

Network Working Group  
Internet-Draft  
Expires: August 25, 2006

W. Hardaker  
Sparta  
February 21, 2006

Use of SHA-256 in DNSSEC Delegation Signer (DS) Resource Records (RRs)  
draft-ietf-dnsexp-ds-sha256-05.txt

#### Status of this Memo

By submitting this Internet-Draft, each author represents that any applicable patent or other IPR claims of which he or she is aware have been or will be disclosed, and any of which he or she becomes aware will be disclosed, in accordance with [Section 6 of BCP 79](#).

Internet-Drafts are working documents of the Internet Engineering Task Force (IETF), its areas, and its working groups. Note that other groups may also distribute working documents as Internet-Drafts.

Internet-Drafts are draft documents valid for a maximum of six months and may be updated, replaced, or obsoleted by other documents at any time. It is inappropriate to use Internet-Drafts as reference material or to cite them other than as "work in progress."

The list of current Internet-Drafts can be accessed at <http://www.ietf.org/ietf/lid-abstracts.txt>.

The list of Internet-Draft Shadow Directories can be accessed at <http://www.ietf.org/shadow.html>.

This Internet-Draft will expire on August 25, 2006.

#### Copyright Notice

Copyright (C) The Internet Society (2006).

#### 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 . . . . .](#) [7](#)
  - [8.1. Normative References . . . . .](#) [7](#)
  - [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.

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 [[RFC2119](#)].

## 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](#)] [[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: [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.

```
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 [XXX: IANA assignment should replace the 2 below]:

Hardaker Expires August 25, 2006 [Page 3]

---

Internet-Draft Use of SHA-256 in DNSSEC DS RRs February 2006

```

          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 August 25, 2006

[Page 4]

---

Internet-Draft

Use of SHA-256 in DNSSEC DS RRs

February 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

Only one IANA action is required by this document:

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

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 or not 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. 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.

The following people contributed to portions of this document in some fashion: Mark Andrews, Roy Arends, Olafur Gudmundsson, Paul Hoffman, Olaf M. Kolkman, Edward Lewis, Scott Rose, Stuart E. Schechter, Sam Weiler.

## 8. References

### 8.1. Normative References

[RFC2119] Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", [BCP 14](#), [RFC 2119](#), March 1997.

[RFC4033] Arends, R., Austein, R., Larson, M., Massey, D., and S.

Rose, "DNS Security Introduction and Requirements",  
[RFC 4033](#), March 2005.

[RFC4034] Arends, R., Austein, R., Larson, M., Massey, D., and S. Rose, "Resource Records for the DNS Security Extensions",  
[RFC 4034](#), March 2005.

[RFC4035] Arends, R., Austein, R., Larson, M., Massey, D., and S. Rose, "Protocol Modifications for the DNS Security Extensions", [RFC 4035](#), March 2005.

[SHA256] National Institute of Standards and Technology, "Secure Hash Algorithm. NIST FIPS 180-2", August 2002.

## [8.2.](#) Informative References

[SHA256CODE]  
Eastlake, D., "US Secure Hash Algorithms (SHA)",  
June 2005.



Wes Hardaker  
Sparta  
P.O. Box 382  
Davis, CA 95617  
US

Email: [hardaker@tislabs.com](mailto:hardaker@tislabs.com)

## Intellectual Property Statement

The IETF takes no position regarding the validity or scope of any Intellectual Property Rights or other rights that might be claimed to pertain to the implementation or use of the technology described in this document or the extent to which any license under such rights might or might not be available; nor does it represent that it has made any independent effort to identify any such rights. Information on the procedures with respect to rights in RFC documents can be found in [BCP 78](#) and [BCP 79](#).

Copies of IPR disclosures made to the IETF Secretariat and any assurances of licenses to be made available, or the result of an attempt made to obtain a general license or permission for the use of such proprietary rights by implementers or users of this specification can be obtained from the IETF on-line IPR repository at <http://www.ietf.org/ipr>.

The IETF invites any interested party to bring to its attention any copyrights, patents or patent applications, or other proprietary rights that may cover technology that may be required to implement this standard. Please address the information to the IETF at [ietf-ipr@ietf.org](mailto:ietf-ipr@ietf.org).

## Disclaimer of Validity

This document and the information contained herein are provided on an "AS IS" basis and THE CONTRIBUTOR, THE ORGANIZATION HE/SHE REPRESENTS OR IS SPONSORED BY (IF ANY), THE INTERNET SOCIETY AND THE INTERNET ENGINEERING TASK FORCE DISCLAIM ALL WARRANTIES, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO ANY WARRANTY THAT THE USE OF THE INFORMATION HEREIN WILL NOT INFRINGE ANY RIGHTS OR ANY IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.

## Copyright Statement

Copyright (C) The Internet Society (2006). This document is subject to the rights, licenses and restrictions contained in [BCP 78](#), and except as set forth therein, the authors retain all their rights.

## Acknowledgment

Funding for the RFC Editor function is currently provided by the

Internet Society.

Hardaker

Expires August 25, 2006

[Page 9]