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Persistent Identifiers for Earth Science Provenance

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Overview

- Background
- Identification
- Persistence
- Actionable Identifiers
- (a few) Identifier issues
- Earth Science Data
- (some) Identifier schemes:
  - W3C: URI, URL, URN
  - UUID: Universally Unique IDentifier
  - OID: Object Identifier
  - PURL: Persisent URL
  - DOI: Digital Object Identifier
  - XRI: Extensible Resource Identifier
  - ARK: Archival Resource Key
  - N2T: Name to Thing Resolver
- References

Background

- Historically, published scientific research includes a description of the experiment that yielded the results – in sufficient detail to reproduce the experiment and get the same results.
- Reproducibility(among other things) -> Credibility -> Trust
- Modern research in earth science (and other fields) depends often involves sifting through mounds of data from a variety of sources (field sensors, satellite data, etc.) and applying various algorithms to reduce/ transform/massage that data in various ways
- The data is likely the result of the work of hundreds of individuals over decades.
- Representing the provenance of such scientific results in a manner conducive to exploration, understanding and reproducibility is one of my interests.
- A key to this sort of representation is identifiers.

What am I trying to identify?

- All of the "artifacts" involved in the provenance of a scientific result
  - Data
  - Algorithms
  - Documentation
  - Sensors/Instruments/Instrument platforms
  - People (reputation)
  - Organizations (reputation)
  - Published scientific papers (add to credibility)
  - Computer systems
  - Abstract things like "a data transformation event" or "a validation experiment"
  - An ephemeral execution of a web service

Data identification

- How do you identify a person?
- Consider Shakespeare's *"Romeo and Juliet"*
  - Is that a good "identifier"?
  - The intellectual content of the play
  - A published book with the play
  - A specific book (with a little jelly on page 32)
  - A performance of the play
  - A translation into another language
  - Can I cite an act, scene, line, page, paragraph? ("microattribution")
  - ...
- The library folks have a very good handle on this for various content and media.

Persistence

- "It is intended that the lifetime of a [persistent identifier] be permanent. That is, the [persistent identifier] will be globally unique forever, and may well be used as a reference to a resource well beyond the lifetime of the resource it identifies or of any naming authority involved in the assignment of its name."

http://www.doi.org/doi_presentations/overview_slides_4Dec2007/071205DOIOverview.ppt

- My definition – I want the provenance web leading to a published component of the scientific literature to live as long as the publication is scientifically valid. (In fact, you can use a citation chain to determine when the identifier is no longer referenced in any way.)

Actionable Identifiers

- 'Actionable' Identifier = *Can I click on it?*
  - What happens if the resource is no longer around? We (NASA archive) delete old, obsolete data that takes up expensive space.
- Even if the data is gone, I'd still like to keep the identifier around...
- What happens if valuable data is moved from one "steward" to another? (We do this all the time...)
  - An entire archive taken over by another organization
  - A single dataset within the archive moved from one organization to another
  - What about data served from multiple locations?
  - What about data served in multiple formats?

A few identifier issues

- Data itself vs. a specific representation/format of that data
- Content invariance: Subject to correction? Subject to revision? What is the difference?
- Consider a reprocessing with identical inputs and algorithms, but in a slightly different computing environment..
- Does more than one identifier refer to the same resource?
- Can you compare two identifiers for equivalence?
- What happens when the resource itself moves?
- What happens when there is a new 'steward' for the resource?
- What happens if the resource physically resides in multiple places?
- What about “produce on demand”? Can be “real-time” or not..
- How are resources cited? discovered?
- Identifier standards, security, scalability, compatibility
- Dependent on central registries or authorities?
- Should identifiers be opaque or meaningful (include bits of metadata with semantics)? Structured with hierarchies? Can I predict a URI? ('OpenURL')

- Consider a published research paper that concludes some fact and says the data came from NASA instrument “MODIS”.
  - There are two MODIS instruments flying right now.
  - The set of standard products have 5 different reprocessing “collections”.
  - The data are too big to keep forever, usually all but the last two versions are deleted.
  - There are dozens of different algorithms that derive products from the captured data
  - A different calibration of the level 1 data can affect the level 2 and level 3 data

Earth Science Data (cont)

- Metadata
  - We have a tremendous amount of metadata for the content of data (Date, Orbit number, quality flags, etc.)
  - There is a distinct set of metadata for the content container (file size, file format, digital signature)
- Versions
  - Every algorithm has strict configuration management with versions mapping to revisions (should have better documentation)
  - What does “version” mean to data?
  - Consider Algorithm X of version 1.2 is used to produce file A
  - If we revise algorithm X and reprocess with version 1.3, the produced file A is different, we note in its metadata that it was produced with version 1.3
  - Now what happens if we recalibrate the instrument that produced the data that was fed to algorithm X?

W3C: URI,URL,URN

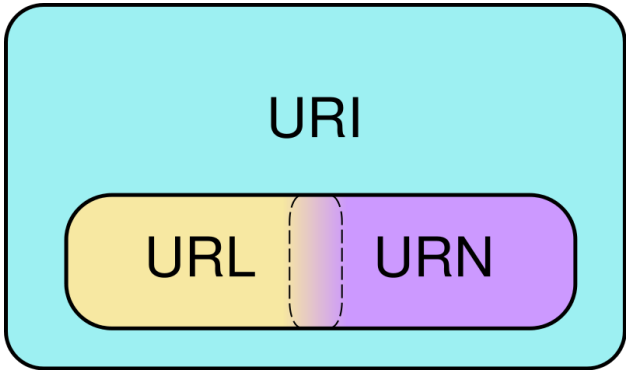
- URI – Uniform Resource Identifier
- URN – Name = What is it called?
- URL – Locator = Where can I find it?

<scheme>:<scheme specific identifier>

http://example.org/something

urn:<namespace>:<namespace specific string>

urn:isbn:0451450523



http://www.w3.org/TR/uri-clarification/

http://en.wikipedia.org/wiki/File:URI_Venn_Diagram.svg

UUID: Universally Unique IDentifier

- A scheme for distributed systems to independently create unique identifiers without central coordination
- A 16-byte (128-bit) number (Enough to make 1 trillion UUIDs every nanosecond for over 10 billion years)
- Several different versions based on MAC address, time, hashing, random numbers.
- Canonical representation to make them easy to recognize:

```
550e8400-e29b-41d4-a716-446655440000
urn:uuid:550e8400-e29b-41d4-a716-446655440000
```

OID: Object Identifier

- Very Formal, ISO standard hierarchical naming scheme
- Think a truly global, universal directory tree similar to a unix directory tree. Any organization can register and get a "path" in the tree and populate it how they please.
- Several different notations in use:

```
{iso(1)member-body(2)f(250)type-org(1)ft(16)test(99)88}
1.2.250.1.16.99.88
oid://1/2/250/1/16/99/88
urn:oid:1.2.250.1.16.99.88
```

PURL: Persistent URL

- Very simple indirect mapping that redirects from a PURL to a URL with standard HTTP redirect
- Includes “partial redirects” to relocate whole hierarchies
- Multiple PURLs could map to one URL (don't do that!)
- What about bookmarks?

<scheme>://<PURL resolver>/<name>

http://purl.org/mypath/mydocs/mydoc

DOI: Digital Object Identifer

- A framework for persistent identification
- A federation of “Registration Agencies” that control portions of the namespace
- RA pay fees based on volume to register DOIs

<RA id>/<RA specific part>

10.1007/978-3-540-89965-5_23

http://dx.doi.org/10.1007/978-3-540-89965-5_23

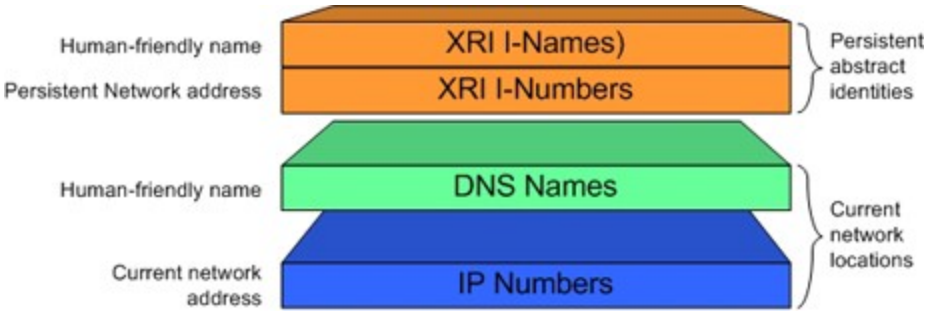
urn:info:doi:10.1007/978-3-540-89965-5_23

XRI: Extensible Resource Identifier

- From OASIS (Organization for the Advancement of Structured Information Standards)
- "Brokers" register with XDI.ORG and handle registration of identifiers (brokers are accredited and have "reputation"
- I-numbers – machine friendly identifiers (like IP addresses) for any resource
- I-names – human friendly identifiers that resolve to an I-number
  - Various types =Person, @trademark, +anything

xri://<authority>/<path>

=Curt.Tilmes



http://www.xdi.org/xri-and-xdi-explained.html

XRI (cont.)

- Hierarchical like URIs, but includes "cross-referencing"
- Fragments can be either persistent(!) or reassignable(*)
- Formal methods for normalization and comparison
- Any URI could be a global authority, not just a "hostname:port"

```
xri://@example.com/something
xri://(mailto:john.doe@example.com)/favorites
```

- Apparently actively opposed by (portions of) W3C. Last standard proposal was voted down.
- *"We are not satisfied that XRIs provide functionality not readily available from http: URIs."*

http://www.equalsdrummond.name/?p=130

ARK: Archival Resource Key

- Scheme for Long-Term, Persistent Actionable Identifiers
- From California Digital Library, John Kunze
- Organizations must make a commitment to “long-term,” “persistent”, “actionable”
- PURLs, Handles, etc. add indirection, but not (necessarily) organizational commitment
- Goals:
  - Identifiers deliver you to objects (where feasible) (not a “404”)
  - Identifiers deliver you to object metadata
  - Identifiers deliver you to statements of commitment

ARK (cont.)

- Name Mapping Authority Hostport (NMAH)= replaceable address that can be used to resolve the identifier (Kunze calls this the “booster rocket”)
- Name Assigning Authority Number (NAAN) = centrally registered list of organizations
- Append '?' for metadata and '??' for commitment policies
  - Human readable and structured for computers
- If the NMAH goes away, you can still find the object by checking central registry for new NMAH for the NAAN

[<NMAH>/]ark:/<NAAN>/<Name>

ark:12345/myname

http://some.org/ark:12345/myname

http://other.org/ark:12345/myname

N2T : Name to Thing Resolver

- http://n2t.info
- Very simple resolver mirrored by consortium volunteers under one hostname

http://n2t.info/<global prefix>/<local part>

```
http://n2t.info/NAA/...          (NAA = N2T NAA Number, eg, 12345)
http://n2t.info/ark:/NAA/...     (NAA = ARK NAA Number, eg, 12345)
http://n2t.info/urn:NAA:...      (NAA = URN Naming Authority, eg, nbn)
http://n2t.info/hdl:NAA/...      (NAA = Handle Naming Authority, eg, 12345)
http://n2t.info/doi:NAA/...      (NAA = DOI Naming Authority, eg, 10.12345)
http://n2t.info/purl:/NAA/...    (NAA = PURL Resolver Hostport, eg, purl.org)
```

References

- "Cool URIs Don't Change." http://www.w3.org/Provider/Style/URI
- "Naming and Addressing: URIs, URLs, ..." http://www.w3.org/Addressing/
- "Object Identifer (OID)" http://www.oid-info.com/
- "The Digital Object Identifier (DOI) System." http://www.doi.org/
- "Persistent Uniform Resource Locator" http://purl.org/
- " A Universally Unique IDentifier (UUID) URN Namespace" http://www.ietf.org/rfc/rfc4122.txt
- "XRI (Extensible Resource Identifier)" http://www.xdi.org/xri-and-xdi-explained.html
- "ARK (Archival Resource Key)" http://www.cdlib.org/inside/diglib/ark/arkspec.html
- "Name-to-Thing (N2T) Resolver" http://n2t.info

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