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## Transport Layer Security (TLS) Authorization Using Digital Transmission Content Protection (DTCP) Certificates

### Abstract

This document specifies the use of Digital Transmission Content Protection (DTCP) certificates as an authorization data type in the authorization extension for the Transport Layer Security (TLS) protocol. This is in accordance with the guidelines for authorization extensions as specified in RFC 5878. As with other TLS extensions, this authorization data can be included in the client and server hello messages to confirm that both parties support the desired authorization data types. If supported by both the client and the server, DTCP certificates are exchanged in the supplemental data TLS handshake message as specified in RFC 4680. This authorization data type extension is in support of devices containing DTCP certificates issued by the Digital Transmission Licensing Administrator (DTLA).

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## Table of Contents

1. Introduction .....	3
1.1. Applicability Statement .....	3
1.2. Conventions .....	4
2. Overview .....	4
2.1. Overview of DTCP Certificates .....	4
2.2. Overview of SupplementalData Handshake .....	5
2.3. Overview of Authorization Extensions .....	5
2.4. Overview of SupplementalData Usage for Authorization .....	6
3. DTCP Authorization Data Format .....	6
3.1. DTCP Authorization Type .....	6
3.2. DTCP Authorization Data .....	6
3.3. Usage Rules for Clients to Exchange DTCP Authorization Data .....	7
3.4. Usage Rules for Servers to Exchange DTCP Authorization Data .....	8
3.5. TLS Message Exchange with dtcp_authz_data .....	8
3.6. Alert Messages .....	9
4. IANA Considerations .....	10
5. Security Considerations .....	10
6. References .....	11
6.1. Normative References .....	11
6.2. Informative References .....	12
Appendix A. Alternate Double Handshake Example .....	13
Acknowledgements .....	15
Author's Address .....	15

## 1. Introduction

The Transport Layer Security (TLS) protocol (see TLS 1.0 [RFC2246], TLS 1.1 [RFC4346], and TLS 1.2 [RFC5246]) is being used in an ever increasing variety of operational environments, the most common among which is its use in securing HTTP traffic [RFC2818]. [RFC5878] introduces extensions that enable TLS to operate in environments where authorization information needs to be exchanged between the client and the server before any protected data is exchanged. The use of these TLS authorization extensions is especially attractive since it allows the client and server to determine the type of protected data to exchange based on the authorization information received in the extensions.

A substantial number of deployed consumer electronics devices, such as televisions, tablets, game consoles, set-top boxes, and other multimedia devices, contain Digital Transmission Content Protection [DTCP] certificates issued by [DTLA]. These DTCP certificates enable secure transmission of premium audiovisual content between devices over various types of links (e.g., DTCP over IP [DTCP-IP]). These DTCP certificates can also be used to verify device functionality (e.g., supported device features).

This document describes the format and necessary identifiers to exchange DTCP certificates within the supplemental data message (see [RFC4680]) while negotiating a TLS session. The DTCP certificates are then used independent of their use for content protection (e.g., to verify supported features) and the corresponding DTCP Authentication and Key Exchange (AKE) protocol. This communication allows either the client, the server, or both to perform certain actions or provide specific services. The actual semantics of the authorization decision by the client/server are beyond the scope of this document. The DTCP certificate, which is not an X.509 certificate, can be cryptographically tied to the X.509 certificate being used during the TLS tunnel establishment by an Elliptic Curve Digital Signature Algorithm (EC-DSA) [DTCP] signature.

### 1.1. Applicability Statement

DTCP-enabled consumer electronics devices (e.g., televisions, game consoles) use DTCP certificates for secure transmission of audiovisual content. The AKE protocol defined in [DTCP] is used to exchange DTCP certificates and allows a device to be identified and authenticated based on the information in the DTCP certificate. However, these DTCP-enabled devices offer additional functionality (e.g., via HTML5 User Agents or web-enabled applications) that is distinct from its capability to transmit and play audiovisual content. The mechanism outlined in this document allows a DTCP-

enabled consumer electronics device to authenticate and authorize using its DTCP certificate when accessing services over the internet; for example, web applications on televisions that can enable value-added services. This is anticipated to be very valuable since there are a considerable number of such devices. The reuse of well-known web security will also keep such communication consistent with existing standards and best practices.

## 1.2. Conventions

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].

## 2. Overview

### 2.1. Overview of DTCP Certificates

DTCP certificates issued by [DTLA] to DTLA-compliant devices come in three general variations (see Section 4.2.3.1 of [DTCP]):

- o Restricted Authentication device certificate format (Format 0): Typically issued to devices with limited computation resources.
- o Baseline Full Authentication device certificate format (Format 1): This is the most commonly issued certificate format. Format 1 certificates include a unique DeviceID and device EC-DSA public/private key pair generated by the DTLA. (See Section 4.3 of [DTCP]).
- o Extended Full Authentication device certificate format (Format 2): This is issued to devices that possess additional functions (e.g., additional channel ciphers, specific device properties). The presence of these additional functions is indicated by the device capability mask as specified in Section 4.2.3.2 of [DTCP]. Format 2 certificates also include a unique DeviceID and device EC-DSA public/private key pair generated by the DTLA (see Section 4.3 of [DTCP]).

The mechanism specified in this document allows only Formats 1 and 2 DTCP certificates to be exchanged in the supplemental data message since it requires the use of the EC-DSA private key associated with the certificate.

## 2.2. Overview of SupplementalData Handshake

Figure 1 illustrates the exchange of the SupplementalData message during the TLS handshake as specified in [RFC4680] (repeated here for convenience):

```

Client                                                    Server

ClientHello (with extensions) ----->

                                     ServerHello(with extensions)
                                     SupplementalData*
                                     Certificate*
                                     ServerKeyExchange*
                                     CertificateRequest*
                                     <----- ServerHelloDone

SupplementalData*
Certificate*
ClientKeyExchange
CertificateVerify*
[ChangeCipherSpec]
Finished ----->
                                     [ChangeCipherSpec]
                                     <----- Finished
Application Data <-----> Application Data

* Indicates optional or situation-dependent messages that are
  not always sent.

[] Indicates that ChangeCipherSpec is an independent TLS
  protocol content type; it is not a TLS handshake message.

```

Figure 1: TLS Handshake Message Exchange with SupplementalData

## 2.3. Overview of Authorization Extensions

[RFC5878] defines two authorization extension types that are used in the ClientHello and ServerHello messages and are repeated below for convenience:

```

enum {
    client_authz(7), server_authz(8), (65535)
} ExtensionType;

```

A client uses the client\_authz and server\_authz extensions in the ClientHello message to indicate that it will send client authorization data and receive server authorization data,

respectively, in the SupplementalData messages. A server uses the extensions in a similar manner in its ServerHello message. [RFC5878] also establishes a registry that is maintained by IANA to register authorization data formats. This document defines a new authorization data type for both the client\_authz and server\_authz extensions and allows the client and server to exchange DTCP certificates in the SupplementalData message.

#### 2.4. Overview of SupplementalData Usage for Authorization

Section 3 of [RFC5878] specifies the syntax of the supplemental data message when carrying the authz\_data message that is negotiated in the client\_authz and/or server\_authz types. This document defines a new authorization data format that is used in the authz\_data message when sending DTCP Authorization Data.

### 3. DTCP Authorization Data Format

#### 3.1. DTCP Authorization Type

The DTCP Authorization type definition in the TLS Authorization Data Formats registry is:

```
dtcp_authorization(66);
```

#### 3.2. DTCP Authorization Data

The DTCP Authorization Data is used when the AuthzDataFormat type is dtcp\_authorization. The syntax of the authorization data is:

```
struct {  
    opaque random_bytes[32];  
} RandomNonce;  
  
struct {  
    opaque RandomNonce nonce;  
    opaque DTCPCert<0..2^24-1>;  
    opaque ASN.1Cert<0..2^24-1>;  
    opaque signature<0..2^16-1>;  
} dtcp_authz_data;
```

RandomNonce is generated by the server and consists of 32 bytes generated by a high-quality, secure random number generator. The client always sends back the server-generated RandomNonce in its dtcp\_authz\_data structure. The RandomNonce helps the server in detecting replay attacks. A client can detect replay attacks by

associating the ASN.1 certificate in the `dtcp_authz_data` structure with the certificate received in the Certificate message of the TLS handshake, so a separate nonce for the client is not required.

DTCPCert is the sender's DTCP certificate. See Section 4.2.3.1 of the DTCP Specification [DTCP].

ASN.1Cert is the sender's certificate used to establish the TLS session, i.e., it is sent in the Certificate or ClientCertificate message using the Certificate structure defined in Section 7.4.2 of [RFC5246].

The DTCPCert and ASN.1Cert are variable-length vectors as specified in Section 4.3 of [RFC5246]. Hence, the actual length precedes the vector's contents in the byte stream. If the ASN.1Cert is not being sent, the `ASN.1Cert_length` MUST be zero.

`dtcp_authz_data` contains the RandomNonce, the DTCP certificate, and the optional ASN.1 certificate. This is then followed by the digital signature covering the RandomNonce, the DTCP certificate, and the ASN.1 certificate (if present). The signature is generated using the private key associated with the DTCP certificate and using the Signature Algorithm and Hash Algorithm as specified in Section 4.4 of [DTCP]. This signature provides proof of the possession of the private key by the sender. A sender sending its own DTCP certificate MUST populate this field. The length of the signature field is determined by the Signature Algorithm and Hash Algorithm as specified in Section 4.4 of [DTCP], and so it is not explicitly encoded in the `dtcp_authz_data` structure (e.g., the length will be 40 bytes for a SHA1+ECDSA algorithm combination).

### 3.3. Usage Rules for Clients to Exchange DTCP Authorization Data

A client includes both the `client_authz` and `server_authz` extensions in the extended client hello message when indicating its desire to exchange `dtcp_authorization` data with the server. Additionally, the client includes the `AuthzDataFormat` type specified in Section 3.1 in the `extension_data` field to specify the format of the authorization data.

A client will receive the server's `dtcp_authz_data` before it sends its own `dtcp_authz_data`. When sending its own `dtcp_authz_data` message, the client includes the same RandomNonce that it receives in the server's `dtcp_authz_data` message. Clients MUST include its DTCP certificate in the `dtcp_authz_data` message. A client MAY include its ASN.1 certificate (certificate in the ClientCertificate message) in

the `ASN.1Cert` field of the `dtcp_authz_data` to cryptographically tie the `dtcp_authz_data` with its `ASN.1Cert` being used to establish the TLS session (i.e., sent in the `ClientCertificate` message).

#### 3.4. Usage Rules for Servers to Exchange DTCP Authorization Data

A server responds with both the `client_authz` and `server_authz` extensions in the extended server hello message when indicating its desire to exchange `dtcp_authorization` data with the client.

Additionally, the server includes the `AuthzDataFormat` type specified in Section 3.1 in the `extension_data` field to specify the format of the `dtcp_authorization` data. A client may or may not include an `ASN.1` certificate during the TLS handshake. However, the server will not know that at the time of sending the `SupplementalData` message. Hence, a server **MUST** generate and populate the `RandomNonce` in the `dtcp_authz_data` message. If the client's hello message does not contain both the `client_authz` and `server_authz` extensions with `dtcp_authorization` type, the server **MUST NOT** include support for `dtcp_authorization` data in its hello message. A server **MAY** include its DTCP certificate in the `dtcp_authz_data` message. If the server does not send a DTCP certificate, it will send only the `RandomNonce` in its `dtcp_authz_data` message. If the server includes its DTCP certificate, it **MUST** also include its server certificate (sent in the `TLS Certificate` message) in the `certs` field to cryptographically tie its `dtcp_authz_data` with the `ASN.1` certificate used in the TLS session being established. This also helps the client in detecting replay attacks.

#### 3.5. TLS Message Exchange with `dtcp_authz_data`

Based on the usage rules in the sections above, Figure 2 provides one possible TLS message exchange where the client sends its DTCP certificate to the server within the `dtcp_authz_data` message.

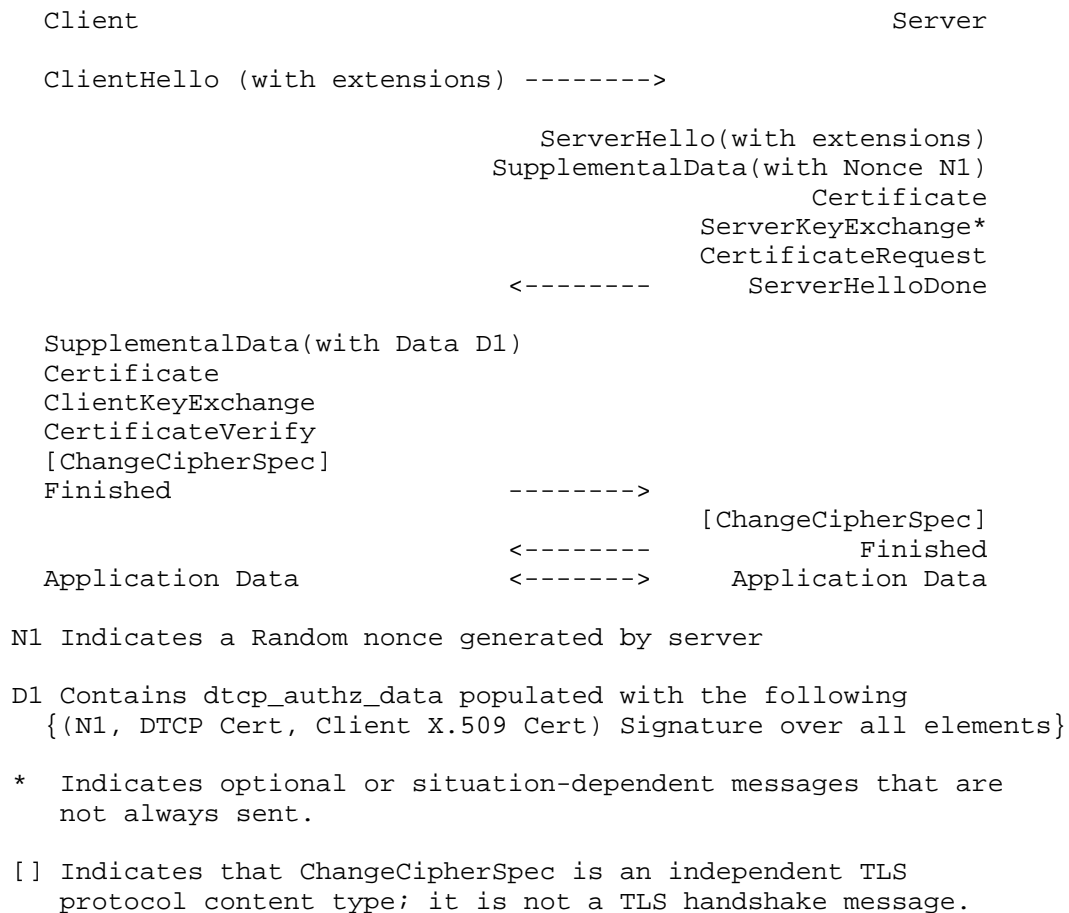


Figure 2: DTCP SupplementalData Exchange

### 3.6. Alert Messages

This document reuses TLS Alert messages for any errors that arise during authorization processing and reuses the AlertLevels as specified in [RFC5878]. Additionally, the following AlertDescription values are used to report errors in dtcp\_authorization processing:

#### unsupported\_extension:

During processing of dtcp\_authorization, a client uses this when it receives a server hello message that includes support for dtcp\_authorization in only one of client\_authz or server\_authz but not in both the extensions. This message is always fatal. Note:

Completely omitting the dtcp\_authorization extension and/or omitting the client\_authz and server\_authz completely is allowed and should not constitute the reason that this alert is sent.

certificate\_unknown:

During processing of dtcp\_authorization, a client or server uses this when it has received an X.509 certificate in the dtcp\_authorization data and that X.509 certificate does not match the certificate sent in the corresponding ClientCertificate or Certificate message.

#### 4. IANA Considerations

This document includes an entry registered in the IANA-maintained "TLS Authorization Data Formats" registry for dtcp\_authorization(66). This registry is defined in [RFC5878] and defines two ranges: one is IETF Review, and the other is Specification Required. The value for dtcp\_authorization should be assigned via [RFC5226] Specification Required. The extension defined in this document is compatible with Data Transport Layer Security (DTLS) [RFC6347], and the registry assignment has been marked "Y" for DTLS-OK.

#### 5. Security Considerations

The dtcp\_authorization data, as specified in this document, carries the DTCP certificate that identifies the associated device. Inclusion of the X.509 certificate being used to establish a TLS Session in the dtcp\_authorization data allows an application to cryptographically tie them. However, a TLS Client is not required to use (and may not possess) an X.509 certificate. In this case, the dtcp\_authorization data exchange is prone to a man-in-the-middle (MITM) attack. In such situations, a TLS server MUST deny access to the application features dependent on the DTCP certificate or use a double handshake. The double handshake mechanism is also vulnerable to the TLS MITM Renegotiation exploit as explained in [RFC5746]. In order to address this vulnerability, clients and servers MUST use the secure\_renegotiation extension as specified in [RFC5746] when exchanging dtcp\_authorization data. Additionally, the renegotiation is also vulnerable to the Triple Handshake exploit. To mitigate this, servers MUST use the same ASN.1 certificate during renegotiation as the one used in the initial handshake.

It should be noted that for the double handshake to succeed, any extension (e.g., TLS Session Ticket [RFC5077]) that results in the TLS handshake sequence being modified may result in failure to exchange SupplementalData.

Additionally, the security considerations specified in [RFC5878] and [RFC5246] apply to the extension specified in this document. In addition, the dtcp\_authorization data may be carried along with other supplemental data or some other authorization data and that information may require additional protection. Finally, implementers should also reference [DTCP] and [DTCP-IP] for more information regarding DTCP certificates, their usage, and associated security considerations.

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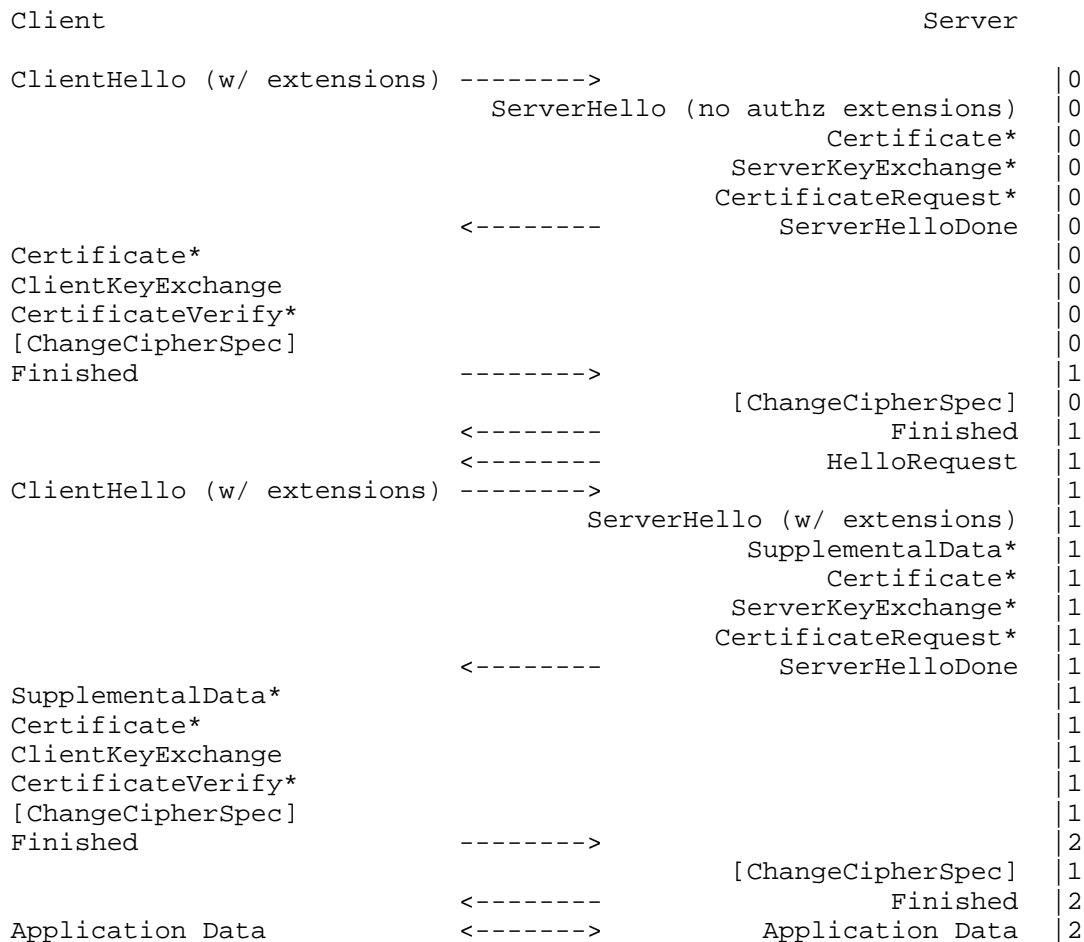
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## Appendix A. Alternate Double Handshake Example

This document specifies a TLS authorization data extension that allows TLS clients and servers to exchange DTCP certificates during a TLS handshake exchange. In cases where the supplemental data contains sensitive information, the double handshake technique described in [RFC4680] can be used to provide protection for the supplemental data information. The double handshake specified in [RFC4680] assumes that the client knows the context of the TLS session that is being set up and uses the authorization extensions as needed. Figure 3 illustrates a variation of the double handshake that addresses the case where the client may not have a priori knowledge that it will be communicating with a server capable of exchanging `dtcp_authz_data` (typical for https connections; see [RFC2818]). In Figure 3, the client's hello messages includes the `client_authz` and `server_authz` extensions. The server simply establishes an encrypted TLS session with the client in the first handshake by not indicating support for any authz extensions. The server initiates a second handshake by sending a `HelloRequest`. The second handshake will include the server's support for authz extensions, which will result in `SupplementalData` being exchanged.

Alternately, it is also possible to do a double handshake where the server sends the authorization extensions during both the first and the second handshake. Depending on the information received in the first handshake, the server can decide whether or not a second handshake is needed.



\* Indicates optional or situation-dependent messages.

Figure 3: Double Handshake to Protect SupplementalData

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