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SDP-based Data Channel Negotiation
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Abstract

The Real-Time Communication in WEB-browsers (RTCWeb) working group is charged to provide protocols to support direct interactive rich communications using audio, video, and data between two peers' web-browsers. For the support of data communication, the RTCWeb working group has in particular defined the concept of bi-directional data channels over SCTP (Stream Control Transmission Protocol), where each data channel might be used to transport other protocols, called subprotocols. Data channel setup can be done using either the in-band Data Channel Establishment Protocol (DCEP) or using some out-of-band non-DCEP protocol. This document specifies how the SDP (Session Description Protocol) offer/answer exchange can be used to achieve such an out-of-band non-DCEP negotiation. Even though data channels are designed for RTCWeb use initially, they may be used by other protocols like, but not limited to, the CLUE protocol (which is defined by the IETF "ControLling mUltiple streams for tElepresence" working group). This document is intended to be used wherever data channels are used.

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1. Introduction

The RTCWeb working group has defined the concept of bi-directional data channels running on top of the Stream Control Transmission Protocol (SCTP). RTCWeb allows applications to use data channels. RTCWeb defines an in-band Data Channel Establishment Protocol (DCEP),

however other in-band or out-of-band protocols may be used for establishing data channels. Each data channel consists of paired SCTP streams sharing the same SCTP Stream Identifier. Data channels are created by endpoint applications through the WebRTC API (Application Programming Interface), or other users of a data channel like CLUE. They can be used to transport proprietary or well-defined protocols, which in the latter case can be signaled by the data channel "subprotocol" parameter, conceptually similar to the WebSocket "subprotocol". However, apart from the "subprotocol" value transmitted to the peer, RTCWeb leaves it open how endpoint applications can agree on how to instantiate a given subprotocol on a data channel, and whether it is signaled in-band using DCEP or out-of-band using a non-DCEP protocol (or both). In particular, the SDP offer generated by the RTCweb data channel stack includes no channel-specific information.

This document defines SDP offer/answer negotiation procedures to establish data channels for transport of well-defined subprotocols, to enable out-of-band negotiation. These procedures are based on generic SDP offer/answer negotiation rules for SCTP based media transport as specified in [I-D.ietf-mmusic-sctp-sdp] for the SDP "m" line proto values UDP/DTLS/SCTP and TCP/DTLS/SCTP. In future data channels could be defined over other SCTP based protocols, such as SCTP over IP. However, corresponding potential other "m" line proto values are not considered in this document.

This document makes use of MSRP (Message Session Relay Protocol) in many of the examples. It does not provide a complete specification of how to negotiate the use of a data channel to transport MSRP. Procedures specific to each subprotocol such as MSRP are documented elsewhere. The use of MSRP in some examples is only to show how the generic procedures described herein might apply to a specific subprotocol.

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:

Data channel: A WebRTC data channel as specified in [I-D.ietf-rtcweb-data-channel].

Data channel stack: An entity which, upon application request, runs the data channel protocol to keep track of states, sending and receive data. If the application is a browser based JavaScript application then this stack resides in the browser. If the application is a native application then this stack resides in the application and is accessible via some sort of APIs.

Data channel properties: Fixed properties assigned to a data channel at the time of its creation. Some of these properties determine the way the data channel stack transmits data on this channel (e.g., stream identifier, reliability, order of delivery...).

Data channel subprotocol: The application protocol which is transported over a single data channel. Data channel subprotocol messages are sent as data channel payload over an established data channel. If an SDP offer/answer exchange is used as specified in this document to negotiate the establishment of data channels, corresponding data channel properties, associated data channel subprotocols and data channel subprotocol properties, then the data channel subprotocols may be identified by the values of the "subprotocol" parameters of the SDP "a=dcmap" attribute as described in Section 5.1.1.5. Within this document the term "data channel subprotocol" is often abbreviated as just "subprotocol".

DCEP: Data Channel Establishment Protocol defined in [I-D.ietf-rtcweb-data-protocol].

In-band: Transmission through the peer-to-peer SCTP association.

Out-of-band: Transmission through the application signaling path.

Peer: From the perspective of one of the agents in a session, its peer is the other agent. Specifically, from the perspective of the SDP offerer, the peer is the SDP answerer. From the perspective of the SDP answerer, the peer is the SDP offerer.

SCTP Stream Sequence Number (SSN): the SCTP stream sequence number as specified in [RFC4960].

Stream identifier: The identifier of the outbound and inbound SCTP streams composing a data channel.

4. Applicability Statement

The mechanism in this document only applies to the Session Description Protocol (SDP) [RFC4566], when used together with the SDP

offer/answer mechanism [RFC3264]. Declarative usage of SDP is out of scope of this document, and is thus undefined.

5. SDP Offer/Answer Negotiation

This section defines an SDP extension by which two clients can negotiate data channel-specific and subprotocol-specific parameters without using DCEP [I-D.ietf-rtcweb-data-protocol]. This SDP extension only defines usage in the context of SDP offer/answer.

Appendix A provides information how data channels work in general and especially summarizes some key aspects, which should be considered for the negotiation of data channels if DCEP is not used.

5.1. SDP Syntax

Two new SDP attributes are defined to support SDP offer/answer negotiation of data channels. The first attribute provides for negotiation of channel-specific parameters. The second attribute provides for negotiation of subprotocol-specific parameters.

5.1.1. SDP Attribute for Data Channel Parameter Negotiation

Associated with the SDP "m" line that defines the SCTP association for data channels (defined in Section 3), each SDP offer and answer includes one "a=dcmap:" attribute that defines the data channel parameters for each data channel to be negotiated. Each such attribute line specifies the following parameters for a data channel: SCTP stream identifier, subprotocol, label, maximal number of retransmissions, maximal retransmission time, order of delivery, and priority.

The intention in exchanging these attributes is to create, on two peers, without use of DCEP [I-D.ietf-rtcweb-data-protocol], matched pairs of oppositely directed data channels having the same set of attributes. It is assumed that the data channel properties (reliable/partially reliable, ordered/unordered) are suitable per the subprotocol transport requirements.

5.1.1.1. dcmap Attribute

"a=dcmap:" is a media level attribute having following ABNF (Augmented Backus-Naur Form, [RFC5234]) syntax.

Formal Syntax:

Name: dcmap

Value: dcmap-value

Usage Level: media

Charset Dependent: no

Syntax:

```
dcmap-value     = dcmap-stream-id
                  [ SP dcmap-opt *(";" dcmap-opt) ]
dcmap-opt       = ordering-opt / subprotocol-opt / label-opt
                  / maxretr-opt / maxtime-opt / priority-opt
                  ; Either only maxretr-opt or maxtime-opt
                  ; is present.

dcmap-stream-id = 1*DIGIT
ordering-opt    = "ordered=" ordering-value
ordering-value  = "true" / "false"
subprotocol-opt = "subprotocol=" quoted-string
label-opt       = "label=" quoted-string
maxretr-opt     = "max-retr=" maxretr-value
maxretr-value   = "0" / integer
                  ; number of retransmissions,
                  ; less than 2^32,
                  ; derived from 'Reliability Parameter' of
                  ; [I-D.ietf-rtcweb-data-protocol]
maxtime-opt     = "max-time=" maxtime-value
maxtime-value   = "0" / integer
                  ; milliseconds,
                  ; less than 2^32,
                  ; derived from 'Reliability Parameter' of
                  ; [I-D.ietf-rtcweb-data-protocol]
priority-opt    = "priority=" priority-value
priority-value  = "0" / integer
                  ; unsigned integer value indicating the priority of
                  ; the data channel,
                  ; less than 2^16,
                  ; derived from 'Priority' of
                  ; [I-D.ietf-rtcweb-data-protocol]

quoted-string   = DQUOTE *(quoted-char / escaped-char) DQUOTE
quoted-char     = SP / quoted-visible
quoted-visible  = %21 / %23-24 / %26-7E ; VCHAR without " or %
escaped-char    = "%" HEXDIG HEXDIG
DQUOTE          = <from-RFC5234>
integer         = <from-RFC4566>
```

Examples:

```
a=dcmap:0
a=dcmap:1 subprotocol="BFCP";max-time=60000;priority=512
a=dcmap:2 subprotocol="MSRP";ordered=true;label="MSRP"
a=dcmap:3 label="Label 1";ordered=false;max-retr=5;priority=128
a=dcmap:4 label="foo%09bar";ordered=true;max-time=15000
```

Note: The last example (a=dcmap:4) shows a 'label' parameter value which contains one non-printable 'escaped-char' character (the tabulator character).

Within an 'a=dcmap:' attribute line's 'dcmap-opt' value either only one 'maxretr-opt' parameter or one 'maxtime-opt' parameter MAY be present. Both MUST NOT be present.

5.1.1.2. dcmap Multiplexing Category

Multiplexing characteristics of SDP attributes are described in [I-D.ietf-mmusic-sdp-mux-attributes]. Various SDP attribute multiplexing categories are introduced there.

The multiplexing category of the "a=dcmap:" attribute is SPECIAL.

As the usage of multiple SCTP associations on top of a single DTLS association is outside the scope of [I-D.ietf-mmusic-sctp-sdp], no "a=dcmap:" attribute multiplexing rules are specified for the UDP/DTLS/SCTP and TCP/DTLS/SCTP proto values. If future extensions of [I-D.ietf-mmusic-sctp-sdp] define how to negotiate multiplexing of multiple SCTP associations on top of a single DTLS association, or how to add multiple SCTP associations to one BUNDLE group, then multiplexing rules for the "a=dcmap:" attribute need to be defined as well, for instance in an extension of this SDP based data channel negotiation specification.

5.1.1.3. dcmap-stream-id Parameter

The 'dcmap-stream-id' parameter indicates the SCTP stream identifier within the SCTP association used to form the data channel.

5.1.1.4. label Parameter

The 'label' parameter indicates the name of the channel. It represents a label that can be used to distinguish, in the context of the WebRTC API [WebRtcAPI], an RTCDataChannel object from other RTCDataChannel objects. This parameter maps to the 'Label' parameter defined in [I-D.ietf-rtcweb-data-protocol]. The 'label' parameter is optional. If it is not present, then its value defaults to the empty string.

Note: The empty string MAY also be explicitly used as a 'label' value, such that 'label=""' is equivalent to the 'label' parameter not being present at all. [I-D.ietf-rtcweb-data-protocol] allows the DATA_CHANNEL_OPEN message's 'Label' value to be an empty string.

5.1.1.5. subprotocol Parameter

The 'subprotocol' parameter indicates which protocol the client expects to exchange via the channel. This parameter maps to the 'Protocol' parameter defined in [I-D.ietf-rtcweb-data-protocol]. Section 8.1 specifies how new subprotocol parameter values are registered. 'Subprotocol' is an optional parameter. If the 'subprotocol' parameter is not present, then its value defaults to an empty string.

Note: The empty string MAY also be explicitly used as 'subprotocol' value, such that 'subprotocol=""' is equivalent to the 'subprotocol' parameter not being present at all. [I-D.ietf-rtcweb-data-protocol] allows the DATA_CHANNEL_OPEN message's 'Subprotocol' value to be an empty string.

5.1.1.6. max-retr Parameter

This parameter indicates that the data channel is partially reliable. The 'max-retr' parameter indicates the maximal number of times a user message will be retransmitted. The max-retr parameter is optional. If the max-retr parameter is not present, then the maximal number of retransmissions is determined as per the generic SCTP retransmission rules as specified in [RFC4960]. This parameter maps to the 'Number of RTX' parameter defined in [I-D.ietf-rtcweb-data-protocol].

5.1.1.7. max-time Parameter

This parameter indicates that the data channel is partially reliable. A user message will no longer be transmitted or retransmitted after a specified life-time given in milliseconds in the 'max-time' parameter. The max-time parameter is optional. If the max-time parameter is not present, then the generic SCTP retransmission timing rules apply as specified in [RFC4960]. This parameter maps to the 'Lifetime in ms' parameter defined in [I-D.ietf-rtcweb-data-protocol].

5.1.1.8. ordered Parameter

The 'ordered' parameter with value "true" indicates that the receiver MUST dispatch DATA chunks in the data channel to the upper layer while preserving the order. The ordered parameter is optional and takes two values: "true" for ordered and "false" for unordered

delivery with "true" as the default value. Any other value is ignored and default "ordered=true" is assumed. In the absence of this parameter "ordered=true" is assumed. This parameter maps to the ordered or unordered data channel types as defined in [I-D.ietf-rtcweb-data-protocol].

5.1.1.9. priority Parameter

The 'priority' parameter indicates the data channel's priority relative to the priorities of other data channels, which may additionally exist over the same SCTP association. The 'priority' parameter maps to the 'Priority' parameter defined in [I-D.ietf-rtcweb-data-protocol]. The 'priority' parameter is optional. In the absence of this parameter "priority=256" is assumed.

5.1.2. Other Media Level Attributes

In the SDP, each data channel declaration MAY also be followed by other media level SDP attributes, which are either specifically defined for or applied to the subprotocol in use. Each of these attributes is represented by one new attribute line, and it includes the contents of a media-level SDP attribute already defined for use with this (sub)protocol in another IETF (Internet Engineering Task Force) document. Subprotocol specific attributes MAY also be defined for exclusive use with data channel transport, but MUST use the same syntax described here for other subprotocol related attributes.

5.1.2.1. dcsa Attribute

Each SDP attribute, related to the subprotocol, that would normally be used to negotiate the subprotocol using SDP is replaced with an attribute of the form "a=dcsa:stream-id original-attribute", where dcsa stands for "data channel subprotocol attribute", stream-id is the SCTP stream identifier assigned to this subprotocol instance, and original-attribute represents the contents of the subprotocol related attribute to be included.

The same syntax applies to any other SDP attribute required for negotiation of this instance of the subprotocol.

Formal Syntax:

Name: dcsa

Value: dcsa-value

Usage Level: media

Charset Dependent: no

Syntax:

```
dcsa-value      = stream-id SP attribute
attribute       = <from-RFC4566>
```

Example:

```
a=dcsa:2 accept-types:text/plain
```

Note that the above reference to [RFC4566] defines where the attribute definition can be found; it does not provide any limitation on support of attributes defined in other documents in accordance with this attribute definition. Note however that not all SDP attributes are suitable as a "a=dcsa:" parameter. [IANA-SDP-Parameters] contains the lists of IANA (Internet Assigned Numbers Authority) registered session and media level or media level only SDP attributes.

Thus in the example above, the original attribute line "a=accept-types:text/plain" is represented by the attribute line "a=dcsa:2 accept-types:text/plain", which specifies that this instance of the MSRP subprotocol being transported on the SCTP association using the data channel with stream id 2 accepts plain text files.

As opposed to the data channel "a=dcmap:" attribute parameters, these parameters are subject to offer/answer negotiation following the procedures defined in the subprotocol specific documents.

It is assumed that in general the usages of subprotocol related media level attributes are independent from the subprotocol's transport protocol. Such transport protocol independent subprotocol related attributes are used in the same way as defined in the original subprotocol specification, also if the subprotocol is transported over a data channel and if the attribute is correspondingly embedded in a "a=dcsa" attribute.

There may be cases, where the usage of a subprotocol related media level attribute depends on the subprotocol's transport protocol. In

such cases the subprotocol related usage of the attribute is expected to be described for the data channel transport. A data channel specific usage of a subprotocol attribute is expected to be specified in the same document, which registers the subprotocol's identifier for data channel usage as described in Section 8.1.

5.1.2.2. dcsa Multiplexing Category

The multiplexing category of the "a=dcsa:" attribute is SPECIAL.

As the usage of multiple SCTP associations on top of a single DTLS association is outside the scope of [I-D.ietf-mmusic-sctp-sdp], no "a=dcsa:" attribute multiplexing rules are specified for the UDP/DTLS/SCTP and TCP/DTLS/SCTP proto values. If future extensions of [I-D.ietf-mmusic-sctp-sdp] define how to negotiate multiplexing of multiple SCTP associations on top of a single DTLS association, or how to add multiple SCTP associations to one BUNDLE group, then multiplexing rules for the "a=dcsa:" attribute need to be defined as well, for instance in an extension of this SDP based data channel negotiation specification.

5.2. Procedures

5.2.1. Managing Stream Identifiers

If a SDP offer/answer exchange (could be the initial or a subsequent one) results in a UDP/DTLS/SCTP or TCP/DTLS/SCTP based media description being accepted, and if this SDP offer/answer exchange results in the establishment of a new SCTP association, then the SDP offerer owns the even SCTP stream ids of this new SCTP association and the answerer owns the odd SCTP stream identifiers. If this "m" line is removed from the signaling session (its port number set to zero), and if usage of this or of a new UDP/DTLS/SCTP or TCP/DTLS/SCTP based "m" line is renegotiated later on, then the even and odd SCTP stream identifier ownership is re-determined as described above.

This document allows simultaneous use of SDP offer/answer and DCEP negotiation. However, an SCTP stream MUST NOT be referenced in a "a=dcmap:" or "a=dcsa:" attribute of an SDP offer/answer exchange if the associated SCTP stream has already been negotiated via DCEP. Stream ids that are not currently used in SDP can be used for DCEP negotiation. Stream id allocation per SDP offer/answer negotiation may not align with DTLS role based allocation. This could cause glare conditions when one side tries to do SDP offer/answer negotiation on a stream id while the other end tries to open a data channel on the same stream id using DCEP negotiation. To avoid these glare conditions this document recommends that the data channel stack user always selects stream ids per the above described SDP offer/

answer rule even when DCEP negotiation is used. To avoid glare conditions, it is possible to come up with a different stream id allocation scheme, but such schemes are outside the scope of this document.

5.2.2. Negotiating Data Channel Parameters

Conveying a reliable data channel is achieved by including neither 'max-retr' nor 'max-time' in corresponding SDP offer's or answer's "a=dcmap:" attribute line. Conveying a partially reliable data channel is achieved by including only one of 'max-retr' or 'max-time'. By definition max-retr and max-time are mutually exclusive, so at most one of them MAY be present in the "a=dcmap:" attribute line. If a SDP offer contains both of these parameters then the receiver of such an SDP offer MUST reject the SDP offer. If a SDP answer contains both of these parameters then the offerer MAY treat it as an error and MAY assume the associated SDP offer/answer failed and MAY take appropriate recovery actions. These recovery options are outside the scope of this document.

The SDP answer SHALL echo the same subprotocol, max-retr, max-time, ordered parameters, if those were present in the offer, and MAY include a label parameter. They MAY appear in any order, which could be different from the SDP offer, in the SDP answer.

When sending a subsequent offer or an answer, and for as long as the data channel is still open, the sender MUST replicate the same information.

Data channel types defined in [I-D.ietf-rtcweb-data-protocol] are mapped to SDP in the following manner, where "ordered=true" is the default and may be omitted:

```
DATA_CHANNEL_RELIABLE
      ordered=true

DATA_CHANNEL_RELIABLE_UNORDERED
      ordered=false

DATA_CHANNEL_PARTIAL_RELIABLE_REXMIT
      ordered=true;max-retr=<number of retransmissions>

DATA_CHANNEL_PARTIAL_RELIABLE_REXMIT_UNORDERED
      ordered=false;max-retr=<number of retransmissions>

DATA_CHANNEL_PARTIAL_RELIABLE_TIMED
      ordered=true;max-time=<lifetime in milliseconds>

DATA_CHANNEL_PARTIAL_RELIABLE_TIMED_UNORDERED
      ordered=false;max-time=<lifetime in milliseconds>
```

5.2.3. Opening a Data Channel

The procedure for opening a data channel using SDP offer/answer negotiation starts with the agent preparing to send an SDP offer. If a peer receives an SDP offer before starting to send a new SDP offer with data channels that are to be SDP offer/answer negotiated, or loses an SDP offer glare resolution procedure in this case, it MUST wait until the ongoing SDP offer/answer completes before resuming the SDP offer/answer negotiation procedure.

The agent that intends to send an SDP offer to create data channels through SDP offer/answer negotiation performs the following:

- Creates data channels using stream identifiers from the owned set (see Section 5.2.1).
- Generates a new SDP offer.
- Determines the list of stream identifiers assigned to data channels opened through SDP offer/answer negotiation.
- Completes the SDP offer with the "a=dcmap:" and "a=dcsa:" attributes needed, if any, for each SDP offer/answer negotiated data channel, as described in Section 5.1 and in Section 5.2.2.
- If it adds "a=dcsa" attributes to the SDP offer, then it SHOULD add the subprotocol parameter to the "a=dcmap" attribute with a non-empty subprotocol identifier.
- Sends the SDP offer.

The peer receiving such an SDP offer performs the following:

- Parses and applies the SDP offer, taking into account the considerations discussed in Section 5.2.5.
- Analyzes the channel parameters and subprotocol attributes to determine whether to accept each offered data channel.
- For accepted data channels, it creates peer instances for the data channels with the agent using the channel parameters described in the SDP offer. Note that the agent is asked to create data channels with SCTP stream identifiers contained in the SDP offer if the SDP offer is accepted.
- Generates an SDP answer.
- Completes the SDP answer with the "a=dcmap:" and optional "a=dcsa:" attributes needed for each SDP offer/answer negotiated data channel, as described in Section 5.1 and in Section 5.2.2.
- Sends the SDP answer.

The agent receiving such an SDP answer performs the following:

- Closes any created data channels as described in Section 5.2.4 for which the expected "a=dcmap:" and "a=dcsa:" attributes are not present in the SDP answer.
- Applies the SDP answer.

Each agent application MUST wait to send data until it has confirmation that the data channel at the peer is instantiated. For WebRTC, this is when both data channel stacks have channel parameters instantiated. This occurs:

- At both peers when a data channel is created without an established SCTP association, as soon as the SCTP association is successfully established.
- At the agent receiving an SDP offer for which there is an established SCTP association, as soon as it creates an SDP offer/answer negotiated data channel based on information signaled in the SDP offer.
- At the agent sending an SDP offer to create a new SDP offer/answer negotiated data channel for which there is an established SCTP association, when it receives the SDP answer confirming acceptance

of the data channel or when it begins to receive data on the data channel from the peer, whichever occurs first.

Note: DCEP is not used, that is neither the SDP offerer nor the SDP answerer send an in-band DCEP DATA_CHANNEL_OPEN message.

5.2.4. Closing a Data Channel

When the application requests the closing of a data channel that was negotiated via SDP offer/answer, the data channel stack always performs an SCTP SSN reset for this channel.

It is specific to the subprotocol whether this closing MUST in addition be signaled to the peer via a new SDP offer/answer exchange.

The intention to close a data channel can be signaled by sending a new SDP offer which excludes the "a=dcmap:" and "a=dcsa:" attribute lines for the data channel. The offerer SHOULD NOT change the port value for the "m" line (e.g. to zero) when closing a data channel (unless all data channels are being closed and the SCTP association is no longer needed), since this would close the SCTP association and impact all of the data channels. If the answerer accepts the SDP offer then the answerer MUST close those data channels whose "a=dcmap:" and "a=dcsa:" attribute lines were excluded from the received SDP offer, unless those data channels were already closed, and the answerer MUST also exclude the corresponding attribute lines in the answer. In addition to that, the SDP answerer MAY exclude other data channels which were closed but not yet communicated to the peer. So, the offerer MUST inspect the answer to see if it has to close other data channels which are now not included in the answer.

If a new SDP offer/answer is used to close data channels then the data channel(s) SHOULD only be closed by the answerer/offerer after a successful SDP answer is sent/received.

This delayed closure is RECOMMENDED in order to handle cases where a successful SDP answer is not received, in which case the state of the session SHOULD be kept per the last successful SDP offer/answer.

If a client receives a data channel close indication (due to inband SCTP SSN reset or some other reason) without associated SDP offer then the client SHOULD generate an SDP offer which excludes this closed data channel.

The application MUST also close any data channel that was negotiated via SDP offer/answer, for which the stream identifiers are not listed in an incoming SDP offer.

A closed data channel using local close (SCTP SSN reset), without an additional SDP offer/answer to close it, may be reused for a new data channel. This can only be done via new SDP offer/answer, describing the new subprotocol and its attributes, only after the corresponding data channel close acknowledgement is received from the peer (i.e. SCTP SSN reset of both incoming and outgoing streams is completed). This restriction is to avoid the race conditions between arrival of "SDP offer which reuses stream" with "SCTP SSN reset which closes outgoing stream" at the peer.

5.2.5. Various SDP Offer/Answer Scenarios and Considerations

SDP offer has no "a=dcmap:" attributes.

* Initial SDP offer: No data channel is negotiated yet. The DTLS association and SCTP association is negotiated and, if agreed, established as per [I-D.ietf-mmusic-sctp-sdp].

* Subsequent SDP offer: All the SDP offer/answer negotiated data channels are expected be closed now. The DTLS/SCTP association remains open for SDP offer/answer or DCEP negotiation of data channels.

SDP answer has no "a=dcmap:" attributes.

* Initial SDP answer: Either the peer does not support "a=dcmap:" attributes or it rejected all the data channels. In either case the offerer closes all the SDP offer/answer negotiated data channels that were open at the time of initial offer. The DTLS association and SCTP association will still be setup.

* Subsequent SDP answer: All the SDP offer/answer negotiated data channels are expected be closed now. The SCTP association remains open for future SDP offer/answer or DCEP negotiation of data channels.

SDP offer or answer has no "a=dcmap:" attributes but has "a=dcsa:" attributes.

* This is considered an error case. In this case the receiver of such an SDP offer or answer SHOULD ignore the "a=dcsa:" attributes and SHOULD process the SDP offer or answer as per above case 'SDP offer has no "a=dcmap:" attributes' or case 'SDP answer has no "a=dcmap:" attributes'.

SDP offer has no "a=dcsa:" attributes for a data channel.

* This is allowed and indicates there are no subprotocol parameters to convey.

SDP answer has no "a=dcsa:" attributes for a data channel.

* This is allowed and indicates there are no subprotocol parameters to convey in the SDP answer. The number of "a=dcsa:" attributes in the SDP answer does not have to match the number of "a=dcsa:" attributes in the SDP offer.

SDP offer or answer has an "a=dcsa" attribute, whose subprotocol attribute is unknown.

* The receiver of such an SDP offer or answer SHOULD ignore this entire "a=dcsa" attribute line.

SDP offer or answer has an "a=dcsa" attribute, whose subprotocol attribute is known, but whose subprotocol attribute semantic is not known for the data channel transport case.

* The receiver of such an SDP offer or answer SHOULD ignore this entire "a=dcsa" attribute line.

6. Examples

SDP offer:

```
m=application 10001 UDP/DTLS/SCTP webrtc-datachannel
c=IN IP4 10.10.10.1
a=max-message-size:100000
a=sctp-port:5000
a=setup:actpass
a=connection:new
a=fingerprint:SHA-1 \
    4A:AD:B9:B1:3F:82:18:3B:54:02:12:DF:3E:5D:49:6B:19:E5:7C:AB
a=dtls-id:4a7565
a=dcmap:0 subprotocol="BFCP";label="BFCP"
```

SDP answer:

```
m=application 10002 UDP/DTLS/SCTP webrtc-datachannel
c=IN IP4 10.10.10.2
a=max-message-size:100000
a=sctp-port:5002
a=setup:passive
a=connection:new
a=fingerprint:SHA-1 \
    5B:AD:67:B1:3E:82:AC:3B:90:02:B1:DF:12:5D:CA:6B:3F:E5:54:FA
a=dtls-id:532d42
```

Figure 1: Example 1

In the above example the SDP answerer rejected the data channel with stream id 0 either for explicit reasons or because it does not understand the "a=dcmap:" attribute. As a result the offerer will close the data channel created with the SDP offer/answer negotiation option. The SCTP association will still be setup over DTLS. At this point the offerer or the answerer may use DCEP negotiation to open data channels.

SDP offer:

```
m=application 10001 UDP/DTLS/SCTP webrtc-datachannel
c=IN IP4 10.10.10.1
a=max-message-size:100000
a=sctp-port:5000
a=setup:actpass
a=connection:new
a=fingerprint:SHA-1 \
    4A:AD:B9:B1:3F:82:18:3B:54:02:12:DF:3E:5D:49:6B:19:E5:7C:AB
a=dtls-id:4a7565
a=dcmap:0 subprotocol="BFCP";label="BFCP"
a=dcmap:2 subprotocol="MSRP";label="MSRP"
a=dcsa:2 accept-types:message/cpim text/plain
a=dcsa:2 path:msrp://alice.example.com:10001/2s93i93idj;dc
```

SDP answer:

```
m=application 10002 UDP/DTLS/SCTP webrtc-datachannel
c=IN IP4 10.10.10.2
a=max-message-size:100000
a=sctp-port:5002
a=setup:passive
a=connection:new
a=fingerprint:SHA-1 \
    5B:AD:67:B1:3E:82:AC:3B:90:02:B1:DF:12:5D:CA:6B:3F:E5:54:FA
a=dtls-id:532d42
a=dcmap:2 subprotocol="MSRP";label="MSRP"
a=dcsa:2 accept-types:message/cpim text/plain
a=dcsa:2 path:msrp://bob.example.com:10002/si438dsaodes;dc
```

Figure 2: Example 2

In the above example the SDP offer contains data channels for BFCP (Binary Floor Control Protocol) and MSRP subprotocols. The SDP answer rejected BFCP and accepted MSRP. So, the offerer closes the data channel for BFCP and both offerer and answerer may start using the MSRP data channel (after the SCTP association is set up). The data channel with stream id 0 is free and can be used for future DCEP or SDP offer/answer negotiation.

Continuing the example in Figure 2.

Subsequent SDP offer:

```
m=application 10001 UDP/DTLS/SCTP webrtc-datachannel
c=IN IP4 10.10.10.1
a=max-message-size:100000
a=sctp-port:5000
a=setup:actpass
a=connection:existing
a=fingerprint:SHA-1 \
    4A:AD:B9:B1:3F:82:18:3B:54:02:12:DF:3E:5D:49:6B:19:E5:7C:AB
a=dtls-id:4a7565
a=dcmap:4 subprotocol="MSRP";label="MSRP"
a=dcsa:4 accept-types:message/cpim text/plain
a=dcsa:4 path:msrp://alice.example.com:10001/2s93i93idj;dc
```

Subsequent SDP answer:

```
m=application 10002 UDP/DTLS/SCTP webrtc-datachannel
c=IN IP4 10.10.10.2
a=max-message-size:100000
a=sctp-port:5002
a=setup:passive
a=connection:existing
a=fingerprint:SHA-1 \
    5B:AD:67:B1:3E:82:AC:3B:90:02:B1:DF:12:5D:CA:6B:3F:E5:54:FA
a=dtls-id:532d42
a=dcmap:4 subprotocol="MSRP";label="MSRP"
a=dcsa:4 accept-types:message/cpim text/plain
a=dcsa:4 path:msrp://bob.example.com:10002/si438dsaodes;dc
```

Figure 3: Example 3

The above example is a continuation of the example in Figure 2. The SDP offerer now removes the MSRP data channel with stream id 2, but opens a new MSRP data channel with stream id 4. The answerer accepts the entire offer. As a result the offerer closes the earlier negotiated MSRP related data channel and both offerer and answerer may start using new the MSRP related data channel.

7. Security Considerations

No security considerations are envisaged beyond those already documented in [RFC4566].

8. IANA Considerations

8.1. Subprotocol Identifiers

Registration of new subprotocol identifiers is performed using the existing IANA "WebSocket Subprotocol Name Registry" table.

The following text should be added following the title of the table.

"This table also includes subprotocol identifiers specified for usage within a WebRTC data channel."

The following reference should be added to under the heading reference: "RFC XXXX".

This document assigns no new values to this table.

A subprotocol may simultaneously be defined for data channel transport and for Websocket transport. In such a case the "Subprotocol Definition" and "Reference" cells in the subprotocol's row of the IANA "WebSocket Subprotocol Name Registry" table should contain two entries. One entry in each of these cells should refer to the Websocket related subprotocol specification, and the other entry should refer to the data channel related subprotocol specification.

NOTE to RFC Editor: Please replace "XXXX" with the number of this RFC.

8.2. New SDP Attributes

8.2.1. dcmap

NOTE to RFC Editor: Please replace "XXXX" with the number of this RFC.

This document defines a new SDP media-level attribute "a=dcmap:" as follows:

Contact name:	MMUSIC Chairs
Contact email:	mmusic-chairs@ietf.org
Attribute name:	dcmap
Attribute syntax:	As per Section 5.1.1.1
Attribute semantics:	As per Section 5.1.1.1
Usage level:	media
Charset dependent:	No
Purpose:	Define data channel specific parameters
Appropriate values:	As per Section 5.1.1.1
O/A procedures:	As per Section 5.2
Mux category:	SPECIAL. See Section 5.1.1.2
Reference:	RFCXXXX

8.2.2. dcsa

NOTE to RFC Editor: Please replace "XXXX" with the number of this RFC.

This document defines a new SDP media-level attribute "a=dcsa:" as follows:

Contact name:	MMUSIC Chairs
Contact email:	mmusic-chairs@ietf.org
Attribute name:	dcsa
Attribute syntax:	As per Section 5.1.2.1
Attribute semantics:	As per Section 5.1.2.1
Usage level:	media
Charset dependent:	No
Purpose:	Define data channel subprotocol specific attributes
Appropriate values:	As per Section 5.1.2.1
O/A procedures:	As per Section 5.2
Mux category:	SPECIAL. See Section 5.1.2.2
Reference:	RFCXXXX

8.3. New Usage Level

This document introduces a new "Data Channel Subprotocol Attribute" (dcsa) usage level to the SDP to the IANA SDP att-field registry. SDP attributes that are defined for use at the dcsa usage level only shall use the dcsa usage level when registering the attribute. If existing media attributes are used in a datachannel subprotocol specific way (Section 5.1.2.1), then a new dcsa usage level MUST be defined for the existing media attribute. Where the SDP attribute is

applicable to a particular subprotocol/s this SHALL also be registered by indicating the applicable subprotocol identifiers (see Section 8.1) along with the dcsa usage level. E.g.

...	...
Usage level:	dcsa(MSRP)
...	...

9. Acknowledgments

The authors wish to acknowledge the borrowing of ideas from other internet drafts by Salvatore Loreto, Gonzalo Camarillo, Peter Dunkley and Gavin Llewellyn, and to thank Flemming Andreasen, Roni Even, Christian Groves, Gunnar Hellstrom, Christer Holmberg, Paul Kyzivat, Jonathan Lennox, Uwe Rauschenbach and Roman Shpount for their invaluable comments.

10. CHANGE LOG

10.1. Changes against 'draft-ietf-mmusic-data-channel-sdpneg-09'

- In the introduction:
  - Replacement of the sentence "The RTCWeb working group has defined the concept of bi-directional data channels running on top of SCTP/DTLS (SCTP over the Datagram Transport Layer Security protocol)" with "The RTCWeb working group has defined the concept of bi-directional data channels running on top of the Stream Control Transmission Protocol (SCTP)".
  - Addition of following sentences to the second paragraph: "These procedures are based on generic SDP offer/answer negotiation rules for SCTP based media transport as specified in [I-D.ietf-mmusic-sctp-sdp] for the SDP "m" line proto values UDP/DTLS/SCTP and TCP/DTLS/SCTP. In future data channels could be defined over other SCTP based protocols, such as SCTP over IP. However, corresponding potential other "m" line proto values are not considered in this document."
- Replacement of "DTLS connection" with "DTLS association" throughout the document.
- In sections Section 5.1.1.2 and Section 5.1.2.2 removal of the sentences "This document also does not specify multiplexing rules for this attribute for SCTP or SCTP/DTLS proto values".

- In the text related to "Subsequent SDP answer" in section Section 5.2.5 replacement of "The DTLS/SCTP association remains open ..." with "The SCTP association remains open ...".

- In the text after the second SDP answer in section Section 6 replacement of "... (after SCTP/DTLS association is setup)" with "... (after the SCTP association is set up)".

- Addition of [I-D.ietf-mmusic-dtls-sdp] to the list of informative references.

- Addition of "a=dtls-id" attribute lines to the SDP offer/answer examples in Section 6.

10.2. Changes against 'draft-ietf-mmusic-data-channel-sdpneg-08'

- Addition of definition of "data channel subprotocol" to Section 3 as proposed on the MMUSIC list, https://www.ietf.org/mail-archive/web/mmusic/current/msg15827.html.

- Addition of [I-D.ietf-mmusic-rfc4566bis] to list of normative references.

- Updates of tables in Section 8.2.1 and Section 8.2.2 as per section 8.2.4 of [I-D.ietf-mmusic-rfc4566bis].

- Addition of new Section 8.3.

10.3. Changes against 'draft-ietf-mmusic-data-channel-sdpneg-07'

- Addition of two new paragraphs to Section 5.1.2.1 regarding subprotocol attribute relationship with transport protocol.

- Addition of a note to Section 8.1 regarding subprotocols simultaneously defined for data channel and Websocket usage.

- Addition of two further SDP offer/answer considerations to Section 5.2.5 regarding unknown subprotocol attributes and known subprotocol attributes with unknown data channel transport related semantic.

10.4. Changes against 'draft-ietf-mmusic-data-channel-sdpneg-06'

- Changes addressing Christian Groves's WGLC review comments raised in http://www.ietf.org/mail-archive/web/mmusic/current/msg15357.html and http://www.ietf.org/mail-archive/web/mmusic/current/msg15359.html.

10.5. Changes against 'draft-ietf-mmusic-data-channel-sdpneg-05'

- In IANA registration Section 8.2.1 and Section 8.2.2 replacement of contact name and e-mail address with "MMUSIC Chairs" and "mmusic-chairs@ietf.org".

- In Section 5.1.2.1 replacement of "Thus in the example above, the original attribute line "a=accept- types:text/plain" is represented by the attribute line "a=dcsa:2 accept-types:text/plain", which specifies that this instance of MSRP being transported on the SCTP association using the data channel with stream id 2 accepts plain text files." with "... which specifies that this instance of the MSRP subprotocol being transported ...".

- The last paragraph of Section 5.1.2.1 started with "Note: This document does not provide a complete specification ...". Removal of "Note:" and move of this paragraph to the introduction in Section 1 as last paragraph.

- Section 5.1.2's headline was "Subprotocol Specific Attributes". Change of this headline to "Other Media Level Attributes" and adaptations of the first paragraph of this section and the first paragraph of Section 5.1.2.1 in order to clarify that not only those attributes may be encapsulated in a "dcsa" attribute, which are specifically defined for the subprotocol, but that also other attributes may be encapsulated if they are related to the specific subprotocol instance.

- Move of the last but one paragraph of Section 5.1.2.1 starting with "The same syntax applies to ..." right in front of the formal syntax definition of the "dcsa" attribute.

- Modifications of the text in Section 5.1.1.2 and Section 5.1.2.2 in order not to explicitly restrict usage of the "a=dcmap:" and "a=dcsa:" attributes to "m" lines with proto values "UDP/DTLS/SCTP" or "TCP/DTLS/SCTP".

10.6. Changes against 'draft-ietf-mmusic-data-channel-sdpneg-04'

- In Section 5.1.1.5 the first (and only) paragraph was "The 'subprotocol' parameter indicates which protocol the client expects to exchange via the channel. 'Subprotocol' is an optional parameter. If the 'subprotocol' parameter is not present, then its value defaults to the empty string." Replacement of this paragraph with following two paragraphs:

  * The 'subprotocol' parameter indicates which protocol the client expects to exchange via the channel. This parameter maps to

the 'Protocol' parameter defined in [I-D.ietf-rtcweb-data-protocol]. Section 8.1 specifies how new subprotocol parameter values are registered. 'Subprotocol' is an optional parameter. If the 'subprotocol' parameter is not present, then its value defaults to the empty string.

* Note: The empty string MAY also be explicitly used as 'subprotocol' value, such that 'subprotocol=""' is equivalent to the 'subprotocol' parameter not being present at all. [I-D.ietf-rtcweb-data-protocol] allows the DATA_CHANNEL_OPEN message's 'Subprotocol' value to be an empty string.

- Addition of [I-D.ietf-mmusic-sdp-mux-attributes] to list the of normative references.

- Addition of dcmap attribute specific IANA registration Section 8.2.1.

- Addition of dcsa attribute specific IANA registration Section 8.2.2.

- Addition of new Section 5.1.1.2 describing the mux category of the dcmap SDP attribute. This section and the new "a=dcsa:" attribute related mux category section are similar to the "Mux Category" sections of the "a=sctp-port:" and "a=max-message-size:" attributes in [I-D.ietf-mmusic-sctp-sdp].

- Addition of new Section 5.1.2.2 describing the mux category of the dcsa SDP attribute.

10.7. Changes against 'draft-ietf-mmusic-data-channel-sdpneg-03'

- In Section 1 replacement of "RTCWeb leaves it open for other applications to use data channels and its in-band DCEP or out-of-band non-DCEP protocols for creating them" with "... to use data channels and its in-band DCEP or other in-band or out-of-band protocols for creating them". Additionally replacement of "In particular, the SDP offer generated by the application includes no channel-specific information" with "... generated by the RTCweb data channel stack includes no channel-specific information".

- Move of former section 5 ("Data Channels") to new Appendix A and removal of JavaScript API specific discussions from this moved text (like mentioning of data channel stack specific states). Therefore former section 6 ("SDP Offer/Answer Negotiation") is now Section 5.

- In Section 5:

  * Relacement of Section 5's first paragraph "This section defines a method of non-DCEP negotiation by which two clients can negotiate data channel-specific and subprotocol-specific parameters, using the out-of-band SDP offer/answer exchange. This SDP extension can only be used with the SDP offer/answer model." with "This section defines an SDP extension by which two clients can negotiate data channel-specific and subprotocol-specific parameters without using DCEP [I-D.ietf-rtcweb-data-protocol]. This SDP extension only defines usage in the context of SDP offer/answer."

  * Addition of new paragraph: "Appendix A provides information how data channels work in general and especially summarizes some key aspects, which should be considered for the negotiation of data channels if DCEP is not used."

- In Section 5.1.1 replacement of "The intention of exchanging these attributes is to create data channels on both the peers with the same set of attributes without actually using the DCEP [I-D.ietf-rtcweb-data-protocol]" with "The intention in exchanging these attributes is to create, on two peers, without use of DCEP [I-D.ietf-rtcweb-data-protocol], matched pairs of oppositely directed data channels having the same set of attributes".

- In Section 5.1.1.6 replacement of "The 'max-retr' parameter indicates the maximal number a user message will be retransmitted" with "The 'max-retr' parameter indicates the maximal number of times a user message will be retransmitted".

- In Section 5.2.1 replacement of "However, an SDP offer/answer exchange MUST NOT be initiated if the associated SCTP stream is already negotiated via DCEP" with "However, an SCTP stream MUST NOT be referenced in a dcmap or dcsa attribute of an SDP offer/answer exchange if the associated SCTP stream has already been negotiated via DCEP".

- In the examples in Section 6 addition of the previously missing colons to the "a=sctp-port" attribute lines.

10.8. Changes against 'draft-ietf-mmusic-data-channel-sdpneg-02'

- Move of reference [I-D.ietf-rtcweb-jsep] from the list of normative references to the list of informative references.

- Addition of [IANA-SDP-Parameters] to the list of informative references and addition of following two sentences to the first paragraph after the ABNF definition: "Note however that not all SDP attributes are suitable as "a=dcsa:" parameter.

[IANA-SDP-Parameters] contains the lists of IANA registered session and media level or media level only SDP attributes."

- In the introduction replacement of last sentence "This document defines SDP-based out-of-band negotiation procedures to establish data channels for transport of well-defined subprotocols" with "This document defines SDP offer/answer negotiation procedures to establish data channels for transport of well-defined subprotocols, to enable out-of-band negotiation".

- Throughout the document replacement of "external negotiation" with "SDP offer/answer negotiation" and removal of term "external negotiation" from the terminology list in Section 3.

- Throughout the document replacement of "internal negotiation" with "DCEP" and removal of terms "internal negotiation" and "in-band negotiation" from the terminology list in Section 3.

- Addition of "SCTP Stream Sequence Number (SSN)" to the list of terms.

- In Section 5.2.1 replacement of sentence "However, a single stream is managed using one method at a time." with "However, an SDP offer/answer exchange MUST NOT be initiated if the associated SCTP stream is already negotiated via DCEP".

- In Section 5.2.2 replacement of sentence "By definition max-retr and max-time are mutually exclusive, so only one of them can be present in a=dcmap" with "By definition max-retr and max-time are mutually exclusive, so at most one of them MAY be present in a=dcmap".

- Move of reference [WebRtcAPI] from list of normative references to list of informative references.

- Removal of almost all text parts, which discussed JavaScript or other API specific aspects. Such API specific aspects were mainly discussed in sub-sections of Section 5 and Section 5 of draft-ietf-mmusic-data-channel-sdpneg-02.

10.9. Changes against 'draft-ietf-mmusic-data-channel-sdpneg-01'

- New Section 4 regarding applicability to SDP offer/answer only.

- Addition of new Section 8.1 "Subprotocol identifiers" as subsection of the "IANA Considerations" related Section 8. Also removal of the temporary note "To be completed. As [I-D.ietf-

rtcweb-data-protocol] this document should refer to IANA's WebSocket Subprotocol Name Registry defined in [RFC6455]."

- In Section 5.2.2:
  - In the first paragraph replacement of the sentence "If an SDP offer contains both of these parameters then such an SDP offer will be rejected." with "If an SDP offer contains both of these parameters then the receiver of such an SDP offer MUST reject the SDP offer."
  - In the second paragraph capitalization of "shall" and "may" such that both sentences now read: "The SDP answer SHALL echo the same subprotocol, max-retr, max-time, ordered parameters, if those were present in the offer, and MAY include a label parameter. They MAY appear in any order, which could be different from the SDP offer, in the SDP answer."
  - In the third paragraph replacement of the sentence "The same information MUST be replicated without changes in any subsequent offer or answer, as long as the data channel is still opened at the time of offer or answer generation." with "When sending a subsequent offer or an answer, and for as long as the data channel is still open, the sender MUST replicate the same information.".
- In Section 5.2.2 the mapping of data channel types defined in [I-D.ietf-rtcweb-data-protocol] to the SDP "a=dcmap" attribute parameters were illustrated using example "a=dcmap" attribute lines. Replacement of these example "a=dcmap" attribute lines with just the "a=dcmap" attribute parameters being relevant for the channel type.
- In Section 5.2.5 the description of bullet point "SDP offer has no a=dcmap attributes - Initial SDP offer:" was "Initial SDP offer: No data channel negotiated yet." Replacement of this description with "Initial SDP offer: No data channel is negotiated yet. The DTLS connection and SCTP association is negotiated and, if agreed, established as per [I-D.ietf-mmusic-sctp-sdp]."
- In Section 5.2.5 in both bullet points related to "Subsequent SDP offer" and "Subsequent SDP answer" replacement of "All the externally negotiated data channels must be closed now." with "All the externally negotiated data channels are expected be closed now.".
- In Appendix A.2.2's sixth paragraph beginning with "[ASSUMPTION]" replacement of the two occurrences of "must" with "MUST".

- In Section 5.1.1.1 in the definition of the ABNF rule "dcmap-opt" there was a comment saying that "Either only maxretr-opt or maxtime-opt is present. Both MUST not be present." Removal of the second normative sentence and instead addition of following new paragraph to the end of this section: "Within an 'a=dcmap' attribute line's 'dcmap-opt' value either only one 'maxretr-opt' parameter or one 'maxtime-opt' parameter is present. Both MUST NOT be present."

- In Section 5.1.1.8 replacement of the first sentence "The 'ordered' parameter with value "true" indicates that DATA chunks in the channel MUST be dispatched to the upper layer by the receiver while preserving the order." with "The 'ordered' parameter with value "true" indicates that the receiver MUST dispatch DATA chunks in the data channel to the upper layer while preserving the order.".

- In Section 5.2.3's first paragraph replacement of the one occurrence of "must" with "..., it MUST wait until ...".

- In Section 5.2.4:

  * In the second paragraph replacement of "must" with "... whether this closing MUST in addition ..."

  * In the third paragraph replacement of the sentence "The port value for the "m" line SHOULD not be changed (e.g., to zero) when closing a data channel ..." with "The offerer SHOULD NOT change the port value for the "m" line (e.g., to zero) when closing a data channel ...".

  * In the last but two paragraph replacement of the sentence "... then an SDP offer which excludes this closed data channel SHOULD be generated." with "... then the client SHOULD generate an SDP offer which excludes this closed data channel.".

  * In the last but one paragraph replacement of "must" with "The application MUST also close...".

- In Section 5.1.2 addition of following note after the formal definition of the 'a=dcsa' attribute: "Note that the above reference to RFC 4566 defines were the attribute definition can be found; it does not provide any limitation on support of attributes defined in other documents in accordance with this attribute definition."

10.10. Changes against 'draft-ietf-mmusic-data-channel-sdpneg-00'

- In Section 3 "WebRTC data channel" was defined as "A bidirectional channel consisting of paired SCTP outbound and inbound streams." Replacement of this definition with "Data channel: A WebRTC data channel as specified in [I-D.ietf-rtcweb-data-channel]", and consistent usage of "data channel" in the remainder of the document including the document's headline."

- In Section 5 removal of following note: 'OPEN ISSUE: The syntax in [I-D.ietf-mmusic-sctp-sdp] may change as that document progresses. In particular we expect "webrtc-datachannel" to become a more general term.'

- Consistent usage of '"m" line' in whole document as per [RFC4566].

- In Section 5.1.1 removal of the example dcmap attribute line 'a=dcmap:2 subprotocol="BFCP";label="channel 2' as there are already four examples right after the ABNF rules in Section 5.1.1.1. Corresponding removal of following related note: "Note: This document does not provide a complete specification of how to negotiate the use of a WebRTC data channel to transport BFCP. Procedures specific to each subprotocol such as BFCP will be documented elsewhere. The use of BFCP is only an example of how the generic procedures described herein might apply to a specific subprotocol."

- In Section 5.1.1 removal of following note: "Note: This attribute is derived from attribute "webrtc-DataChannel", which was defined in old version 03 of the following draft, but which was removed along with any support for SDP external negotiation in subsequent versions: [I-D.ietf-mmusic-sctp-sdp]."

- Insertion of following new sentence to the beginning of Section 5.1.1.1: "dcmap is a media level attribute having following ABNF syntax:"

- Insertion of new Section 5.1.1.3 containing the dcmap-stream-id specifying sentence, which previously was placed right before the formal ABNF rules. Removal of the sentence 'Stream is a mandatory parameter and is noted directly after the "a=dcmap:" attribute's colon' as this information is part of the ABNF specification.

- In Section 5.1.1.1 modification of the 'ordering-value' values from "0" or "1" to "true" or "false". Corresponding text modifications in Section 5.1.1.8.

- In Section 5.1.1.1 the ABNF definition of "quoted-string" referred to rule name "escaped-char", which was not defined. Instead a rule with name "escaped" was defined. Renamed that rule's name to "escaped-char".

- Insertion of a dedicated note right after the "a=dcmap:4" attribute example in Section 5.1.1.1 regarding the non-printable "escaped-char" character within the "label" value.

- In Section 5.1.2's second paragraph replacement of "sctp stream identifier" with "SCTP stream identifier".

- In first paragraph of Section 5.2.1 replacement of first two sentences 'For the SDP-based external negotiation described in this document, the initial offerer based "SCTP over DTLS" owns by convention the even stream identifiers whereas the initial answerer owns the odd stream identifiers. This ownership is invariant for the whole lifetime of the signaling session, e.g. it does not change if the initial answerer sends a new offer to the initial offerer.' with 'If an SDP offer/answer exchange (could be the initial or a subsequent one) results in a UDP/DTLS/SCTP or TCP/DTLS/SCTP based media description being accepted, and if this SDP offer/answer exchange results in the establishment of a new SCTP association, then the SDP offerer owns the even SCTP stream ids of this new SCTP association and the answerer owns the odd SCTP stream identifiers. If this "m" line is removed from the signaling session (its port number set to zero), and if usage of this or of a new UDP/DTLS/SCTP or TCP/DTLS/SCTP based "m" line is renegotiated later on, then the even and odd SCTP stream identifier ownership is redetermined as well as described above.'

- In Section 5.2.3 the first action of an SDP answerer, when receiving an SDP offer, was described as "Applies the SDP offer. Note that the browser ignores data channel specific attributes in the SDP." Replacement of these two sentences with "Parses and applies the SDP offer. Note that the typical parser normally ignores unknown SDP attributes, which includes data channel related attributes."

- In Section 5.2.3 the second sentence of the third SDP answerer action was "Note that the browser is asked to create data channels with stream identifiers not "owned" by the agent.". Replacement of this sentence with "Note that the agent is asked to create data channels with SCTP stream identifiers contained in the SDP offer if the SDP offer is accepted."

- In Section 5.2.4 the third paragraph began with "A data channel can be closed by sending a new SDP offer which excludes the dcmap

and dcsa attribute lines for the data channel. The port value for the m line should not be changed (e.g., to zero) when closing a data channel (unless all data channels are being closed and the SCTP association is no longer needed), since this would close the SCTP association and impact all of the data channels. If the answerer accepts the SDP offer then it MUST also exclude the corresponding attribute lines in the answer. ..." Replacement of this part with "The intention to close a data channel can be signaled by sending a new SDP offer which excludes the "a=dcmap:" and "a=dcsa:" attribute lines for the data channel. The port value for the "m" line SHOULD not be changed (e.g., to zero) when closing a data channel (unless all data channels are being closed and the SCTP association is no longer needed), since this would close the SCTP association and impact all of the data channels. If the answerer accepts the SDP offer then it MUST close those data channels whose "a=dcmap:" and "a=dcsa:" attribute lines were excluded from the received SDP offer, unless those data channels were already closed, and it MUST also exclude the corresponding attribute lines in the answer."

- In Section 5.2.4 the hanging text after the third paragraph was "This delayed close is to handle cases where a successful SDP answer is not received, in which case the state of session should be kept per the last successful SDP offer/answer." Replacement of this sentence with "This delayed closure is RECOMMENDED in order to handle cases where a successful SDP answer is not received, in which case the state of the session SHOULD be kept per the last successful SDP offer/answer."

- Although dedicated to "a=dcmap" and "a=dcsa" SDP syntax aspects Section 5.1.1 contained already procedural descriptions related to data channel reliability negotiation. Creation of new Section 5.2.2 and moval of reliability negotiation related text to this new section.

10.11. Changes against 'draft-ejzak-mmusic-data-channel-sdpneg-02'

- Removal of note "[ACTION ITEM]" from section "subprotocol parameter". As [I-D.ietf-rtcweb-data-protocol] this document should refer to IANA's WebSocket Subprotocol Name Registry defined in [RFC6455].

- In whole document, replacement of "unreliable" with "partially reliable", which is used in [I-D.ietf-rtcweb-data-channel] and in [I-D.ietf-rtcweb-data-protocol] in most places.

- Clarification of the semantic if the "max-retr" parameter is not present in an a=dcmap attribute line. In section "max-retr

parameter" the sentence "The max-retr parameter is optional with default value unbounded" was replaced with "The max-retr parameter is optional. If the max-retr parameter is not present, then the maximal number of retransmissions is determined as per the generic SCTP retransmission rules as specified in [RFC4960]".

- Clarification of the semantic if the "max-time" parameter is not present in an a=dcmap attribute line. In section "max-time parameter" the sentence "The max-time parameter is optional with default value unbounded" was replaced with "The max-time parameter is optional. If the max-time parameter is not present, then the generic SCTP retransmission timing rules apply as specified in [RFC4960]".

- In section "label parameter" the sentence "Label is a mandatory parameter." was removed and following new sentences (including the note) were added: "The 'label' parameter is optional. If it is not present, then its value defaults to the empty string. Note: The empty string may also be explicitly used as 'label' value, such that 'label=""' is equivalent to the 'label' parameter not being present at all. [I-D.ietf-rtcweb-data-protocol] allows the DATA_CHANNEL_OPEN message's 'Label' value to be an empty string."

- In section "subprotocol parameter" the sentence "Subprotocol is a mandatory parameter." was replaced with "'Subprotocol' is an optional parameter. If the 'subprotocol' parameter is not present, then its value defaults to the empty string."

- In the "Examples" section, in the first two SDP offer examples in the a=dcmap attribute lines 'label="BGCP"' was replaced with 'label="BFCP"'.

- In all examples, the "m" line proto value "DTLS/SCTP" was replaced with "UDP/DTLS/SCTP" and the "a=fmtp" attribute lines were replaced with "a=max-message-size" attribute lines, as per draft-ietf-mmusic-sctp-sdp-12.

10.12. Changes against '-01'

- Formal syntax for dcmap and dcsa attribute lines.

- Making subprotocol as an optional parameter in dcmap.

- Specifying disallowed parameter combinations for max-time and max-retr.

- Clarifications on WebRTC data channel close procedures.

10.13. Changes against '-00'

- Revisions to identify difference between internal and external negotiation and their usage.
- Introduction of more generic terminology, e.g. "application" instead of "browser".
- Clarification of how "max-retr and max-time affect the usage of unreliable and reliable WebRTC data channels.
- Updates of examples to take into account the SDP syntax changes introduced with draft-ietf-mmusic-sctp-sdp-07.
- Removal of the SCTP port number from the a=dcmap and a=dcsa attributes as this is now contained in the a=sctp-port attribute, and as draft-ietf-mmusic-sctp-sdp-07 supports only one SCTP association on top of the DTLS connection.

11. References

11.1. Normative References

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Appendix A. Generic Data Channel Negotiation Aspects When Not Using DCEP

This appendix summarizes how data channels work in general and discusses some key aspects, which should be considered for the out-of-band negotiation of data channels if DCEP is not used.

A WebRTC application creates a data channel by providing a number of setup parameters (subprotocol, label, maximal number of retransmissions, maximal retransmission time, order of delivery, priority). The application also specifies if it wants to make use of the negotiation using the DCEP [I-D.ietf-rtcweb-data-protocol], or if the application intends to negotiate data channels using the SDP offer/answer protocol.

In any case, the SDP offer generated by the application is per [I-D.ietf-mmusic-sctp-sdp]. In brief, it contains one "m" line for the SCTP association on top of which data channels will run:

```
m=application 54111 UDP/DTLS/SCTP webrtc-datachannel
c=IN IP4 79.97.215.79
a=max-message-size:100000
a=sctp-port:5000
a=setup:actpass
a=connection:new
a=fingerprint:SHA-1 \
    4A:AD:B9:B1:3F:82:18:3B:54:02:12:DF:3E:5D:49:6B:19:E5:7C:AB
```

Note: A WebRTC application will only use "m" line format "webrtc-datachannel", and will not use other formats in the "m" line for other protocols such as t38. [I-D.ietf-mmusic-sctp-sdp] supports only one SCTP association to be established on top of a DTLS association.

Note: The above SDP media description does not contain any channel-specific information.

A.1. Stream Identifier Numbering

Independently from the requested type of negotiation, the application creating a data channel can either pass to the data channel stack the stream identifier to assign to the data channel or else let the data channel stack pick one identifier from the unused ones.

To avoid glare situations, each endpoint can moreover own an exclusive set of stream identifiers, in which case an endpoint can only create a data channel with a stream identifier it owns.

Which set of stream identifiers is owned by which endpoint is determined by convention or other means.

For data channels negotiated with the DCEP, one endpoint owns by convention the even stream identifiers, whereas the other owns the odd stream identifiers, as defined in [I-D.ietf-rtcweb-data-protocol].

For data channels negotiated via some protocol different from DCEP, no convention is defined by default.

A.2. Generic Data Channel Negotiation Not Using DCEP

A.2.1. Overview

DCEP negotiation only provides for negotiation of data channel transport parameters and does not provide for negotiation of subprotocol specific parameters. DCEP-less data channel negotiation can be defined to allow negotiation of parameters beyond those handled by DCEP, e.g., parameters specific to the subprotocol instantiated on a particular data channel.

The following procedures are common to all methods of data channel negotiation not using DCEP, whether in-band (communicated using proprietary means on an already established data channel) or out-of-band (using SDP offer/answer or some other protocol associated with the signaling channel).

A.2.2. Opening a Data Channel

In the case of DCEP-less negotiation, the endpoint application has the option to fully control the stream identifier assignments. However these assignments have to coexist with the assignments controlled by the data channel stack for the DCEP negotiated data channels (if any). It is the responsibility of the application to ensure consistent assignment of stream identifiers.

When the application requests the creation of a new data channel to be set up via DCEP-less negotiation, the data channel stack creates the data channel locally without sending any DATA_CHANNEL_OPEN message in-band. However, even if the ICE (Interactive Connectivity Establishment), DTLS and SCTP procedures were already successfully completed, the application can't send data on this data channel until the negotiation is complete with the peer. This is because the peer needs to be aware of and accept the usage of this data channel. The peer, after accepting the data channel offer, can start sending data immediately. This implies that the offerer may receive data channel

subprotocol messages before the negotiation is complete and the application should be ready to handle it.

If the peer rejects the data channel part of the offer then it doesn't have to do anything as the data channel was not created using the stack. The offerer on the other hand needs to close the data channel that was opened by invoking relevant data channel stack API procedures.

It is also worth noting that a data channel stack implementation may not provide any API to create and close data channels; instead the data channels may be used on the fly as needed just by communicating via non-DCEP means or by even having some local configuration/ assumptions on both the peers.

The application then negotiates the data channel properties and subprotocol properties with the peer's application using a mechanism different from DCEP.

The peer then symmetrically creates a data channel with these negotiated data channel properties. This is the only way for the peer's data channel stack to know which properties to apply when transmitting data on this channel. The data channel stack must allow data channel creation with any non-conflicting stream identifier so that both peers can create the data channel with the same stream identifier.

A.2.3. Closing a Data Channel

When the application requests the closing of a data channel negotiated without DCEP, the data channel stack always performs an SCTP SSN reset for this channel.

Depending upon the method used for DCEP-less negotiation and the subprotocol associated with the data channel, the closing might in addition be signaled to the peer via SDP offer/answer negotiation.

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