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Integrity Check Value and Timestamp TLV Definitions for Mobile Ad Hoc Networks (MANETs)

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Abstract

This document revises, extends and replaces RFC 6622. It describes general and flexible TLVs for representing cryptographic Integrity Check Values (ICVs) and timestamps, using the generalized Mobile Ad Hoc Network (MANET) packet/message format defined in RFC 5444. It defines two Packet TLVs, two Message TLVs, and two Address Block TLVs for affixing ICVs and timestamps to a packet, a message, and one or more addresses, respectively.

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1. Introduction

[RFC Editor note: Please replace "xxxx" throughout this document with the RFC number assigned to this document, and remove this note.]

This document specifies a syntactical representation of security-related information for use with [RFC5444] addresses, messages, and packets, and also reports and updates IANA registrations (from [RFC6622]) of TLV types and type extension registries for these TLV types. This specification does not represent a stand-alone protocol, but is intended for use by MANET routing protocols, or security extensions thereof.

Specifically, this document, which revises, extends, and replaces [RFC6622], specifies:

o Two kinds of TLV: one for carrying Integrity Check Values (ICVs) and one for timestamps in packets, messages, and address blocks as defined by [RFC5444].

o A generic framework for use of these TLVs, accounting for specific features of Packet, Message and Address Block TLVs.

This document retains the IANA registries, defined in [RFC6622], for recording code points for ICV calculations, and requests an additional allocation from each these registries. This document retains the IANA registries, defined in [RFC6622], for recording code points for timestamps, hash-functions, and cryptographic functions, but does not request any additional allocations from these registries. This document replaces [RFC6622] as the reference for these registries.

Moreover, in Section 12, this document defines the following:

o A method for generating ICVs using a combination of a cryptographic function and a hash function, and for including such ICVs in the value field of a TLV.

1.1. Differences from RFC6622

This document obsoletes [RFC6622], replacing that document as the specification of two TLV types, TIMESTAMP and ICV, for packets, messages and address blocks. For the ICV TLV as well as repeating the specification of two type extensions, 0 and 1, it also specifies a new type extension, 2, in Section 12 of this document.

The TLV value of an ICV TLV with type extension 2 has the same internal structure as an ICV TLV with type extension 1, but is

calculated also over the source address of the IP datagram carrying the packet, message, or Address Block. The rationale for adding this type extension is that some MANET protocols, such as [RFC6130], use the IP source address of the IP datagram carrying the packet, message or Address Block, e.g., to identify links with neighbor routers. If this address is not otherwise contained in the packet, message, or Address Block payload (which is permitted, e.g., in [RFC6130]), then the address is not protected against tampering.

This document also incorporates a number of editorial improvements over [RFC6622]. In particular, it makes it clear that an ICV TLV may be used to carry a truncated ICV, and that a single- or multi-value TIMESTAMP or ICV Address Block TLV may cover more than one address.

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 [RFC2119].

This document uses the terminology and notation defined in [RFC5444]. In particular, the following TLV fields and notation from [RFC5444] are used in this specification:

<msg-hop-limit> is the hop limit of a message, as specified in Section 5.2 of [RFC5444].

<msg-hop-count> is the hop count of a message, as specified in Section 5.2 of [RFC5444].

<length> is the length of the value field in a TLV in octets, as specified in Section 5.4.1 of [RFC5444].

single-length is the length of a single value in the value field in a TLV in octets, as specified in Section 5.4.1 of [RFC5444]. (It is equal to <length> except in a multivalue Address Block TLV.)

In addition to the regular expressions defined in Section 2.1.1 of [RFC5444] this document defines:

+ - One or more occurrences of the preceding element or group.

3. Applicability Statement

MANET routing protocols using the format defined in [RFC5444] are accorded the ability to carry additional information in control messages and packets, through the inclusion of TLVs. Information so

included MAY be used by a MANET routing protocol, or by an extension of a MANET routing protocol, according to its specification.

This document specifies how to include an ICV for a packet, a message, and addresses in Address Blocks within a message, using such TLVs. This document also specifies how to treat an empty Packet TLV Block, and "mutable" fields, specifically the <msg-hop-count> and <msg-hop-limit> fields, if present in the Message Header when calculating ICVs, such that the resulting ICV can be correctly verified by any recipient.

This document describes a generic framework for creating ICVs, and how to include these ICVs in TLVs. In Section 12, an example method for calculating such ICVs is given, using a cryptographic function and a hash function, for which two TLV type extensions are allocated.

4. Security Architecture

MANET routing protocol specifications may have a clause allowing a control message to be rejected as "badly formed" or "insecure" prior to the message being processed or forwarded. In particular, MANET routing protocols such as the Neighborhood Discovery Protocol (NHDP) [RFC6130] and the Optimized Link State Routing Protocol version 2 [OLSRv2] recognize external reasons (such as failure to verify an ICV) for rejecting a message that would be considered "invalid for processing".

This architecture is a result of the observation that with respect to security in MANETs, "one size rarely fits all" and that MANET routing protocol deployment domains have varying security requirements ranging from "unbreakable" to "virtually none". The virtue of this approach is that MANET routing protocol specifications (and implementations) can remain "generic", with extensions providing proper security mechanisms specific to a deployment domain.

The MANET routing protocol "security architecture", in which this specification situates itself, can therefore be summarized as follows:

- MANET routing protocol specifications, each with a clause allowing an extension to reject a message (prior to processing/forwarding) as "badly formed" or "insecure".

- MANET routing protocol security extensions, each rejecting messages as "badly formed" or "insecure", as appropriate for a given security requirement specific to a deployment domain.

- o Code points and an exchange format for information, necessary for specification of such MANET routing protocol security extensions.

This document addresses the last of the points above, by specifying a common exchange format for cryptographic ICVs and timestamps, making reservations from within the Packet TLV, Message TLV, and Address Block TLV registries of [RFC5444], to be used by (and shared among) MANET routing protocol security extensions.

For the specific decomposition of an ICV using a cryptographic function and a hash function (specified in Section 12), this document reports the two IANA registries from [RFC6622] for code points for hash functions and cryptographic functions.

With respect to [RFC5444], this document is:

- o Intended to be used in the non-normative, but intended, mode of use described in Appendix B of [RFC5444].

- o A specific example of the Security Considerations section of [RFC5444] (the authentication part).

5. Overview and Functioning

This document specifies a syntactical representation of security-related information for use with [RFC5444] addresses, messages, and packets, and also reports and updates IANA registrations (from [RFC6622]) of TLV types and type extension registries for these TLV types.

Moreover, this document provides guidelines for how MANET routing protocols, and MANET routing protocol extensions using this specification, should treat ICV and Timestamp TLVs, and mutable fields in messages. This specification does not represent a stand-alone protocol. MANET routing protocols, and MANET routing protocol extensions using this specification, MUST provide instructions as to how to handle packets, messages, and addresses with security information, associated as specified in this document.

This document reports previously assigned TLV types (from [RFC6622]) from the registries defined for Packet, Message, and Address Block TLVs in [RFC5444]. When a TLV type is assigned from one of these registries, a registry for type extensions for that TLV type is created by IANA. This document reports and updates these type extension registries, in order to specify internal structure (and accompanying processing) of the <value> field of a TLV.

For example, and as reported in this document, an ICV TLV with type

extension = 0 specifies that the <value> field has no pre-defined internal structure, but is simply a sequence of octets. An ICV TLV with type extension = 1 specifies that the <value> field has a pre-defined internal structure and defines its interpretation. An ICV TLV with type extension = 2 (added in this document) is the same as an ICV TLV with type extension = 1, except that the integrity protection also covers the source address of the IP datagram carrying the packet, message, or Address Block.

Specifically, with type extension = 1 or type extension = 2, the <value> field contains the result of combining a cryptographic function and a hash function, calculated over the contents of the packet, message, or Address Block. The <value> field contains sub-fields indicating which hash function and cryptographic function have been used, as specified in Section 12.

Other documents can request assignments for other type extensions; if they do so, they MUST specify their internal structure (if any) and interpretation.

6. General ICV TLV Structure

The value of the ICV TLV is:

    <value> := <ICV-value>+

where:

<ICV-value> is a field, of length <length> octets (except in a multivalue Address Block TLV, where each <ICV-value> is of length single-length octets) that contains the information to be interpreted by the ICV verification process, as specified by the type extension.

Note that this does not specify how to calculate the <ICV-value> nor the internal structure thereof, if any; such information MUST be specified by the type extension for the ICV TLV type; see Section 13. This document specifies three such type extensions -- one for ICVs without pre-defined structures, and two for ICVs constructed combining a cryptographic function and a hash function.

7. General Timestamp TLV Structure

The value of the Timestamp TLV is:

    <value> := <time-value>+

where:

<time-value> is a field, of length <length> octets (except in a multivalue Address Block TLV, where each <time-value> is of length single-length octets) that contains the timestamp.

Note that this does not specify how to calculate the <time-value> nor the internal structure thereof, if any; such information MUST be specified by the type extension for the TIMESTAMP TLV type; see Section 13.

A timestamp is essentially "freshness information". As such, its setting and interpretation are to be determined by the MANET routing protocol, or MANET routing protocol extension, that uses the timestamp and can, for example, correspond to a POSIX timestamp, GPS timestamp, or a simple sequence number. Note that ensuring time synchronization in a MANET may be difficult because of the decentralized architecture as well as highly dynamic topology due to mobility or other factors. It is out of scope for this document to specify a time synchronization mechanism.

8. Packet TLVs

Two Packet TLVs are defined: one for including the cryptographic ICV of a packet and one for including the timestamp indicating the time at which the cryptographic ICV was calculated.

8.1. ICV Packet TLV

An ICV Packet TLV is an example of an ICV TLV as described in Section 6. When determining the <ICV-value> for a packet, and adding an ICV Packet TLV to a packet, the following considerations MUST be applied:

o Because packets as defined in [RFC5444] are never forwarded by routers, no special considerations are required regarding mutable fields (i.e., <msg-hop-count> and <msg-hop-limit>), if present within any messages in the packet, when calculating the ICV.

o Any Packet ICV TLVs already present in the Packet TLV Block MUST be removed before calculating the ICV, and the Packet TLV Block size MUST be recalculated accordingly.

o If the Packet TLV Block now contains no Packet TLVs, the Packet TLV Block MUST be removed, and the phastlv bit in the <pkt-flags> field in the Packet Header MUST be cleared ('0').

o Any removed ICV Packet TLVs MUST be restored after having calculated the ICV, and the Packet TLV Block size MUST be recalculated accordingly.

- When any removed ICV Packet TLVs, and the newly calculated ICV Packet TLV, are added to the packet, if there is no Packet TLV Block then one MUST be added, including setting ('1') the phastlv bit in the <pkt-flags> field in the Packet Header.

The rationale for removing any Packet ICV TLVs already present prior to calculating the ICV is that several ICV TLVs may be added to the same packet, e.g., using different ICV cryptographic and/or hash functions. The rationale for removing an empty Packet TLV Block is because the receiver of the packet cannot tell the difference between what was an absent Packet TLV Block, and what was an empty Packet TLV Block when removing and verifying the ICV Packet TLV if no other Packet TLVs are present.

8.2. TIMESTAMP Packet TLV

A TIMESTAMP Packet TLV is an example of a Timestamp TLV as described in Section 7. If a packet contains one or more TIMESTAMP TLVs and one or more ICV TLVs, then the TIMESTAMP TLVs (as well as any other Packet TLVs) MUST be added to the packet before the ICV TLVs, in order to include the timestamps and other TLVs in the calculation of the ICVs.

9. Message TLVs

Two Message TLVs are defined: one for including the cryptographic ICV of a message and one for including the timestamp indicating the time at which the cryptographic ICV was calculated.

9.1. ICV Message TLV

An ICV Message TLV is an example of an ICV TLV as described in Section 6. When determining the <ICV-value> for a message, the following considerations MUST be applied:

- The fields <msg-hop-limit> and <msg-hop-count>, if present in the Message Header, MUST both be assumed to have the value 0 (zero) when calculating the ICV.

- Any Message ICV TLVs already present in the Message TLV Block MUST be removed before calculating the ICV, and the message size as well as the Message TLV Block size MUST be recalculated accordingly. Also, all relevant TLVs other than ICV TLVs MUST be added prior to TCV value calculation.

- Any removed ICV Message TLVs MUST be restored after having calculated the ICV, and the message size as well as the Message TLV Block size MUST be recalculated accordingly.

The rationale for removing any ICV Message TLVs already present prior to calculating the ICV is that several ICV TLVs may be added to the same message, e.g., using different ICV cryptographic and/or hash functions.

9.2. TIMESTAMP Message TLV

A TIMESTAMP Message TLV is an example of a Timestamp TLV as described in Section 7. If a message contains one or more TIMESTAMP TLVs and one or more ICV TLVs, then the TIMESTAMP TLVs (as well as any other Message TLVs) MUST be added to the message before the ICV TLVs, in order to include the timestamps and other Message TLVs in the calculation of the ICV.

10. Address Block TLVs

Two Address Block TLVs are defined: one for associating a cryptographic ICV to one or more addresses and their associated information, and one for including the timestamp indicating the time at which the cryptographic ICV was calculated.

10.1. ICV Address Block TLV

An ICV Address Block TLV is an example of an ICV TLV as described in Section 6. The ICV is calculated over one or more addresses, concatenated with any other values -- for example, other Address Block TLV <value> fields -- associated with those addresses. A MANET routing protocol, or MANET routing protocol extension, using Address Block ICV TLVs MUST specify how to include any such concatenated attributes of the addresses in the calculation and verification processes for the ICV. When determining an <ICV-value> for one or more addresses, the following consideration MUST be applied:

- If other TLV values are concatenated with the addresses for calculating the ICV, the corresponding TLVs MUST NOT be ICV Address Block TLVs already associated with any of the addresses.

The rationale for not concatenating the addresses with any ICV TLV values already associated with the addresses when calculating the ICV is that several ICVs may be added to the same address or addresses, e.g., using different ICV cryptographic and/or hash functions, and the order of addition is not known to the recipient.

10.2. TIMESTAMP Address Block TLV

A TIMESTAMP Address Block TLV is an example of a Timestamp TLV as described in Section 7. If one or more TIMESTAMP TLVs and one or more ICV TLVs are associated with an address, the relevant TIMESTAMP

TLV <time-value>(s) MUST be included before calculating the value of the ICV to be contained in the ICV TLV value (i.e., concatenated with the associated addresses and any other values as described in Section 10.1).

11. ICV: Basic

The basic ICV, represented by way of an ICV TLV with type extension = 0, is a simple bit-field containing the cryptographic ICV. This assumes that the mechanism stipulating how ICVs are calculated and verified is established outside of this specification, e.g., by administrative configuration or external out-of-band signaling. Thus, the <ICV-value>, when using type extension = 0, is:

```
<ICV-value> := <ICV-data>
```

where:

<ICV-data> is a field, of length <length> octets (or single-length octets in a multivalue Address Block TLV) that contains the cryptographic ICV.

12. ICV: Hash Function and Cryptographic Function

One common way of calculating an ICV is combining a cryptographic function and a hash function applied to the content. This decomposition is specified in this section, using either type extension = 1 or type extension = 2, in the ICV TLVs.

12.1. General ICV TLV Structure

The following data structure allows representation of a cryptographic ICV, including specification of the appropriate hash function and cryptographic function used for calculating the ICV:

```
<ICV-value> := <hash-function>
               <cryptographic-function>
               <key-id-length>
               <key-id>?
               <ICV-data>
```

where:

<hash-function> is a one octet unsigned integer field specifying the hash function.

<cryptographic-function> is a one octet unsigned integer field specifying the cryptographic function.

<key-id-length> is a one octet unsigned integer field specifying the length of the <key-id> field as a number of octets. The value zero (0x00) is reserved for using a single pre-installed, shared key.

<key-id> is a field specifying the key identifier of the key that was used to calculate the ICV of the message, which allows unique identification of different keys with the same originator. It is the responsibility of each key originator to make sure that actively used keys that it issues have distinct key identifiers. If <key-id-length> equals zero (0x00), the <key-id> field is not contained in the TLV, and a single pre-installed, shared key is used.

<ICV-data> is a field with length <length> - 3 - <key-id-length> octets (except in a multivalue Address Block TLV, in which it is single-length - 3 - <key-id-length> octets) and which contains the cryptographic ICV.

The version of this TLV, specified in this section, assumes that, unless otherwise specified, calculating the ICV can be decomposed into:

```
ICV-value = cryptographic-function(hash-function(content))
```

In some cases a different combination of cryptographic function and hash function may be specified. This is the case for the HMAC function, which is specified as defined in Section 13.12, using the hash function twice.

The difference between the two type extensions is that in addition to the information covered by the ICV using type extension 1 (which is detailed in the following sections), the ICV using type extension 2 also MUST cover the source address of the IP datagram carrying the corresponding packet, message, or Address Block.

The <ICV-data> field MAY be truncated after being calculated, this is indicated by its length, calculated as described above. The truncation SHOULD be as specified for the relevant cryptographic function (and, if appropriate, hash function).

The hash function and the cryptographic function correspond to the entries in two IANA registries, which are reported by this specification and are described in Section 13.

12.1.1. Rationale

The rationale for separating the hash function and the cryptographic function into two octets instead of having all combinations in a single octet -- possibly as a TLV type extension -- is that adding further hash functions or cryptographic functions in the future may lead to a non-contiguous number space, as well as providing a smaller overall space.

The rationale for not including a field that lists parameters of the cryptographic ICV in the TLV is that, before being able to validate a cryptographic ICV, routers have to exchange or acquire keys. Any additional parameters can be provided together with the keys in that bootstrap process. It is therefore not necessary, and would even entail an extra overhead, to transmit the parameters within every message.

The rationale for the addition of type extension 2 is that the source code address is used in some cases, such as when processing HELLO messages in [RFC6130]. This is applicable only to packets (which only ever travel one hop) and messages (and their Address Blocks) that only travel one hop. It is not applicable to messages that may be forwarded more than one hop, such as TC messages in [OLSRv2].

12.2. Considerations for Calculating the ICV

The considerations listed in the following subsections MUST be applied when calculating the ICV for Packet, Message, and Address Block TLVs, respectively.

12.2.1. Packet ICV TLV

When determining the <ICV-data> for a packet, with type extension = 1:

- The ICV is calculated over the fields <hash-function>, <cryptographic-function>, <key-id-length>, and -- if present -- <key-id> (in that order), followed by the entire packet, including the Packet Header, including all Packet TLVs (other than ICV Packet TLVs), and all included messages. The considerations of Section 8.1 MUST be applied.

When determining the <ICV-data> for a packet, with type extension = 2:

- The same procedure as for type extension = 1 is used, except that the data used consists of a representation of the source address of the IP datagram carrying the packet, followed by the remaining

data (as for type extension = 1). The representation of the source address consists of a single octet containing the address length, in octets, followed by that many octets containing the address in network byte order.

12.2.2. Message ICV TLV

When determining the <ICV-data> for a message, with type extension = 1:

- The ICV is calculated over the fields <hash-function>, <cryptographic-function>, <key-id-length>, and -- if present -- <key-id> (in that order), followed by the entire message. The considerations in Section 9.1 MUST be applied.

When determining the <ICV-data> for a message, with type extension = 2:

- The same procedure as for type extension = 1 is used, except that the data used consists of a representation of the source address of the IP datagram carrying the message, followed by the remaining data (as for type extension = 1). The representation of the source address consists of a single octet containing the address length, in octets, followed by that many octets containing the address in network byte order.

12.2.3. Address Block ICV TLV

When determining the <ICV-data> for one or more addresses, with type extension = 1:

- The ICV is calculated over the fields <hash-function>, <cryptographic-function>, <key-id-length>, and -- if present -- <key-id> (in that order), followed by the addresses, and followed by any other values -- for example, other address block TLV <value>s that are associated with those addresses. A MANET routing protocol, or MANET routing protocol extension, using ICV Address Block TLVs MUST specify how to include any such concatenated attribute of the addresses in the verification process of the ICV. The considerations in Section 10.1 MUST be applied.

When determining the <ICV-data> for one or more addresses, with type extension = 2:

- The same procedure as for type extension = 1 is used, except that the data used consists of a representation of the source address of the IP datagram carrying the Address Block, followed by the

remaining data (as for type extension = 1). The representation of the source address consists of a single octet containing the address length, in octets, followed by that many octets containing the address in network byte order.

12.3. Example of a Message Including an ICV

The sample message depicted in Figure 1 is derived from Appendix D of [RFC5444]. The message contains an ICV Message TLV, with the value representing an ICV that is 16 octets long of the whole message, and a key identifier that is 4 octets long. The type extension of the Message TLV is 1, for the specific decomposition of an ICV using a cryptographic function and a hash function, as specified in Section 12.

```
    0                   1                   2                   3
    0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   | PV=0 |  PF=8  |    Packet Sequence Number     | Message Type  |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   | MF=15 | MAL=3 |      Message Length = 44      | Msg Orig Addr |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |       Message Originator Address (cont)       |   Hop Limit   |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |   Hop Count   |    Message Sequence Number    | Msg TLV Block |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   | Length = 27   |      ICV      |  MTLVF = 144  |  MTLVExt = 1  |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |Value Len = 23 |   Hash Func   |  Crypto Func  |Key ID length=4|
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                          Key Identifier                       |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                          ICV Value                            |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                          ICV Value (cont)                     |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                          ICV Value (cont)                     |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                          ICV Value (cont)                     |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Figure 1: Example Message with ICV

13. IANA Considerations

This specification reports the following, originally specified in [RFC6622]:

- Two Packet TLV Types, which have been allocated from the 0-223 range of the "Packet TLV Types" repository of [RFC5444], as specified in Table 1.

- Two Message TLV Types, which have been allocated from the 0-127 range of the "Message TLV Types" repository of [RFC5444], as specified in Table 2.

- Two Address Block TLV Types, which have been allocated from the 0-127 range of the "Address Block TLV Types" repository of [RFC5444], as specified in Table 3.

This specification updates the following, created in [RFC6622]:

- A type extension registry for each of these TLV types with values as listed in Tables 1, 2, and 3.

The following terms are used as defined in [BCP26]: "Namespace", "Registration", and "Designated Expert".

The following policy is used as defined in [BCP26]: "Expert Review".

13.1. Expert Review: Evaluation Guidelines

For TLV type extensions registries where an Expert Review is required, the Designated Expert SHOULD take the same general recommendations into consideration as those specified by [RFC5444].

For both TIMESTAMP and ICV TLVs, functionally similar extensions for Packet, Message, and Address Block TLVs SHOULD be numbered identically.

13.2. Packet TLV Types

IANA has, in accordance with [RFC6622], made allocations from the "Packet TLV Types" namespace of [RFC5444] for the Packet TLVs specified in Table 1. IANA is requested to modify this allocation as indicated.

Type	Description	Reference
5	ICV	RFC xxxx
6	TIMESTAMP	RFC xxxx

Table 1: Packet TLV Types

13.3. Message TLV Types

IANA has, in accordance with [RFC6622], made allocations from the "Message TLV Types" namespace of [RFC5444] for the Message TLVs specified in Table 2. IANA is requested to modify this allocation as indicated.

Type	Description	Reference
5	ICV	RFC xxxx
6	TIMESTAMP	RFC xxxx

Table 2: Message TLV Types

13.4. Address Block TLV Types

IANA has, in accordance with [RFC6622], made allocations from the "Address Block TLV Types" namespace of [RFC5444] for the Packet TLVs specified in Table 3. IANA is requested to modify this allocation as indicated.

Type	Description	Reference
5	ICV	RFC xxxx
6	TIMESTAMP	RFC xxxx

Table 3: Address Block TLV Types

13.5. ICV Packet TLV Type Extensions

IANA has, in accordance with [RFC6622], made allocations from the "ICV Packet TLV Type Extensions" namespace of [RFC6622] for the Packet TLVs specified in Table 4. IANA is requested to modify this allocation (including defining type extension = 2) as indicated.

Type Extension	Description	Reference
0	ICV of a packet	RFC xxxx
1	ICV, using a cryptographic function and a hash function, as specified in Section 12 of this document	RFC xxxx
2	ICV, using a cryptographic function and a hash function, and including the IP datagram source address, as specified in Section 12 of this document	RFC xxxx
3-251	Unassigned; Expert Review	
252-255	Experimental Use	RFC xxxx

Table 4: ICV Packet TLV Type Extensions

More than one ICV Packet TLV with the same type extension MAY be included in a packet if these represent different ICV calculations (e.g., with type extension 1 or 2 and different cryptographic function and/or hash function, or with a different key identifier). ICV Packet TLVs that carry what is declared to be the same information MUST NOT be included in the same packet.

13.6. TIMESTAMP Packet TLV Type Extensions

IANA has, in accordance with [RFC6622], made allocations from the "TIMESTAMP Packet TLV Type Extensions" namespace of [RFC6622] for the Packet TLVs specified in Table 5. IANA is requested to modify this allocation as indicated.

Type Extension	Description	Reference
0	Unsigned timestamp of arbitrary length, given by the TLV Length field. The MANET routing protocol has to define how to interpret this timestamp	RFC xxxx
1	Unsigned 32-bit timestamp, as specified in [IEEE 1003.1-2008 (POSIX)]	RFC xxxx
2	NTP timestamp format, as specified in [RFC5905]	RFC xxxx
3	Signed timestamp of arbitrary length with no constraints such as monotonicity. In particular, it may represent any random value	RFC xxxx
4-251	Unassigned; Expert Review	
252-255	Experimental Use	RFC xxxx

Table 5: TIMESTAMP Packet TLV Type Extensions

More than one TIMESTAMP Packet TLV with the same type extension MUST NOT be included in a packet.

13.7. ICV Message TLV Type Extensions

IANA has, in accordance with [RFC6622], made allocations from the "ICV Message TLV Type Extensions" namespace of [RFC6622] for the Message TLVs specified in Table 6. IANA is requested to modify this allocation (including defining type extension = 2) as indicated.

Type Extension	Description	Reference
0	ICV of a message	RFC xxxx
1	ICV, using a cryptographic function and a hash function, as specified in Section 12 of this document	RFC xxxx
2	ICV, using a cryptographic function and a hash function, and including the IP datagram source address, as specified in Section 12 of this document	RFC xxxx
3-251	Unassigned; Expert Review	
252-255	Experimental Use	RFC xxxx

Table 6: ICV Message TLV Type Extensions

More than one ICV Message TLV with the same type extension MAY be included in a message if these represent different ICV calculations (e.g., with type extension 1 or 2 and different cryptographic function and/or hash function, or with a different key identifier). ICV Message TLVs that carry what is declared to be the same information MUST NOT be included in the same message.

13.8. TIMESTAMP Message TLV Type Extensions

IANA has, in accordance with [RFC6622], made allocations from the "TIMESTAMP Message TLV Type Extensions" namespace of [RFC6622] for the Message TLVs specified in Table 7. IANA is requested to modify this allocation as indicated.

Type Extension	Description	Reference
0	Unsigned timestamp of arbitrary length, given by the TLV Length field. The MANET routing protocol has to define how to interpret this timestamp	RFC xxxx
1	Unsigned 32-bit timestamp, as specified in [IEEE 1003.1-2008 (POSIX)]	RFC xxxx
2	NTP timestamp format, as specified in [RFC5905]	RFC xxxx
3	Signed timestamp of arbitrary length with no constraints such as monotonicity. In particular, it may represent any random value	RFC xxxx
4-251	Unassigned; Expert Review	
252-255	Experimental Use	RFC xxxx

Table 7: TIMESTAMP Message TLV Type Extensions

More than one TIMESTAMP Message TLV with the same type extension MUST NOT be included in a message.

13.9. ICV Address Block TLV Type Extensions

IANA has, in accordance with [RFC6622], made allocations from the "ICV Address Block TLV Type Extensions" namespace of [RFC6622] for the Address Block TLVs specified in Table 8. IANA is requested to modify this allocation (including defining type extension = 2) as indicated.

Type Extension	Description	Reference
0	ICV of an object (e.g., an address)	RFC xxxx
1	ICV, using a cryptographic function and a hash function, as specified in Section 12 of this document	RFC xxxx
2	ICV, using a cryptographic function and a hash function, and including the IP datagram source address, as specified in Section 12 of this document	RFC xxxx
3-251	Unassigned; Expert Review	
252-255	Experimental Use	RFC xxxx

Table 8: ICV Address Block TLV Type Extensions

More than one ICV Address Block TLV with the same type extension MAY be associate with an address if these represent different ICV calculations (e.g., with type extension 1 or 2 and different cryptographic function and/or hash function, or with a different key identifier). ICV Address Block TLVs that carry what is declared to be the same information MUST NOT be associated with the same address.

13.10. TIMESTAMP Address Block TLV Type Extensions

IANA has, in accordance with [RFC6622], made allocations from the "TIMESTAMP Address Block TLV Type Extensions" namespace of [RFC6622] for the Address Block TLVs specified in Table 9. IANA is requested to modify this allocation as indicated.

Type Extension	Description	Reference
0	Unsigned timestamp of arbitrary length, given by the TLV Length field. The MANET routing protocol has to define how to interpret this timestamp	RFC xxxx
1	Unsigned 32-bit timestamp, as specified in [IEEE 1003.1-2008 (POSIX)]	RFC xxxx
2	NTP timestamp format, as specified in [RFC5905]	RFC xxxx
3	Signed timestamp of arbitrary length with no constraints such as monotonicity. In particular, it may represent any random value	RFC xxxx
4-251	Unassigned; Expert Review	
252-255	Experimental Use	RFC xxxx

Table 9: TIMESTAMP Address Block TLV Type Extensions

More than one TIMESTAMP Address Block TLV with the same type extension MUST NOT be associated with any address.

13.11. Hash Functions

IANA has, in accordance with [RFC6622], created a registry for hash functions that can be used when creating an ICV, as specified in Section 12 of this document. The initial assignments and allocation policies are specified in Table 10. IANA is requested to modify this allocation as indicated.

Value	Algorithm	Description	Reference
0	none	The "identity function": The hash value of an object is the object itself	RFC xxxx
1	SHA-1	[NIST-FIPS-180-4]	RFC xxxx
2	SHA-224	[NIST-FIPS-180-4]	RFC xxxx
3	SHA-256	[NIST-FIPS-180-4]	RFC xxxx
4	SHA-384	[NIST-FIPS-180-4]	RFC xxxx
5	SHA-512	[NIST-FIPS-180-4]	RFC xxxx
6-251		Unassigned; Expert Review	
252-255		Experimental Use	RFC xxxx

Table 10: Hash Function Registry

13.12. Cryptographic Functions

IANA has, in accordance with [RFC6622], created a registry for the cryptographic functions, as specified in Section 12 of this document. Initial assignments and allocation policies are specified in Table 11. IANA is requested to modify this allocation as indicated.

Value	Algorithm	Description	Reference
0	none	The "identity function": The value of an encrypted hash is the hash itself	RFC xxxx
1	RSA	[RFC3447]	RFC xxxx
2	DSA	[NIST-FIPS-186-3]	RFC xxxx
3	HMAC	[RFC2104]	RFC xxxx
4	3DES	[NIST-SP-800-67]	RFC xxxx
5	AES-128	[NIST-FIPS-197]	RFC xxxx
6	ECDSA	[ANSI-X9-62-2005]	RFC xxxx
7-251		Unassigned; Expert Review	
252-255		Experimental Use	RFC xxxx

Table 11: Cryptographic Function Registry

14. Security Considerations

This document does not specify a protocol. It provides a syntactical component for cryptographic ICVs of messages and packets, as defined in [RFC5444]. It can be used to address security issues of a MANET routing protocol or MANET routing protocol extension. As such, it

has the same security considerations as [RFC5444].

In addition, a MANET routing protocol or MANET routing protocol extension that uses this specification MUST specify how to use the framework, and the TLVs presented in this document. In addition, the protection that the MANET routing protocol or MANET routing protocol extensions attain by using this framework MUST be described.

As an example, a MANET routing protocol that uses this component to reject "badly formed" or "insecure" messages if a control message does not contain a valid ICV SHOULD indicate the security assumption that if the ICV is valid, the message is considered valid. It also SHOULD indicate the security issues that are counteracted by this measure (e.g., link or identity spoofing) as well as the issues that are not counteracted (e.g., compromised keys).

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