

[MS-OXPSVAL]: E-Mail Postmark Validation Algorithm

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Preliminary

1 Introduction

The E-Mail Postmark Validation Algorithm enables a client to create an e-mail message with a **postmark** header. This algorithm also enables a client to validate the postmark property on an incoming e-mail message to determine whether it is **spam**.

Section 2 of this specification is normative and can contain the terms MAY, SHOULD, MUST, MUST NOT, and SHOULD NOT as defined in RFC 2119. Section 1.6 is also normative but cannot contain those terms. All other sections and examples in this specification are informative.

1.1 Glossary

The following terms are defined in [\[MS-GLOS\]](#):

ASCII
GUID
resource
Unicode

The following terms are defined in [\[MS-OXGLOS\]](#):

base64 encoding
messaging object
Multipurpose Internet Mail Extensions (MIME)
non-Unicode
recipient
Simple Mail Transfer Protocol (SMTP)
spam

The following terms are specific to this document:

postmark: A computational proof that is applied to outgoing messages to help recipient messaging systems distinguish legitimate e-mail messages from junk e-mail messages, which reduces the chance of false positives.

presolution header: A string that contains the prepended solutions for the puzzle.

Pre-Solver: A component that, given specific inputs, generates a message postmark.

MAY, SHOULD, MUST, SHOULD NOT, MUST NOT: These terms (in all caps) are used as described in [\[RFC2119\]](#). All statements of optional behavior use either MAY, SHOULD, or SHOULD NOT.

1.2 References

References to Microsoft Open Specifications documentation do not include a publishing year because links are to the latest version of the technical documents, which are updated frequently. References to other documents include a publishing year when one is available.

1.2.1 Normative References

We conduct frequent surveys of the normative references to assure their continued availability. If you have any issue with finding a normative reference, please contact dochelp@microsoft.com. We will assist you in finding the relevant information. Please check the archive site, <http://msdn2.microsoft.com/en-us/library/E4BD6494-06AD-4aed-9823-445E921C9624>, as an additional source.

[FIPS180] Federal Information Processing Standards Publication, "Secure Hash Standard", FIPS PUB 180-1, April 1995, <http://www.itl.nist.gov/fipspubs/fip180-1.htm>

[MS-OXCNOTIF] Microsoft Corporation, "[Core Notifications Protocol Specification](#)".

[MS-OXOMSG] Microsoft Corporation, "[E-Mail Object Protocol Specification](#)".

[MS-OXPROPS] Microsoft Corporation, "[Exchange Server Protocols Master Property List](#)".

[RFC1123] Braden, R., "Requirements for Internet Hosts - Application and Support", STD 3, RFC 1123, October 1989, <http://www.ietf.org/rfc/rfc1123.txt>

[RFC2119] Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", BCP 14, RFC 2119, March 1997, <http://www.rfc-editor.org/rfc/rfc2119.txt>

[RFC2821] Klensin, J., "Simple Mail Transfer Protocol", STD 10, RFC 2821, April 2001, <http://www.ietf.org/rfc/rfc2821.txt>

[RFC2822] Resnick, P., Ed., "Internet Message Format", STD 11, RFC 2822, April 2001, <http://www.ietf.org/rfc/rfc2822.txt>

1.2.2 Informative References

[MS-GLOS] Microsoft Corporation, "[Windows Protocols Master Glossary](#)".

[MS-OXGLOS] Microsoft Corporation, "[Exchange Server Protocols Master Glossary](#)".

1.3 Overview

Postmark validation is a computational proof that a client applies to outgoing e-mail messages. Postmarks help **recipients (1)** distinguish legitimate e-mail from spam. When a recipient (1) has postmark validation enabled, its spam filter parses each incoming e-mail message for a postmark header.

An e-mail message with a postmark header is less likely to be spam than one without a postmark header. This is because a computer does not require significant processing time to solve an individual computational postmark, but the processing time required to do so for large numbers of messages is expected to be prohibitive. This computational cost is expected to discourage spam senders. For examples of postmarked e-mails, see sections [3.1](#) and [3.2](#).

1.4 Relationship to Protocols and Other Algorithms

When the e-mail client and recipient (1) server are communicating via the E-mail Object Protocol, as specified in [\[MS-OXOMSG\]](#), the E-Mail Postmark Validation Algorithm uses two properties that the client attaches to an e-mail message. Therefore, the E-Mail Postmark Validation Algorithm relies on the underlying message structures and the handling specified in [\[MS-OXOMSG\]](#).

The Core Notifications Protocol, as specified in [\[MS-OXCNOTIF\]](#), provides more information about the properties that are used to send and receive messages.

The Exchange Protocols Master Property List Specification, as specified in [\[MS-OXPROPS\]](#), provides more information about the data types that are used by this algorithm.

1.5 Applicability Statement

This algorithm specification defines how e-mail messaging clients can generate and understand computational postmarks. By using this algorithm, the client can reduce the number of false positives detected by the recipient (1) server when it tries to identify spam e-mail messages.

1.6 Standards Assignments

None.

Preliminary

2 Algorithm Details

2.1 Common Algorithm Details

The following sections specify the properties that are used by the E-Mail Postmark Validation Algorithm. Before sending these requests to the server, the messaging client MUST be logged on to the server. The client MUST open/acquire handles to all **messaging objects** and properties that are set or retrieved by this algorithm.

2.1.1 Abstract Data Model

2.1.1.1 Input Parameters for Generating the Puzzle

The input parameters specified in the following sections are used to calculate the puzzle.

Note All **string** values, unless otherwise specified, MUST be in **Unicode** format UTF-16 or UCS-2. It is up to the client implementation to choose which format to use; the algorithm treats both formats identically. <1>

2.1.1.1.1 Number of Recipients

This parameter specifies the total count of **SMTP** message recipients (1) on the "To:" and "Cc: " lines.

This parameter MUST be a decimal value formatted as type **string**.

Note Message recipients (1) other than SMTP message recipients (1) MUST NOT be counted.

2.1.1.1.2 Message "To: " and "Cc: " Recipients

This parameter is a string that contains a semicolon separated list of SMTP [\[RFC2821\]](#) addresses that are found on the "To: " and "Cc: " lines.

This parameter MUST be formatted as type **string** and MUST be encoded with **base64 encoding**.

Note Addresses on the "Bcc:" lines MUST NOT be used.

Note Accounts that are compatible with [\[MS-OXOMSG\]](#) MUST reference the following properties:

- **PidTagEmailAddress**
- **PidTagAddressType**

The recipient (1) string is calculated by means of the following pseudologic:

```
For each of the recipients in the [Recipient List] {
    Get the PidTagAddressType and PidTagEmailAddress properties.
    if (PidTagAddressType == "SMTP") {
        Append PidTagEmailAddress value, followed by a semi-colon,
        to recipient string.
    }
}
Remove the last semi-colon at the end of the recipient string.
```


2.1.1.1.3 Algorithm type

This parameter contains the algorithm type that is used to generate the puzzle.

This parameter MUST be formatted as type **string**.

Note The puzzle-solving system MUST use "sosha1_v1", as it is currently the only valid algorithm type.

2.1.1.1.4 Degree of Difficulty

This parameter contains the degree of difficulty for which a puzzle solution is sought. A larger Degree of Difficulty value indicates that the puzzle-generating application used more computing **resources** to create the puzzle. Therefore, the receiving system typically assumes that a larger Degree of Difficulty value corresponds to a lower likelihood that the message is spam. This is only a generally accepted guideline, and is not a protocol requirement.

This parameter MUST be a positive integer value that is formatted as type **string**.<2>

2.1.1.1.5 Message Identifier

This parameter contains a unique ID that is represented by a **GUID**.

This parameter MUST be formatted as type **string** and MUST be enclosed in brackets "{}".

2.1.1.1.6 Message "From: "Address

This parameter contains the sender's SMTP e-mail "From: " address.

This parameter MUST be formatted as type **string** and MUST be encoded with base64 encoding.

Note Accounts that are compatible with [\[MS-OXOMSG\]](#) MUST use the **PidTagSenderEmailAddress** property.

2.1.1.1.7 Datetime

This parameter contains the creation time of the puzzle.

This parameter MUST consist of **ASCII** characters and MUST be formatted as specified in [\[RFC1123\]](#).

2.1.1.1.8 Subject Line

This parameter contains the subject of the message, as specified in [\[RFC2822\]](#).

This parameter MUST be formatted as type **string** and MUST be encoded with base64 encoding.

Note Accounts that are compatible with [\[MS-OXOMSG\]](#) MUST reference the **PidTagSubject** property.

2.1.1.2 Pre-Solver Output values

The **Pre-Solver** will return two values, which are then stored in the message header as x-header properties.

2.1.1.2.1 "X-CR-PuzzleID" X-Header Property

The value of the "X-CR-PuzzleID" x-header property MUST be the same value as the message ID specified in section [2.1.1.1.5](#).

The "X-CR-PuzzleID" x-header property MUST be formatted as type **string**.

2.1.1.2.2 "X-CR-HashedPuzzle" X-Header Property

The value of the "X-CR-HashedPuzzle" x-header property contains the puzzle solution as defined in section [2.2.3.1](#).

The "X-CR-PuzzleID" x-header property MUST be formatted as type **string**.

2.1.2 Initialization

None.

2.1.3 Processing Rules

None.

2.2 Submit Message Algorithm Details

2.2.1 Abstract Data Model

None.

2.2.2 Initialization

None.

2.2.3 Processing Rules

2.2.3.1 Generating X-CR-HashedPuzzle

The puzzle P takes the following parameters as input (see section [2.1.1.1](#)):

- Number of recipients (1) r.
- E-mail addresses of the recipients (1) t.
- Algorithm type a.
- A 'degree of difficulty' n.
- A message id m.
- An e-mail 'From: address' f.
- A datetime d.
- A subject line s.

From these parameters, a document D is formed by concatenating all the parameters together, separating each field with ';'. The constructed document D is represented in a **non-Unicode** string.

Given the sequence of bytes comprising a document D , the computational task involved in the puzzle is to find and exhibit a set of sixteen documents δ such that both of the following are true:

- When each δ is prepended to the hash under the Son-of-SHA-1 hash algorithm H (see section 2.3.3) of D with its whitespace removed and then hashed again to form $H(\delta \circ H(NWS(D)))$, the result is zero in at least the first n bits (taken most significant bit first within each byte taken in order). Here, NWS is the function that takes a sequence of bytes as input, removes all those that are legal characters that could match the FWS production specified in [RFC2822], and produces the remaining as output.
- The last 12 bits of each $H(\delta \circ H(NWS(D)))$ are the same (the particular 12-bit suffix value shared by these documents does not matter).

Note In the previous two computations, the \circ operator denotes string concatenation.

That is, the answer to the puzzle $P(t, n, m, f, d, s)$ is a set of 16 documents δ each with these characteristics. The hash $H(NWS(D))$ is used as the suffix to which each δ is prepended rather than simply D in order to minimize the effect of variation in the length of D on the length of time required to solve the puzzle. Whitespace is stripped from D before being input to the hash in order to minimize sensitivity to the encoding of D in header fields where it can be subjected to folding.

No means other than brute force is known to locate satisfactory δ ; however, that a given set of δ indeed answers the puzzle can be quickly verified. The particular brute force approach of first trying all one-byte solutions, then trying all two-byte solutions, then all three-byte solutions, and so on, is as good a solution algorithm as any other, but has the additional benefit that the solutions found will be as small as possible. Furthermore, for puzzles that have reasonable degrees of difficulty, solutions with four or fewer bytes will be typical.

Specifically, the following pseudocode describes the brute force algorithm:

```
Solution = 0;
While(true){
    Hash = H(concatenate(Solution, H(NWS(D))))
    If Verify(Solution, Puzzle) succeeds {
        Remember this solution and Hash
        If we have 16 solutions whose last 12 bits of their
        corresponding Hash are the same {
            Return these 16 solutions
        }
    }
    Solution ++
}
```

After the solutions for puzzle P are found, a **presolution header** is generated. The presolution header MUST be the concatenation of the solutions string and the document D separated by a semicolon. The solutions string MUST be a **string** formed by base64 encoding each of the 16 puzzle solutions and concatenating them together, with a " " (space) delimiter.

The value of **X-CR-HashedPuzzle** MUST be set to the presolution header. See section 3 for examples.

2.3 Son-Of-SHA-1 Hash Algorithm Details

2.3.1 Abstract Data Model

None.

2.3.2 Initialization

None.

2.3.3 Processing Rules

The Son-of-SHA-1 algorithm is defined as a constrained perturbation of the [\[FIPS180\]](#) algorithm. The intent of defining a new hash algorithm that is unique to the proposed use of computational puzzles for spam reduction is to reduce the ease with which hardware accelerators can be applied to reduce the cost and duration of puzzle solving. In conformant systems, the Son-of-SHA-1 algorithm **MUST NOT** be implemented in hardware.

In "§5 Functions Used", as specified in [\[FIPS180\]](#), a set of eighty functions are defined that are subsequently used in the core of the algorithm specified in §7 and §8. Each f_t , $0 \leq t \leq 79$, operates on three 32-bit words B, C, D and produces a 32-bit word as output.

The Son-Of-SHA-1 algorithm differs from [\[FIPS180\]](#) only in the specification of these functions. Specifically, where [\[FIPS180\]](#) specifies the eighty functions as follows:

$$f_t(B,C,D) = (B \text{ AND } C) \text{ OR } ((\text{NOT } B) \text{ AND } D) \quad (0 \leq t \leq 19)$$

$$f_t(B,C,D) = B \text{ XOR } C \text{ XOR } D \quad (20 \leq t \leq 39)$$

$$f_t(B,C,D) = (B \text{ AND } C) \text{ OR } (B \text{ AND } D) \text{ OR } (C \text{ AND } D) \quad (40 \leq t \leq 59)$$

$$f_t(B,C,D) = B \text{ XOR } C \text{ XOR } D \quad (60 \leq t \leq 79)$$

The Son-of-SHA-1 algorithm instead specifies the first of these functions as involving an additional **XOR** operation:

$$f_t(B,C,D) = g(B,C,D) \text{ XOR } ((B \text{ AND } C) \text{ OR } ((\text{NOT } B) \text{ AND } D)) \quad (0 \leq t \leq 19)$$

$$f_t(B,C,D) = B \text{ XOR } C \text{ XOR } D \quad (20 \leq t \leq 39)$$

$$f_t(B,C,D) = (B \text{ AND } C) \text{ OR } (B \text{ AND } D) \text{ OR } (C \text{ AND } D) \quad (40 \leq t \leq 59)$$

$$f_t(B,C,D) = B \text{ XOR } C \text{ XOR } D \quad (60 \leq t \leq 79)$$

The supporting function $g(B,C,D)$ is defined as follows:

$$g_t(B,C,D) = n(r(m(B,C), m(C,D)))$$

The binary function $m()$ takes two 32-bit words as input and produces a non-negative 64-bit integer as output by concatenating the two 32-bit words together with the first word, forming the high-order bits of the following result:

$$m(B,C) = (B \ll 32) \text{ OR } C$$

The unary function $n()$ takes a single 64-bit integer as input and returns the word consisting of the following lower 32 bits:

$$n(x) = x \text{ AND } \text{FFFFFFFF}$$

Finally, the binary function $r()$ takes two 64-bit integers as input and computes the 64-bit integer that is the remainder of the first when divided by the second (unless the latter is zero). Specifically, $r(x, y)$ is defined by the following relations:

If $y \neq 0$: $x = k y + r(x, y)$ for some non-negative integer k , where $0 \leq r(x, y) < y$

If $y = 0$: $x = r(x, y)$

Other than the introduction of function $g()$, another difference between Son-Of-SHA-1 and [\[FIPS180\]](#) is that in [\[FIPS180\]](#), the following are the constants that are used:

$K = 5A827999$ ($0 \leq t \leq 19$)

$K_t = 6ED9EBA1$ ($20 \leq t \leq 39$)

$K_t = 8F1BBCDC$ ($40 \leq t \leq 59$)

$K_t = CA62C1D6$ ($60 \leq t \leq 79$).

In Son-Of-SHA-1, the constants are instead the following:

$K = 041D0411$ ($0 \leq t \leq 19$)

$K_t = 416C6578$ ($20 \leq t \leq 39$)

$K_t = A116F5B6$ ($40 \leq t \leq 59$)

$K_t = 404B2429$ ($60 \leq t \leq 79$).

In all other ways, the Son-of-SHA-1 algorithm is identical to [\[FIPS180\]](#).

2.4 Message Delivery Algorithm Details

2.4.1 Abstract Data Model

None.

2.4.2 Initialization

None.

2.4.3 Processing Rules

2.4.3.1 Determining When to Validate

The presence of the custom SMTP header **X-CR-HashedPuzzle** indicates that the message is a presolved message.

The receiving client SHOULD verify that the parameters, as expressed in the puzzle, match the fields of the e-mail message as specified in section 2, in order to prevent spammers from reusing the same presolved message binary large object (BLOB) for multiple recipients (1), thereby allowing them to get away with doing less computation.

The actual difficulty of computing a presolution can be expressed as the difficulty indicated by n , multiplied by the number of To: and Cc: recipients (1) in the presolved message indicated by r (in other words, the number of Recipient tags in the presolution data).

2.4.3.2 Validating the Puzzle

The process of validating the puzzle is performed on the receiving end of the communication. The server-side Mail Transport Authority (MTA) SHOULD validate the puzzle. Also, e-mail clients SHOULD validate the puzzle.

The validating process is divided into the following steps:

1. Validate the puzzle part inside the presolution, making sure that the puzzle is generated for the received e-mail message. An e-mail message passes this validation if all the following tests pass:
 1. Extract recipient part information from the puzzle string (r & t).
 - The recipient part SHOULD be a subset of the **MIME** recipients (1) extracted from the MIME header of the e-mail message.
 - The recipient part SHOULD contain the recipient's (1) SMTP address.
 - If the algorithm is being run on an e-mail client, the client will have a list of e-mail accounts, recipient catalog. At least one e-mail address from the recipient catalog MUST be in recipient part.
 - If the algorithm is being run on an e-mail server, the protocol server will have a list of e-mail addresses, and received recipients (1) from the RCPT TO command as part of the SMTP [RFC2821] process. The received recipients (1) MUST be a subset of recipient part.
 2. Extract the message identifier from the puzzle string m. The identifier MUST match the puzzle ID extracted from the X-CR-PuzzleID header.
 3. Extract the sender part from the puzzle string f. The sender's e-mail address MUST match the FROM address in the MIME header of the e-mail message.
 4. Extract the subject line from the puzzle string s. The subject line MUST match the subject extracted from the MIME header of the e-mail message.
2. Validate the solution part inside the presolution. The solution for the puzzle MUST meet the difficulty level n.

3 Algorithm Examples

3.1 Postmark for a Message with One Recipient Using Son-of-SHA-1 Algorithm

The following table describes a message with one recipient (1) that is postmarked using the Son-of-SHA-1 algorithm on the indicated input values. For information about the Son-of-SHA-1 algorithm, see section [2.3](#).

Input	Parameter	Value	Encoded With Base64 Encoding
Input	Number of recipients (1)	1	
	recipient (1) list	"user1@contoso.com"	dQBzAGUAcgAxAEAAZQB4AGEAbQBwAGwAZQAUAGMABwBtAA==
	Algorithm type	"sosha1_v1"	
	Degree of difficulty	7	
	message Identifier	"{d04b23f4-b443-453a-abc6-3d08b5a9a334}"	
	From address	"sender@contoso.com"	cwBIAG4AZABIAHIAQABIAHgAYQBtAHAAbABIAC4AYwBvAG0A
	DateTime	"Tue, 01 Jan 2008 08:00:00 GMT"	
	Subject	"Hello"	SABIAGwAbABvAA==
Result	"X-CR-HashedPuzzle: BjHi CbbP CsE4 DoWO EhAv FJE7 FMx3 FOJO FjsQ HDPJ IFAE IRyJ I5E3 I+BV KBb7 L+gd;1;dQBzAGUAcgAxAEAAZQB4AGEAbQBwAGwAZQAUAGMABwBtAA==;Sosha1_v1;7;{d04b23f4-b443-453a-abc6-3d08b5a9a334};cwBIAG4AZABIAHIAQABIAHgAYQBtAHAAbABIAC4AYwBvAG0A;Tue, 01 Jan 2008 08:00:00 GMT;SABIAGwAbABvAA==X-CR-PuzzleID: {d04b23f4-b443-453a-abc6-3d08b5a9a334}"		

3.2 Postmark for a Message with Two Recipients Using Son-of-SHA-1 Algorithm

The following table describes a message with two recipients (1) that is postmarked using the Son-of-SHA-1 algorithm on the indicated input values. For information about the Son-of-SHA-1 algorithm, see section [2.3](#).

Input	Parameter	Value	Encoded With Base64 Encoding
Input	Number of recipients	2	

Input	Parameter	Value	Encoded With Base64 Encoding
	(1)		
	recipient (1) list	"user1@contoso.com; user2@contoso.com"	dQBzAGUAcgAxAEAAZQB4AGEAbQBwAGwAZQAUAGMABwBtADsAdQBzAGUAcgAyAEAAZQB4AGEAbQBwAGwAZQAUAGMABwBtAA==
	Algorithm type	"sosha1_v1"	
	Degree of difficulty	7	
	message Identifier	"{d04b23f4-b443-453a-abc6-3d08b5a9a334}"	
	From address	"sender@contoso.com"	cwBIAG4AZABIAHIAQABIAHgAYQBtAHAAbABIAC4AYwBvAG0A
	DateTime	"Tue, 01 Jan 2008 08:00:00 GMT"	
	Subject	"Hello"	SABIAGwAbABvAA==
Result	"X-CR-HashedPuzzle: AeJ A Arsz Bwjf DuSf Een1 Et0s FrxA GmCG HaiQ It8u Jpqj QdZB R6vS SDZh SrAv UANK;2;dQBzAGUAcgAxAEAAZQB4AGEAbQBwAGwAZQAUAGMABwBtADsAdQBzAGUAcgAyAEAAZQB4AGEAbQBwAGwAZQAUAGMABwBtAA==;Sosha1_v1;7;{d04b23f4-b443-453a-abc6-3d08b5a9a334};cwBIAG4AZABIAHIAQABIAHgAYQBtAHAAbABIAC4AYwBvAG0A;Tue, 01 Jan 2008 08:00:00 GMT;SABIAGwAbABvAA==X-CR-PuzzleID: {d04b23f4-b443-453a-abc6-3d08b5a9a334}"		

3.3 Hash Values from Son-of-SHA-1 Algorithm

The following table provides four examples of hash values that result from using the Son-of-SHA-1 algorithm on the indicated input values. For information about the Son-of-SHA-1 algorithm, see section [2.3](#).

Input	Son-of-SHA-1 hash value
The string "abc"	FA12E295 9DB79C97 25338C0F D4DE3E01 78C286BD
The string "abcdbcdecdefdefgefghfghighijhijkijklklmklmnlmnomnopnpq"	48F6CE9F DCF53F40 89200091 ED9739E1 7D73D975
A string consisting of 1,000,000 "a" characters	57338A4C C33E70D4 3A3D3AD7 E93C85ED E6996CCD

Input	Son-of-SHA-1 hash value
An empty string	7A790886 F5044A7B DA812BA8 BFC286C4 F51E7B34

Preliminary

4 Security

4.1 Security Considerations for Implementers

There are no special security considerations specific to the E-Mail Postmark Validation Algorithm. General security considerations that pertain to the underlying E-mail Object Protocol, as specified in [\[MS-OXOMSG\]](#), apply.

4.2 Index of Security Parameters

None.

5 Appendix A: Product Behavior

The information in this specification is applicable to the following Microsoft products or supplemental software. References to product versions include released service packs:

- Microsoft® Exchange Server 2003
- Microsoft® Exchange Server 2007
- Microsoft® Exchange Server 2010
- Microsoft® Exchange Server 2013 Preview
- Microsoft® Office Outlook® 2007

Exceptions, if any, are noted below. If a service pack or Quick Fix Engineering (QFE) number appears with the product version, behavior changed in that service pack or QFE. The new behavior also applies to subsequent service packs of the product unless otherwise specified. If a product edition appears with the product version, behavior is different in that product edition.

Unless otherwise specified, any statement of optional behavior in this specification that is prescribed using the terms SHOULD or SHOULD NOT implies product behavior in accordance with the SHOULD or SHOULD NOT prescription. Unless otherwise specified, the term MAY implies that the product does not follow the prescription.

[<1> Section 2.1.1.1.1](#): Office Outlook 2007 always formats parameters as UTF-16.

[<2> Section 2.1.1.1.4](#): Office Outlook 2007 always uses "7" as the Degree of Difficulty value.

6 Change Tracking

No table of changes is available. The document is either new or has had no changes since its last release.

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