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Domain Name System (DNS) IANA Considerations

Abstract

This document specifies Internet Assigned Numbers Authority (IANA) parameter assignment considerations for the allocation of Domain Name System (DNS) resource record types, CLASSes, operation codes, error codes, DNS protocol message header bits, and AFSDB resource record subtypes. It obsoletes RFC 6195 and updates RFCs 1183, 2845, 2930, and 3597.

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 5741.

Information about the current status of this document, any errata, and how to provide feedback on it may be obtained at http://www.rfc-editor.org/info/rfc6895.

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1. Introduction

The Domain Name System (DNS) provides replicated distributed secure hierarchical databases that store "resource records" (RRs) under domain names. DNS data is structured into CLASSes and zones that can be independently maintained. Familiarity with [RFC1034], [RFC1035], [RFC2136], [RFC2181], and [RFC4033] is assumed.

This document provides, either directly or by reference, the general IANA parameter assignment considerations that apply across DNS query and response headers and all RRs. There may be additional IANA considerations that apply to only a particular RRTYPE or query/response OpCode. See the specific RFC defining that RRTYPE or query/response OpCode for such considerations if they have been defined, except for AFSDB RR considerations [RFC1183], which are included herein. This RFC obsoletes [RFC6195]; however, the only significant changes are those to the RRTYPE IANA allocation process, aimed at streamlining it and clarifying the expected behavior of the parties involved, and the closing of the AFSDB subtype registry.

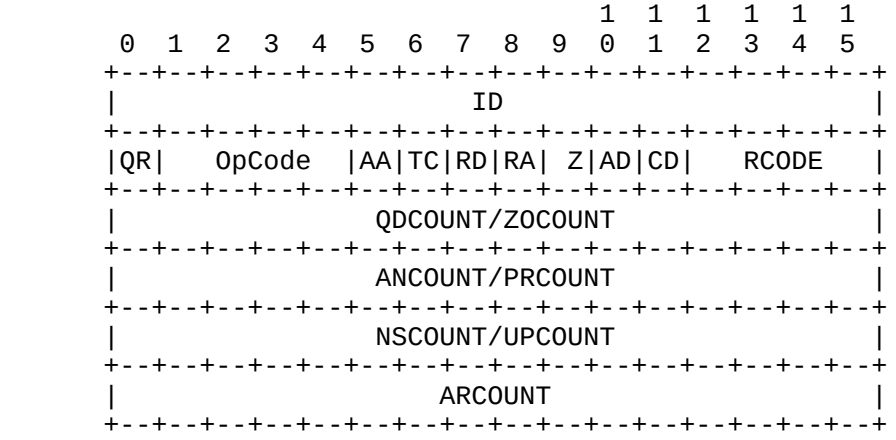
IANA currently maintains a web page of DNS parameters available from <http://www.iana.org>.

1.1. Terminology

"Standards Action", "IETF Review", "Specification Required", and "Private Use" are as defined in [RFC5226].

2. DNS Query/Response Headers

The header for DNS queries and responses contains field/bits in the following diagram taken from [RFC2136]:



The ID field identifies the query and is echoed in the response so they can be matched.

The QR bit indicates whether the header is for a query or a response.

The AA, TC, RD, RA, and CD bits are each theoretically meaningful only in queries or only in responses, depending on the bit. The AD bit was only meaningful in responses but is expected to have a separate but related meaning in queries (see Section 5.7 of [RFC6840]). Only the RD and CD bits are expected to be copied from the query to the response; however, some DNS implementations copy all the query header as the initial value of the response header. Thus, any attempt to use a "query" bit with a different meaning in a response or to define a query meaning for a "response" bit may be dangerous, given the existing implementation. Meanings for these bits may only be assigned by a Standards Action.

The unsigned integer fields query count (QDCOUNT), answer count (ANCOUNT), authority count (NSCOUNT), and additional information count (ARCOUNT) express the number of records in each section for all OpCodes except Update [RFC2136]. These fields have the same

structure and data type for Update but are instead the counts for the zone (ZOCOUNT), prerequisite (PRCOUNT), update (UPCOUNT), and additional information (ARCOUNT) sections.

2.1. One Spare Bit?

There have been ancient DNS implementations for which the Z bit being on in a query meant that only a response from the primary server for a zone is acceptable. It is believed that current DNS implementations ignore this bit.

Assigning a meaning to the Z bit requires a Standards Action.

2.2. OpCode Assignment

Currently, DNS OpCodes are assigned as follows:

OpCode	Name	Reference
0	Query	[RFC1035]
1	IQuery (Inverse Query, OBSOLETE)	[RFC3425]
2	Status	[RFC1035]
3	Unassigned	
4	Notify	[RFC1996]
5	Update	[RFC2136]
6-15	Unassigned	

Although the Status OpCode is reserved in [RFC1035], its behavior has not been specified. New OpCode assignments require a Standards Action with early allocation permitted as specified in [RFC4020].

2.3. RCODE Assignment

It would appear from the DNS header above that only four bits of RCODE, or response/error code, are available. However, RCODEs can appear not only at the top level of a DNS response but also inside TSIG RRs [RFC2845], TKEY RRs [RFC2930], and extended by OPT RRs [RFC6891]. The OPT RR provides an 8-bit extension to the 4 header bits, resulting in a 12-bit RCODE field, and the TSIG and TKEY RRs have a 16-bit field designated in their RFCs as the "Error" field.

Error codes appearing in the DNS header and in these other RR types all refer to the same error code space with the exception of error code 16, which has a different meaning in the OPT RR than in the TSIG RR, and error code 9, whose variations are described after the table below. The duplicate assignment of 16 was accidental. To the extent that any prior RFCs imply any sort of different error number space for the OPT, TSIG, or TKEY RRs, they are superseded by this unified

DNS error number space. (This paragraph is the reason this document updates [RFC2845] and [RFC2930].) With the existing exceptions of error numbers 9 and 16, the same error number must not be assigned for different errors even if they would only occur in different RR types. See table below.

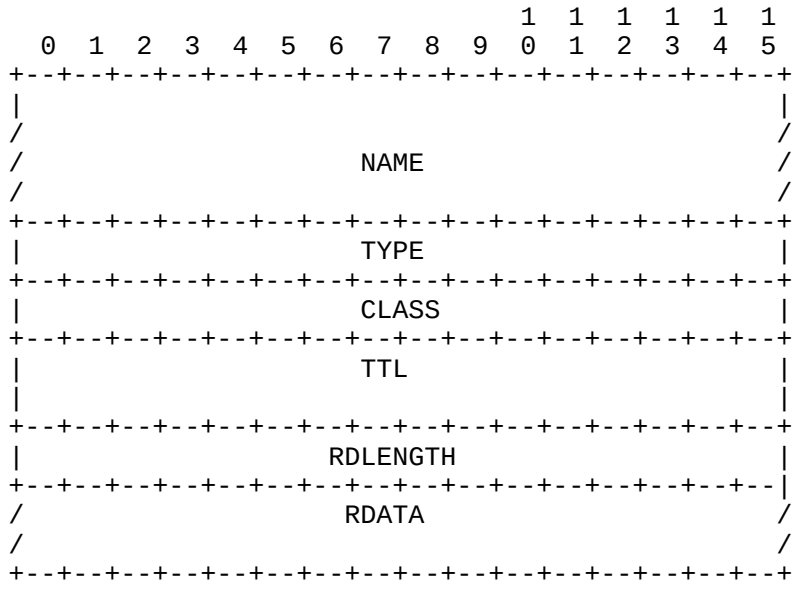
RCODE Decimal / Hexadecimal	Name	Description	Reference
0	NoError	No Error	[RFC1035]
1	FormErr	Format Error	[RFC1035]
2	ServFail	Server Failure	[RFC1035]
3	NXDomain	Non-Existent Domain	[RFC1035]
4	NotImp	Not Implemented	[RFC1035]
5	Refused	Query Refused	[RFC1035]
6	YXDomain	Name Exists when it should not	[RFC2136]
7	YXRRSet	RR Set Exists when it should not	[RFC2136]
8	NXRRSet	RR Set that should exist does not	[RFC2136]
9	NotAuth	Server Not Authoritative for zone	[RFC2136]
9	NotAuth	Not Authorized	[RFC2845]
10	NotZone	Name not contained in zone	[RFC2136]
11 - 15 0xB - 0xF		Unassigned	
16	BADVERS	Bad OPT Version	[RFC6891]
16	BADSIG	TSIG Signature Failure	[RFC2845]
17	BADKEY	Key not recognized	[RFC2845]
18	BADTIME	Signature out of time window	[RFC2845]
19	BADMODE	Bad TKEY Mode	[RFC2930]
20	BADNAME	Duplicate key name	[RFC2930]
21	BADALG	Algorithm not supported	[RFC2930]
22	BADTRUNC	Bad Truncation	[RFC4635]
23 - 3,840 0x0017 - 0x0F00		Unassigned	
3,841 - 4,095 0x0F01 - 0x0FFF		Reserved for Private Use	
4,096 - 65,534 0x1000 - 0xFFFE		Unassigned	
65,535 0xFFFF		Reserved; can only be allocated by Standards Action.	

Note on error number 9 (NotAuth): This error number means either "Not Authoritative" [RFC2136] or "Not Authorized" [RFC2845]. If 9 appears as the RCODE in the header of a DNS response without a TSIG RR or with a TSIG RR having a zero error field, then it means "Not Authoritative". If 9 appears as the RCODE in the header of a DNS response that includes a TSIG RR with a non-zero error field, then it means "Not Authorized".

Since it is important that RCODEs be understood for interoperability, assignment of a new RCODE in the ranges listed above as "Unassigned" requires an IETF Review.

3. DNS Resource Records

All RRs have the same top-level format, shown in the figure below taken from [RFC1035].



NAME is an owner name, i.e., the name of the node to which this resource record pertains. NAMEs are specific to a CLASS as described in Section 3.2. NAMEs consist of an ordered sequence of one or more labels, each of which has a label type [RFC1035] [RFC6891].

TYPE is a 2-octet unsigned integer containing one of the RRTYPE codes. See Section 3.1.

CLASS is a 2-octet unsigned integer containing one of the RR CLASS codes. See Section 3.2.

TTL is a 4-octet (32-bit) unsigned integer that specifies, for data TYPEs, the number of seconds that the resource record may be cached before the source of the information should again be consulted. Zero is interpreted to mean that the RR can only be used for the transaction in progress.

RDLENGTH is an unsigned 16-bit integer that specifies the length in octets of the RDATA field.

RDATA is a variable-length string of octets that constitutes the resource. The format of this information varies according to the TYPE and, in some cases, the CLASS of the resource record.

3.1. RRTYPE IANA Considerations

There are three subcategories of RRTYPE numbers: data TYPEs, QTYPEs, and Meta-TYPEs.

Data TYPEs are the means of storing data. QTYPES can only be used in queries. Meta-TYPEs designate transient data associated with a particular DNS message and, in some cases, can also be used in queries. Thus far, data TYPEs have been assigned from 1 upward, plus the block from 100 through 103, and from 32,768 upward, while Q and Meta-TYPEs have been assigned from 255 downward except for the OPT Meta-RR, which is assigned TYPE 41. There have been DNS implementations that made caching decisions based on the top bit of the bottom byte of the RRTYPE.

There are currently three Meta-TYPEs assigned: OPT [RFC6891], TSIG [RFC2845], and TKEY [RFC2930]. There are currently five QTYPEs assigned: * (ALL/ANY), MAILA, MAILB, AXFR, and IXFR.

Allocated RRTYPEs have mnemonics that must be completely disjoint from the mnemonics used for CLASSes and that must match the regular expression below. In addition, the generic CLASS and RRTYPE names specified in Section 5 of [RFC3597] cannot be assigned as new RRTYPE mnemonics.

```
[A-Z][A-Z0-9\-]*[A-Z0-9]
         but not
   (TYPE|CLASS)[0-9]*
```

Considerations for the allocation of new RRTYPEs are as follows:

Decimal Hexadecimal	Assignment Policy
0 0x0000	RRTYPE zero is used as a special indicator for the SIG(0) RR [RFC2931] [RFC4034] and in other circumstances and must never be allocated for ordinary use.
1 - 127 0x0001 - 0x007F	Remaining RRTYPEs in this range are assigned for data TYPEs by the DNS RRTYPE Allocation Policy as specified in Section 3.1.1.
128 - 255 0x0080 - 0x00FF	Remaining RRTYPEs in this range are assigned for Q and Meta-TYPEs by the DNS RRTYPE Allocation Policy as specified in Section 3.1.1.
256 - 61,439 0x0100 - 0xEFFF	Remaining RRTYPEs in this range are assigned for data RRTYPEs by the DNS RRTYPE Allocation Policy as specified in Section 3.1.1. (32,768 and 32,769 (0x8000 and 0x8001) have been assigned.)
61,440 - 65,279 0xF000 - 0xFEFF	Reserved for future use. IETF Review required to define use.
65,280 - 65,534 0xFF00 - 0xFFFE	Reserved for Private Use.
65,535 0xFFFF	Reserved (Standards Action)

3.1.1. DNS RRTYPE Allocation Policy

Parameter values specified in Section 3.1 above, as assigned based on DNS RRTYPE Allocation Policy, are allocated by Expert Review if they meet the two requirements listed below. There will be a pool of a small number of Experts appointed by the IESG. Each application will be judged by an Expert selected by IANA. In any case where the selected Expert is unavailable or states they have a conflict of interest, IANA may select another Expert from the pool. Some guidelines for the Experts are given in Section 3.1.2.

RRTYPEs that do not meet the requirements below may nonetheless be allocated by a Standards Action with early allocation permitted as specified in [RFC4020].

1. A complete template as specified in Appendix A has been posted to the dns-rrtype-applications@ietf.org mailing list and received by the Expert.

   Note that the posting of partially completed, draft, or formally submitted templates to dnsext@ietf.org by the applicant or Expert for comment and discussion is highly encouraged. Before formal submission of an RRTYPE template, we recommend submitting it for community review and considering the responses in order to reduce the probability of initial rejection and the need for modification and resubmission.

2. The RR for which an RRTYPE code is being requested is either (a) a data TYPE that can be handled as an Unknown RR as described in [RFC3597] or (b) a Meta-TYPE whose processing is optional, i.e., it is safe to simply discard RRs with that Meta-TYPE in queries or responses.

   Note that such RRs may include additional section processing, provided such processing is optional.

After the applicant submits their formal application to IANA by sending the completed template specified in Appendix A to the dns-rrtype-applications@ietf.org mailing list, IANA appoints an Expert and sends the completed template to the Expert, copying the applicant. No more than two weeks after receiving the application, the Expert shall explicitly approve or reject the application, informing IANA, the applicant, and the dnsext@ietf.org mailing list. A rejection should include the reason for rejection and may include suggestions for improvement. The Expert should consult with other technical experts and the dnsext@ietf.org mailing list as necessary. If the Expert does not approve the application within this period, it is considered rejected. IANA should report non-responsive Experts to the IESG.

IANA shall maintain a public archive of approved templates. In addition, if the required description of the RRTYPE applied for is referenced by URL, a copy of the document so referenced should be included in the archive.

3.1.2. DNS RRTYPE Expert Guidelines

The Designated Expert should normally be lenient, preferring to approve most requests. However, the Expert should usually reject any RRTYPE allocation request that meets one or more of the following criteria:

1. The request was documented in a manner that was not sufficiently clear or complete to evaluate or implement. (Additional documentation can be provided during the Expert Review period.)

2. The proposed RRTYPE or RRTYPEs affect DNS processing and do not meet the criteria in point 2 of Section 3.1.1 above.

3. Application use as documented makes incorrect assumptions about DNS protocol behavior, such as wildcards, CNAME, DNAME, etc.

4. An excessive number of RRTYPE values is being requested when the purpose could be met with a smaller number of values or with Private Use values.

3.1.3. Special Note on the OPT RR

The OPT (OPTion) RR (RRTYPE 41) and its IANA considerations are specified in [RFC6891]. Its primary purpose is to extend the effective field size of various DNS fields, including RCODE, label type, OpCode, flag bits, and RDATA size. In particular, for resolvers and servers that recognize it, it extends the RCODE field from 4 to 12 bits.

3.1.4. The AFSDB RR Subtype Field

The AFSDB RR [RFC1183] is a CLASS-insensitive RR that has the same RDATA field structure as the MX RR [RFC1035], but the 16-bit unsigned integer field at the beginning of the RDATA is interpreted as a subtype as shown below. Use of the AFSDB RR to locate AFS cell database servers was deprecated by [RFC5864]. This subtype registry is hereby closed, and allocation of new subtypes is no longer permitted.

Decimal Hexadecimal	Assignment Policy
0 0x0000	Reserved; registry closed
1 0x0001	AFS v3.0 Location Service [RFC1183]
2 0x0002	DCE/NCA root cell directory node [RFC1183]
3 - 65,279 0x0003 - 0xFEFF	Not allocated; registry closed
65,280 - 65,534 0xFF00 - 0xFFFE	Private Use
65,535 0xFFFF	Reserved; registry closed

3.2. RR CLASS IANA Considerations

There are currently two subcategories of DNS CLASSes: normal, data-containing classes; and QCLASSes that are only meaningful in queries or updates.

DNS CLASSes have been little used but constitute another dimension of the DNS distributed database. In particular, there is no necessary relationship between the namespace or root servers for one data CLASS and those for another data CLASS. The same DNS NAME can have completely different meanings in different CLASSes. The label types are the same, and the null label is usable only as root in every CLASS. As global networking and DNS have evolved, the IN, or Internet, CLASS has dominated DNS use.

As yet, there has not been a requirement for "Meta-CLASSes". That would be a CLASS to designate transient data associated with a particular DNS message, which might be usable in queries. However, it is possible that there might be a future requirement for one or more "Meta-CLASSes".

Assigned CLASSes have mnemonics that must be completely disjoint from the mnemonics used for RRTYPEs and that must match the regular expression below. In addition, the generic CLASS and RRTYPE names specified in Section 5 of [RFC3597] cannot be assigned as new CLASS mnemonics.

[A-Z][A-Z0-9\-]*[A-Z0-9]
but not
(CLASS|TYPE)[0-9]*

The current CLASS assignments and considerations for future assignments are as follows:

Decimal Hexadecimal	Assignment / Policy, Reference
0 0x0000	Reserved; assignment requires a Standards Action.
1 0x0001	Internet (IN) [RFC1035]
2 0x0002	Available for assignment by IETF Review as a data CLASS.
3 0x0003	Chaos (CH) [Moon1981]
4 0x0004	Hesiod (HS) [Dyer1987]
5 - 127 0x0005 - 0x007F	Available for assignment by IETF Review for data CLASSes only.
128 - 253 0x0080 - 0x00FD	Available for assignment by IETF Review for QCLASSes and Meta-CLASSes only.
254 0x00FE	QCLASS NONE [RFC2136]
255 0x00FF	QCLASS * (ANY) [RFC1035]
256 - 32,767 0x0100 - 0x7FFF	Available for assignment by IETF Review.
32,768 - 57,343 0x8000 - 0xDFFF	Available for assignment to data CLASSes only; Specification Required.

57,344 - 65,279 0xE000 - 0xFEFF	Available for assignment to QCLASSes and Meta-CLASSes only; Specification Required.
65,280 - 65,534 0xFF00 - 0xFFFE	Private Use
65,535 0xFFFF	Reserved; can only be assigned by a Standards Action.

3.3. Label Considerations

DNS NAMEs are sequences of labels [RFC1035].

3.3.1. Label Types

At the present time, there are two categories of label types: data labels and compression labels. Compression labels are pointers to data labels elsewhere within an RR or DNS message and are intended to shorten the wire encoding of NAMEs.

The two existing data label types are sometimes referred to as Text and Binary. Text labels can, in fact, include any octet value including zero-value octets, but many current uses involve only printing ASCII characters [US-ASCII]. For retrieval, Text labels are defined to treat ASCII uppercase and lowercase letter codes as matching [RFC4343]. Binary labels are bit sequences [RFC2673]. The Binary Label type is Historic [RFC6891].

3.3.2. Label Contents and Use

The last label in each NAME is "ROOT", which is the zero-length label. By definition, the null or ROOT label cannot be used for any other NAME purpose.

NAMEs are local to a CLASS. The Hesiod [Dyer1987] and Chaos [Moon1981] CLASSes are for essentially local use. The IN, or Internet, CLASS is thus the only DNS CLASS in global use on the Internet at this time.

A somewhat out-of-date description of name allocation in the IN CLASS is given in [RFC1591]. Some information on reserved top-level domain names is in BCP 32 [RFC2606].

4. Security Considerations

This document addresses IANA considerations in the allocation of general DNS parameters, not security. See [RFC4033], [RFC4034], and [RFC4035] for secure DNS considerations.

5. IANA Considerations

This document consists entirely of DNS IANA considerations.

IANA has established a process for accepting Appendix A templates and selecting an Expert from those appointed to review such template form applications. IANA forwards the template to the Expert, copying the applicant. IANA archives and makes available all approved RRTYPE allocation templates and referred documentation (unless it is readily available at a stable URI). It is the duty of the applicant to post the formal application template to the dns-rrtype-applications@ietf.org mailing list, which IANA will monitor. The dnsext@ietf.org mailing list is for community discussion and comment. See Section 3.1 and Appendix A for more details.

Appendix A. RRTYPE Allocation Template

DNS RRTYPE PARAMETER ALLOCATION TEMPLATE

When ready for formal consideration, this template is to be submitted to IANA for processing by emailing the template to dns-rrtype-applications@ietf.org.

A. Submission Date:

B.1 Submission Type: [ ] New RRTYPE [ ] Modification to RRTYPE
B.2 Kind of RR: [ ] Data RR [ ] Meta-RR

C. Contact Information for submitter (will be publicly posted):
Name: Email Address:
International telephone number:
Other contact handles:

D. Motivation for the new RRTYPE application.
Please keep this part at a high level to inform the Expert and reviewers about uses of the RRTYPE. Most reviewers will be DNS experts that may have limited knowledge of your application space.

E. Description of the proposed RR type.
This description can be provided in-line in the template, as an attachment, or with a publicly available URL.

F. What existing RRTYPE or RRTYPEs come closest to filling that need and why are they unsatisfactory?

G. What mnemonic is requested for the new RRTYPE (optional)?

Note: If a mnemonic is not supplied, not allowed, or duplicates an existing RRTYPE or CLASS mnemonic, the Expert will assign a mnemonic.

H. Does the requested RRTYPE make use of any existing IANA registry or require the creation of a new IANA subregistry in DNS Parameters? If so, please indicate which registry is to be used or created. If a new subregistry is needed, specify the allocation policy for it and its initial contents. Also include what the modification procedures will be.

I. Does the proposal require/expect any changes in DNS servers/resolvers that prevent the new type from being processed as an unknown RRTYPE (see [RFC3597])?

J. Comments:

Appendix B. Changes from RFC 6195

Dropped description of changes from RFC 5395 to [RFC6195], since those changes have already happened and we don't need to do them again. Added description of changes from [RFC6195] to this document.

Cut back RRTYPE Expert Review period to two weeks and eliminated the mandatory dnsext@ietf.org comment period. Changed workflow description for RRTYPE review and allocation to correspond more closely to actual practice.

Closed the AFSDB subtype registry and added an informative reference to [RFC5864] where the use of the AFSDB RR to locate AFS cell database servers is deprecated.

Clarified IANA archiving of referenced documentation as well as approved RRTYPE application template.

In the RRTYPE application template, changed the label of question "B" to "B.1" and added "B.2" to ask about the kind of RR.

Added text and an exclusory regular expression to Sections 3.1 and 3.2 to prohibit the use of a slight generalization of the generic CLASS and RRTYPE names specified in [RFC3597] as the mnemonics for new CLASSes and RRTYPEs.

Parenthetically listed "ANY" as well as "ALL" as a meaning for the "*" RRTYPE.

Clarified that there is one DNS error number space for headers, OPT extended headers, TSIG RRs, and TKEY RRs. Noted that this is considered to update [RFC2845] and [RFC2930]. Noted the overloading of error number 9 as well as 16.

Updated references for revised versions.

Incorporated a number of editorial changes and typo fixes.

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[RFC5226] Narten, T. and H. Alvestrand, "Guidelines for Writing an IANA Considerations Section in RFCs", BCP 26, RFC 5226, May 2008.

[RFC6840] Weiler, S., Ed., and D. Blacka, Ed., "Clarifications and Implementation Notes for DNS Security (DNSSEC)", RFC 6840, February 2013.

[RFC6891] Damas, J., Graff, M., and Vixie, P., "Extension Mechanisms for DNS (EDNS(0))", STD 75, RFC 6891, April 2013.

[US-ASCII] American National Standards Institute (formerly United States of America Standards Institute), "USA Code for Information Interchange", ANSI X3.4-1968, 1968.

ANSI X3.4-1968 has been replaced by newer versions with slight modifications, but the 1968 version remains definitive for the Internet.

Informative References

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[Moon1981] Moon, D., "Chaosnet", A.I. Memo 628, Massachusetts Institute of Technology Artificial Intelligence Laboratory, June 1981.

[RFC1183] Everhart, C., Mamakos, L., Ullmann, R., and P. Mockapetris, "New DNS RR Definitions", RFC 1183, October 1990.

[RFC1591] Postel, J., "Domain Name System Structure and Delegation", RFC 1591, March 1994.

[RFC2606] Eastlake 3rd, D. and A. Panitz, "Reserved Top Level DNS Names", BCP 32, RFC 2606, June 1999.

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[RFC2931] Eastlake 3rd, D., "DNS Request and Transaction Signatures (SIG(0)s)", RFC 2931, September 2000.

[RFC4343] Eastlake 3rd, D., "Domain Name System (DNS) Case Insensitivity Clarification", RFC 4343, January 2006.

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