

Network Working Group  
Internet-Draft  
Updates: [5652](#) (if approved)  
Intended status: Standards Track  
Expires: February 28, 2021

R. Housley  
Vigil Security  
August 27, 2020

**Update to the Cryptographic Message Syntax (CMS) for Algorithm  
Identifier Protection  
draft-ietf-lamps-cms-update-alg-id-protect-04**

Abstract

This document updates the Cryptographic Message Syntax (CMS) specified in [RFC 5652](#) to ensure that algorithm identifiers in signed-data and authenticated-data content types are adequately protected.

Status of This Memo

This Internet-Draft is submitted in full conformance with the provisions of [BCP 78](#) and [BCP 79](#).

Internet-Drafts are working documents of the Internet Engineering Task Force (IETF). Note that other groups may also distribute working documents as Internet-Drafts. The list of current Internet-Drafts is at <https://datatracker.ietf.org/drafts/current/>.

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."

This Internet-Draft will expire on February 28, 2021.

Copyright Notice

Copyright (c) 2020 IETF Trust and the persons identified as the document authors. All rights reserved.

This document is subject to [BCP 78](#) and the IETF Trust's Legal Provisions Relating to IETF Documents (<https://trustee.ietf.org/license-info>) in effect on the date of publication of this document. Please review these documents carefully, as they describe your rights and restrictions with respect to this document. Code Components extracted from this document must include Simplified BSD License text as described in Section 4.e of the Trust Legal Provisions and are provided without warranty as described in the Simplified BSD License.

## Table of Contents

<a href="#">1.</a>	Introduction . . . . .	<a href="#">2</a>
<a href="#">2.</a>	Terminology . . . . .	<a href="#">3</a>
<a href="#">3.</a>	Required use the same hash algorithm . . . . .	<a href="#">3</a>
<a href="#">3.1.</a>	<a href="#">RFC 5652, Section 5.3</a> . . . . .	<a href="#">3</a>
<a href="#">3.2.</a>	<a href="#">RFC 5652, Section 5.4</a> . . . . .	<a href="#">4</a>
<a href="#">3.3.</a>	<a href="#">RFC 5652, Section 5.6</a> . . . . .	<a href="#">4</a>
<a href="#">3.4.</a>	Backward Compatibility Considerations . . . . .	<a href="#">5</a>
<a href="#">3.5.</a>	Timestamp Compatibility Considerations . . . . .	<a href="#">5</a>
<a href="#">4.</a>	Recommended inclusion of the CMSAlgorithmProtection attribute	6
<a href="#">4.1.</a>	<a href="#">RFC 5652, Section 14</a> . . . . .	<a href="#">6</a>
<a href="#">5.</a>	IANA Considerations . . . . .	<a href="#">6</a>
<a href="#">6.</a>	Security Considerations . . . . .	<a href="#">6</a>
<a href="#">7.</a>	Acknowledgements . . . . .	<a href="#">7</a>
<a href="#">8.</a>	References . . . . .	<a href="#">7</a>
<a href="#">8.1.</a>	Normative References . . . . .	<a href="#">7</a>
<a href="#">8.2.</a>	Informative References . . . . .	<a href="#">8</a>
	Author's Address . . . . .	<a href="#">9</a>

## [1.](#) Introduction

This document updates the Cryptographic Message Syntax (CMS) [[RFC5652](#)] to ensure that algorithm identifiers in signed-data and authenticated-data content types are adequately protected.

The CMS signed-data Content Type [[RFC5652](#)], unlike X.509 certificates [[RFC5280](#)], can be vulnerable to algorithm substitution attacks. In an algorithm substitution attack, the attacker changes either the algorithm identifier or the parameters associated with the algorithm identifier to change the verification process used by the recipient. The X.509 certificate structure protects the algorithm identifier and the associated parameters by signing them.

In an algorithm substitution attack, the attacker looks for a different algorithm that produces the same result as the algorithm used by the originator. As an example, if the signer of a message used SHA-256 [[SHS](#)] as the digest algorithm to hash the message content, then the attacker looks for a weaker hash algorithm that produces a result that is of the same length. The attacker's goal is to find a different message that results in the same hash value, which is called a cross-algorithm collision. Today, there are many hash functions that produce 256-bit results. One of them may be found to be weak in the future.

Further, when a digest algorithm produces a larger result than is needed by a digital signature algorithm, the digest value is reduced to the size needed by the signature algorithm. This can be done both

Housley

Expires February 28, 2021

[Page 2]

by truncation and modulo operations, with the simplest being straightforward truncation. In this situation, the attacker needs to find a collision with the reduced digest value. As an example, if the message signer uses SHA-512 [[SHS](#)] as the digest algorithm and ECDSA with the P-256 curve [[DSS](#)] as the signature algorithm, then the attacker needs to find a collision with the first half of the digest.

Similar attacks can be mounted against parameterized algorithm identifiers. When looking at randomized hash functions, such as the example in [[RFC6210](#)], the algorithm identifier parameter includes a random value that can be manipulated by an attacker looking for collisions. Some other algorithm identifiers include complex parameter structures, and each value provides another opportunity for manipulation by an attacker.

This document makes two updates to CMS to provide protection for the algorithm identifier. First, it mandates a convention followed by many implementations by requiring the originator to use the same hash algorithm to compute the digest of the message content and the digest of signed attributes. Second, it recommends that the originator include the CMSAlgorithmProtection attribute [[RFC6211](#)].

## **2. Terminology**

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.

## **3. Required use the same hash algorithm**

This section updates [[RFC5652](#)] to require the originator to use the same hash algorithm to compute the digest of the message content and the digest of signed attributes.

### **3.1. [RFC 5652, Section 5.3](#)**

Change the paragraph describing the digestAlgorithm as follows:

OLD:

digestAlgorithm identifies the message digest algorithm, and any associated parameters, used by the signer. The message digest is computed on either the content being signed or the content together with the signed attributes using the process described in [Section 5.4](#). The message digest algorithm SHOULD be among those listed in the digestAlgorithms field of the associated SignerData.



Implementations MAY fail to validate signatures that use a digest algorithm that is not included in the SignedData digestAlgorithms set.

NEW:

digestAlgorithm identifies the message digest algorithm, and any associated parameters, used by the signer. The message digest is computed on either the content being signed or the content together with the signedAttrs using the process described in [Section 5.4](#). The message digest algorithm SHOULD be among those listed in the digestAlgorithms field of the associated SignerData. If the signedAttrs field is present in the SignerInfo, then the same digest algorithm MUST be used to compute both the digest of the SignedData encapContentInfo eContent, which is carried in the message-digest attribute, and the digest of the DER-encoded signedAttrs, which is passed to the signature algorithm. Implementations MAY fail to validate signatures that use a digest algorithm that is not included in the SignedData digestAlgorithms set.

### **[3.2. RFC 5652, Section 5.4](#)**

Add the following paragraph as the second paragraph in [Section 5.4](#):

ADD:

When the signedAttrs field is present, the same digest algorithm MUST be used to compute the digest of the encapContentInfo eContent OCTET STRING, which is carried in the message-digest attribute, and the digest of the collection of attributes that are signed.

nit: there may be a grammar nit here, relating to the parallelism of "compute the digest of" - I think "the collection of attributes that are signed" should also have an "of" or "digest of" prefix.

### **[3.3. RFC 5652, Section 5.6](#)**

Change the paragraph discussing the signed attributes as follows:

OLD:

The recipient MUST NOT rely on any message digest values computed by the originator. If the SignedData signerInfo includes signedAttributes, then the content message digest MUST be calculated as described in [Section 5.4](#). For the signature to be valid, the message digest value calculated by the recipient MUST



be the same as the value of the messageDigest attribute included in the signedAttributes of the SignedData signerInfo.

NEW:

The recipient MUST NOT rely on any message digest values computed by the originator. If the SignedData signerInfo includes the signedAttrs field, then the content message digest MUST be calculated as described in [Section 5.4](#), using the same digest algorithm to compute the digest of the encapContentInfo eContent OCTET STRING and the message-digest attribute. For the signature to be valid, the message digest value calculated by the recipient MUST be the same as the value of the messageDigest attribute included in the signedAttrs field of the SignedData signerInfo.

### **[3.4.](#) Backward Compatibility Considerations**

The new requirement introduced above might lead to incompatibility with an implementation that allowed different digest algorithms to be used to compute the digest of the message content and the digest of signed attributes. The signatures produced by such an implementation when two different digest algorithms are used will be considered invalid by an implementation that follows this specification. However, most, if not all, implementations already require the originator to use the same digest algorithm for both operations.

### **[3.5.](#) Timestamp Compatibility Considerations**

The new requirement introduced above might lead to compatibility issues for timestamping systems when the originator does not wish to share the message content with the Time Stamp Authority (TSA) [[RFC3161](#)]. In this situation, the originator sends a TimeStampReq to the TSA that includes a MessageImprint, which consists of a digest algorithm identifier and a digest value, then the TSA uses the originator-provided digest in the MessageImprint.

When producing the TimeStampToken, the TSA MUST use the same digest algorithm to compute the digest of the encapContentInfo eContent, which is an OCTET STRING that contains the TSTInfo, and the message-digest attribute within the SignerInfo.

To ensure that TimeStampToken values that were generated before this update remain valid, no requirement is placed on a TSA to ensure that the digest algorithm for the TimeStampToken matches the digest algorithm for the MessageImprint embedded within the TSTInfo.





#### **4. Recommended inclusion of the CMSAlgorithmProtection attribute**

This section updates [RFC5652] to recommend that the originator include the CMSAlgorithmProtection attribute [RFC6211] whenever signed attributes or authenticated attributes are present.

##### **4.1. RFC 5652, Section 14**

Add the following paragraph as the eighth paragraph in [Section 14](#):

ADD:

While there are no known algorithm substitution attacks today, the inclusion of the algorithm identifiers used by the originator as a signed attribute or an authenticated attribute makes such an attack significantly more difficult. Therefore, the originator of a signed-data content type that includes signed attributes SHOULD include the CMSAlgorithmProtection attribute [RFC6211] as one of the signed attributes. Likewise, the originator of an authenticated-data content type that includes authenticated attributes SHOULD include the CMSAlgorithmProtection attribute [RFC6211] as one of the authenticated attributes.

#### **5. IANA Considerations**

This document makes no requests of the IANA.

#### **6. Security Considerations**

The security properties of the CMS [RFC5652] signed-data and authenticated-data content types are updated to offer protection for algorithm identifiers, which makes algorithm substitution attacks significantly more difficult.

For the signed-data content type, the improvements specified in this document force an attacker to mount a hash algorithm substitution attack on the overall signature, not just on the message digest of the encapContentInfo eContent.

Some digital signature algorithms have prevented hash function substitutions by including a digest algorithm identifier as an input to the signature algorithm. As discussed in [HASHID], such a "firewall" may not be effective or even possible with newer signature algorithms. For example, RSASSA-PKCS1-v1\_5 [RFC8017] protects the digest algorithm identifier, but RSASSA-PSS [RFC8017] does not. Therefore, it remains important that a signer have a way to signal to a recipient which digest algorithms are allowed to be used in conjunction with the verification of an overall signature. This



signaling can be done as part of the specification of the signature algorithm, in an X.509v3 certificate extension [[RFC5280](#)], or some other means. The Digital Signature Standard (DSS) [[DSS](#)] takes the first approach by requiring the use of an "approved" one-way hash algorithm.

For the authenticated-data content type, the improvements specified in this document force an attacker to mount a MAC algorithm substitution attack, which is difficult because the attacker does not know the authentication key.

The CMSAlgorithmProtection attribute [[RFC6211](#)] offers protection for the algorithm identifiers used in the signed-data and authenticated-data content types. However, no protection is provided for the algorithm identifiers in the enveloped-data, digested-data, or encrypted-data content types. Likewise, The CMSAlgorithmProtection attribute provides no protection for the algorithm identifiers used in the authenticated-enveloped-data content type defined in [[RFC5083](#)]. A mechanism for algorithm identifier protection for these content types is work for the future.

## **[7.](#) Acknowledgements**

Many thanks to Jim Schaad and Peter Gutmann; without knowing it, they motivated me to write this document. Thanks to Roman Danyliw, Ben Kaduk, and Peter Yee for their careful review and editorial suggestions.

## **[8.](#) References**

### **[8.1.](#) Normative References**

- [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>>.
- [RFC3161] Adams, C., Cain, P., Pinkas, D., and R. Zuccherato, "Internet X.509 Public Key Infrastructure Time-Stamp Protocol (TSP)", [RFC 3161](#), DOI 10.17487/RFC3161, August 2001, <<https://www.rfc-editor.org/info/rfc3161>>.
- [RFC5652] Housley, R., "Cryptographic Message Syntax (CMS)", STD 70, [RFC 5652](#), DOI 10.17487/RFC5652, September 2009, <<https://www.rfc-editor.org/info/rfc5652>>.



- [RFC6211] Schaad, J., "Cryptographic Message Syntax (CMS) Algorithm Identifier Protection Attribute", [RFC 6211](#), DOI 10.17487/RFC6211, April 2011, <<https://www.rfc-editor.org/info/rfc6211>>.
- [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>>.

## **8.2. Informative References**

- [DSS] National Institute of Standards and Technology (NIST), "Digital Signature Standard (DSS)", FIPS Publication 186-4, July 2013.
- [HASHID] Kaliski, B., "On Hash Function Firewalls in Signature Schemes", Lecture Notes in Computer Science, Volume 2271, DOI 10.1007/3-540-45760-7\_1, February 2002.
- [RFC5083] Housley, R., "Cryptographic Message Syntax (CMS) Authenticated-Enveloped-Data Content Type", [RFC 5083](#), DOI 10.17487/RFC5083, November 2007, <<https://www.rfc-editor.org/info/rfc5083>>.
- [RFC5280] Cooper, D., Santesson, S., Farrell, S., Boeyen, S., Housley, R., and W. Polk, "Internet X.509 Public Key Infrastructure Certificate and Certificate Revocation List (CRL) Profile", [RFC 5280](#), DOI 10.17487/RFC5280, May 2008, <<https://www.rfc-editor.org/info/rfc5280>>.
- [RFC6210] Schaad, J., "Experiment: Hash Functions with Parameters in the Cryptographic Message Syntax (CMS) and S/MIME", [RFC 6210](#), DOI 10.17487/RFC6210, April 2011, <<https://www.rfc-editor.org/info/rfc6210>>.
- [RFC8017] Moriarty, K., Ed., Kaliski, B., Jonsson, J., and A. Rusch, "PKCS #1: RSA Cryptography Specifications Version 2.2", [RFC 8017](#), DOI 10.17487/RFC8017, November 2016, <<https://www.rfc-editor.org/info/rfc8017>>.
- [SHS] National Institute of Standards and Technology (NIST), "Secure Hash Standard", FIPS Publication 180-4, August 2015.



Author's Address

Russ Housley  
Vigil Security, LLC  
516 Dranesville Road  
Herndon, VA 20170  
US

Email: [housley@vigilsec.com](mailto:housley@vigilsec.com)