Digital Object Architecture and The Handle System

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Technical Innovation for Digital Policy
Goals of the Digital Object Architecture

The Digital Object Architecture provides a solution to the following digital information management issues:

– Provide standard access to heterogeneous information and services.
  - Identification
  - Description, search and retrieval
  - Security, integrity, and trust
  - Typing of data and services

– Interoperability across heterogeneous information systems.
  - Independent of the specific underlying technologies that host and serve the information.

– Interoperability over long periods of time.
  - 10 – 100 – 1000 years.

– Very large level of scalability.
  - Distributed architecture
  - Open architecture framework
  - Standard protocols and procedures
Motivations for the Digital Object Architecture

- The Internet is about sharing information.
- Information is more than packets.
- Information needs to be a “First Class Citizen” in the Internet.
  - Information is complex, it has context, uses, monetary value, etc...
  - Information needs to be locatable and attributable.
  - Information needs to be understandable and reusable.
  - Information needs to be protected, secure, and trusted.
  - Information needs to persist over time.
- The Web has made information widely available but there are many issues that remain when dealing with information management.
  - Heterogeneous access policies
  - Heterogeneous data and systems
    - Big Data
    - IoT
Digital Object Architecture’s Beginnings

• The Digital Object Architecture had its roots in a digital library project - CS-TR project (Computer Science – Technical Report) funded by DARPA.
• The Digital Object Architecture was first described in a paper: A Framework for Distributed Digital Object Services by Bob Kahn/Robert Wilensky.
• The work was developed to be publicly available.
• The underlying philosophy: build the minimum that is needed to achieve the desired functionality.
• Define a series of protocols and procedures that are technology independent
• Some of its components have been in operation for over 15 years.
Digital Object Architecture: Information Management on Networks

Client

Repositories

Resource Discovery

Identifier Resolution Service

Search Engines, Metadata Databases, Catalogues, Registries, etc.
The Handle System ™

- Provides a basic identifier resolution system for the Internet.
- The identifiers within the Handle System™ are called handles.
- A handle identifies an digital object.
- A handle is globally unique.
- A handle can be resolved to its object’s current state data.
- A handle persists even if attributes of the object changes.
- Provides secure handle resolution and administration with its own PKI as an option.
- Optimized for speed and reliability.
- Open architecture, Open Source, well-defined protocol, and data model (RFC3650 - 51- 52).
The Handle System ™ - 2

- Logically a single system, but physically and organizationally distributed across many separate independent handle services.
  - Anyone anywhere can run their own handle service to manage their own handles. (1000s are currently operating around the world)
- Highly scalable.
  - A single handle service can scale into the billions of unique handles.
- Provides infrastructure for a wide application domain:
  - Digital libraries & publishing (DOIs)
  - e-research
  - Multimedia asset management (EIDR)
  - Anti-counterfeiting solutions
  - ID management
  - IoT
  - Etc...
What is a Handle?

Every registered handle is globally unique and resolvable.
- The **handle prefix** is resolvable by the **Global Handle Registry (GHR)** into the **handle service** responsible for that prefix.
- The handle is resolvable by that **handle service** into set of typed values.

- Character Set: Unicode 2.0 and above.
- Prefix: Currently allocating only numeric values.
- Suffix: No restrictions.
## Handles Resolve to Typed Data

<table>
<thead>
<tr>
<th>Handle</th>
<th>Data Type</th>
<th>Handle Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>35.1525/b.2009.59.5.9</td>
<td>HS_ADMIN</td>
<td>handle=0.na/35.1525; index=200; [delete hdl, add val, read val, modify val, del admin, add admin, list]</td>
</tr>
<tr>
<td></td>
<td>URL</td>
<td><a href="http://caliber.ucpress.net/doi/abs/35.1525/bio.2009.59.5.9">http://caliber.ucpress.net/doi/abs/35.1525/bio.2009.59.5.9</a></td>
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<tr>
<td>10320/loc</td>
<td></td>
<td>&lt;locations chooseby=&quot;locatt, country, weighted&quot;&gt;</td>
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|             |              | <location id="1" cr_type="MR-LIST" href="http://mr.crossref.org/iPage?doi=35.1525%2Fbio.2009.59.5.9" weight="1" />
|             |              | <location id="2" cr_src="unca" label="SECONDARY_BIOONE" cr_type="MR-LIST" href="http://www.bioone.org/doi/full/35.1525/bio.2009.59.5.9" weight="0" /> |
|             |              | </locations>                                                               |
| HS_PUBKEY   |              | 00000000B4453415F50555425F4B45590000000000015009760508F15230B...             |
| HS_SIGNATURE|              | eyJhbGciOiJSUzI1NiJ9.ejJkaWdlc3RzIjp7ImFsYlI6IiQ50yNTYiLCJkaWdlc3I...  |
Handles Data Types

• **Handle Data Types** are inherently extensible.
• Handle data types should be identified using a handle to promote interoperability.
• A Handle Data Type’s handle should resolve to:
  • A human readable descriptions.
  • A machine parsable descriptions.
  • A set of services, interfaces, and code that can process the information in the handle value.
• There are basic data types to enable the Handle System to operate:
  • **HS_ADMIN** (0.TYPE/HS_ADMIN)
  • **HS_PUBKEY**
  • **HS_SITE**
  • **HS_SERV**
  • Etc...
Handle Resolution

Resolve 10.152/59.5.9

Handle Service for 0.NA10.152

Handle Service 0.NA/35.12

Handle Service 0.NA/10.152

Handle Service 0.NA/86.1

Handle Service 0.NA/20.123.1

Handle System™

Global Handle Registry

Authoritative Service

Mirror Service 1

Mirror Service n

SVR #1

SVR #2

SVR #3

SVR #4

SVR #n

Resolve 0.NA10.152

Handle Service for 0.NA10.152

SVR #1

SVR #2

SVR #3

SVR #4

SVR #n

10.152/59.5.9

URL 4  http://www.acme.com/

URL 20  http://www.acme.com/
Who is responsible for operating the GHR?

- The original GHR was operated by CNRI (Corporation for National Research Initiatives) in Reston VA in the US starting in the late 1990s.
- Until recently, CNRI had the sole credential and authorization to create all new prefixes.
- The handle user community requested that the prefix creation be decentralized across multiple organizations.
- Development of a new Multi-Primary GHR architecture.
- Creation of the DONA Foundation in Geneva to oversee the operations of this new GHR.
Multi-Primary GHR Architecture

• Multi-Primary Administrators (MPA): organizations / entities that are credentialed and authorized by DONA to create their own derived prefixes.
• Each MPA is allotted a single prefix (e.g. 0.NA/21)
• Every MPA can create an unlimited number of derived prefixes from its allotted prefix and allot them to whomever and however they see fit.
• All MPA cryptographically verify and replicate all valid prefix creations from all other MPAs.
• DONA and the MPAs coordinate the operations of the GHR.
• The new GHR maintains backwards compatibility with legacy GHR.
GHR – Coordinated Across MPAs

Multi Organizational Coordinated GHR

DONA GHR SVC

MPA Org A GHR SVC 20

MPA Org N GHR SVC 99

LHS 20.1
LHS 20.10
LHS 99.1

LHS 20.1.1
DONA Foundation’s GHR Operations

- DONA coordinates with all Multi-Primary Administrators (MPA) to maintain the stable and secure operation of the Global Handle Registry (GHR).
- DONA credentials and authorizes new MPAs.
- The DONA Foundation will work in collaboration with the MPAs to improve the architectural, technical, and performance of the GHR.
- The Multi-Primary GHR Operations started on the 9th of December 2015.
The Role of the DONA Foundation

• Based in Geneva, Switzerland.
• Provide coordination, software, software development, and other strategic services for the technical development, evolution, application, and other uses in the public interest around the world of the Digital Object Architecture (DOA) with a mission to promote interoperability across heterogeneous information systems.
• DONA will promote the X.1255 standard and the use of the DOA across many different countries, domains, and industries.
• Make the developed DOA standards and/or software accessible to the community to further their development and adoption.
Questions?