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WebRTC Data Channel Establishment Protocol
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Abstract

The WebRTC framework specifies protocol support for direct interactive rich communication using audio, video, and data between two peers' web-browsers. This document specifies a simple protocol for establishing symmetric Data Channels between the peers. It uses a two way handshake and allows sending of user data without waiting for the handshake to complete.

Status of This Memo

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1. Introduction

The Data Channel Establishment Protocol (DCEP) is designed to provide, in the WebRTC Data Channel context [I-D.ietf-rtcweb-data-channel], a simple in-band method to open symmetric Data Channels. As discussed in [I-D.ietf-rtcweb-data-channel], the protocol uses the Stream Control Transmission Protocol (SCTP) [RFC4960] encapsulated in the Datagram Transport Layer Security (DTLS) as described in [I-D.ietf-tsvwg-sctp-dtls-encaps] to benefit from their already standardized transport and security features. DTLS 1.0 is defined in [RFC4347] and the present latest version, DTLS 1.2, is defined in [RFC6347].

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].

3. Terminology

This document uses the following terms:

Association: An SCTP association.

Stream: A unidirectional stream of an SCTP association. It is uniquely identified by an SCTP stream identifier (0-65534). Note: the SCTP stream identifier 65535 is reserved due to SCTP INIT and INIT-ACK chunks only allowing a maximum of 65535 Streams to be negotiated (0-65534).

Stream Identifier: The SCTP stream identifier uniquely identifying a Stream.

Data Channel: Two Streams with the same Stream Identifier, one in each direction, which are managed together.

4. Protocol Overview

The Data Channel Establishment Protocol is a simple, low-overhead way to establish bidirectional Data Channels over an SCTP association with a consistent set of properties.

The set of consistent properties includes:

- reliable or unreliable message transmission. In case of unreliable transmissions, the same level of unreliability is used.
- in-order or out-of-order message delivery.
- the priority of the Data Channel.
- an optional label for the Data Channel.
- an optional protocol for the Data Channel.
- the Streams.

This protocol uses a two way handshake to open a Data Channel. The handshake pairs one incoming and one outgoing Stream, both having the same Stream Identifier, into a single bidirectional Data Channel. The peer that initiates opening a Data Channel selects a Stream Identifier for which the corresponding incoming and outgoing Streams are unused and sends a DATA_CHANNEL_OPEN message on the outgoing Stream. The peer responds with a DATA_CHANNEL_ACK message on its corresponding outgoing Stream. Then the Data Channel is open. Data Channel Establishment Protocol messages are sent on the same Stream

as the user messages belonging to the Data Channel. The demultiplexing is based on the SCTP payload protocol identifier (PPID), since the Data Channel Establishment Protocol uses a specific PPID.

Note: The opening side MAY send user messages before the DATA_CHANNEL_ACK is received.

To avoid collisions where both sides try to open a Data Channel with the same Stream Identifiers, each side MUST use Streams with either even or odd Stream Identifiers when sending a DATA_CHANNEL_OPEN message. When using SCTP over DTLS [I-D.ietf-tsvwg-sctp-dtls-encaps], the method used to determine which side uses odd or even is based on the underlying DTLS connection role: the side acting as the DTLS client MUST use Streams with even Stream Identifiers, the side acting as the DTLS server MUST use Streams with odd Stream Identifiers.

Note: There is no attempt to ensure uniqueness for the label; if both sides open a Data Channel labeled "x" at the same time, there will be two Data Channels labeled "x" - one on an even Stream pair, one on an odd pair.

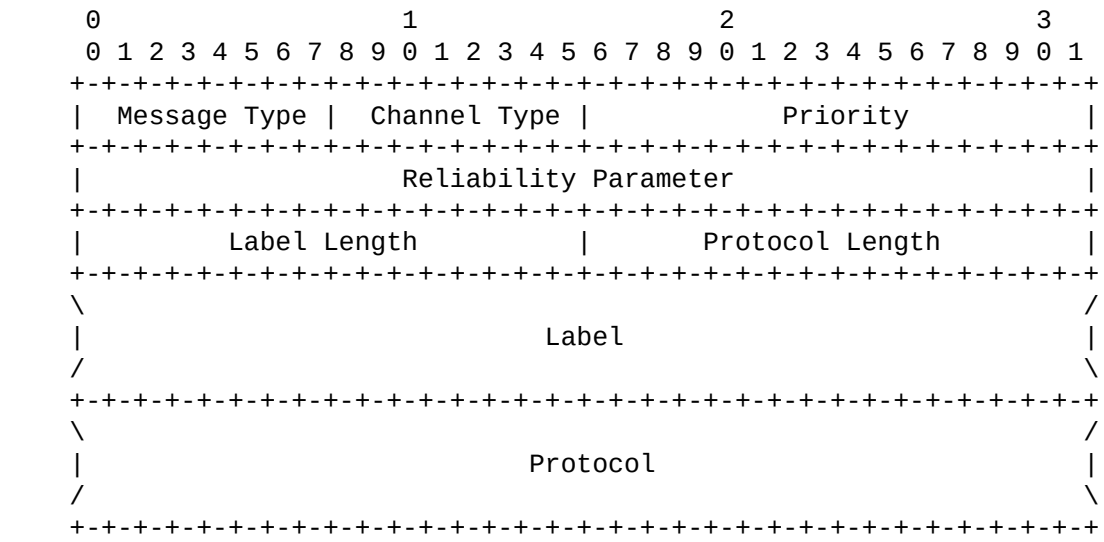
The protocol field is to ease cross-application interoperation ("federation") by identifying the user data being passed with an IANA-registered string (’WebSocket Subprotocol Name Registry’ defined in [RFC6455]), and may be useful for homogeneous applications which may create more than one type of Data Channel. Please note that there is also no attempt to ensure uniqueness for the protocol field.

5. Message Formats

Every Data Channel Establishment Protocol message starts with a one byte field called "Message Type" which indicates the type of the message. The corresponding values are managed by IANA (see Section 8.2.1).

5.1. DATA_CHANNEL_OPEN Message

This message is sent initially on the Stream used for user messages using the Data Channel.



Message Type: 1 byte (unsigned integer)
This field holds the IANA defined message type for the DATA_CHANNEL_OPEN message. The value of this field is 0x03 as specified in Section 8.2.1.

Channel Type: 1 byte (unsigned integer)
This field specifies the type of the Data Channel to be opened and the values are managed by IANA (see Section 8.2.2):

DATA_CHANNEL_RELIABLE (0x00): The Data Channel provides a reliable in-order bi-directional communication.

DATA_CHANNEL_RELIABLE_UNORDERED (0x80): The Data Channel provides a reliable unordered bi-directional communication.

DATA_CHANNEL_PARTIAL_RELIABLE_REXMIT (0x01): The Data Channel provides a partially-reliable in-order bi-directional communication. User messages will not be retransmitted more times than specified in the Reliability Parameter.

DATA_CHANNEL_PARTIAL_RELIABLE_REXMIT_UNORDERED (0x81): The Data Channel provides a partial reliable unordered bi-directional communication. User messages will not be retransmitted more times than specified in the Reliability Parameter.

DATA_CHANNEL_PARTIAL_RELIABLE_TIMED (0x02): The Data Channel provides a partial reliable in-order bi-directional communication. User messages might not be transmitted or retransmitted after a specified life-time given in milli-

seconds in the Reliability Parameter. This life-time starts when providing the user message to the protocol stack.

DATA_CHANNEL_PARTIAL_RELIABLE_TIMED_UNORDERED (0x82): The Data Channel provides a partial reliable unordered bi-directional communication. User messages might not be transmitted or retransmitted after a specified life-time given in milli-seconds in the Reliability Parameter. This life-time starts when providing the user message to the protocol stack.

Priority: 2 bytes (unsigned integer)
The priority of the Data Channel as described in [I-D.ietf-rtcweb-data-channel].

Reliability Parameter: 4 bytes (unsigned integer)
For reliable Data Channels this field MUST be set to 0 on the sending side and MUST be ignored on the receiving side. If a partial reliable Data Channel with limited number of retransmissions is used, this field specifies the number of retransmissions. If a partial reliable Data Channel with limited lifetime is used, this field specifies the maximum lifetime in milliseconds. The following table summarizes this:

Channel Type	Reliability Parameter
DATA_CHANNEL_RELIABLE	Ignored
DATA_CHANNEL_RELIABLE_UNORDERED	Ignored
DATA_CHANNEL_PARTIAL_RELIABLE_REXMIT	Number of RTX
DATA_CHANNEL_PARTIAL_RELIABLE_REXMIT_UNORDERED	Number of RTX
DATA_CHANNEL_PARTIAL_RELIABLE_TIMED	Lifetime in ms
DATA_CHANNEL_PARTIAL_RELIABLE_TIMED_UNORDERED	Lifetime in ms

Label Length: 2 bytes (unsigned integer)
The length of the label field in bytes.

Protocol Length: 2 bytes (unsigned integer)
The length of the protocol field in bytes.

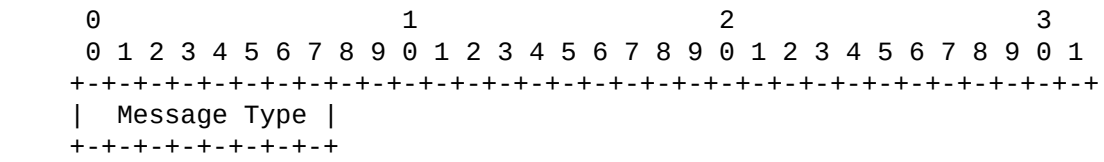
Label: Variable Length (sequence of characters)
The name of the Data Channel as a UTF-8 encoded string as specified in [RFC3629]. This may be an empty string.

Protocol: Variable Length (sequence of characters)
If this is an empty string the protocol is unspecified. If it is a non-empty string, it specifies a protocol registered in the

'WebSocket Subprotocol Name Registry' created in [RFC6455]. This string is UTF-8 encoded as specified in [RFC3629].

5.2. DATA_CHANNEL_ACK Message

This message is sent in response to a DATA_CHANNEL_OPEN_RESPONSE message on the stream used for user messages using the Data Channel. Reception of this message tells the opener that the Data Channel setup handshake is complete.



Message Type: 1 byte (unsigned integer)
This field holds the IANA defined message type for the DATA_CHANNEL_ACK message. The value of this field is 0x02 as specified in Section 8.2.1.

6. Procedures

All Data Channel Establishment Protocol messages MUST be sent using ordered delivery and reliable transmission. They MUST be sent on the same outgoing Stream as the user messages belonging to the corresponding Data Channel. Multiplexing and demultiplexing is done by using the SCTP payload protocol identifier (PPID). Therefore Data Channel Establishment Protocol message MUST be sent with the assigned PPID for the Data Channel Establishment Protocol (see Section 8.1). Other messages MUST NOT be sent using this PPID.

The peer that initiates opening a Data Channel selects a Stream Identifier for which the corresponding incoming and outgoing Streams are unused. If the side is the DTLS client, it MUST choose an even Stream Identifier, if the side is the DTLS server, it MUST choose an odd one. It fills in the parameters of the DATA_CHANNEL_OPEN message and sends it on the chosen Stream.

If a DATA_CHANNEL_OPEN message is received on an unused Stream, the Stream Identifier corresponds to the role of the peer and all parameters in the DATA_CHANNEL_OPEN message are valid, then a corresponding DATA_CHANNEL_ACK message is sent on the Stream with the same Stream Identifier as the one the DATA_CHANNEL_OPEN message was received on.

If the DATA_CHANNEL_OPEN message doesn't satisfy the conditions above, for instance if a DATA_CHANNEL_OPEN message is received on an

already used Stream or there are any problems with parameters within the DATA_CHANNEL_OPEN message, the odd/even rule is violated or the DATA_CHANNEL_OPEN message itself is not well-formed, the receiver MUST close the corresponding Data Channel using the procedure described in [I-D.ietf-rtcweb-data-channel] and MUST NOT send a DATA_CHANNEL_ACK message in response to the received message. Therefore, receiving an SCTP stream reset request for a Stream on which no DATA_CHANNEL_ACK message has been received indicates to the sender of the corresponding DATA_CHANNEL_OPEN message the failure of the Data Channel setup procedure. After also successfully resetting the corresponding outgoing Stream, which concludes the Data Channel closing initiated by the peer, a new DATA_CHANNEL_OPEN message can be sent on the Stream.

After the DATA_CHANNEL_OPEN message has been sent, the sender of the DATA_CHANNEL_OPEN MAY start sending messages containing user data without waiting for the reception of the corresponding DATA_CHANNEL_ACK message. However, before the DATA_CHANNEL_ACK message or any other message has been received on a Data Channel, all other messages containing user data and belonging to this Data Channel MUST be sent ordered, no matter whether the Data Channel is ordered or not. After the DATA_CHANNEL_ACK or any other message has been received on the Data Channel, messages containing user data MUST be sent ordered on ordered Data Channels and MUST be sent unordered on unordered Data Channels. Therefore receiving a message containing user data on an unused Stream indicates an error. The corresponding Data Channel MUST be closed as described in [I-D.ietf-rtcweb-data-channel].

7. Security Considerations

The DATA_CHANNEL_OPEN messages contains two variable length fields: the protocol and the label. A receiver must be prepared to receive DATA_CHANNEL_OPEN messages where these field have the maximum length of 65535 bytes. Error cases like the use of inconsistent lengths fields, unknown parameter values or violation the odd/even rule must also be handled by closing the corresponding Data Channel. An end-point must also be prepared that the peer open the maximum number of Data Channels.

This protocol does not provide privacy, integrity or authentication. It needs to be used as part of a protocol suite that contains all these things. Such a protocol suite is specified in [I-D.ietf-tsvwg-sctp-dtls-encaps].

For general considerations see [I-D.ietf-rtcweb-security] and [I-D.ietf-rtcweb-security-arch].

8. IANA Considerations

[NOTE to RFC-Editor:

"RFCXXXX" is to be replaced by the RFC number you assign this document.

]

IANA is asked to update the reference of an already existing SCTP PPID assignment (Section 8.1) and to create a new standalone registry with its own URL for the DCEP (Section 8.2) containing two new registration tables (Section 8.2.1 and Section 8.2.2).

8.1. SCTP Payload Protocol Identifier

This document uses one already registered SCTP Payload Protocol Identifier (PPID) named "WebRTC Control". [RFC4960] creates the registry "SCTP Payload Protocol Identifiers" from which this identifier was assigned. IANA is requested to update the reference of this assignment to point to this document and to update the name. The corresponding date should be kept.

Therefore this assignment should be updated to read:

Value	SCTP PPID	Reference	Date
WebRTC DCEP	50	[RFCXXXX]	2013-09-20

8.2. New Standalone Registry for the DCEP

IANA is requested to create a new standalone registry (aka a webpage) with its own URL for the Data Channel Establishment Protocol (DCEP). The title should be "Data Channel Establishment Protocol (DCEP) Parameters". It will contain the two tables as described in Section 8.2.1 and Section 8.2.2.

8.2.1. New Message Type Registry

IANA is requested to create a new registration table "Message Type Registry" for the Data Channel Establishment Protocol (DCEP) to manage the one byte "Message Type" field in DCEP messages (see Section 5). This registration table should be part of the registry described in Section 8.2.

The assignment of new message types is done through an RFC required action, as defined in [RFC5226]. Documentation of the new message type MUST contain the following information:

1. A name for the new message type;

2. A detailed procedural description of the use of messages with the new type within the operation of the Data Channel Establishment Protocol.

Initially the following values need to be registered:

Name	Type	Reference
Reserved	0x00	[RFCXXXX]
Reserved	0x01	[RFCXXXX]
DATA_CHANNEL_ACK	0x02	[RFCXXXX]
DATA_CHANNEL_OPEN	0x03	[RFCXXXX]
Unassigned	0x04-0xfe	
Reserved	0xff	[RFCXXXX]

Please note that the values 0x00 and 0x01 are reserved to avoid interoperability problems, since they have been used in earlier versions of the document. The value 0xff has been reserved for future extensibility. The range of possible values is from 0x00 to 0xff.

8.2.2. New Channel Type Registry

IANA is requested to create a new registration table "Channel Type Registry" for the Data Channel Establishment Protocol to manage the one byte "Channel Type" field in DATA_CHANNEL_OPEN messages (see Section 5.1). This registration table should be part of the registry described in Section 8.2.

The assignment of new message types is done through an RFC required action, as defined in [RFC5226]. Documentation of the new Channel Type MUST contain the following information:

1. A name for the new Channel Type;

2. A detailed procedural description of the user message handling for Data Channels using this new Channel Type.

Please note that if new Channel Types support ordered and unordered message delivery, the high order bit MUST be used to indicate whether the message delivery is unordered or not.

Initially the following values need to be registered:

Name	Type	Reference
DATA_CHANNEL_RELIABLE	0x00	[RFCXXXX]
DATA_CHANNEL_RELIABLE_UNORDERED	0x80	[RFCXXXX]
DATA_CHANNEL_PARTIAL_RELIABLE_REXMIT	0x01	[RFCXXXX]
DATA_CHANNEL_PARTIAL_RELIABLE_REXMIT_UNORDERED	0x81	[RFCXXXX]
DATA_CHANNEL_PARTIAL_RELIABLE_TIMED	0x02	[RFCXXXX]
DATA_CHANNEL_PARTIAL_RELIABLE_TIMED_UNORDERED	0x82	[RFCXXXX]
Reserved	0x7f	[RFCXXXX]
Reserved	0xff	[RFCXXXX]
Unassigned	rest	

Please note that the values 0x7f and 0xff have been reserved for future extensibility. The range of possible values is from 0x00 to 0xff.

9. Acknowledgments

The authors wish to thank Harald Alvestrand, Richard Barnes, Adam Bergkvist, Spencer Dawkins, Barry Dingle, Stefan Haekansson, Cullen Jennings, Paul Kyzivat, Doug Leonard, Alexey Melnikov, Pete Resnick, Irene Ruengeler, Randall Stewart, Peter Thatcher, Martin Thompson, Justin Uberti, and many others for their invaluable comments.

10. References

10.1. Normative References

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[RFC3629] Yergeau, F., "UTF-8, a transformation format of ISO 10646", STD 63, RFC 3629, November 2003.

[RFC4347] Rescorla, E. and N. Modadugu, "Datagram Transport Layer Security", RFC 4347, April 2006.

[RFC4960] Stewart, R., "Stream Control Transmission Protocol", RFC 4960, September 2007.

[RFC5226] Narten, T. and H. Alvestrand, "Guidelines for Writing an IANA Considerations Section in RFCs", BCP 26, RFC 5226, May 2008.

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10.2. Informational References

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[I-D.ietf-rtcweb-security] Rescorla, E., "Security Considerations for WebRTC", draft-ietf-rtcweb-security-07 (work in progress), July 2014.

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