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ORCID AND DATACITE

INTEROPERABILITY NETWORK

http://odin-project.eu

D4.2 Workflow for interoperability

WP4 – Interoperability

V1_0

Final

Abstract: We analyze the different persistent identifiers (PIDs) and the potential interoperability between them. We propose different approach to the interoperability between DataCite DOIs and ORCID IDs as well as between other PIDs. We present claim tools and data connections for different types of research objects.

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1. INTRODUCTION

Interoperation between Persistent Identifier (PID) systems is desirable for numerous reasons. By connecting unambiguously-identified individuals to their research contributions, be it datasets or more "traditional" publications, all the participants in the research process benefit. Researchers can gain recognition and reward for a fundamental part of their activity as their contribution to specific datasets can be collated, publicised and cited. Funders, institutions and projects can analyse the way that the datasets are used, re-used, cited, modified and commented upon, giving a much richer understanding of the impact and value of research activities. Whether the focus is on tracking the progress from blue-skies, fundamental research to real-world applications, or in analysing the return on investment from a specific facility, the policy value from the research in this field is potentially enormous. The benefits to the research community of interoperation are such that it is imperative that we overcome the sociotechnical obstacles to the adoption of PIDs.

ODIN has advanced both the state of the art in PID interoperation, and our understanding of the nature and extent of the remaining challenges. In this deliverable, we set out how ODIN has integrated PIDs into real-life research systems, from electronic theses and dissertations aggregators, to large-scale open access platforms, to datacentres across disciplines. We discuss the lessons learned and new understanding gained during these integrations. We draw out the specific issues that emerge from our work as a priority for future work in this area, and set ODIN's work in the context of the wider landscape, of PID use and development. We offer insight into one of the key enablers of interoperation, metadata schema harmonization, a process that offers as many opportunities and challenges as there are schemas deployed. Finally, by providing a series of rich case studies of the interoperation of PIDs in systems and platforms across the research ecosystem, we illustrate both the power and benefits of PID interoperability and the value of the conceptual model of interoperation developed during the project.

2. THE ODIN CONCEPTUAL MODEL

In D4.1 (Conceptual model of interoperability) we developed a conceptual model for addressing the following interoperability challenges:

- Inability to follow interconnections between datasets and contributors as a method of data discovery
- Inability to share and connect identifiers of contributors and authors between different user communities
- Inability to uniquely identify datasets attributed to a particular contributor or contributors to a particular dataset

The approach we took for the development of this model entailed the following:

- Building a model of interoperability that is open, discipline-neutral, and inclusive
- Building upon existing e-Infrastructures where possible
- Focusing on data citation and attribution as the most tangible, immediate goal
- Suggesting proof of concept studies for first practical implementations of this model

The proposed model consists of three layers of increasing complexity:

- **The trusted identifier layer** - criteria for persistent identifiers for objects and people
- **The data citation virtuous circle** linking research data and their contributors via data centers, DataCite, and ORCID
- **Common data services e-infrastructures** which provide linked persistent identifiers in the data services e-infrastructures for the European e-Infrastructure framework

Based on this model we have created tools such as the ORCID/DataCite claiming tool (see section 4.1.1) and the ORCID/Ethos import tool (see section 4.2.2). These tools are discussed in this report in some detail, and serve as test implementations of the

ODIN model, validating it and pointing the way to remaining challenges and potential solutions.

3. PID HARMONIZATION

The ODIN project has necessarily focussed on interoperability between ORCID and DataCite PIDs, and with other initiatives via these organisations. But the identifier landscape is much broader than these few examples. The nature of the challenges to be met in rolling out a truly interoperable, accessible and scalable infrastructure should be set in that broader context. Researchers engage with many systems, many of which use PIDs of one kind or another. Some systems are proprietary. Others are used only in a given institution, or a given discipline.

By establishing this context for the detailed practical work that the ODIN team has undertaken, we can begin to better understand both the impact and limitations of what has been achieved. It is important to prioritise interoperation with those systems that offer the greatest benefits to research stakeholders, since it is essential that researchers are incentivised to engage with interoperable systems that can help them to draw together their disparate identifiers, profiles, and records. ODIN's achievements in moving forward the state-of-the-art, alongside its analysis of the PID ecosystem, provide the foundation for a move toward a more useful and usable suite of PID-linked services. Interoperability turns overlaps into interactions, and smoother interactions can lead to better services. The steps taken here to map these overlaps and to understand how we can enable new interactions are an essential part of the process of evolving PID provision and implementation.

3.1. Researchers' PIDs

Over the years there have been many attempts to assign authors unique identifiers and it is not uncommon to encounter widely published, active researchers with more than 10 unique identifiers.

Identifier types can be specific to a single vendor, country, discipline, institution, funder or publisher, or can emerge from wider community initiatives. Some identifiers have emerged as byproducts of online scholarly tools designed to manage publications and reading lists. In addition there are multiple social tools, academically focused or otherwise, which are in wide use and that have the concept of identity built in.

Through informal conversations from staff in different data centers it seems that they see two distinct uses for author identifiers within their systems: disambiguation and linking. They have expressed the view that, while author identifiers and author publication lists are related, they serve very different functions.

The type and scope of identities vary depending not just on the use-case they were designed to meet, but also on the use-cases they have evolved to address. This section describes some of the most commonly seen identifiers, their popularity, their history and their usage. It also suggests ways in which these identifiers might be linked. These findings are from desktop research conducted during the project and derived from meetings with the Medical Research Council (MRC), Australian National Data Service (ANDS), Dryad and the UK Data Archive (UKDA).

3.1.1. Author Identifiers in the wild

All published authors have multiple identifiers. This is unavoidable as many are automatically generated and assigned. One professor from the University of Bath has twelve identifiers listed on his blog[1], and the list excluded his semi-persistent institutional and blog-based email addresses. Very few of these were under the control of institutions such as libraries, funders or universities and the professor expends a significant effort coordinating the content of his various profiles.

[1] http://chemosensors.wordpress.com/tonyjames/

There are diverse drivers towards the adoption of specific non-automatically assigned identifier systems. Common reasons include:

- popularity amongst peers (use by colleagues, co-authors etc.),
- utility (citation tracking, publication history management, author promotion or similar)
- and institutional mandates (required to publish, register for services or get funding).

Identifier systems have taken various approaches to attracting users and creating/maintaining profiles. In appendix 1 we summarise their approach to openness and list known barriers to interoperability:

Publisher led

- Scopus ID[2] (Elsevier)
- ResearcherID[3] (Thomson-Reuters)

Disciplinary

- arXiv[4]
- RePEc Author Service[5]
- PubMed Author ID[6]

Discovery led

- Google Scholar Profiles[7]

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[2] http://www.scopus.com/search/form/authorFreeLookup.url

[3] http://www.researcherid.com/Home.action?returnCode=ROUTER.Unauthorized&SrcApp=CR&Init=Yes

[4] http://uk.arxiv.org/help/author_identifiers

[5] https://authors.repec.org/

[6] http://www.nlm.nih.gov/pubs/techbull/nd10/nd10_pm_author_id.html

- Microsoft academic research ID[8]
- AuthorClaim[9]
- ORCID ID[10]

Repository/Institutions led

- JISC Names[11]
- ISNI[12]

Social

- Linkedin[13]
- Mendeley Profiles[14]
- ResearchGate[15]

3.1.2. Trusted identifiers

The D4.1 report discussed the concept of "trusted identifiers", those which are unique, persistent, descriptive, interoperable and governed. Each of the identifiers above has been reviewed in this light. To recap, trusted identifiers are:

- unique on a global scale, allowing large numbers of unique identifiers

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[7] http://scholar.google.com/citations?view_op=search_authors

[8] http://academic.research.microsoft.com/

[9] http://authorclaim.org/

[10] http://orcid.org/

[11] http://names.mimas.ac.uk/

[12] http://www.isni.org/

[13] https://www.linkedin.com/

[14] http://resources.mendeley.com/Mendeley_Web/online_profile/

[15] https://www.researchgate.net/go.Profile.html?pli=1

- resolve as HTTP URI's with support for content negotiation, and these HTTP URI's should be persistent.
- come with metadata that describe their most relevant properties, including a minimum set of common metadata elements. A search of metadata elements across all trusted identifiers of that service should be possible.
- are interoperable with other identifiers through metadata elements that describe their relationship.
- are issued and managed by an organization that focuses on that goal as its primary mission, has a sustainable business model and a critical mass of member organizations that have agreed to common procedures and policies, has a trusted governance structure, and is committed to using open technologies.

Of the identifiers discussed in 3.1.1, only two met the criteria to qualify as trusted: ORCID and ISNI. The main stumbling block other identifiers hit was that of governance; they were either controlled by a single commercial entity, too narrowly focused to be universally applicable or were built on short term non-sustainable funding.

3.1.3. Author identifiers vs Author profiles

Since most existing scholarly identity systems attempt to both uniquely identify the individual scholar and manage the profile of his or her scholarly output, it is a common misunderstanding that the two functions are inseparably linked. While there is an obvious need to link authors with output, the idea that they must be bundled together is false and, in fact, may not be desirable.

A profile in this context could contain almost anything; academic output, biographical information, blog posts, charitable work, curriculum vitae, to name a few. Content depends on the use-case of the particular profile provider and the profile creator. In addition, there are differing levels of trust associated with different

profile sources. Some contain only self-asserted associations, while others contain assertions derived from authoritative sources such as employers, publishers or libraries. Assertions from various sources all have their place but users of the profile data should be able to distinguish between the two.

Profile management tools have evolved into de-facto author identity systems (i.e. Google profiles or LinkedIn) and identity systems have been built with their own profile management tools. This has resulted in an ecosystem that duplicates effort and functionality in multiple places. It means authors have to manually maintain and synchronize multiple, and in some cases identical, publication lists across sites.

In contrast, a unique author identifier identifies the author, independent of their output. It is used to refer to the author in external contexts, such as grant applications, data deposit or publication submissions. It is required to disambiguate between those not-so-unique identifiers that we all have: our names. It should be a requirement that the identifier can resolve to the various associated profiles, and that metadata attached to the identifier should link to other identifiers or profiles.

The striking difference between them is that identifiers have exactly one use-case, which is uniquely identifying authors, whereas profile management tools address a myriad of disparate use-cases at various levels of trust. This means that while an author requires exactly one identifier, they could require multiple profiles. Although derived from a different angle, this conceptual model bears a remarkable similarity with the linked data approach to identity.

In the face of the current 'combined' approach to author identity, attempts to unify identifiers have also been attempts to unify author profiles. They have taken the "import and synchronize" approach from existing identity/profile systems. One problem with this approach is that attempts at unification can result in *Yet Another Identifier And Profile Management Tool*, which means *Yet Another Place* for authors to keep up to date and *Yet Another Identifier* they need to remember.

3.1.4. User vs Institution

It is important to note that researchers have very different priorities from the various parties that handle data about researchers, such as data centers, libraries, funders and publishers. Authors talk of dissemination, recognition and networking. Institutions are interested mainly in cataloguing, adding and updating metadata, validation/claiming, etc. Both choose the tools that best serve their purposes and it is not always the case that they overlap. Measuring impact is one area that both sides of the equation have been traditionally interested in, especially given that this has become increasingly important for funders in recent years.

Another aspect of identifier systems that deserves consideration is control. Who creates and maintains the identifiers, are they user driven or institutional? From the previously mentioned informal discussions with users and data centers we have found that both want control of the identity systems they utilize. Datacentres desire authoritative sources, users like to be able to assert and edit their identity information. User use-cases usually involve them having control and vice versa for institutions.

This presents a quandary. Are they mutually exclusive or can they be combined? Is there a viable hybrid model? ORCID have attempted to bridge the gap by allowing users or institutions to create identities and users to edit them, import data from external sources, and give trusted parties some rights to update their data. ISNI depend entirely on institutional sources such as library catalogues with no user editing or creation. The end result is that while ORCID iDs are more flexible and more likely to be adopted by users, the records attached to them are seen as less reliable by some data centers than ISNIs. The fact that anyone can create an ORCID iD at any time and could potentially claim to be anyone can be seen as both a blessing and a curse.

3.1.5. Linking author identifiers

The identifier landscape is constantly evolving. New technologies appear and users are compelled to use them, even while maintaining largely defunct profiles elsewhere. Bitrot and broken links mean that users are reluctant or unwilling to delete these old profiles even if they are rarely used and there are better tools available to replace them with.

Given that many identifiers don't allow updates and others require manual work (i.e. ISNI), automatically creating bi-directional links between identifier systems may be difficult if not impossible. Even where the capacity to link is built in, older systems often don't recognise newer systems and newer systems only recognise a subsection of available identifiers.

Merging profiles by importing and synchronising the contents of multiple sources has proved difficult. Attempting to automatically disambiguate items, keeping up to date, and allowing push or pull, all whilst allowing users to curate their profiles has often resulted in quirky non-intuitive behaviour. User expectations lead to complaints of automatic updates overwriting their profiles while simultaneously expecting the same system to reduce the need for manual intervention. This is another area that warrants further work and investigation.

What is definitely possible is for a single persistent identifier to link out to all known other identifiers using a hub and spoke model. This could then form the backbone of a linked identify system. It's worth noting here that ORCID supports this concept. The ORCID registry interoperates on a technical, metadata and political level with other PID systems and providers in order to facilitate a smooth and seamless flow of information between records. A full discussion of this topic is beyond the scope of this document but it deserves fuller and more detailed consideration in the context of identifiers.

As an example of how such discussions and considerations could evolve, organisational PIDs are available via Ringgold (an ISNI Registration Agency), which

also maintains those records[16]. As planned improvements in the interoperation between the Ringgold and ISNI systems are not still online, the ORCID record will capture ISNI organisational PIDs in addition to those from Ringgold.

At the metadata level, ORCID aims to comply with CASRAI standards, to ensure that terms and descriptions used in the ORCID metadata should crosswalk easily with other schemas.

Future developments in interoperability can be driven by close cooperation and mutual understanding between PID registries. As an example, ISNI and ORCID have signed a Memorandum of Understanding[17], establishing a strategic partnership aiming to further technical interoperability and to work together on harmonising communications.

3.1.6. Key findings

With a wide range of use cases to satisfy, and the fact that multiple identifiers are the norm rather than the exception, being able to link and connect disparate identifier schemes using a trusted identifier system is of paramount importance. If the goal is to have a single unique identifier for an author then attempting to duplicate the proprietary profile management software and data held by large publishers, search aggregators or social networks is a mammoth task and in the end, unnecessary. A unified author identity system should join rather than replicate existing systems. It should link out or present a merged view of an author's output rather than attempt to manage it. It should enable the discovery of author profiles and combine their contents intelligently rather than store the contents itself. Put simply, a unified identifier should enable aggregation of profiles rather than attempt to replace existing profile management systems.

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[16] http://ORCID.org/blog/2013/06/27/ORCID-plans-launch-affiliation-module-using-isni-and-ringgold-organization

[17] http://www.isni.org/content/isni-and-ORCID-sign-memo-understanding

ORCID and ISNI stand out as the current best of breed. If combined and used correctly, ORCID and ISNI could form a trusted identifier system that achieves all this and satisfies both researcher and institutional use-cases. ORCID was envisioned and implemented with identifier interoperability in mind. Its wide scope and vendor-neutral position has given it a broad base of support from a variety of publishers, institutions, data repositories and governments, and there is growing user and organizational uptake. It is also sustainable given long-term community-based funding. ISNI also has a broad base of vendor neutral support, from libraries as well as publishers, and is an accepted ISO standard. Where ORCID lacks, ISNI excels and vice versa. Where ORCID is dynamic and user driven, ISNI is authoritative and institution or library driven. Where ORCID focuses on journal articles, ISNI focuses on monographs, books and other outputs such as music or patents. Where ORCID focuses solely on current researchers, ISNI examines historical as well as contemporary records.

Both identifiers take an 'import and synchronize profiles' approach, but importantly they both also have the capacity to provide links to the original sources. They interoperate well, with an ORCID iD being able to reference the associated ISNIs. They share the same identifier format and have reserved, non-overlapping identifier series, so that they can fit in the same workflows with little adaptation and can always be told apart by automated agents. If ISNIs can be made to reference ORCID iDs then they could be used interchangeably to cover many more use cases.

A trusted identifier system that links others together will provide stability that counterpoints the growth and decline of other identifiers in use. It will also be able to adapt to emerging identifiers and other technology.

3.2. Data PIDs

The persistence of the links to information provided in a scholarly citation is a critical aspect of a good citation[18] [19].The scholarly community has developed a number of systems to incorporate more permanence into the data distribution system.

Organizations are increasingly recognizing the importance of technology in properly citing data (i.e.: the Force 11 Joint Declaration of Data Citation Principles[20]). Persistent identifiers (e.g., resolvable DOIs, URIs, and Handles) provide both human- and machine-readable means that can direct users to the data set of interest. Their benefit is the fact that they identify the data set, regardless of its physical location, thereby avoiding the common issue of changing or disappearing URLs. More importantly, for the purpose of citing data, persistent identifiers provide digital data citations with additional findability characteristics, making data easier to access and reuse. However, it is important to note failure to maintain registries of persistent identifiers will cause the same instability problem that URLs present.

Although there is no current model for persistent identifiers that is universally used for scholarly citations, one system that has received the most use for is the DOI system. Recently published as ISO Standard 26324:2012[21], the DOI is a unique alphanumeric string assigned by an authorized DOI registration agency to an object in a digital system. Objects identified with a DOI can be digital or analog, but in the case of data citations, we expect that the objects in question will be digital.

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[18] "URL decay in MEDLINE—a 4-year follow-up study" J.D. Wren, Bioinformatics (2008) 24 (11):1381-1385.doi:10.1093/bioinformatics/btn127

[19] "Unavailability of online supplementary scientific information from articles published in major journals", E. Evangelou, T.A. Triaklinos, J.P.A Ioannidis, December 2005 The FASEB Journal, vol. 19 no. 14 1943-1944, doi:10.1096/fj.05-4784lsf

[20] https://www.force11.org/datacitation

[21] http://www.iso.org/iso/catalogue_detail.htm?csnumber=43506

DataCite[22] is a membership registration agency within the International DOI Foundation. It authorise its member organizations (libraries, information institutions) to act as registrants, issuing DOI names for data sets and other scientific content. DataCite keeps centralised records of the metadata associated with each DOI submitted by each registrant. Currently DataCite has over 3.5 million records with DOI names and provides the corresponding metadata.

Other systems for persistent linking of content exist, other than accession numbers, the most commonly used identifiers are URNs, ARKs and Handles. Again we have attempted to summarise their approach to openness and listed known barriers to interoperability in appendix 2.

- URN - Uniform Resource Name
- ARK - Archival Resource Key
- Handle

3.3. The ORCID and DataCite metadata schemas harmonization

Enhanced interoperation between ORCID iDs and DataCite DOIs is one of the aims of this project. The lessons learned from this can be applied to improve interoperation with other PIDs. The challenges faced can inform priorities for future developments. Crucially, by ensuring that trusted PIDs interoperate with one another, they are able to act as bridges between other PID sets, and to function as reliable linking points within the PID landscape. Ensuring that the two interoperate well on every level is therefore a core task of ODIN. Here we describe the process of establishing this interoperability at the metadata level which is detailed in appendix 6. In appendix 3 we provide details on how to approach the interoperation of metadata schemas for other PIDs. In later chapters, we describe some of the technical achievements which

[22] For a list of data centers that utilize DOIs at DataCite see: http://stats.datacite.org/.

have built on this endeavour and which demonstrate the potential of trusted PIDs to enhance related services and systems.

3.1.7. Reasons to harmonize metadata schemas

It is important to provide a means to connect a researcher's identity with their research data. This can be achieved by harmonizing metadata standards and providing standardized mappings between person identifiers and research data metadata for easy connections.

To achieve ORCID and DataCite metadata harmonization, common elements need to be identified and assigned the same meanings for metadata exchange and future interoperability. Additionally, harmonization will lower incidents of data loss when exchanging data between systems.

The usage of common standards is an important step on the way to a harmonization. The harmonization process of the metadata standards lead to the expansion of both schemas - ORCID now includes elements to describe research data, whereas DataCite references CASRAI, a controlled vocabulary standard to describe free-text resource types.

3.1.8. Methodology

We identified mandatory and recommended elements from both ORCID v. 1.1 and DataCite v. 3.0 (see appendix 6) metadata schemas to determine which elements are most important for each party. ORCID emphasizes author information and classical text publications, whereas DataCite focuses on research data and other non-textual materials. This difference in focus impacts the granularity of information and mapping.

The two schemas were analyzed according to the needs of both parties and a mapping was created (see Appendix 6).

Elements from the DataCite schema that are especially important for a metadata exchange with ORCID are:

- DataCite **<creator>** and **<contributor>** should include **<nameIdentifier nameIdentifierScheme**="ORCID" **schemeURI=**"http://ORCID.org"**>**.
- DataCite **<title>**.
- DataCite **<resourceType>** should follow ORCID practice of mapping free-text to the CASRAI dictionary vocabulary.

ORCID stores information about data contributions within its "Works" activity type. Since it is designed to describe several different resource types, the metadata elements have been generalized so that they are applicable to several different resource types. The Elements from the ORCID Works schema that are most important during metadata exchange include:

- **<external-identifier>** one or more unique identifiers to the item. This field would include the DataCite DOI.
- **<work-type>** describes the type of resource being referenced. ORCID's original schema had only one type to describe data, "data set." This characterization is not rich enough to capture the types of information stored within DataCite, and the list should be expanded to incorporate more types contained within DataCite.
- **<title>** is an important field for describing the item that the metadata describes.

ORCID uses standardised terms from the CASRAI dictionary to describe the type of resource. DataCite will implement a recommendation to use these for the free-text part of the resourceType in its schema documentation. In addition, as more resource types are added to the ORCID schema for describing the items stored within DataCite, ORCID should work with CASRAI on the inclusion of these terms into the

standard dictionary. For better mapping, both schemas should use similar terminology, and if possible the same standards.

A potential future project to optimize a researcher's connectivity with multiple scholarly output types (e.g., publications and data sets) would be to add the ORCID iD to existing metadata records in the DataCite Metadata Store.

4. ODIN ACHIEVEMENTS

In order to explore the potential benefits of PID interoperation in live systems, the ODIN team identified a number of use cases and challenges, detailed below. These were then explored during the project CodeFests and other project activities. A number of tools emerged from these efforts. Some enable individual authors to connect data from disparate sources using PIDs to provide a fuller picture of their research activity. Others enable datacentres and organisations to leverage these connections. These tools show that new services, and more timely information about both the usage and quality of information, are possible when PIDs are linked.

These implementations and tools also served as a test bed, enabling the ODIN team to ensure that the connections being built by members of the project between PIDs and associated services were robust, and to assess the value of making these connections.

This chapter provides an overview of some of the exemplars that have emerged from ODIN, explaining the use cases that inspired them and showing how they were addressed. They are divided by functional type: the first group are claim tools that enable individuals to connect their personal PIDs to themselves and to their work. The second group of tools enable datacentres to exploit information about these connections to gain better metadata.

4.1. Claim tools

4.1.1. ORCID/DataCite claim tool

In D4.1 (Conceptual model of interoperability) we described a tool that could be used by authors to claim their published data in the DataCite Metadata Store under their ORCID profile. The tool was developed as a beta[23] on the ORCID site and shortly after integrated as part of the ORCID services.

The DataCite search and link service[24] is based on a related open source tool previously developed by CrossRef[25,26] for a similar purpose. The service enables ORCID users to search the DataCite Metadata Store for research datasets (or any other works they have created or contributed to that have a DOI from DataCite) and claim them to their ORCID profile (Fig. 1).

ODIN's claiming service uses DataCite's public Search API to find works based on a simple name and/or keyword search and retrieve metadata for them, including their DOIs. When the user clicks the "Add to ORCID" button next to a work, the service uses the ORCID read/write Member API to post the work DOI and associated metadata to the central ORCID system. The action of "claiming" creates a persistent link between the DOI of a published work registered in the DataCite Metadata Store and the user's ORCID iD.

As a practical consequence of this, the DataCite claim service (like the other services described in this section) is transient, in the sense that its presence is only needed for the user to create the link initially. The service thus operates as an intermediary to assist the user in finding and linking to works in this particular catalogue. The crucial

[23] http://odin-project.eu/2013/05/13/new-ORCID-integrated-data-citation-tool/

[24] http://datacite.labs.ORCID-eu.org

[25] https://github.com/CrossRef/cr-search

[26] http://search.crossref.org

element - the DOI to ORCID link - is ultimately archived in the ORCID system for posterity.

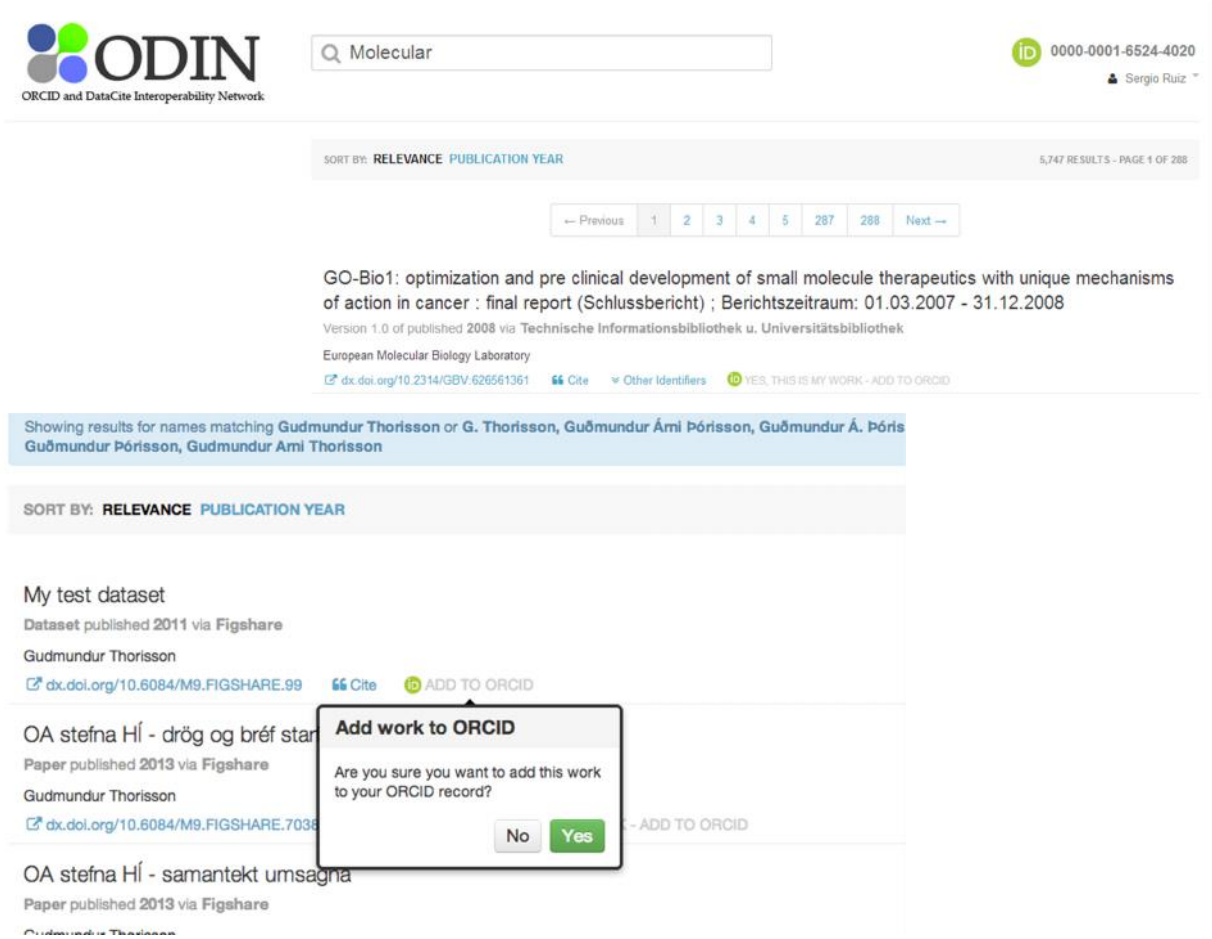

Fig. 1. Claiming datasets under ORCID profile

Since the tool was implemented in December 2014, and up to August 2014, 7,389 datasets have been linked to 6,690 different authors. These claims can have been initiated either by the authors themselves or the data center who offers this link. Later in this report we detail the different ways in which this can be achieved.

The code for the DataCite claim tool is available as open source[27].

4.1.2. EThOS import service

EThOS is the UK's national thesis service[28] provided by the British Library. It aims to maximise visibility of the UK's doctoral research theses, uniquely identifying and hosting the metadata for over 300,000 theses. Through EThOS users can find and obtain a digital copy of a thesis, either directly from a university repository or via British Library digitisation services.

The EThOS team were looking to:

- Promote their service
- Raise the profile of PhDs as an academic output
- Create links between their internal identifiers and external author identifiers
- Enrich their metadata
- Produce a proof of concept they could re-use on their own site

In collaboration with ODIN partners the EThOS team developed a set of tools and a public website that enables authors to import thesis metadata held by EThOS into their ORCID profile[29]. The website is presented in a modern, clean and simple manner and the user journey is simple – users enter their E-Thesis ID, log into ORCID and confirm the update. See appendix 4 for screenshots.

EThOS is a particularly interesting use-case as it is a kind of meta-repository. Some of the content is uniquely held at the British Library, some is held in external university repositories and some is held in both. In addition, some of the content is digital,

[27] https://github.com/ORCID-EU-Labs/DataCite-ORCID

[28] http://ethos.bl.uk

[29] http://ethos-ORCID.appspot.com

some is print (but can be digitised on demand). While all content has an EThOS identifier, much of it also has another identifier assigned by the originating institution. When present these identifiers differ in format from URLs to Handles, DOIs or even arbitrary strings. This means that the identifier space for EThOS is complex with multiple identifiers per object. While EThOS is very keen to assign DOIs, discussions about how this might work are on-going and out of scope of the ODIN project. For now the ORCID import tool relies on EThOS identifiers but also imports any additional identifiers EThOS knows about, including DOIs.

One consequence of the mixed identifier ecosystem EThOS inhabits has been that ORCID will support EThOS specific identifiers. In addition, Figshare has added a "Thesis" type that is reflected in the DataCite metadata schema. ORCID have also expressed an interest in Handle identifiers, which are closely related DOIs. Many institutional repositories use handles as their persistent identifier type, as a handle license is in many cases already provided in content management systems like DSpace and requires less overhead than the assignment of a DOI name for example. As a result of this work we have also identified the need for users to be able to link multiple identifiers for a single work with a "sameAs" type relationship within ORCID and have submitted a formal enhancement request to do so.

The initial concept and interoperability prototype was developed at the ODIN codefest in Geneva (October 2013) and subsequently developed into production. Behind the scenes the metadata from EThOS is harvested via HTTP meta tags, transformed into ORCID metadata and POSTed to their RESTful API.

To facilitate re-use, the web based import tool and accompanying general purpose ORCID java client library are available under an open source BSD licence on Github[30].

[30] https://github.com/TomDemeranville/ORCID-update-java and https://github.com/TomDemeranville/ORCID-java-client

The software has been designed and documented in a way that makes it simple to modify and deploy for other metadata sources. The hope is that it will encourage ORCID integration by presenting a very low barrier for entry; modifying configuration and implementing an interface into the new metadata source is sufficient. It can then be deployed, free of charge, on Google App Engine[31] or another compatible service. Since being open sourced, work has begun to improve the tool to work with EPrints[32], which has already been demonstrated to work with selected repositories[33]. The library component is actively discussed on the ORCID mailing list and it has received contributions from outside the ODIN project team.

ORCID have made it clear they are keen to integrate this functionality by including it as part of their import tool suite. Once this is done, a complete how-to guide will be developed to facilitate other data holders following the same route.

Outreach activities with other E-Thesis repositories are underway. Contact has already been established with multiple international partners who are keen to integrate. Conference papers presenting the tool, libraries, reasoning behind them and a how-to guide were presented at ETD2014[34] and ELAG2014[35].

There is a similarity between ANDS and EThOS platforms in aggregating metadata from multiple registries with heterogeneous identifiers. The ANDS experience in this domain shows that lack of connectivity between these identifiers can lead to duplicated records in national registries such as Research Data Australia (ANDS supported portal for the Australian Research Data Commons). In addition, lack of harmonisation between these identifiers hinders the connectedness of research

[31] https://developers.google.com/appengine

[32] http://www.eprints.org/

[33] http://oro.open.ac.uk/information.html

[34] http://www2.le.ac.uk/library/etd2014

[35] http://elag2014.org/

projects (grants) and research outcomes. A similar approach to EThOS is taken by ANDS for ORCID integration that is described in section 4.2.2.

4.1.3. ISNI claim tool

ORCID cross links with several person identifiers, enabling multiple PIDs to be attached to an ORCID record, including ISNI. The method for matching a PID with the ORCID identifier is dependent on the system, with explicit authentication to both systems being the most reliable method (e.g., the individual logs into both the ORCID system and the other PID system to make the match). In the absence of such a user login on the ISNI system, the match is made through a comparison of biographical information, specifically the person's name.

A name matching approach is used primarily because ISNI and ORCID biographical metadata do not entirely overlap. For example, ISNI collects the date of birth of individuals, which is not a field in the ORCID registry. In addition, because of the different models for assignment (authority based vs. self claim) of the two initiatives there are types of information available in a person's record that make a direct machine-based match difficult on fields beyond the name. Since name alone is rarely sufficient to make a confident match, the computer match is supplemented with direct individual involvement to select the correct ISNI record. This approach also fits with the ORCID ethos of each individual having ultimate control over their record. This connection is achieved using the ORCID2ISNI tool developed during the ODIN project. This tool was developed as a proof of concept to connect the two identifiers.

The ORCID2ISNI tool queries the matched ISNI record to harvest related ISBN data. Once the ISBNs are obtained, the tool queries the WorldCat database web services for the book metadata related to each ISBN, and posts this information back to the ORCID record at the individual's discretion. The ISNI database is not directly used to obtain the full metadata for the ISBN because the data structure used for ISNI is not designed to provide information in this form.

Launched in January 2014, the ORCID2ISNI tool beta project has had over 2,000 unique visitors who attached ISNIs and ISBNs (if applicable).

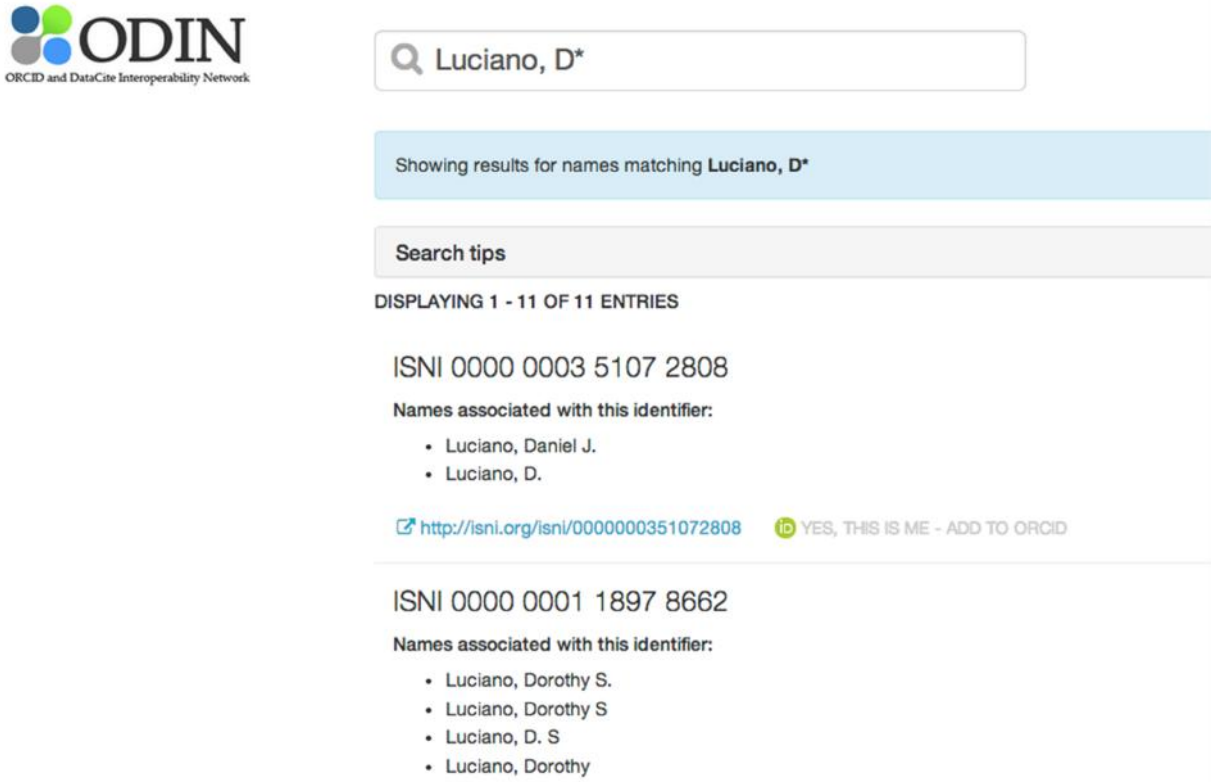

Figure 2. Finding the correct ISNI based on the author name.

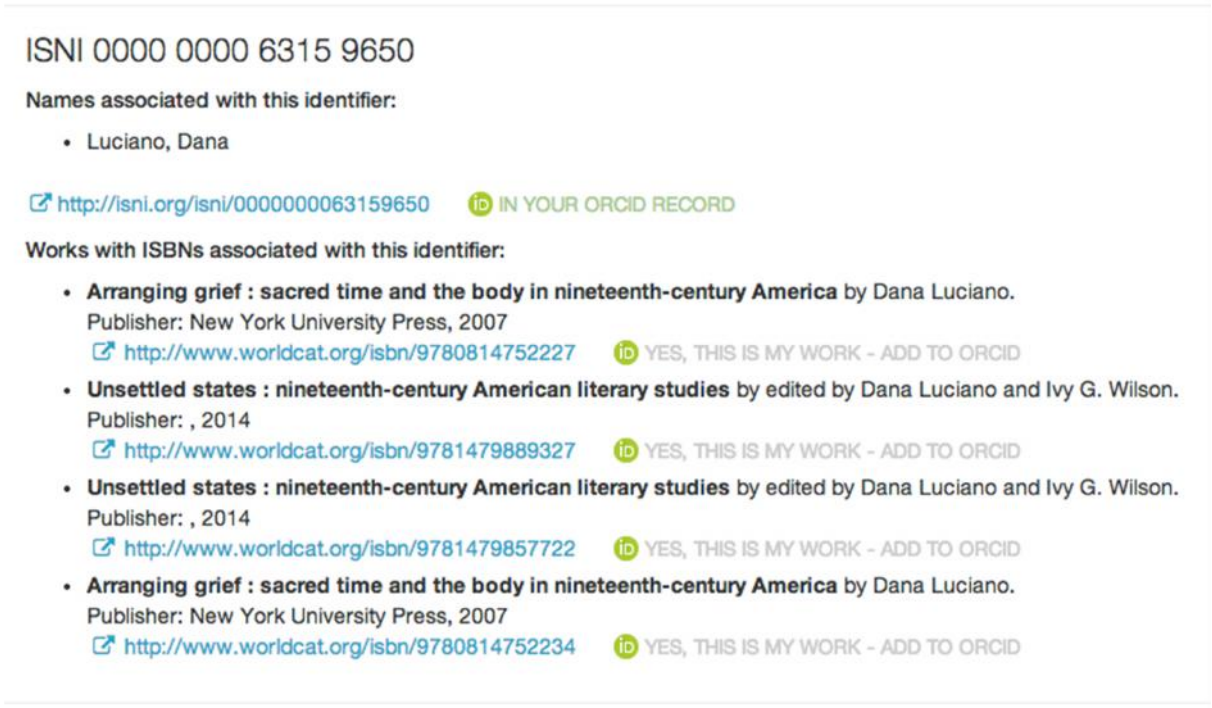

Figure 3. Once the ISNI is selected, the list of published books related to the ISNI are presented for inclusion into the ORCID Record.

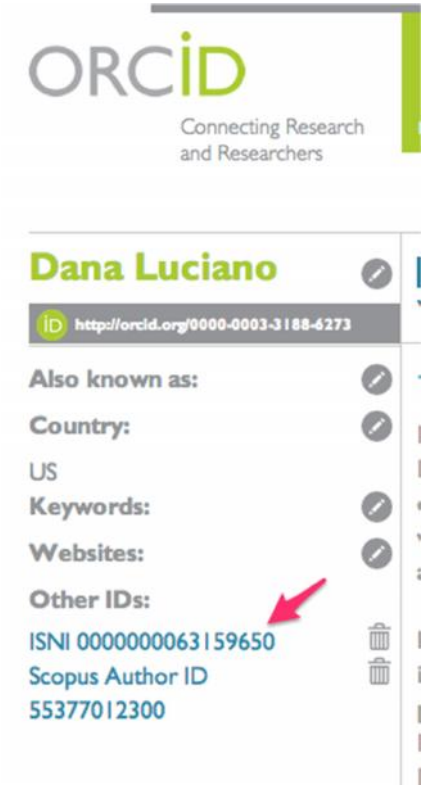

Figure 4. The ISNI and books are included in the ORCID Record

The code for the ORCID2ISNI tool is available as open source[36].

4.2. Data connections

4.2.1. ODIN's HAMR

A compelling use case was identified at the October 2013 codefest[37]. Datacentres would like to be notified when someone claims a DOI minted by them, or at least be able to query this information so they can enrich their own metadata and create bi-directional links. ODIN's HAMR is a demonstration project initially developed by

[36] https://github.com/ORCID-EU-Labs/ISNI-ORCID

[37] http://odin-project.eu/project-outputs/first-codesprint-oct-2013/

Dryad to address this use case. Since the codefest, other datacentres have expressed the same requirement, and a general purpose query website has been constructed and deployed by the British Library[38]. The code is open-source and available on GitHub[39].

The extended datacentre reporting tool was initially developed so that the EThOS team could monitor claims within ORCID. The tool enables the team to query (via a web based interface or REST API) which ORCID users have claimed which EThOS identifiers. This means they can pull ORCID metadata back into their own systems, completing a virtuous circle of metadata synchronisation and bi-directional linking. As both Dryad and EThOS had the same use-case, the reporting tool was made datacentre agnostic. It works equally well with DataCite and CrossRef DOIs as EThOS identifiers and Handles.

The tool has been pre-loaded with over 3,000 journals, publishers and datacentres. These are presented as a type-ahead search allowing users to search ORCID for anyone who has claimed a DOI or other identifier belonging to a specific publisher or datacentre, and if not found custom prefixes can be entered. The tool can also be used to identify authors of specific works and datasets. Use of this tool has revealed that the current links DataCite and ORCID metadata are mostly uni-directional. We can see that there are over 28,000 ORCID iDs in Pangaea-minted DOIs but only 28 can be found in ORCID. This is mirrored by other data centers, Dryad and EThOS included. The reason for this might be that creators and contributors provide their ORCID IDs in the object metadata on submission, however they don't actually go back to their ORCID profiles to update them.

Figshare is a popular digital repository that allows researchers to receive DOIs for a variety of digital scholarly outputs, among them datasets. Up to August 2014,

[38] http://ethos-ORCID.appspot.com/search

[39] https://github.com/TomDemeranville/orcid-update-java

Figshare minted more than 100k DOIs. From those, 261 ORCID iDs have Figshare DOIs, whereas there are 1,275 ORCID IDs attached to Figshare DOIs in DataCite.

The existing ORCID API could be improved to make this reverse look-up easier. At present, while it is relatively simple to find out which users have claimed particular DOI prefixes, a query per user is then required to find out exactly which DOIs have been claimed. An enhancement request has been submitted to ORCID to address this matter.

Screenshots of the tool can be found in appendix 5.

4.2.2. ANDS

ANDS has leveraged the ORCID platform as a method of connecting research data collections to authors. Following collaboration with ODIN partners in developing the ODIN interoperability model, ANDS created an ORCID integration module that enables ORCID users to search and link their data collections from Research Data Australia to the user ORCID identifiers. The workflow for ANDS-ORCID integration is demonstrated in the following figure.

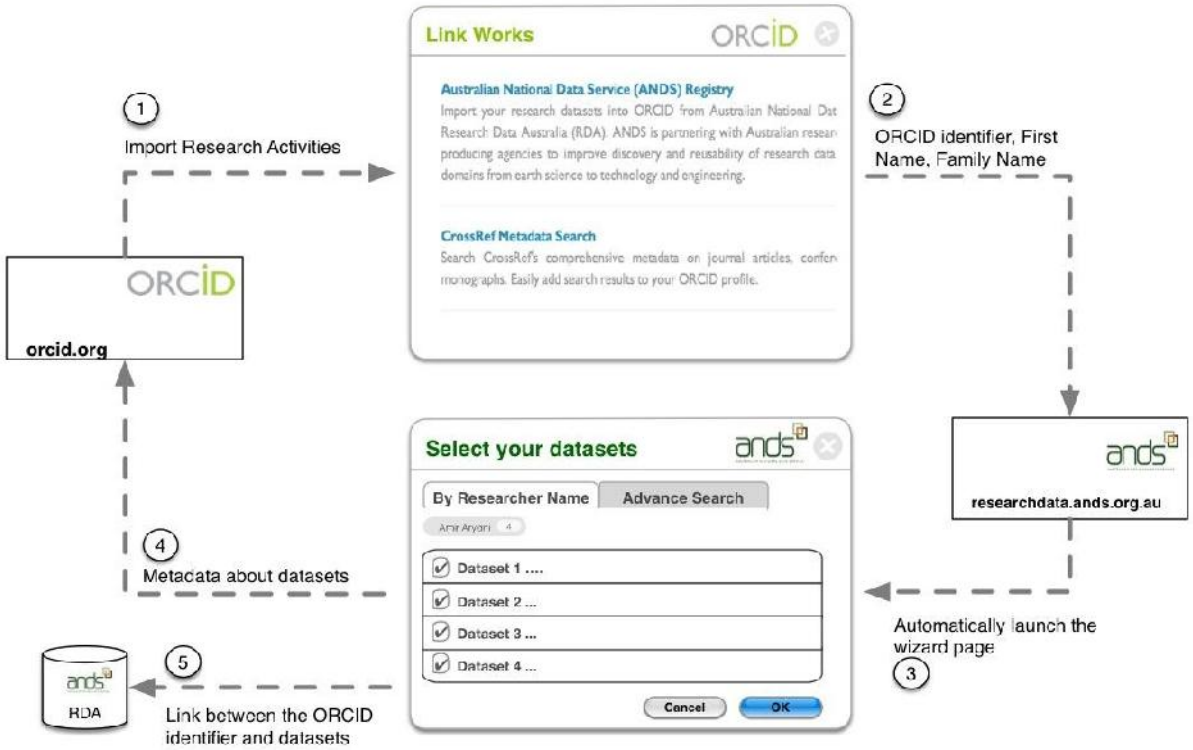

Figure 5. ANDS - ORCID integration model.

The workflow includes 5 steps:

1. the user initiates the Import Research Activity process from the ORCID login panel.
2. the ORCID web calls a webservice function from Research Data Australia (RDA) and provide RDA webservice with the user information.
3. RDA provides user with a search/wizard screen where users can find and confirm their datasets.
4. RDA sends the user back to ORCID web and provides ORCID services with the information about the user's datasets.
5. RDA records the links between the ORCID identifier and datasets in an open access repository.

Although the Australian research community is still in the early stages of adopting ORCID, the outcome of the ANDS-ORCID integration shows that an ORCID identifier can be a strong connector between researchers and their research outputs.

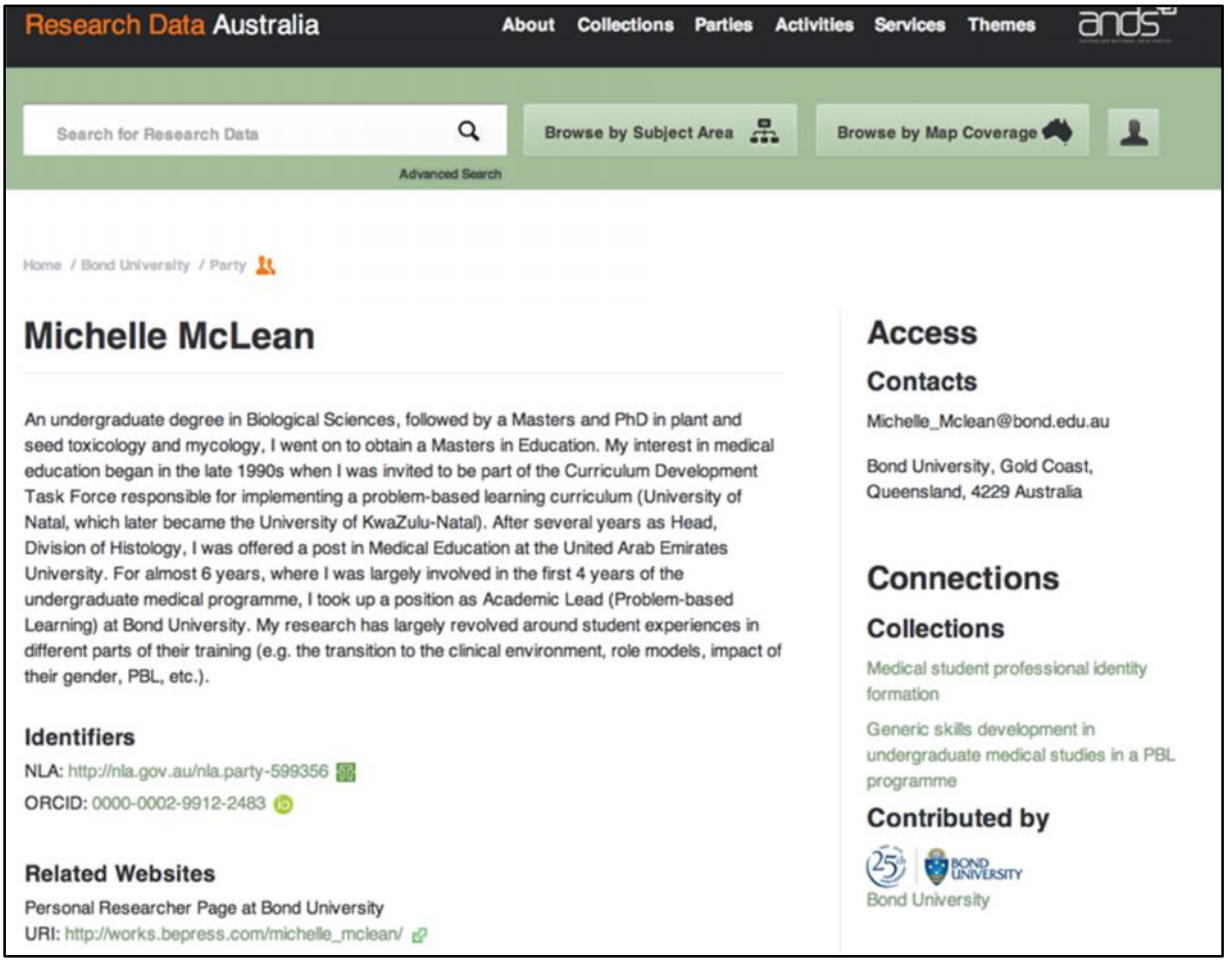

Figure 6. An example of a research record in Research Data Australia with connected ORCID identifier[40].

[40] http://researchdata.ands.org.au/michelle-mclean/184000

5. CONCLUSIONS

This report clearly shows that interoperation between PIDs is not only desirable but also possible. The project demonstrated a set of solutions which worked well, especially given the limits of the project's reach and scope. This report has demonstrated that the adoption of existing PIDs that meet the criteria for trustedness (like ORCIDs, ISNIs and DataCite DOIs) represent a relatively easy way to import and gather information. The use cases presented and addressed within the project show the value and utility of the interoperation of identifiers. Moving to the future, the lessons that can be drawn from this work are already being implemented in the ORCID and DataCite systems.

Other challenges remain to be addressed and resolved, and this report provides an outline of some of these. Achieving interoperation is not a minor exercise, and the investment in time and effort may not deliver rewards if one, or indeed both, systems thus linked are not used. Therefore it is clear that a relatively lightweight approach to interoperability will deliver the best returns whilst presenting the least risk. Risks are diminished by using a trusted, sustainable PID system as a hub to connect disparate identifiers, profiles, metadata and platforms. Each service, platform and community is then free to pursue the use-cases that matter to them, supported by, and connected to the wider scholarly information network via the hub.

Business models, competing priorities and divergent use cases can all hamper steps towards interoperability. This serves to underline the need for a lightweight approach, enabling services and infrastructure components to preserve their uniqueness whilst enhancing their utility. This is the essence of the ODIN model as it has emerged from the conceptual work undertaken previously and from the test-bed of real-world implementations described here.

APPENDIX

1. Author identifiers

Scopus ID

- Algorithm based author identifiers and profiles
- Based on affiliation, subject area and other author characteristics
- Author search is inaccessible to non-subscribers
- There is an extensive API
- Some authors have multiple Scopus profiles, especially if the author works in multiple disciplines or institutions
- No direct editing or claiming but author feedback allows for amendments to profiles
- A tool is provided to pull the publications from a Scopus author profile into an ORCID profile
- Service provided by Elsevier and integrated with their other products such as Mendeley
- Notably used by the UK research excellence framework (REF)

ResearcherID

- User or institution created author identifiers and profiles
- User populated
- Can create bi-directional links with ORCID profiles
- Has a process in place to settle inaccurate claim disputes
- An API is provided, but documentation currently unavailable for assessment

- Service provided by Thompson Reuters and heavily integrated in their other products
- Around 270k identifiers.

arXiv Author ID

- Discipline specific (High Energy Physics) author identifier and profile
- Author identifiers are intended to disambiguate papers within the arXiv repository
- User created and maintained, semi-automatically populated
- API unknown

RePec Author Service

- Discipline specific (Economics) identifier and profiles
- Users claim from a list of research outputs provided by academic publishers such as Elsevier, Wiley Blackwell, CEPR and institutional archives
- There is no API
- Used by RePEc services

PubMed Author ID

- Development announced in 2010 and abandoned in 2014 in favour of external identifiers provided by publishers
- Update specifically mentions ORCIDs

Google Scholar Profiles

- User driven, semi-automated author profiles
- Initial import is algorithm based with the ability for users to add and remove works
- Continuous algorithmic profile updates possible

- Requires a verified institutional email to make public
- There is no API, and rate limitations and T&C prevent scraping, no interoperability features
- Manual user driven export possible
- Not intended as an author identifier
- Provided by Google and integrated with Google Scholar

Microsoft academic research ID

- Provides human editable automatically generated author profiles with attached unique identifiers
- Provides other tools such as co-author visualization, profile merging and citation counts
- In contrast with Google Scholar, Microsoft do offer an API
- It is limited by terms and conditions to non-commercial, academic-only use.

AuthorClaim

- Non-discipline specific author disambiguation and profiles
- Generates author output profiles
- Based on RePEc Author service
- Users claim from a list of research outputs provided by publishers and repositories including Crossref, ArXiv and PubMed
- There is no API, but data is available as bulk download in CC0
- Venerable, in operation since 1992
- Funded by the Open Society Institute

JISC Names

- Automatic author disambiguation system with manual intervention and quality assurance
- Generating identifiers and associated research outputs
- Ran from 2007 until 2013
- Collected data now submitted to ISNI
- Codebase now open source

ISNI

- Semi-automatically derived from library catalogues and other trusted sources using human intervention for quality control
- Institutions that are members can submit data for matching and ISNI creation. Provides searchable interface and extensive query API
- Not user editable, although users can suggest changes to existing profiles
- Intended to be an authoritative source of authorship identifiers

Linkedin

- Used to maintain professional resume and publication lists, and network with co-authors and funders
- Frequently mentioned when discussing author identifiers with researchers
- Positioning itself as an identity authority as well as profile management tool
- Mature API for identity and profile.

Mendeley Profiles

- User driven and populated author profiles with social networking/collaboration features

- Manual creation and import
- Both desktop and mobile software and a service
- Public API
- Not intended as an author identifier
- Provided by Mendeley/Elsevier
- Around 3 million profiles

ResearchGate

- Academic social network and collaboration platform for researchers, institutions and publications
- Users can manage their publishing and work profiles and create connections
- Provides sharing and citation metrics
- Open Query API, no update API

ORCID ID

- User driven identifier service
- Users can create, manage and edit their publishing history and import from various other systems
- Institutions can create blocks of identifiers and ask authors to 'claim' them
- Extensive search and authentication API with various open source client implementations
- Update rights via the API require membership

2. Data Identifiers

URN - Uniform Resource Name

- Introduced in 1994, formalized in 1997 and is now an IETF standard
- No central governance for URN and no central resolving infrastructure
- Major national libraries in Europe have established their own subgroup of URN, the URN:NBN and operate a joint resolving infrastructure
- ISBNs for books are part of the URN system

No license costs involved for assigning URNs, but a URN registration agency needs to establish an assigning and a resolving infrastructure. As no joint resolving infrastructure or workflow for URNs exist apart from "island-solutions" like URN:NBN, it is impossible to establish general interoperability with URNs. The biggest initiative to harmonize URN registration in Europe is currently undertaken by the PersID project[41].

ARK - Archival Resource Key

- Introduced in 1995
- Not a formal standard, all ARKs follow the same structure and workflows[42]
- No central resolver
- Organisations can sign up to become Name Assigning Authority Numbers (NAANs) and run their own resolution infrastructure for ARKs

The system is run by the California Digital Library with dozens of NAANs worldwide through a combined ARK/DOI infrastructure EZID. This EZID infrastructure allows interoperability between ARKs and DOI names under the umbrella of DataCite.

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[41] http://www.persid.org

[42] https://confluence.ucop.edu/display/Curation/ARK

Handle

- Established in 1995
- Non-commercial decentralized identifier resolution system Operated by CNRI
- Used by many other higher-level systems, e.g. DOI
- Non-commercial Handle system operated by the Corporation for National Research Initiatives (CNRI)

Different initiatives use commercial handle licenses to establish local handle system, like the European Persistent Identifier Consortium (EPIC)[43]. Many existing content management systems, e.g. institutional repositories, currently also operate their own local handle system. As the DOI names and handles share the same technical infrastructure, there is 100% technical interoperability between these identifiers.

3. Proposed workflow to harmonize metadata schemas

Based on this successful work between DataCite and ORCID, we recommend the following workflow for other PIDs schema harmonization efforts:

1. **Project Initiation** - Set the expected outcomes, secure buy-in and resources needed to act on any outcomes from this effort, and understand the expected timeframe for action. Communicate the project initiation with parties that could be affected by future changes, including expected benefits for engaging in the project.

[43] http://www.pidconsortium.eu

2. **Schema Review & Prioritization** - review the elements within each schema, and evaluate the relative importance of each element within their respective schema.
3. **Element Comparison** - compare the elements within the schemas to each other. Identify similarities and differences, and the extent of these differences.
4. **Value/impact Evaluation** - evaluate the expected value and impact of changing elements within the schemas to make the schemas more alike.
5. **Recommendation** - document recommended changes for each affected schema, including the expected value and impact of the changes. Suggest a timeline and approach for changes based on internal change processes for the schema.
6. **Action** - Make changes based on the recommendations.
7. **Evaluation** - Test and review the changes made, and evaluate them against the expected values and impacts. Determine if additional work is needed, or if the project has been completed. Communicate outcomes with those who may have been affected by changes, and with other parties who may be interested in embarking on a similar harmonization project.

We further recommend the following guidelines for each step:

Project Initiation

- Understand the steps needed to effect a change on each schema. Schema changes often require review by a committee, and potential impacts (technical, user or data)must be evaluated before any change can take effect. If considered early in the project, it is more likely that important input is considered during future project phases.

Schema Review & Prioritisation

- Create a mapping of both metadata schemas.
- If possible use common standards and assign the same meaning to metadata elements. For example "creator" in a data environment is something different from "author" in a classic publishing or library environment.
- Understand what is mandatory in each schema, particularly where they do not have matching fields. Does the schema that doesn't have a certain field need to provide it to another schema because it's mandatory? If so, how will it be obtained?

Element Comparison

- If one metadata schema is to be harmonized with several other schemas it should be decided which schema is the "master" i.e. which schema is identified as the standard to which the others should confirm?. Otherwise the work of one harmonization process can be undone by the next one.
- Consider multiple harmonization projects separately when possible. Undertaking multiple projects at once can be challenging, and may ultimately require more time to complete.
- It may be helpful to include other standard schemas to use as a benchmark or information source. If the schemas being harmonized are very different, it may be useful to consider how other schemas handle similar data.

Value/Impact Evaluation

- When considering the impact of proposed changes, it is helpful to solicit input from other stakeholders and users of the schema. Unknown uses of data fields could cause unforeseen issues when those fields are changed. Alternatively, there could be unforeseen benefits in changing a field with undocumented challenges.

Recommendation

- The recommendation document can be used to announce a proposed change before taking action. The inclusion of a proposed timeline will help provide context for those who may be impacted by the change.
- Be prepared to consider input received on the recommendation document. Allow enough time in your schedule to make adjustments if needed.

Action

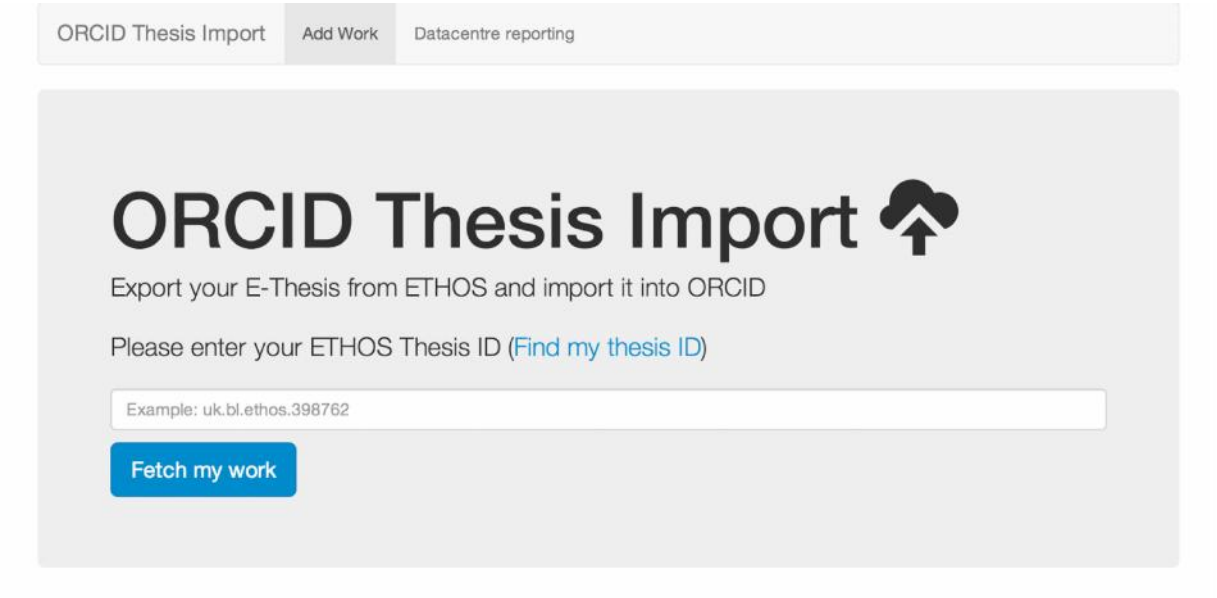
- When making changes, consider an implementation plan that provides graduated impact for those using the fields and schema. For example, pilot the change with a small audience, or break the change up into several phases.
- In some instances there may not be the option for graduated impact. In these situations be sure the change is well communicated with all stakeholders before proceeding.

Evaluation

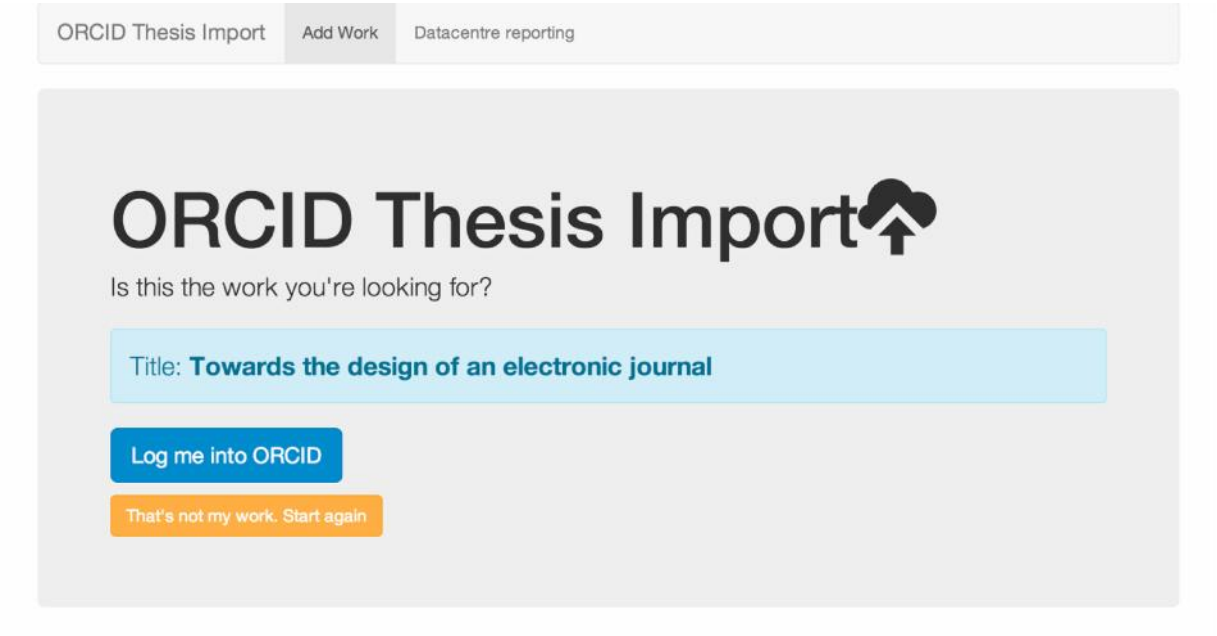
- Evaluate the changes against your expected impacts and benefits. Document anything that is unexpected.

- Prepare to iterate. It's rare that everything is perfect on the first round.
- Celebrate the success! Communicate the change broadly, emphasizing the benefits achieved in the harmonization.

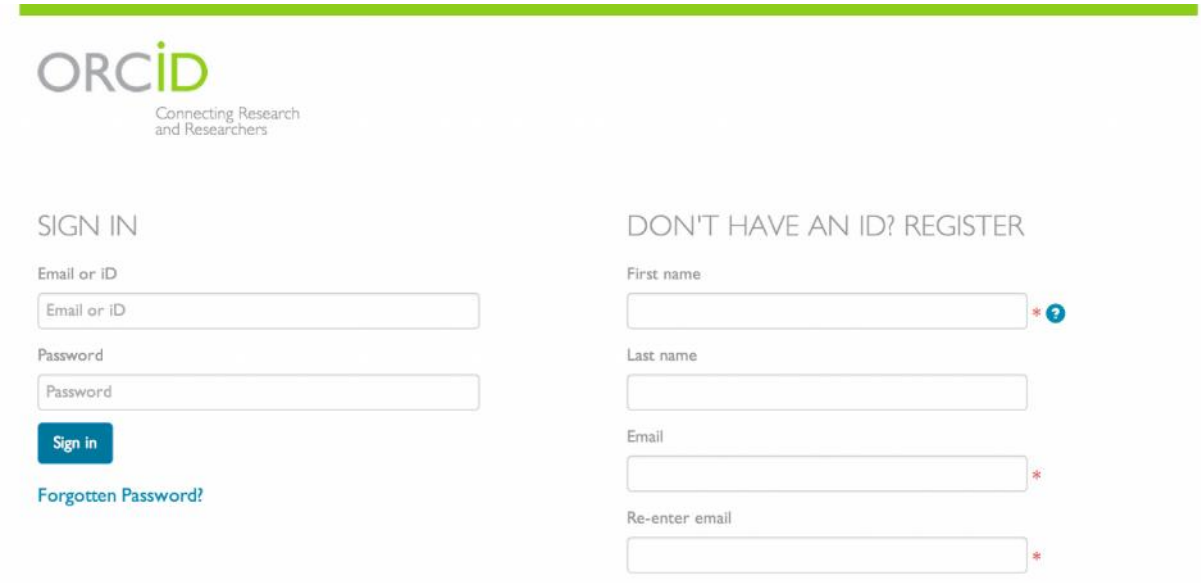
4. EThOS user journey screenshots



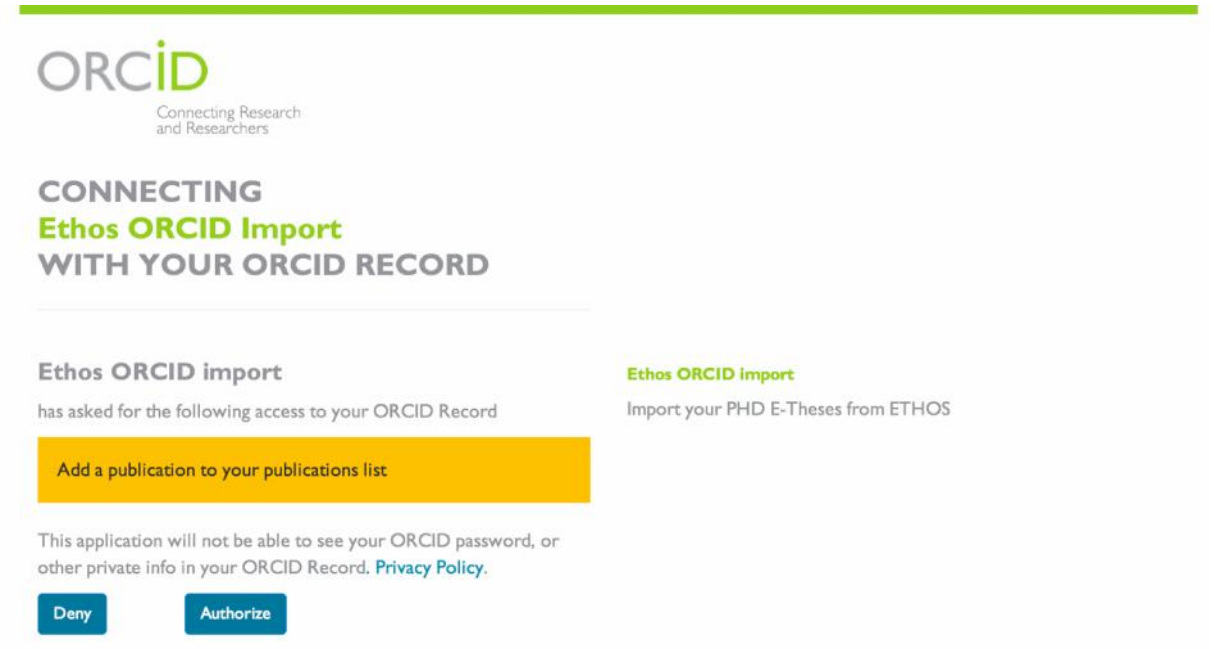
Step 1 - Entering an EThOS E-Thesis ID



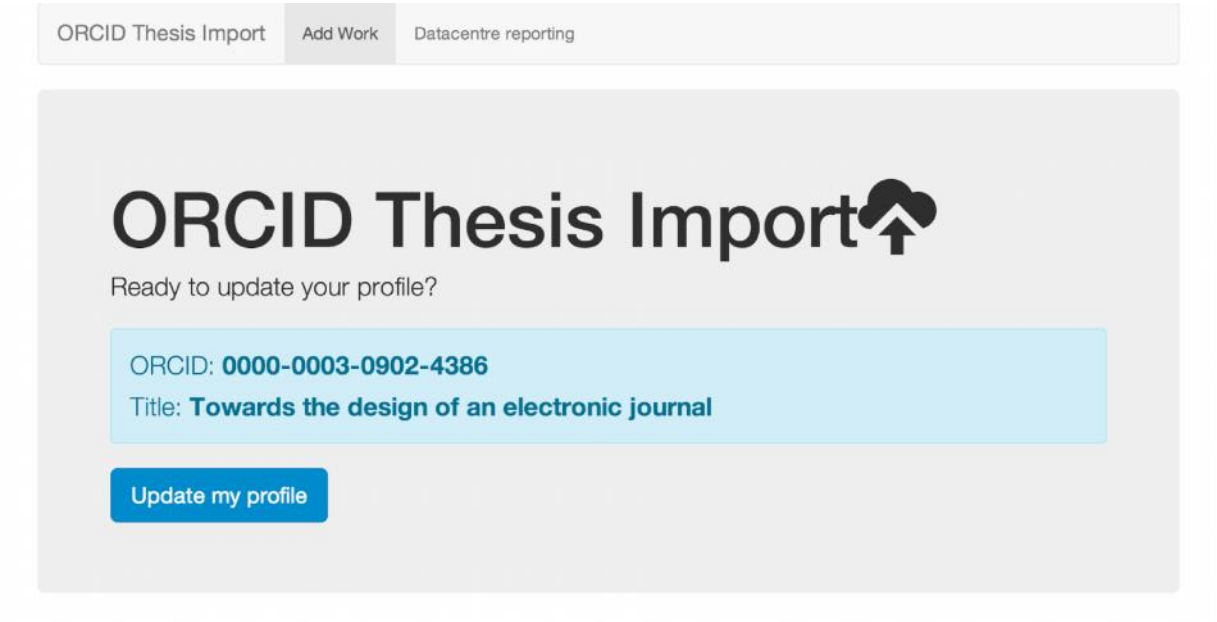
Step 2 - Confirm E-Thesis title



Step 3 - Log in to ORCID (if not already logged in)

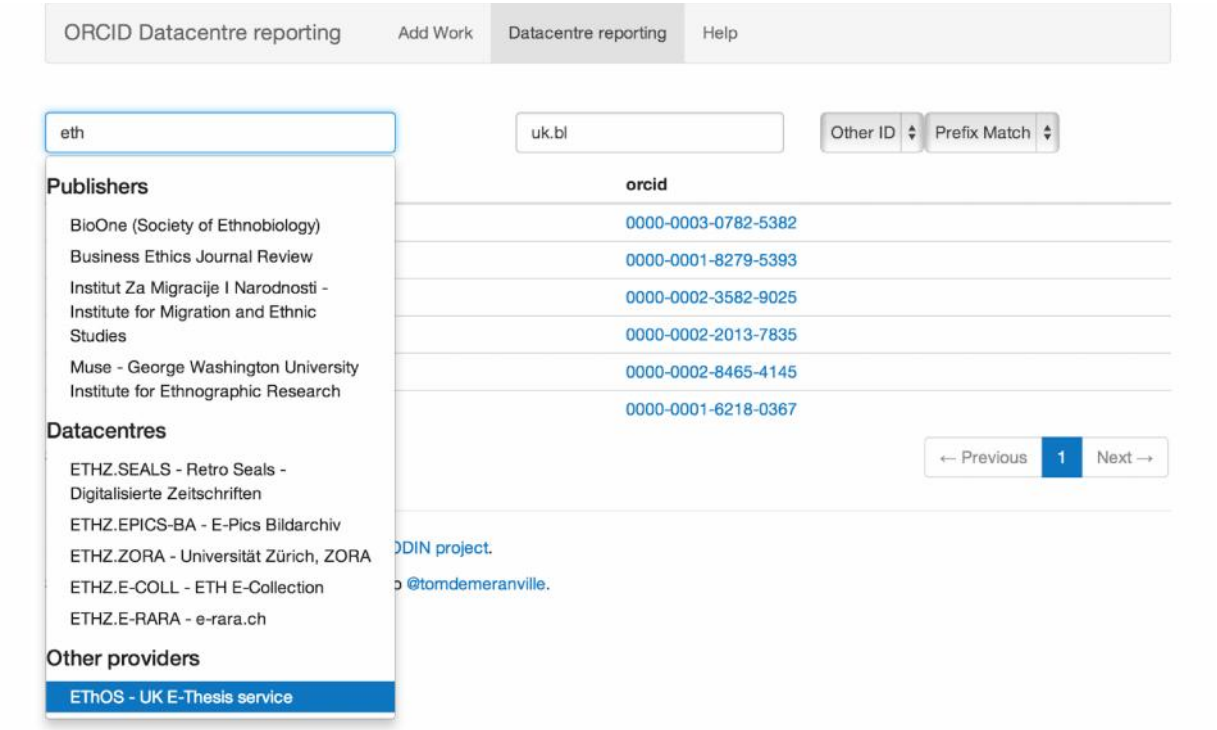


Step 4 - Authorize EThOS updates

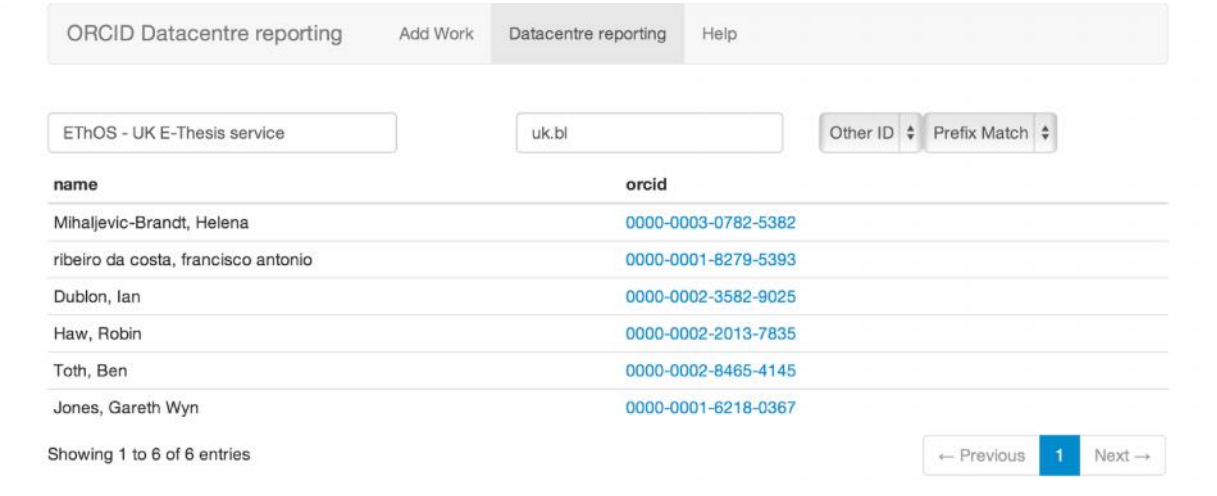


Step 5 - Confirm profile update

5. Datacentre reporting tools



Reporting 1 - Typeahead drop down for publisher/datacentre search



Reporting 2 - EThOS search results

6. DataCite Metadata Schema V 3.0 to ORCID Mapping

DataCite Obligation **M=**Mandatory **MA=**Mandatory if applicable R=Recommended O=Optional	***DataCite Property***	***ORCID Mapping***	***Comments*** ***(critical comments are in Bold font)***
M	**<identifier>**	<work-external-identifier>	**In DataCite, DOI is the ONLY accepted identifier and is mandatory**. Other identifiers are recorded as either AlternateIdentifier (another identifier for the primary resource) or RelatedIdentifier (identifier pointing to a related resource)
M	<identifier identifierType="DOI">	<work-external-identifier-type>doi	DOI (Digital Object Identifier) registered by a DataCite member. Format should be “10.1234/foo”
M	<identifier identifierType="DOI">10.5072/testpub	<work-external-identifier> <work-external-identifier-type>doi</work-external-identifier-type> <work-external-identifier-id>10.5072/testpub</work-external-identifier-id> </work-external-identifier>	

M	**<creator>**	**ORCID-bio** Concatenate <family-name>,<given-names> OR in <credit-name> use format: family name, given-names <personal-details> <given-names>Albert</given-names> <family-name>Einstein</family-name> <credit-name>Einstein, Albert</credit-name> </personal-details> **ORCID-works** <contributor> <credit-name>LastName, FirstName</credit-name> <contributor-attributes> <contributor-role>author</contributor-role> </contributor-attributes> </contributor>	**In DataCite, Creator is mandatory.** **In DataCite, Authors are considered as Creator, not Contributor**

M	<creatorName>Einstein, Albert	<contributor> <credit-name>Einstein, Albert</credit-name> </contributor> In ORCID: <given-names> The first or given name of the researcher. This is the only required name field.	The personal name format should be: family, given. Einstein, Albert; Miller, Elizabeth May be a corporate/institutional or personal name.
O	<nameIdentifier>	<contributor-orcid>	
MA	<nameIdentifier nameIdentifierScheme="ORCID">	ORCID	**If <nameIdentifier> is used, <nameIdentifierScheme is mandatory>.** Examples: ORCID, ISNI
O	schemeURI="http://orcid.org"	<url>http://orcid.org</url>	Examples: http://orcid.org http://www.isni.org
M	**<title>**	<title>	xml:lang="xx" allowed for Title and its attributes
O	<title titleType="Subtitle">	<subtitle>	

O	<title titleType="TranslatedTitle" xml:lang="xx">	<translated-title language-code="xx">	
O	<title titleType="AlternativeTitle">	No equivalent found in ORCID	
M	**<publisher>**	**No equivalent found in ORCID** May be able to use information from <affiliation><organization>	**In DataCite, Publisher is mandatory**. DataCite definition: The name of the entity that holds, archives, publishes prints, distributes, releases, issues, or produces the resource. This property will be used to formulate the citation, so consider the prominence of the role.
M	**<publicationYear>yyyy**	<publication-date><year>yyyy	**In DataCite, Publication Year is mandatory**.
R	<subject>	<keyword>	xml:lang="xx" allowed for Subject and its attributes Free text In DataCite, "Subject" covers: subject, keyword, classification code, or key phrase describing the resource.

	<subjectScheme>	n/a	Free text
	<schemeURI>	n/a	
R	<contributor>	<contributor>	
MA	<contributor contributorType>	<contributor-role>	**In DataCite, if Contributor is used, <contributorType> is mandatory and has a controlled values list.** **NOTE: In DataCite, Authors are considered as Creator, not Contributor**
	<contributor contributorType=”select DataCite controlled list term”>	<contributor-role>assignee	ORCID controlled list term
	<contributor contributorType=”Editor”>	<contributor-role>editor	ORCID controlled list term (exact match to DataCite term)
	<contributor contributorType=”select DataCite controlled list term”>	<contributor-role>chair-or-translator	ORCID controlled list term

	<contributor contributorType="select DataCite controlled list term">	<contributor-role>co-investigator	ORCID controlled list term
	<contributor contributorType="select DataCite controlled list term">	<contributor-role>co-inventor	ORCID controlled list term
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	<contributor contributorType=”Editor”>	<contributor-role>editor	DataCite controlled list term (exact match to ORCID term)
	<contributor contributorType=”Funder”>	<contributor-role>select ORCID controlled list term	DataCite controlled list term
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	<contributor contributorType=”Other”>	<contributor-role>select ORCID controlled list term	DataCite controlled list term

	<contributorName>	ORCID-bio Concatenate <family-name>, <given-names> OR in <credit-name> use format: family name, given-names <personal-details> <given-names>Albert</given-names> <family-name>Einstein</family-name> <credit-name>Einstein, Albert</credit-name> </personal-details> ORCID-works <contributor> <credit-name>LastName, FirstName</credit-name> <contributor-attributes> <contributor-role>author</contributor-role> </contributor-attributes> </contributor>	

R	<nameIdentifier>0000-0000-0001-0000	<contributor-orcid>0000-0000-0001-0000	In DataCite, format would be: <nameIdentifier nameIdentifierScheme="ORCID">0000-0000-0001-0000</nameIdentifier>
R	<nameIdentifier nameIdentifierScheme=”ORCID”>	ORCID	If <nameIdentifier> is used, <nameIdentifierScheme is mandatory>. Examples: ORCID, ISNI
O	schemeURI=”http://orcid.org”	<url>http://orcid.org</url>	Examples: http://orcid.org http://www.isni.org
R	<date>	No equivalent in ORCID (except for <publication-date> which is matched below to DataCite <dateType=”Issued”>	**In DataCite, if Date is used, dateType is mandatory**. To indicate a date range, follow RKMS-ISO8601: <date dateType="created">2012-03-01/2012-03-05</date>
MA	<dateType=”Accepted”>	No equivalent in ORCID	To indicate the start of an embargo period, use Submitted or Accepted, as appropriate.

MA	<dateType=”Available”>	No equivalent in ORCID	To indicate the end of an embargo period, use Available.
MA	<dateType=”Copyrighted”>	No equivalent in ORCID	
MA	<dateType=”Collected”>	No equivalent in ORCID	To indicate precise or particular timeframes in which research was conducted.
MA	<dateType=”Created”>	No equivalent in ORCID	
MA	<dateType=”Issued”>	<publication-date> <year>yyyy</year> <month>mm</month> <day>dd</day> </publication-date>	In DataCite, <publicationYear> is mandatory. <dateType=”Issued”> may be used to capture the month and year that the resource is published or distributed e.g. to a data center
MA	<dateType=”Submitted”>	No equivalent in ORCID	To indicate the start of an embargo period, use Submitted or Accepted, as appropriate.
MA	<dateType=”Updated”>	No equivalent in ORCID	

MA	<dateType="Valid">	No equivalent in ORCID	
O	<language>	<language-code>	In DataCite, allowed values are taken from IETF BCP 47, ISO 639-1 language codes. Examples: en, de, fr
R	<resourceType>	<work-type> NOTE: <resourceType> and <resourceTypeGeneral> have been combined for the mapping	**In DataCite, if ResourceType is used, resourceTypeGeneral is mandatory and has a controlled values list.** Example: Text/journal-article where "Text" is resourceTypeGeneral value and "journal-article" is ResourceType value taken from CASRAI dictionary
	<resourceType resourceTypeGeneral="Text">journal-article	<work-type>journal-article	Values taken from http://dictionary.casrai.org/documents/research-contributions/1.0/contributions/outputs/publications
	<resourceType resourceTypeGeneral="Text">journal-issue	<work-type>journal-issue	Values taken from http://dictionary.casrai.org/documents/research-contributions/1.0/contributions/outputs/publications
	<resourceType resourceTypeGeneral="Text">book	<work-type>book	Values taken from http://dictionary.casrai.org/documents/research-contributions/1.0/contributions/outputs/publications

	<resourceType resourceTypeGeneral="Text">edited-book	<work-type>edited-book	<work-type> values taken from http://dictionary.casrai.org/documents/research-contributions/1.0/contributions/outputs/publications
	<resourceType resourceTypeGeneral="Text">book-chapter	<work-type>book-chapter	<work-type> values taken from http://dictionary.casrai.org/documents/research-contributions/1.0/contributions/outputs/publications
	<resourceType resourceTypeGeneral="Text">book-review	<work-type>book-review	<work-type> values taken from http://dictionary.casrai.org/documents/research-contributions/1.0/contributions/outputs/publications
	<resourceType resourceTypeGeneral="Text">translation	<work-type>translation	<work-type> values taken from http://dictionary.casrai.org/documents/research-contributions/1.0/contributions/outputs/publications
	<resourceType resourceTypeGeneral="Text">dissertation	<work-type>dissertation	<work-type> values taken from http://dictionary.casrai.org/documents/research-contributions/1.0/contributions/outputs/publications
	<resourceType resourceTypeGeneral="Text">supervised-student-publication	<work-type>supervised-student-publication	<work-type> values taken from http://dictionary.casrai.org/documents/research-contributions/1.0/contributions/outputs/publications
	<resourceType resourceTypeGeneral="Text">newspaper-article	<work-type>newspaper-article	<work-type> values taken from http://dictionary.casrai.org/documents/research-contributions/1.0/contributions/outputs/publications

	<resourceType resourceTypeGeneral="Text">newsletter-article</resourceType>	<work-type>newsletter-article	<work-type> values taken from http://dictionary.casrai.org/documents/research-contributions/1.0/contributions/outputs/publications
	<resourceType resourceTypeGeneral="Text">encyclopedia-entry	<work-type>encyclopedia-entry	<work-type> values taken from http://dictionary.casrai.org/documents/research-contributions/1.0/contributions/outputs/publications
	<resourceType resourceTypeGeneral="Text">magazine-article	<work-type>magazine-article	<work-type> values taken from http://dictionary.casrai.org/documents/research-contributions/1.0/contributions/outputs/publications
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	<resourceType resourceTypeGeneral="Text">report	<work-type>report	<work-type> values taken from http://dictionary.casrai.org/documents/research-contributions/1.0/contributions/outputs/publications
	<resourceType resourceTypeGeneral="Text">working-paper	<work-type>working-paper	<work-type> values taken from http://dictionary.casrai.org/documents/research-contributions/1.0/contributions/outputs/publications
	<resourceType resourceTypeGeneral="Text">research-tool	<work-type>research-tool	<work-type> values taken from http://dictionary.casrai.org/documents/research-contributions/1.0/contributions/outputs/publications

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	<resourceType resourceTypeGeneral="Text">patent	<work-type>patent	<work-type> values taken from http://dictionary.casrai.org/documents/research-contributions/1.0/contributions/outputs/publications
	<resourceType resourceTypeGeneral="Text">license	<work-type>license	<work-type> values taken from http://dictionary.casrai.org/documents/research-contributions/1.0/contributions/outputs/publications
	<resourceType resourceTypeGeneral="Text">disclosure	<work-type>disclosure	<work-type> values taken from http://dictionary.casrai.org/documents/research-contributions/1.0/contributions/outputs/publications
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	<resourceType resourceTypeGeneral="Text">trademark	<work-type>trademark	<work-type> values taken from http://dictionary.casrai.org/documents/research-contributions/1.0/contributions/outputs/publications
	<resourceType resourceTypeGeneral="Text">standards-and-policy	<work-type>standards-and-policy	<work-type> values taken from http://dictionary.casrai.org/documents/research-contributions/1.0/contributions/outputs/publications
	<resourceType resourceTypeGeneral="Text">invention	<work-type>invention	<work-type> values taken from http://dictionary.casrai.org/documents/research-contributions/1.0/contributions/outputs/publications

	<resourceType resourceTypeGeneral="Text">litigation	<work-type>litigation	<work-type> values taken from http://dictionary.casrai.org/documents/research-contributions/1.0/contributions/outputs/publications
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	<resourceType resourceTypeGeneral="Workflow ">research-technique	<work-type>research-technique	<work-type> values taken from http://dictionary.casrai.org/documents/research-contributions/1.0/contributions/outputs/publications
	<resourceType resourceTypeGeneral="Other ">spin-off-company	<work-type>spin-off-company	<work-type> values taken from http://dictionary.casrai.org/documents/research-contributions/1.0/contributions/outputs/publications
	<resourceType resourceTypeGeneral="Text">technical-standard	<work-type>technical-standard	<work-type> values taken from http://dictionary.casrai.org/documents/research-contributions/1.0/contributions/outputs/publications
	<resourceType resourceTypeGeneral="Event">lecture-speech	<work-type>lecture-speech	<work-type> values taken from http://dictionary.casrai.org/documents/research-contributions/1.0/contributions/outputs/publications
	<resourceType resourceTypeGeneral="Text">other	<work-type>other	<work-type> value NOT LISTED IN http://dictionary.casrai.org/documents/research-contributions/1.0/contributions/outputs/publications

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MA	resourceTypeGeneral=”Collection”	No equivalent in ORCID	DataCite controlled list term
MA	resourceTypeGeneral=”Dataset”	No equivalent in ORCID	DataCite controlled list term
MA	resourceTypeGeneral=”Event”	No equivalent in ORCID	DataCite controlled list term
MA	resourceTypeGeneral=”Image”	No equivalent in ORCID	DataCite controlled list term
MA	resourceTypeGeneral=”InteractiveResource”	No equivalent in ORCID	DataCite controlled list term
MA	resourceTypeGeneral=”Model”	No equivalent in ORCID	DataCite controlled list term
MA	resourceTypeGeneral=”PhysicalObject”	No equivalent in ORCID	DataCite controlled list term
MA	resourceTypeGeneral=”Service”	No equivalent in ORCID	DataCite controlled list term
MA	resourceTypeGeneral=”Software”	No equivalent in ORCID	DataCite controlled list term

MA	resourceTypeGeneral=”Sound”	No equivalent in ORCID	DataCite controlled list term
MA	resourceTypeGeneral=”Text”	No equivalent in ORCID	DataCite controlled list term
MA	resourceTypeGeneral=”Workflow”	No equivalent in ORCID	DataCite controlled list term
MA	resourceTypeGeneral=”Other”	No equivalent in ORCID	DataCite controlled list term
O	AlternateIdentifier	<work-external-identifier-id>	Free text. Example: A local accession number: E-GEOD-34814
MA	alternateIdentifierType	<work-external-identifier-type> Any reference ID (other than DOI) taken from Supported Work Identifiers list at http://support.orcid.org/knowledgebase/articles/118807	**In DataCite, if AlternateIdentifier is used, alternateIdentifierType is mandatory.** Free text.

R	RelatedIdentifier	<work-external-identifier-id>	**If RelatedIdentifier is used, relationType and relatedIdentifierType are mandatory.** Free text. Use this property to indicate subsets of properties, as appropriate.
MA	relatedIdentifierType	<work-external-identifier-type> Any reference ID (other than DOI) taken from Supported Work Identifiers list at http://support.orcid.org/knowledgebase/articles/118807	**In DataCite, if RelatedIdentifier is used, relatedIdentifierType is mandatory.**
	No equivalent in DataCite	<work-external-identifier-type>other-id	other-id: A unique identifier, used where none of the specialized identifiers are applicable.
	<relatedIdentifier relatedIdentifierType="ARK">	<work-external-identifier-type>other-id	ARK: Archival Resource Key; URL designed to support long-term access to information objects. In general, ARK syntax is of the form (brackets indicate [optional] elements: [http*://NMA/*]ark*:/NAAN/Name[Qualifier*]

	<relatedIdentifier relatedIdentifierType="EAN13">	<work-external-identifier-type>other-id	EAN-13: European Article Number, now renamed International Article Number, but retaining the original acronym, is a 13-digit barcoding standard which is a superset of the original 12-digit Universal Product Code (UPC) system.
	<relatedIdentifier relatedIdentifierType="eISSN">	<work-external-identifier-type>other-id	eISSN: Electronic International Standard Serial Number; ISSN used to identify periodicals in electronic form (eISSN or e-ISSN)
	<relatedIdentifier relatedIdentifierType="Handle">	<work-external-identifier-type>other-id	Handle: A handle is an abstract reference to a resource.
	<relatedIdentifier relatedIdentifierType="ISTC">	<work-external-identifier-type>other-id	ISTC: International Standard Text Code; a unique “number” assigned to a textual work. An ISTC consists of 16 numbers and/or letters.

	<relatedIdentifier relatedIdentifierType="LISSN"	<work-external-identifier-type>other-id	LISSN: The linking ISSN or ISSN-L enables collocation or linking among different media versions of a continuing resource.
	<relatedIdentifier relatedIdentifierType="LSID" >	<work-external-identifier-type>other-id	LSID: Life Science Identifiers; a unique identifier for data in the Life Science domain. Format: urn:lsid:authority:namespace:identifier:revision
	<relatedIdentifier relatedIdentifierType="PURL ">	<work-external-identifier-type>other-id	PURL: Persistent Uniform Resource Locator. A PURL has three parts: (1) a *protocol*, (2) a *resolver address*, and (3) a *name.*
	<relatedIdentifier relatedIdentifierType="UPC" >	<work-external-identifier-type>other-id	UPC: Universal Product Code is a barcode symbology used for tracking trade items in stores. Its most common form, the UPC-A, consists of 12 numerical digits.

	<relatedIdentifier relatedIdentifierType="URL" >	<work-external-identifier-type>other-id	URL: Uniform Resource Locator, also known as web address, is a specific character string that constitutes a reference to a resource. The syntax is: scheme://domain:port/path?query_string#fragment_id
	<relatedIdentifier relatedIdentifierType="URN" >	<work-external-identifier-type>other-id	URN: Uniform Resource Name; is a unique and persistent identifier of an electronic document. The syntax is: urn:< NID>:<NSS> The leading urn: sequence is case-insensitive, <NID> is the namespace identifier, <NSS> is the namespace-specific string.
	No equivalent in DataCite	<work-external-identifier-type>arxiv	arxiv: ArXiv
	No equivalent in DataCite	<work-external-identifier-type>asin	asin: Amazon Standard Identification Number.
	No equivalent in DataCite	<work-external-identifier-type>asin-tld	asin-tld: ASIN top-level domain for Amazon sites other than the US; valid values: co.jp, co.uk, ca, cn, fr, de, it, es
	No equivalent in DataCite	<work-external-identifier-type>bibcode	bibcode: Bibcode; used by a number of astronomical data systems; example: *1924MNRAS..84..308E*

	<relatedIdentifier identifierType="DOI">	<work-external-identifier-type>doi	DOI: Digital Object Identifier; a character string used to uniquely identify an object. A DOI name is divided into two parts, a prefix and a suffix, separated by a slash. doi:Digital object identifier; example: *10.1038/news070508-7*.
	No equivalent in DataCite	<work-external-identifier-type>eid	eid: Identifier used by Scopus.
	<relatedIdentifier identifierType="ISBN">	<work-external-identifier-type>isbn	ISBN: International Standard Book Number; a unique numeric book identifier. There are 2 formats: a 10-digit ISBN format and a 13-digit ISBN. isbn: International Standard Book Number such as *978-0812695939*.
	<relatedIdentifier identifierType="ISSN">	<work-external-identifier-type>issn	ISSN: International Standard Serial Number; a unique 8-digit number used to identify a print or electronic periodical publication. issn: International Standard Serial Number.
	No equivalent in DataCite	<work-external-identifier-type>jfm	jfm: Jahrbuch über die Fortschritte der Mathematik.
	No equivalent in DataCite	<work-external-identifier-type>jstor	jstor: JSTOR abstract.

	No equivalent in DataCite	<work-external-identifier-type>lccn	lccn: Library of Congress Control Number.
	No equivalent in DataCite	<work-external-identifier-type>mr	mr: Mathematical Reviews.
	No equivalent in DataCite	<work-external-identifier-type>oclc	oclc: Online Computer Library Center.
	No equivalent in DataCite	<work-external-identifier-type>ol	ol: Open Library
	No equivalent in DataCite	<work-external-identifier-type>osti	osti: Office of Scientific and Technical Information.
	No equivalent in DataCite	<work-external-identifier-type>pmc	pmc: PubMed Central article number for full-text free repository of an article.
	<relatedIdentifier relatedIdentifierType="PMID" >	<work-external-identifier-type>pmid	PMID: PubMed identifier; a unique number assigned to each PubMed record. pmid: PubMed Unique Identifier
	No equivalent in DataCite	<work-external-identifier-type>rfc	rfc: Request for Comments.
	No equivalent in DataCite	<work-external-identifier-type>ssrn	ssrn: Social Science Research Network
	No equivalent in DataCite	<work-external-identifier-type>zbl	zbl: Zentralblatt MATH

MA	<relationType>		In DataCite, this property is a description of the relationship of the resource being registered (A) and the related resource (B)
MA	relationType=”IsCitedBy”		indicates that B includes A in a citation <relatedIdentifier relatedIdentifierType="DOI" relationType="IsCitedBy">10.4232/10.ASEAS-5.2-1</relatedIdentifier>
MA	relationType=”Cites”		indicates that A includes B in a citation <relatedIdentifier relatedIdentifierType ="ISBN” relationType="Cites“>0761964312</ relatedIdentifier>

MA	relationType="IsSupplementTo"		indicates that A is a supplement to B <relatedIdentifier relatedIdentifierType="URN" relationType="IsSupplementTo">http://nbn-resolving.de/urn:nbn:de:0168-ssoar-13172</ relatedIdentifier>
MA	relationType="IsSupplementedBy"		indicates that B is a supplement to A <relatedIdentifier relatedIdentifierType="PMID" relationType="IsSupplementedBy">16911322/</ relatedIdentifier>
MA	relationType="isContinuedBy"		indicates A is continued by the work B <relatedIdentifier relatedIdentifierType="URN" relationType="IsContinuedBy">http://nbn-resolving.de/urn:nbn:de:bsz:21-opus-4967</relatedIdentifier>

MA	relationType=”Continues”		indicates A is a continuation of the work B <relatedIdentifier relatedIdentifierType="URN" relationType="Continues">http://nbn-resolving.de/urn:nbn:de:bsz:21-opus-4966</relatedIdentifier>
MA	relationType=”HasMetadata”		indicates resource A has additional metadata B <relatedIdentifier relatedIdentifierType="DOI" relationType="HasMetadata" relatedMetadataScheme="DDI-L" schemeURI="http://www.ddialliance.org/Specification/DDI-Lifecycle/3.1/XMLSchema/instance.xsd ">10.1234/567890</relatedIdentifier>
MA	relationType=”IsMetadataFor”		indicates additional metadata A for a resource B <relatedIdentifier relatedIdentifierType="DOI" relationType="IsMetadataFor" relatedMetadataScheme="DDI-L" schemeURI="http://www.ddialliance.org/Specification/DDI-Lifecycle/3.1/XMLSchema/instance.xsd">10.1234/567891</relatedIdentifier>

MA	relationType=”IsNewVersionOf”		indicates A is a new edition of B, where the new edition has been modified or updated <relatedIdentifier relatedIdentifierType="DOI" relationType="IsNewVersionOf">10.5438/0005</relatedIdentifier>
MA	relationType=”IsPreviousVersionOf”		indicates A is a previous edition of B <relatedIdentifier relatedIdentifierType="DOI" relationType="IsPreviousVersionOf">10.5438/0007</relatedIdentifier>

MA	relationType=”IsPartOf”		indicates A is a portion of B; may be used for elements of a series <relatedIdentifier relatedIdentifierType="ISBN" relationType="IsPartOf">0-486-27557-4</relatedIdentifier>
MA	relationType=”HasPart”		indicates A includes the part B <relatedIdentifier relatedIdentifierType="DOI" relationType="HasPart">10.1234/7894</relatedIdentifier>

MA	relationType=”IsReferenced By”		indicates A is used as a source of information by B <relatedIdentifier relatedIdentifierType="URL" relationType="IsReferencedBy">http://www.testpubl.de </relatedIdentifier>
MA	relationType=”References”		indicates B is used as a source of information for A <relatedIdentifier relatedIdentifierType="URN" relationType="References">http://nbn-resolving.de/urn:nbn:de:bsz:21-opus-963</relatedIdentifier>
MA	relationType=”IsDocumented By”		indicates B is documentation about/explaining A <relatedIdentifier relatedIdentifierType="URL" relationType="IsDocumentedBy">http://tobias-lib.uni-tuebingen.de/volltexte/2000/96/</relatedIdentifier>

MA	relationType=”Documents”		indicates A is documentation about/explaining B <relatedIdentifier relatedIdentifierType="DOI" relationType="Documents">10.1234/7836</relatedIdentifier>
MA	relationType=”IsCompiledBy”		indicates B is used to compile or create A <relatedIdentifier relatedIdentifierType="URL" relationType="isCompiledBy">http://d-nb.info/gnd/4513749-3</relatedIdentifier>
MA	relationType=”Compiles”		indicates B is the result of a compile or creation event using A <relatedIdentifier relatedIdentifierType="URN" relationType="Compiles">http://nbn-resolving.de/urn:nbn:de:bsz:21-opus-963</relatedIdentifier>

MA	relationType="IsVariantFormOf"		indicates A is a variant or different form of B, e.g. calculated or calibrated form or different packaging <relatedIdentifier relatedIdentifierType="DOI" relationType="IsVariantFormOf">10.1234/8675</relatedIdentifier>
MA	relationType="IsOriginalFormOf"		indicates A is the original form of B <relatedIdentifier relatedIdentifierType="DOI" relationType="IsOriginalFormOf">10.1234/9035</relatedIdentifier>

MA	relationType=”IsIdenticalTo”		indicates that A is identical to B, for use when there is a need to register two separate instances of the same resource <relatedIdentifier relatedIdentifierType="URL" relationType="IsIdenticalTo">http://oac.cdlib.org/findaid/ark:/13030/c8r78fzq</relatedIdentifier> IsIdenticalTo should be used for a resource that is the same as the registered resource but is saved on another location, maybe another institution
R	relatedMetadataScheme		Use only with relation pair: HasMetadata/IsMetadataFor
R	schemeURI		Use only with relation pair: HasMetadata/IsMetadataFor
R	schemeType		Use only with relation pair: HasMetadata/IsMetadataFor Examples: XSD, DDI, Turtle

O	Size		Free text Examples: “15 pages”, “6 MB”
O	Format		Free text Use file extension or MIME type where possible, e.g., PDF, XML, MPG or application/pdf, text/xml, video/mpeg.
O	Version		Suggested practice: track major_version.minor_version Register a new identifier for a major version change. Individual stewards need to determine which are major vs. minor versions. May be used in conjunction with AlternateIdentifier and RelatedIdentifier to indicate various information updates. May be used in conjunction with Description to indicate the nature and file/record range of version.

O	Rights		Free text. Provide a rights management statement for the resource or reference a service providing such information. Include embargo information if applicable. Use the complete title of a license and include version information if applicable. Example: Creative Commons Attribution 3.0 Germany License
O	rightsURI		Example: http://creativecommons.org/licenses/by/3.0/de/deed.en
R	Description		xml:lang=”xx” allowed for Description and its attributes The format is open It is a best practice to supply a description.

MA	descriptionType		**In DataCite, if Description is used, descriptionType is mandatory.**
R	<description descriptionType=”Abstract”>	<short-description>	Example: http://data.datacite.org/10.1594/PANGAEA.771774
R	<description descriptionType=”Methods”>		For example, see section “Sampling, Processing and Quality Control Methods” in the following dataset record: http://knb.ecoinformatics.o rg/knb/metacat?action=read&qformat=knb&sessionid=0&docid=knb-lter-gce.275.16 .

R	<description descriptionType="SeriesInformation">		For use with grey literature. If providing an ISSN, use RelatedIdentifier, relatedIdentifierType=ISSN. For dataset series, use RelatedIdentifier and describe the relationships with isPartOf or HasPart. Example: http://data.datacite.org/10.4229/23RDEUPVSEC2008-5CO.8.3
R	<description descriptionType="TableOfContents">		Example: http://data.datacite.org/10.5678/LCRS/FOR816.CIT.1031
R	<description descriptionType="Other">		Use for any other description type.
R	GeoLocation		Repeat this property to indicate several different locations.

R	geoLocationPoint		A point contains a single latitude-longitude pair, separated by whitespace. Example: <geoLocationPoint> 31.233 - 67.302 </geoLocationPoint>
R	geoLocationBox		A box contains two whitespace separated latitude-longitude pairs, with each pair separated by whitespace. The first pair is the lower corner (normally south west), the second is the upper corner (normally north east). Example: <geoLocationBox> 41.090-71.032 42.893-68.211 </geoLocationBox

R	geoLocationPlace		Free text. Use to describe a geographic location.
	Citation	<work-citation><citation>	In DataCite, Citation is concatenated from parsed metadata.