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TLS Application-Layer Protocol Settings Extension

Abstract

This document describes a Transport Layer Security (TLS) extension for negotiating application-layer protocol settings (ALPS) within the TLS handshake. Any application-layer protocol operating over TLS can use this mechanism to indicate its settings to the peer in parallel with the TLS handshake completion.

Discussion Venues

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

Discussion of this document takes place on the TLS Working Group mailing list (tls@ietf.org), which is archived at https://mailarchive.ietf.org/arch/browse/tls/.

Source for this draft and an issue tracker can be found at https://github.com/vasilvv/tls-alps.

Status of This Memo

This Internet-Draft is submitted in full conformance with the provisions of BCP 78 and BCP 79.

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This Internet-Draft will expire on 25 March 2021.

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1. Introduction

An application-layer protocol often starts with both parties negotiating parameters under which the protocol operates; for instance, HTTP/2 [RFC7540] uses a SETTINGS frame to exchange the list of protocol parameters supported by each endpoint. This is usually achieved by waiting for TLS handshake [RFC8446] to complete and then performing the application-layer handshake within the application protocol itself. This approach, despite its apparent simplicity at first, has multiple drawbacks:

1. While the server is technically capable of sending configuration to the peer as soon as it sends its Finished message, most TLS implementations do not allow any application data to be sent until the Finished message is received from the client. This adds an extra round-trip to the time of when the server settings are available to the client.

2. In QUIC, any settings delivered within the application layer can arrive after other application data; thus, the application has to operate under the assumption that peer's settings are not always available.

3. If the application needs to be aware of the server settings in order to send 0-RTT data, the application has to manually integrate with the TLS stack to associate the settings with TLS session tickets.

This document introduces a new TLS extension, application_settings, that allows applications to exchange settings within the TLS handshake. Through doing that, the settings can be made available to the application as soon as the handshake completes, and can be associated with TLS session tickets automatically at the TLS layer. This approach allows the application protocol to be designed with the assumption that it has access to the peer's settings whenever it is able to send data.

2. Conventions and Definitions

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 BCP 14 [RFC2119] [RFC8174] when, and only when, they appear in all capitals, as shown here.

3. Semantics

Settings are defined to be an opaque blob that is specified by the application when initiating a TLS connection. The settings are meant to be a *declaration* of the protocol parameters supported by the sender. While in this version of the extension the server settings are always sent first, this may change in future versions; thus, the application MUST NOT vary client settings based on the ones received from the server.

ALPS is *not* a negotiation mechanism: there is no notion of rejecting peer's settings, and the settings are not responses to one another. Nevertheless, it is possible for parties to coordinate behavior by, for instance, requiring a certain parameter to be present in both client and server settings. This makes ALPS mechanism similar to QUIC transport parameters [I-D.ietf-quic-transport] or HTTP/2 SETTINGS frame [RFC7540], but puts it in contrast to similar mechanisms in TLS.

Settings are exchanged as a part of the TLS handshake that is encrypted with the handshake keys. When the server settings are sent, the identity of the client has not been yet established; therefore, an application MUST NOT use ALPS if it requires the settings to be available only to the authenticated clients.

The ALPS model provides applications with a guarantee that the settings are available before any application data can be written. Note that this implies that when the full handshake is performed,

the server can no longer send data immediately after sending its Finished message; it has to wait for the client to respond with its settings. This may negatively impact the latency of the protocols where the server sends the first message, however it should be noted that sending application data before receiving has not been widely supported by TLS implementations, nor has it been allowed in situations when establishing client identity through TLS is required.

ALPS can only be used in conjunction with Application-Layer Protocol Negotiation: the client MUST offer ALPN [RFC7301] if advertising ALPS support, and the server MUST NOT reply with ALPS unless it is also negotiating ALPN. The ALPS payload is protocol-dependent, and as such it MUST be specified with respect to a selected ALPN.

4. Wire Protocol

ALPS is only supported in TLS version 1.3 or later, as the earlier versions do not provide any confidentiality protections for the handshake data. The exchange is performed in three steps:

1. The client sends an extension in ClientHello that enumerates all ALPN values for which ALPS is supported.

2. The server sends an encrypted extension containing the server settings.

3. The client sends an encrypted extension containing the client settings.

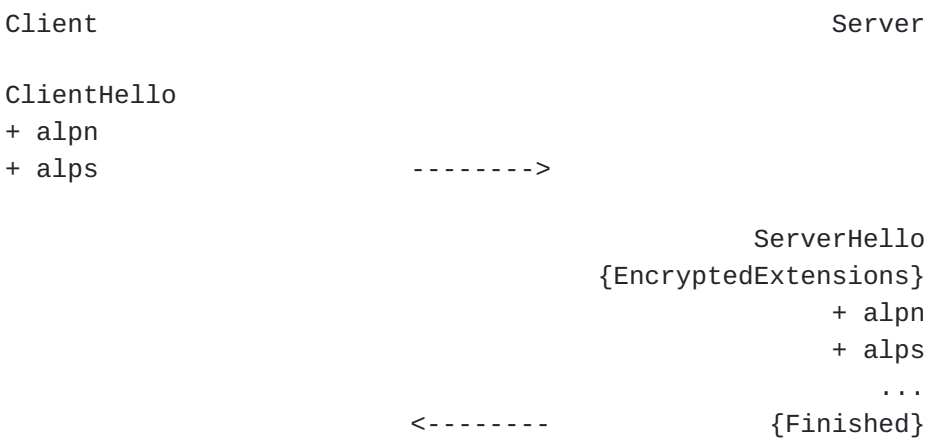

Figure 1: ALPS exchange in a full TLS handshake

A TLS client can enable ALPS by specifying an application_settings extension in the ClientHello message. The value of the extension_data field for this extension SHALL be a ApplicationSettingsSupport struct:

```
struct {
    ProtocolName supported_protocols<2..2^16-1>;
} ApplicationSettingsSupport;
```

Here, the supported_protocols field indicates the names of the protocols (as defined in [RFC7301]) for which ALPS exchange is supported; this is necessary for the situations when the client offers multiple ALPN values but only supports ALPS in some of them.

If the server chooses an ALPN value for which the client has offered ALPS support, the server MAY negotiate ALPS by sending an application_settings extension in its EncryptedExtensions message. The value of the extension_data field in that case SHALL be an opaque blob containing the server settings as specified by the application protocol.

If the client receives an EncryptedExtensions message containing an application_settings extension from the server, it MUST send an EncryptedExtensions message (see Section 4.1) containing an application_extensions extension. The value of the extension_data in this extension SHALL be an opaque blob containing the client settings as specified by the application protocol. A server which negotiates ALPS MUST abort the handshake with a missing_extension alert if the client's EncryptedExtensions is missing this extension.

4.1. Client Encrypted Extensions

This specification introduces the client EncryptedExtensions message. The format and HandshakeType code point match the server EncryptedExtensions message. When sent, it is encrypted with handshake traffic keys and sent by the client after receiving the server Finished message and before the client sends the Certificate, CertificateVerify (if any), and Finished messages. It SHALL be appended to the Client Handshake Context, as defined Section 4.4 of [RFC8446]. It additionally SHALL be inserted after the server Finished in the Post-Handshake Handshake Context.

The client MUST send the EncryptedExtensions message if any extension sent in the server EncryptedExtension message contains the CEE token in the TLS 1.3 column of the TLS ExtensionType Values registry. Otherwise, the client MUST NOT send the message. The server MUST abort the handshake with a unexpected_message alert if the message was sent or omitted incorrectly.

The client MAY send an extension in the client EncryptedExtension message if that extension's entry in the registry contains a CEE token and the server EncryptedExtensions message included the extension. Otherwise, the client MUST NOT send the extension. If a server receives an extension which does not meet this criteria, it MUST abort the handshake with an unsupported_extension alert.

Future extensions MAY use the client EncryptedExtensions message by including the CEE token in the TLS 1.3 registry. The above rules ensure clients will not send EncryptedExtensions messages to older servers, but will send EncryptedExtensions when some negotiated extension uses it.

[[TODO: Section 4.6.1 of RFC8446 allows the server to predict the client Finished flight and send a ticket early. This is still possible with 0-RTT handshakes here because we omit rather than repeat the redudant ALPS information, but, in the general extension case, client EncryptedExtensions breaks this. Extension order is unpredictable. We should resolve this conflict, either by dropping that feature or removing flexibility here.]]

4.2. 0-RTT Handshakes

ALPS ensures settings are available before reading and writing application data, so handshakes which negotiate early data instead use application settings from the PSK. To use early data with a PSK, the TLS implementation MUST associate both client and server application settings, if any, with the PSK. For a resumption PSK, these values are determined from the original connection. For an external PSK, this values should be configured with it. Existing PSKs are considered to not have application settings.

If the server accepts early data, the server SHALL NOT send an application_settings extension, and thus the client SHALL NOT send a application_settings extension in its EncryptedExtensions message. Unless the server has sent some other extension which uses client EncryptedExtensions, the client SHALL NOT send an EncryptedExtensions message. Instead, the connection implicitly uses the PSK's application settings, if any.

If the server rejects early data, application settings are negotiated independently of the PSK, as if early data were not offered.

If the client wishes to send different client settings for the connection, it MUST NOT offer 0-RTT. Conversely, if the server wishes to use send different server settings, it MUST reject 0-RTT. Note that the ALPN itself is similarly required to match the one in the original connection, thus the settings only need to be remembered or checked for a single application protocol. Implementations are RECOMMENDED to first determine the desired application protocol and settings independent of early data, and then decline to offer or accept early data if the values do not match the PSK. This preserves any ALPN and ALPS configuration specified by the calling application.

5. Security Considerations

ALPS is protected using the handshake keys, which are the secret keys derived as a result of (EC)DHE between the client and the server.

In order to ensure that the ALPS values are authenticated, the TLS implementation MUST NOT reveal the contents of peer's ALPS until peer's Finished message is received, with exception of cases where the ALPS has been carried over from the previous connection.

6. IANA Considerations

IANA will update the "TLS ExtensionType Values" registry to include application_settings with the value of TBD; the list of messages in which this extension may appear is CH, EE, CEE.

7. References

7.1. Normative References

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