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Uniform Resource Names (URNs)

Abstract

A Uniform Resource Name (URN) is a Uniform Resource Identifier (URI) that is assigned under the "urn" URI scheme and a particular URN namespace, with the intent that the URN will be a persistent, location-independent resource identifier. With regard to URN syntax, this document defines the canonical syntax for URNs (in a way that is consistent with URI syntax), specifies methods for determining URN-equivalence, and discusses URI conformance. With regard to URN namespaces, this document specifies a method for defining a URN namespace and associating it with a namespace identifier, and it describes procedures for registering namespace identifiers with the Internet Assigned Numbers Authority (IANA). This document obsoletes both RFCs 2141 and 3406.

Status of This Memo

This is an Internet Standards Track document.

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1. Introduction

A Uniform Resource Name (URN) is a Uniform Resource Identifier (URI) [RFC3986] that is assigned under the "urn" URI scheme and a particular URN namespace, with the intent that the URN will be a persistent, location-independent resource identifier. A URN namespace is a collection of such URNs, each of which is (1) unique, (2) assigned in a consistent and managed way, and (3) assigned according to a common definition. (Some URN namespaces create names that exist only as URNs, whereas others assign URNs based on names that were already created in non-URN identifier systems, such as ISBNs [RFC3187], ISSNs [RFC3044], or RFCs [RFC2648].)

The assignment of URNs is done by an organization (or, in some cases, according to an algorithm or other automated process) that has been formally delegated a URN namespace within the "urn" scheme (e.g., a URN in the "example" URN namespace [RFC6963] might be of the form "urn:example:foo").

This document rests on two key assumptions:

1. Assignment of a URN is a managed process.
2. The space of URN namespaces is itself managed.

While other URI schemes may allow resource identifiers to be freely chosen and assigned, such is not the case for URNs. The syntactical correctness of a name starting with "urn:" is not sufficient to make it a URN. In order for the name to be a valid URN, the namespace identifier (NID) needs to be registered in accordance with the rules defined here, and the remaining parts of the assigned-name portion of the URN need to be generated in accordance with the rules for the registered URN namespace.

So that information about both URN syntax and URN namespaces is available in one place, this document does the following:

1. Defines the canonical syntax for URNs in general (in a way that is consistent with URI syntax), specifies methods for determining URN-equivalence, and discusses URI conformance.
2. Specifies a method for defining a URN namespace and associating it with a particular NID, and describes procedures for registering URN NIDs with the Internet Assigned Numbers Authority (IANA).

For URN syntax and URN namespaces, this document modernizes and replaces the original specifications for URN syntax [RFC2141] and for the definition and registration of URN namespaces [RFC3406]. These modifications build on the key requirements provided in the original functional description for URNs [RFC1737] and on the lessons of many years of experience. In those original documents and in the present one, the intent is to define URNs in a consistent manner so that, wherever practical, the parsing, handling, and resolution of URNs can be independent of the URN namespace within which a given URN is assigned.

Together with input from several key user communities, the history and experiences with URNs dictated expansion of the URN definition to support new functionality, including the use of syntax explicitly reserved for future standardization in RFC 2141. All URN namespaces and URNs that were valid under the earlier specifications remain valid, even though it may be useful to update the definitions of some URN namespaces to take advantage of new features.

The foregoing considerations, together with various differences between URNs and URIs that are locators (specifically URLs) as well as the greater focus on URLs in RFC 3986 as the ultimate successor to [RFC1738] and [RFC1808], may lead to some interpretations of RFC 3986 and this specification that appear (or perhaps actually are) not completely consistent, especially with regard to actions or semantics other than the basic syntax itself. If such situations arise, discussions of URNs and URN namespaces should be interpreted according to this document and not by extrapolation from RFC 3986.

Summaries of changes from RFCs 2141 and 3406 appear in Appendices B and C, respectively. This document obsoletes both [RFC2141] and [RFC3406]. While it does not explicitly update or replace [RFC1737] or [RFC2276], the reader who references those documents should be aware that the conceptual model of URNs in this document is slightly different from those older specifications.

1.1. Terminology

The following terms are distinguished from each other as described below:

URN: A URI (as defined in RFC 3986) using the "urn" scheme and with the properties of a "name" as described in that document as well as the properties described in this one. The term applies to the entire URI including its optional components. Note to the reader: the term "URN" has been used in other contexts to refer to a URN namespace, the namespace identifier, the assigned-name, and URIs that do not use the "urn" scheme. All but the last of these is described using more specific terminology elsewhere in this document, but, because of those other uses, the term should be used and interpreted with care.

Locator: An identifier that provides a means of accessing a resource.

Identifier system: A managed collection of names. This document refers to identifier systems outside the context of URNs as "non-URN identifier systems".

URN namespace: An identifier system that is associated with a URN NID.

NID: The identifier associated with a URN namespace.

NSS: The URN-namespace-specific part of a URN.

Assigned-name: The combination of the "urn:" scheme, the NID, and the namespace specific string (NSS). An "assigned-name" is consequently a substring of a URN (as defined above) if that URN contains any additional components (see Section 2).

The term "name" is deliberately not defined here and should be (and, in practice, is) used only very informally. RFC 3986 uses the term as a category of URI distinguished from "locator" (Section 1.1.3) but also uses it in other contexts. If those uses are treated as definitional, they would conflict with, e.g., the idea of URN namespace names (i.e., NIDs) and with terms associated with non-URN identifier systems.

This document uses the terms "resource", "identifier", "identify", "dereference", "representation", and "metadata" roughly as defined in the URI specification [RFC3986].

This document uses the terms "resolution" and "resolver" in roughly the sense in which they were used in the original discussion of architectural principles for URNs [RFC2276], i.e., "resolution" is the act of supplying services related to the identified resource, such as translating the persistent URN into one or more current locators for the resource, delivering metadata about the resource in an appropriate format, or even delivering a representation of the resource (e.g., a document) without requiring further intermediaries. At the time of this writing, resolution services are described in [RFC2483].

On the distinction between representations and metadata, see Section 1.2.2 of [RFC3986].

Several other terms related to "normalization" operations that are not part of the Unicode Standard [UNICODE] are also used here as they are in RFC 3986.

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "NOT RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in [RFC2119].

1.2. Design Trade-offs

To a degree much greater than when URNs were first considered and their uses outlined (see [RFC1737]), issues of persistent identifiers on the Internet involve fundamental design trade-offs that are much broader than URNs or the URN approach and even touch on open research questions within the information sciences community. Ideal and comprehensive specifications about what should be done or required across the entire universe of URNs would require general agreement about, and solutions to, a wide range of such issues. Although some of those issues were introduced by the Internet or computer-age approaches to character encodings and data abstraction, others predate the Internet and computer systems by centuries; there is unlikely to be agreement about comprehensive solutions in the near future.

Although this specification consequently contains some requirements and flexibility that would not be present in a more perfect world, this has been necessary in order to produce a consensus specification that provides a modernized definition of URNs (the unattractive alternative would have been to not modernize the definition in spite of widespread deployment).

The following sub-sections describe two of the relevant issues in greater detail.

1.2.1. Resolution

One issue that is specific to URNs (as opposed to naming systems in general) is the fairly difficult topic of "resolution", discussed in Sections 1.1, 2.3.1, 6.4.6, and elsewhere below.

With traditional Uniform Resource Locators (URLs), i.e., with most URIs that are locators, resolution is relatively straightforward because it is used to determine an access mechanism that in turn is used to dereference the locator by (typically) retrieving a representation of the associated resource, such as a document (see Section 1.2.2 of [RFC3986]).

By contrast, resolution for URNs is more flexible and varied.

One important case involves the mapping of a URN to one or more locators. In this case, the end result is still a matter of dereferencing the mapped locator(s) to one or more representations. The primary difference here is persistence: even if a mapped locator has changed (e.g., a DNS domain name has changed hands and a URL has not been modified to point to a new location or, in a more extreme and hypothetical case, the DNS is replaced entirely), a URN user will be able to obtain the correct representation (e.g., a document) as long as the resolver has kept its URN-to-locator mappings up to date. Consequently, the relevant relationships can be defined quite precisely for URNs that resolve to locators that in turn are dereferenced to a representation.

However, this specification permits several other cases of URN resolution as well as URNs for resources that do not involve information retrieval systems. This is true either individually for particular URNs or (as defined below) collectively for entire URN namespaces.

Consider a namespace of URNs that resolve to locators that in turn are dereferenced only to metadata about resources because the underlying systems contain no representations of those resources; an example might be a URN namespace for International Standard Name Identifiers (ISNIs) as that identifier system is defined in the relevant standard [ISO.27729.2012], wherein by default a URN would be resolved only to a metadata record describing the public identity identified by the ISNI.

Consider also URNs that resolve to representations only if the requesting entity is authorized to obtain the representation, whereas other entities can obtain only metadata about the resource; an example might be documents held within the legal depository collection of a national library.

Finally, some URNs might not be intended to resolve to locators at all; examples might include URNs identifying XML namespace names (e.g., the "dgiwg" URN namespace specified by [RFC6288]), URNs identifying application features that can be supported within a communications protocol (e.g., the "alert" URN namespace specified by [RFC7462]), and URNs identifying enumerated types such as values in a registry (e.g., a URN namespace could be used to individually identify the values in all IANA registries, as provisionally proposed in [IANA-URN]).

Various types of URNs and multiple resolution services that may be available for them leave the concept of "resolution" more complicated but also much richer for URNs than the straightforward case of resolution to a locator that is dereferenced to a representation.

1.2.2. Character Sets and Encodings

A similar set of considerations apply to character sets and encodings. URNs, especially URNs that will be used as user-facing identifiers, should be convenient to use in local languages and writing systems, easily specified with a wide range of keyboards and local conventions, and unambiguous. There are trade-offs among those goals, and it is impossible at present to see how a simple and readily understandable set of rules could be developed that would be optimal, or even reasonable, for all URNs. The discussion in Section 2.2 defines an overall framework that should make generalized parsing and processing possible but also makes recommendations about rules for individual URN namespaces.

2. URN Syntax

As discussed above, the syntax for URNs in this specification allows significantly more functionality than was the case in the earlier specifications, most recently [RFC2141]. It is also harmonized with the general URI syntax [RFC3986] (which, it must be noted, was completed after the earlier URN specifications).

However, this specification does not extend the URN syntax to allow direct use of characters outside the ASCII range [RFC20]. That restriction implies that any such characters need to be percent-encoded as described in Section 2.1 of the URI specification [RFC3986].

The basic syntax for a URN is defined using the Augmented Backus-Naur Form (ABNF) as specified in [RFC5234]. Rules not defined here (specifically: `alphanum`, `fragment`, and `pchar`) are defined as part of the URI syntax [RFC3986] and used here to point out the syntactic relationship with the terms used there. The definitions of some of

the terms used below are not comprehensive; additional restrictions are imposed by the prose that can be found in sections of this document that are specific to those terms (especially r-component in Section 2.3.1 and q-component in Section 2.3.2).

```

namestring      = assigned-name
                  [ rq-components ]
                  [ "#" f-component ]
assigned-name    = "urn" ":" NID ":" NSS
NID              = (alphanum) 0*30(ldh) (alphanum)
ldh              = alphanum / "-"
NSS              = pchar *(pchar / "/" )
rq-components    = [ "?" r-component ]
                  [ "?=" q-component ]
r-component      = pchar *( pchar / "/" / "?" )
q-component      = pchar *( pchar / "/" / "?" )
f-component      = fragment

```

The question mark character "?" can be used without percent-encoding inside r-components, q-components, and f-components. Other than inside those components, a "?" that is not immediately followed by "=" or "+" is not defined for URNs and SHOULD be treated as a syntax error by URN-specific parsers and other processors.

The following sections provide additional information about the syntactic elements of URNs.

2.1. Namespace Identifier (NID)

NIDs are case insensitive (e.g., "ISBN" and "isbn" are equivalent).

Characters outside the ASCII range [RFC20] are not permitted in NIDs, and no encoding mechanism for such characters is supported.

Sections 5.1 and 5.2 impose additional constraints on the strings that can be used as NIDs, i.e., the syntax shown above is not comprehensive.

2.2. Namespace Specific String (NSS)

The NSS is a string, unique within a URN namespace, that is assigned and managed in a consistent way and that conforms to the definition of the relevant URN namespace. The combination of the NID (unique across the entire "urn" scheme) and the NSS (unique within the URN namespace) ensures that the resulting URN is globally unique.

The NSS as specified in this document allows several characters not permitted by earlier specifications (see Appendix B). In particular, the "/" character, which is now allowed, effectively makes it possible to encapsulate hierarchical names from non-URN identifier systems. For instance, consider the hypothetical example of a hierarchical identifier system in which the names take the form of a sequence of numbers separated by the "/" character, such as "1/406/47452/2". If the authority for such names were to use URNs, it would be natural to place the existing name in the NSS, resulting in URNs such as "urn:example:1/406/47452/2".

Those changes to the syntax for the NSS do not modify the encoding rules for URN namespaces that were defined in accordance with [RFC2141]. If any such URN namespace whose names are used outside of the URN context (i.e., in a non-URN identifier system) also allows the use of "/", "~", or "&" in the native form within that identifier system, then the encoding rules for that URN namespace are not changed by this specification.

Depending on the rules governing a non-URN identifier system and its associated URN namespace, names that are valid in that identifier system might contain characters that are not allowed by the "pchar" production referenced above (e.g., characters outside the ASCII range or, consistent with the restrictions in RFC 3986, the characters "/", "?", "#", "[", and "]"). While such a name might be valid within the non-URN identifier system, it is not a valid URN until it has been translated into an NSS that conforms to the rules of that particular URN namespace. In the case of URNs that are formed from names that exist separately in a non-URN identifier system, translation of a name from its "native" format to a URN format is accomplished by using the canonicalization and encoding methods defined for URNs in general or specific rules for that URN namespace. Software that is not aware of namespace-specific canonicalization and encoding rules MUST NOT construct URNs from the name in the non-URN identifier system.

In particular, with regard to characters outside the ASCII range, URNs that appear in protocols or that are passed between systems MUST use only Unicode characters encoded in UTF-8 and further encoded as required by RFC 3986. To the extent feasible and consistent with the requirements of names defined and standardized elsewhere, as well as the principles discussed in Section 1.2, the characters used to represent names SHOULD be restricted to either ASCII letters and digits or to the characters and syntax of some widely used models such as those of Internationalizing Domain Names in Applications (IDNA) [RFC5890], Preparation, Enforcement, and Comparison of Internationalized Strings (PRECIS) [RFC7613], or the Unicode Identifier and Pattern Syntax specification [UAX31].

In order to make URNs as stable and persistent as possible when protocols evolve and the environment around them changes, URN namespaces SHOULD NOT allow characters outside the ASCII range [RFC20] unless the nature of the particular URN namespace makes such characters necessary.

2.3. Optional Components

This specification includes three optional components in the URN syntax. They are known as r-component, q-component, and f-component and are described in more detail below. Because this specification focuses almost exclusively on URN syntax, it does not define detailed semantics of these components for URNs in general. However, each of these components has a distinct role that is independent of any given URN and its URN namespace. It is intended that clients will be able to handle these components uniformly for all URNs. These components MAY be used with URNs from existing URN namespaces, whether or not a URN namespace explicitly supports them. However, consistent with the approach taken in RFC 3986, the behavior of a URN that contains components that are undefined or meaningless for a particular URN namespace or resource is not defined. The following sections describe these optional components and their interpretation in greater detail.

2.3.1. r-component

The r-component is intended for passing parameters to URN resolution services (taken broadly, see Section 1.2) and interpreted by those services. (By contrast, passing parameters to the resources identified by a URN, or to applications that manage such resources, is handled by q-components as described in the next section.)

The URN r-component has no syntactic counterpart in any other known URI scheme.

The sequence "?+" introduces the r-component. The r-component ends with a "?=" sequence (which begins a q-component) or a "#" character (number sign, which begins an f-component). If neither of those appear, the r-component continues to the end of the URN. Note that characters outside the ASCII range [RFC20] MUST be percent-encoded using the method defined in Section 2.1 of the generic URI specification [RFC3986].

As described in Section 3, the r-component SHALL NOT be taken into account when determining URN-equivalence. However, the r-component SHALL be supplied along with the URN when presenting a request to a URN resolution service.

This document defines only the syntax of the r-component and reserves it for future use. The exact semantics of the r-component and its use in URN resolution protocols are a matter for potential standardization in separate specifications, presumably including specifications that define conventions and a registry for resolution service identifiers.

Consider the hypothetical example of passing parameters to a resolution service (say, an ISO alpha-2 country code [ISO.3166-1] in order to select the preferred country in which to search for a physical copy of a book). This could perhaps be accomplished by specifying the country code in the r-component, resulting in URNs such as:

```
urn:example:foo-bar-baz-qux?+CCResolve:cc=uk
```

While the above should serve as a general explanation and illustration of the intent for r-components, there are many open issues with them, including their relationship to resolution mechanisms associated with the particular URN namespace at registration time. Thus, r-components SHOULD NOT be used for URNs before their semantics have been standardized.

2.3.2. q-component

The q-component is intended for passing parameters to either the named resource or a system that can supply the requested service, for interpretation by that resource or system. (By contrast, passing parameters to URN resolution services is handled by r-components as described in the previous section.)

The URN q-component has the same syntax as the URI query component but is introduced by "?=", not "?" alone. For a URN that may be resolved to a URI that is a locator, the semantics of the q-component are identical to those for the query component of that URI. Thus, URN resolvers returning a URI that is a locator for a URN with a q-component do this by copying the q-component from the URN to the query component of the URI. An example of the copying operation appears below.

This specification does not specify a required behavior in the case of URN resolution to a URI that is a locator when the original URN has a q-component and the URI has a query string. Different circumstances may require different approaches. Resolvers SHOULD document their strategy in such cases.

If the URN does not resolve to a URI that is a locator, the interpretation of the q-component is undefined by this specification. For URNs that may be resolved to a URI that is a locator, the semantics of the q-component are identical to those for queries to the resource located via that URI.

For the sake of consistency with RFC 3986, the general syntax and the semantics of q-components are not defined by, or dependent on, the URN namespace of the URN. In parallel with RFC 3986, specifics of syntax and semantics, e.g., which keywords or terms are meaningful, of course may depend on a particular URN namespace or even a particular resource.

The sequence "?=" introduces the q-component. The q-component ends with a "#" character (number sign, which begins an f-component). If that character does not appear, the q-component continues to the end of the URN. The characters slash ("/") and question mark ("?") may represent data within the q-component. Note that characters outside the ASCII range [RFC20] MUST be percent-encoded using the method defined in Section 2.1 of the generic URI specification [RFC3986].

As described in Section 3, the q-component SHALL NOT be taken into account when determining URN-equivalence.

URN namespaces and associated information placement in syntax SHOULD be designed to avoid any need for a resolution service to consider the q-component. Namespace-specific and more generic resolution systems MUST NOT require that q-component information be passed to them for processing.

Consider the hypothetical example of passing parameters to an application that returns weather reports from different regions or for different time periods. This could perhaps be accomplished by specifying latitude and longitude coordinates and datetimes in the URN's q-component, resulting in URNs such as the following.

```
urn:example:weather?=op=map&lat=39.56
&lon=-104.85&datetime=1969-07-21T02:56:15Z
```

If this example resolved to an HTTP URI, the result might look like:

```
https://weatherapp.example?op=map&lat=39.56
&lon=-104.85&datetime=1969-07-21T02:56:15Z
```

2.3.3. f-component

The f-component is intended to be interpreted by the client as a specification for a location within, or region of, the named resource. It distinguishes the constituent parts of a resource named by a URN. For a URN that resolves to one or more locators that can be dereferenced to a representation, or where the URN resolver directly returns a representation of the resource, the semantics of an f-component are defined by the media type of the representation.

The URN f-component has the same syntax as the URI fragment component. If a URN containing an f-component resolves to a single URI that is a locator associated with the named resource, the f-component from the URN can be applied (usually by the client) as the fragment of that URI. If the URN does not resolve to a URI that is a locator, the interpretation of the f-component is undefined by this specification. Thus, for URNs that may be resolved to a URI that is a locator, the semantics of f-components are identical to those of fragments for that resource.

For the sake of consistency with RFC 3986, neither the general syntax nor the semantics of f-components are defined by, or dependent on, the URN namespace of the URN. In parallel with RFC 3986, specifics of syntax and semantics, e.g., which keywords or terms are meaningful, of course may depend on a particular URN namespace or even a particular resource.

The f-component is introduced by the number sign ("#") character and terminated by the end of the URI. Any characters outside the ASCII range [RFC20] that appear in the f-component MUST be percent-encoded using the method defined in Section 2.1 of the generic URI specification [RFC3986].

As described in Section 3, the f-component SHALL NOT be taken into account when determining URN-equivalence.

Clients SHOULD NOT pass f-components to resolution services unless those services also perform object retrieval and interpretation functions.

Consider the hypothetical example of obtaining resources that are part of a larger entity (say, the chapters of a book). Each part could be specified in the f-component, resulting in URNs such as:

```
urn:example:foo-bar-baz-qux#somepart
```

3. URN-Equivalence

3.1. Procedure

For various purposes such as caching, it is often desirable to determine if two URNs are "the same". This is done most generally (i.e., independent of the scheme) by testing for equivalence (see Section 6.1 of [RFC3986]).

The generic URI specification [RFC3986] is very flexible about equality comparisons, putting the focus on allowing false negatives and avoiding false positives. If comparisons are made in a scheme-independent way, i.e., as URI comparisons only, many URNs that this specification considers equal would be rejected. The discussion below applies when the URIs involved are known to be URNs and thus uses the terms "URN-equivalent" and "URN-equivalence" to refer to equivalence as specified in this document.

Two URNs are URN-equivalent if their assigned-name portions are octet-by-octet equal after applying case normalization (as specified in Section 6.2.2.1 of [RFC3986]) to the following constructs:

1. the URI scheme "urn", by conversion to lower case
2. the NID, by conversion to lower case
3. any percent-encoded characters in the NSS (that is, all character triplets that match the <pct-encoding> production found in Section 2.1 of the base URI specification [RFC3986]), by conversion to upper case for the digits A-F.

Percent-encoded characters MUST NOT be decoded, i.e., percent-encoding normalization (as specified in Section 6.2.2.2 of [RFC3986]) MUST NOT be applied as part of the comparison process.

If an r-component, q-component, or f-component (or any combination thereof) is included in a URN, it MUST be ignored for purposes of determining URN-equivalence.

URN namespace definitions MAY include additional rules for URN-equivalence, such as case insensitivity of the NSS (or parts thereof). Such rules MUST always have the effect of eliminating some of the false negatives obtained by the procedure above and MUST NOT result in treating two URNs as not "the same" if the procedure here says they are URN-equivalent. For related considerations with regard to NID registration, see below.

3.2. Examples

This section shows a variety of URNs (using the "example" NID defined in [RFC6963]) that highlight the URN-equivalence rules.

First, because the scheme and NID are case insensitive, the following three URNs are URN-equivalent to each other:

- o urn:example:a123,z456
- o URN:example:a123,z456
- o urn:EXAMPLE:a123,z456

Second, because the r-component, q-component, and f-component are not taken into account for purposes of testing URN-equivalence, the following three URNs are URN-equivalent to the first three examples above:

- o urn:example:a123,z456?+abc
- o urn:example:a123,z456?=xyz
- o urn:example:a123,z456#789

Third, because the "/" character (and anything that follows it) in the NSS is taken into account for purposes of URN-equivalence, the following URNs are not URN-equivalent to each other or to the six preceding URNs:

- o urn:example:a123,z456/foo
- o urn:example:a123,z456/bar
- o urn:example:a123,z456/baz

Fourth, because of percent-encoding, the following URNs are URN-equivalent only to each other and not to any of those above (note that, although %2C is the percent-encoded transformation of ",", from the previous examples, such sequences are not decoded for purposes of testing URN-equivalence):

- o urn:example:a123%2Cz456
- o URN:EXAMPLE:a123%2cz456

Fifth, because characters in the NSS other than percent-encoded sequences are treated in a case-sensitive manner (unless otherwise specified for the URN namespace in question), the following URNs are not URN-equivalent to the first three URNs:

- o urn:example:A123,z456
- o urn:example:a123,Z456

Sixth, on casual visual inspection of a URN presented in a human-oriented interface, the following URN might appear the same as the first three URNs (because U+0430 CYRILLIC SMALL LETTER A can be confused with U+0061 LATIN SMALL LETTER A), but it is not URN-equivalent to the first three URNs:

- o urn:example:%D0%B0123,z456

4. URI Conformance

4.1. Use in URI Protocol Slots

Because a URN is, syntactically, a URI under the "urn" scheme, in theory a URN can be placed in any protocol slot that allows for a URI (to name just a few, the "href" and "src" attributes in HTML, the base element in HTML, the "xml:base" attribute in XML [XML-BASE], and the "xmlns" attribute in XML for XML namespace names [XML-NAMES]).

However, this does not imply that, semantically, it always makes sense in practice to place a URN in a given URI protocol slot; in particular, because a URN might not specify the location of a resource or even point indirectly to one, it might not be appropriate to place a URN in a URI protocol slot that points to a resource (e.g., the aforementioned "href" and "src" attributes).

Ultimately, guidelines regarding when it is appropriate to use URIs under the "urn" scheme (or any other scheme) are the responsibility of specifications for individual URI protocol slots (e.g., the specification for the "xml:base" attribute in XML might recommend that it is inappropriate to use URNs in that protocol slot). This specification cannot possibly anticipate all of the relevant cases, and it is not the place of this specification to require or restrict usage for individual protocol slots.

4.2. Parsing

In part because of the separation of URN semantics from more general URI syntax, generic URI processors need to pay special attention to the parsing and analysis rules of RFC 3986 and, in particular, must treat the URI as opaque unless the scheme and its requirements are recognized. In the latter case, such processors may be in a position to invoke scheme-appropriate processing, e.g., by a URN resolver. A URN resolver can either be an external resolver that the URI resolver knows of or be functionality built into the URI resolver. Note that this requirement might impose constraints on the contexts in which URNs are appropriately used; see Section 4.1.

4.3. URNs and Relative References

Section 5.2 of [RFC3986] describes an algorithm for converting a URI reference that might be relative to a given base URI into "parsed components" of the target of that reference, which can then be recomposed per RFC 3986, Section 5.3 into a target URI. This algorithm is problematic for URNs because their syntax does not support the necessary path components. However, if the algorithm is applied independent of a particular scheme, it should work predictably for URNs as well, with the following understandings (syntax production terminology taken from RFC 3986):

1. A system that encounters a <URI-reference> that obeys the syntax for <relative-ref>, whether it explicitly has the scheme "urn" or not, will convert it into a target URI as specified in RFC 3986.
2. Because of the persistence and stability expectations of URNs, authors of documents, etc., that utilize URNs should generally avoid the use of the "urn" scheme in any <URI-reference> that is not strictly a <URI> as specified in RFC 3986, specifically including those that would require processing of <relative-ref>.

4.4. Transport and Display

When URNs are transported and exchanged, they MUST be represented in the format defined herein. Further, URN-aware applications are strongly encouraged to offer the option of displaying URNs in this canonical form to allow for direct transcription (for example by copy-and-paste techniques). Such applications might support the display of URNs in a more human-friendly form and might use a character set that includes characters that are not permitted in URN syntax as defined in this specification (e.g., when displaying URNs to humans, such applications might replace percent-encoded strings with characters from an extended character repertoire such as Unicode [UNICODE]).

To minimize user confusion, any application displaying URIs SHOULD display the complete URI (including, for URNs, the "urn" scheme and any components) to ensure that there is no confusion between URN NIDs and URI scheme identifiers. For example, a URI beginning with "urn:xmpp:" [RFC4854] is very different from a URI beginning with "xmpp:" [RFC5122]. Similarly, a potential Digital Object Identifier (DOI) URI scheme [DOI-URI] is different from, and possibly completely unrelated to, a possible DOI URN namespace.

4.5. URI Design and Ownership

As mentioned, the assignment of URNs within a URN namespace is a managed process, as is the assignment of URN namespaces themselves. Although design of the URNs to be assigned within a given URN namespace is ceded by this specification to the URN namespace manager, doing so in a managed way avoids the problems inherent in unmanaged generation of URIs as described in the recommendations regarding URI design and ownership [RFC7320].

5. URN Namespaces

A URN namespace is a collection of names that obey three constraints: each name is (1) unique, (2) assigned in a consistent way, and (3) assigned according to a common definition.

1. The "uniqueness" constraint means that a name within the URN namespace is never assigned to more than one resource and never reassigned to a different resource (for the kind of "resource" identified by URNs assigned within the URN namespace). This holds true even if the name itself is deprecated or becomes obsolete.
2. The "consistent assignment" constraint means that a name within the URN namespace is assigned by an organization or created in accordance with a process or algorithm that is always followed.
3. The "common definition" constraint means that there are clear definitions for the syntax of names within the URN namespace and for the process of assigning or creating them.

A URN namespace is identified by a particular NID in order to ensure the global uniqueness of URNs and, optionally, to provide a cue regarding the structure of URNs assigned within a URN namespace.

With regard to global uniqueness, using different NIDs for different collections of names ensures that no two URNs will be the same for different resources, because each collection is required to uniquely assign each name. However, a single resource MAY have more than one

URN assigned to it, either in the same URN namespace (if the URN namespace permits it) or in different URN namespaces, and for either similar purposes or different purposes. (For example, if a publisher assigns an ISBN [RFC3187] to an electronic publication and that publication is later incorporated into a digital long-term archive operated by a national library, the library might assign the publication a national bibliography number (NBN) [RFC3188], resulting in two URNs referring to the same book.) Subject to other constraints, such as those imposed by the URI syntax [RFC3986], the rules of the URN scheme are intended to allow preserving the normal and natural form of names specified in non-URN identifier systems when they are treated as URNs.

With regard to the structure of names assigned within a URN namespace, the development of a naming structure (and thereby a collection of names) depends on the requirements of the community defining the names, how the names will be assigned and used, etc. These issues are beyond the scope of URN syntax and the general rules for URN namespaces, because they are specific to the community defining a non-URN identifier system or a particular URN namespace (e.g., the bibliographic and publishing communities in the case of the "ISBN" URN namespace [RFC3187] and the "ISSN" URN namespace [RFC3044] or the developers of extensions to the Extensible Messaging and Presence Protocol [RFC6120] in the case of the "XMPP" URN namespace [RFC4854]).

Because the colon character (":") is used to separate "urn" from the NID and the NID from the NSS, it's tempting to think of the entire URN as being structured by colon characters and to assume that colons create a structure or hierarchy within the NSS portion of the URN. Such structure could be specified by a particular NID specification, but there is no implicit structure. In a URN such as

```
urn:example:apple:pear:plum:cherry
```

the NSS string is "apple:pear:plum:cherry" as a whole, and there is no specific meaning to the colon characters within that NSS string unless such meaning is described in the specification of the "example" namespace.

URN namespaces inherit certain rights and responsibilities by the nature of URNs, in particular:

1. They uphold the general principles of a well-managed URN namespace by providing persistent identification of resources and unique assignment of names in accordance with a common definition.

2. Optionally, they can be registered in global registration services such as those described in [RFC2483].

There are two types of URN namespaces: formal and informal. These are distinguished by the expected level of service, the information needed to define the URN namespace, and the procedures for registration. Because the majority of the URN namespaces registered so far have been formal, this document concentrates on formal URN namespaces.

5.1. Formal URN Namespaces

A formal URN namespace provides benefit to some subset of users on the Internet. In particular, it would not make sense for a formal URN namespace to be used only by a community or network that is not connected to the Internet. For example, it would be inappropriate for a URN namespace to effectively force someone to use a proprietary network or service not open to the general Internet user. The intent is that, while the community of those who might actively use the URNs assigned within that URN namespace might be small, the potential use of names within that URN namespace is open to any user on the Internet. Formal URN namespaces might be appropriate even when some aspects are not fully open. For example, a URN namespace might make use of a fee-based, privately managed, or proprietary registry for assignment of URNs in the URN namespace. However, it might still benefit some Internet users if the associated services have openly published names.

An organization that will assign URNs within a formal URN namespace SHOULD meet the following criteria:

1. Organizational stability and the ability to maintain the URN namespace for a long time; absent such evidence, it ought to be clear how the URN namespace can remain viable if the organization can no longer maintain the URN namespace.
2. Competency in URN assignment. This will improve the likelihood of persistence (e.g., to minimize the likelihood of conflicts).
3. Commitment to not reassigning existing URNs and to allowing old URNs to continue to be valid (e.g., if the assignee of a URN is no longer a member or customer of the assigning organization, if various information about the assignee or named entity happens to change, or even if the assignee or the named entity itself is no longer in existence; in all these cases, the URN is still valid).

A formal URN namespace establishes a particular NID, subject to the following constraints (above and beyond the syntax rules already specified):

1. It MUST NOT be an already-registered NID.
2. It MUST NOT start with "urn-" (which is reserved for informal URN namespaces).
3. It MUST be more than two characters long, and it MUST NOT start with ALPHA ALPHA "--", i.e., any string consisting of two letters followed by one hyphen; such strings are reserved for potential use as NIDs based on ISO alpha-2 country codes [ISO.3166-1] for eventual national registrations of URN namespaces (however, the definition and scoping of rules for allocation of responsibility for such country-code-based URN namespaces are beyond the scope of this document). As a consequence, it MUST NOT start with the string "xn--" or any other string consisting of two letters followed by two hyphens; such strings are reserved for potential representation of DNS A-labels and similar strings in the future [RFC5890].
4. It MUST NOT start with the string "X-" so that it will not be confused with or conflict with any experimental URN namespace previously permitted by [RFC3406].

Applicants and reviewers considering new NIDs should also be aware that they may have semantic implications and hence be a source of conflict. Particular attention should be paid to strings that might be construed as identifiers for, or registered under the authority of, countries (including ISO 3166-1 alpha-3 codes) and to strings that might imply association with existing URI schemes, non-URN identifier systems, or trademarks. However, in line with traditional policies, disputes about "ownership" of particular strings are disagreements among the parties involved; neither IANA nor the IETF will become involved in such disputes except in response to orders from a court of competent jurisdiction.

5.2. Informal URN Namespaces

Informal URN namespaces are full-fledged URN namespaces, with all the associated rights and responsibilities. Informal URN namespaces differ from formal URN namespaces in the process for assigning the NID: for an informal URN namespace, the registrant does not designate the NID; instead, IANA assigns the NID consisting of the string "urn-" followed by one or more digits (e.g., "urn-7") where the

digits consist of the next available number in the sequence of positive integers assigned to informal URN namespaces. Thus, the syntax of an informal URN namespace identifier is:

```
InformalNamespaceName = "urn-" Number
Number                 = DigitNonZero 0*Digit
DigitNonZero          = "1" / "2" / "3" / "4" / "5"
                       / "6" / "7" / "8" / "9"
Digit                  = "0" / DigitNonZero
```

The only restrictions on <Number> are that it (1) consist strictly of ASCII digits, (2) not have leading zeros, and (3) not cause the NID to exceed the length limitations defined for the URN syntax (see Section 2).

6. Defining and Registering a URN Namespace

6.1. Overview

Because the space of URN namespaces is itself managed, the definition of a URN namespace SHOULD pay particular attention to:

1. The purpose of the URN namespace.
2. The syntax of URNs assigned within the URN namespace, including the internal syntax and anticipated effects of r-components or q-components. (The syntax and interpretation of f-components are defined in RFC 3986.)
3. The process for assigning URNs within the URN namespace.
4. The security implications of assigning URNs within the URN namespace and of using the assigned URNs.
5. Any potential interoperability issues with URNs assigned within the URN namespace.
6. Optionally, the process for resolving URNs assigned within the URN namespace.

The section on completing the template (Section 6.4) explains these matters in greater detail. Although the registration templates are the same in all cases, slightly different procedures are used depending on the source of the registration.

6.2. Registration Policy and Process: Community Registrations

The basic registration policy for URN namespaces is Expert Review as defined in the IANA Considerations document [RFC5226]. For URN namespaces or their definitions that are intended to become standards or constituent parts of standards, the output of the Expert Review process is intended to be a report rather than instructions to IANA to take action (see below). The key steps are:

1. Fill out the URN namespace registration template (see Section 6.4 and Appendix A). This can be done as part of an Internet-Draft or a specification in another series, although that is not a requirement.
2. Send the completed template to the urn@ietf.org discussion list for review.
3. If necessary to address comments received, repeat steps 1 and 2.
4. If the Designated Experts approve the request and no standardization action is involved, the IANA will register the requested NID. If standardization is anticipated, the Designated Experts will prepare a report and forward it to the appropriate standards approval body (the IESG in the case of the IETF); IANA will register the requested NID only after receiving directions from that body and a copy of the Expert Review report.

A URN namespace registration can be revised by updating the registration template, following the same steps outlined above for new registrations. A revised registration **MUST** describe differences from prior versions and **SHOULD** make special note of any relevant changes in the underlying technologies or URN namespace management processes.

Experience to date with URN namespace registration requests has shown that registrants sometimes do not initially understand some of the subtleties of URN namespaces and that defining the URN namespace in the form of a specification enables the registrants to clearly formulate their "contract" with the intended user community. Therefore, although the registration policy for formal URN namespaces is Expert Review and a specification (as distinct from the registration template) is not strictly required, registrants **SHOULD** provide a stable specification documenting the URN namespace definition and expanding upon the issues described herein.

Because naming can be difficult and contentious, URN namespace registrants and the Designated Experts are strongly encouraged to work together in a spirit of good faith and mutual understanding to

achieve rough consensus (see [RFC7282]) on handling registration requests. They are also encouraged to bring additional expertise into the discussion if that would be helpful in providing perspective or otherwise resolving issues.

Especially when iterations in the registration process are prolonged, Designated Experts are expected to take reasonable precautions to avoid "race conditions" on proposed NIDs and, if such situations arise, to encourage applicants to work out any conflicts among themselves.

6.3. Registration Policy and Process: Fast Track for Standards Development Organizations, Scientific Societies, and Similar Bodies

The IETF recognizes that situations will arise in which URN namespaces will be created to either embed existing and established standards, particularly identifier standards, or reflect knowledge, terminology, or methods of organizing information that lie well outside the IETF's scope or the likely subject matter knowledge of its Designated Experts. In situations in which the registration request originates from, or is authorized by, a recognized standards development organization, scientific society, or their designees, a somewhat different procedure is available at the option of that body:

1. The URN namespace registration template is filled out and submitted as in steps 1 and 2 of Section 6.2.
2. A specification is required that reflects or points to the needed external standards or specifications. Publication in the RFC Series or through an IETF process (e.g., posting as an Internet-Draft) is not expected and would be appropriate only under very unusual circumstances.
3. The reviews on the discussion list and by the Designated Experts are strictly advisory, with the decisions about what advice to accept and the length of time to allocate to the process strictly under the control of the external body.
4. When that body concludes that the application is sufficiently mature, its representative(s) will request that IANA complete the registration for the NID, and IANA will do so.

Decisions about whether to recognize the requesting entity as a standards development organization or scientific society are the responsibility of the IESG.

A model similar to this has already been defined for recognized standards development organizations that wish to register media types. The document describing that mechanism [RFC6838] provides somewhat more information about the general approach.

6.4. Completing the Template

A template for defining and registering a URN namespace is provided in Appendix A. This section describes considerations for completing the template.

6.4.1. Purpose

The "Purpose" section of the template describes matters such as:

1. The kinds of resources identified by URNs assigned within the URN namespace.
2. The scope and applicability of the URNs assigned within the URN namespace; this might include information about the community of use (e.g., a particular nation, industry, technology, or organization), whether the assigned URNs will be used on public networks or private networks, etc.
3. How the intended community (and the Internet community at large) will benefit from using or resolving the assigned URNs.
4. How the URN namespace relates to and complements existing URN namespaces, URI schemes, and non-URN identifier systems.
5. The kinds of software applications that can use or resolve the assigned URNs (e.g., by differentiating among disparate URN namespaces, identifying resources in a persistent fashion, or meaningfully resolving and accessing services associated with the URN namespace).
6. Whether resolution services are available or will be available (and, if so, the nature or identity of the services). Examples of q-component and (when they are standardized) r-component semantics and syntax are helpful here, even if detailed definitions are provided elsewhere or later.
7. Whether the URN namespace or its definition is expected to become a constituent part of a standard being developed in the IETF or some other recognized standards body.

6.4.2. Syntax

The "Syntax" section of the template contains:

1. A description of the structure of URNs within the URN namespace, in conformance with the fundamental URN syntax. The structure might be described in terms of a formal definition (e.g., using ABNF [RFC5234]), an algorithm for generating conformant URNs, or a regular expression for parsing the name into constituent parts; alternatively, the structure might be opaque.
2. Any special character encoding rules for assigned URNs (e.g., which character ought to always be used for quotes).
3. Rules for determining URN-equivalence between two names in the URN namespace. Such rules ought to always have the effect of eliminating false negatives that might otherwise result from comparison. If it is appropriate and helpful, reference can be made to particular equivalence rules defined in the URI specification [RFC3986] or to Section 3 of this document. Examples of URN-equivalence rules include equivalence between uppercase and lowercase characters in the NSS, between hyphenated and non-hyphenated groupings in the name, or between single quotes and double quotes. There may also be namespace-specific special encoding considerations, especially for URNs that contain embedded forms of names from non-URN identifier systems. (Note that these are not normative statements for any kind of best practice related to handling of relationships between characters in general; such statements are limited to one particular URN namespace only.)
4. Any special considerations necessary for conforming with the URN syntax. This is particularly applicable in the case of existing, non-URN identifier systems that are used in the context of URNs. For example, if a non-URN identifier system is used in contexts other than URNs, it might make use of characters that are reserved in the URN syntax. This section ought to note any such characters and outline necessary mappings to conform to URN syntax. Normally, this will be handled by percent-encoding the character as specified in Section 2.1 of the URI specification [RFC3986] and as discussed in Section 1.2.2 of this specification.
5. Any special considerations for the meaning of q-components (e.g., keywords) or f-components (e.g., predefined terms) in the context of this URN namespace.

6.4.3. Assignment

The "Assignment" section of the template describes matters such as:

1. Mechanisms or authorities for assigning URNs to resources. It ought to make clear whether assignment is completely open (e.g., following a particular procedure such as first-come, first-served (FCFS)), completely closed (e.g., for a private organization), or limited in various ways (e.g., delegated to authorities recognized by a particular organization); if limited, it ought to explain how to become an assigner of names or how to request assignment of names from existing assignment authorities.
2. Methods for ensuring that URNs within the URN namespace are unique. For example, names might be assigned sequentially or in accordance with some well-defined process by a single authority, assignment might be partitioned among delegated authorities that are individually responsible for respecting uniqueness rules, or URNs might be created independently following an algorithm that itself guarantees uniqueness.

6.4.4. Security and Privacy

The "Security and Privacy" section of the template describes any potential issues related to security and privacy with regard to assignment, use, and resolution of names within the URN namespace. Examples of such issues include:

- o The consequences of producing false negatives and false positives during comparison for URN-equivalence (see Section 3.1 of this specification and "Issues in Identifier Comparison for Security Purposes" [RFC6943]).
- o Leakage of private information when names are communicated on the public Internet.
- o The potential for directory harvesting.
- o Various issues discussed in the guidelines for security considerations in RFCs [RFC3552] and the privacy considerations for Internet protocols [RFC6973]. In particular, note the privacy considerations text for the Global System for Mobile Communications Association (GSMA) / International Mobile station Equipment Identity (IMEI) namespace [RFC7254], which may provide a useful model for such cases.

6.4.5. Interoperability

The "Interoperability" section MUST specify any known potential issues related to interoperability. Examples include possible confusion with other URN namespaces, non-URN identifier systems, or URI schemes because of syntax (e.g., percent-encoding of certain characters) or scope (e.g., overlapping areas of interest). If at all possible, concerns that arise during the registration of a URN namespace (e.g., due to the syntax or scope of a non-URN identifier system) should be resolved as part of or in parallel to the registration process.

6.4.6. Resolution

The "Resolution" section MUST specify whether resolution mechanisms are intended or anticipated for URNs assigned within the URN namespace.

If resolution is intended, then this section SHOULD specify whether the organization that assigns URNs within the URN namespace intends to operate or recommend any resolution services for URNs within that URN namespace. In addition, if the assigning organization intends to implement registration for publicly advertised resolution services (for example, using a system developed in the spirit of the original architectural principles and service descriptions for URN resolution [RFC2276] [RFC2483]), then this section SHOULD list or reference the requirements for being publicly advertised by the assigning organization. In addition, this section SHOULD describe any special considerations for the handling of r-components in the context of this URN namespace.

6.4.7. Additional Information

The "Additional Information" section includes information that would be useful to those trying to understand this registration or its relationship to other registrations, such as comparisons to existing URN namespaces that might seem to overlap.

This section of the template is optional.

7. IANA Considerations

7.1. URI Scheme

This section updates the registration of the "urn" URI scheme in the Permanent URI Registry [URI-Registry].

URI Scheme Name: urn

Status: permanent

URI Scheme Syntax: See Section 2 of RFC 8141.

URI Scheme Semantics: The "urn" scheme identifies Uniform Resource Names, which are persistent, location-independent resource identifiers.

Encoding Considerations: See Section 2 of RFC 8141.

Applications/Protocols That Use This URI Scheme Name: Uniform Resource Names are used in a wide variety of applications, including bibliographic reference systems and as names for Extensible Markup Language (XML) namespaces.

Interoperability Considerations: See Section 4 of RFC 8141.

Security Considerations: See Sections 6.4.4 and 8 of RFC 8141.

Contact: URNBIS working group [mailto:urn@ietf.org]

Author/Change Controller: This scheme is registered under the IETF tree. As such, the IETF maintains change control.

References: None.

7.2. Registration of URN Namespaces

This document outlines the processes for registering URN namespaces and has implications for the IANA in terms of registries to be maintained (see especially Section 6). In all cases, the IANA ought to assign the appropriate NID (formal or informal) once the procedures outlined in Section 6 have been completed.

7.3. Discussion List for New and Updated NID Registrations

As discussed elsewhere in this document, the discussion list specified in RFC 3406 (urn-nid@apps.ietf.org) is discontinued and replaced by the discussion list urn@ietf.org.

8. Security and Privacy Considerations

The definition of a URN namespace needs to account for potential security and privacy issues related to assignment, use, and resolution of names within the URN namespace (e.g., some URN resolvers might assign special meaning to certain characters in the NSS); see Section 6.4.4 for further discussion.

In most cases, URN namespaces provide a way to declare public information. Normally, these declarations will have a relatively low security profile; however, there is always the danger of "spoofing" and providing misinformation. Information in these declarations ought to be taken as advisory.

9. References

9.1. Normative References

- [RFC20] Cerf, V., "ASCII format for network interchange", STD 80, RFC 20, DOI 10.17487/RFC0020, October 1969, <<http://www.rfc-editor.org/info/rfc20>>.
- [RFC2119] Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", BCP 14, RFC 2119, DOI 10.17487/RFC2119, March 1997, <<http://www.rfc-editor.org/info/rfc2119>>.
- [RFC3986] Berners-Lee, T., Fielding, R., and L. Masinter, "Uniform Resource Identifier (URI): Generic Syntax", STD 66, RFC 3986, DOI 10.17487/RFC3986, January 2005, <<http://www.rfc-editor.org/info/rfc3986>>.
- [RFC5226] Narten, T. and H. Alvestrand, "Guidelines for Writing an IANA Considerations Section in RFCs", BCP 26, RFC 5226, DOI 10.17487/RFC5226, May 2008, <<http://www.rfc-editor.org/info/rfc5226>>.
- [RFC5234] Crocker, D., Ed. and P. Overell, "Augmented BNF for Syntax Specifications: ABNF", STD 68, RFC 5234, DOI 10.17487/RFC5234, January 2008, <<http://www.rfc-editor.org/info/rfc5234>>.

9.2. Informative References

- [DOI-URI] Paskin, N., Neylon, E., Hammond, T., and S. Sun, "The "doi" URI Scheme for the Digital Object Identifier (DOI)", Work in Progress, draft-paskin-doi-uri-04, June 2003.

- [IANA-URN] Saint-Andre, P. and M. Cotton, "A Uniform Resource Name (URN) Namespace for IANA Registries", Work in Progress, draft-saintandre-iana-urn-01, February 2013.
- [ISO.27729.2012]
ISO, "Information and documentation - International standard name identifier (ISNI)", ISO 27729:2012, Technical Committee ISO/TC 46, Information and documentation, Subcommittee SC 9, Identification and description, March 2012.
- [ISO.3166-1]
ISO, "Codes for the representation of names of countries and their subdivisions -- Part 1: Country codes", ISO 3166-1:2013, November 2013.
- [RFC1737] Sollins, K. and L. Masinter, "Functional Requirements for Uniform Resource Names", RFC 1737, DOI 10.17487/RFC1737, December 1994, <<http://www.rfc-editor.org/info/rfc1737>>.
- [RFC1738] Berners-Lee, T., Masinter, L., and M. McCahill, "Uniform Resource Locators (URL)", RFC 1738, DOI 10.17487/RFC1738, December 1994, <<http://www.rfc-editor.org/info/rfc1738>>.
- [RFC1808] Fielding, R., "Relative Uniform Resource Locators", RFC 1808, DOI 10.17487/RFC1808, June 1995, <<http://www.rfc-editor.org/info/rfc1808>>.
- [RFC2141] Moats, R., "URN Syntax", RFC 2141, DOI 10.17487/RFC2141, May 1997, <<http://www.rfc-editor.org/info/rfc2141>>.
- [RFC2276] Sollins, K., "Architectural Principles of Uniform Resource Name Resolution", RFC 2276, DOI 10.17487/RFC2276, January 1998, <<http://www.rfc-editor.org/info/rfc2276>>.
- [RFC2483] Mealling, M. and R. Daniel, "URI Resolution Services Necessary for URN Resolution", RFC 2483, DOI 10.17487/RFC2483, January 1999, <<http://www.rfc-editor.org/info/rfc2483>>.
- [RFC2648] Moats, R., "A URN Namespace for IETF Documents", RFC 2648, DOI 10.17487/RFC2648, August 1999, <<http://www.rfc-editor.org/info/rfc2648>>.
- [RFC3044] Rozenfeld, S., "Using The ISSN (International Serial Standard Number) as URN (Uniform Resource Names) within an ISSN-URN Namespace", RFC 3044, DOI 10.17487/RFC3044, January 2001, <<http://www.rfc-editor.org/info/rfc3044>>.

- [RFC3187] Hakala, J. and H. Walravens, "Using International Standard Book Numbers as Uniform Resource Names", RFC 3187, DOI 10.17487/RFC3187, October 2001, <<http://www.rfc-editor.org/info/rfc3187>>.
- [RFC3188] Hakala, J., "Using National Bibliography Numbers as Uniform Resource Names", RFC 3188, DOI 10.17487/RFC3188, October 2001, <<http://www.rfc-editor.org/info/rfc3188>>.
- [RFC3406] Daigle, L., van Gulik, D., Iannella, R., and P. Faltstrom, "Uniform Resource Names (URN) Namespace Definition Mechanisms", BCP 66, RFC 3406, DOI 10.17487/RFC3406, October 2002, <<http://www.rfc-editor.org/info/rfc3406>>.
- [RFC3552] Rescorla, E. and B. Korver, "Guidelines for Writing RFC Text on Security Considerations", BCP 72, RFC 3552, DOI 10.17487/RFC3552, July 2003, <<http://www.rfc-editor.org/info/rfc3552>>.
- [RFC4854] Saint-Andre, P., "A Uniform Resource Name (URN) Namespace for Extensions to the Extensible Messaging and Presence Protocol (XMPP)", RFC 4854, DOI 10.17487/RFC4854, April 2007, <<http://www.rfc-editor.org/info/rfc4854>>.
- [RFC5122] Saint-Andre, P., "Internationalized Resource Identifiers (IRIs) and Uniform Resource Identifiers (URIs) for the Extensible Messaging and Presence Protocol (XMPP)", RFC 5122, DOI 10.17487/RFC5122, February 2008, <<http://www.rfc-editor.org/info/rfc5122>>.
- [RFC5890] Klensin, J., "Internationalized Domain Names for Applications (IDNA): Definitions and Document Framework", RFC 5890, DOI 10.17487/RFC5890, August 2010, <<http://www.rfc-editor.org/info/rfc5890>>.
- [RFC6120] Saint-Andre, P., "Extensible Messaging and Presence Protocol (XMPP): Core", RFC 6120, DOI 10.17487/RFC6120, March 2011, <<http://www.rfc-editor.org/info/rfc6120>>.
- [RFC6288] Reed, C., "URN Namespace for the Defence Geospatial Information Working Group (DGIWG)", RFC 6288, DOI 10.17487/RFC6288, August 2011, <<http://www.rfc-editor.org/info/rfc6288>>.

- [RFC6648] Saint-Andre, P., Crocker, D., and M. Nottingham, "Deprecating the "X-" Prefix and Similar Constructs in Application Protocols", BCP 178, RFC 6648, DOI 10.17487/RFC6648, June 2012, <<http://www.rfc-editor.org/info/rfc6648>>.
- [RFC6838] Freed, N., Klensin, J., and T. Hansen, "Media Type Specifications and Registration Procedures", BCP 13, RFC 6838, DOI 10.17487/RFC6838, January 2013, <<http://www.rfc-editor.org/info/rfc6838>>.
- [RFC6943] Thaler, D., Ed., "Issues in Identifier Comparison for Security Purposes", RFC 6943, DOI 10.17487/RFC6943, May 2013, <<http://www.rfc-editor.org/info/rfc6943>>.
- [RFC6963] Saint-Andre, P., "A Uniform Resource Name (URN) Namespace for Examples", BCP 183, RFC 6963, DOI 10.17487/RFC6963, May 2013, <<http://www.rfc-editor.org/info/rfc6963>>.
- [RFC6973] Cooper, A., Tschofenig, H., Aboba, B., Peterson, J., Morris, J., Hansen, M., and R. Smith, "Privacy Considerations for Internet Protocols", RFC 6973, DOI 10.17487/RFC6973, July 2013, <<http://www.rfc-editor.org/info/rfc6973>>.
- [RFC7254] Montemurro, M., Ed., Allen, A., McDonald, D., and P. Gosden, "A Uniform Resource Name Namespace for the Global System for Mobile Communications Association (GSMA) and the International Mobile station Equipment Identity (IMEI)", RFC 7254, DOI 10.17487/RFC7254, May 2014, <<http://www.rfc-editor.org/info/rfc7254>>.
- [RFC7282] Resnick, P., "On Consensus and Humming in the IETF", RFC 7282, DOI 10.17487/RFC7282, June 2014, <<http://www.rfc-editor.org/info/rfc7282>>.
- [RFC7320] Nottingham, M., "URI Design and Ownership", BCP 190, RFC 7320, DOI 10.17487/RFC7320, July 2014, <<http://www.rfc-editor.org/info/rfc7320>>.
- [RFC7462] Liess, L., Ed., Jesske, R., Johnston, A., Worley, D., and P. Kyzivat, "URNs for the Alert-Info Header Field of the Session Initiation Protocol (SIP)", RFC 7462, DOI 10.17487/RFC7462, March 2015, <<http://www.rfc-editor.org/info/rfc7462>>.

- [RFC7613] Saint-Andre, P. and A. Melnikov, "Preparation, Enforcement, and Comparison of Internationalized Strings Representing Usernames and Passwords", RFC 7613, DOI 10.17487/RFC7613, August 2015, <<http://www.rfc-editor.org/info/rfc7613>>.
- [UAX31] The Unicode Consortium, "Unicode Standard Annex #31: Unicode Identifier and Pattern Syntax", Unicode 9.0.0, June 2015, <<http://unicode.org/reports/tr31/>>.
- [UNICODE] The Unicode Consortium, "The Unicode Standard", <<http://www.unicode.org/versions/latest/>>.
- [URI-Registry] IANA, "Uniform Resource Identifier (URI) Schemes", <<http://www.iana.org/assignments/uri-schemes>>.
- [XML-BASE] Marsh, J. and R. Tobin, "XML Base (Second Edition)", W3C Recommendation REC-xmlbase-20090128, January 2009, <<http://www.w3.org/TR/2009/REC-xmlbase-20090128>>.
- [XML-NAMES] Thompson, H., Hollander, D., Layman, A., Bray, T., and R. Tobin, "Namespaces in XML 1.0 (Third Edition)", W3C Recommendation REC-xml-names-20091208, December 2009, <<http://www.w3.org/TR/2009/REC-xml-names-20091208>>.

Appendix A. Registration Template

Namespace Identifier: Requested of IANA (formal) or assigned by IANA (informal).

Version: The version of the registration, starting with 1 and incrementing by 1 with each new version.

Date: The date when the registration is requested of IANA, using the format YYYY-MM-DD.

Registrant: The person or organization that has registered the NID, including the name and address of the registering organization, as well as the name and contact information (email, phone number, or postal address) of the designated contact person. If the registrant is a recognized standards development organization, scientific society, or similar body requesting the fast-track registration procedure (see Section 6.3), that information should be clearly indicated in this section of the template.

Purpose: Described in Section 6.4.1 of this document.

Syntax: Described in Section 6.4.2 of this document. Unless the registration explicitly describes the semantics of r-components, q-components, and f-components in the context of this URN namespace, those semantics are undefined.

Assignment: Described in Section 6.4.3 of this document.

Security and Privacy: Described in Section 6.4.4 of this document.

Interoperability: Described in Section 6.4.5 of this document.

Resolution: Described in Section 6.4.6 of this document.

Documentation: A pointer to an RFC, a specification published by another standards development organization, or another stable document that provides further information about this URN namespace.

Additional Information: Described in Section 6.4.7 of this document.

Revision Information: Description of changes from prior version(s). (Applicable only when earlier registrations have been revised.)

Appendix B. Changes from RFC 2141

This document makes substantive changes from the syntax and semantics of [RFC2141]:

B.1. Syntax Changes from RFC 2141

The syntax of URNs as provided in [RFC2141] was defined before the updated specification of URIs in [RFC3986]. The definition of URN syntax is updated in this document to do the following:

- o Ensure consistency with the URI syntax.
- o Facilitate the use of URNs with parameters similar to URI queries and fragments.
- o Permit parameters influencing URN resolution.
- o Ease the use of URNs with non-URN identifier systems that include the "/" character.

In particular, this specification does the following:

- o Extends URN syntax to explicitly allow the characters "/", "?", and "#", which were reserved for future use by RFC 2141. This change also effectively allows several components of the URI syntax although without necessarily tying those components to URI semantics.
- o Defines general syntax for an additional component that can be used in interactions with a URN resolution service.
- o Disallows "-" at the end of the NID.
- o Allows the "/", "~", and "&" characters in the NSS.
- o Makes several smaller syntax adjustments.

B.2. Other Changes from RFC 2141

- o Formally registers "urn" as a URI scheme.
- o Allows what are now called r-components, q-components, and f-components.

In addition, some of the text has been updated to be consistent with the definition of URIs [RFC3986] and the processes for registering information with the IANA [RFC5226], as well as more modern guidance with regard to security [RFC3552], privacy [RFC6973], and identifier comparison [RFC6943].

Appendix C. Changes from RFC 3406

This document makes the following substantive changes from [RFC3406]:

1. Relaxes the registration policy for formal URN namespaces from "IETF Review" to "Expert Review" as discussed in Section 6.2.
2. Removes the category of experimental URN namespaces, consistent with [RFC6648]. Experimental URN namespaces were denoted by prefixing the namespace identifier with the string "X-". Because experimental URN namespaces were never registered, removing the experimental category has no impact on the existing registries. Because experimental URN namespaces are not managed, strings conforming to URN syntax within experimental URN namespaces are not valid URNs. Truly experimental usages may, of course, employ the "example" namespace [RFC6963].
3. Adds some information to, but generally simplifies, the URN namespace registration template.

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Contributors

RFC 2141, which provided the basis for the syntax portion of this document, was authored by Ryan Moats.

RFC 3406, which provided the basis for the namespace portion of this document, was authored by Leslie Daigle, Dirk-Willem van Gulik, Renato Iannella, and Patrik Faltstrom.

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