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RFC 9598

Internationalized Email Addresses in X.509 Certificates

Abstract

This document defines a new name form for inclusion in the otherName field of an X.509 Subject Alternative Name and Issuer Alternative Name extension that allows a certificate subject to be associated with an internationalized email address.

This document updates RFC 5280 and obsoletes RFC 8398.

Status of This Memo

This is an Internet Standards Track document.

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Information about the current status of this document, any errata, and how to provide feedback on it may be obtained at <https://www.rfc-editor.org/info/rfc9598>.

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1. Introduction

[RFC5280] defines the `rfc822Name` `subjectAltName` name type for representing email addresses as described in [RFC5321]. The syntax of `rfc822Name` is restricted to a subset of US-ASCII characters and thus can't be used to represent internationalized email addresses [RFC6531]. This document defines a new `otherName` variant to represent internationalized email addresses. In addition, this document requires all email address domains in X.509 certificates to conform to IDNA2008 [RFC5890].

This document obsoletes [RFC8398]. The primary motivation of this document is to simplify the encoding of domain labels found in the domain part of internationalized email addresses. In particular, [RFC8398] specifies that domain labels are conditionally encoded using either A-labels or U-labels. This specification simplifies encoding and processing of domain labels by mandating that the A-label representation be used in all cases.

2. Conventions Used in This Document

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. Name Definitions

The GeneralName structure [RFC5280] supports many different name forms including otherName for extensibility. This section specifies the Smtputf8Mailbox name form of otherName so that internationalized email addresses can appear in the subjectAltName of a certificate, the issuerAltName of a certificate, or anywhere else that GeneralName is used.

```
id-on-Smtputf8Mailbox OBJECT IDENTIFIER ::= { id-on 9 }

Smtputf8Mailbox ::= UTF8String (SIZE (1..MAX))
-- Smtputf8Mailbox conforms to Mailbox as specified
-- in Section 3.3 of RFC 6531. Additionally, all domain
-- labels included in the Smtputf8Mailbox value are
-- encoded as LDH labels. In particular, domain labels
-- are not encoded as U-labels and instead are encoded
-- using their A-label representation.
```

When the subjectAltName (or issuerAltName) extension contains an internationalized email address with a non-ASCII Local-part, the address **MUST** be stored in the Smtputf8Mailbox name form of otherName. The format of Smtputf8Mailbox is a modified version of the internationalized Mailbox that was defined in Section 3.3 of [RFC6531], which was derived from Mailbox as defined in Section 4.1.2 of [RFC5321]. [RFC6531] defines the following ABNF rules for Mailbox whose parts are modified for internationalization: Local-part, Dot-string, Quoted-string, QcontentSMTP, Domain, and Atom. In particular, Local-part was updated to also support UTF8-non-ascii. UTF8-non-ascii was described by Section 3.1 of [RFC6532]. Also, domain was extended to support U-labels, as defined in [RFC5890].

This document further refines internationalized Mailbox ABNF rules as described in [RFC6531] and calls this Smtputf8Mailbox. In Smtputf8Mailbox, labels that include non-ASCII characters **MUST** be stored in A-label (rather than U-label) form [RFC5890]. This restriction reduces complexity for implementations of the certification path validation algorithm defined in Section 6 of [RFC5280]. In Smtputf8Mailbox, domain labels that solely use ASCII characters (meaning neither A- nor U-labels) **SHALL** use NR-LDH restrictions as specified by Section 2.3.1 of [RFC5890].

NR-LDH stands for "Non-Reserved Letters Digits Hyphen" and is the set of LDH labels that do not have "--" characters in the third and fourth character positions, which excludes "tagged domain names" such as A-labels. To facilitate octet-for-octet comparisons of Smtputf8Mailbox values, all NR-LDH and A-label labels that constitute the domain part **SHALL** only be encoded with lowercase letters. Consistent with the treatment of rfc822Name in [RFC5280], Smtputf8Mailbox is an envelope Mailbox and has no phrase (such as a common name) before it, has no comment (text surrounded in parentheses) after it, and is not surrounded by "<" and ">" characters.

Due to name constraint compatibility reasons described in Section 6, Smtputf8Mailbox subjectAltName **MUST NOT** be used unless the Local-part of the email address contains non-ASCII characters. When the Local-part is ASCII, rfc822Name subjectAltName **MUST** be used instead of Smtputf8Mailbox. This is compatible with legacy software that supports only rfc822Name (and not Smtputf8Mailbox). The appropriate usage of rfc822Name and Smtputf8Mailbox is summarized in Table 1 below.

Smtputf8Mailbox is encoded as UTF8String. The UTF8String encoding **MUST NOT** contain a Byte Order Mark (BOM) [RFC3629] to aid consistency across implementations, particularly for comparison.

Local-part char	subjectAltName
ASCII-only	rfc822Name
non-ASCII	Smtputf8Mailbox

Table 1: Email Address Formatting

Non-ASCII Local-part values may additionally include ASCII characters.

4. IDNA2008

To facilitate comparison between email addresses, all email address domains in X.509 certificates **MUST** conform to IDNA2008 [RFC5890] (and avoid any "mappings" mentioned in that document). Use of non-conforming email address domains introduces the possibility of conversion errors between alternate forms. This applies to Smtputf8Mailbox and rfc822Name in subjectAltName, issuerAltName, and anywhere else that these are used.

5. Matching of Internationalized Email Addresses in X.509 Certificates

Equivalence comparisons with Smtputf8Mailbox consist of a domain part step and a Local-part step. The comparison form for Local-parts is always UTF-8. The comparison form for domain parts is always performed with the LDH label ([RFC5890]) encoding of the relevant domain labels. The comparison of LDH labels in domain parts reduces complexity for implementations of the certification path validation algorithm as defined in Section 6 of [RFC5280] by obviating the need to convert domain labels to their Unicode representation.

Comparison of two `Smtputf8Mailboxes` is straightforward with no setup work needed. They are considered equivalent if there is an exact octet-for-octet match.

Comparison of an `Smtputf8Mailbox` and `rfc822Name` will always fail. `Smtputf8Mailbox` values **SHALL** contain a Local-part that includes one or more non-ASCII characters, while `rfc822Name` only includes ASCII characters (including the Local-part). Thus, an `Smtputf8Mailbox` and `rfc822Name` will never match.

Comparison of `Smtputf8Mailbox` values with internationalized email addresses from other sources (such as received email messages, user input, etc.) requires additional setup steps for domain part and Local-part. The initial preparation for the email address to compare with the `Smtputf8Mailbox` value is to remove any phrases, comments, and "<" or ">" characters.

For the setup of the domain part, the following conversions **SHALL** be performed:

1. Convert all labels that constitute the domain part that include non-ASCII characters to A-labels, if not already in that form.
 - a. Detect all U-labels present within the domain part using [Section 5.1](#) of [\[RFC5891\]](#).
 - b. Transform all detected U-labels (Unicode) to A-labels (ASCII) as specified in [Section 5.5](#) of [\[RFC5891\]](#).
2. Convert all uppercase letters found within the NR-LDH and A-label labels that constitute the domain part to lowercase letters.

For the setup of the Local-part, the Local-part **MUST** be verified to conform to the requirements of [\[RFC6530\]](#) and [\[RFC6531\]](#), including being a string in UTF-8 form. In particular, the Local-part **MUST NOT** be transformed in any way, such as by doing case folding or normalization of any kind. The Local-part of an internationalized email address is already in UTF-8. Once setup is complete, they are again compared octet for octet.

To summarize non-normatively, the comparison steps, including setup, are:

1. If the domain contains U-labels, transform them to A-labels.
2. If any NR-LDH or A-label domain label in the domain part contains uppercase letters, lowercase them.
3. Compare strings octet for octet for equivalence.

This specification expressly does not define any wildcard characters, and `Smtputf8Mailbox` comparison implementations **MUST NOT** interpret any characters as wildcards. Instead, to specify multiple email addresses through `Smtputf8Mailbox`, the certificate **MUST** use multiple `subjectAltNames` or `issuerAltNames` to explicitly carry any additional email addresses.

6. Name Constraints in Path Validation

This section updates [Section 4.2.1.10](#) of [\[RFC5280\]](#) to extend `rfc822Name` name constraints to `Smtputf8Mailbox` `subjectAltNames`. `Smtputf8Mailbox`-aware path validators will apply name constraint comparison to the subject distinguished name and both forms of subject alternative names, `rfc822Name` and `Smtputf8Mailbox`.

Both `rfc822Name` and `Smtputf8Mailbox` subject alternative names represent the same underlying email address namespace. Since legacy Certification Authorities (CAs) constrained to issue certificates for a specific set of domains would lack corresponding UTF-8 constraints, [\[RFC9549\]](#) updates, modifies, and extends `rfc822Name` name constraints defined in [\[RFC5280\]](#) to cover `Smtputf8Mailbox` subject alternative names. This ensures that the introduction of `Smtputf8Mailbox` does not violate existing name constraints. Since it is not valid to include non-ASCII UTF-8 characters in the Local-part of `rfc822Name` name constraints, and since name constraints that include a Local-part are rarely, if at all, used in practice, name constraints updated in [\[RFC9549\]](#) allow the forms that represent all addresses at a host, or all mailboxes in a domain and deprecates `rfc822Name` name constraints that represent a particular mailbox. That is, `rfc822Name` constraints with a Local-part **SHOULD NOT** be used.

Constraint comparison with `Smtputf8Mailbox` `subjectAltName` starts with the setup steps defined in [Section 5](#). Setup converts the inputs of the comparison (which is one of a subject distinguished name, an `rfc822Name`, or an `Smtputf8Mailbox` `subjectAltName`, and one of an `rfc822Name` name constraint) to constraint comparison form. For both the name constraint and the subject, this will convert all A-labels and NR-LDH labels to lowercase. Strip the Local-part and "@" separator from each `rfc822Name` and `Smtputf8Mailbox`, which leaves just the domain part. After setup, follow the comparison steps defined in [Section 4.2.1.10](#) of [\[RFC5280\]](#) as follows. If the resulting name constraint domain starts with a "." character, then for the name constraint to match, a suffix of the resulting subject alternative name domain **MUST** match the name constraint (including the leading ".") octet for octet. If the resulting name constraint domain does not start with a "." character, then for the name constraint to match, the entire resulting subject alternative name domain **MUST** match the name constraint octet for octet.

Certificate Authorities that wish to issue CA certificates with email address name constraints **MUST** use `rfc822Name` subject alternative names only. These **MUST** be IDNA2008-conformant names with no mappings and with non-ASCII domains encoded in A-labels only.

The name constraint requirement with an `Smtputf8Mailbox` subject alternative name is illustrated in the non-normative diagram in [Figure 1](#). The first example (1) illustrates a permitted `rfc822Name` ASCII-only host name constraint and the corresponding valid `rfc822Name` `subjectAltName` and `Smtputf8Mailbox` `subjectAltName` email addresses. The second example (2) illustrates a permitted `rfc822Name` host name constraint with an A-label, and the corresponding valid `rfc822Name` `subjectAltName` and `Smtputf8Mailbox` `subjectAltName` email addresses. Note that an email address with an ASCII-only Local-part is encoded as `rfc822Name` despite also having Unicode present in the domain.

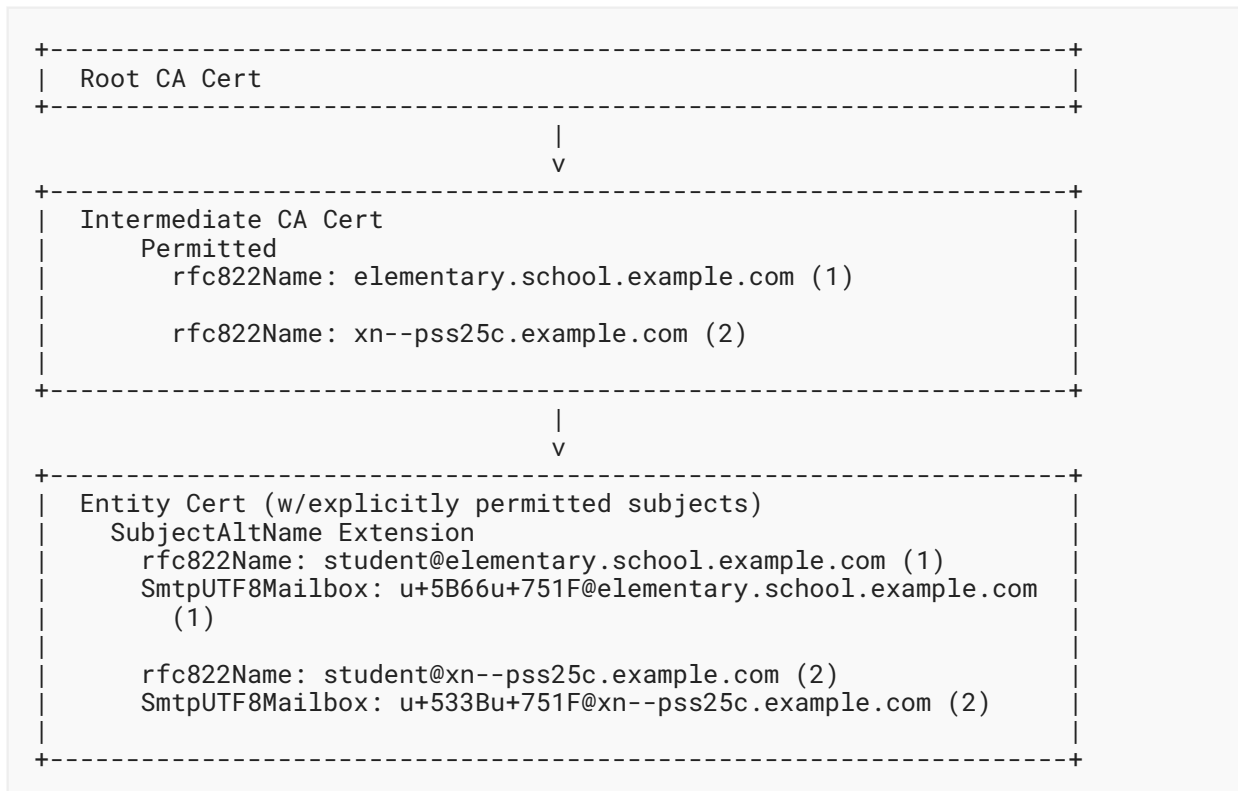


Figure 1: Name Constraints with Smtputf8Name and rfc822Name

7. Security Considerations

Use of Smtputf8Mailbox for certificate subjectAltName (and issuerAltName) will incur many of the same security considerations described in [Section 8](#) of [\[RFC5280\]](#), but it introduces a new issue by permitting non-ASCII characters in the email address Local-part. This issue, as mentioned in [Section 4.4](#) of [\[RFC5890\]](#) and in [Section 4](#) of [\[RFC6532\]](#), is that use of Unicode introduces the risk of visually similar and identical characters that can be exploited to deceive the recipient. The former document references some means to mitigate against these attacks. See [\[WEBER\]](#) for more background on security issues with Unicode.

Additionally, it is possible to encode a string of Unicode user-perceived characters in multiple ways. While various Unicode normalization forms exist, [\[RFC6531\]](#) does not mandate the use of any such forms for the encoding of the Local-part. Thus, it may be possible to encode a Local-part value in multiple ways. To mitigate against attacks where different encodings are used by the mail system and the Certification Authority issues certificates containing Smtputf8Mailbox values, this specification requires an octet-for-octet comparison of the Local-part. However, requiring the use of binary comparison may raise interoperability concerns where the mail system employs one encoding and the Certification Authority employs another.

8. Differences from RFC 8398

This document obsoletes [RFC8398]. There are three major changes defined in this specification:

1. In all cases, domain labels in mail addresses **SHALL** be encoded as LDH labels. In particular, domain names **SHALL NOT** be encoded using U-Labels; instead, use A-Labels.
2. To accommodate the first change listed above, the mail address matching algorithm defined in Section 5 of [RFC8398] has been modified to only accept domain labels that are encoded using their A-label representation.
3. Additionally, the procedure to process rfc822Name name constraints as defined in Section 6 of [RFC8398] has been modified to only accept domain labels that are encoded using their A-label representation.

9. IANA Considerations

IANA has updated the reference for the id-mod-lamps-eai-addresses-2016 module in the "SMI Security for PKIX Module Identifier" (1.3.6.1.5.5.7.0) registry to refer to this document instead of [RFC8398].

IANA has updated the reference for the SmtUTF8Mailbox otherName in the "SMI Security for PKIX Other Name Forms" (1.3.6.1.5.5.7.8) registry to refer to this document instead of [RFC8398].

10. References

10.1. Normative References

- [RFC2119] Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", BCP 14, RFC 2119, DOI 10.17487/RFC2119, March 1997, <<https://www.rfc-editor.org/info/rfc2119>>.
- [RFC3629] Yergeau, F., "UTF-8, a transformation format of ISO 10646", STD 63, RFC 3629, DOI 10.17487/RFC3629, November 2003, <<https://www.rfc-editor.org/info/rfc3629>>.
- [RFC5280] Cooper, D., Santesson, S., Farrell, S., Boeyen, S., Housley, R., and W. Polk, "Internet X.509 Public Key Infrastructure Certificate and Certificate Revocation List (CRL) Profile", RFC 5280, DOI 10.17487/RFC5280, May 2008, <<https://www.rfc-editor.org/info/rfc5280>>.
- [RFC5321] Klensin, J., "Simple Mail Transfer Protocol", RFC 5321, DOI 10.17487/RFC5321, October 2008, <<https://www.rfc-editor.org/info/rfc5321>>.
- [RFC5890] Klensin, J., "Internationalized Domain Names for Applications (IDNA): Definitions and Document Framework", RFC 5890, DOI 10.17487/RFC5890, August 2010, <<https://www.rfc-editor.org/info/rfc5890>>.

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- [RFC5891] Klensin, J., "Internationalized Domain Names in Applications (IDNA): Protocol", RFC 5891, DOI 10.17487/RFC5891, August 2010, <<https://www.rfc-editor.org/info/rfc5891>>.
 - [RFC6530] Klensin, J. and Y. Ko, "Overview and Framework for Internationalized Email", RFC 6530, DOI 10.17487/RFC6530, February 2012, <<https://www.rfc-editor.org/info/rfc6530>>.
 - [RFC6531] Yao, J. and W. Mao, "SMTP Extension for Internationalized Email", RFC 6531, DOI 10.17487/RFC6531, February 2012, <<https://www.rfc-editor.org/info/rfc6531>>.
 - [RFC6532] Yang, A., Steele, S., and N. Freed, "Internationalized Email Headers", RFC 6532, DOI 10.17487/RFC6532, February 2012, <<https://www.rfc-editor.org/info/rfc6532>>.
 - [RFC8174] Leiba, B., "Ambiguity of Uppercase vs Lowercase in RFC 2119 Key Words", BCP 14, RFC 8174, DOI 10.17487/RFC8174, May 2017, <<https://www.rfc-editor.org/info/rfc8174>>.
 - [RFC8398] Melnikov, A., Ed. and W. Chuang, Ed., "Internationalized Email Addresses in X.509 Certificates", RFC 8398, DOI 10.17487/RFC8398, May 2018, <<https://www.rfc-editor.org/info/rfc8398>>.
 - [RFC9549] Housley, R., "Internationalization Updates to RFC 5280", RFC 9549, DOI 10.17487/RFC9549, March 2024, <<https://www.rfc-editor.org/info/rfc9549>>.

10.2. Informative References

- [RFC5912] Hoffman, P. and J. Schaad, "New ASN.1 Modules for the Public Key Infrastructure Using X.509 (PKIX)", RFC 5912, DOI 10.17487/RFC5912, June 2010, <<https://www.rfc-editor.org/info/rfc5912>>.
- [WEBER] Weber, C., "Unraveling Unicode: A Bag of Tricks for Bug Hunting", July 2009, <https://www.lookout.net/files/Chris_Weber_Character%20Transformations%20v1.7_IUC33.pdf>.

Appendix A. ASN.1 Module

The following ASN.1 module normatively specifies the Smtputf8Mailbox structure. This specification uses the ASN.1 definitions from [RFC5912] with the 2002 ASN.1 notation used in that document. [RFC5912] updates normative documents using older ASN.1 notation.

```

LAMPS-EaiAddresses-2016
{ iso(1) identified-organization(3) dod(6)
  internet(1) security(5) mechanisms(5) pkix(7) id-mod(0)
  id-mod-lamps-eai-addresses-2016(92) }

DEFINITIONS IMPLICIT TAGS ::=
BEGIN

IMPORTS
OTHER-NAME
FROM PKIX1Implicit-2009
  { iso(1) identified-organization(3) dod(6) internet(1) security(5)
    mechanisms(5) pkix(7) id-mod(0) id-mod-pkix1-implicit-02(59) }

id-pkix
FROM PKIX1Explicit-2009
  { iso(1) identified-organization(3) dod(6) internet(1) security(5)
    mechanisms(5) pkix(7) id-mod(0) id-mod-pkix1-explicit-02(51) } ;

--
-- otherName carries additional name types for subjectAltName,
-- issuerAltName, and other uses of GeneralNames.
--

id-on OBJECT IDENTIFIER ::= { id-pkix 8 }

Smtputf8OtherNames OTHER-NAME ::= { on-Smtputf8Mailbox, ... }

on-Smtputf8Mailbox OTHER-NAME ::= {
  Smtputf8Mailbox IDENTIFIED BY id-on-Smtputf8Mailbox
}

id-on-Smtputf8Mailbox OBJECT IDENTIFIER ::= { id-on 9 }

Smtputf8Mailbox ::= UTF8String (SIZE (1..MAX))
-- Smtputf8Mailbox conforms to Mailbox as specified
-- in Section 3.3 of RFC 6531. Additionally, all domain
-- labels included in the Smtputf8Mailbox value are
-- encoded as LDH Labels. In particular, domain labels
-- are not encoded as U-Labels and instead are encoded
-- using their A-label representation.

END

```

Appendix B. Example of Smtputf8Mailbox

This non-normative example demonstrates using Smtputf8Mailbox as an otherName in GeneralName to encode the email address "u+533Bu+751F@xn--pss25c.example.com".

The hexadecimal DER encoding of the block is:

```

a02b0608 2b060105 05070809 a01f0c1d e58cbbe7 949f4078 6e2d2d70
73733235 632e6578 616d706c 652e636f 6d

```

The text decoding is:

```
0 43: [0] {
2  8:  OBJECT IDENTIFIER '1 3 6 1 5 5 7 8 9'
12 31:  [0] {
14 29:  UTF8String 'u+533Bu+751F@xn--pss25c.example.com'
      :  }
      :  }
```

The example was encoded using Google's "der-ascii" program and the above text decoding is an output of Peter Gutmann's "dumpasn1" program.

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