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DTLS-SRTP Handling in Session Initiation Protocol (SIP) Back-to-Back User Agents (B2BUAs)
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Abstract

Session Initiation Protocol (SIP) Back-to-Back User Agents (B2BUAs) often function on the media plane, rather than just on the signaling path. This document describes the behavior B2BUAs should follow when acting on the media plane that use Secure Real-time Transport (SRTP) security context setup with Datagram Transport Layer Security (DTLS) protocol.

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1. Introduction

1.1. Overview

[RFC5763] describes how Session Initiation Protocol (SIP) [RFC3261] can be used to establish a Secure Real-time Transport Protocol (SRTP) [RFC3711] security context with Datagram Transport Layer Security (DTLS) [RFC6347] protocol. It describes a mechanism of transporting a certificate fingerprint in the Session Description Protocol (SDP) [RFC4566], which identifies the certificate that will be presented during the DTLS handshake. DTLS-SRTP is defined for point-to-point media sessions, in which there are exactly two participants. Each DTLS-SRTP session (described in section 3 of [RFC5764]) contains a single DTLS association, and either two SRTP contexts (if media traffic is flowing in both directions on the same 5-tuple) or one SRTP context (if media traffic is only flowing in one direction).

In many SIP deployments, SIP entities exist in the SIP signaling path between the originating and final terminating endpoints. These SIP

entities, as described in [RFC7092], modify SIP and SDP bodies and also are likely to be on the media path. Such entities, when present in the signaling/media path, are likely to do several things. For example, some B2BUAs modify parts of the SDP body (like IP address, port) and subsequently modify the RTP headers as well.

1.2. Goals

[RFC7092] describes two different categories of such B2BUAs, according to the level of activities performed on the media plane:

A B2BUA that act as a simple media relay effectively unaware of anything that is transported and only modifies the UDP/IP header of the packets.

A B2BUA that performs a media-aware role. It inspects and potentially modifies RTP or RTP Control Protocol (RTCP) headers; but it does not modify the payload of RTP/RTCP.

The following sections describe the behavior B2BUAs should follow in order to avoid any impact on end-to-end DTLS-SRTP streams.

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].

The following generalized terms are defined in [RFC3261], Section 6.

B2BUA: a SIP Back-to-Back User Agent, which is the logical combination of a User Agent Server (UAS) and User Agent Client (UAC).

UAS: a SIP User Agent Server.

UAC: a SIP User Agent Client.

All of the pertinent B2BUA terminology and taxonomy used in this document is based on [RFC7092].

It is assumed the reader is already familiar with the fundamental concepts of the RTP protocol [RFC3550] and its taxonomy [I-D.ietf-avtext-rtp-grouping-taxonomy], as well as those of SRTP [RFC3711], and DTLS [RFC6347].

3. Media Plane B2BUA handling of DTLS-SRTP

3.1. General

This section describes the DTLS-SRTP handling by the different types of media plane B2BUAs defined in [RFC7092].

3.1.1. Media Relay

A media relay, as defined in section 3.2.1 of [RFC7092], from an application layer point-of-view, forwards all packets it receives on a negotiated UDP connection, without inspecting or modifying them. It forwards the UDP payload as-is changing only the UDP/IP header.

A media relay B2BUA MUST forward the certificate fingerprint and setup attribute it receives in the SDP from the originating endpoint as-is to the remote side and vice-versa. The example below shows an "INVITE with SDP" SIP call flow, with both SIP user agents doing DTLS-SRTP and a media relay B2BUA that changes only the IP address/ port.

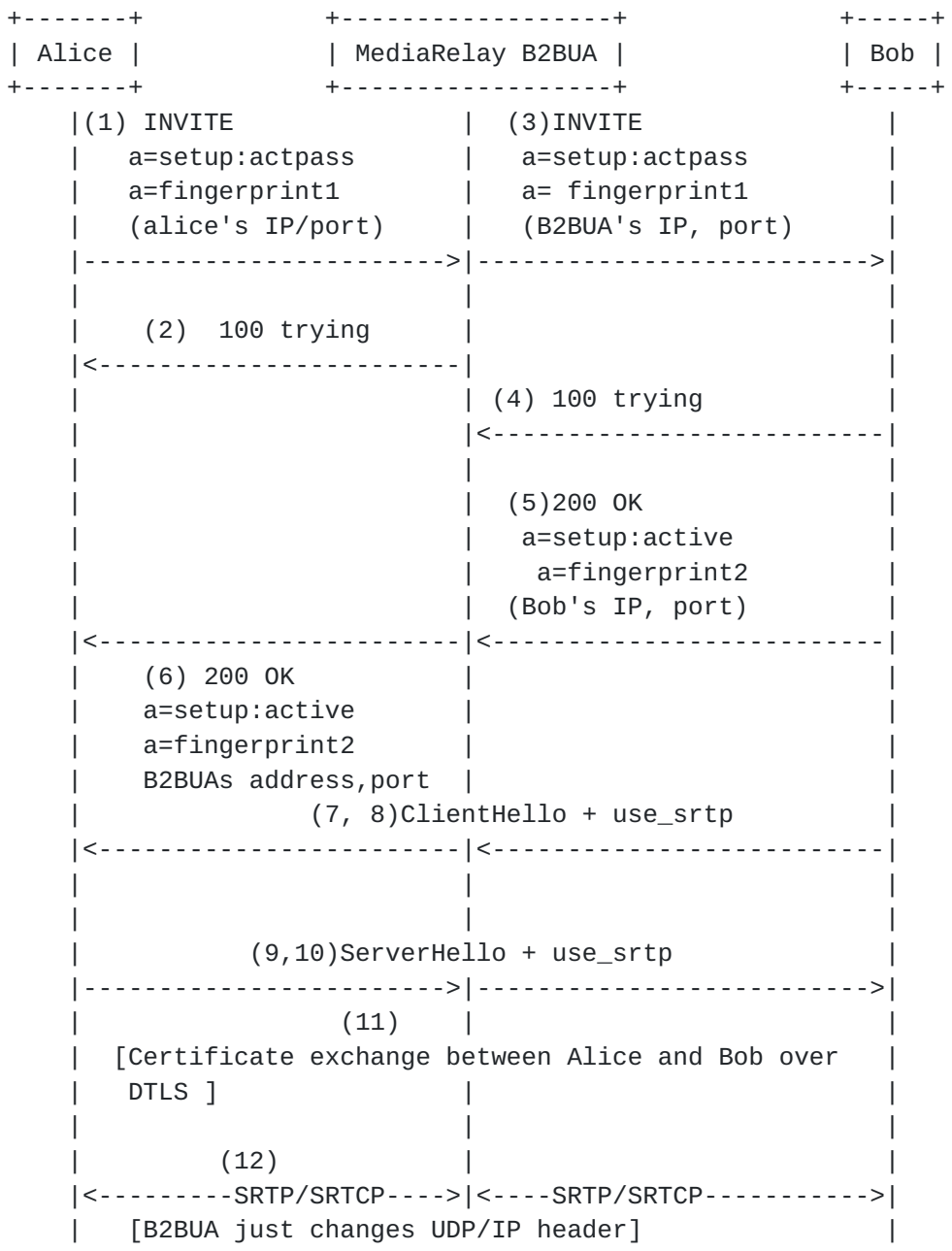


Figure 1: INVITE with SDP call-flow for Media Relay B2BUA

NOTE: For brevity the entire fingerprint attribute is not shown.

For each RTP or RTCP flow, the peers do a DTLS handshake on the same source and destination port pair to establish a DTLS association. In this case, Bob, after he receives an INVITE, triggers a DTLS connection. Note the DTLS handshake and the response to the INVITE may happen in parallel; thus, the B2BUA SHOULD be prepared to receive media on the ports it advertised to Bob in the OFFER. Since a media relay B2BUA does not differentiate between a DTLS, RTP or any packet

sent it receives, it just changes the UDP/IP addresses and forwards the packet on either leg.

[I-D.ietf-stir-rfc4474bis] provides a means for signing portions of SIP requests in order to provide identity assurance and certificate pinning by providing a signature over the fingerprint of keying material in SDP for DTLS-SRTP [RFC5763]. A media relay B2BUA MUST ensure that it does not modify any of the headers used to construct the signature.

In the above example Alice may be authorized by the authorization server (SIP proxy) in its domain using the procedures in section 5 of [I-D.ietf-stir-rfc4474bis]. In such a case, if B2BUA changes some of the SIP headers or SDP content that was used by Alice's authorization server to generate the identity, it would break the identity verification procedure explained in section 4.2 of [I-D.ietf-stir-rfc4474bis] resulting in a 438 error response being returned.

3.1.2. Media Aware Relay

A media-aware relay, unlike the media relay discussed in the previous section, is actually aware of the media traffic it is handling. A media-aware relay inspects SRTP and SRTCP packets flowing through it, and may or may not modify the headers of the packets before forwarding them.

3.1.2.1. RTP and RTCP Header Inspection

B2BUAs explained in Section 3.2.2 of [RFC7092] do not modify the RTP and RTCP headers but only inspect the headers. Such B2BUA MUST NOT terminate the DTLS-SRTP session.

3.1.2.2. RTP and RTCP Header Modification

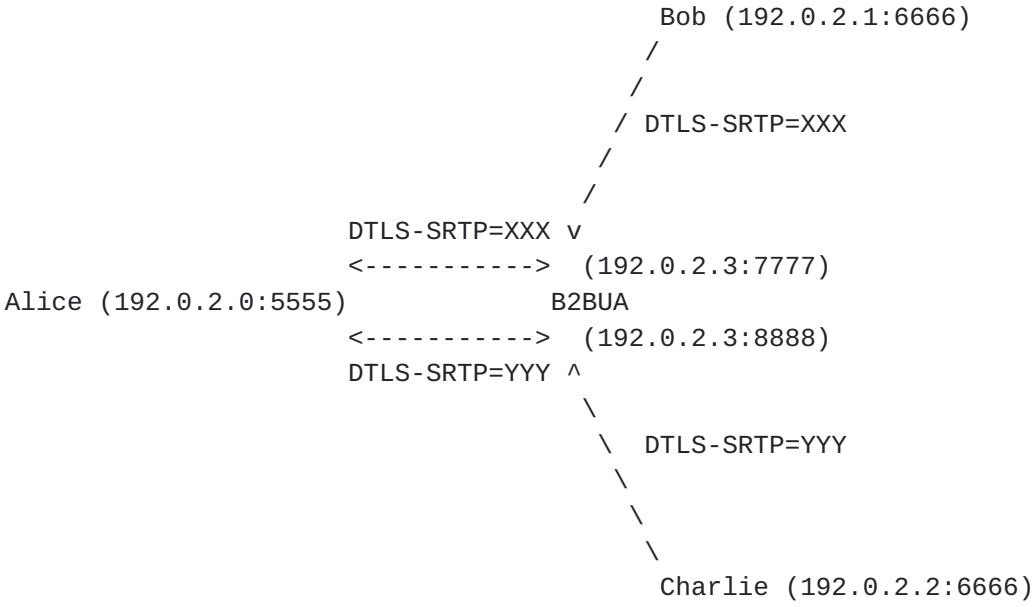
In addition to inspecting the RTP and RTCP headers, the B2BUAs explained in section 3.2.2 [RFC7092], can also potentially modify them. To modify media headers a B2BUA needs to act as a DTLS endpoint and terminate the DTLS connection so it can decrypt/re-encrypt RTP packets. This breaks end-to-end security and hence a B2BUA MUST NOT terminates DTLS-SRTP sessions. This security and privacy problem can be addressed by having separate keys for encrypting the RTP header and media payload as discussed in the on going work in [I-D.jones-perc-private-media-reqts], in which case the B2BUA is not aware of the keys used to decrypt the media payload.

3.2. Media Plane B2BUA with NAT handling

DTLS-SRTP handshakes and offer/answer can happen in parallel. If a UA is behind a NAT and acting as a DTLS server, the ClientHello message from a B2BUA(DTLS client) is likely to be lost, as described in section 7.3 of [RFC5763]. In order to overcome this problem, a UA and B2BUA must support ICE as discussed in section 7.3 of [RFC5763]. If ICE check is successful then UA will receive ClientHello packet from B2BUA.

4. Forking

In SIP, it is possible that a request can get forked and multiple answers might be received for that request. So a single endpoint may end up negotiating multiple DTLS-SRTP sessions due to forking. B2BUA in both media relay and media aware relay modes MUST forward the certificate fingerprints and setup attributes it receives from each answerer as-is to the offerer. Since DTLS operates on the 5-tuple, B2BUA MUST replace the answerers transport addresses in each answer with its unique transport addresses so that the offerer can establish a DTLS association with each answerer.



For instance, if Alice makes a call that is forked and receives multiple answers from Bob and Charlie, B2BUA must advertise different B2BUA transport address in each answer, as shown in the above Figure, where XXX and YYY represent different DTLS-SRTP associations, B2BUA replaces the Bob's transport address (192.0.2.1:6666) in the answer with its transport address (192.0.2.3:7777) and Charlie's transport address (192.0.2.2:6666) in the answer with its transport address (192.0.2.3:8888). B2BUA tracks the remote sources (Bob and Alice)

and associates them to the local sources that are used to send packets to Alice.

5. Security Considerations

This document describes the behavior media plane B2BUAs (media-aware and media-unaware) should follow when acting on the media plane that uses SRTP security context setup with the DTLS protocol. Attempting to cover Media-aware Relay and Media Termination scenarios involving secure sessions (like DTLS-SRTP) will inevitably lead to the B2BUA acting as a man-in-the-middle, and as such its behavior is unspecified and Discouraged. It does not introduce any specific security considerations beyond those detailed in [RFC5763]. The B2BUA behaviors outlined here also do not impact the security and integrity of the DTLS-SRTP session nor the data exchanged over it. A malicious B2BUA can try to break into the DTLS session, but such an attack can be prevented using the identity validation mechanism discussed in [I-D.ietf-stir-rfc4474bis].

6. IANA Considerations

This document makes no request of IANA.

7. Acknowledgments

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8. Contributors

Rajeev Seth provided substantial contributions to this document.

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