A New Cryptographic Signature Method for
DomainKeys Identified Mail (DKIM)

Abstract

This document adds a new signing algorithm, Ed25519-SHA256, to "DomainKeys Identified Mail (DKIM) Signatures" (RFC 6376). DKIM verifiers are required to implement this algorithm.

Status of This Memo

This is an Internet Standards Track document.

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1. **Introduction**

DKIM [RFC6376] signs email messages by creating hashes of selected message header fields 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] (which has since been obsoleted by [RFC8017]).

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] when, 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. It signs the hash with the PureEdDSA variant Ed25519, as defined in RFC 8032, Section 5.1 [RFC8032]. Example keys and signatures in Appendix A 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 an RSA key.

This is an additional DKIM signature algorithm added to Section 3.3 of [RFC6376] as envisioned in Section 3.3.4 of that document.

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 work even with DNS provisioning software that doesn’t handle multistring 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. Choice and Strength of Keys and Algorithms

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 has updated a registry as follows.

8.1. "DKIM Key Type" Registry

The following value has been added to the "DKIM Key Type" registry:

+---------+-----------+--------+
<table>
<thead>
<tr>
<th>TYPE</th>
<th>REFERENCE</th>
<th>STATUS</th>
</tr>
</thead>
<tbody>
<tr>
<td>ed25519</td>
<td>[RFC8032]</td>
<td>active</td>
</tr>
</tbody>
</table>
+---------+-----------+--------+

Table 1: Value Added to the "DKIM Key Type" Registry
9. References

9.1. Normative References


9.2. Informative References

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-----
MIICXQIBAAKBgQDkHlOQoBTzWRiGsV5V6NpP3idY6Wk08a5qhdR6wy5bdOKb2jLQiY/J16JYi0Qvx/byYzCNb3W91y3FutACdfzwQ/BC/e/8uBsCR+yz1Lxj+PL61HvgMQKr3rG4hstT5QjvHO9PzoxZyVYLzBf02Eec3Iep3G+2kryOTIKT+1/K4w3QIDAQAB AoGAH0cxoHFDgzXWbdhADw5s4r00XN40hjixA8W7Y3rhX3FjQmJSNu8C89Nqm65VbsaALAE4SG5mLMueH1h4Kxw6FpUeLrINp9s304YfLiQpRgQ7TeM5SSxKjvQoZzezHorimoaChRL2it47iuWzxxSiRMv4c+7j0GiWdxXnxe4UoEQCDzJB/0U58W7R2y6enGVj2kWF732CnWFZwzi1FicudrBFoy63QwcowpoCauKtvZGMN1PWnC7x/6c8GcuSe0ga2xAkEA8C7PipPml/1fTRQvjio/dMz2p243044ZYxjg+/OPN0oWcbXIGxyWvmZbXrOw0SuALJTjExEgraHEgnXssuk7QJRAL15IcYMu6hMx073gnfNayNgPxdWVFV67UNkJV7HSVF0hqOHjye99gaMtijYoo0zGN+L3AAtn9pH9uhqkW1zECEQallicIeViolet+qJ6MqgrQ7Aa7fa1Z448ccBFYEPD6soFxi109Y9se91YHZKkfcstc7DUwij/hz2CK4N5JrgUCQQCyKveNvjzkkd8HjiyoswMW0fPJk16/7qDZ2UI1GonueEzxBDAR518Z8VFbR4lin3W4Y3yCDgQ1LleETrs+yCle
-----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=11qYAYKxCrFpVS/7TyWQH0g7hcvPapiMLrwIaaPcHUro=")

test._domainkey.football.example.com. IN TXT ("v=DKIM1; k=rsa; p=MiGFmaAVGCSgGGXib3DQEBAAAIA4GNADCBiQKBgDzQkHD1TOqBTzWR" "iGsV5V6NpP3idY6Wk08a5qhdR6wy5bdOKb2jLQiY/J16JYi0Qvx/byYzCNb3W91y3FutAC" "DfzwQ/BC/e/8uBsCR+yz1Lxj+PL61HvgMKr3rG4hstT5QjvHO9PzoxZyVYLzBf02EeC3" "Ip3G+2kryOTIKT+1/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 header fields, 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=2jUSOH9NhtVGCQNWr9BrIAPreKQj06Sn7XIkfJVOzv8=; b=/gCrinpcQ0oIfuHNQIbq4pgh9kyIK3AQUdt9odqQehSwhEIug4D11BusFa3bT3FY50sU72bnKELq+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=2jUSOH9NhtVGCQNWr9BrIAPreKQj06Sn7XIkfJVOzv8=; b=F45dVWDfMbQDGHiF1XUNB2HkfbcE0yhDXgFpEL8GwspRe0IeiixNTe3DhCV1UrsJv4BwcLcOF6+FF3zo9po1F0eS9mPy QTnGdaSgsgeefOsk2Jz da+i1Ov1y9bgDFQNZtKdN1WO/KeJqXPo7dEFE4LjFYNCUxZQ4FADY+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.

Author’s Address

John Levine
Taughannock Networks
PO Box 727
Trumansburg, NY 14886
United States of America

Phone: +883.5100.01196712
Email: standards@taugh.com