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A. Malhotra  
S. Goldberg  
Boston University  
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Message Authentication Code for the Network Time Protocol  
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## Abstract

[RFC 5905](#) states that Network Time Protocol (NTP) packets should be authenticated by appending the NTP data to a 128-bit key, and hashing the result with MD5 to obtain a 128-bit tag. This document deprecates MD5-based authentication, which is considered to be too weak, and recommends the use of AES-CMAC as in [RFC 4493](#) as a replacement.

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## [1.](#) Introduction

[RFC 5905](#) [[RFC5905](#)] states that Network Time Protocol (NTP) packets should be authenticated by appending the NTP data to a 128-bit key, and hashing the result with MD5 to obtain a 128-bit tag. This document deprecates MD5-based authentication, which is considered to be too weak, and recommends the use of AES-CMAC [[RFC4493](#)] as a replacement.

### [1.1.](#) Requirements Language

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.

## [2.](#) Deprecating the use of MD5

[RFC 5905](#) [[RFC5905](#)] defines how the MD5 digest algorithm in [RFC 1321](#) [[RFC1321](#)] can be used as a message authentication code (MAC) for authenticating NTP packets. However, as discussed in [[BCK](#)] and [RFC 6151](#) [[RFC6151](#)], this is not a secure MAC and therefore MUST be deprecated.

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### 3. Replacement Recommendation

If NTP authentication is implemented, then AES-CMAC as specified in [RFC 4493](#) [RFC4493] MUST be computed over all fields in the NTP header, and any extension fields that are present in the NTP packet as described in [RFC 5905](#) [RFC5905]. The MAC key for NTP MUST be 128 bits long AES-128 key and the resulting MAC tag MUST be at least 128 bits long as stated in [section 2.4 of RFC 4493](#) [RFC4493]. NTP makes this transition possible as it supports algorithm agility as described in [Section 2.1 of RFC 7696](#) [RFC7696].

The hosts who wish to use NTP authentication share a symmetric key out-of-band. So they MUST implement AES-CMAC and share the corresponding symmetric key. A symmetric key is a triplet of ID, type (e.g. MD5, AES-CMAC) and the key itself. All three have to match in order to successfully authenticate packets between two hosts. Old implementations that don't support AES-CMAC will not accept and will not send packets authenticated with such a key.

### 4. Motivation

AES-CMAC is recommended for the following reasons:

1. It is an IETF standard that is available in many open source implementations.
2. It is immune to nonce-reuse vulnerabilities (e.g. [Joux]) because it does not use a nonce.
3. It has fine performance in terms of latency and throughput.
4. It benefits from native hardware support, for instance, Intel's New Instruction set GUE [GUE].

### 5. Test Vectors

For test vectors and their outputs refer to [Section 4 of RFC 4493 \[RFC4493\]](#)

## 6. Security Considerations

Refer to the Appendices A, B and C of NIST document on recommendation for the CMAC mode of authentication [[NIST](#)] and Security Considerations Section of [RFC 4493 \[RFC4493\]](#) for discussion on security guarantees of AES-CMAC.

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## 7. Acknowledgements

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## 8. IANA Considerations

This memo includes no request to IANA.

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## Authors' Addresses

Aanchal Malhotra  
Boston University

111 Cummington St  
Boston, MA 02215  
US

Email: [aanchal4@bu.edu](mailto:aanchal4@bu.edu)

Sharon Goldberg  
Boston University  
111 Cummington St  
Boston, MA 02215  
US

Email: [goldbe@cs.bu.edu](mailto:goldbe@cs.bu.edu)