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Message Authentication Code for the Network Time Protocol  
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## Abstract

[RFC 5905](#) [[RFC5905](#)] states that Network Time Protocol (NTP) packets should be authenticated by appending a 128-bit key to the NTP data, 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.

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MAC for NTP

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## [1.](#) Introduction

[RFC 5905](#) [[RFC5905](#)] states that Network Time Protocol (NTP) packets should be authenticated by appending a 128-bit key to the NTP data, 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", "MAY", and "OPTIONAL" in this document are to be interpreted as described in [RFC 2119](#) [[RFC2119](#)].

## [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.

## [3.](#) Replacement Recommendation

If authentication is implemented, then AES-CMAC as specified in [RFC 4493](#) [[RFC4493](#)] SHOULD 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 at

least 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.

#### [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 [[NIST](#)] and

Security Considerations Section of [RFC 4493](#) [[RFC4493](#)] for discussion on security guarantees of AES-CMAC.

## 7. Acknowledgements

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## 8. IANA Considerations

This memo includes no request to IANA.

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