Network Working Group
Request for Comments: 3845
Updates: 3755, 2535
Category: Standards Track

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August 2004

DNS Security (DNSSEC) NextSECure (NSEC) RDATA Format

Status of this Memo

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Abstract

This document redefines the wire format of the "Type Bit Map" field in the DNS NextSECure (NSEC) resource record RDATA format to cover the full resource record (RR) type space.

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1. Introduction

The DNS [6][7] NSEC [5] Resource Record (RR) is used for authenticated proof of the non-existence of DNS owner names and types. The NSEC RR is based on the NXT RR as described in RFC 2535 [2], and is similar except for the name and typecode. The RDATA format for the NXT RR has the limitation in that the RDATA could only carry information about the existence of the first 127 types. RFC 2535 did reserve a bit to specify an extension mechanism, but the mechanism was never actually defined.

In order to avoid needing to develop an extension mechanism into a deployed base of DNSSEC aware servers and resolvers once the first 127 type codes are allocated, this document redefines the wire format of the "Type Bit Map" field in the NSEC RDATA to cover the full RR type space.

This document introduces a new format for the type bit map. The properties of the type bit map format are that it can cover the full possible range of typecodes, that it is relatively economical in the amount of space it uses for the common case of a few types with an owner name, that it can represent owner names with all possible types present in packets of approximately 8.5 kilobytes, and that the representation is simple to implement. Efficient searching of the type bitmap for the presence of certain types is not a requirement.

For convenience and completeness, this document presents the syntax and semantics for the NSEC RR based on the specification in RFC 2535 [2] and as updated by RFC 3755 [5], thereby not introducing changes except for the syntax of the type bit map.

This document updates RFC 2535 [2] and RFC 3755 [5].

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in BCP 14, RFC 2119 [1].

2. The NSEC Resource Record

The NSEC resource record lists two separate things: the owner name of the next RRset in the canonical ordering of the zone, and the set of RR types present at the NSEC RR’s owner name. The complete set of NSEC RRs in a zone indicate which RRsets exist in a zone, and form a chain of owner names in the zone. This information is used to provide authenticated denial of existence for DNS data, as described in RFC 2535 [2].

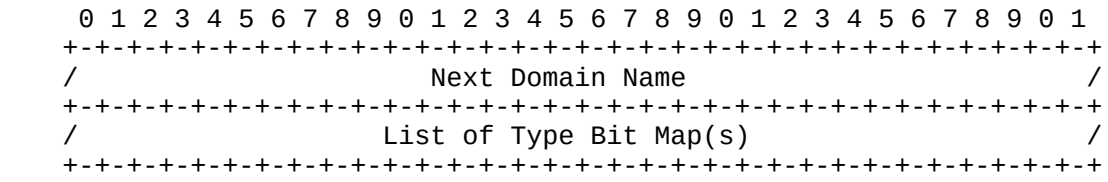
The type value for the NSEC RR is 47.

The NSEC RR RDATA format is class independent and defined for all classes.

The NSEC RR SHOULD have the same TTL value as the SOA minimum TTL field. This is in the spirit of negative caching [8].

2.1. NSEC RDATA Wire Format

The RDATA of the NSEC RR is as shown below:



2.1.1. The Next Domain Name Field

The Next Domain Name field contains the owner name of the next RR in the canonical ordering of the zone. The value of the Next Domain Name field in the last NSEC record in the zone is the name of the zone apex (the owner name of the zone's SOA RR).

A sender MUST NOT use DNS name compression on the Next Domain Name field when transmitting an NSEC RR.

Owner names of RRsets that are not authoritative for the given zone (such as glue records) MUST NOT be listed in the Next Domain Name unless at least one authoritative RRset exists at the same owner name.

2.1.2. The List of Type Bit Map(s) Field

The RR type space is split into 256 window blocks, each representing the low-order 8 bits of the 16-bit RR type space. Each block that has at least one active RR type is encoded using a single octet window number (from 0 to 255), a single octet bitmap length (from 1 to 32) indicating the number of octets used for the window block's bitmap, and up to 32 octets (256 bits) of bitmap.

Window blocks are present in the NSEC RR RDATA in increasing numerical order.

"|" denotes concatenation

Type Bit Map(s) Field = (Window Block # | Bitmap Length | Bitmap) +

Each bitmap encodes the low-order 8 bits of RR types within the window block, in network bit order. The first bit is bit 0. For window block 0, bit 1 corresponds to RR type 1 (A), bit 2 corresponds to RR type 2 (NS), and so forth. For window block 1, bit 1 corresponds to RR type 257, and bit 2 to RR type 258. If a bit is set to 1, it indicates that an RRset of that type is present for the NSEC RR's owner name. If a bit is set to 0, it indicates that no RRset of that type is present for the NSEC RR's owner name.

Since bit 0 in window block 0 refers to the non-existing RR type 0, it MUST be set to 0. After verification, the validator MUST ignore the value of bit 0 in window block 0.

Bits representing Meta-TYPEs or QTYPEs, as specified in RFC 2929 [3] (section 3.1), or within the range reserved for assignment only to QTYPEs and Meta-TYPEs MUST be set to 0, since they do not appear in zone data. If encountered, they must be ignored upon reading.

Blocks with no types present MUST NOT be included. Trailing zero octets in the bitmap MUST be omitted. The length of each block's bitmap is determined by the type code with the largest numerical value within that block, among the set of RR types present at the NSEC RR's owner name. Trailing zero octets not specified MUST be interpreted as zero octets.

2.1.3. Inclusion of Wildcard Names in NSEC RDATA

If a wildcard owner name appears in a zone, the wildcard label ("*") is treated as a literal symbol and is treated the same as any other owner name for purposes of generating NSEC RRs. Wildcard owner names appear in the Next Domain Name field without any wildcard expansion. RFC 2535 [2] describes the impact of wildcards on authenticated denial of existence.

2.2. The NSEC RR Presentation Format

The presentation format of the RDATA portion is as follows:

The Next Domain Name field is represented as a domain name.

The List of Type Bit Map(s) Field is represented as a sequence of RR type mnemonics. When the mnemonic is not known, the TYPE representation as described in RFC 3597 [4] (section 5) MUST be used.

2.3. NSEC RR Example

The following NSEC RR identifies the RRsets associated with alfa.example.com. and the next authoritative name after alfa.example.com.

```
alfa.example.com. 86400 IN NSEC host.example.com. A MX RRSIG NSEC
TYPE1234
```

The first four text fields specify the name, TTL, Class, and RR type (NSEC). The entry host.example.com. is the next authoritative name after alfa.example.com. in canonical order. The A, MX, RRSIG, NSEC, and TYPE1234 mnemonics indicate there are A, MX, RRSIG, NSEC, and TYPE1234 RRsets associated with the name alfa.example.com.

The RDATA section of the NSEC RR above would be encoded as:

```
0x04 'h'  'o'  's'  't'
0x07 'e'  'x'  'a'  'm'  'p'  'l'  'e'
0x03 'c'  'o'  'm'  0x00
0x00 0x06 0x40 0x01 0x00 0x00 0x00 0x03
0x04 0x1b 0x00 0x00 0x00 0x00 0x00 0x00
0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00
0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00
0x00 0x00 0x00 0x00 0x20
```

Assuming that the resolver can authenticate this NSEC record, it could be used to prove that beta.example.com does not exist, or could be used to prove that there is no AAAA record associated with alfa.example.com. Authenticated denial of existence is discussed in RFC 2535 [2].

3. IANA Considerations

This document introduces no new IANA considerations, because all of the protocol parameters used in this document have already been assigned by RFC 3755 [5].

4. Security Considerations

The update of the RDATA format and encoding does not affect the security of the use of NSEC RRs.

5. References

5.1. Normative References

[1] Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", BCP 14, RFC 2119, March 1997.

[2] Eastlake 3rd, D., "Domain Name System Security Extensions", RFC 2535, March 1999.

[3] Eastlake 3rd, D., Brunner-Williams, E., and B. Manning, "Domain Name System (DNS) IANA Considerations", BCP 42, RFC 2929, September 2000.

[4] Gustafsson, A., "Handling of Unknown DNS Resource Record (RR) Types", RFC 3597, September 2003.

[5] Weiler, S., "Legacy Resolver Compatibility for Delegation Signer (DS)", RFC 3755, May 2004.

5.2. Informative References

[6] Mockapetris, P., "Domain names - concepts and facilities", STD 13, RFC 1034, November 1987.

[7] Mockapetris, P., "Domain names - implementation and specification", STD 13, RFC 1035, November 1987.

[8] Andrews, M., "Negative Caching of DNS Queries (DNS NCACHE)", RFC 2308, March 1998.

6. Acknowledgements

The encoding described in this document was initially proposed by Mark Andrews. Other encodings where proposed by David Blacka and Michael Graff.

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8. Full Copyright Statement

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Acknowledgement

Funding for the RFC Editor function is currently provided by the Internet Society.