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**Algorithm Implementation Requirements and Usage Guidance for DNSSEC
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Abstract

The DNSSEC protocol makes use of various cryptographic algorithms in order to provide authentication of DNS data and proof of non-existence. To ensure interoperability between DNS resolvers and DNS authoritative servers, it is necessary to specify a set of algorithm implementation requirements and usage guidance to ensure that there is at least one algorithm that all implementations support. This document defines the current algorithm implementation requirements and usage guidance for DNSSEC. This document obsoletes [[RFC6944](#)].

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[1.](#) Introduction

The DNSSEC signing algorithms are defined by various RFCs, including [\[RFC4034\]](#), [\[RFC5155\]](#), [\[RFC5702\]](#), [\[RFC5933\]](#), [\[RFC6605\]](#), [\[RFC8080\]](#). DNSSEC is used to provide authentication of data. To ensure interoperability, a set of "mandatory-to-implement" DNSKEY algorithms are defined. This document obsoletes [\[RFC6944\]](#).

[1.1.](#) Updating Algorithm Implementation Requirements and Usage Guidance

The field of cryptography evolves continuously. New stronger algorithms appear and existing algorithms are found to be less secure than originally thought. Therefore, algorithm implementation requirements and usage guidance need to be updated from time to time to reflect the new reality. The choices for algorithms must be conservative to minimize the risk of algorithm compromise.

[1.2.](#) Updating Algorithm Requirement Levels

The mandatory-to-implement algorithm of tomorrow should already be available in most implementations of DNSSEC by the time it is made mandatory. This document attempts to identify and introduce those

algorithms for future mandatory-to-implement status. There is no guarantee that the algorithms in use today may become mandatory in the future. Published algorithms are continuously subjected to cryptographic attack and may become too weak or could become completely broken before this document is updated.

This document only provides recommendations for the mandatory-to-implement algorithms or algorithms too weak that are recommended not to be implemented. As a result, any algorithm listed at the [\[DNSKEY-IANA\]](#) and [\[DS-IANA\]](#) registries not mentioned in this document MAY be implemented. For clarification and consistency, an algorithm will be set to MAY only when it has been downgraded.

Although this document updates the algorithms to keep the DNSSEC authentication secure over time, it also aims at providing recommendations so that DNSSEC implementations remain interoperable. DNSSEC interoperability is addressed by an incremental introduction or deprecation of algorithms.

While [\[RFC2119\]](#) consider term SHOULD equivalent to RECOMMENDED, and term SHOULD NOT to NOT RECOMMENDED, the authors of this document has chosen to use terms RECOMMENDED and NOT RECOMMENDED, as it better reflects the recommendations for implementations.

It is expected that deprecation of an algorithm is performed gradually. This provides time for various implementations to update their implemented algorithms while remaining interoperable. Unless there are strong security reasons, an algorithm is expected to be downgraded from MUST to NOT RECOMMENDED or MAY, instead of MUST NOT. Similarly, an algorithm that has not been mentioned as mandatory-to-implement is expected to be introduced with a RECOMMENDED instead of a MUST.

Since the effects of using an unknown DNSKEY algorithm is for the zone to be treated as insecure, it is recommended that algorithms downgraded to NOT RECOMMENDED or below are no longer used by authoritative nameservers and DNSSEC signers to create new DNSKEY's. This will allow for algorithms to slowly become more unused over time. Once deployment has reached a sufficiently low point these algorithms can finally be marked as MUST NOT so that recursive nameservers can remove support for these algorithms.

Recursive nameservers are encouraged to keep support for all algorithms not marked as MUST NOT.

1.3. Document Audience

The recommendations of this document mostly target DNSSEC implementers as implementations need to meet both high security expectations as well as high interoperability between various vendors and with different versions. Interoperability requires a smooth move to more secure algorithms. This may differ from a user point of view that may deploy and configure DNSSEC with only the safest algorithm. On the other hand, comments and recommendations from this document are also expected to be useful for such users.

2. Conventions Used in This Document

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](#)].

3. Algorithm Selection

3.1. DNSKEY Algorithms

Implementation recommendations for DNSKEY algorithms [[DNSKEY-IANA](#)].

Number	Mnemonics	DNSSEC Signing	DNSSEC Validation
1	RSAMD5	MUST NOT	MUST NOT
3	DSA	MUST NOT	MUST NOT
5	RSASHA1	NOT RECOMMENDED	MUST
6	DSA-NSEC3-SHA1	MUST NOT	MUST NOT
7	RSASHA1-NSEC3-SHA1	NOT RECOMMENDED	MUST
8	RSASHA256	MUST	MUST
10	RSASHA512	NOT RECOMMENDED	MUST
12	ECC-GOST	MUST NOT	MAY
13	ECDSAP256SHA256	MUST	MUST
14	ECDSAP384SHA384	NOT RECOMMENDED	RECOMMENDED
15	ED25519	RECOMMENDED	RECOMMENDED
16	ED448	MAY	RECOMMENDED

RSAMD5 is not widely deployed and there is an industry-wide trend to deprecate MD5 usage.

RSASHA1 and RSASHA1-NSEC3-SHA1 are widely deployed, although zones deploying it are recommended to switch to ECDSAP256SHA256 as there is an industry-wide trend to move to elliptic curve cryptography. RSASHA1 does not support NSEC3. RSASHA1-NSEC3-SHA1 can be used with or without NSEC3.

DSA and DSA-NSEC3-SHA1 are not widely deployed and vulnerable to private key compromise when generating signatures using a weak or compromised random number generator.

RSASHA256 is in wide use and considered strong.

RSASHA512 is NOT RECOMMENDED for DNSSEC Signing because it has not seen wide deployment, but there are some deployments hence DNSSEC Validation MUST implement RSASHA512 to ensure interoperability. There's isn't significant difference in cryptographics strength between RSASHA512 and RSASHA256, therefore it is discouraged to use RSASHA512, as it will only make deprecation of older algorithms harder. People that want to use cryptographically stronger algorithm should switch to elliptic curve cryptography algorithms.

ECC-GOST (GOST R 34.11-94) has been superseded by GOST R 34.11-2012 in [[RFC6986](#)]. The GOST R 34.11-2012 hasn't been standardized for use in DNSSEC.

ECDSAP256SHA256 provide more strength for signature size than RSASHA256 and RSASHA512 variants. ECDSAP256SHA256 has been widely deployed and therefore it is now at MUST level for both validation and signing. It is RECOMMENDED to use deterministic digital signature generation procedure of the ECDSA ([\[RFC6979\]](#)) when implementing ECDSAP256SHA256 (and ECDSAP384SHA384).

ECDSAP384SHA384 share the same properties as ECDSAP256SHA256, but offers only a little advantage over ECDSAP256SHA256 and has not seen wide deployment, so the usage of this algorithm is discouraged, especially for signing.

ED25519 and ED448 uses Edwards-curve Digital Security Algorithm (EdDSA). There are three main advantages of the EdDSA algorithm: It does not require the use of a unique random number for each signature, there are no padding or truncation issues as with ECDSA, and it is more resilient to side-channel attacks. Furthermore, EdDSA cryptography is less prone to implementation errors ([\[RFC8080\]](#)). It is expected that ED25519 will become the future RECOMMENDED default algorithm once there's enough support for this algorithm in the deployed DNSSEC validators.

[3.2.](#) DNSKEY Algorithm Recommendation

Operation recommendation for new and existing deployments.

Due to industry-wide trend to move to elliptic curve cryptography, the ECDSAP256SHA256 is RECOMMENDED to be used by new DNSSEC

deployments, and users of RSA based algorithms SHOULD upgrade to ECDSAP256SHA256.

3.3. DS and CDS Algorithms

Recommendations for Delegation Signer Digest Algorithms [[DNSKEY-IANA](#)]
 These also apply to the CDS RRTYPE as specified in [[RFC7344](#)]

Number	Mnemonics	DNSSEC Delegation	DNSSEC Validation
0	NULL (CDS only)	MUST NOT [*]	MUST NOT [*]
1	SHA-1	MUST NOT	MUST
2	SHA-256	MUST	MUST
3	GOST R 34.11-94	MUST NOT	MAY
4	SHA-384	MAY	RECOMMENDED

[*] - This is a special type of CDS record signaling removal of DS at the parent in [[RFC8078](#)]

NULL is a special case, see [[RFC8078](#)]

SHA-1 is still in wide use for DS records, so validators MUST implement the validation, but it is disallowed to use SHA-1 to generate new DS records. (See Operational Considerations for caveats when upgrading from SHA-1 to SHA-256 DS Algorithm.)

SHA-256 is in wide use and considered strong.

GOST R 34.11-94 has been deprecated by [[RFC6986](#)].

SHA-384 is not in wide use. It is still recommended to be supported in validators so that adoption can increase.

4. Security Considerations

The security of cryptographic-based systems depends on both the strength of the cryptographic algorithms chosen and the strength of the keys used with those algorithms. The security also depends on the engineering of the protocol used by the system to ensure that there are no non-cryptographic ways to bypass the security of the overall system.

This document concerns itself with the selection of cryptographic algorithms for the use of DNSSEC, specifically with the selection of "mandatory-to-implement" algorithms. The algorithms identified in this document as MUST or RECOMMENDED to implement are not known to be

broken at the current time, and cryptographic research so far leads us to believe that they will likely remain secure into the foreseeable future. However, this isn't necessarily forever and it is expected that new revisions of this document will be issued from time to time to reflect the current best practice in this area.

Retiring an algorithm too soon would result in a signed zone with such an algorithm to be downgraded to the equivalent of an unsigned zone. Therefore, algorithm deprecation must be done very slowly and only after careful consideration and measurements of its use.

5. Operational Considerations

DNSKEY algorithm rollover in a live zone is a complex process. See [[RFC6781](#)] and [[RFC7583](#)] for guidelines on how to perform algorithm rollovers.

DS algorithm rollover in a live zone is also a complex process. Upgrading algorithm at the same time as rolling the new KSK key will lead to DNSSEC validation failures, and users MUST upgrade the DS algorithm first before rolling the Key Signing Key.

6. IANA Considerations

This document makes no requests of IANA.

7. Acknowledgements

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