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The Role of Wildcard Domains in the Domain Name System

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Status of this Memo

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Abstract

This is an update to the wildcard definition of RFC 1034. The interaction with wildcards and CNAME is changed, an error condition removed, and the words defining some concepts central to wildcards are changed. The overall goal is not to change wildcards, but to refine the definition of RFC 1034.

1 Introduction

In RFC 1034 [RFC1034], sections 4.3.2 and 4.3.3 describe the synthesis of answers from special resource records called wildcards. The definition

in RFC 1034 is incomplete and has proven to be confusing. This document describes the wildcard synthesis by adding to the discussion and making limited modifications. Modifications are made to close inconsistencies that have led to interoperability issues. This description does not expand the service intended by the original definition.

Staying within the spirit and style of the original documents, this document avoids specifying rules for DNS implementations regarding wildcards. The intention is to only describe what is needed for interoperability, not restrict implementation choices. In addition, consideration has been given to minimize any backwards compatibility with implementations that have complied with RFC 1034's definition.

This document is focused on the concept of wildcards as defined in RFC 1034. Nothing is implied regarding alternative approaches, nor are alternatives discussed.

[Note to the WG - this draft is not complete, it is presented as fodder for the upcoming meeting. Sections 4.2.3, 4.6, 3.7, and 4.8 are particularly incomplete. I wanted to make sure there was something recent in the draft repository before setting out on more travel.

For 4.2.3, refer to the threads for the most recent discussions...
http://ops.ietf.org/lists/namedroppers/namedroppers.2004/msg01601.html
http://ops.ietf.org/lists/namedroppers/namedroppers.2004/msg01603.html

And you might want to check out the minutes from the last IETF meeting as well as http://www.ietf.org/proceedings/03nov/131.htm.]

1.1 Motivation

Many DNS implementations have diverged with respect to wildcards in different ways from the original definition, or at from least what had been intended. Although there is clearly a need to clarify the original documents in light of this alone, the impetus for this document lay in the engineering of the DNS security extensions [RFC TBD]. With an unclear definition of wildcards the design of authenticated denial became entangled.

This document is intended to limit changes, only those based on implementation experience, and to remain as close to the original document as possible. To reinforce this, relevant sections of RFC 1034 are repeated verbatim to help compare the old and new text.

1.2 The Original Definition

The context of the wildcard concept involves the algorithm by which a name server prepares a response (in RFC 1034's section 4.3.2) and the way in which a resource record (set) is identified as being a source of synthetic data (section 4.3.3).

The beginning of the discussion ought to start with the definition of the term "wildcard" as it appears in RFC 1034, section 4.3.3.

```
# In the previous algorithm, special treatment was given to RRs with owner
# names starting with the label "*".  Such RRs are called wildcards.
# Wildcard RRs can be thought of as instructions for synthesizing RRs.
# When the appropriate conditions are met, the name server creates RRs
# with an owner name equal to the query name and contents taken from the
# wildcard RRs.
```

This passage appears after the algorithm in which the term wildcard is first used. In this definition, wildcard refers to resource records. In other usage, wildcard has referred to domain names, and it has been used to describe the operational practice of relying on wildcards to generate answers. It is clear from this that there is a need to define clear and unambiguous terminology in the process of discussing wildcards.

The mention of the use of wildcards in the preparation of a response is contained in step 3c of RFC 1034's section 4.3.2 entitled "Algorithm." Note that "wildcard" does not appear in the algorithm, instead references are made to the "*" label. The portion of the algorithm relating to wildcards is deconstructed in detail in section 3 of this document, this is the beginning of the passage.

```
#       c. If at some label, a match is impossible (i.e., the
#          corresponding label does not exist), look to see if a
#          the "*" label exists.
```

The scope of this document is the RFC 1034 definition of wildcards and the implications of updates to those documents, such as DNSSEC. Alternate schemes for synthesizing answers are not considered. (Note that there is no reference listed. No document is known to describe any alternate schemes, although there has been some mention of them in mailing lists.)

1.3 This Document

This document accomplishes these three items.
- o Defines new terms
- o Makes minor changes to avoid conflicting concepts
- o Describe the actions of certain resource records as wildcards

1.3.1 New Terms

To help in discussing what resource records are wildcards, two terms will be defined - "asterisk label" and "wild card domain name". These are defined in section 2.1.1.

To assist in clarifying the role of wildcards in the name server algorithm in RFC 1034, 4.3.2, "source of synthesis" and "closest encloser" are defined. These definitions are in section 3.3.2. "Label match" is

defined in section 3.2.

The introduction of new terms ought not have an impact on any existing implementations. The new terms are used only to make discussions of wildcards clearer.

1.3.2 Changed Text

The definition of "existence" is changed, superficially. This change will not be apparent to implementations; it is needed to make descriptions more precise. The change appears in section 2.2.3.

RFC 1034, section 4.3.3., seems to prohibit having two asterisk labels in a wildcard owner name. With this document the restriction is removed entirely. This change and its implications are in section 2.1.3.

The actions when a source of synthesis owns a CNAME RR are changed to mirror the actions if an exact match name owns a CNAME RR. This is an addition to the words in RFC 1034, section 4.3.2, step 3, part c. The discussion of this is in section 3.3.3.

Only the latter change represents an impact to implementations. The definition of existence is not a protocol impact. The change to the restriction on names is unlikely to have an impact, as there was no discussion of how to enforce the restriction.

1.3.3 Considerations with Special Types

This document describes semantics of wildcard CNAME RRSets [RFC2181], wildcard NS RRSets, wildcard SOA RRSets, wildcard DNAME RRSets [RFC2672], wildcard DS RRSets [RFC TBD], and empty non-terminal wildcards. Understanding these types in the context of wildcards has been clouded because these types incur special processing if they are the result of an exact match. This discussion is in section 4.

These discussions do not have an implementation impact, they cover existing knowledge of the types, but to a greater level of detail.

1.4 Standards Terminology

This document does not use terms as defined in "Key words for use in RFCs to Indicate Requirement Levels." [RFC2119]

Quotations of RFC 1034 are denoted by a '#' in the leftmost column.

2 Wildcard Syntax

The syntax of a wildcard is the same as any other DNS resource record, across all classes and types. The only significant feature is the owner name.

Because wildcards are encoded as resource records with special names, they are included in zone transfers and incremental zone transfers. [RFC1995]. This feature has been underappreciated until discussions on alternative approaches to wildcards appeared on mailing lists.

2.1 Identifying a wildcard

To provide a more accurate description of "wildcards", the definition has to start with a discussion of the domain names that appear as owners. Two new terms are needed, "Asterisk Label" and "Wild Card Domain Name."

2.1.1 Wild Card Domain Name and Asterisk Label

A "wild card domain name" is defined by having its initial (i.e., left-most or least significant) label be, in binary format:

0000 0001 0010 1010 (binary) = 0x01 0x2a (hexadecimal)

The first octet is the normal label type and length for a 1 octet long label, the second octet is the ASCII representation [RFC20] for the '*' character.

A descriptive name of a label equaling that value is an "asterisk label."

RFC 1034's definition of wildcard would be "a resource record owned by a wild card domain name."

2.1.2 Asterisks and Other Characters

No label values other than that in section 2.1.1 are asterisk labels, hence names beginning with other labels are never wild card domain names. Labels such as 'the*' and '**' are not asterisk labels, they do not start wild card domain names.

2.1.3 Non-terminal Wild Card Domain Names

In section 4.3.3, the following is stated:

```
#    .........................  The owner name of the wildcard RRs is of
#    the form "*.<anydomain>", where <anydomain> is any domain name.
#    <anydomain> should not contain other * labels.....................
```

This restriction is lifted because the original documentation of it is incomplete and the restriction does not serve any purpose given years of operational experience.

Indirectly, the above passage raises questions about wild card domain names having subdomains and possibly being an empty non-terminal. By

thinking of domain names such as "*.example.*.example." and "*.*.example." and focusing on the right-most asterisk label in each, the issues become apparent.

Although those example names have been restricted per RFC 1034, a name such as "example.*.example." illustrates the same problems. The sticky issue of subdomains and empty non-terminals is not removed by the restriction. With that conclusion, the restriction appears to be meaningless, worse yet, it implies that an implementation would have to perform checks that do little more than waste CPU cycles.

A wild card domain name can have subdomains. There is no need to inspect the subdomains to see if there is another asterisk label in any subdomain.

A wild card domain name can be an empty non-terminal. (See the upcoming sections on empty non-terminals.) In this case, any lookup encountering it will terminate as would any empty non-terminal match.

2.2 Existence Rules

The notion that a domain name 'exists' is mentioned in the definition of wildcards. In section 4.3.3 of RFC 1034:

```
# Wildcard RRs do not apply:
#
...
#    - When the query name or a name between the wildcard domain and
#      the query name is know[n] to exist.  For example, if a wildcard
```

RFC 1034 also refers to non-existence in the process of generating a response that results in a return code of "name error." NXDOMAIN is introduced in RFC 2308, section 2.1 says "In this case the domain ... does not exist." The overloading of the term "existence" is confusing.

For the purposes of this document, a domain name is said to exist if it plays a role in the execution of the algorithms in RFC 1034. This document avoids discussion determining when an authoritative name error has occurred.

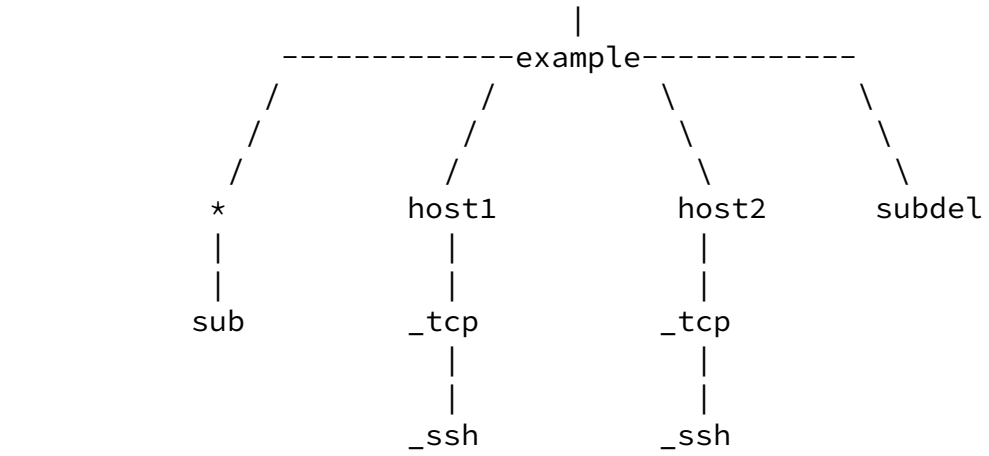
2.2.1 An Example

To illustrate what is meant by existence consider this complete zone:

```
$ORIGIN example.
example.                 3600 IN  SOA   <SOA RDATA>
example.                 3600     NS    ns.example.com.
example.                 3600     NS    ns.example.net.
*.example.               3600     TXT   "this is a wild card"
*.example.               3600     MX    10 host1.example.
```

```
sub.*.example.            3600     TXT   "this is not a wild card"
host1.example.            3600     A     192.0.4.1
_ssh._tcp.host1.example.  3600     SRV  <SRV RDATA>
_ssh._tcp.host2.example.  3600     SRV  <SRV RDATA>
subdel.example.           3600     NS   ns.example.com.
subdel.example.           3600     NS   ns.example.net.
```

A look at the domain names in a tree structure is helpful:



The following queries would be synthesized from one of the wildcards:

QNAME=host3.example. QTYPE=MX, QCLASS=IN
the answer will be a "host3.example. IN MX ..."

QNAME=host3.example. QTYPE=A, QCLASS=IN
the answer will reflect "no error, but no data"
because there is no A RR set at '*.example.'

QNAME=foo.bar.example. QTYPE=TXT, QCLASS=IN
the answer will be "foo.bar.example. IN TXT ..."
because bar.example. does not exist, but the wildcard does.

The following queries would not be synthesized from any of the wildcards:

QNAME=host1.example., QTYPE=MX, QCLASS=IN
because host1.example. exists

QNAME=ghost.*.example., QTYPE=MX, QCLASS=IN
because *.example. exists

QNAME=sub.*.example., QTYPE=MX, QCLASS=IN
because sub.*.example. exists

QNAME=_telnet._tcp.host1.example., QTYPE=SRV, QCLASS=IN
because _tcp.host1.example. exists (without data)

QNAME=host.subdel.example., QTYPE=A, QCLASS=IN
because subdel.example. exists (and is a zone cut)

2.2.2 Empty Non-terminals

Empty non-terminals [RFC2136, Section 7.16] are domain names that own no resource records but have subdomains that do. In section 2.2.1, "_tcp.host1.example." is an example of a empty non-terminal name. Empty non-terminals are introduced by this text in section 3.1 of RFC 1034:

```
#    The domain name space is a tree structure.  Each node and leaf on the
#    tree corresponds to a resource set (which may be empty).  The domain
#    system makes no distinctions between the uses of the interior nodes and
#    leaves, and this memo uses the term "node" to refer to both.
```

The parenthesized "which may be empty" specifies that empty non-terminals are explicitly recognized, and that empty non-terminals "exist."

Pedantically reading the above paragraph can lead to an interpretation that all possible domains exist - up to the suggested limit of 255 octets for a domain name [RFC1035]. For example, www.example. may have an A RR, and as far as is practically concerned, is a leaf of the domain tree. But the definition can be taken to mean that sub.www.example. also exists, albeit with no data. By extension, all possible domains exist, from the root on down. As RFC 1034 also defines "an authoritative name error indicating that the name does not exist" in section 4.3.1, this is not the intent of the original document.

2.2.3 Yet Another Definition of Existence

RFC1034's wording is fixed by the following paragraph:

The domain name space is a tree structure. Nodes in the tree either own at least one RRSet and/or have descendants that collectively own at least on RRSet. A node may have no RRSets if it has descendents that do, this node is a empty non-terminal. A node may have its own RRSets and have descendants with RRSets too.

A node with no descendants is a leaf node. Empty leaf nodes do not exist.

Note that at a zone boundary, the domain name owns data, including the NS RR set. At the delegating server, the NS RR set is not authoritative, but that is of no consequence here. The domain name owns data, therefore, it exists.

2.3 When does a Wild Card Domain Name is not Special

When a wild card domain name appears in a message's query section, no special processing occurs. An asterisk label in a query name

only (label) matches an asterisk label in the existing zone tree when the 4.3.2 algorithm is being followed.

When a wild card domain name appears in the resource data of a record, no special processing occurs. An asterisk label in that context literally means just an asterisk.

3. Impact of a Wild Card Domain Name On a Response

The description of how wildcards impact response generation is in RFC 1034, section 4.3.2. That passage contains the algorithm followed by a server in constructing a response. Within that algorithm, step 3, part 'c' defines the behavior of the wild card.

The algorithm in RFC 1034, section 4.3.2. is not intended to be pseudo code, i.e., its steps are not intended to be followed in strict order. The "algorithm" is a suggestion. As such, in step 3, parts a, b, and c, do not have to be implemented in that order.

3.1 Step 2

Step 2 of the RFC 1034's section 4.3.2 reads:

```
#    2. Search the available zones for the zone which is the nearest
#       ancestor to QNAME.  If such a zone is found, go to step 3,
#       otherwise step 4.
```

In this step, the most appropriate zone for the response is chosen. The significance of this step is that it means all of step 3 is being performed within one zone. This has significance when considering whether or not an SOA RR can be ever be used for synthesis.

3.2 Step 3

Step 3 is dominated by three parts, labelled 'a', 'b', and 'c'. But the beginning of the step is important and needs explanation.

```
#    3. Start matching down, label by label, in the zone.  The
#       matching process can terminate several ways:
```

The word 'matching' refers to label matching. The concept is based in the view of the zone as the tree of existing names. The query name is considered to be an ordered sequence of labels - as if the name were a path from the root to the owner of the desired data. (Which it is - 3rd paragraph of RFC 1034, section 3.1.)

The process of label matching a query name ends in exactly one of three choices, the parts 'a', 'b', and 'c'. Either the name is found, the name is below a cut point, or the name is not found.

Once one of the parts is chosen, the other parts are not considered.

(E.g., do not execute part 'c' and then change the execution path to finish in part 'b'.) The process of label matching is also done independent of the query type (QTYPE).

Parts 'a' and 'b' are not an issue for this clarification as they do not relate to record synthesis. Part 'a' is an exact match that results in an answer, part 'b' is a referral. It is possible, from the description given, that a query might fit into both part a and part b, this is not within the scope of this document.

3.3 Part 'c'

The context of part 'c' is that the process of label matching the labels of the query name has resulted in a situation in which there is no corresponding label in the tree. It is as if the lookup has "fallen off the tree."

```
#         c. If at some label, a match is impossible (i.e., the
#            corresponding label does not exist), look to see if a
#            the "*" label exists.
```

To help describe the process of looking 'to see if a [sic] the "*" label exists' a term has been coined to describe the last label matched. The term is "closest encloser."

3.3.1 Closest Encloser and the Source of Synthesis

The closest encloser is the node in the zone's tree of existing domain names that has the most labels matching the query name (consecutively, counting from the root label downward). Each match is a "label match" and the order of the labels is the same.

The closest encloser is, by definition, an existing name in the zone. The closest encloser might be an empty non-terminal or even be a wild card domain name itself. In no circumstances is the closest encloser the used to synthesize records for the current query.

The source of synthesis is defined in the context of a query process as that wild card domain name immediately descending from the closest encloser, provided that this wild card domain name exists. "Immediately descending" means that the source of synthesis has a name of the form <asterisk label>.<closest encloser>. A source of synthesis does not guarantee having a RRSet to use for synthesis. The source of synthesis could be an empty non-terminal.

If the source of synthesis does not exist (not on the domain tree), there will be no wildcard synthesis. There is no search for an alternate.

The important concept is that for any given lookup process, there is at most one place at which wildcard synthetic records can be

obtained. If the source of synthesis does not exist, the lookup terminates, the lookup does not look for other wildcard records.

3.3.2 Closest Encloser and Source of Synthesis Examples

To illustrate, using the example zone in section 2.2.1 of this document, the following chart shows QNAMEs and the closest enclosers.

QNAME	Closest Encloser	Source of Synthesis
host3.example.	example.	*.example.
_telnet._tcp.host1.example.	_tcp.host1.example.	no source
_telnet._tcp.host2.example.	host2.example.	no source
_telnet._tcp.host3.example.	example.	*.example.
_chat._udp.host3.example.	example.	*.example.
foobar.*.example.	*.example.	no source

3.3.3 Type Matching

RFC 1034 concludes part 'c' with this:

```
#           If the "*" label does not exist, check whether the name
#           we are looking for is the original QNAME in the query
#           or a name we have followed due to a CNAME.  If the name
#           is original, set an authoritative name error in the
#           response and exit.  Otherwise just exit.
#
#           If the "*" label does exist, match RRs at that node
#           against QTYPE.  If any match, copy them into the answer
#           section, but set the owner of the RR to be QNAME, and
#           not the node with the "*" label.  Go to step 6.
```

The final paragraph covers the role of the QTYPE in the lookup process.

Based on implementation feedback and similarities between step 'a' and step 'c' a change to this passage a change has been made.

The change is to add the following text to step 'c':

> If the data at the source of synthesis is a CNAME, and QTYPE doesn't match CNAME, copy the CNAME RR into the answer section of the response changing the owner name to the QNAME, change QNAME to the canonical name in the CNAME RR, and go back to step 1.

This is essentially the same text in step a covering the processing of CNAME RRSets.

4. Considerations with Special Types

Sections 2 and 3 of this document discuss wildcard synthesis with respect to names in the domain tree and ignore the impact of types.

In this section, the implication of wildcards of specific types are discussed. The types covered are those that have proven to be the most difficult to understand. The types are SOA, NS, CNAME, DNAME, SRV, DS, NSEC, RRSIG and "none," i.e., empty non-terminal wild card domain names.

4.1 SOA RRSet at a Wild Card Domain Name

A wild card domain name owning an SOA RRSet means that the domain is at the root of the zone (apex). The domain can not be a source of synthesis because that is, by definition, a descendent node (of the closest encloser) and a zone apex is at the top of the zone.

Although a wild card domain name owning an SOA RRSet can never be a source of synthesis, there is no reason to forbid the ownership of an SOA RRSet.

E.g., given this zone:

```
       $ORIGIN *.example.
       @                3600 IN  SOA   <SOA RDATA>
                        3600     NS    ns1.example.com.
                        3600     NS    ns1.example.net.
       www              3600     TXT   "the www txt record"
```

A query for www.*.example.'s TXT record would still find the "the www txt record" answer. The reason is that the asterisk label only becomes significant when RFC 1034's 4.3.2, step 3 part 'c' in in effect.

Of course, there would need to be a delegation in the parent zone, "example." for this to work too. This is covered in the next section.

4.2 NS RRSet at a Wild Card Domain Name

The semantics of a wild card domain name's ownership of a NS RRSet has been unclear. There are three considerations to cover. One is is that if the query processing lands in part 'a' or part 'b' of RFC 1034's 4.3.2, step 3, the incidence of the wild card domain name owning an NS RRset has no special meaning. Second, synthesized records never appear in the authority section of a response, meaning that referrals are never synthesized. And finally, DNSSEC validators will have to be aware of a quirk in ownership rules.

4.2.1 NS, *, and answers

If the NS RRSet in question is at the top of the zone, i.e., the name also owns an SOA RRSet, the QNAME equals the zone name. This would trigger part 'a' of step 3.

4.2.2 NS, *, and referrals

If the NS RRset is not at the top of the zone and part 'b' is triggered,

this implies that the labels being matched are an asterisk label in the QNAME and the asterisk label owning the NS RRset. In either case, what is copied to the response will have the asterisk label in it - no synthesis, no name substitution.

E.g., consider the parent zone for the example in section 4.1.

```
$ORIGIN example.
@                3600 IN  SOA   <SOA RDATA>
                 3600     NS    ns0.example.com.
                 3600     NS    ns0.example.net.
*                3600     NS    ns1.example.com.
                 3600     NS    ns1.example.net.
```

If the query for www.*.example.'s TXT set arrived here, the response would be a referral as in part 'b'.

```
Response, non-authoritative, no error rcode
ANSWER: (empty)
AUTHORITY:
*                3600     NS    ns1.example.com.
                 3600     NS    ns1.example.net.
ADDITIIONAL: (empty, or with OPT RR)
```

The same response message would be sent to a query for *.example.'s NS set. Note that the NS records in the response are not expanded, simply copied verbatim. (Compare this the case where "*" is "star".)

There is no synthesis of records in the authority section because part 'b' does not specify synthesis. The referral returned would have the wild card domain name in the authority section unchanged.

4.2.3 NS, *, and synthesis

If the QNAME is not the same as the wild card domain name nor a subdomain of it, then part 'c' of step 3 has been triggered. Assuming that "a match is impossible" a source of synthesis is sought. If the source of synthesis owns an NS RRset and the QTYPE is NS, then a NS RRset is synthesized and put into the answer section and marked as an authoritative answer. If the QTYPE is not NS, then the NS RRset is ignored, as it would have been if it were an A RR and the QTYPE was AAAA. An NS RRSet at a wild card domain name will not result in the generation of referral messages for non-existent domains because part 'c' does not write anything into the authority section.

(If we choose this, then we have to have a section 4.2.4 on DNSSEC implications.)

OR

If the QNAME is not the same as the wild card domain name nor a subdomain of it, then part 'c' of step 3 has been triggered. Assuming

that "a match is impossible" a source of synthesis is sought. If the source of synthesis owns an NS RRset and the QTYPE is NS, then no synthesis happens. A NS RRset is never synthesized. The proper response is, what, no error/no data? Name error?

OR

If the QNAME is not the same as the wild card domain name nor a subdomain of it, then part 'c' of step 3 has been triggered. Assuming that "a match is impossible" a source of synthesis is sought. If the source of synthesis owns an NS RRset then no synthesis happens. A cut point is never a source of synthesis. The proper response is, what, no error/no data? Name error?

4.3 CNAME RRSet at a Wild Card Domain Name

The issue of a CNAME RRSet owned by wild card domain names has prompted a suggested change to the last paragraph of step 3c of the algorithm in 4.3.2. The changed text appears in section 3.3.3 of this document.

4.4 DNAME RRSet at a Wild Card Domain Name

A DNAME RRset at a wild card domain name is effectively the same as a CNAME at a wild card domain name.

4.5 SRV RRSet at a Wild Card Domain Name

The definition of the SRV RRset is RFC 2782 [RFC2782]. In the definition of the record, there is some confusion over the term "Name." The definition reads as follows:

```
# The format of the SRV RR
...
#       _Service._Proto.Name TTL Class SRV Priority Weight Port Target
...
#   Name
#       The domain this RR refers to.  The SRV RR is unique in that the
#       name one searches for is not this name; the example near the end
#       shows this clearly.
```

Do not confuse the definition "Name" with a domain name. I.e., once removing the _Service and _Proto labels from the owner name of the SRV RRSet, what remains could be a wild card domain name but this is immaterial to the SRV RRSet.

E.g., If an SRV record is:

```
_foo._udp.*.example. 10800 IN SRV 0 1 9 old-slow-box.example.
```

.example is a wild card domain name and although it it the Name of the SRV RR, it is not the owner (domain name). The owner domain name is "_foo._udp..example." which is not a wild card domain name.

The confusion is likely based on the mixture of the specification of the SRV RR and the description of a "use case."

4.6 DS RRSet at a Wild Card Domain Name

...probably harmless...

4.7 NSEC RRSet at a Wild Card Domain Name

...will be present, don't know if it should be synthesized...

4.8 RRSIG at a Wild Card Domain Name

...need to cross check with DNSSECbis to see what is said about querying for RRSIG...

4.9 Empty Non-terminal Wild Card Domain Name

If a source of synthesis is an empty non-terminal, then the response will be one of no error in the return code and no RRSet in the answer section.

5. Security Considerations

This document is refining the specifications to make it more likely that security can be added to DNS. No functional additions are being made, just refining what is considered proper to allow the DNS, security of the DNS, and extending the DNS to be more predictable.

6. References

Normative References

[RFC20] ASCII Format for Network Interchange, V.G. Cerf, Oct-16-1969

[RFC1034] Domain Names - Concepts and Facilities, P.V. Mockapetris, Nov-01-1987

[RFC1035] Domain Names - Implementation and Specification, P.V Mockapetris, Nov-01-1987

[RFC1995] IXFR ... Ohta

[RFC2119] Key Words for Use in RFCs to Indicate Requirement Levels, S Bradner, March 1997

[RFC2181] Clarifications to the DNS Specification, R. Elz and R. Bush, July 1997.

[RFC2782] A DNS RR for specifying the location of services (DNS SRV),

A. Gulbrandsen, et.al., February 2000.

Informative References

[RFC2136] Dynamic Updates in the Domain Name System (DNS UPDATE), P. Vixie, Ed., S. Thomson, Y. Rekhter, J. Bound, April 1997

[RFC2535] Domain Name System Security Extensions, D. Eastlake, March 1999

[RFC2672] Non-Terminal DNS Name Redirection, M. Crawford, August 1999

7. Others Contributing to This Document

Others who have been editors of this document: Bob Halley.
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9. Trailing Boilerplate

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Expiration

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