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Information and documentation — Digital object identifier system

Information et documentation — Système d'identifiant numérique d'objet

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Foreword

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International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 26324 was prepared by Technical Committee ISO/TC 46, *Information and documentation*, Subcommittee SC 9, *Identification and description*.

Introduction

The digital object identifier [DOI®[1)]] system provides an infrastructure for persistent unique identification of objects of any type.

DOI is an acronym for “digital object identifier”, meaning a “digital identifier of an object” rather than an “identifier of a digital object”. In this International Standard, the term “digital object identifier” refers to the system defined in this International Standard unless otherwise stated. The DOI system was initiated by the International DOI Foundation in 1998, and initially developed with the collaboration of some participants in ISO/TC 46/SC 9. Due to its application in the fields of information and documentation and previous collaboration with some ISO/TC 46/SC 9 participants, it was introduced as a possible work item in 2004 and further developed from 2006 to 2010.

The DOI system is designed to work over the Internet. A DOI name is permanently assigned to an object to provide a resolvable persistent network link to current information about that object, including where the object, or information about it, can be found on the Internet. While information about an object can change over time, its DOI name will not change. A DOI name can be resolved within the DOI system 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 DOI system enables the construction of automated services and transactions. Applications of the DOI system include but are not limited to managing information and documentation location and access; managing metadata; facilitating electronic transactions; persistent unique identification of any form of any data; and commercial and non-commercial transactions.

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

The scope of the DOI system is not defined by reference to the type of content (format, etc.) of the referent, but by reference to the functionalities it provides and the context of use. The DOI system provides, within networks of DOI applications, for unique identification, persistence, resolution, metadata and semantic interoperability.

1) DOI® is a registered trademark. Information concerning trademark issues can be found on ISO online webpage for the ISO 26324 Registration Authority at http://www.iso.org/iso/maintenance_agencies.html.

Information and documentation — Digital object identifier system

1 Scope

This International Standard specifies the syntax, description and resolution functional components of the digital object identifier system, and the general principles for the creation, registration and administration of DOI names (where DOI is an acronym for “digital object identifier”).

This International Standard defines the syntax for a DOI name, which is used for the identification of an object of any material form (digital or physical) or an abstraction (such as a textual work) where there is a functional need to distinguish it from other objects.

The DOI name does not replace, nor is it an alternative for, an identifier used in another scheme, such as the schemes defined by ISO/TC 46/SC 9. This International Standard describes how the DOI system can be used in conjunction with another identifier scheme (for example, to provide additional functionality, such as resolution, where this is not already available), and how the character string of that other scheme can be integrated into the DOI system through the DOI metadata record and/or the DOI syntax.

This International Standard does not specify specific technologies to implement the syntax, description and resolution functional components of the digital object identifier system.

2 Normative references

The following referenced document is indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

Unicode Consortium. *The Unicode™ Standard*[2)]

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
allowed value
item which may be used as a value of an element

3.2
application profile
set of DOI names that share some common characteristics

NOTE A DOI application profile is a grouping mechanism for DOI names; the functional specification of the application profile includes a set of metadata, comprising the kernel metadata and additional information applicable to that particular genre of object and functional requirements. Each DOI name is associated with one or more application profiles.

2) Available at: http://www.unicode.org. Unicode is a trademark of Unicode, Inc. The Unicode Standard imposes additional constraints on implementations of ISO/IEC 10646:2011.

3.3
data dictionary
repository for all data elements and allowed values of those elements used in DOI metadata specifications

3.4
DOI name
string that specifies a unique **object** (3.9) within the **DOI system** (3.6)

NOTE 1 Names consist of characters in a sequence specified by the **DOI syntax** (3.5).

NOTE 2 The terms “identifier” and “number” are sometimes but not always used in the same sense and are to be avoided where ambiguity can arise. The unqualified use of “DOI” alone can also be ambiguous. Therefore “DOI” is always used in conjunction with a specific noun [e.g. **DOI name** (3.4), **DOI system** (3.6)] unless the meaning is sufficiently clear from an earlier mention or the specific context.

3.5
DOI syntax
rules for the form and sequence of characters comprising any **DOI name** (3.4), specifically the form and character of a prefix element, separator and suffix element

3.6
DOI system
social and technical infrastructure for the assignment and administration of **DOI names** (3.4) as identifiers in computer-readable form through assignment, resolution, referent description, administration, etc.

3.7
interoperability
ability of independent systems to exchange meaningful information and initiate actions from each other, in order to operate together to mutual benefit

NOTE In particular, interoperability constitutes the ability for loosely-coupled independent systems to be able to collaborate and communicate. See References [17] and [18] for further information about interoperability.

3.8
metadata
specific data associated with a referent within the **DOI system** (3.6), based on a structured data model that enables the referent of the **DOI name** (3.4) to be associated with data of any desired degree of precision and granularity to support identification, description and services

NOTE This can involve one or more intermediate mapping operations. The resolution might or might not return an instance of the object. *Multiple resolution* is the simultaneous return as output of several pieces of current information related to the object, in defined data structures.

3.9
object
entity within the scope of the **DOI system** (3.6) that can be digital, physical or abstract

NOTE 1 Digital, physical or abstract forms of an entity can be of relevance in information and documentation (e.g. resources, people or agreements).

NOTE 2 A particular object identified by a specific **DOI name** (3.4) is the **referent** (3.12) of that DOI name.

3.10
opaque string
syntax string that has no meaning discernible by simple inspection

NOTE To discover meaning, metadata are required.

3.11
persistent
existence, and ability to be used in services outside the direct control of the issuing assigner, without a stated time limit

3.12
referent
particular **object** (3.9) identified by a **DOI name** (3.4)

3.13
registrant
person or organization that has requested and received the registration of a particular **DOI name** (3.4)

3.14
registrant code
unique string assigned to a registrant, forming part of the prefix element of the **DOI syntax** (3.5) but having no other implied meaning

3.15
resolution
process of submitting a **DOI name** (3.4) to a network service and receiving in return one or more pieces of current information related to the identified object such as metadata or a location (URL) of the object or of metadata

3.16
unique identification
specification by a **DOI name** (3.4) of one and only one **referent** (3.12)

4 DOI name

4.1 Syntax

4.1.1 General characteristics

The DOI syntax shall be made up of a DOI prefix and a DOI suffix separated by a forward slash.

There is no defined limit on the length of the DOI name, or of the DOI prefix or DOI suffix.

The DOI name is case-insensitive and can incorporate any printable characters from the legal graphic characters of Unicode. Further constraints on character use (e.g. use of language-specific alphanumeric characters) can be defined for an application by the ISO 26324 Registration Authority.

The combination of a unique DOI prefix (assigned to a particular DOI registrant) and a unique DOI suffix (provided by that registrant for a specific object) 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 may 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 registrant does not provide evidence of the ownership of rights or current management responsibility of any intellectual property in the referent. Such information may be asserted in the associated metadata.

4.1.2 DOI prefix

4.1.2.1 Elements

4.1.2.1.1 General

The DOI prefix shall be composed of a directory indicator followed by a registrant code. These two components shall be separated by a full stop (period).

4.1.2.1.2 Directory indicator

The directory indicator shall be “10”. The directory indicator distinguishes the entire set of character strings (prefix and suffix) as digital object identifiers within the resolution system.

4.1.2.1.3 Registrant code

The second element of the DOI prefix shall be the registrant code. The registrant code is a unique string assigned to a registrant.

EXAMPLE 1

10.1000 DOI prefix comprising a directory indicator “10” followed by registrant code “1000”.

The registrant code may be further divided into sub-elements for administrative convenience if desired. Each sub-element of the registrant code shall be preceded by a full stop. Such subdivision implies no hierarchical relationship; each registrant code, whether subdivided or not, has equal status in the DOI system. However a subdivided registrant code can have technical resolution implications. It is recommended that registrants consult the ISO 26324 Registration Authority for further information about assignment of registrant codes.

EXAMPLE 2

10.1000.10 DOI prefix in which the registrant code has a subdivision “10” (cf. Example 1).

4.1.2.2 Changes

Once a DOI name has been assigned it shall not be changed, regardless of any changes in the ownership or management of the referent.

NOTE: The original registrant might no longer have any role in maintaining a DOI name and its associated records even though its registrant code remains a permanent element of that DOI name.

4.1.3 DOI suffix

The DOI suffix shall consist of a character string of any length chosen by the registrant. Each suffix shall be unique to the prefix element that precedes it. The unique suffix can be a sequential number, or it might incorporate an identifier generated from or based on another system used by the registrant, e.g. ISAN[5][6], ISBN[1], ISRC[3], ISSN[2], ISTC[10], ISNI[11]; in such cases, a preferred construction for such a suffix can be specified, as in Example 2. See Annex A for further details.

EXAMPLE 1

10.1000/123456 DOI name with the DOI prefix “10.1000” and the DOI suffix “123456”.

EXAMPLE 2

10.1038/issn.1476-4687 DOI suffix using an ISSN. To construct a DOI suffix using an ISSN, precede the ISSN (including the hyphen) with the lowercase letters “issn” and a period, as in this hypothetical example of a DOI for the electronic version of *Nature*.

4.2 Visual presentation and other representation of DOI names

4.2.1 Screen and print presentation

When displayed on screen or in print, a DOI name shall be preceded by a lowercase “doi:” unless the context clearly indicates that a DOI name is implied. The "doi:” label is not part of the DOI name value.

EXAMPLE

The DOI name “10.1006/jmbi.1998.2354” is displayed and printed as “doi:10.1006/jmbi.1998.2354”.

4.2.2 URI presentation

The use of the lowercase string “doi” complies with the IETF specification, RFC 3986[14], for representation as a URI (uniform resource identifier), such as “ftp:” and “http:”.

When displayed in web browsers, the DOI name can be attached to the address for an appropriate proxy server, to enable resolution of the DOI name via a standard web hyperlink. To resolve a DOI 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 actionable 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 DOIs; some characters are reserved and will need percent-encoding.

NOTE: Certain client or server software might be able to process DOIs using native 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).

4.2.3 Other representations

DOI names can be represented in other forms in certain contexts (e.g. in the info URI scheme RFC 4452[15]).

Characters which cannot be handled directly in a specific network or reference context, or where ambiguity can arise (e.g. minus sign, the hyphen, and the en-dash all look similar on the screen but carry different character values) should be avoided or encoded in an appropriate way (e.g. for URLs convert to UTF-8 and then percent-encode).

5 Assignment of DOI name

5.1 Principles of assignment

A DOI name shall not be used as a replacement for other ISO identifier schemes such as ISAN[5][6], ISBN[1], ISRC[3], ISSN[2], ISTC[10], ISNI[11] and other commonly recognized identifiers. See Annex A for further details.

A DOI name can be assigned to any object whenever there is a functional need to distinguish it from other objects.

“DOI” is construed as “digital identifier of an object” (not “identifier of a digital object”).

Rules for assignment of DOI names can include a functional definition of scope based on appropriate metadata through a DOI application profile.

5.2 Granularity

A DOI name can be assigned to any object, regardless of the extent to which that object might be a component part of some larger entity. DOI names can be assigned at any desired degree of precision and granularity that a registrant deems to be appropriate.

EXAMPLE For granularity in textual materials, separate DOI names can 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

— a quotation,

as well as to each specific manifestation in which any of those entities are published or otherwise made available.

5.3 Description

The assignment of a DOI name requires that the registrant provide metadata describing the object to which the DOI name is being assigned. The metadata shall describe the object to the degree that is necessary to distinguish it as a separate entity within the DOI system. See Annex B for further details.

5.4 Uniqueness

Each DOI name shall specify one and only one referent in the DOI system. While a referent can be specified by more than one DOI name, it is recommended that each referent have only one DOI name.

5.5 Persistence

No time limit for the existence of a DOI name shall be assumed in any assignment, service or application.

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.

The DOI system provides a means to continue interoperability through exchange of information about identified entities (at a minimum, the DOI name and a description of the referent).

6 Resolution of DOI name

6.1 General

Resolution of a DOI name can include, but is not restricted to, resolution to associated values such as a location (URL), an e-mail address, another DOI name and descriptive metadata. The referent can be of various types (e.g. abstract “works”, physical “manifestations”, or performances) and are not always directly accessible in the form of a digital file or other manifestation; i.e. resolution might or might not return an instance of the object. Resolution can also involve one or more intermediate mapping operations.

DOI resolution records can include one or more URLs, where the object can be located, and other information provided about the object 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.

6.2 Functionality

The technology deployed to manage the resolution of the DOI name shall support the functions listed in a) to l) as follows.

a) *Internet compatible* — Transmission via the global information system that is logically linked by a globally unique address space and communications.

b) *First class naming* — Identifiers resolved by the system shall have an identity independent of any other object.

c) *Unique identification* — The specification by an identifier string of one and only one referent.

d) *Functional granularity* — It shall be possible to separately resolve an object whenever it needs to be distinguished.

e) *Data typing* — The extensible definition of constraints placed upon the interpretation of certain data entries in a resolution record, such that data values with similar constraints can be grouped and treated in the same way (e.g. for application profile definition).

f) *Multiple resolution* — The simultaneous return as output of several pieces of current information related to the object, in defined typed data structures. Resolution requests should be capable of returning all associated values of current information, individual values or all values of one data type.

g) *Designated authority* — The administrator of an identifier shall be securely identified and capable of transfer.

h) *Appropriate access to resolution records* — Changes to a resolution record shall be recorded and shall be capable of providing access to the data on which the administrator depends and privacy and confidentiality from those who are not dependent on it.

i) *DNS independent but compatible* — Not reliant on the Domain Name System (DNS), but capable of working with DNS domain naming and resolution services.

j) *Granularity of administration* — DOI names can be administered individually or in groups.

k) *Scalability*:

1) efficient and infinitely scalable protocol;

2) no limitations on absolute number of identifiers assigned or length of identifier string.

l) *Unicode compliant.*

7 DOI metadata

7.1 General

The object shall be described unambiguously and precisely by DOI metadata, based on a structured data model that enables the referent of a DOI name to be associated with metadata of any desired degree of precision and granularity to support identification, description and services associated with a referent. This is designed to do the following.

a) Promote interoperability within networks of DOI users by enabling independent systems to exchange information and initiate actions from each other in transactions involving DOI names. Since DOI names can be assigned to any type of object, such interoperability can be across different types of content (e.g. audiovisual, music and text).

b) Ensure minimum standards of quality of administration of DOI names by registrants, and facilitate the administration of the DOI system as a whole.

7.2 Functionality

DOI metadata should support the following functions.

a) Generic mechanism for handling complex metadata for all different types of intellectual property.

EXAMPLE Instead of treating sound carriers, books, videos, and photographs as fundamentally different things with different (if similar) characteristics, they are all recognized as creations with different values of the same higher-level attributes, whose metadata can be supported in a common environment.

b) Interoperability of metadata across applications, with reference to:

1) media (e.g. books, serials, audio, audiovisual, software, abstract works, visual material),

2) functions (e.g. cataloguing, discovery, workflow, and rights management),

3) levels of metadata (from simple to complex),

4) semantic barriers, and

5) linguistic barriers.

c) Functional granularity, making it possible to identify an object whenever it needs to be distinguished.

7.3 Registration of DOI metadata

7.3.1 Metadata describing and identifying the object to which the DOI name is being assigned shall be recorded promptly and accurately.

7.3.2 Data elements and allowed values used in DOI metadata specifications shall be placed in a repository to facilitate interoperability across selected existing schemes. The data dictionary described in B.1 shall be used as the repository for all data elements and allowed values.

7.3.3 The metadata shall meet the minimum requirements of the DOI Kernel Metadata Declaration described in B.2.

8 Administration of the DOI system

The DOI system shall be administered by the ISO Registration Authority for this International Standard, hereafter referred to as the ISO 26324 Registration Authority, in accordance with the specifications outlined in Annex C.

Annex A
(normative)

Relationship between the DOI system and other identifier schemes

A.1 Principles

A DOI name shall not be used as a replacement for other identifier schemes such as ISAN[5][6], ISBN[1], ISRC[3], ISSN[2], ISTC[10], ISNI[11] and other commonly recognized identifiers, but when used with them it can enhance the identification functionality provided by those systems with additional DOI system functionality.

The guiding principles for referencing other identifier schemes within the DOI system are to maximize utility to potential users and to maximize its internal management efficiency.

A.2 Expression of the relationship within the DOI system of DOI names to other identifier schemes

A.2.1 Referent of a DOI name having an existing identifier within other identifier schemes

Where the referent of a DOI name also has an existing identifier within a commonly recognized identifier scheme or schemes, at least one of the following methods is used to express the relationship.

a) The other existing identifier(s) is(are) indicated in the DOI metadata field “referentIdentifier(s)” [other identifier(s) commonly referencing the same referent], irrespective of whether the identifier(s) is(are) incorporated into the syntax of the DOI name.

b) An existing identifier can be incorporated as an explicit part of the DOI name for the referent.

Examples 1 and 2 show the incorporation of an ISBN and an ISSN into a DOI name. Other agreed syntaxes for integration are also possible. Example 3 shows that the DOI name is not a replacement for the other identifier scheme.

EXAMPLE 1

10.978.86123/45678 shows a possible incorporation of an ISBN (978-86-123-4567-8) into a DOI prefix and suffix.

EXAMPLE 2

10.1038/issn.1476-4687 shows a DOI suffix using an ISSN.

EXAMPLE 3

10.97812345/99990 is a DOI name; it cannot be validly submitted to an ISBN point-of-sale ordering system, or converted to a GS1 bar code for use as an ISBN bar code; it does not conform to the ISBN syntax.

978-12345-99990 is an ISBN. It cannot be validly submitted to a DOI resolution service; it does not conform to the DOI syntax.

However both identifier strings have the same referent.

A.2.2 Incorporation of an existing identifier into a DOI name

Where syntax rules permit the incorporation of an existing identifier from another scheme as part of the DOI name, such rules shall not form part of this International Standard. In such cases, attention is drawn to the following points.

a) The same referent shall be denoted by both the DOI name and the included identifier string, to the degree that is necessary to distinguish it as a separate entity within each identifier scheme.

b) Within the DOI system itself, the DOI name is an opaque string. No definitive information relating to the other identifier scheme should be inferred from the specific character string used for a DOI name, and the DOI name is not guaranteed to be usable in any non-DOI applications designed for the other identifier scheme (see Example 3 in A.2.1).

c) The existence of multiple (third, fourth, etc.) identifiers should be recognized in the DOI metadata field "referentIdentifier(s)" [other identifier(s) commonly referencing the same referent by multiple values], rather than by incorporation in the DOI name.

d) Specific syntax rules for the incorporation of an existing identifier from another scheme shall be maintained by the ISO 26324 Registration Authority.

A.3 Additional functionality

The DOI system functionality can be offered to complement other identifier services which are available through other parties, e.g. for the resolution of identifiers in a variety of contexts. Services using an identifier can be offered by multiple providers. Rules of certain identifier systems can necessitate the use of only specified preferred service providers; in such cases, the application of the identifier shall follow the rules of the relevant registration authority. Each registration authority for an identifier scheme retains autonomy in determining rules for usage within its own scheme or community.

Annex B
(normative)

DOI metadata specification

B.1 Data dictionary

The data dictionary used as the repository for all data elements and allowed values (the items which may be used as values of each element) used in DOI metadata specifications shall enable the definition within an ontology of all metadata elements to be available to all registration agencies, and provide the mappings to support metadata integration and transformations required for data interchange.

If desired, metadata may be consolidated for a specific service; in this case, the data dictionary shall provide the data mappings such that the consolidated metadata are presented as if from a single set.

All allowed values used by a registrant in Kernel Metadata (see B.2) shall be registered in the data dictionary.

B.2 DOI Kernel Metadata Declaration

The assignment of a DOI name requires that the registrant provide metadata describing the object to which the DOI name is being assigned. At minimum, these metadata shall consist of a DOI Kernel Metadata Declaration (also known as the DOI Kernel) as specified in Table B.1. A specification of data elements (with sub-elements, cardinality, etc.), current allowed values and XML expression shall be maintained by the ISO 26324 Registration Authority.

Table B.1 — Descriptive elements of the DOI Kernel Metadata Declaration

Kernel element(s)	Description
DOI name	Specific DOI name allocated to the identified referent.
referentIdentifier(s)[a]	Other identifier(s) referencing the same referent (e.g. *ISAN*[5][6], *ISBN*[1], *ISRC*[3], *ISSN*[2], *ISTC*[10], *ISNI*[11]).
referentName(s)	Name(s) by which the referent is usually known (e.g. *title*).
primaryReferentType	The primary type of the referent (e.g. *creation, party, event*). This is an open list; new primaryReferentTypes may be registered.
structuralType	The primary structuralType of a referent. For *creations*, there are four mutually exclusive structuralTypes (*physical, digital, performance, abstraction*) that allow classification according to overall form. Where structuralTypes may be contained within one another, the referent's structuralType is defined by the overall form [e.g. a CD (*physical*) may contain files (*digital*) which contain recordings of performances of songs (*abstractions*)], and elements of content can be further classified if necessary under referentType. For *parties* there are three mutually exclusive structuralTypes (*person, animal, organization*).
mode(s)	For *creations* only, the principal sensory mode(s) by which a referent is intended to be perceived (*audio, visual, tangible, olfactory, tasteable, none*). Mode identifies only the principal intended modes of perception; most physical resources are perceivable with all five senses, but some of these perceptions may be trivial. For example, a printed book may be touched or smelled, but these are supplementary or incidental to *visual* mode, the intended function as a content carrier. For a Braille book, however, *tangible* would be a principal mode.
character(s)	For *creations* only, a fundamental form of communication in which the content of a referent is expressed. There are four values: *music, language, image, other*.
referentType	Specification of type(s) of referent (e.g. for creations: *audio file, scientific journal, musical composition, dataset, serial article, eBook, PDF;* for parties: *author, composer, book publisher, library, university, financial institution, film studio*). For creations, the abstract nature of the content of a referent, irrespective of its structuralType, is typically described by referentType; for parties, referentType is a role with which the party is associated. referentType may be extended as needed (e.g. for creations, to include format and genre elements, such as "medical journal article pdf"). This is an open list; new referentTypes may be registered.
principalAgent(s), agentRole(s)	For *creations* only, the entity or entities principally responsible for the creation or publication of the referent, with specification of the agent's role(s).

[a] This shall be included separately even if incorporated into a DOI name as the suffix (see A.2).