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T. Mizrahi
Marvell
D. Mayer
Network Time Foundation

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Using NTP Extension Fields without Authentication
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Abstract

The Network Time Protocol Version 4 (NTPv4) defines the optional usage of extension fields. An extension field is an optional field that resides at the end of the NTP header, and can be used to add optional capabilities or additional information that is not conveyed in the standard NTP header. The current definition of extension fields in NTPv4 is somewhat ambiguous regarding the connection between extension fields and the presence of a Message Authentication Code (MAC). This draft clarifies the usage of extension fields in the presence and in the absence of a MAC, while maintaining interoperability with existing implementations.

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1. Introduction

The NTP header format consists of a set of fixed fields that may be followed by some optional fields. Two types of optional fields are defined, Message Authentication Codes (MAC), and extension fields.

If a MAC is used, it resides at the end of the packet. This field can be either 24 octets long, 20 octets long, or a 4-octet crypto-NAK.

NTP extension fields were defined in [NTPv4] as a generic mechanism that allows to add future extensions and features without modifying the NTP header format.

The only currently defined extension field is the one used by the AutoKey protocol [AutoKey].

The NTP specification is somewhat ambiguous with regards to the connection between using extension fields and the presence of a MAC.

- The definition of the NTP extension field implies that it was intended to be a generic mechanism that can be used for various future features of the protocol (see Section A.1.).

- On the other hand, the NTP extension field description in [NTPv4] states that a MAC is always present when an extension field is present (see Section A.2.).

The last two quotes seem to be in contradiction; since the extension field was defined as a generic future-compatible building block, it seems unlikely to bind it to a specific feature in the protocol.

Moreover, the extension field parsing rules presented in [AutoKey] imply that an extension field can be present without a MAC, provided that the extension field is at least 28 Octets long.

This document attempts to resolve the ambiguity with regards to the connection between NTP extension fields and MACs, updating Section 7.5 of the NTP v4 protocol [NTPv4], and describes the usage of extension fields in the absence of a MAC in a way that is interoperable with current implementations.

2. Conventions Used in this Document

2.1. Terminology

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 [KEYWORDS].

2.2. Terms & Abbreviations

NTPv4	Network Time Protocol Version 4

MAC Message Authentication Code

3. NTP Extension Fields with and without a MAC - Clarifications

This section clarifies the usage of extension fields in the absence of a MAC, in accordance with the definitions in [NTPv4] and [AutoKey]. Section 4 . defines a more generic and flexible usage of extension fields.

3.1. Extension Field Format

The NTP extension field is defined in [NTPv4]. The extension field format is quoted here in Section A.3.

The minimal length of an extension field, as defined in [NTPv4], is 16 octets.

3.2. Extension Fields in the Absence of a MAC

Extension fields can be used when a MAC is not present in the NTP packet. In this case, the extension fields must comply with the parsing rules in Section A.4. Specifically:

- If the packet includes a single extension field, the length of the extension field MUST be at least 7 words, i.e., at least 28 octets.

- If the packet includes more than one extension field, the length of the last extension field MUST be at least 28 octets. The length of the other extension fields in this case MUST be at least 16 octets each, as defined in [NTPv4].

A host that supports NTP extension fields MUST parse NTP extension fields as described in Section A.4.

3.3. Unknown Extension Fields

If an extension field is unknown to the receiving server the server should ignore the extension field and may optionally drop the packet altogether if policy requires it. Note that in the presence of an unknown extension field any MAC that may be present may be misinterpreted as an unknown extension though in this case the apparent extension length will be totally inconsistent with the total length of the rest of the packet.

3.4. Interoperability with Current Implementations

The behavior described in Section 3.2. is compliant to [AutoKey], and thus should be compatible with existing implementations that support NTP extension fields.

4. NTP Extension Field Usage with and without a MAC - Extensions

This section updates [NTPv4] and [AutoKey] with respect to the usage of extension fields, allowing a more flexible and unambiguous usage.

4.1. MAC in the absence of an Extension Field

If there is no extension field present then a MAC MUST NOT be included in the packet. This is because there is no way to tell the difference between an unknown extension field and a MAC.

4.2. Extension Fields in the Presence of a MAC

The usage of extension fields in the presence of a MAC is specified in [NTPv4] and in [AutoKey]. The requirement for a MAC MUST be specified by the specification for the extension field and the specification MUST include both the algorithm to be used to create the MAC and the length of the MAC thus created. An extension field may allow for more than one algorithm to be used in which case the information about which one was used MUST be included in the extension field itself.

4.3. Extension Fields in the Absence of a MAC

Extension fields can be used when a MAC is not present in the NTP packet. In this case, the extension fields must comply with the following:

- If the packet includes a single extension field, the length of the extension field MUST be at least 16 octets. The extension length is specified in the length field of the extension and is the number of octets in the extension field.

- If the packet includes more than one extension field, the length of the last extension field MUST be at least 28 octets. The length of the other extension fields in this case MUST be at least 16 octets each, as defined in [NTPv4].

4.4. Multiple Extension fields in an NTP packet

If there are multiple extension fields that require a MAC they MUST all require use of the same algorithm and MAC length. Extension fields that do not require a MAC can be included with extension fields that do require a MAC.

5. Security Considerations

The security considerations of the network time protocol are discussed in [NTPv4]. This document clarifies some ambiguity with regards to the usage of the NTP extension field, and thus the behavior described in this document does not introduce new security considerations.

6. IANA Considerations

There are no new IANA considerations implied by this document.

7. Acknowledgments

The authors thank Dave Mills for his insightful comments.

This document was prepared using 2-Word-v2.0.template.dot.

8. References

8.1. Normative References

[KEYWORDS] Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", BCP 14, RFC 2119, March 1997.

[NTPv4] Mills, D., Martin, J., Burbank, J., Kasch, W., "Network Time Protocol Version 4: Protocol and Algorithms Specification", RFC 5905, June 2010.

[AutoKey] Haberman, B., Mills, D., "Network Time Protocol Version 4: Autokey Specification", RFC 5906, June 2010.

Appendix A. Requirements from NTPv4 and Autokey

A.1. NTP Extension Field for Future Extensions

The following paragraph is quoted from [NTPv4], Section 16.

This document introduces NTP extension fields allowing for the development of future extensions to the protocol, where a particular extension is to be identified by the Field Type sub-field within the extension field.

A.2. NTP Extension Field in the Presence of a MAC

The following paragraph is quoted from [NTPv4], Section 7.5.

In NTPv4, one or more extension fields can be inserted after the header and before the MAC, which is always present when an extension field is present.

A.3. The NTP Extension Field Format

Figure 1 specifies the NTP extension field format, and is quoted from [NTPv4]. For further details refer to [NTPv4].

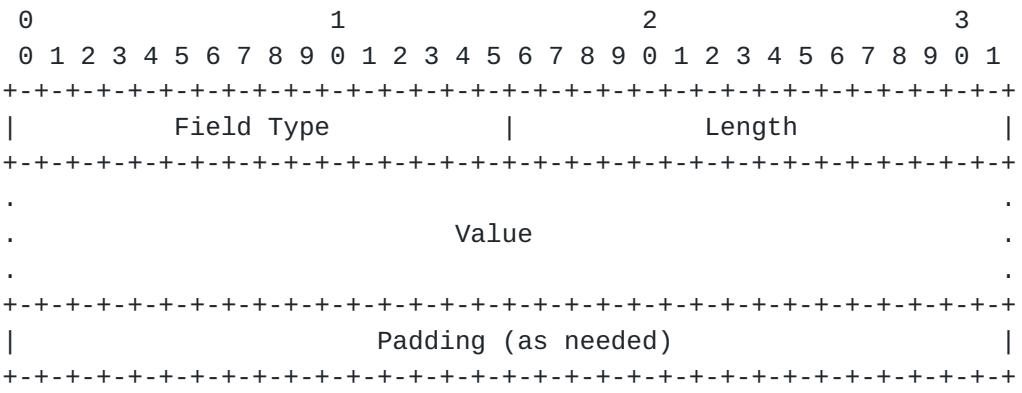

Figure 1 The NTP Extension Field Format

A.4. NTP Extension Field in Autokey

The following paragraph is quoted from [AutoKey], Section 10.

One or more extension fields follow the NTP packet header and the last followed by the MAC. The extension field parser initializes a pointer to the first octet beyond the NTP packet header and calculates the number of octets remaining to the end of the packet If the remaining length is 20 (128-bit digest plus 4-octet key ID) or 22 (160-bit digest plus 4-octet key ID), the remaining data are the MAC and parsing is complete. If the remaining length is greater than 22, an extension field is present. If the remaining length is less than

8 or not a multiple of 4, a format error has occurred and the packet is discarded; otherwise, the parser increments the pointer by the extension field length and then uses the same rules as above to determine whether a MAC is present or another extension field.

Authors' Addresses

Tal Mizrahi
Marvell
6 Hamada St.
Yokneam, 20692 Israel

Email: talmi@marvell.com

Danny Mayer
Network Time Foundation
PO Box 918
Talent OR 97540

Email: mayer@ntp.org