DIGITAL OBJECT IDENTIFIER (DOI®) SYSTEM

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ABSTRACT

The Digital Object Identifier (DOI®) system is a managed system for persistent identification of content on digital networks. Initiated in 1997, the DOI System builds on existing or developing standards, notably the Handle System® for resolution of names to data and the indecs™ (interoperability of data in e-commerce systems) framework for precise specification of an identified entity's attributes (metadata). DOI® names may identify physical, digital, or abstract entities, at any level of granularity. Through multiple resolution, a DOI name can be associated with multiple pieces of data, each of which may be dynamically updated. Once assigned, a DOI name can be used to locate an entity, or to provide services irrespective of changes in location or management responsibility of the entity. The DOI System has been developed and implemented in a range of publishing applications since 2000. By 2007 over 30 million DOI names had been assigned.

The DOI System is managed by the International DOI Foundation (IDF), and is being standardised through the International Standards Organisation. The IDF is also involved in related activities which support or faciliate DOI System uses for interoperability of persistent identifiers and metadata, treating each piece of content as an object in its own right, with a defined name (identifier) and attributes.

The DOI System has been developed to meet the needs of the intellectual property communities in carrying out any transaction (free or paid) through the use of persistent identifiers (unique labels for entities) with metadata (structured relationships between identified entities), as prerequisites for structured management of content. Applications were initially simple redirection to a single URL, but more sophisicated means of management are now being implemented, such as contextual resolution, where the result of a redirection is also a function of some additional information such as local holdings information. The most widely known application of the DOI System is the CrossRef cross-publisher citation linking service which allows a researcher to link from a reference citation directly to the cited content on another publisher's platform, subject to the target publisher's access control practices. Other applications in governemnt documentation, books, and data are available and further applications are under development.

DOI names – the strings that specify unique referents within the DOI System – follow a defined syntax, which may optionally incorporate other identifier schemes, and they may be represented in a number of ways for use in applications. DOI metadata provides attributes for definition of the entity being managed, which is of particular importance when managed entities are often abstractions, and the choice of which possible entities to distinguish as separable is not absolute but dependent on function and context. The IDF maintains a social infrastructire of policies and formal agreements to ensure the consistent implementation of the DOI System as a reliable and persistent framework for identification.

INTRODUCTION

The term "digital object identifier" may be used non-specifically to describe a number of varied technologies concerned with the identification of entities in a digital environment. The capitalised term "Digital Object Identifier" (in full, Digital Object Identifier System) refers to one specific technology, the system defined and managed by the International DOI Foundation[1], which provides an infrastructure for persistent unique identification of

entities (here termed "objects") on digital networks. This system is now widely deployed in a number of content-related applications.

TERMINOLOGY AND STANDARDISATION

DOI[®] is an acronym for Digital Object Identifier. DOI[®] is a registered trademark of the International DOI Foundation, Inc. (abbreviated to IDF). The International DOI Foundation authorizes use of the mark DOI[®] free of charge provided that it is acknowledged by the superscript symbol "®" following the letters "DOI" in any printed or electronic document at its first occurrence, with the exception that when expressed as a URL or similar syntactic string "doi" forms part of the presentation of the DOI name and need not be so identified.

The unqualified term "DOI" alone (which was used in the early years of the system's development) is now deprecated, as a potential source of confusion, and the preferred usage is with a qualifier to refer to either specific components of the DOI System (e.g. "DOI name": the string that specifies a unique referent within the DOI System); or the system as a whole ("DOI System": the functional deployment of DOI names as the application of identifiers in computer sensible form through assignment, resolution, referent description, administration, etc. as prescribed by the specification).

The system has been in widespread use since 2000[2,3], and the specification is currently a work item of the International Standards Organisation, expected to become a formal ISO standard in 2008 or 2009, as part of ISO TC46/SC9 (the group of the International Standards Organisation which deals with identification and description of "content related" entities, such as ISBN, ISSN, etc.)[4]. One component, the syntax of the DOI name, was standardised by the US National Information Standards Organization as "Syntax for the Digital Object Identifier", Z39.84-2000 in 2000 (revised five years later as Z39.84-2005)[5].

The term "Digital Object Identifier" is construed as "digital identifier of an object", rather than "identifier of a digital object": the objects (entities) identified by DOI names may be of any form – digital, physical or abstract – as all these forms are necessary parts of any coherent content management system. The resolution component used in the DOI System is the Handle System, which is part of a wider Digital Object Architecture[6]; that architecture specifically deals only with digital objects with identifiers (handles). There is no conflict in these two views, since any non-digital entity may be reified (or represented) as a corresponding digital object for the purposes of digital object management (though some care is needed in the definition of such objects and how they relate to non-digital entities).

HISTORY

The DOI System was the result of a 1996 initiative of the Association of American Publishers (AAP) to develop tools to enable management of copyrightable materials in an electronic environment. That group recognised the need to uniquely and unambiguously identify content entities, rather than refer to them by locations, and commisioned a study to specify an appropriate technical solution, selected if possible from one or more existing technologies rather than developing a new system. In parallel, the International Publishers Association (IPA) and International Association of Scientific, Techical and Medical Publishers (STM) had commissioned a study to define a "unique file identifier" for similar purposes such as designating digital versions of journal articles. These efforts combined in 1997; recognising that such a practical initiative in unique persistent naming had widepsread potential applications, the combined AAP, IPA and STM group announced the launch of an open membership activity, the International DOI Foundation, at the Frankfurt Book Fair of October 1997, as an effort to implement the technology and develop further tools to manage such persistently named entities.

The role of the International DOI Foundation (IDF) is to "support the needs of the intellectual property community in the digital environment, by the development and promotion of the DOI System as a common infrastructure for content management. The Foundation is international in its membership and activities". The International DOI

Foundation, Inc. is a non-stock membership corporation organized under the General Corporation Law of the State of Delaware, USA. The Foundation is controlled by a Board elected by the members of the Foundation. The Corporation is a "not-for-profit" organization, i.e. prohibited from activities not permitted to be carried on by a corporation exempt from US federal income tax.

In late 2005 a number of changes were made by the International DOI Foundation (IDF) following the completion of a strategic review, with the development of a policy on ensuring persistence, adoption of a patents policy, and the continued evolution to a new structure, appropriate to the completion of the initial DOI System development activity and a focus on building more DOI name registrations among a committed social infrastructure network. As part of this development, a number of existing Registration Agencies in the publishing sector consolidated their activities, recognising the maturation of the DOI name marketplace with the emergence of different business models, and taking advantage of the DOI System's infrastructure which ensures persistence of assigned identifiers. During its initial development years, the Foundation employed a small number of staff; in 2006, in line with the strategic plan, the management of the foundation was outsourced to an independent managing agent. The main IDF technology service is outsourced to the developers of the Handle System (Corporation for National Research Initiatives, based in Reston, VA.).

The IDF is financed entirely by its members. Members are either (a) Registration Agencies (which implement the DOI System, and pay a membership fee plus licence and operating fees to the IDF for support of common technical and social infrastructure) or (b) supporting organisations which have an interest in developing and deploying the system, of which there are two categories (Charter and General). The Foundation is evolving from an organisation funded by supporting organisations to one entirely self-financing, supported by operational regsitration agencies: this migration path has been consistently followed to date, with a year-on-year growth of operational revenues since inception. In 2007, approximatley 82% of revenues were from operational registration agencies. A list of current regsitration agencies is maintained by the IDF at its web site. The Foundation publishes a regular e-mail news bulletin, and holds annual meetings for members, parts of which are open to non-members.

The development of the DOI System has proceeded through three parallel tracks:
- an initial implementation of persistent naming: a single redirection from a DOI name to a digital location (URL) of the entity or information about it;
- the development of more sophisicated means of management, such as contextual resolution, where the result of a redirection is also a function of some additional information such as local holdings information;
- collaboration with other standards activities in the further development of tools for managing entities in a digital environment.

The IDF maintains all technical information about the DOI System, much of which is available in the DOI Handbook.

RELATED ACTIVITIES

The DOI System is associated with two independent technical activities which it has used as components of DOI System implementations: the Handle System[R], and the indecs project. Each is used in other non-DOI System applications (an aim of the IDF has been to use existing solutions where these are available and proven to be useful). In theory, either of these components could be replaced in the DOI System by other technologies offering similar features, but in practice it seems unlilkely that any significant changes to the current technology will be necessary in the forseeable future: each is designed as a general-purpose solution to the particular task it performs.

The Handle System[7], the resolution component of the DOI System, is a general-purpose distributed information system designed to provide an efficient, extensible, and secured global name service for use on networks such as the Internet. The Handle System includes an open set of protocols[8][9][10], a namespace, and a reference implementation of the protocols. The DOI System is one implementation of the Handle System; hence a DOI

name is a *Handle*. DOI names are distinguished from other handles by additional features and functionality, specifically *metadata* and *policy* forming the totality of the DOI System. The Handle System was a component selected by the origianl AAP 1996 study. It enables entities to be assigned first-class names, independent of domain names and other location-specific information, which can then be resolved (re-directed) to appropriate locations: since the resolution destination is managed and can be changed, this provides a tool for persistence, avoiding "404 not found" and similar problems with URLs. The Handle System is used in a variety of applications such as the Content Object Repository Discovery and Resolution Architecture (CORDRA) of the US Dept. of Defense Advanced Distributed Learning initiative; The Library of Congress National Digital Library Program; the US DoD Defense Virtual Information Architecture (DVIA), and applications in GRID computing and advanced future internet architectures. A comprehensive web resource for the Handle System is available.

The indecs (interoperability of data in e commerce systems) project[11] was the basis of the DOI System's data model for semantically interoperable metadata. This allows the use of a variety of existing metadata schemes with DOI names in a common framework. At the time of the International DOI Foundation launch, the importance of interoperable metadata was not widely appreciated and avaiable schemes were weak. The indecs project (1998-2000) was co-funded by the EU and a wide variety of publishing, library and rights bodies to address this problem; the IDF was one of the early funders and supporters of indecs, which delivered a generic data model of e-commerce for all types of intellectual property[12]; this led, through other projects, to a contextual ontology architecture, a detailed extensible data model supporting semantic interoperability in many developments e.g. the ISO MPEG-21000-6 Rights Data Dictionary[13]; the music industry DDEX Digital Data Exchange standards[14]; the publishing industry ONIX messaging schemas and ONIX schemes for Licensing Terms, Repertoire and Distribution[15]. It is consistent with other major ontology work such as FRBR, ABC-Harmony, OWL, CIDOC CRM, and informs the RDA (Resource Description and Access)/ONIX framework for resource categorization built on the foundation established for the Anglo-American Cataloguing Rules (AACR)[16]. The International DOI Foundation is the ISO registration authority for the MPEG-21000-6 Rights Data Dictionary. This dictionary provides the basis for a resource to create widely understood, consistent meaning for Digital Rights Management systems and other systems requiring semantic interoperability of terms.

The International DOI Foundation, particularly through its CrossRef registration agency[17], has also been closely involved in the development of the OpenURL, a mechanism for transporting metadata and identifiers describing a publication for the purpose of context-sensitive linking. The DOI System is now widely implemented using OpenURL by many libraries: further information on this topic is available from the CrossRef web site. The use of open URL was the first widespread example of the second strand of DOI System development: more sophisticated means of management such as contextual resolution.

The expertise of the IDF in issues such as resolution and semantic interoperability has also led to some IDF members being active particpants in discussions of further identifier scheme developemnt in the third track of DOI System development (collaboration with other standards activities in the further development of tools for managing entities in a digital environment), such as the International Standard Text Code (ISTC) numbering system for the identification of textual works, and identifiers for parties (persons and organisations), and licences.

SCOPE

The DOI System specification is an abstract framework which does not specify a particular context of its application, but is designed with the aim of working over the Internet (defined as a global information system including the underlying communications technology, and higher-level protocols and end-user applications, the associated data structures and the means by which the information may be processed, manifested, or otherwise used[18]). A DOI name is permanently assigned to an object, to provide a persistent link to current information about that object, including where the object, or information about it, can be found on the Internet.

A DOI name may be used to identify objects of any material form (digital, physical) as well as abstractions (such as textual works). "DOI" is construed as "digital identifier of an object" (not "identifier of a digital object"). A DOI name is not intended as a replacement for other well-known identifier schemes, such as those of ISO TC46/SC9[19] (ISBN, ISSN, ISAN, ISRC, etc), or other commonly recognised identifiers. If an object is already identified with another identifier string, the character string of the other identifier may be integrated into the DOI name syntax, and/or carried in DOI name metadata.

The scope of the DOI System is not defined by reference to the type of content (format, etc), but by reference to the functionalities it can provide and context of use. The DOI System provides for unique identification, persistence, resolution, metadata and semantic interoperability. Information about an object can change over time, including where to find it, but its DOI name will not change. Applications include but are not limited to managing content location and access; managing metadata; facilitating electronic transactions; persistent unique identification of any form of any data; commercial or non-commercial transactions.

A DOI name may be assigned to any object of any form whenever there is a functional need to distinguish it as a separate entity. Registration Agencies may specify more constrained rules for the assignment of DOI names to objects for DOI-related services. The principal focus of assignment is content-related entities such as text documents; data sets; sound carriers; books; photographs; serials; audio, video and audiovisual recordings; software; abstract works; artwork, etc., and related entities in their management, e.g. licences, parties.

A DOI name can, within the DOI System, be resolved to values of one or more types of data relating to the object identified by that DOI name, such as a URL, an e-mail address, other identifiers, and descriptive metadata.

The content of an object associated with a DOI name is described unambiguously by DOI name metadata, based on a structured extensible data model that enables the object to be associated with arbitrarily precise metadata to support description and services. The data model supports interoperability between DOI System applications.

APPLICATIONS

The first major application of the DOI System, and still currently the largest, was the use of DOI names by CrossRef, an independent membership association founded and directed by publishers. CrossRef's mandate is to connect users to primary research content, by enabling publishers to work collectively in a DOI System registration agency for scholarly and professional publications. Beginning in 2000, it set up and currently operates a cross-publisher citation linking system that allows a researcher to click on a reference citation on one publisher's platform and link directly to the cited content on another publisher's platform, subject to the target publisher's access control practices. The CrossRef citation-linking network in mid 2007 covered some 30 million articles and other content items from several hundred scholarly and professional publishers.

Other applications of the DOI System include in several existing ISBN agencies which have also become DOI Registration Agencies and are active in collaboration to enhance ISBN functionality. In 2004, a programme was announced to assign DOI names to all European Union Publications through the Office for Official Publications of the European Communities. In 2005 an agency was launched to persistently identify scientific data sets through the DOI System. In early 2007 a Chinese DOI Registration Agency was appointed. A list of current Registration Agencies is maintained by the IDF on its web site.

Some applications have remained at a relatively small scale. Trial applications may be developed as pilot-scale (without a corresponding formal Registration Agency); the IDF encourages a wide variety of experimental and development activities. It may be expected that other large-scale applications will emerge as the sophistication of content management on digital networks increases.

A DOI name may be assigned to any entity, regardless of the extent to which it may be a component part of some larger entity. DOI names may be assigned at arbitrary levels of granularity or abstraction. For example, separate DOI names may conceivably be assigned to: a novel as an abstract work; a specific edition of that novel; a specific chapter within that edition of the novel; a single paragraph; a specific image or quotation; as well as to each specific manifestation in which any of those entities are published or otherwise made available, or any other level of granularity which a registrant deems to be appropriate.

Each DOI name specifies one and only one referent in the DOI System. A referent may be specified by more than one DOI name, though this is a deprecated practice: where multiple DOI names are assigned to the same referent, e.g. through assignment of DOI names by two different Registration Agencies, Registration Agencies are encouraged to collaborate in provide a unifying record for that referent.

SYNTAX OF DOI NAMES

A DOI name is the string that specifies a unique object (the referent) within the DOI System. The DOI name syntax (standardised as ANSI/NISO Z39.84-2005) prescribes the form and sequence of characters comprising any DOI name. The DOI name syntax is made up of a *prefix* element and a *suffix* element separated by a forward slash. There is no defined limit on the length of the DOI name, or of its prefix or its suffix elements. The DOI name is case-insensitive and may incorporate any printable characters from the Unicode Standard.

The combination of a unique prefix element (assigned to a particular DOI name registrant) and a unique suffix element (provided by that registrant) is unique, and so allows the de-centralized allocation of DOI names. The DOI name is an opaque string for the purposes of the DOI System. No definitive information should be inferred from the specific character string of a DOI name. In particular, the inclusion in a DOI name of any Registrant code allocated to a specific organization does not provide evidence of the ownership of rights or current management responsibility of any intellectual property in the referent. Such information can be asserted in the associated DOI name metadata.

The DOI name prefix is composed of two components: a Directory indicator followed by a Registrant code, separated by a full stop (period) (e.g. 10.1000). The Directory indicator is always "10" and distinguishes the entire set of character strings (prefix and suffix) as Digital Object Identifiers within the wider resolution system. The Registrant code is a unique alphanumeric string assigned to an organization that wishes to register DOI names (four digit numeric codes are the current preferred though not compulsory registrant code syntax). The Registrant code is assigned through a DOI Registration Agency. A registrant may have multiple registrant codes. Once a DOI name is assigned the string should not be changed, including its Registrant code element, regardless of any changes in the ownership or management of the referent object; if an object is withdrawn from digital access, its DOI name should still resolve to some appropriate message to this effect. The Registrant code may be further divided into sub-elements for administrative convenience if desired (though applications so far have made relatively little use of this functionality). Each sub-element of the Registrant Code is then preceded by a full stop (e.g. 10.1000.10): such sub-division implies no hierarchical relationship; each prefix string, whether subdivided or not, has equal status in the DOI System. Sub-divided prefixes may however have technical resolution implications and should be used with care.

- EXAMPLE: a DOI name with the prefix element "10.1000" and the suffix element "123456": 10.1000/123456

The unique suffix may be a sequential number, or it may incorporate an identifier generated from or based on another system used by the registrant (e.g. ISBN, ISSN, ISTC). In such cases, the existing system may specify its own preferred construction for such a suffix:

- EXAMPLE: a DOI name suffix using an ISSN: 10.1038/issn.0028-0836

VISUAL PRESENTATION AND OTHER REPRESENTATIONS OF DOI NAMES

When displayed on screen or in print, a DOI name is normally preceded by a lowercase "doi:" unless the context clearly indicates that a DOI name is implied.

- EXAMPLE: the DOI name 10.1006/jmbi.1998.2354 is displayed as doi:10.1006/jmbi.1998.2354.

The use of lowercase string "doi" follows the specification for representation as a URI[20] (as for e.g. "ftp:" and "http:").

When displayed in web browsers the DOI name itself may be attached to the address for an appropriate proxy server, to enable resolution of the DOI name via a standard web hyperlink. The IDF maintains a list of approved proxy servers (e.g. http://dx.doi.org/ resolves DOI names in the context of web browsers using the Handle System resolution technology). To resolve a DOI name via a standard web hyperlink, the DOI name itself should be appended to the address for the proxy server:

- EXAMPLE: the DOI name *10.1006/jmbi.1998.2354* would be made an active link as *http://dx.doi.org/10.1006/jmbi.1998.2354*.

DOI names so represented in a URL and transported by the HTTP protocol are constrained to follow standard IETF guidelines for URI representations. The syntax for URIs is more restrictive than the syntax for DOI names; some characters are reserved and will need encoding. The IDF provides current information on appropriate encoding of characters in the DOI Handbook.

Certain client or server software may be able to handle DOI names using native handle resolution technology (i.e. *doi:10.1006/jmbi.1998.2354* would be interpreted by the browser and automatically resolved without the addition of the proxy server address).

DOI names may be represented in other forms in certain contexts (e.g. in the info URI schema[21]). The IDF maintains a current list of such representations.

RESOLUTION OF DOI NAMES

Resolution is the process of submitting a specific DOI name to the DOI System and receiving in return the associated values held in the DOI name resolution record for one or more types of data relating to the object identified by that DOI name. This may include, but is not restricted to, types of data such as a location (URL), an e-mail address, another DOI name, descriptive metadata, etc. The referent objects referred to by DOI names may be of various types (e.g. abstractions as "works", physical "manifestations", performances) that may or may not be directly accessible in the form of a digital file or other manifestation; hence the resolution may or may not return an instance of the object. Resolution may involve one or more intermediate mapping operations.

DOI name resolution records may include one or more URLs, where the object may be located, and other information provided about the entity to which a DOI name has been assigned, optionally including but not restricted to: names, identifiers, descriptions, types, classifications, locations, times, measurements, and relationships to other entities.

The initial implementation of the DOI System, that of persistent naming, uses a single redirection from a DOI name to a digital location (URL) of the entity or information about it (figure 1).
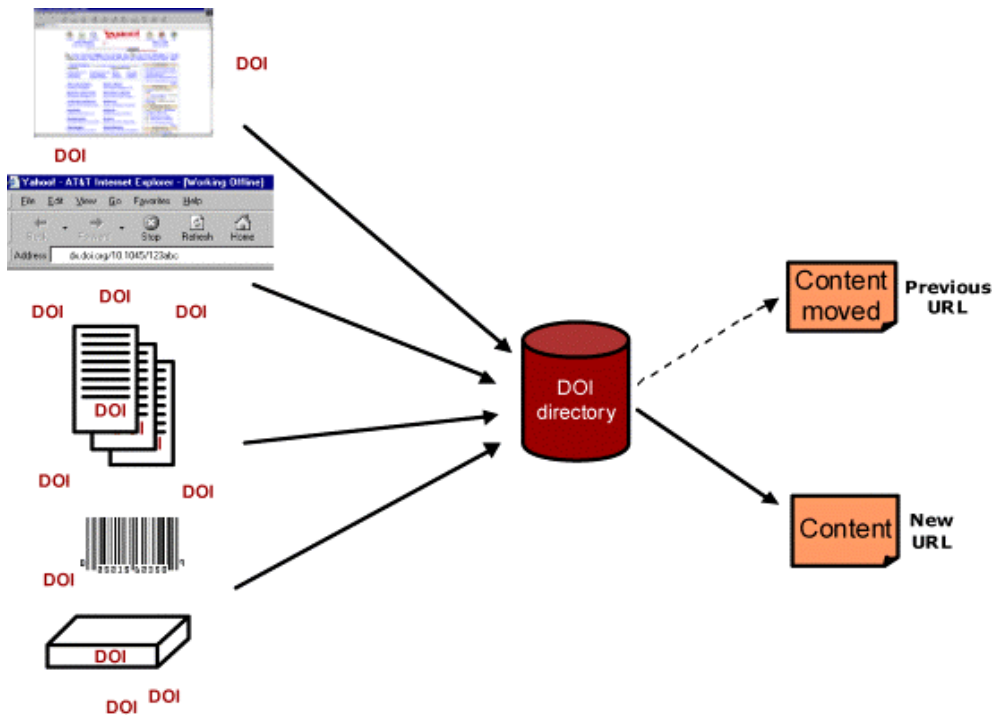
Fig. 1. The role of the DOI System in providing a persistent identifier. Content originally at one URL has been moved to a new URL. Through a single change in the DOI System directory, all instances of the DOI name identifying that content, even if already recorded in print, as bookmarks, etc., will automatically resolve to the new URL, without the user having to take any action. (©International DOI Foundation.)

A significant functionality of the DOI System is the capability of multiple resolution, i.e. delivering more than one typed "value" back from a resolution request. (figure 2)
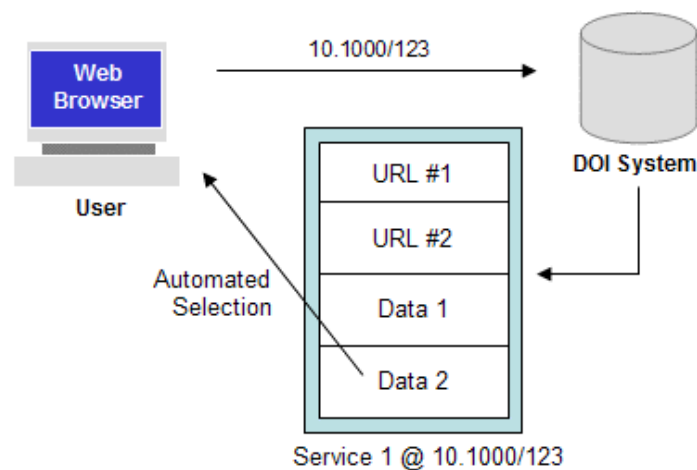

Figure 2: Schematic representation of multiple resolution. The DOI name 10.1000/123 resolves to four values within the DOI System. An application is shown here which has the capability of selecting one of these results on the basis of some information provided in the resolution result and the local application. (©International DOI Foundation.)

The Handle System used in the DOI System is natively capable of multiple resolution; the types are extensible, and only a few are globally defined. Designing an application to use that functionality is open to anyone to do; the downside of that is a potential proliferation of incompatible types. For that reason the IDF developed a consistent data model for each of its Registration Agencies to use, to ensure consistency and enhance interoperability. Within the DOI System a set of handle value types were developed in the context of the DOI[®] API, which type the entire handle: this single type/value pair serves as a guide to evaluating the handle and the rest of its type/value pairs. This is an example of using a minimally defined infrastructure to develop more complex applications and services. This defines the concept of DOI[®] Application Profiles and DOI[®] Services, to group similar typed values and manage DOI names by groups through clustering, association of groups with behaviour (services), and redirection (see figure 3).
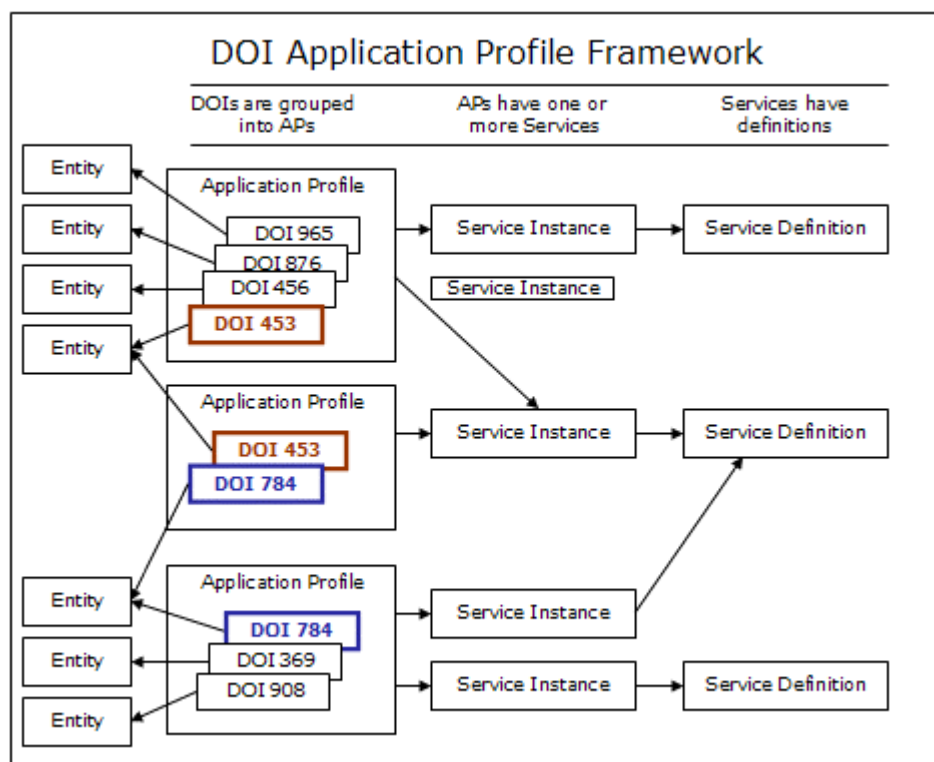

Figure 3: abstract view of Application Profile Framework. DOI names are linked into Application Profiles. Any single DOI name can be a member of multiple Application Profiles. Each Application Profile can be linked into multiple services. That linkage is to one or more specific instances of a service. Each defined service can be made available in multiple ways, referred to as instances. Each of the instances would be usable by all of the members of one or more Application Profiles. This makes it possible to add a service to many DOI names by adding that service to relatively few Application Profiles. (©International DOI Foundation.)

METADATA REGISTERED WITH DOI NAMES

Assignment of a DOI name requires the registrant to record metadata describing the entity to which the DOI name is being assigned. The metadata describes the entity to the degree that is necessary to distinguish it as a separate entity within the DOI System.

The object is described unambiguously and precisely by DOI name metadata, based on a structured data model that enables the referent of a DOI name to be associated with arbitrarily precise metadata to support description and services associated with a referent. This is designed to promote interoperability within networks of DOI name users by enabling independent systems to exchange information and initiate actions from each other in transactions involving DOI names. Since DOI names may be assigned to any type of entity, such interoperability can be across different types of content (e.g. audiovisual,

music and text). The requirement for metadata also ensures minimum standards of quality of administration of DOI names by registration agencies, and facilitates the administration of the DOI System as a whole.

A minimum set of such metadata, the DOI® kernel, is specified by the IDF and this includes some key elements such as other identifiers commonly referencing the same referent (e.g. ISBN, ISRC), and the name by which the referent is usually known (e.g. title). This minimum kernel may be enhanced by the development of specific Application Profiles with metadata elements appropriate to a particular application or set of applications. The IDF also specifies the template for a DOI® Resource Metadata Declaration (RMD), a form of message designed specifically for the exchange of metadata between DOI System Registration Agencies to support their service requirements. A RMD is developed by two or more registration agencies in accordance with the IDF format and schema specifications.

The IDF specifies a Data Dictionary as the repository for all data elements and allowed values used in DOI name metadata specifications.

The use of these tools for DOI name metadata has been limited in initial applications. It may be expected that more applications will emerge as the sophistication of content management on digital networks increases.

SOCIAL INFRASTRUCTURE

No time limit for the existence of a DOI name is assumed in any assignment, service or DOI System application: DOI names are intended to be persistent identifiers. A DOI name and its referent are unaffected by changes in the rights associated with the referent, or changes in the management responsibility of the referent object. Since such persistence requires a social infrastructure, policies as well as technical infrastructure need to be defined and implemented. The IDF develops and implements policies such as rules for transfer of management responsibility between Registration Agencies, requirements placed on Registration Agencies for maintenance of records, default resolution services, and technical infrastructure resilience. These are codified in a formal agreement between the IDF and each of its Registration Agencies.

The DOI System is not a means of archival preservation of identified entities. The DOI System provides a means to continue interoperability through exchange of meaningful information about identified entities and initiated actions between different systems through, at a minimum, persistence of the DOI name and description of the referent.

CONCLUSION

The Digital Object Identifier System provides a system for the identification and hence management of information ("content") on digital networks, providing persistence and semantic interoperability. The DOI System is not designed as a single application, but as a generic framework of identification, resolution, metadata, and policy that can be applied to all entities in a network environment.

The DOI System implements fundamental principles of identification, resulting in a practical implementation already widely adopted in technical publishing and extending to other sectors. It provides both underlying technical standards and practical policies for a cost-recovery, self-supporting network of implementation, including both automated processes and necessary human intervention.

The DOI System uses existing standards while also collaborating with leading work in naming and metadata to develop proposals for further evolving appropriate agreed standards. The system is developed and managed by the non-profit International DOI Foundation, which aims to work with existing standards and partner organizations to facilitate wide uptake of the DOI System.

The DOI System is a proven success and has demonstrated that the system is resilient and scalable and able to support production-scale applications. It brings a practical implementation of what has long been recognized as a fundamental lack in Internet technologies: the ability to treat content entities as first-class objects.

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