National Persistent Identifier for Digital Objects system (NPIDOS) of National Library and Archives of Islamic Republic of Iran (NLAI): a project for ensuring preservation of documentary heritage for future generations

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Abstract

The strategic plan of NLAI refers to this institution as respect for managing the wealth of the documentary heritage. NLAI attempts to collect, organize and make accessible this documentary heritage for scholars. Since one of the most important strategic issues of the NLAI is preservation and conservation national documentary heritage for present and future generations. On the other hand, the NLAI intends to become the national knowledge hub through: developing the national documentary knowledge network, developing national protocols and standards, virtual infrastructures, strategic cooperation and improving the quality of services. In order to achieve the above mission and goals, the development of NPIDOS of the NLAI is significant necessity. This paper presents a plan for implementing of NPIDOS. The result of this study as the zero phase of NPIDOS shows that the ARK is the appropriate system for NLAI. This research lead to present the project of NPIDOS that Operational phases of the project are listed below: 1) The primary study and selection appropriate system(s) 2) Organizing Working Group/ Preparation of Plans and Policy Committee 3) Supplying and Training of specialists for Structure Plan 4) Designing and implementing of the software 5) Designing and implementing of the information and services.

1. Introduction

The strategic plan of National Library and Archives of Islamic Republic of Iran refers to this institution as respect for managing the wealth of the documentary heritage. NLAI is responsible for creating, organizing, preserving and making available content of intellectual and cultural resources at the national level, in line with responsible its organizational missions. Due to the production and dissemination of a large part of these resources on the Web, NLAI is obliged to develop *Web Archive* of *Iran* and also *Digital National Library and Archives of Iran (DNLAI)*. The ultimate goal of digitization resources and archiving of web resources is long-term preservation and providing user services through the web. On the other hand, the NLAI intends to become the national knowledge hub through: developing the national documentary knowledge network, developing national protocols and standards, virtual infrastructures, strategic cooperation and improving the quality of services. In order to achieve the above mission and goals, the development of NPIDOS of the NLAI is significant necessity.

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The success of a distributed information system such as the World Wide Web (www) for research depends on the long-term consistency of the interlinking between online resources and the persistence of the links that are provided in the catalogues, indexes and listings which constitute resource discovery services (National Library of Australia 2001b)**.** Basically, maintaining the links is consequence of good management. One of the most important issues in creating sustainable infrastructure of information is long-term management in the digital environment. Digital management not only deals with the transfer of new media and carriers, but also it is expected to maintain its functions in the new environment. The first step in digital preservation is to identify and locate documents by the users without any ambiguity. Hyper Text Transfer Protocol (HTTP) uses the URLs for addressing documentation. URL is particular type of URI used for locating resources.

As long as nothing changes about the way the data is accessed, this works fine. In the long term however, this arrangement has proven to be fragile: URLs a year later, let alone five years later, often no longer work (This phenomenon is known as 'link rot'). Studies have found half the URLs in scholarly publications will fail after a period of seven to ten years (ANDS, 2009).

Over time the risk grows that the document is no longer accessible at the location given as reference. Web servers that follow the HTTP protocol then give the notorious reply: '404 not found'. This resembles the situation of a book in a – very large – library that is not on the shelf at the position indicated in the catalogue. How is it to be found? It would be even worse if no such error message appeared: a URL may also be unstable in that it now points to a different resource that has replaced the earlier one. Here, the link would be 'broken' too, but users may not recognize this, as there is no error message to alert them and the 'wrong' document is presented instead (Hilse, Hans-Werner; Kothe, Jochen.2006)

Persistent identifiers have several tasks, but perhaps the most important ones are that they render the traditional identifiers (i.e.ISBN,…) actionable in the Web, and provide persistent links to the resources. Using a PI, the user can trust that he or she will get the appropriate work, even if the physical location of its manifestation has changed. In practice the PI has to be mapped to an up-to-date locator or locators which facilitate access to physical manifestation(s) of the resource.

It is necessary for web archives and digital libraries to be compliant with current standards. Due to the material passed, it is essential that a persistent identifier system is implemented in the Web Archive of Iran and National Digital Library and Archives of Iran, until National Library and Archive of Iran could provide infrastructure for long-term preservation and accessibility of documentary heritage.

This project presents a plan for implementing of NPIDOS. This project covers the following: 1) identifying the current persistent identifier systems in the world, 2) adopting one or more persistent identifier systems 3) customizing the selected a system or systems for national use.

This project is currently in phase zero and the initial phase of the study and preliminary studies have been carried.

2. PI systems

The first PI systems emerged in the Mid-1990s, soon after the Web itself (and the problem of non-persistence of the URLs) was introduced. Good overviews have been written about PIs over the years; the most complete one being, but there is still some lack of clarity concerning for instance the relation of traditional and persistent identifiers and the relation between cool URIs and persistent identifiers. This overview aims at clarifying these and some other PI-related issues. The major PI systems are, in chronological order:

1. Handle, 1994
2. Persistent URL (PURL), 1995
3. Uniform Resource Name (URN), 1997
4. Digital object identifier (DOI), 1997
5. Archival Resource Keys (ARK), 2001
6. Extensible Resource Identifier (XRI), 2005

2.1. Handle

The system is a general-purpose naming service which provides a mechanism both for assigning persistent identifiers to digital objects and resolving these identifiers to provide users with access to the information necessary to locate, access or otherwise use the digital object identified by the Handle, or (where appropriate) to the resource itself. Information about a digital object's current location is stored in the Handle records, meaning that when this location changes, only the Handle record (rather than the Handle address) needs to be changed(Persistent identifiers: Handle System 2008).

The Handle System is composed of different elements: a set of protocols, a name space and a reference software implementation. Here, when we talk about the Handle System, we are in fact discussing all of these elements.Handle commonly refers to an identifier created by the Handle System that complies with the Handle System namespace definition.

Handle is a concept for a DNS[3]-independent naming and resolving mechanism.The Handle Protocol in some ways resembles the DNS. It can be used to resolve the names, 'Handles', to URLs but also allows them to be resolved to other identifier formats and arbitrary data.

Technically, Handle defines a two-level hierarchy that can and is being extended to more levels by utilizing administrative naming policies. It gives the freedom to use any printable character from the Unicode UCS-2 character set for the names. Handle allows integration of other naming conventions at the second level of its hierarchy.The resolving infrastructure exists. It works and scales well. The software is freely available and can be tested extensively before registration with CNRI[4]and production use.

2.1.1. Advantages and disadvantages of the Handle System

[3] Domain Name System
[4] Corporation for National Research Initiatives

2.1.1.1. Advantages

- The Handle system was one of the earliest PID schemes to be introduced (contemporary with URNs), and is being used by a number of digital libraries and national institutions. It is maintained by a national organization in the USA, so is stable and well-established.
- It conforms to the functional requirements of the URI and URN concepts, and is independent from, yet interoperable with, current protocols like HTTP.
- Handle syntax is straightforward and is also capable of incorporating existing local identifier systems.
- The system may be adaptable to the different levels of access required for managing personal digital archives: operations on the Handle database are controlled by a detailed authorisation mechanism for security of data; and Local Handle Servers can be configured to allow either internal or external access, which might enable use of Handles as identifiers in a closed environment.
- The distributed model means that local Handle services and NA[5]s have autonomy to manage their own Handles.
- The system is scalable and might allow smaller institutions to share a local service under the same NA.

2.1.1.2. Disadvantages

- Whilst not prohibitive, there is nevertheless an initial fee and an annual charge for those participating in the system, whereas ideally a PID system should be free and the software openly available.
- While there are authorisation mechanisms, the system still has a strong emphasis on identifying resources which are openly available via the Web, rather than held in the more restricted context of a digital archive.
- The system includes some optional metadata elements which are superfluous to the needs of a digital archive: extensive metadata is already produced for each digital object, so the production of a value set for each Handle would therefore be unnecessary.
- The character set for Handles is much broader than is permissible for URIs, so institutional naming policies would have to place restrictions on the characters used in order to comply with URI requirements (Persistent identifiers: Handle system. 2008).

2.2. PURL

A PURL focuses on the location of an electronic resource in a persistent fashion. If a PURL service is properly maintained and administered, it offers persistent identification facilities. There are PURL implementations that offer easy participation and cooperative use of a central service. PURLs offer relocation services and access to the history of known locations of the identified resource (Hilse,Hans-Werner; Kothe, Jochen .2006).

2.2.1. Advantages and disadvantages of the PURL scheme

[5] Naming Authority

2.2.1.1. Advantages

- It is cheap and easy to create and resolve PURLs; making use of existing services means that no new protocols or modifications to client software are necessary, and the software is freely available.
- The system is standards based and compatible with both URI and URN schemes.
- PURLs grew from a library cataloguing context and they could provide an effective means of linking from an EAD[6] catalogue entry to the associated DIP[7].
- The scheme is now well-established and widely used.
- It is scalable: by using the existing distributed technology of DNS/HTTP, many different PURL servers can be established locally, thus avoiding the overloading of servers and enabling greater local control over PURL creation.

2.2.1.2. Disadvantages

- PURLs were designed primarily as identifiers for open, web-based resources (essentially 'published' material), but digital archives have different requirements. Repositories for personal digital archives must identify closed or restricted access material and various metadata. They would therefore need to implement PURLs locally in a manner that prevents access by unauthorized parties.
- They are incapable of dealing with the complexities of any single personal digital archive, which may require different levels of access (e.g. some items may be closed, others subject to access restrictions and others open).
- In a personal digital archive each individual object must be unambiguously identifiable, so a facility like partial resolution is inappropriate (Persistent identifiers: Persistent Uniform Resource Locator(PURL) 2008).

2.3. URN

The URN is a general concept that creates a common namespace for many different kinds of identifiers. The basic functionality of a URN is resource naming. The requirements that led to further syntax and scheme definitions are outlined in the 'Functional Requirements for Uniform Resource Names' RFC[8]:

• Global scope of the names: they have the same meaning everywhere.
• Global uniqueness: different resources cannot have the same URN.
• Persistence: in the URN context, the name's lifespan is permanent, regardless of the lifespan of the named resource.
• Scalability: room to accommodate the number of names required in the next centuries.
• Legacy support: should allow the integration of other naming schemes.
• Extensibility: future extensions to the URN scheme are possible.

[6] .Encoded Archival Description
[7] Dissemination Information Packages
[8] The Requests for Comments

• Independence: determining the conditions for issuing a name is the sole the responsibility of the name-issuing authority.
• Resolution: if a URN corresponds to a URL, there must be some feasible mechanism to resolve it. (Hakala 2010).

2.3.1. Advantages and disadvantages of URNs

2.3.1.1. Advantages

- URNs are flexible and easy to construct: the NSS[9] can take any form, meaning that other namespaces can easily be mapped into URNs, yet global uniqueness is ensured as long as the NSS is unique within the NID[10].
- The URN is an open standard and is technology independent.
- Whilst no universal resolver of URNs has yet been developed, they can be used with the DNS and HTTP: a URN can be coded into a URL, and a proxy server used to route URN requests to a host server, enabling users to resolve URNs using a standard web browser.

2.3.1.2. Disadvantages

- The lack of a universal resolver has hindered the takeup of URNs.
- The ongoing lack of consensus about the value of URNs means that there may be a question mark over their long-term future.
- Existing NIDs may not be suitable for dealing with personal digital archives, so it may be necessary to establish a new NID before using the URN system; this involves developing (to a detailed level) a new identifier scheme and submitting it before joining the queue of NIDs awaiting approval.(Persistent identifiers: Uniform Resource Name (URN) 2008)

2.4. DOI

The DOI makes use of the Handle System for resolving identifiers, but Handles are only one component of the DOI System, which provides a complete framework for managing digital objects, including a structured means of identification, description and resolution, along with policies, procedures, business models and application tools. It is designed to be independent of the DNS and HTTP protocol, although can be used with this system via the DOI proxy server at <http://dx.doi.org>.

The DOI System was developed as part of a project run by the Association of American Publishers and was launched in 1997 at the Frankfurt Book Fair. It grew out of publishers' concern about control of intellectual property in the digital environment. Its focus was initially on content identification (i.e. a unique identifier would be assigned to a work at the point of creation); however, it was recognised that the issue of persistent identification has value beyond the world of electronic publishing, and so the DOI was developed as a cross-industry and cross-sectoral non profit-making organisation, managed by the International DOI Foundation (IDF, founded in 1998). The system is intended to provide a generic framework

[9] Namespace Specific String
[10] Namespace Identifier

applicable to any digital (or other) logical entity; and a DOI name may be assigned to any item of intellectual property, or the parties, events or agreements involved in an intellectual property transaction.

2.4.1. Advantages and disadvantages of the DOI System

2.4.1.1. Advantages

- The scheme is run by an established and robust organisation which is likely to be sustainable in the long-term.
- It has been adopted by libraries as well as commercial organizations.
- It provides an infrastructure for implementing a comprehensive digital identifier system, whilst leaving each RA[11] with a considerable degree of autonomy to implement their own system, e.g. there might be scope for establishing an RA for those working with personal digital archives.
- The possibility of establishing a 'Restricted' Application Profile means that the scheme could be used in a non-public digital repository environment or dark archive as well as an open environment.
- It is standards based and DOI metadata is created using XML, both of which maximize interoperability.

2.4.1.2. Disadvantages

- There is a strong emphasis in the DOI member list on the commercial sector (e.g. publishing and software), or very large information institutions like national libraries. The annual subscription would be prohibitive for smaller libraries and archives. The alternative approach of working with a larger institution that has RA status may mean that the specific requirements of personal digital archives held in smaller institutions are overlooked.
- Whilst the DOI system offers a sophisticated data model which allows the creation of standardized metadata about digital resources and the grouping of resource-types into Application Profiles, these functions are probably superfluous to the needs of many curators looking after digital archives: extensive metadata is already produced for each digital object, and services associated with the digital objects are likely to be managed by the repository. Given the costs involved in subscribing to the DOI system, an institution should probably only sign up if it wishes to take advantage of the full range of functions DOI offers; for the more basic needs of a digital archive, simple identifier systems are probably a more appropriate and cost-effective option.
- DOI currently recommends using the scheme to identify only resources, parties and events associated with intellectual property transactions, whereas Paradigm has identified the need for a wider range of identifiers - e.g. for preservation actions, or agents (repository staff or software) who have carried out preservation actions. (Persistent identifiers: Digital Object Identifier System (DOI) , 2008).

[11] Registration Agency

2.5. ARK

ARKs introduce a concept combining the features that a persistent identifier should have and building a technical and administrative framework on that concept. The ARK is focused on resolving and delivering metadata. The concept of the ARK has a two-level hierarchical namespace. Below the root, there are the Name Assigning Authorities (NAA) that have their own namespace to assign Names. The ARK concept is designed both to allow integration of other identifier schemes as well as being integrated into other identifier schemes itself.

The ARK concept has no commercially motivated background. The technical requirements are fairly low (DNS, Web server and a Web browser on client side). Thus future maintenance will probably be easier than it would be for complex specialized software (Hilse,Hans-Werner; Kothe, Jochen 2006).

2.5.1. Advantages and disadvantages of the DOI System

2.5.1.1. Advantages

- The scheme is standards based and protocol/technology independent.
- It works well either as a simple identification scheme, or as a system for both identifying and accessing digital objects.
- ARKs can be used to identify different types of entity, e.g. they could be used to identify agents and events as well as digital archival objects and metadata records.
- The system was developed in a library context and is designed to meet the needs of digital archivists.
- ARKs can be used in both a closed environment like a dark archive or an open publicly-accessible environment.
- The ARK system makes explicit the importance of organizational commitment to a persistent identifier scheme and writes a requirement for this into the scheme itself.
- It is maintained by a leading institution in the field of digital preservation and has no commercially motivated background (like DOI).
- The model for participating in the ARK scheme is more flexible than some of the other PID schemes: if one institution acts as both NMAH[12] and NAA, it is able to have complete control over its own identification scheme; the possibility of multiple NAAs being connected to one NMAH might also enable one institution to host the digital archives of smaller, less well-resourced institutions.
- The technical requirements for participation are relatively low: currently a normal web server using the DNS.
- Because the scheme is still under development, institutions which choose to participate now can feed into and shape this development.

2.5.1.2. Disadvantages

[12] Name Mapping Authority Hostports

- Because the ARK scheme was so recently established, it is difficult to gauge at this stage how popular and long-lived it might be.
- Some elements of the scheme are probably superfluous to the requirements of digital archives, e.g. hierarchies and variants can be defined using METS and PREMIS metadata rather than complex identifiers. In reality, it is probably more straightforward to use a simple single-level sequence of identifiers.
- Most institutions are moving towards encoding metadata in XML, which is intended to be reasonably human-legible and facilitates the sharing of data across different information systems. The use of Electronic Resource Citation (ERC) for recording ARK metadata (as recommended by the scheme) may involve both duplication of metadata and the additional task of converting it into a different format (Persistent identifiers: Archival Resource Key (ARK) 2008).

2.6. Extensible resource identifier (XRI)

While all the other PI systems listed here have a broad installed base, it is difficult to know how many users XRI has. It was developed by an OASIS[13] XRI Technical Committee. The committee is still active, developing Extensible Resource Descriptor, a simple tool for describing and discovering resources.

According to the XRI syntax specification, XRI is based on both URI and IRI (Internationalized Resource Identifiers). While IRI extends the URI character set (and specifies the way of "dumbing" IRIs down to URIs), XRI extends the IRI syntax and functionality further (Hakala 2010).

3. Guidelines and recommendations

It should be noted that among all the concepts which have been introduced there is no 'one size fits all' strategy for implementing persistent identifiers. Although the basic problems to be solved are the same, each of the systems addresses them in its own way on different administrative and technical levels.

Depending on your individual strategy, (a) one persistent identifier concept introduced here may exactly fit the purpose, (b) multiple systems do, or (c) it could be best not to choose any existing system at all and roll out your own specifications. It is therefore not possible to formulate one single recommendation for all readers of this report. Instead, we will introduce some important questions organizations need to consider, followed by some possible strategies to address various problems. This should give directions for deciding which approach to take.

Determining the status quo First of all, an institution must carefully analyse its current use of identifiers in general. In most cases, where data is collected, it is identified in some way.

[13] Organization for the Advancement of Structured Information Standards

If it is data about other data or objects – metadata – it will often contain an identifier for the referred item. In every data collection the following should be analysed:
– Is persistence needed for this kind of data? How would persistence be defined?
– What features should the implemented system offer? (e.g. resolving, metadata exchange, etc.)
Organisations need to decide whether one of the systems described suits all needs or whether it would be preferable to implement more than one system. In most cases, identification and naming systems are already in use. These systems were mostly not designed with persistence as a first consideration. But nevertheless it may be worth thinking about integrating the old naming scheme in the new one – leading to another important question:
– Are there identification mechanisms in use that should be incorporated into the new strategy, e.g. as a sub-namespace?
Often, an institution already cooperates with other institutions that deal with a similar environment. Before deciding to opt for a new implementation, organizations should therefore consider the following:
– Are there strategies for persistent identification already in active use at partner institutions?
– Do you require interoperability with those institutions? (Hilse, Hans-Werner; Kothe, Jochen.2006)

4. Strategies to select a Persistent Identifier system

It has already been noted that persistence is always a matter of administration. A system for persistent identification is built just to ease the administration, not to make it obsolete. Computers cannot easily take account of changes in real life if these have not been anticipated, so there is no automated solution for persistence: changes must be reflected by administrative work.

Because of this, the most important task for all institutions that are developing their document persistence strategy is to create awareness of the problems of persistence among all individuals concerned with handling the documents both technically and administratively. An institution should issue internal policies for its use of persistent identifiers to avoid a mixture of incompatible implementations. Institutions should recognize that the implementation of persistent identifiers always comes with some costs.

All changes in location, ownership or other metadata must be reflected in the persistent identifier system. Consequently, each migration of the document base, e.g. to a new document server, involves some work in maintaining the identification system. If an institution offers services to external users, it should clarify its own policy regarding the persistence of the identifiers and explain the practical use of the identifiers. This includes directions for resolving or citing these identifier.

When, after considering the questions posed in the previous section, an organization has reached the conclusion that cooperation with other institutions is not an option, it may choose to implement persistent identifiers according to an individual policy.

In such a situation the focus will mainly be on the end users, making it necessary to evaluate what features they expect and what systems may fit these expectations. A strategy

is probably better than none, so one may start with a system that is simple to implement – and may lack a few features of the competing systems.

Very careful checks should be made whether systems that are already existent (database identifiers, sequential numbering schemes, etc.) should be reused in the definition of the naming policy. It is important to emphasize that if such schemes are to be integrated, these systems must either ensure persistent uniqueness themselves, or are only used at one point in time and checked for conflicts with identifiers already issued (Hilse,Hans-Werner; Kothe, Jochen.2006).

If an institution is in a position to organise the process of implementing a strategy for persistent identification together with other institutions (e.g. national libraries, consortia), it may decide to suggest the adoption of one particular system for all associated institutions, as this will greatly enhance interoperability. There are a few important factors to consider:

4.1. Technical interoperability among institutions
In most cases, a common infrastructure is established for interoperability reasons. An example would be if one wants to make use of the 'extended' features of some of the persistent identification systems, e.g. the delivery of object metadata as defined by the ARK. In that case, it would be important that the specific protocol for this task (THUMP[14]) is supported by all implementations.
If the group of institutions intend to use the identifiers only for linking, cataloguing and simple URL resolution and redirection, *and* the organizations have heterogeneous requirements, it may not be necessary to restrict the use of different systems. The group should, however, develop a common naming scheme to be implemented as a sub-namespace for each system in use.

4.2. Synergy effects it should be noted, however, that if one specific solution is implemented at all institutions, it will be easier to share knowledge and administrative tasks within the group. In addition, virtually all systems introduced here allow for later consolidation of the infrastructure.

Before implementing a system, organizations should investigate whether there are possible cooperation partners that have similar problems to solve(Hilse,Hans-Werner; Kothe, Jochen.2006).

5. Final results

Persistent identification plays a key role in ensuring long-term access to objects within repositories, but it doesn't happen automatically. Persistent access needs to be backed by institutional policy, and can be assisted by a number of technical solutions. Remember, don't lose your audience to 404 errors, by ensuring works in the repository have identifiers that persist through time.

In order to implement NPIDOS, written policy and procedure method should be devised. One of the priorities of the national systems should be ability to set different levels of access, which is available in both Handle and ARK. Another important consideration is the cost of the project. ARK system is free. If NLAI wants to offer a centralized system for

[14] Tiny HTTP URL Mapping Protocol

assigning identifiers through a network of branch offices in different provinces, ARK system can achieve this by connecting the NAAs to an NMAH. Also**,** ARK can be used for various types of entities including three-dimensional objects and metadata records. NLAI policy should determine which entity will be covered in persistent identifiers.

So far, studies and reviews of authors of this paper reveals that the most appropriate system for NLAI is ARK. For the final decision and selection of system(s), it is necessary to develop the general policy of NLAI and prepare and review technical requirements by specialists. If the ARK system or any other systems proves to support the needs of NLAI, ARK system or any other system should be duly customized. In this case, experience of The national library of Australia (NLA) can be utilized and followed by NLAI (National library of Australia. 2001a). At the same time the NLAI as a national library must provide and implement operational plan for Digital Objects to cover needs of all Iranian Digital Libraries.

Finally, the present research has lead to developing the project of NPIDOS of which the Operational phases are listed below:

- The primary study and selection appropriate system(s)
- Devising the Technical details of the project
- Providing the general infrastructure
- Organizing Working Group/ Preparation of Plans and Policy Committee
- Supplying and Training of specialists for the Plan
- Designing and implementing the software
- Designing and implementing of the information system and services

Resources:

- ANDS (Australian National Data Service).2009.ANDS guides- working level, persistent identifier http://ands.org.au/guides/persistent-identifiers-working.pdf (access in 14 may. 2014).
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