

Network Working Group
Internet-Draft
Intended status: Informational
Expires: January 3, 2021

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July 2, 2020

Uniform Resource Names for Device Identifiers
draft-ietf-core-dev-urn-07

Abstract

This memo describes a new Uniform Resource Name (URN) namespace for hardware device identifiers. A general representation of device identity can be useful in many applications, such as in sensor data streams and storage, or equipment inventories. A URN-based representation can be easily passed along in any application that needs the information.

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1. Introduction

This memo describes a new Uniform Resource Name (URN) [RFC8141] namespace for hardware device identifiers. A general representation of device identity can be useful in many applications, such as in sensor data streams and storage [RFC8428], or equipment inventories [RFC7252], [I-D.ietf-core-resource-directory].

A URN-based representation can be easily passed along in any application that needs the information, as it fits in protocols mechanisms that are designed to carry URNs [RFC7230], [RFC7540], [RFC3261], [RFC7252]. Finally, URNs can also be easily carried and

stored in formats such as XML [W3C.REC-xml-19980210] or JSON [RFC8259] [RFC8428]. Using URNs in these formats is often preferable as they are universally recognized, self-describing, and therefore avoid the need for agreeing to interpret an octet string as a specific form of a MAC address, for instance.

This memo defines identity URN types for situations where no such convenient type already exist. For instance, [RFC6920] defines cryptographic identifiers, [RFC7254] defines International Mobile station Equipment Identity (IMEI) identifiers for use with 3GPP cellular systems, and [RFC8464] defines Mobile Equipment Identity (MEID) identifiers for use with 3GPP2 cellular systems. Those URN types should be employed when such identities are transported; this memo does not redefine these identifiers in any way.

Universally Unique Identifier (UUID) URNs [RFC4122] are another alternative way for representing device identifiers, and already support MAC addresses as one of type of an identifier. However, UUIDs can be inconvenient in environments where it is important that the identifiers are as simple as possible and where additional requirements on stable storage, real-time clocks, and identifier length can be prohibitive. UUID-based identifiers are recommended for all general purpose uses when MAC addresses are available as identifiers. The device URN defined in this memo is recommended for constrained environments.

Future device identifier types can extend the device URN type defined here, or define their own URNs.

Note that long-term stable unique identifiers are problematic for privacy reasons and should be used with care or avoided as described in [RFC7721].

The rest of this memo is organized as follows. Section 3 defines the "DEV" URN type, and Section 4 defines subtypes for IEEE MAC-48, EUI-48 and EUI-64 addresses and 1-wire device identifiers. Section 5 gives examples. Section 6 discusses the security and privacy considerations of the new URN type. Finally, Section 7 specifies the IANA registration for the new URN type and sets requirements for subtype allocations within this type.

2. Requirements language

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 BCP 14 [RFC2119] [RFC8174] when, and only when, they appear in all capitals, as shown here.

3. DEV URN Definition

Namespace Identifier: "dev" requested

Version: 1

Date: 2020-06-24

Registrant: IETF and the CORE working group. Should the working group cease to exist, discussion should be directed to the general IETF discussion forums or the IESG.

3.1. Purpose

Purpose: The DEV URNs identify devices with device-specific identifiers such as network card hardware addresses. DEV URN is global in scope.

Some typical applications include equipment inventories and smart object systems.

DEV URNs can be used in various ways in applications, software systems, and network components, in tasks ranging from discovery (for instance when discovering 1-wire network devices or detecting MAC-addressable devices on a LAN) to intrusion detection systems and simple catalogues of system information.

While it is possible to implement resolution systems for specific applications or network locations, DEV URNs are typically not used in a way that requires resolution beyond direct observation of the relevant identity fields in local link communication. However, it is often useful to be able to pass device identity information in generic URN fields in databases or protocol fields, which makes the use of URNs for this purpose convenient.

The DEV URN name space complements existing name spaces such as those involving IMEI or UUID identifiers. DEV URNs are expected to be a part of the IETF-provided basic URN types, covering identifiers that have previously not been possible to use in URNs.

3.2. Syntax

Syntax: The identifier is expressed in ASCII characters and has a hierarchical structure as follows:

```
devurn = "urn:dev:" body componentpart
body = machbody / owbody / orgbody / osbody / opsbody / otherbody
machbody = "mac:" hexstring
owbody = "ow:" hexstring
orgbody = "org:" number "-" identifier *( ":" identifier )
osbody = "os:" number "-" serial *( ":" identifier )
opsbody = "ops:" number "-" product "-" serial *( ":" identifier )
otherbody = subtype ":" identifier *( ":" identifier )
subtype = ALPHA *(DIGIT / ALPHA)
identifier = 1*unreserved
identifiernodash = 1*unreservednodash
product = identifiernodash
serial = identifier
componentpart = *( "_" identifier )
unreservednodash = ALPHA / DIGIT / "."
unreserved = unreservednodash / "-"
hexstring = 1*(hexdigit hexdigit)
hexdigit = DIGIT / "a" / "b" / "c" / "d" / "e" / "f"
number = 1*DIGIT
ALPHA = %x41-5A / %x61-7A
DIGIT = %x30-39
```

The above Augmented Backus-Naur Form (ABNF) copies the DIGIT and ALPHA rules originally defined in [RFC5234], exactly as defined there.

The device identity namespace includes three subtypes (see Section 4, and more may be defined in the future as specified in Section 7.

The optional underscore-separated components following the hexstring are strings depicting individual aspects of a device. The specific strings and their semantics are up to the designers of the device, but could be used to refer to specific interfaces or functions within the device.

With the exception of the MAC-address and 1-Wire DEV URNs, each DEV URN may also contain optional colon-separated identifiers. These are provided for extensibility.

There are no special character encoding rules or considerations for conforming with the URN syntax, beyond those applicable for URNs in general [RFC8141], or the context where these URNs are carried (e.g., inside JSON [RFC8259] or SenML [RFC8428]).

The DEV URN syntax allows both upper and lower case characters. The lexical equivalence of the DEV URNs is defined as an exact and case sensitive string match. Character case is not otherwise significant for the DEV URN subtypes defined in this document. Future subtypes

might use identifiers that require other encodings that require a more full-blown character set (such as BASE64). To facilitate equivalence checks, it is RECOMMENDED that implementations always use lower case letters where they have a choice in case, unless there is a reason otherwise. (Such a reason might be, for instance, the use of a subtype that requires the use of both upper case and lower case letters.)

DEV URNs do not use r-, q-, or f-components.

Specific subtypes of DEV URNs may be validated through mechanisms discussed in Section 4.

Finally, the string representation of the device identity URN and of the MEID sub namespace is fully compatible with the URN syntax.

3.3. Assignment

Assignment: The process for identifier assignment is dependent on the used subtype, and documented in the specific subsection under Section 4.

Device identifiers are generally expected to be unique, barring the accidental issue of multiple devices with the same identifiers.

This URN type SHOULD only be used for persistent identifiers, such as hardware-based identifiers or cryptographic identifiers based on keys intended for long-term usage.

3.4. Security and Privacy

Security and Privacy: As discussed in Section 6, care must be taken to use device identifier-based identifiers due to their nature as a long-term identifier that is often not changeable. Leakage of these identifiers outside systems where their use is justified should be controlled.

3.5. Interoperability

Interoperability: There are no specific interoperability concerns.

3.6. Resolution

Resolution: The device identities are not expected to be globally resolvable. No identity resolution system is expected. Systems may perform local matching of identities to previously seen identities or configured information, however.

3.7. Documentation

See RFC NNNN (RFC Editor: Please replace NNNN by a reference to the RFC number of this document).

3.8. Additional Information

See Section 1 for a discussion of related name spaces.

3.9. Revision Information

Revision Information: This is the first version of this registration.

4. DEV URN Subtypes

4.1. MAC Addresses

DEV URNs of the "mac" subtype are based on the EUI-64 identifier [IEEE.EUI64] derived from a device with a built-in 64-bit EUI-64. The EUI-64 is formed from 24 or 36 bits of organization identifier followed by 40 or 28 bits of device-specific extension identifier assigned by that organization.

In the DEV URN "mac" subtype the hexstring is simply the full EUI-64 identifier represented as a hexadecimal string. It is always exactly 16 characters long.

MAC-48 and EUI-48 identifiers are also supported by the same DEV URN subtype. To convert a MAC-48 address to an EUI-64 identifier, The OUI of the Ethernet address (the first three octets) becomes the organization identifier of the EUI-64 (the first three octets). The fourth and fifth octets of the EUI are set to the fixed value FFFF hexadecimal. The last three octets of the Ethernet address become the last three octets of the EUI-64. The same process is used to convert an EUI-48 identifier, but the fixed value FFFE is used instead.

Identifier assignment for all of these identifiers rests within the IEEE.

4.2. 1-Wire Device Identifiers

The 1-Wire* system is a device communications bus system designed by Dallas Semiconductor Corporation. 1-Wire devices are identified by a 64-bit identifier that consists of 8 byte family code, 48 bit identifier unique within a family, and 8 bit CRC code [OW].

*) 1-Wire is a registered trademark.

In DEV URNs with the "ow" subtype the hexstring is a representation of the full 64 bit identifier as a hexadecimal string. It is always exactly 16 characters long. Note that the last two characters represent the 8-bit CRC code. Implementations MAY check the validity of this code.

Family code and identifier assignment for all 1-wire devices rests with the manufacturers.

4.3. Organization-Defined Identifiers

Device identifiers that have only a meaning within an organisation can also be used to represent vendor-specific or experimental identifiers or identifiers designed for use within the context of an organisation.

Organisations are identified by their Private Enterprise Number (PEN) [RFC2578]. These numbers can be obtained from IANA. Current PEN assignments can be viewed at <https://www.iana.org/assignments/enterprise-numbers/enterprise-numbers> and new assignments requested at <https://pen.iana.org/pen/PenApplication.page>.

When included in an "org" DEV URN, the number MUST NOT be padded with extra leading zeroes.

4.4. Organization Serial Numbers

The "os" subtype specifies an organization and a serial number. Organizations are identified by their PEN. As with the organization-defined identifiers (Section 4.3), PEN number assignments are maintained by IANA, and assignments for new organizations can be made easily.

Editor's Note (Please remove before publication): The DEV URN "os" subtype has originally been defined in the LwM2M standard, but has been incorporated here to collect all syntax associated with DEV URNs in one place. At the same time, the syntax of this subtype was changed to avoid the possibility of characters that are not allowed in SenML Name field (see [RFC8428] Section 4.5.1).

When included in an "os" DEV URN, the PEN number MUST NOT be padded with extra leading zeroes. Organizations are also encouraged to select serial number formats that avoid possibility for ambiguity, in the form of leading zeroes or otherwise.

Organization serial number DEV URNs consist of the PEN number and the serial number. As with other DEV URNs, for carrying additional information and extensibility, optional colon-separated identifiers

and underscore-separated components may also be included. The serial numbers themselves are defined by the organization, and this specification does not specify how they are allocated.

4.5. Organization Product and Serial Numbers

The DEV URN "ops" subtype has originally been defined in the LwM2M standard, but has been incorporated here to collect all syntax associated with DEV URNs in one place. The "ops" subtype specifies an organization, product class, and a serial number. Organizations are identified by their PEN. Again, as with the organization-defined identifiers (Section 4.3), PEN number assignments are maintained by IANA.

Editor's Note (Please remove before publication): As with the "os" subtype, the "ops" subtype has originally been defined in the LwM2M standard, and its format has been slightly changed.

Organization product and serial number DEV URNs consist of the PEN number, product class, and the serial number. As with other DEV URNs, for carrying additional information and extensibility, optional colon-separated identifiers and underscore-separated components may also be included. Both the product class and serial numbers themselves are defined by the organization, and this specification does not specify how they are allocated.

When included in an "ops" DEV URN, the PEN number MUST NOT be padded with extra leading zeroes. Organizations are also encouraged to select product and serial number formats that avoid possibility for ambiguity.

5. Examples

The following three examples provide examples of MAC-based, 1-Wire, and Cryptographic identifiers:

urn:dev:mac:0024beffff804ff1	# The MAC-48 address of # 0024be804ff1, converted # to EUI-64 format
urn:dev:mac:0024beffffe804ff1	# The EUI-48 address of # 0024be804ff1, converted # to EUI-64 format
urn:dev:mac:acde48234567019f	# The EUI-64 address of # acde48234567019f
urn:dev:ow:10e2073a01080063	# The 1-Wire temperature # sensor in Jari's # kitchen
urn:dev:ow:264437f5000000ed_humidity	# The laundry sensor's # humidity part
urn:dev:ow:264437f5000000ed_temperature	# The laundry sensor's # temperature part
urn:dev:org:32473-foo	# An organization- # specific URN in # the RFC 5612 example # organisation, 32473.
urn:dev:os:32473-123456	# Device 123456 in # the RFC 5612 example # organisation
urn:dev:os:32473-12-34-56	# A serial number with # dashes in it
urn:dev:ops:32473-Refrigerator-5002	# Refrigerator serial # number 5002 in the # RFC 5612 example # organisation
urn:dev:newsubtype:example-1-2-3_comp	# A yet-to-be-defined # subtype

6. Security Considerations

On most devices, the user can display device identifiers. Depending on circumstances, device identifiers may or may not be modified or tampered with by the user. An implementation of the DEV URN MUST NOT change these properties from what they were intended. In particular, a device identifier that is intended to be immutable should not

become mutable as a part of implementing the DEV URN type. More generally, nothing in this memo should be construed to override what the relevant device specifications have already said about the identifiers.

6.1. Privacy

Other devices in the same network may or may not be able to identify the device. For instance, on Ethernet network, the MAC address of a device is visible to all other devices.

The URNs generated according to the rules defined in this document result in long-term stable unique identifiers for the devices. Such identifiers may have privacy and security implications because they may enable correlating information about a specific device over a long period of time, location tracking, and device specific vulnerability exploitation [RFC7721]. Also, usually there is no easy way to change the identifier. Therefore these identifiers need to be used with care and especially care should be taken to avoid leaking them outside of the system that is intended to use the identifiers.

7. IANA Considerations

This document requests the registration of a new URN namespace for "DEV", as described in Section 3.

Additional subtypes for DEV URNs can be defined through Specification Required or IESG Approval [RFC8126].

Such allocations are appropriate when there is a new namespace of some type of device identifiers, defined in stable fashion and with a publicly available specification that can be pointed to.

Note that the organisation (Section 4.3) device identifiers can also be used in some cases, at least as a temporary measure. It is preferable, however, that long-term usage of a broadly employed device identifier be registered with IETF rather than used through the organisation device identifier type.

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Appendix A. Changes from Previous Version

Version -07 of the WG draft took into account Carsten Bormann's feedback, primarily on character case issues and editorials.

Version -06 of the WG draft took into account Marco Tiloca's feedback before a second WGLC, primarily on further cleanup of references and editorial issues.

Version -05 of the WG draft made some updates based on WGLC input: examples for MAC-48 and EUI-48, clarification with regards to leading zeroes, new recommendation with the use of lower-case letters to avoid comparison problems, small update of the RFC 8141 template usage, reference updates, and editorial corrections.

Version -04 of the WG draft cleaned up the ABNF:

- o Parts of the ANBF now allow for use cases for the component part that were not previously covered: the syntax now allows the character "." to appear, and serial numbers can have dashes in them.
- o The syntax was also extended to allow for extensibility by adding additional ":" separated parts for the org, op, ops, and other subtypes.
- o The ABNF was changed to include directly the ALPHA and DIGIT parts imported from RFC 5234, instead of just having a verbal comment about it. (Note that the style in existing RFCs differs on this.)

In addition, in -04 the MAC example was corrected to use the inserted value ffff instead of fffe, required by Section 4.1, the org example was corrected, the os: examples and otherbody examples were added. The IANA rules for allocating new subtypes was slightly relaxed in order to cover for new subtype cases that are brought up regularly, and often not from inside the IETF. Finally, the allocation of PEN numbers and the use of product classes and serial numbers was better explained.

Version -03 of the WG draft removed some unnecessary references, updated some other references, removed pct-encoding to ensure the DEV URNs fit [RFC8428] Section 4.5.1 rules, and clarified that the original source of the "os" and "ops" subtypes.

Version -02 of the WG draft folded in the "ops" and "os" branches of the dev:urn syntax from LwM2M, as they seemed to match well what already existed in this memo under the "org" branch. However, as a part of this three changes were incorporated:

- o The syntax for the "org:" changes to use "-" rather than ":" between the OUI and the rest of the URN.
- o The organizations for the "ops" and "os" branches have been changed to use PEN numbers rather than OUI numbers [OUI]. The reason for this is that PEN numbers are allocated through a simpler and less costly process. However, this is a significant change to how LwM2M identifiers were specified before.
- o There were also changes to what general characters can be used in the otherbody branch of the ABNF.

The rationale for all these changes is that it would be helpful for the community collect and unify syntax between the different uses of DEV URNs. If there is significant use of either the org:, os:, or ops: subtypes, then changes at this point may not be warranted, but otherwise unified syntax, as well as the use of PEN numbers would probably be beneficial. Comments on this topic are appreciated.

Version -01 of the WG draft converted the draft to use the new URN registration template from [RFC8141].

Version -00 of the WG draft renamed the file name and fixed the ABNF to correctly use "org:" rather than "dn:".

Version -05 made a change to the delimiter for parameters within a DEV URN. Given discussions on allowed character sets in SenML [RFC8428], we would like to suggest that the "_" character be used instead of ";", to avoid the need to translate DEV URNs in SenML-

formatted communications or files. However, this reverses the earlier decision to not use unreserved characters. This also means that device IDs cannot use "_" characters, and have to employ other characters instead. Feedback on this decision is sought.

Version -05 also introduced local or organisation-specific device identifiers. Organisations are identified by their PEN number (although we considered FQDNs as a potential alternative. The authors believe an organisation-specific device identifier type will make experiments and local use easier, but feedback on this point and the choice of PEN numbers vs. other possible organisation identifiers would be very welcome.

Version -05 also added some discussion of privacy concerns around long-term stable identifiers.

Finally, version -05 clarified the situations when new allocations within the registry of possible device identifier subtypes is appropriate.

Version -04 is a refresh, as the need and interest for this specification has re-emerged. And the editing author has emerged back to actual engineering from the depths of IETF administration.

Version -02 introduced several changes. The biggest change is that with the NI URNs [RFC6920], it was no longer necessary to define cryptographic identifiers in this specification. Another change was that we incorporated a more generic syntax for future extensions; non-hexstring identifiers can now also be supported, if some future device identifiers for some reason would, for instance, use BASE64. As a part of this change, we also changed the component part separator character from '-' to ';' so that the general format of the rest of the URN can employ the unreserved characters [RFC3986].

Version -03 made several minor corrections to the ABNF as well as some editorial corrections.

Appendix B. Acknowledgments

The authors would like to thank Ari Keranen, Stephen Farrell, Christer Holmberg, Peter Saint-Andre, Wouter Cloetens, Jaime Jimenez, Joseph Knapp, Padmakumar Subramani, Mert Ocak, Hannes Tschofenig, Jim Schaad, Thomas Fossati, Carsten Bormann, Marco Tiloca, and Ahmad Muhanna for interesting discussions in this problem space. We would also like to note prior documents that focused on specific device identifiers, such as [RFC7254] or [RFC8464].

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