                      Multiplexing Scheme Updates
        for Secure Real-time Transport Protocol (SRTP) Extension
             for Datagram Transport Layer Security (DTLS)

Abstract

   This document defines how Datagram Transport Layer Security (DTLS),
   Real-time Transport Protocol (RTP), RTP Control Protocol (RTCP),
   Session Traversal Utilities for NAT (STUN), Traversal Using Relays
   around NAT (TURN), and ZRTP packets are multiplexed on a single
   receiving socket. It overrides the guidance from RFC 5764 ("SRTP
   Extension for DTLS"), which suffered from four issues described and
   fixed in this document.

   This document updates RFC 5764.

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Table of Contents

1. Introduction

   Section 5.1.2 of "Datagram Transport Layer Security (DTLS) Extension
   to Establish Keys for the Secure Real-time Transport Protocol (SRTP)"
   [RFC5764] defines a scheme for a Real-time Transport Protocol (RTP)
   [RFC3550] receiver to demultiplex DTLS [RFC6347], Session Traversal
   Utilities for NAT (STUN) [RFC5389], and Secure Real-time Transport
   Protocol (SRTP) / Secure Real-time Transport Control Protocol (SRTCP)
   [RFC3711] packets that are arriving on the RTP port. Unfortunately,
   this demultiplexing scheme has created problematic issues:

   1. It implicitly allocated codepoints for new STUN methods without
       an IANA registry reflecting these new allocations.

   2. It did not take into account the fact that ZRTP [RFC6189] also
       needs to be demultiplexed with the other packet types explicitly
       mentioned in Section 5.1.2 of RFC 5764.

   3. It implicitly allocated codepoints for new Transport Layer
       Security (TLS) ContentTypes without an IANA registry reflecting
       these new allocations.

   4. It did not take into account the fact that the Traversal Using
       Relays around NAT (TURN) usage of STUN can create TURN channels
       that also need to be demultiplexed with the other packet types
       explicitly mentioned in Section 5.1.2 of RFC 5764.

   Having overlapping ranges between different IANA registries becomes
   an issue when a new codepoint is allocated in one of these registries
   without carefully analyzing the impact it could have on the other
   registries when that codepoint is demultiplexed. Among other
   downsides of the bad design of the demultiplexing algorithm detailed
   in [RFC5764], it creates a requirement for coordination between
   codepoint assignments where none should exist, and that is
   organizationally and socially undesirable. However, RFC 5764 has
   been widely deployed, so there must be an awareness of this issue and
   how it must be dealt with. Thus, even if the feature related to a
   codepoint is not initially thought to be useful in the context of
   demultiplexing, the respective IANA registry expert should at least
   raise a flag when the allocated codepoint irrevocably prevents
   multiplexing.

The first goal of this document is to make sure that future
allocations in any of the affected protocols are done with the full
knowledge of their impact on multiplexing. This is achieved by
updating [RFC5764], which includes modifying the IANA registries with
instructions for coordination between the protocols at risk.

A second goal is to permit the addition of new protocols to the list
of existing multiplexed protocols in a manner that does not break
existing implementations.

At the time of this writing, the flaws in the demultiplexing scheme
were unavoidably inherited by other documents, such as [RFC7345] and
[SDP-BUNDLE]. So in addition, these and any other affected documents
will need to be corrected with the updates this document provides.

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. Implicit Allocation of Codepoints for New STUN Methods

The demultiplexing scheme in [RFC5764] states that the receiver can
identify the packet type by looking at the first byte. If the value
of this first byte is 0 or 1, the packet is identified to be STUN.
The problem with this implicit allocation is that it restricts the
codepoints for STUN methods (as described in Section 18.1 of
[RFC5389]) to values between 0x000 and 0x07F, which in turn reduces
the number of possible STUN method codepoints assigned by IETF Review
(i.e., the range 0x000 - 0x7FF) from 2048 to only 128 and eliminates
the possibility of having STUN method codepoints assigned by
Designated Expert (i.e., the range 0x800 - 0xFFF).

To preserve the Designated Expert range, this document allocates the
values 2 and 3 to also identify STUN methods.

The IANA Registry for STUN methods has been modified to mark the
codepoints from 0x100 to 0xFFF as Reserved. These codepoints can
still be allocated, but require IETF Review with a document that will
properly evaluate the risk of an assignment overlapping with other
registries.

   In addition, this document also updates the IANA registry such that
   the STUN method codepoints assigned in the 0x080-0x0FF range are also
   assigned via Designated Expert. The "STUN Methods" registry has been
   changed as follows:

   OLD:

   0x000-0x7FF   IETF Review
   0x800-0xFFF   Designated Expert

   NEW:

   0x000-0x07F   IETF Review
   0x080-0x0FF   Designated Expert
   0x100-0xFFF   Reserved

4. Multiplexing of ZRTP

   ZRTP [RFC6189] is a protocol for media path Diffie-Hellman exchange
   to agree on a session key and parameters for establishing unicast
   SRTP sessions for Voice over IP (VoIP) applications. The ZRTP
   protocol is media path keying because it is multiplexed on the same
   port as RTP and does not require support in the signaling protocol.

   In order to prevent future documents from assigning values from the
   unused range to a new protocol, this document modifies the [RFC5764]
   demultiplexing algorithm to properly account for ZRTP [RFC6189] by
   allocating the values from 16 to 19 for this purpose.

5. Implicit Allocation of New Codepoints for TLS ContentTypes

   The demultiplexing scheme in [RFC5764] dictates that if the value of
   the first byte is between 20 and 63 (inclusive), then the packet is
   identified to be DTLS. For DTLS 1.0 [RFC4347] and DTLS 1.2
   [RFC6347], that first byte corresponds to the TLS ContentType field.
   Considerations must be taken into account when assigning additional
   ContentTypes in the codepoint ranges 0 to 19 and 64 to 255, so this
   does not prevent demultiplexing when this functionality is desirable.
   Note that [RFC5764] describes a narrow use of DTLS that works as long
   as the specific DTLS version used abides by the restrictions on the
   demultiplexing byte (the ones that this document imposes on the "TLS
   ContentType Registry"). Any extension or revision to DTLS that
   causes it to no longer meet these constraints should consider what
   values may occur in the first byte of the DTLS message and what
   impact it would have on the multiplexing that [RFC5764] describes.

   With respect to TLS packet identification, this document explicitly
   adds a warning to the codepoints from 0 to 19 and from 64 to 255
   indicating that allocations in these ranges require coordination, as
   described in this document. The "TLS ContentType Registry" has been
   changed as follows:

   OLD:

   0-19   Unassigned
   20   change_cipher_spec
   21   alert
   22   handshake
   23   application_data
   24   heartbeat
   25-255   Unassigned

   NEW:

   0-19   Unassigned (Requires coordination; see RFC 7983)
   20   change_cipher_spec
   21   alert
   22   handshake
   23   application_data
   24   heartbeat
   25-63   Unassigned
   64-255   Unassigned (Requires coordination; see RFC 7983)

6. Multiplexing of TURN Channels

   When used with Interactive Connectivity Establishment (ICE)
   [RFC5245], an implementation of RFC 5764 can receive packets on the
   same socket from three different paths, as shown in Figure 1:

   1. Directly from the source

   2. Through a NAT

   3. Relayed by a TURN server

```
        +------+
        | TURN |<-----------------------+
        +------+                        |
           |                            |
           | +-----------------------+  |
           | |                       |  |
           v v                       |  |
  NAT -----------                    |  |
           | | +-------------------+ |  |
           | | |                   | |  |
           v v v                   | |  |
      +----------+             +----------+
      | RFC 5764 |             | RFC 5764 |
      +----------+             +----------+
```
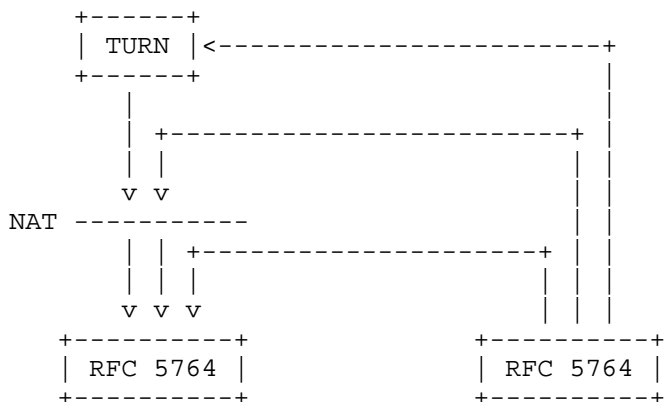
        Figure 1: Packet Reception by an Implementation of RFC 5764

   Even if the ICE algorithm succeeded in selecting a non-relayed path,
   it is still possible to receive data from the TURN server. For
   instance, when ICE is used with aggressive nomination, the media path
   can quickly change until it stabilizes. Also, freeing ICE candidates
   is optional, so the TURN server can restart forwarding STUN
   connectivity checks during an ICE restart.

   TURN channels are an optimization where data packets are exchanged
   with a 4-byte prefix instead of the standard 36-byte STUN overhead
   (see Section 2.5 of [RFC5766]). The problem is that the RFC 5764
   demultiplexing scheme does not define what to do with packets
   received over a TURN channel since these packets will start with a
   first byte whose value will be between 64 and 127 (inclusive). If
   the TURN server was instructed to send data over a TURN channel, then
   the demultiplexing scheme specified in RFC 5764 will reject these
   packets. Current implementations violate RFC 5764 for values 64 to
   127 (inclusive) and they instead parse packets with such values as
   TURN.

   In order to prevent future documents from assigning values from the
   unused range to a new protocol, this document modifies the
   demultiplexing algorithm in RFC 5764 to properly account for TURN
   channels by allocating the values from 64 to 79 for this purpose.
   This modification restricts the TURN channel space to a more limited
   set of possible channels when the TURN client does the channel
   binding request in combination with the demultiplexing scheme
   described in [RFC5764].

7. Updates to RFC 5764

   This document updates the text in Section 5.1.2 of [RFC5764] as
   follows:

   OLD TEXT

   The process for demultiplexing a packet is as follows. The receiver
   looks at the first byte of the packet. If the value of this byte is
   0 or 1, then the packet is STUN. If the value is in between 128 and
   191 (inclusive), then the packet is RTP (or RTCP, if both RTCP and
   RTP are being multiplexed over the same destination port). If the
   value is between 20 and 63 (inclusive), the packet is DTLS. This
   process is summarized in Figure 3.

```
                   +----------------+
                   | 127 < B < 192 -+--> forward to RTP
                   |                |
        packet --> |   19 < B < 64  -+--> forward to DTLS
                   |                |
                   |        B < 2   -+--> forward to STUN
                   +----------------+
```
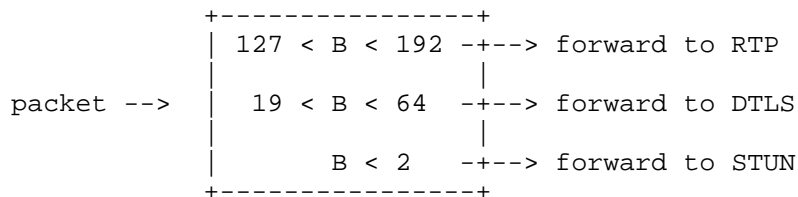
      Figure 3: The DTLS-SRTP receiver's packet demultiplexing algorithm.
          Here the field B denotes the leading byte of the packet.

   END OLD TEXT

NEW TEXT

The process for demultiplexing a packet is as follows. The receiver
looks at the first byte of the packet. If the value of this byte is
in between 0 and 3 (inclusive), then the packet is STUN. If the
value is between 16 and 19 (inclusive), then the packet is ZRTP. If
the value is between 20 and 63 (inclusive), then the packet is DTLS.
If the value is between 64 and 79 (inclusive), then the packet is
TURN Channel. If the value is in between 128 and 191 (inclusive),
then the packet is RTP (or RTCP, if both RTCP and RTP are being
multiplexed over the same destination port). If the value does not
match any known range, then the packet MUST be dropped and an alert
MAY be logged. This process is summarized in Figure 3.

```
                   +----------------+
                   |           [0..3] -+--> forward to STUN
                   |                |
                   |          [16..19] -+--> forward to ZRTP
                   |                |
         packet -->|          [20..63] -+--> forward to DTLS
                   |                |
                   |          [64..79] -+--> forward to TURN Channel
                   |                |
                   |        [128..191] -+--> forward to RTP/RTCP
                   +----------------+
```
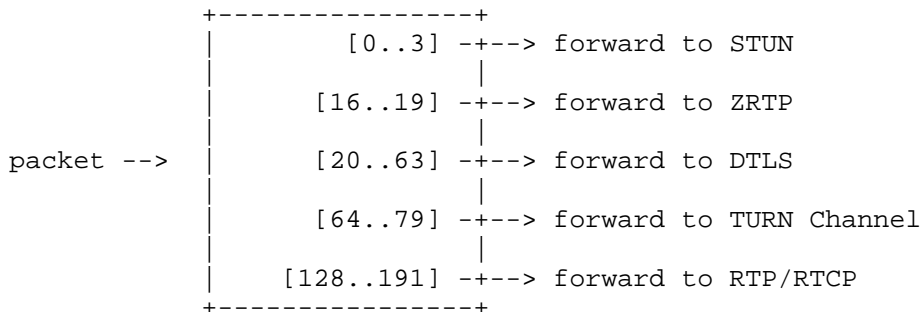
   Figure 3: The DTLS-SRTP receiver's packet demultiplexing algorithm.

END NEW TEXT

8. Security Considerations

   This document updates existing IANA registries and adds a new range
   for TURN channels in the demultiplexing algorithm.

   These modifications do not introduce any specific security
   considerations beyond those detailed in [RFC5764].

9. IANA Considerations

9.1. STUN Methods

   This specification contains the registration information for reserved
   STUN Methods codepoints, as explained in Section 3 and in accordance
   with the procedures defined in Section 18.1 of [RFC5389].

   Value: 0x100-0xFFF

   Name: Reserved (For DTLS-SRTP multiplexing collision avoidance, see
      RFC 7983. Cannot be made available for assignment without IETF
      Review.)

   Reference: RFC 5764, RFC 7983

   This specification also reassigns the ranges in the STUN Methods
   Registry as follows:

   Range: 0x000-0x07F

   Registration Procedures: IETF Review

   Range: 0x080-0x0FF

   Registration Procedures: Designated Expert

9.2. TLS ContentType

   This specification contains the registration information for reserved
   TLS ContentType codepoints, as explained in Section 5 and in
   accordance with the procedures defined in Section 12 of [RFC5246].

   Value: 0-19

   Description: Unassigned (Requires coordination; see RFC 7983)

   DTLS-OK: N/A

   Reference: RFC 5764, RFC 7983

   Value: 64-255

   Description: Unassigned (Requires coordination; see RFC 7983)

   DTLS-OK: N/A

   Reference: RFC 5764, RFC 7983

9.3. Traversal Using Relays around NAT (TURN) Channel Numbers

   This specification contains the registration information for reserved
   codepoints in the "Traversal Using Relays around NAT (TURN) Channel
   Numbers" registry, as explained in Section 6 and in accordance with
   the procedures defined in Section 18 of [RFC5766].

   Value: 0x5000-0xFFFF

   Name: Reserved (For DTLS-SRTP multiplexing collision avoidance, see
      RFC 7983.)

   Reference: RFC 7983

10. References

10.1. Normative References

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10.2. Informative References

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