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Use of SHA-256 in DNSSEC Delegation Signer (DS) Resource Records (RRs)  
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#### Abstract

This document specifies how to use the SHA-256 digest type in DNS Delegation Signer (DS) Resource Records (RRs). DS records, when stored in a parent zone, point to key signing DNSKEY key(s) in a child zone.

Table of Contents

- [1. Introduction . . . . .](#) [3](#)
- [2. Implementing the SHA-256 algorithm for DS record support . . .](#) [3](#)
  - [2.1. DS record field values . . . . .](#) [3](#)
  - [2.2. DS Record with SHA-256 Wire Format . . . . .](#) [3](#)
  - [2.3. Example DS Record Using SHA-256 . . . . .](#) [4](#)
- [3. Implementation Requirements . . . . .](#) [4](#)
- [4. Deployment Considerations . . . . .](#) [4](#)
- [5. IANA Considerations . . . . .](#) [5](#)
- [6. Security Considerations . . . . .](#) [5](#)
  - [6.1. Potential Digest Type Downgrade Attacks . . . . .](#) [5](#)
  - [6.2. SHA-1 vs SHA-256 Considerations for DS Records . . . . .](#) [6](#)
- [7. Acknowledgments . . . . .](#) [6](#)
- [8. References . . . . .](#) [6](#)
  - [8.1. Normative References . . . . .](#) [6](#)
  - [8.2. Informative References . . . . .](#) [7](#)
- [Author's Address . . . . .](#) [8](#)
- [Intellectual Property and Copyright Statements . . . . .](#) [9](#)

## 1. Introduction

The DNSSEC [[RFC4033](#)] [[RFC4034](#)] [[RFC4035](#)] DS RR is published in parent zones to distribute a cryptographic digest of a child's Key Signing Key (KSK) DNSKEY RR. The DS RRset is signed by at least one of the parent zone's private zone data signing keys for each algorithm in use by the parent. Each signature is published in an RRSIG resource record, owned by the same domain as the DS RRset and with a type covered of DS.

## 2. Implementing the SHA-256 algorithm for DS record support

This document specifies that the digest type code [XXX: To be assigned by IANA; likely 2] is to be assigned to SHA-256 [[SHA256](#)] for use within DS records. The results of the digest algorithm MUST NOT be truncated and the entire 32 byte digest result is to be published in the DS record.

### 2.1. DS record field values

Using the SHA-256 digest algorithm within a DS record will make use of the following DS-record fields:

Digest type: [XXX: To be assigned by IANA; likely 2]

Digest: A SHA-256 bit digest value calculated by using the following formula ("|" denotes concatenation). The resulting value is not truncated and the entire 32 byte result is to be used in the resulting DS record and related calculations.

$$\text{digest} = \text{SHA}_{256}(\text{DNSKEY owner name} \mid \text{DNSKEY RDATA})$$

where DNSKEY RDATA is defined by [[RFC4034](#)] as:

$$\text{DNSKEY RDATA} = \text{Flags} \mid \text{Protocol} \mid \text{Algorithm} \mid \text{Public Key}$$

The Key Tag field and Algorithm fields remain unchanged by this document and are specified in the [\[RFC4034\]](#) specification.

## 2.2. DS Record with SHA-256 Wire Format

The resulting on-the-wire format for the resulting DS record will be [XXX: IANA assignment should replace the 2 below]:

```

          1 1 1 1 1 1 1 1 1 1 2 2 2 2 2 2 2 2 2 2 3 3
    0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
    +-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
    |           Key Tag           | Algorithm | DigestType=2 |
    +-----+-----+-----+-----+-----+-----+-----+-----+-----+
    /                               /
    /           Digest (length for SHA-256 is 32 bytes) /
    /                               /
    +-----+-----+-----+-----+-----+-----+-----+-----+-----+
  
```

## 2.3. Example DS Record Using SHA-256

The following is an example DNSKEY and matching DS record. This DNSKEY record comes from the example DNSKEY/DS records found in [section 5.4 of \[RFC4034\]](#).

The DNSKEY record:

```

dskey.example.com. 86400 IN DNSKEY 256 3 5 ( AQ0eiiR0GOMYkDshWoSKz9Xz
fwJr1AYtsmx3TGkJaNXVbfi/
2pHm822aJ5iI9BMzNXxeYcmZ
DRD99WYwYqUSdjMmmAphXdvx
egXd/M5+X70rzKBaMbCVdFLU
Uh6DhweJBjEVv5f2wwjM9Xzc
nOf+EPbtG9DMbMADjFDc2w/r
ljwvFw==
) ; key id = 60485
  
```

The resulting DS record covering the above DNSKEY record using a SHA-

256 digest: [RFC Editor: please replace XXX with the assigned digest type (likely 2):]

```
dskey.example.com. 86400 IN DS 60485 5 XXX ( D4B7D520E7BB5F0F67674A0C
                                             CEB1E3E0614B93C4F9E99B83
                                             83F6A1E4469DA50A )
```

### 3. Implementation Requirements

Implementations MUST support the use of the SHA-256 algorithm in DS RRs. Validator implementations SHOULD ignore DS RRs containing SHA-1 digests if DS RRs with SHA-256 digests are present in the DS RRset.

### 4. Deployment Considerations

If a validator does not support the SHA-256 digest type and no other DS RR exists in a zone's DS RRset with a supported digest type, then

Hardaker

Expires July 17, 2006

[Page 4]

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Internet-Draft

Use of SHA-256 in DNSSEC DS RRs

January 2006

the validator has no supported authentication path leading from the parent to the child. The resolver should treat this case as it would the case of an authenticated NSEC RRset proving that no DS RRset exists, as described in [\[RFC4035\], section 5.2](#).

Because zone administrators can not control the deployment speed of support for SHA-256 in validators that may be referencing any of their zones, zone operators should consider deploying both SHA-1 and SHA-256 based DS records. This should be done for every DNSKEY for which DS records are being generated. Whether to make use of both digest types and for how long is a policy decision that extends beyond the scope of this document.

### 5. IANA Considerations

The Digest Type to be used for supporting SHA-256 within DS records needs to be assigned by IANA. This document requests that the Digest Type value of 2 be assigned to the SHA-256 digest algorithm.

At the time of this writing, the current digest types assigned for use in DS records are as follows:

| VALUE | Digest Type | Status    |
|-------|-------------|-----------|
| 0     | Reserved    | -         |
| 1     | SHA-1       | MANDATORY |
| 2     | SHA-256     | MANDATORY |
| 3-255 | Unassigned  | -         |

## [6.](#) Security Considerations

### [6.1.](#) Potential Digest Type Downgrade Attacks

A downgrade attack from a stronger digest type to a weaker one is possible if all of the following are true:

- o A zone includes multiple DS records for a given child's DNSKEY, each of which use a different digest type.
- o A validator accepts a weaker digest even if a stronger one is present but invalid.

For example, if the following conditions are all true:

- o Both SHA-1 and SHA-256 based digests are published in DS records within a parent zone for a given child zone's DNSKEY.

- o The DS record with the SHA-1 digest matches the digest computed using the child zone's DNSKEY.
- o The DS record with the SHA-256 digest fails to match the digest computed using the child zone's DNSKEY.

Then if the validator accepts the above situation as secure then this can be used as a downgrade attack since the stronger SHA-256 digest is ignored.

### [6.2.](#) SHA-1 vs SHA-256 Considerations for DS Records

Because of the weaknesses recently discovered within the SHA-1 algorithm, users of DNSSEC are encouraged to deploy the use of SHA-256 as soon as the software implementations in use allow for it.

At the time of this publication, the SHA-256 digest algorithm is considered sufficiently strong for the immediate future. It is also considered sufficient for use in DNSSEC DS RRs for the immediate future. However, future published attacks may weaken the usability of this algorithm within the DS RRs. It is beyond the scope of this document to speculate extensively on the cryptographic strength of the SHA-256 digest algorithm.

Likewise, it is also beyond the scope of this document to specify whether or for how long SHA-1 based DS records should be simultaneously published alongside SHA-256 based DS records.

## 7. Acknowledgments

This document is a minor extension to the existing DNSSEC documents and those authors are gratefully appreciated for the hard work that went into the base documents.

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Hardaker

Expires July 17, 2006

[Page 9]