

Internet Engineering Task Force (IETF)
Request for Comments: 8553
BCP: 222

D. Crocker
Brandenburg InternetWorking
March 2019

Updates: [2782](#), [3263](#), [3529](#), [3620](#), [3832](#),
[3887](#), [3958](#), [4120](#), [4227](#), [4386](#),
4387, 4976, 5026, 5328, 5389,
5415, 5518, 5555, 5617, 5679,
5766, 5780, 5804, 5864, 5928,
6120, 6186, 6376, 6733, 6763,
7208, 7489, 8145

Category: Best Current Practice
ISSN: 2070-1721

DNS AttrLeaf Changes:
Fixing Specifications That Use Underscored Node Names

Abstract

Using an underscore for a prefix creates a space for constrained interoperation of resource records. Original uses of an underscore character as a domain node name prefix were specified without the benefit of an IANA registry. This produced an entirely uncoordinated set of name-creation activities, all drawing from the same namespace. A registry for these names has now been defined by [RFC 8552](#). However, the existing specifications that use underscored naming need to be modified in order to be in line with the new registry. This document specifies those changes. The changes preserve existing software and operational practice, while adapting the specifications for those practices to the newer underscore registry model.

Status of This Memo

This memo documents an Internet Best Current Practice.

This document is a product of the Internet Engineering Task Force (IETF). It represents the consensus of the IETF community. It has received public review and has been approved for publication by the Internet Engineering Steering Group (IESG). Further information on BCPs is available in [Section 2 of RFC 7841](#).

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/rfc8553>.

Copyright Notice

Copyright (c) 2019 IETF Trust and the persons identified as the document authors. All rights reserved.

This document is subject to [BCP 78](#) and the IETF Trust's Legal Provisions Relating to IETF Documents (<https://trustee.ietf.org/license-info>) in effect on the date of publication of this document. Please review these documents carefully, as they describe your rights and restrictions with respect to this document. Code Components extracted from this document must include Simplified BSD License text as described in Section 4.e of the Trust Legal Provisions and are provided without warranty as described in the Simplified BSD License.

Table of Contents

1. Introduction	2
2. Underscored RRset Use in Specifications	3
2.1. TXT RRset	4
2.2. SRV RRset	5
2.3. URI RRset	6
3. Underscored Template Specifications	7
3.1. SRV Specification Changes	7
3.2. URI Specification Changes	8
3.3. DNSSEC Signaling Specification Changes	10
4. IANA Considerations	11
5. Security Considerations	11
6. References	11
6.1. Normative References	11
6.2. Informative References	12
Acknowledgements	15
Author's Address	15

1. Introduction

Original uses of an underscore character as a domain node name [[RFC1035](#)] prefix, which creates a space for constrained interpretation of resource records, were specified without the benefit of an IANA registry [[IANA-reg](#)]. This produced an entirely uncoordinated set of name-creation activities, all drawing from the same namespace. A registry has now been defined (see [Section 4 of \[RFC8552\]](#)); the RFC that defined it discusses the background for the use of underscored domain names [[RFC8552](#)].

The basic model for underscored name registration, as specified in [RFC8552], is to have each registry entry be unique in terms of the combination of a resource record type and a "global" (highest-level) underscored node name; that is, the node name beginning with an underscore that is the closest to the DNS root.

The specifications describing the existing uses of underscored naming do not reflect the existence of this integrated registry. For the new reader or the new editor of one of those documents, there is currently nothing signaling that the underscored name(s) defined in the document are now processed through an IANA registry. This document remedies that, by marking such a published document with an update that indicates the nature of the change.

Further, the documents that define the SRV [RFC2782] and URI [RFC7553] DNS resource records provide a meta-template for underscored name assignments, partially based on separate registries [RFC6335]. For the portion that selects the global (highest-level) underscored node name, this perpetuates uncoordinated assignment activities by separate technical specifications, out of the same namespace. This document remedies that by providing detail for revisions to the SRV and URI specifications to bring their use in line with the single, integrated "Underscored and Globally Scoped DNS Node Names" registry.

The result of these changes preserves existing software and operations practices while adapting the technical specifications to the newer underscore registry model.

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.

2. Underscored RRset Use in Specifications

The use of underscored node names is specific to each RR TYPE that is being scoped. Each name defines a place but does not define the rules for what appears underneath that place, either as additional underscored naming or as a leaf node with resource records. Details for those rules are provided by specifications for individual RR TYPES. The sections below describe the way that existing underscored names are used with the RR TYPES that they name.

2.1. TXT RRset

NOTE - Documents falling into this category include: [RFC5518], [RFC5617], [RFC6120], [RFC6376], [RFC6763], [RFC7208], and [RFC7489].

This section provides a generic approach for changes to existing specifications that define straightforward use of underscored node names when scoping the use of a TXT RRset. The approach provides the information needed for adapting such specifications to the use of the IANA "Underscored and Globally Scoped DNS Node Names" registry [RFC8552]. Hence, the approach is meant both as an update to these existing specifications and as guidance for changes when those documents are revised.

For any document that specifies the use of a TXT RRset under one or more underscored names, the global node name is expected to be registered in the IANA "Underscored and Globally Scoped DNS Node Names" registry [RFC8552]. An effort has been made to locate existing documents that do this, to register the global underscored node names, and to list them in the initial set of names added to the registry.

If a public specification defines use of a TXT RRset and calls for the use of an underscored node name, here is a template of suggested text for registering the global underscored node name -- the one closest to the root -- that can be used through the IANA Considerations section of the specification:

"Per [RFC8552], please add the following entry to the "Underscored and Globally Scoped DNS Node Names" registry:"

RR Type	_NODE NAME	Reference
TXT	_{DNS node name}	{citation for the document making the addition}

Table 1: Entry for the "Underscored and Globally Scoped DNS Node Names" Registry for TXT RR Use

2.2. SRV RRset

NOTE - Documents falling into this category include:

[RFC3263], [RFC3529], [RFC3620], [RFC3832], [RFC3887],
[RFC3958], [RFC4120], [RFC4227], [RFC4386], [RFC4387],
[RFC4976], [RFC5026], [RFC5328], [RFC5389], [RFC5415],
[RFC5555], [RFC5679], [RFC5766], [RFC5780], [RFC5804],
[RFC5864], [RFC5928], and [RFC6186].

Specification of the SRV resource record [RFC2782] provides a template for use of underscored node names. The global node name is characterized as referencing the 'protocol' that is associated with SRV RRset usage.

This section provides a generic approach for changes to existing specifications that define the use of an SRV RRset. The approach provides the information needed for adapting such specifications to the use of the IANA "Underscored and Globally Scoped DNS Node Names" registry [RFC8552]. Hence, the approach is meant both as an update to these existing specifications and as guidance for changes when those documents are revised.

For any document that specifies the use of an SRV RRset, the global ('protocol') underscored node name is expected to be registered in the IANA "Underscored and Globally Scoped DNS Node Names" registry [RFC8552]. An effort has been made to locate existing documents that do this, to register the global underscored node names, and to list them in the initial set of names added to the registry.

If a public specification defines use of an SRV RRset and calls for the use of an underscored node name, here is a template of suggested text for registering the global underscored node name -- the one closest to the root -- that can be used through the IANA Considerations section of the specification:

"Per [RFC8552], please add the following entry to the "Underscored and Globally Scoped DNS Node Names" registry:

RR Type	_NODE NAME	Reference
SRV	_{DNS 'protocol' node name}	{citation for the document making the addition}

Table 2: Entry for the "Underscored and Globally Scoped DNS Node Names" Registry for SRV RR Use

2.3. URI RRset

Specification of the URI resource record [RFC7553] provides a template for use of underscored node names. The global node name is characterized as naming the 'protocol' that is associated with URI RR usage or by reversing an Enumservice sequence [RFC6117].

This section provides a generic approach for changes to existing specifications that define use of a URI RRset. The approach provides the information needed for adapting such specifications to the use of the IANA "Underscored and Globally Scoped DNS Node Names" registry [RFC8552]. Hence, the approach is meant both as an update to these existing specifications and as guidance for changes when those documents are revised.

For any document that specifies the use of a URI RRset, the global ('protocol' or highest-level Enumservice) underscored node name is expected to be registered in the IANA "Underscored and Globally Scoped DNS Node Names" registry [RFC8552]. An effort has been made to locate existing documents that do this, to register the global underscored node names, and to list them in the initial set of names added to the registry.

If a public specification defines use of a URI RRset and calls for the use of an underscored node name, here is a template of suggested text for registering the global underscored node name -- the one closest to the root -- that can be used through the IANA Considerations section of the specification:

"Per [RFC8552], please add the following entry to the "Underscored and Globally Scoped DNS Node Names" registry:

RR Type	_NODE NAME	Reference
URI	_{DNS 'protocol' or Enumservice node name}	{citation for the document making the addition}

Table 3: Entry for the "Underscored and Globally Scoped DNS Node Names" Registry for URI RR Use

3. Underscored Template Specifications

3.1. SRV Specification Changes

The specification for a domain name, under which an SRV resource record [RFC2782] appears, provides a template for use of underscored node names. The global underscored node name is characterized as indicating the 'protocol' that is associated with SRV RR usage.

The text of [RFC2782] is changed as described below. In addition, note that a normative reference to RFC 8552 is added to the References section of RFC 2782.

OLD:

The format of the SRV RR

Here is the format of the SRV RR, whose DNS type code is 33:

_Service._Proto.Name TTL Class SRV Priority Weight Port Target

...

Proto

The symbolic name of the desired protocol, with an underscore (_) prepended to prevent collisions with DNS labels that occur in nature. _TCP and _UDP are at present the most useful values for this field, though any name defined by Assigned Numbers or locally may be used (as for Service). The Proto is case insensitive.

NEW:

The format of the SRV RR

Here is the format of the SRV RR, whose DNS type code is 33:

```
"_Service._Proto.Name TTL Class SRV Priority Weight Port
Target"
```

```
-----
```

Proto

The symbolic name of the desired protocol with an underscore (e.g., "_name") prepended to prevent collisions with DNS labels that occur in nature. _TCP and _UDP are at present the most useful values for this field. The Proto is case insensitive.

The SRV RRset 'protocol' (global) underscored node name SHOULD be registered in the IANA "Underscored and Globally Scoped DNS Node Names" registry [RFC8552].

3.2. URI Specification Changes

Specification for the domain name (under which a URI resource record [RFC7553] occurs) is similar to that for the SRV resource record [RFC2782], although the text refers only to 'service' name, rather than distinguishing 'service' from 'protocol'. Further, the URI RR specification permits alternative underscored naming schemes:

One matches what is used for SRV, with the global underscored node name called 'protocol'.

The other is based on a reversing of an Enumservice [RFC6117] sequence.

Text of [RFC7553] is changed as described below. In addition, a normative reference to RFC 8552 is added to the References section of RFC 7553.

OLD:

4.1. Owner Name, Class, and Type

The URI owner name is subject to special conventions.

Just like the SRV RR [RFC2782], the URI RR has service information encoded in its owner name. In order to encode the service for a specific owner name, one uses service parameters. Valid service parameters are those registered by IANA in the "Service Name and Transport Protocol Port Number Registry" [RFC6335] or as "Enumservice ---

Registrations [RFC6117]. The Enumservice Registration parameters are reversed (i.e., subtype(s) before type), prepended with an underscore (_), and prepended to the owner name in separate labels. The underscore is prepended to the service parameters to avoid collisions with DNS labels that occur in nature, and the order is reversed to make it possible to do delegations, if needed, to different zones (and therefore providers of DNS).

For example, suppose we are looking for the URI for a service with ENUM Service Parameter "A:B:C" for host example.com. Then we would query for (QNAME,QTYPE)=("_C._B._A.example.com","URI").

As another example, suppose we are looking for the URI for a service with Service Name "A" and Transport Protocol "B" for host example.com. Then we would query for (QNAME,QTYPE)=("_A._B.example.com","URI").

NEW:

4.1. Owner Name, Class, and Type

The URI owner name is subject to special conventions.

As for the SRV RRset [RFC2782], the URI RRset global (highest-level) underscored node name SHOULD be registered in the IANA "Underscored and Globally Scoped DNS Node Names" registry [RFC8552].

Just like the SRV RRset, the URI RRset has service information encoded in its owner name. In order to encode the service for a specific owner name, one uses service parameters. Valid service parameters are:

- + Those registered by IANA in the "Service Name and Transport Protocol Port Number Registry" [RFC6335]. The underscore is prepended to the service parameters to avoid collisions with

DNS labels that occur in nature, and the order is reversed to make it possible to do delegations, if needed, to different zones (and therefore providers of DNS).

- + Those listed in "Enumservice Registrations" [RFC6117]. The Enumservice Registration parameters are reversed (i.e., subtype(s) before type), prepended with an underscore (e.g., "_name"), and prepended to the owner name in separate labels. The highest-level (global) underscored Enumservice name becomes the global name per RFC 8552 to register.

For example, suppose we are looking for the URI for a service with ENUM Service Parameter "A:B:C" for host example.com. Then we would query for
(QNAME,QTYPE)=("_C._B._A.example.com","URI").

As another example, suppose we are looking for the URI for a service with Service Name "A" and Transport Protocol "B" for host example.com. Then we would query for
(QNAME,QTYPE)=("_A._B.example.com","URI").

3.3. DNSSEC Signaling Specification Changes

"Signaling Trust Anchor Knowledge in DNS Security Extensions (DNSSEC)" [RFC8145] defines a use of DNS node names that effectively consumes all names beginning with the string "_ta-" when using the NULL RR in the query.

Text of Section 5.1, "Query Format", of RFC 8145 is changed as described below. In addition, a normative reference to RFC 8552 is added to the References section of RFC 8145.

OLD:

For example, a validating DNS resolver ...
QNAME=_ta-4444.

NEW:

For example, a validating DNS resolver ... "QNAME=_ta-4444".

Under the NULL RR, an entry is registered in the IANA "Underscored and Globally Scoped DNS Node Names" registry [RFC8552] for all node names beginning with "_ta-".

4. IANA Considerations

Although this document makes reference to IANA registries, it introduces no new IANA registries or procedures.

5. Security Considerations

This memo raises no security issues.

6. References

6.1. 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>>.
- [RFC6117] Hoeneisen, B., Mayrhofer, A., and J. Livingood, "IANA Registration of Enumservices: Guide, Template, and IANA Considerations", [RFC 6117](#), DOI 10.17487/RFC6117, March 2011, <<https://www.rfc-editor.org/info/rfc6117>>.
- [RFC6335] Cotton, M., Eggert, L., Touch, J., Westerlund, M., and S. Cheshire, "Internet Assigned Numbers Authority (IANA) Procedures for the Management of the Service Name and Transport Protocol Port Number Registry", [BCP 165](#), [RFC 6335](#), DOI 10.17487/RFC6335, August 2011, <<https://www.rfc-editor.org/info/rfc6335>>.
- [RFC7553] Faltstrom, P. and O. Kolkman, "The Uniform Resource Identifier (URI) DNS Resource Record", [RFC 7553](#), DOI 10.17487/RFC7553, June 2015, <<https://www.rfc-editor.org/info/rfc7553>>.
- [RFC8145] Wessels, D., Kumari, W., and P. Hoffman, "Signaling Trust Anchor Knowledge in DNS Security Extensions (DNSSEC)", [RFC 8145](#), DOI 10.17487/RFC8145, April 2017, <<https://www.rfc-editor.org/info/rfc8145>>.
- [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>>.
- [RFC8552] Crocker, D., "Scoped Interpretation of DNS Resource Records through "Underscored" Naming of Attribute Leaves", [RFC 8552](#), DOI 10.17487/RFC8552, March 2019, <<https://www.rfc-editor.org/info/rfc8552>>.

6.2. Informative References

- [IANA-reg] IANA, "Protocol Registries", <<https://www.iana.org/protocols>>.
- [RFC1035] Mockapetris, P., "Domain names - implementation and specification", STD 13, RFC 1035, DOI 10.17487/RFC1035, November 1987, <<https://www.rfc-editor.org/info/rfc1035>>.
- [RFC2782] Gulbrandsen, A., Vixie, P., and L. Esibov, "A DNS RR for specifying the location of services (DNS SRV)", RFC 2782, DOI 10.17487/RFC2782, February 2000, <<https://www.rfc-editor.org/info/rfc2782>>.
- [RFC3263] Rosenberg, J. and H. Schulzrinne, "Session Initiation Protocol (SIP): Locating SIP Servers", RFC 3263, DOI 10.17487/RFC3263, June 2002, <<https://www.rfc-editor.org/info/rfc3263>>.
- [RFC3529] Harold, W., "Using Extensible Markup Language-Remote Procedure Calling (XML-RPC) in Blocks Extensible Exchange Protocol (BEEP)", RFC 3529, DOI 10.17487/RFC3529, April 2003, <<https://www.rfc-editor.org/info/rfc3529>>.
- [RFC3620] New, D., "The TUNNEL Profile", RFC 3620, DOI 10.17487/RFC3620, October 2003, <<https://www.rfc-editor.org/info/rfc3620>>.
- [RFC3832] Zhao, W., Schulzrinne, H., Guttman, E., Bisdikian, C., and W. Jerome, "Remote Service Discovery in the Service Location Protocol (SLP) via DNS SRV", RFC 3832, DOI 10.17487/RFC3832, July 2004, <<https://www.rfc-editor.org/info/rfc3832>>.
- [RFC3887] Hansen, T., "Message Tracking Query Protocol", RFC 3887, DOI 10.17487/RFC3887, September 2004, <<https://www.rfc-editor.org/info/rfc3887>>.
- [RFC3958] Daigle, L. and A. Newton, "Domain-Based Application Service Location Using SRV RRs and the Dynamic Delegation Discovery Service (DDDS)", RFC 3958, DOI 10.17487/RFC3958, January 2005, <<https://www.rfc-editor.org/info/rfc3958>>.
- [RFC4120] Neuman, C., Yu, T., Hartman, S., and K. Raeburn, "The Kerberos Network Authentication Service (V5)", RFC 4120, DOI 10.17487/RFC4120, July 2005, <<https://www.rfc-editor.org/info/rfc4120>>.

- [RFC4227] O'Tuathail, E. and M. Rose, "Using the Simple Object Access Protocol (SOAP) in Blocks Extensible Exchange Protocol (BEEP)", [RFC 4227](#), DOI 10.17487/RFC4227, January 2006, <<https://www.rfc-editor.org/info/rfc4227>>.
- [RFC4386] Boeyen, S. and P. Hallam-Baker, "Internet X.509 Public Key Infrastructure Repository Locator Service", [RFC 4386](#), DOI 10.17487/RFC4386, February 2006, <<https://www.rfc-editor.org/info/rfc4386>>.
- [RFC4387] Gutmann, P., Ed., "Internet X.509 Public Key Infrastructure Operational Protocols: Certificate Store Access via HTTP", [RFC 4387](#), DOI 10.17487/RFC4387, February 2006, <<https://www.rfc-editor.org/info/rfc4387>>.
- [RFC4976] Jennings, C., Mahy, R., and A. Roach, "Relay Extensions for the Message Sessions Relay Protocol (MSRP)", [RFC 4976](#), DOI 10.17487/RFC4976, September 2007, <<https://www.rfc-editor.org/info/rfc4976>>.
- [RFC5026] Giaretta, G., Ed., Kempf, J., and V. Devarapalli, Ed., "Mobile IPv6 Bootstrapping in Split Scenario", [RFC 5026](#), DOI 10.17487/RFC5026, October 2007, <<https://www.rfc-editor.org/info/rfc5026>>.
- [RFC5328] Adolf, A. and P. MacAvock, "A Uniform Resource Name (URN) Namespace for the Digital Video Broadcasting Project (DVB)", [RFC 5328](#), DOI 10.17487/RFC5328, September 2008, <<https://www.rfc-editor.org/info/rfc5328>>.
- [RFC5389] Rosenberg, J., Mahy, R., Matthews, P., and D. Wing, "Session Traversal Utilities for NAT (STUN)", [RFC 5389](#), DOI 10.17487/RFC5389, October 2008, <<https://www.rfc-editor.org/info/rfc5389>>.
- [RFC5415] Calhoun, P., Ed., Montemurro, M., Ed., and D. Stanley, Ed., "Control And Provisioning of Wireless Access Points (CAPWAP) Protocol Specification", [RFC 5415](#), DOI 10.17487/RFC5415, March 2009, <<https://www.rfc-editor.org/info/rfc5415>>.
- [RFC5518] Hoffman, P., Levine, J., and A. Hathcock, "Vouch By Reference", [RFC 5518](#), DOI 10.17487/RFC5518, April 2009, <<https://www.rfc-editor.org/info/rfc5518>>.
- [RFC5555] Soliman, H., Ed., "Mobile IPv6 Support for Dual Stack Hosts and Routers", [RFC 5555](#), DOI 10.17487/RFC5555, June 2009, <<https://www.rfc-editor.org/info/rfc5555>>.

- [RFC5617] Allman, E., Fenton, J., Delany, M., and J. Levine, "DomainKeys Identified Mail (DKIM) Author Domain Signing Practices (ADSP)", [RFC 5617](#), DOI 10.17487/RFC5617, August 2009, <<https://www.rfc-editor.org/info/rfc5617>>.
- [RFC5679] Bajko, G., "Locating IEEE 802.21 Mobility Services Using DNS", [RFC 5679](#), DOI 10.17487/RFC5679, December 2009, <<https://www.rfc-editor.org/info/rfc5679>>.
- [RFC5766] Mahy, R., Matthews, P., and J. Rosenberg, "Traversal Using Relays around NAT (TURN): Relay Extensions to Session Traversal Utilities for NAT (STUN)", [RFC 5766](#), DOI 10.17487/RFC5766, April 2010, <<https://www.rfc-editor.org/info/rfc5766>>.
- [RFC5780] MacDonald, D. and B. Lowekamp, "NAT Behavior Discovery Using Session Traversal Utilities for NAT (STUN)", [RFC 5780](#), DOI 10.17487/RFC5780, May 2010, <<https://www.rfc-editor.org/info/rfc5780>>.
- [RFC5804] Melnikov, A., Ed. and T. Martin, "A Protocol for Remotely Managing Sieve Scripts", [RFC 5804](#), DOI 10.17487/RFC5804, July 2010, <<https://www.rfc-editor.org/info/rfc5804>>.
- [RFC5864] Allbery, R., "DNS SRV Resource Records for AFS", [RFC 5864](#), DOI 10.17487/RFC5864, April 2010, <<https://www.rfc-editor.org/info/rfc5864>>.
- [RFC5928] Petit-Huguenin, M., "Traversal Using Relays around NAT (TURN) Resolution Mechanism", [RFC 5928](#), DOI 10.17487/RFC5928, August 2010, <<https://www.rfc-editor.org/info/rfc5928>>.
- [RFC6120] Saint-Andre, P., "Extensible Messaging and Presence Protocol (XMPP): Core", [RFC 6120](#), DOI 10.17487/RFC6120, March 2011, <<https://www.rfc-editor.org/info/rfc6120>>.
- [RFC6186] Daboo, C., "Use of SRV Records for Locating Email Submission/Access Services", [RFC 6186](#), DOI 10.17487/RFC6186, March 2011, <<https://www.rfc-editor.org/info/rfc6186>>.
- [RFC6376] Crocker, D., Ed., Hansen, T., Ed., and M. Kucherawy, Ed., "DomainKeys Identified Mail (DKIM) Signatures", STD 76, [RFC 6376](#), DOI 10.17487/RFC6376, September 2011, <<https://www.rfc-editor.org/info/rfc6376>>.

- [RFC6763] Cheshire, S. and M. Krochmal, "DNS-Based Service Discovery", [RFC 6763](#), DOI 10.17487/RFC6763, February 2013, <<https://www.rfc-editor.org/info/rfc6763>>.
- [RFC7208] Kitterman, S., "Sender Policy Framework (SPF) for Authorizing Use of Domains in Email, Version 1", [RFC 7208](#), DOI 10.17487/RFC7208, April 2014, <<https://www.rfc-editor.org/info/rfc7208>>.
- [RFC7489] Kucherawy, M., Ed. and E. Zwicky, Ed., "Domain-based Message Authentication, Reporting, and Conformance (DMARC)", [RFC 7489](#), DOI 10.17487/RFC7489, March 2015, <<https://www.rfc-editor.org/info/rfc7489>>.

Acknowledgements

Thanks go to Bill Fenner, Dick Franks, Tony Hansen, Peter Koch, Olaf Kolkman, and Andrew Sullivan for diligent review of the (much) earlier draft versions. For the later enhancements, thanks to Tim Wicinski, John Levine, Bob Harold, Joel Jaeggli, Ondrej Sury, and Paul Wouters.

Special thanks to Ray Bellis for his persistent encouragement to continue this effort, as well as the suggestion for an essential simplification to the registration model.

Author's Address

Dave Crocker
Brandenburg InternetWorking
675 Spruce Dr.
Sunnyvale, CA 94086
United States of America

Phone: +1.408.246.8253
Email: dcrocker@bbiw.net
URI: <http://bbiw.net/>