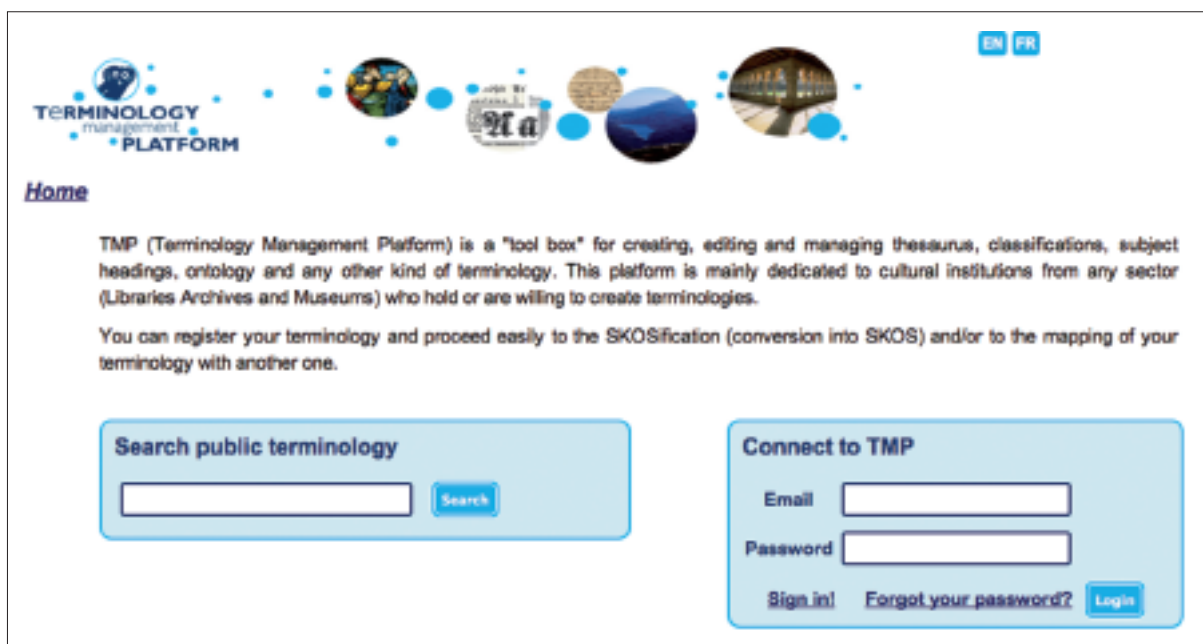
Work carried out: Requirements for a terminology tool were captured by investigating key principles such as the semantic web, SKOS/RDF, multilingual thesaurus alignment, automatic import of various file-formats etc. An **open source tool** was developed with a public and login entry: the Terminology Management Platform (TMP).

A **state of the art** of all the **terminologies** used by Linked Heritage partners was analysed, serving as a starting point for importing controlled vocabularies from Linked Heritage partners in the TMP. **Mapping experiments** have been performed using multilingual terminologies in xTree (DigiCult).

Linked Heritage-content is delivered using the MINT tool, where data is mapped to ESE through the intermediate of LIDO. We looked at ways in which LIDO elements can be enriched in the MINT-tool. The **integration of an enriched meta-thesaurus** from the TMP in the MINT-tool was investigated, so content providers can map their in-house terminologies to a Europeana-compliant format, resulting in maximum value to Europeana and to services which use the Europeana API.

3.5.1 Key Results

- Development of a **Terminology Management Platform** (TMP) making it possible for partners to upload, edit, map and export terminologies in SKOS/RDF. A prototype is indefinitely available at: www.culture-terminology.org. Access is maintained on the project website and on the project showcase in DigitalmeetsCulture.net
- Publication of **guidelines** in "*Your terminology as a part of the semantic Web, recommendations for design and management*" with an easy step-by-step structure of the booklet allows non-experts to make their data visible and accessible on the web. Access to the booklet is maintained in the website: http://www.linkedheritage.org/getFile.php?id=244
- A **questionnaire** containing detailed information on 57 terminologies from 33 partners for future planning of TMP import.
- Manual **mapping** of multilingual and monolingual concepts from terminologies in xTree, using 6 reference terminologies in different languages.
- Implementation of 25 LIDO **event types** and 99 LIDO **actor roles** in the MINT-tool. The event types and roles were translated in 18 languages and then skossified.

TMP (Terminology Management Platform) is a "tool box" for creating, editing and managing thesaurus, classifications, subject headings, ontology and any other kind of terminology. This platform is mainly dedicated to cultural institutions from any sector (Libraries Archives and Museums) who hold or are willing to create terminologies.

You can register your terminology and proceed easily to the SKOSification (conversion into SKOS) and/or to the mapping of your terminology with another one.

3.5.2 Impact

The way to finally get to interoperable metadata has been a long way around and the necessity to get to a semantic interoperability has just emerged. The booklet on terminologies addresses the issue of the semantic Web for cultural institutions. The guidelines and recommendations provided in the booklet help them move towards the semantic web in a most economic and efficient way.

The Terminology Management Platform is a very concrete achievement which makes it easy for institutions to make their terminologies available as Linked Open Data. The Terminology management platform offers a scalable, bottom-up approach to terminology harmonisation but also offers an easy way to reach multilingualism and normalisation. Reuse of the Terminology Management Platform will be assured through other projects such as Europeana Photography and EAGLE.

3.6 Linking Cultural Heritage Information

Challenges: Expertise and capacity in critical technologies for collaboration and interoperability are not widespread in the digital cultural heritage community. Two particularly important technologies are linked data and permanent identifiers, because they address interoperability with external (linked data) data repositories, and because they overcome issues linked to natural site evolution and changes in URL address.

Aim: Linked Heritage WP2 demonstrated the publication of Linked Data to the digital cultural heritage community, including the establishment of a linked data server which delivers our metadata as linked data triples. To identify the most effective way for the cultural heritage sector to create, manage and apply permanent identifiers.

Work carried out: A survey across the project identified high levels of awareness of linked data, but limited practical experience of using (17.5%) or publishing (10%) linked data. Background research and input from the thematic working group fed into a best practice report on linked data (D2.1). Further research and discussion in the domain of persistent identifiers resulted in a research report (D2.2) and the specification of a management infrastructure for persistent identifiers (D2.4).

Following on from the research, the team established technical specifications for linked data in digital cultural heritage (deliverable D2.3), and then implemented a demonstrator server, which published some Linked Heritage metadata as linked data (RDF) triples and showed how they can be combined with external third party linked data.

3.6.1 Key Results

Metadata: The LIDO *metadata format* was identified as the most appropriate to use within Linked Heritage, and to recommend to the wider community. This reflects several years, many projects and millions of Europeana-items that have been underpinned by LIDO and the MINT system. A key recommendation is that, in order to continue to derive value from LIDO, funding organisations (e.g. national partners) should consider making its use mandatory in projects which focus on content aggregation and interoperability.

Licensing: An important finding in this work was that more than half of all linked data collections of triples ('packages') and of all triples are not 'open' (licensed in such a manner as to be freely available for re-use). In fact, 70% of the non-open packages have no **license** whatsoever- this impedes re-use and is very probably not what was intended by the publisher.
A key lesson from the work carried out in Linked Heritage is that *any publication of linked data must be accompanied by a licence* statement, either a standard (Creative Commons) licence or a custom one.

Formats: while the amount of cultural heritage linked data at this time is relatively small, this population is growing. We strongly recommend that *proprietary linked data formats are not created*, but instead standard formats (RDF, dc or FOAF) be used.

Links: the large majority of links in the linked data cloud are to reference packages such as DBpedia and GeoNames, or (in the cultural heritage sector) Library of Congress Subject Heading, Dewey Decimal Classification, etc.). We advise publishers of linked data to *link to reference packages* such as those mentioned above.

Demonstrator: a demonstrator package was developed using material from two partners (CT and UNIMAR), and enhanced data integration and searching using information from the UK Government Art Collection (GAC) was demonstrated.

Persistent identifiers: there are many different PID schemes and providers. Europeana will need to *support a broad range* thereof, as there is no dominant or emerging leader. Memory institutions which plan to support PIDs must have a long-term commitment and clear responsibility, as longevity is central to PID value.

Future Use of Linked data in Cultural Heritage: we have demonstrated feasibility, but licensing and IP remain key issues. *New opportunities to deliver value through linked data should be p*ursued, as its potential is significant.

3.6.2 Impact

The interweaving of cultural heritage material with third party data from other sectors, and with reference data from within the cultural heritage domain, has enormous potential to facilitate new services, new forms of re-use, new business models and new benefits for the sector, for the public and for other stakeholders. We have delivered concrete demonstrations of how this can be done, as well as specific, clear recommendations for avoiding pitfalls and maximising success.

3.7 Dissemination & Training

Challenges: For the project to have as much impact as possible, it required a high profile and awareness in its target audiences, most notably content providers and other ecosystem projects. A perennial issue for DCH is a shortage of expertise in advanced technical topics.

Aim: **Linked Heritage WP7** addressed these two challenges: (a) to raise awareness of the project and its results across key target audiences and (b) to create a series of learning objects which address key elements of the Linked Heritage project (Europeana, aggregation, linked data, terminologies, etc.).

Work carried out: Dissemination a public **website** was established (www.linkedheritage.org) with full information about the project, its team, etc. The site was enhanced with publications, deliverables and other outputs throughout the project lifetime. Extensive use has been made of online **video**, **LinkedIn**, Scoop.it and a wiki. Social media were in constant use, with all partners encouraged to post and tweet about the project. Leaflets, booklets and posters supplemented these online resources. The team also edited two issues o the Uncommon Culture journal. Collaborations with other projects (ATHENA, INDICATE, Europeana Photography) led to **durable publications** intended to inform the cultural heritage community into the future, on topics such as Terminologies and Geocoding of Cultural Heritage. We also concluded a position paper with DC-NET. The project benefited from a permanent showcase in the **DigitalmeetsCulture.net** online magazine (www.digitalmeetsculture.net), site, an online magazine in the digital cultural heritage area featured by partner Promoter and dedicated to the themes of the digital technologies applied to cultural heritage and the arts. The project launch, two seminars and a final EU Presidency Digitisation Conference in Dublin were key dissemination events; these are supplemented by many third party seminars, conferences and workshops to which Linked Heritage contributed.

Work carried out: Training a personalised learning environment was created on the Moodle platform, consisting of a series of **learning objects** (LOs) aimed at key audiences (Teachers, LIS professionals, market experts, cultural institution decision makers). The LOs cover **topics** such as Europeana, aggregation, metadata standards and mapping, digitisation life-cycle, persistent identifiers, linked data, terminology, etc.), and address an identified shortage of awareness of these important topics in our target audience. All LOs were created in collaboration with the relevant WP teams. The LOs are **hosted** in the long-term PHAIDRA1 repository, and can be accessed via a range of channels (project website, partner sites, YouTube, via FreeLOMS2) under a relatively open creative commons **licence** (CC-BY-NC-SA).

3.7.1 Key Results

The key **dissemination** result for WP7 is the high **profile** of the project in the cultural heritage community, with excellent coverage in a range of media. This reflects an effective dissemination plan.

The project has pushed the envelope of several technologies in the Europeana space, and **awareness** of our results is strong. The team has a track record of high-use **durable publications** from other projects, and we anticipate strong demand for the Linked Heritage outputs. Interactions with other projects have been mutually beneficial. Twelve new content providers joined the best practice network- a practical demonstration of the effectiveness of our dissemination.

The most important results in the **training** area are of course the set of learning objects and the Moodle course, which provide engaging visual and text analysis of technology and research topics that are of great interest and relevance to Europeana and (especially) new content providers. These have been translated into multiple languages and are freely available on the Linked Heritage virtual e-learning environment developed by the University of Padova.

3.7.2 Impact

The best practice network has grown during the project by twelve additional content providers. The importance of effective communication and collaboration across the cultural heritage sector in Europe cannot be over-stated. The Linked Heritage network is an excellent avenue for the sharing of expertise and best practice across the EU.
In addition, the new content providers helped to increase the levels of material from nations previously under-represented in Europeana, such a Bulgaria and Estonia.

Expertise and capacity in the technological enhancement of cultural heritage material remains in short supply across the sector. The **durable publications** will serve the cultural heritage community over the medium term, as requirements for expertise in terminologies and geo-enabled cultural heritage become increasingly common. They complement other guidances from related projects in topics such as digitisation, metadata standards, etc. The **learning objects** represent another approach to capacity building in the sector, with the added advantage of market-leading Moodle delivery.

3.8 Coordinating a large international best practice network

Challenges: effectively delivering a project with (at project end) 60 beneficiaries, affiliates and external content providers, with a wide range of skills and expertise and very diverse resources and technologies is a significant challenge, as is establishing, growing and running an international network of common interest so that it delivers the maximum long-term benefit.

Achievement: **Linked Heritage WP1** focused on the orchestration of the efforts of all partners, from content providers to technologists, consultants to publishers. The capabilities of all partners were harnessed to deliver the project aims. Durable networks of contact and collaboration were established and/or reinforced, with long-term benefits.

Work carried out: The establishment of the Linked Heritage **best practice network** has been a fundamental building block for the achievement of our aims. The network includes the project partners, plus experts and stakeholders from across Europe with an interest in the work of the project and of Europeana. Two categories of working groups were established: Thematic Working Groups were set up at **European** level, focusing on specific pan-European challenges (and supporting work-packages with similar points of focus) and broader-scope **National** Working Groups working at national level.

The best practice network has enabled the project to benefit from the input of a wide population of experts, over and above the consortium members.

Twelve new content providers joined the network during the project lifetime, as external third parties perceived the benefits of working with the technologies, support structures and networks offered by Linked Heritage.

Varied levels of experience across the project were addressed by dedicated resources for supporting partners throughout the process. A specific **helpdesk** function supported content providers in the mapping, conversion and publication of their metadata using MINT. Training materials and familiarisation events enabled all partners to achieve their goals. A dedicated Technical Coordinator for the entire project acted as a central person to reply in real time to the questions of partners, an effective help desk to support the partners in finding the right person for each question, a constant monitoring of the project's different activities in order to avoid duplication of efforts to do the same job, or repetition of mistakes already addressed by another partner, etc. In such a big consortium this role has been very important for the smooth progress of the project.

3.8.1 Key Results

A best practice network of 38 project beneficiaries (plus affiliates and external content providers) and over 100 individuals was established as a portfolio of working groups, addressing common topics in varied organisational and national contexts. Organisations from beyond the project consortium were well represented. The network acted as an information source and a validation capability for the work-

packages of the project itself, and ensured it remained true to the needs of the cultural heritage sector as a whole.

The resources and capabilities of the large team were effectively orchestrated. Structure, organisation and efficiency were put in place, in order that project activities be effective and successful. A Technical Coordinator acted as a one-stop-shop for information, support and expertise. Roles and responsibilities of all partners (especially WP leaders) were clearly agreed.

In the second half of the project another working group was added, the **Digital Exhibitions Working Group**, involving partners from Germany, Greece, Hungary, Israel, Italy, Poland and Sweden. This Working Group, which created added value for Linked Heritage, explores current practices, searches through recent bibliography and identifies key questions in order to develop a simple set of effective guidelines for the use of memory institutions in the field of digital exhibitions.

3.8.2 Impact

The long term impact of the network is the network itself – the relationships, awareness of competences, effective collaborations and awareness of how the organisations can learn from one another. Such networks are the at the root of many successful R&D initiatives (including the original core team in Linked Heritage). The project has helped to establish, and to grow, the EU's virtual research community in digital cultural heritage.

4. Lessons Learnt

This section identifies the most important lessons learnt in the delivery of the project, that can inform similar initiatives. These lessons have resonance for the further development and evolution of Europeana and for the broader development of digital culture in Europe.

Content: the large size of the Linked Heritage consortium reflects the fact that the 'low hanging fruit' of very large collections of content are mostly now already in Europeana, or have explicitly declined to take part. Further large-scale expansion (in tens of millions of items) will be feasible, but will require incrementally more institutions and effort-per-item.

Facilitating ingestion: Further expansion requires that the ingestion process is as simple as possible, both technically and legally. The MINT technology used in Linked Heritage can deal with very diverse source metadata formats and can support any new content provider. But human expertise (in terms of both content and technology) is still required at the content provider, as is a help-desk or other support structure. More broadly, it can be concluded that large-scale ingestion will require human intervention an on an ongoing basis.

Communication: the project had an effective dissemination programme, with several events, a closing conference, an active website, a showcase in DigitalmeetsCulture and two durable publications. These were important in helping to attract a dozen new content providers and demonstrate the scalability and broad value of the project.

Support: existing and new content providers were well supported throughout the project. This ongoing support for new providers made their contributing to Europeana more feasible than 'going it alone'. Strong technology and a willing help-desk support function were valuable to simplify the contribution process for new partners. New content providers realised the benefit of working with the Linked Heritage team and toolkit, rather than 'going it alone' in contributing to Europeana.

Linked data: the project demonstrated how metadata contributed to Europeana via Linked Heritage can be converted to linked data and published as a linked data 'package'. It also showed examples of new services that can be delivered, based on interweaving cultural heritage linked data with third party packages. A series of pragmatic recommendations are made, which apply to any cultural heritage publisher of linked data.

Legal aspects: during the delivery of Linked Heritage, the legal framework for Europeana changed significantly, with the introduction of the DEA and the requirement for public-domain (CC0) metadata. This led to a good deal of discussion, disquiet and (in some cases) resistance. The CC0 approach simplifies the landscape, in that the requirement placed on content providers is quite straightforward. It is, however, difficult for many content providers to agree with, or to feel comfortable with, after so agreeing. In the medium term, the intellectual property model used by Europeana may require revisiting. Clear **licensing of linked data** packages (CC0 or not) is also important, to underpin new linked data initiatives that re-use or link to cultural heritage content.

Technical aspects: the optimum use of digitised cultural heritage materials requires more than the now-routine digitisation and online publication. Increasingly, end users and re-users alike require content that is linked to other sources of data, or linkable from other data, be that via a linked-data triple or using a geo-code for positioning, with a stable online location and a description that includes standardised terms. Both new and (critically) existing

digital cultural heritage materials need to be revisited, to be enhanced with new characteristics and made ready for applications which go far beyond the classical web page.

Sustainability of the technology: the technologies used in Linked Heritage have been shown to be very useful, both to content providers and in the service of Europeana. Linked Heritage built on, and enhanced, the MINT system, but also introduced and developed a prototype of **terminology management platform** (TMP). Such a system is essential if the search and retrieve functions of Europeana are to be optimised, and (more broadly) if semantic interoperability across organisational and national boundaries to be a reality. In common with MINT, the TMP is a 'many to one' tool, accepting terminologies from diverse sources, SKOSifying them and mapping them to a shared thesaurus. Sustaining the service over the medium and longer term represents a challenge, which deserves consideration from an international perspective.

Training: Linked Heritage developed an online set of courseware (the learning objects) to address specific knowledge gaps in the cultural heritage sector. However, there is significant demand for more such material, and for the flexible and personalised learning enabled by online virtual learning environments. Digital cultural heritage is central to the future of the cultural sector across Europe, and **more resources to build capacity** and expertise beyond the most commonly-involved bodies (most of which are national in scope) are needed. This is particularly the case for new and challenging technologies such as 3D-visualisation and augmented reality, as well as the management of 'big data' which is increasingly emerging from humanities research.

5. Impact

Linked Heritage has delivered benefit to Europeana, to the broader digital cultural heritage sector and to society in Europe as a whole.

5.1 Benefit to Europeana

Europeana is Europe's digital library, museum and archive and provides digital access to millions of books, paintings, films, photographs, archives, museum objects and other cultural media across Europe. Europeana is the EU's flagship enterprise in digital cultural heritage and its success is fundamental to the success of EU policy in the area. Enhanced quality and increased volume of content are critical to the advancement of the Europeana initiative.

5.1.1 Europeana - The Challenges

Significant challenges have faced Europeana in recent years in respect of the quality and quantity of the content provided, the accessibility of that content and the nature of the user experience. The problems experienced include:

1 Need to increase the **volume of digital items** accessible through Europeana.
2 Issues of **interoperability** and combining collections and external data sources.
3 Uneven (non-standard) **terminologies** – which impedes searching.
4 Lack of **persistent identifiers** (e.g. leading to duplicate records and broken links).
5 **Complex metadata** models (making content provision difficult) and **poor quality of metadata** provided.
6 Lack of content from the **private sector**.
7 Need to attract **wider spread of contributors**/lack of content from some European States.
8 Multiple approaches to **best practice**, technologies and processes.
9 Limitations in the **technical capacity** in the cultural heritage sector regarding Europeana.

These challenges impede Europeana in reaching its full potential.

5.1.2 Linked Heritage - The Solutions

①
More Content: One of the biggest challenges currently facing Europeana is the expansion of its collection. Linked Heritage has directly contributed 2.7 million new items to Europeana (representing 7.5 million digital items) from a broad range of contributors, including **new** and **private-sector** content providers. Apart from sheer volume, the content provided by Linked Heritage is of very high quality, including masterpieces, unique material and material with high re-use potential. Linked Heritage also helps support future growth by facilitating the delivery of content from new sources (e.g. through mapping to the private-sector ONIX metadata standard).

②
Interoperability via Linked Data: The project has demonstrated how cultural heritage metadata can join the linked data 'cloud', where they can be accessed by third parties, adding value to many applications. The content used for the demonstration has been converted to Linked Data RDF triples and published as a LD package, for contribution to the LD "cloud". The Linked Heritage LD package may be used as a model by other initiatives, and can be up-scaled to enable the entire Europeana dataset to be published as LD.

③
Terminology Standards: Linked Heritage has delivered cross-domain multilingual terminologies enabling more precise searching and more relevant search results. The Linked Heritage terminologies are focused mainly on controlled vocabularies concerning People, Locations and Concepts; they can be extended, refined and maintained by members of the Europeana community. The thesaurus delivers more precise user searches, as well as more relevant and targeted search results.

④

Persistent Identifiers: We have identified and disseminated best practice for persistent identifiers, thus addressing the issues of broken links and duplication and improving the search experience. Content has been tagged with a persistent unique identifier, allocated using a scalable and effective management model, to ensure that identifiers are truly unique, and that a one-to-one mapping between items and identifiers is assured. Several pragmatic recommendations are made for cultural heritage organisations which intend to support permanent identifiers, now or in the future.

⑤

Metadata Models: Linked Heritage has provided metadata models, best practice tools and techniques to facilitate content contribution and the enhancement and aggregation of content from content providers. Linked Heritage content records contain a rich metadata set, through the use of an intermediate mapping specification which captures the **rich metadata** before transforming it to the Europeana specification (present and/or future) in a manner which **minimises information loss**. The Linked Heritage model provides quality-controlled metadata which is also DEA-compliant. The Linked Heritage aggregation used a checklist at publication time, to ensure the metadata provided was as complete as possible, leading to more meaningful and fruitful search and retrieve potential.

⑥

Private Sector Contribution: In addition to direct contribution by the private sector through Linked Heritage, the project has also laid the foundations and framework for significant future collaborations with the private sector, through, for example, support for the ONIX metadata standard.

⑦

The large consortium, and particularly the addition of new content providers during the project, meant that content is now being provided to Europeana from a significant number of **new sources**. Several of these are from **under-represented countries**.

⑧

Best practice: The consensus-based approach used by Linked Heritage means that common solutions to Europe-wide issues have been identified and validated. The broad representation and involvement of many stakeholders means that the best practice guidance from the project is likely to be accepted consistently.

⑨

Dissemination and training: A comprehensive training and dissemination programme has produced numerous publications, training resources and on-line tools, building awareness of the project and developing technical capacity in the sector.

5.2 Benefit to Cultural Heritage Sector

The global cultural heritage sector ('the sector') is in a state of continuing dynamic evolution. The mission of the sector is changing rapidly, with the emphasis shifting from curation to collaboration, repositories to re-use. Increasingly, DCH collections are seen as critical digital data sources for a multitude of purposes, from education to tourism to creative industries.

5.2.1 The Sector – Challenges

The imperative to interwork with other actors, including the contribution of material to Europeana, leads to a series of challenges, experienced across the sector:

The need to **deliver interoperable metadata**. This of course includes contributing to Europeana, but has been a key challenge since DCH organisations first started to collaborate. While mapping of metadata to standards (e.g. Dublin Core) is a well-established model, it often leads to loss of richness in the metadata.

A related issue is the use of **different terminologies**, where organisations use different terms to describe the same entity or concept. This impedes effective searching and efficient re-use of Europeana content by third parties.

- The need to **interlink with third party data sources**, both within and beyond the cultural heritage sector. Increasingly, individual initiatives are seen as open data sources, and combined innovatively to develop new services. The cultural heritage sector must not be left behind.
- The need to **protect intellectual property** – content providers are often rather protective of their content (reflecting the fact that it is typically their most important organisational asset). The Europeana DEA is a particular challenge for some content providers.

- The need to **learn from one another** - the sector is very large and diverse - most problems will have been encountered, and solved, by someone else. Access to best practice and expertise is crucial.
- The need to engage the **private sector** to a greater degree in collaborated digital cultural heritage initiatives.
- The shortage of **technical expertise** – the sector as a whole continues to lack sufficient personnel with the combination of cultural heritage and technological skills to deliver optimal digital cultural heritage services.
- The 'project-based' nature of much digital cultural heritage funding encourages '**research silos**' and impedes effective sharing of results across projects

5.2.2 Linked Heritage – the Solutions

- Linked Heritage's **key enabling mapping and publication technologies** are available to the entire sector on a zero-cost open source basis. The tools support mapping from any source metadata format to ESE; other destination formats can readily be added. A particular focus is on **maintaining metadata richness** as far as possible.
- A registry and **management system for terminology harmonisation** is an important output of the project, which will remain available and valuable to the sector.
- We have demonstrated the creation of a **linked data** package, using metadata generated in the project (and ingested into Europeana). This demonstration is an important early step to web-2.0-enabling of other cultural heritage resources. We have also explored the use of **permanent identifiers**, which are critical to the durable interlinking of online resources.
- Our key enabling technology platform explicitly supports **different levels of licensing** of metadata, in order to allow content providers to specify the license they wish to apply for different end-purposes (e.g. Linked Heritage

experiments, as opposed to Europeana publication) and for different metadata sets.

- The Linked Heritage **best practice network** brings together a substantial team (>100 individuals) with a range of specialisations and experience from across the sector. These networks of contacts and shared experience will persist long after the project has ended, and will stimulate the flow of information from one organisation to another.
- We engaged from the very start with the **private sector** and several such companies are partners in Linked Heritage. An important output is the demonstration mappings between private sector metadata models (notably ONIX) and public-sector models (notably LIDO and ESE). However, the business models promoted by Europeana (notably the CC0 DEA) are not commercially feasible.
- Our **training** activities have already benefited the sector, and remain an important part of our legacy. This includes both online learning objects and durable publications, as well as the project website and resources.
- Linked Heritage had a strong focus on **inter-project collaboration**, and has meaningful engagement with several other projects (INDICATE, EuropeanaPhotography, DCA, DCH-RP, Europeana1914-1918 etc.).
- To communicate and establish a factual dialogue with the community of cultural heritage organisations, to promote Europeana and to encourage them to join Europeana; this has been realised with several complementary instruments, i.e.: the project's website, the show-case on digitalmeetsculture online magazine, the Uncommon Culture magazine, booklets and other dissemination material.

5.3 Benefit to Society as a Whole

The provision of an effective digital cultural heritage platform (such as Europeana) is important for a number of reasons. Linked Heritage has made a valuable contribution to furthering the socio-economic benefits identified below, through its impact on Europeana and the digital cultural heritage sector as a whole.

Cultural impact: Europe has a vast, varied, multi-lingual cultural heritage. Ensuring optimal access to Europe's digital cultural heritage has cultural benefits for the general public across the continent and ensures that cultural heritage is maintained for, and appreciated by, future generations. The impact leads to improved quality of life for European citizens, re-use of content for general social and recreational purposes and an increased appreciation for European cultural patrimony.

Educational impact: A more user-friendly Europeana, with more effective search provides significant benefits to students, academics and researchers (e.g. developing learning and educational content), thereby delivering educational and academic benefits.

Commercial impact: The availability of an optimal digital cultural heritage resource also has significant commercial benefits e.g. the reuse and leverage of content for the travel and tourism sectors and the creative. The potential for significant economic impact is reflected by the inclusion of cultural heritage in the Digital Agenda for Europe.

6. Dissemination and Exploitation

The dissemination of the Linked Heritage activities and results has primarily been aimed at content providers and other projects. This reflects the nature of the project as a 'feeder' project to Europeana and as a technology validation initiative.

6.1.1 Other Projects

Inter-project Cooperation Agreements were signed with the following projects

6.1.2 The Cultural Heritage Sector and New Content Providers

Dissemination to the cultural heritage sector and to both new and existing content providers has been the focus of the best practice network; this has led to twelve new partners joining the network during the project lifetime.

Formal **Cooperation Agreements** were signed with **new content providers and aggregators** in Belgium, Croatia, Lithuania, Ukraine, Italy and the Russian Federation, who joined the team (without external funding) in order to benefit from the network and facilities offered by Linked Heritage.

6.1.3 Printed publications

Linked Heritage and its partners have featured widely in printed publications, appearing in educational booklets, academic journals, and scientific articles.

Terminology Education Booklet
The booklet, *Your Terminology As A Part Of The Semantic Web Recommendations For Design And Management,* was published in the initial phase of the project. With over 1500 copies distributed at dissemination events, and over 4500 copies downloaded from the project website in total, the booklet has served as a useful tool for those addressing the complicated issue of terminology in cultural heritage and linked data. Following the successful French translation, Hungarian and Italian versions will soon be available.

Geocoded Digital Cultural Content
Following the fruitful memorandum of understanding between the Indicate project and Linked Heritage, another publication has been printed: *Geocoded Digital Cultural Content*, by Franc J. Zakrasjek and Vlasta Vodeb. This publication addresses the central issue of digital geographic coordinates, which can serve as incredibly valuable geographic descriptions. They allow for a far greater user experience, where cultural portals can provide information about overlapping cultural content at the same location but originating from different sources at different times.
This study investigates the possibilities and approaches regarding the use of e-infrastructure in geo-coded digital culture.
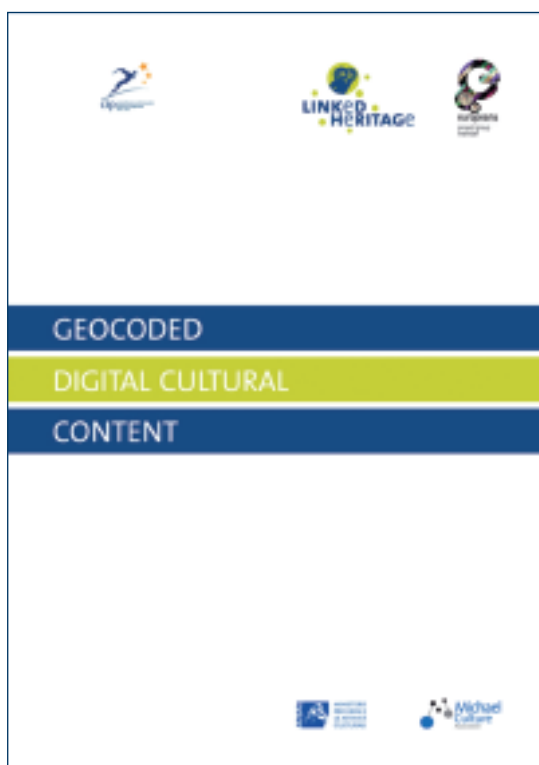
**www.linkedheritage.eu
/index.php?en/181/publications**

6.1.4 Uncommon Culture

Professional journal (ISSN 2083-0599 (online); 2082-6923 (print)) directed by ICIMISS, born during the Athena Project. It provides unique perspectives on a rich variety of cultural activities in Europe. Examining cultural institutions and their collections, this magazine gives new insight into diverse cultural activities.

During the Linked Heritage Project, two issues were edited:
• From closed doors to open gates
• Collections development.
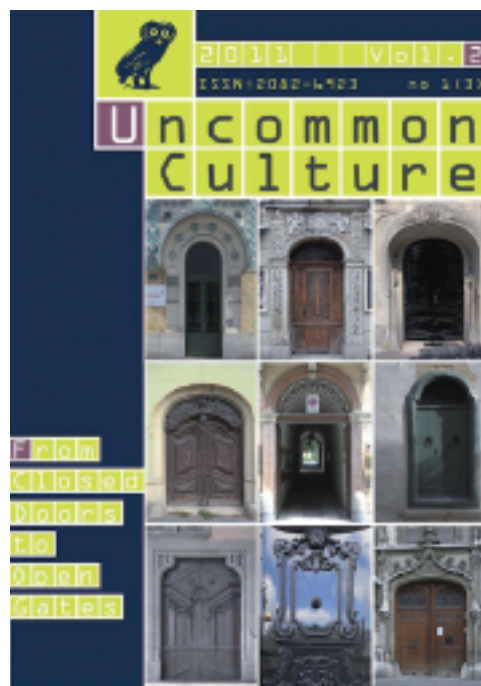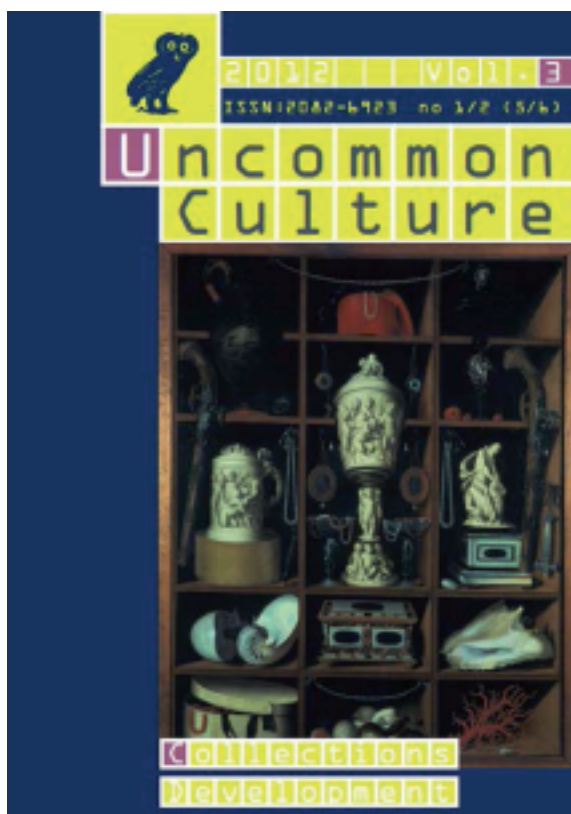
www.uncommonculture.org

6.1.5 Linked Heritage on the Web

Linked Heritage has gained a strong presence on the web, utilising its own website as well as featuring on a variety of important sites in the cultural heritage community. Below is a selection of the project's online activities:

Project Website
The project website serves as the centrepiece of the Linked Heritage online effort. Featuring partner profiles, project information, and dissemination publications, it provides a useful portal to understanding both Linked Heritage and the wider cultural heritage community.

A broad portfolio of publications, assets, learning objects and deliverables are available for download.

www.linkedheritage.eu

Michael Culture Website
The Michael Culture Website serves as a Europe-wide network for the valorisation of cultural content. The Linked Heritage project features heavily on the site's homepage, with a permanent link and button directing visitors towards the Linked Heritage Wiki.

The Michael Culture website showcases Linked Heritage Partners, where they discuss their main challenges.

DigitalMeetsCulture Showcase

The project currently features on the digitalmeetsculture site, an important online magazine in the digital cultural heritage area featured by partner Promoter and dedicated to the themes of the digital technologies applied to cultural heritage and the arts. The online magazine is becoming increasingly popular, with over 50,000 visitors and 100,000 pages visited in the last year. Linked Heritage has a button permanently featured on the homepage, providing easy access to information about the project, including the latest news, documents and over half a dozen highlighted articles. Linked Heritage also features in the DigitalMeetsCulture Newsletters, which are distributed to over 4,000 readers.

7. Partners and Contributors

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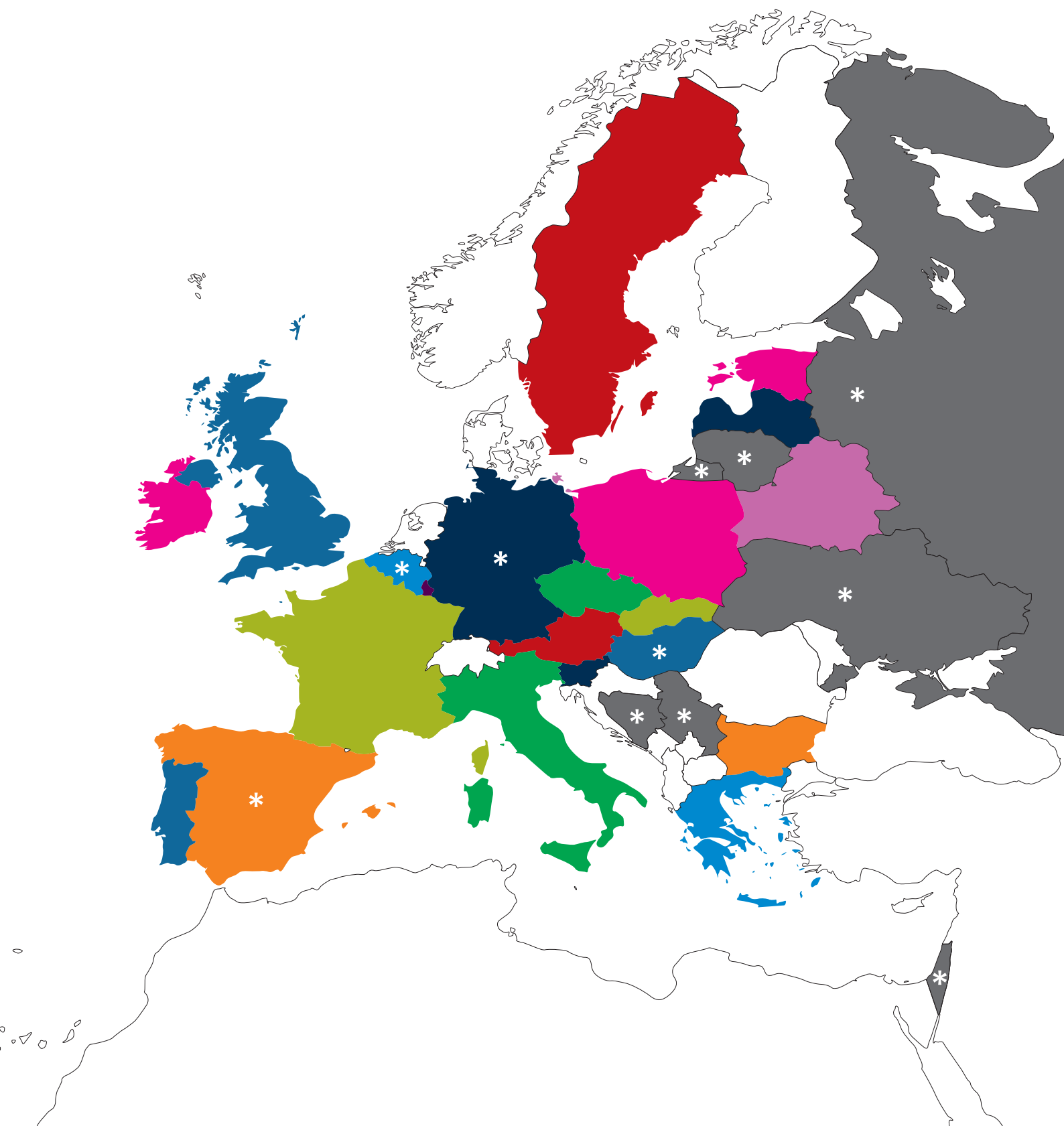**RUSSIAN FEDERATION**
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30 months on, its results are impressive. 38 partners from 26 countries, together with 10 more external contributors recruited during the project including Lithuania, Russia, Croatia and Ukraine, coordinated the aggregation of over 2.7 million items to Europeana, making it one of Europeana's biggest aggregators. The Linked Heritage aggregation includes data from archives, museums, libraries, research centres and universities, and covers 3D models, manuscripts, ancient prints, medieval antiquities, archaeological artefacts, monuments, Greek and Latin inscriptions, fossils, ancient and modern paintings, ethnographic collections and more.

From the Europeana pro blog