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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 DNSKEYs in a child zone.

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1. Introduction

The DNSSEC [RFC4033] [RFC4034] [RFC4035] DS RR is published in parent zones to distribute a cryptographic digest of one key in a child's DNSKEY RRset. 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, with a type covered of DS.

In this document, the key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" are to be interpreted as described in [RFC2119].

2. Implementing the SHA-256 Algorithm for DS Record Support

This document specifies that the digest type code 2 has been assigned to SHA-256 [SHA256] [SHA256CODE] 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: 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.

```
digest = SHA_256(DNSKEY owner name | DNSKEY RDATA)
```

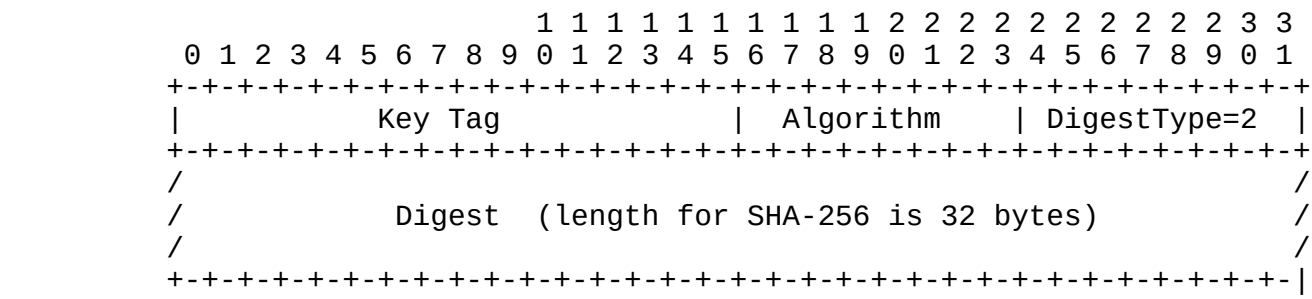
where DNSKEY RDATA is defined by [RFC4034] as:

```
DNSKEY RDATA = Flags | Protocol | Algorithm | 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 as follows:



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 ( AQOeiiR0GOMYkDshWoSKz9Xz
                                             fwJr1AYtsmx3TGkJaNXVbfi/
                                             2pHm822aJ5iI9BMzNXxeYCmZ
                                             DRD99WYwYqUSdjMmmAphXdvx
                                             egXd/M5+X7OrzKBaMbCVdFLU
                                             Uh6DhweJBjEVv5f2wwjM9Xzc
                                             nOf+EPbtG9DMBmADjFDc2w/r
                                             ljwvFw==
                                             ) ;  key id = 60485
```

The resulting DS record covering the above DNSKEY record using a SHA-256 digest:

```
dskey.example.com. 86400 IN DS 60485 5 2   ( 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 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 cannot 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

Only one IANA action is required by this document:

The Digest Type to be used for supporting SHA-256 within DS records has been assigned by IANA.

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:

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

For example, if the following conditions are all true:

- Both SHA-1 and SHA-256 based digests are published in DS records within a parent zone for a given child zone's DNSKEY.
- The DS record with the SHA-1 digest matches the digest computed using the child zone's DNSKEY.
- 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

Users of DNSSEC are encouraged to deploy SHA-256 as soon as software implementations allow for it. SHA-256 is widely believed to be more resilient to attack than SHA-1, and confidence in SHA-1's strength is being eroded by recently announced attacks. Regardless of whether the attacks on SHA-1 will affect DNSSEC, it is believed (at the time of this writing) that SHA-256 is the better choice for use in DS records.

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. Acknowledgements

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8. References

8.1. Normative References

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8.2. Informative References

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