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# Completely Encrypting RTP Header Extensions and Contributing Sources

## Abstract

While the Secure Real-time Transport Protocol (SRTP) provides confidentiality for the contents of a media packet, a significant amount of metadata is left unprotected, including RTP header extensions and contributing sources (CSRCs). However, this data can be moderately sensitive in many applications. While there have been previous attempts to protect this data, they have had limited deployment, due to complexity as well as technical limitations.

This document proposes a new mechanism to completely encrypt header extensions and CSRCs as well a simpler signaling mechanism intended to facilitate deployment.

## Discussion Venues

This note is to be removed before publishing as an RFC.

Source for this draft and an issue tracker can be found at https://github.com/juberti/cryptex.

## Status of This Memo

## Copyright Notice



## Table of Contents



## 1. Introduction

### 1.1. Problem Statement

The Secure Real-time Transport Protocol [RFC3711] mechanism provides message authentication for the entire RTP packet, but only encrypts the RTP payload. This has not historically been a problem, as much of the information carried in the header has minimal sensitivity (e.g., RTP timestamp); in addition, certain fields need to remain as

cleartext because they are used for key scheduling (e.g., RTP SSRC and sequence number).

However, as noted in [RFC6904], the security requirements can be different for information carried in RTP header extensions, including the per-packet sound levels defined in [RFC6464] and [RFC6465], which are specifically noted as being sensitive in the Security Considerations section of those RFCs.

In addition to the contents of the header extensions, there are now enough header extensions in active use that the header extension identifiers themselves can provide meaningful information in terms of determining the identity of endpoint and/or application. Accordingly, these identifiers can be considered at least slightly sensitive.

Finally, the CSRCs included in RTP packets can also be sensitive, potentially allowing a network eavesdropper to determine who was speaking and when during an otherwise secure conference call.

### 1.2. Previous Solutions

[RFC6904] was proposed in 2013 as a solution to the problem of unprotected header extension values. However, it has not seen significant adoption, and has a few technical shortcomings.

First, the mechanism is complicated. Since it allows encryption to be negotiated on a per-extension basis, a fair amount of signaling logic is required. And in the SRTP layer, a somewhat complex transform is required to allow only the selected header extension values to be encrypted. One of the most popular SRTP implementations had a significant bug in this area that was not detected for five years.

Second, it only protects the header extension values, and not their ids or lengths. It also does not protect the CSRCs. As noted above, this leaves a fair amount of potentially sensitive information exposed.

Third, it bloats the header extension space. Because each extension must be offered in both unencrypted and encrypted forms, twice as many header extensions must be offered, which will in many cases push implementations past the 14-extension limit for the use of one-byte extension headers defined in [RFC8285]. Accordingly, implementations will need to use two-byte headers in many cases, which are not supported well by some existing implementations.

Finally, the header extension bloat combined with the need for backwards compatibility results in additional wire overhead. Because two-byte extension headers may not be handled well by existing

implementations, one-byte extension identifiers will need to be used for the unencrypted (backwards compatible) forms, and two-byte for the encrypted forms. Thus, deployment of [RFC6904] encryption for header extensions will typically result in multiple extra bytes in each RTP packet, compared to the present situation.

### 1.3. Goals

From this analysis we can state the desired properties of a solution:

- Build on existing [RFC3711] SRTP framework (simple to understand)
- Build on existing [RFC8285] header extension framework (simple to implement)
- Protection of header extension ids, lengths, and values
- Protection of CSRCs when present
- Simple signaling
- Simple crypto transform and SRTP interactions
- Backward compatible with unencrypted endpoints, if desired
- Backward compatible with existing RTP tooling

The last point deserves further discussion. While we considered possible solutions that would have encrypted more of the RTP header (e.g., the number of CSRCs), we felt the inability to parse the resultant packets with current tools, as well as additional complexity incurred, outweighed the slight improvement in confidentiality.

## 2. 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 [RFC2119].

## 3. Design

This specification proposes a mechanism to negotiate encryption of all RTP header extensions (ids, lengths, and values) as well as CSRC values. It reuses the existing SRTP framework, is accordingly simple to implement, and is backward compatible with existing RTP packet parsing code, even when support for this mechanism has been negotiated.

## 4. Signaling

In order to determine whether this mechanism defined in this specification is supported, this document defines a new "a=cryptex" Session Description Protocol (SDP) [RFC4566] attribute to indicate support. This attribute takes no value, and can be used at the session level or media level. Offering this attribute indicates that the endpoint is capable of receiving RTP packets encrypted as defined below.

The formal definition of this attribute is:

Name: cryptex

Value: None

Usage Level: session, media

Charset Dependent: No

Example:

```
a=cryptex
```

When used with BUNDLE, this attribute is assigned to the TRANSPORT category [RFC8859].

## 5. RTP Header Processing

[RFC8285] defines two values for the "defined by profile" field for carrying one-byte and two-byte header extensions. In order to allow a receiver to determine if an incoming RTP packet is using the encryption scheme in this specification, two new values are defined:

* 0xC0DE for the encrypted version of the one-byte header extensions (instead of 0xBEDE).

* 0xC2DE for the encrypted versions of the two-byte header extensions (instead of 0x100).

In the case of using two-byte header extensions, the extension id with value 256 MUST NOT be negotiated, as the value of this id is meant to be contained in the "appbits" of the "defined by profile" field, which are not available when using the values above.

If the "a=extmap-allow-mixed" attribute defined in [RFC8285] is negotiated, either one-byte or two-byte header ids can be used (with the values above), as in [RFC8285].

### 5.1. Sending

When the mechanism defined by this specification has been negotiated, sending a RTP packet that has any CSRCs or contains any {RFC8285}} header extensions follows the steps below. This mechanism MUST NOT be used with header extensions other than the [RFC8285] variety.

If the packet contains solely one-byte extension ids, the 16-bit RTP header extension tag MUST be set to 0xC0DE to indicate that the encryption has been applied, and the one-byte framing is being used. If the packet contains only two-byte extension ids, the header extension tag MUST be set to 0xC2DE to indicate encryption has been applied, and the two-byte framing is being used.

If the packet contains CSRCs but no header extensions, an empty extension block consisting of the 0xC0DE tag and a 16-bit length field set to zero (explicitly permitted by [RFC3550]) MUST be appended, and the X bit MUST be set to 1 to indicate an extension block is present. This is necessary to provide the receiver an indication that the CSRCs in the packet are encrypted.

The RTP packet MUST then be encrypted as described in Encryption Procedure.

### 5.2. Receiving

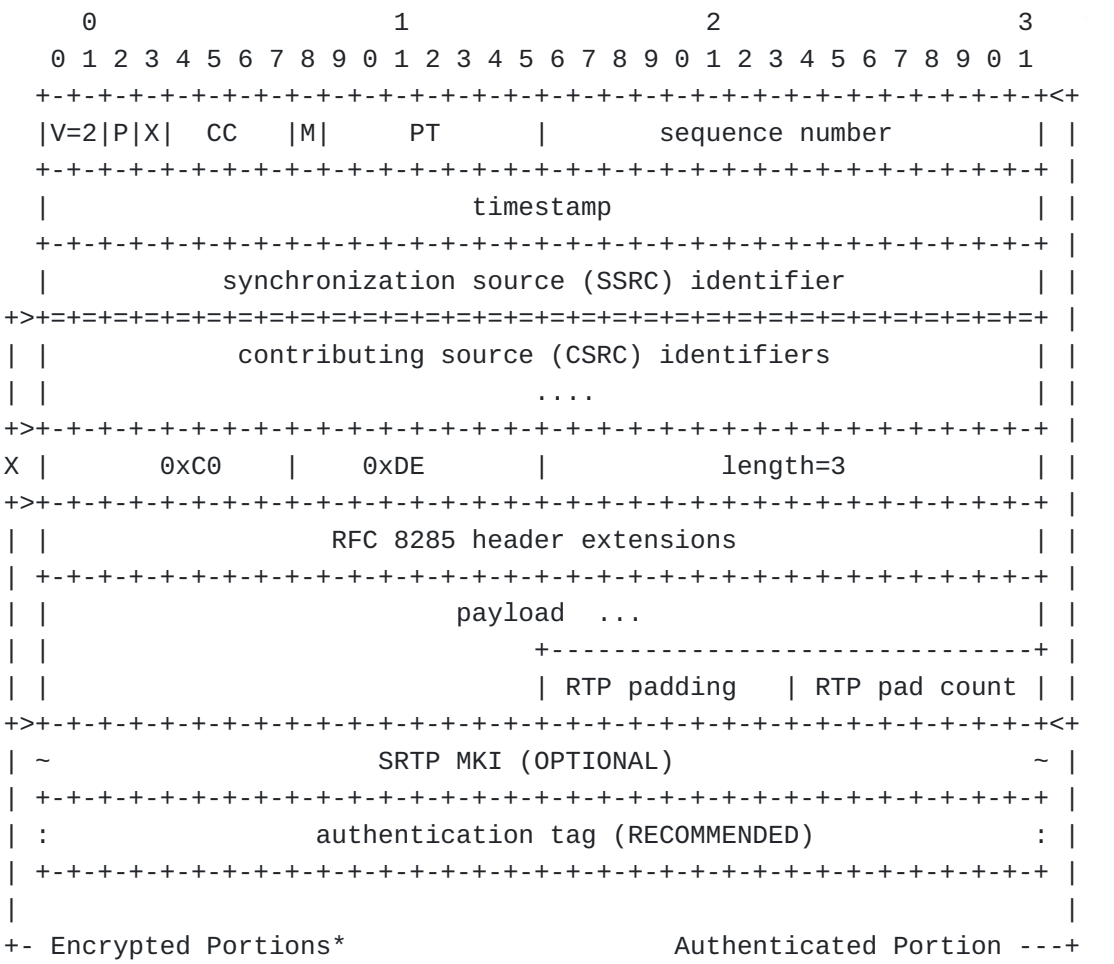
When receiving an RTP packet that contains header extensions, the "defined by profile" field MUST be checked to ensure the payload is formatted according to this specification. If the field does not match one of the values defined above, the implementation MUST instead handle it according to the specification that defines that value. The implemntation MAY stop and report an error if it considers use of this specification mandatory for the RTP stream.

If the RTP packet passes this check, it is then decrypted according to Decryption Procedure, and passed to the the next layer to process the packet and its extensions. In the event that a zero-length extension block was added as indicated above, it can be left as-is and will be processed normally.

## 6. Encryption and Decryption

### 6.1. Packet Structure

When this mechanism is active, the SRTP packet is protected as follows:




*Note that the 4 bytes at the start of the extension block are not encrypted, as required by [RFC8285].

Specifically, the encrypted portion MUST include any CSRC identifiers, any RTP header extension (except for the first 4 bytes), and the RTP payload.

### 6.2. Encryption Procedure

The encryption procedure is identical to that of [RFC3711] except for the region to encrypt, which is as shown in the section above.

To minimize changes to surrounding code, the encryption mechanism can choose to replace a "defined by profile" field from [RFC8285] with its counterpart defined in RTP Header Processing above and encrypt at the same time.

### 6.3. Decryption Procedure

The decryption procedure is identical to that of [RFC3711] except for the region to decrypt, which is as shown in the section above.

To minimize changes to surrounding code, the decryption mechanism can choose to replace the "defined by profile" field with its no-encryption counterpart from [RFC8285] and decrypt at the same time.

## 7. Backwards Compatibility

This specification attempts to encrypt as much as possible without interfering with backwards compatibility for systems that expect a certain structure from an RTPv2 packet, including systems that perform demultiplexing based on packet headers. Accordingly, the first two bytes of the RTP packet are not encrypted.

This specification also attempts to reuse the key scheduling from SRTP, which depends on the RTP packet sequence number and SSRC identifier. Accordingly these values are also not encrypted.

## 8. Security Considerations

This specification extends SRTP by expanding the portion of the packet that is encrypted, as shown in Packet Structure. It does not change how SRTP authentication works in any way. Given that more of the packet is being encrypted than before, this is necessarily an improvement.

The RTP fields that are left unencrypted (see rationale above) are as follows:

- RTP version
- padding bit
- extension bit
- number of CSRCs
- marker bit
- payload type
- sequence number
- timestamp
- SSRC identifier
- number of [RFC8285] header extensions

These values contain a fixed set (i.e., one that won't be changed by extensions) of information that, at present, is observed to have low sensitivity. In the event any of these values need to be encrypted,

SRTP is likely the wrong protocol to use and a fully-encapsulating protocol such as DTLS is preferred (with its attendant per-packet overhead).

## 9. IANA Considerations

This document defines two new 'defined by profile' attributes, as noted in RTP Header Processing.

## 10. Acknowledgements

The authors wish to thank Lennart Grahl for pointing out many of the issues with the existing header encryption mechanism, as well as suggestions for this proposal. Thanks also to Jonathan Lennox and Inaki Castillo for their review and suggestions.

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