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A new cryptographic signature method for DKIM  
draft-ietf-dcrup-dkim-crypto-14

## Abstract

This document adds a new signing algorithm, ed25519-sha256, to DKIM [[RFC6376](#)]. DKIM verifiers are required to implement this algorithm.

## Status of This Memo

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DKIM Crypto Update

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[1.](#) Introduction

Discussion Venue: Discussion about this draft is directed to the [dcrup@ietf.org](mailto:dcrup@ietf.org) [\[1\]](#) mailing list.

DKIM [\[RFC6376\]](#) signs e-mail messages, by creating hashes of the message headers and body and signing the header hash with a digital signature. Message recipients fetch the signature verification key from the DNS. The defining documents specify a single signing algorithm, RSA [\[RFC3447\]](#).

This document adds a new stronger signing algorithm, Edwards-Curve Digital Signature Algorithm using the Curve25519 curve (ed25519), which has much shorter keys than RSA for similar levels of security.

[2.](#) Conventions Used in This Document

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "NOT RECOMMENDED", "MAY", and

"OPTIONAL" in this document are to be interpreted as described in [BCP 14](#) [[RFC2119](#)] [[RFC8174](#)], and only when, they appear in all capitals, as shown here.

Syntax descriptions use Augmented BNF (ABNF) [[RFC5234](#)]. The ABNF tokens sig-a-tag-k and key-k-tag-type are imported from [[RFC6376](#)].

### [3.](#) Ed25519-SHA256 Signing Algorithm

The ed25519-sha256 signing algorithm computes a message hash as defined in [section 3 of \[RFC6376\]](#) using SHA-256 [[FIPS-180-4-2015](#)] as the hash-alg, and signs it with the PureEdDSA variant Ed25519, as defined in in [RFC 8032 section 5.1 \[RFC8032\]](#). Example keys and signatures in [Appendix A](#) below are based on the test vectors in [RFC 8032 section 7.1 \[RFC8032\]](#).

The DNS record for the verification public key has a "k=ed25519" tag to indicate that the key is an Ed25519 rather than RSA key.

This is an additional DKIM signature algorithm added to [Section 3.3 of \[RFC6376\]](#) as envisioned in [Section 3.3.4 of \[RFC6376\]](#).

Note: since Ed25519 public keys are 256 bits long, the base64 encoded key is only 44 octets, so DNS key record data will generally fit in a single 255 byte TXT string, and will work even with DNS provisioning software that doesn't handle multi-string TXT records.

## [4.](#) Signature and key syntax

The syntax of DKIM signatures and DKIM keys are updated as follows.

### [4.1.](#) Signature syntax

The syntax of DKIM algorithm tags in [section 3.5 of \[RFC6376\]](#) is updated by adding this rule to the existing rule for sig-a-tag-k:

ABNF:

```
sig-a-tag-k =/ "ed25519"
```

## [4.2.](#) Key syntax

The syntax of DKIM key tags in [section 3.6.1 of \[RFC6376\]](#) is updated by adding this rule to the existing rule for key-k-tag-type:

ABNF:

```
key-k-tag-type =/ "ed25519"
```

The p= value in the key record is the ed25519 public key encoded in base64. Since the key is 256 bits long, the base64 text is 44 octets

long. See [Appendix A.2](#) for a sample key record using the public key in [\[RFC8032\] Section 7.1](#), Test 1.

## [5.](#) Key and algorithm choice and strength

[Section 3.3 of \[RFC6376\]](#) describes DKIM's hash and signature algorithms. It is updated as follows:

Signers SHOULD implement and verifiers MUST implement the ed25519-sha256 algorithm.

## [6.](#) Transition Considerations

For backward compatibility, signers can add multiple signatures that use old and new signing algorithms. Since there can only be a single key record in the DNS for each selector, the signatures have to use different selectors, although they can use the same d= and i= identifiers.

The example message in [Appendix A](#) has two signatures with the same d= and i= identifiers but different a= algorithms and s= selectors.

## [7.](#) Security Considerations

All of the security advice in [\[RFC6376\]](#) continues to apply except that the security advice about ED25519 in [Section 8 of \[RFC8032\]](#) supplants the advice about RSA threats.

## [8.](#) IANA Considerations

IANA is requested to update registries as follows.

### [8.1.](#) DKIM Key Type registry

The following value is added to the DKIM Key Type Registry

TYPE	REFERENCE	STATUS
ed25519	<a href="#">[RFC8032]</a>	active

Table 1: DKIM Key Type Registry Added Values

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## [9.](#) References

### [9.1.](#) Normative References

[FIPS-180-4-2015]

U.S. Department of Commerce, "Secure Hash Standard", FIPS PUB 180-4, August 2015, <<http://nvlpubs.nist.gov/nistpubs/FIPS/NIST.FIPS.180-4.pdf>>.

[RFC2119] Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", [BCP 14](#), [RFC 2119](#), DOI 10.17487/RFC2119, March 1997, <<https://www.rfc-editor.org/info/rfc2119>>.

[RFC5234] Crocker, D., Ed. and P. Overell, "Augmented BNF for Syntax Specifications: ABNF", STD 68, [RFC 5234](#), DOI 10.17487/RFC5234, January 2008, <<https://www.rfc-editor.org/info/rfc5234>>.

[RFC6376] Crocker, D., Ed., Hansen, T., Ed., and M. Kucherawy, Ed., "DomainKeys Identified Mail (DKIM) Signatures", STD 76,

[RFC 6376](#), DOI 10.17487/RFC6376, September 2011,  
<<https://www.rfc-editor.org/info/rfc6376>>.

[RFC8032] Josefsson, S. and I. Liusvaara, "Edwards-Curve Digital Signature Algorithm (EdDSA)", [RFC 8032](#), DOI 10.17487/RFC8032, January 2017, <<https://www.rfc-editor.org/info/rfc8032>>.

[RFC8174] Leiba, B., "Ambiguity of Uppercase vs Lowercase in [RFC 2119](#) Key Words", [BCP 14](#), [RFC 8174](#), DOI 10.17487/RFC8174, May 2017, <<https://www.rfc-editor.org/info/rfc8174>>.

## [9.2](#). Informative References

[RFC3447] Jonsson, J. and B. Kaliski, "Public-Key Cryptography Standards (PKCS) #1: RSA Cryptography Specifications Version 2.1", [RFC 3447](#), DOI 10.17487/RFC3447, February 2003, <<https://www.rfc-editor.org/info/rfc3447>>.

## [9.3](#). URIs

[1] <mailto:dcrup@ietf.org>

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## [Appendix A](#). Example of a signed message

This is a small message with both rsa-sha256 and ed25519-sha256 DKIM signatures. The signatures are independent of each other, so either signature would be valid if the other were not present.

### [A.1](#). Secret keys

Ed25519 secret key in base64. This is the secret key from [\[RFC8032\] section 7.1](#) test 1, converted from hex to base64.

```
nWGxne/9WmC6hEr0kuwsxERJxWl7MmkZcDusAxyuf2A=
```

RSA secret key in PEM format.

```
-----BEGIN RSA PRIVATE KEY-----
MIICXQIBAAKBgQDkHlOQoBTzWRiGs5V6NpP3idY6Wk08a5qhdR6wy5bdOKb2jLQi
Y/J16JYi0Qvx/byYzCNb3W91y3FutACDfzwQ/BC/e/8uBsCR+yz1Lxj+PL6lHvqM
KrM3rG4hstT5QjvH09PzoxZyVYLzBf02EeC3Ip3G+2kryOTIKT+l/K4w3QIDAQAB
AoGAH0cx0hFZDgzXWhDhnAJDw5s4roOXN40hjiXa8W7Y3rhX3FJqmJSPuC8N9vQm
6SVbaLAE4SG5mLMueHlh4KXffEpuLEiNp9Ss304YfLiQpbRqE7Tm5SxKjvvQoZZe
zHorim0aChRL2it47iuWxzxSiRMv4c+j70GiWdxXnxe4UoECQQDzJB/0U58W7RZy
6enGVj2kWF732CoWFZWzi1FicudrBFoy63QwcowpoCazKtvZGMNlPwnc7x/6o8Gc
uSe0ga2xAkEA8C7PipPm1/1fTRQvj1o/dDmZp243044Znyxjg+/OPN0oWCbXIGxy
WvmZbXri0WoSALJTjExEgraHEgnXssuk7QJBALl5ICsYMu6hMx073gnfNayNgPxd
WfV6Z7ULnKyV7HSVYF0hgY0HjeYe9gaMtiJYoo0zGN+L3AAAtNP9huqkwlzECQE1a
licIevlo1e+qJ6Mgqr0Q7Aa7falZ448ccbSFYEpd6oFxi0l9Y9se9iYHZKKfIcst
o7DUw1/hz2Ck4N5JrgUCQQCyKveNvjzkkd8HjYs0SwM0fPjK16//5qDZ2UiDgn0e
uEzxBDAR518Z8VfBR41in3W4Y3yCDgQLllcETrs+zYcL
-----END RSA PRIVATE KEY-----
```

## [A.2.](#) Public key DNS records

The public key `p=` value in the first record is the public key from [\[RFC8032\] section 7.1](#) test 1, converted from hex to base64.

```
brisbane._domainkey.football.example.com. IN TXT (
  "v=DKIM1; k=ed25519; p=11qYAYKxCrFVS/7TyWQH0g7hcvPapiMlrwIaaPchURo=")
```

```
test._domainkey.football.example.com. IN TXT (
  "v=DKIM1; k=rsa; p=MIGfMA0GCSqGSIb3DQEBAQUAA4GNADCBiQKBgQDkHlOQoBTzWR"
  "iGs5V6NpP3idY6Wk08a5qhdR6wy5bdOKb2jLQiY/J16JYi0Qvx/byYzCNb3W91y3FutAC"
  "DfzwQ/BC/e/8uBsCR+yz1Lxj+PL6lHvqMKrM3rG4hstT5QjvH09PzoxZyVYLzBf02EeC3"
  "Ip3G+2kryOTIKT+l/K4w3QIDAQAB")
```

## [A.3.](#) Signed Message

The text in each line of the message starts at the first position except for the continuation lines on the DKIM-Signature headers which start with a single space. A blank line follows the "Joe." line.

```
DKIM-Signature: v=1; a=ed25519-sha256; c=relaxed/relaxed;
  d=football.example.com; i=@football.example.com;
```

q=dns/txt; s=brisbane; t=1528637909; h=from : to :  
subject : date : message-id : from : subject : date;  
bh=2jUS0H9NhtVGCQWnr9BrIAPreKQj06Sn7XIkfJV0zv8=;  
b=/gCripncQ0oIfuHNQIbq4pgh9kyIK3AQUdt90dqQehSwhEIug4D11Bus  
Fa3bT3FY50sU7ZbnKELq+eXdp1Q1Dw==  
DKIM-Signature: v=1; a=rsa-sha256; c=relaxed/relaxed;  
d=football.example.com; i=@football.example.com;  
q=dns/txt; s=test; t=1528637909; h=from : to : subject :  
date : message-id : from : subject : date;  
bh=2jUS0H9NhtVGCQWnr9BrIAPreKQj06Sn7XIkfJV0zv8=;  
b=F45dVWdfMbQDGHJFLXUNB2HKfbCeLRyhDXgFpEL8GwpsRe0IeIixNTe3  
DhCVlUrSjV4BwcVc0F6+FF3Zo9Rpo1tF0eS9mPYQTnGdaSGsgeef0sk2Jz  
dA+L10TeYt9BgDfQNZtKdN1W0//KgIqXP70dEFE4LjFYncUxZQ4FADY+8=  
From: Joe SixPack <joe@football.example.com>  
To: Suzie Q <suzie@shopping.example.net>  
Subject: Is dinner ready?  
Date: Fri, 11 Jul 2003 21:00:37 -0700 (PDT)  
Message-ID: <20030712040037.46341.5F8J@football.example.com>

Hi.

We lost the game. Are you hungry yet?

Joe.

## [Appendix B](#). Change log

- 13 to 14 Editorial nits.
- 12 to 13 Made example even less wrong.
- 11 to 12 Made example less wrong.
- 10 to 11 New example with both signatures, minor nits.
- 09 to 10 Improve abstract, minor nits.
- 08 to 09 Specify sha-256 for the extremely literal minded. Take out the prehash stuff. Add example.

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- 07 to 08 Specify base64 key records. Style edits per Dave C.



- 06 to 07: Remove RSA fingerprints. Change Pure to hashed eddsa.
- 05 to 06: Editorial changes only.
- 04 to 05: Remove deprecation cruft and inconsistent key advice. Fix p= and k= text.
- 03 to 04: Change eddsa to ed25519. Add Martin's key regeneration issue. Remove hashed ed25519 keys. Fix typos and clarify text. Move syntax updates to separate section. Take out SHA-1 stuff.
- 01 to 02: Clarify EdDSA algorithm is ed25519 with Pure version of the signing. Make references to tags and fields consistent.

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