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**Session Description Protocol (SDP) Extension For Setting Up Audio and
Video Media Streams Over Circuit-Switched Bearers In The Public Switched
Telephone Network (PSTN)**
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Abstract

This memo describes use cases, requirements, and protocol extensions for using the Session Description Protocol (SDP) Offer/Answer model for establishing audio and video media streams over circuit-switched bearers in the Public Switched Telephone Network (PSTN).

Status of this Memo

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1. Introduction

The Session Description Protocol (SDP) [[RFC4566](#)] is intended for describing multimedia sessions for the purposes of session announcement, session invitation, and other forms of multimedia session initiation. SDP is most commonly used for describing media streams that are transported over the Real-Time Transport Protocol (RTP) [[RFC3550](#)], using the profiles for audio and video media defined in RTP Profile for Audio and Video Conferences with Minimal Control [[RFC3551](#)].

However, SDP can be used to describe other transport protocols than RTP. Previous work includes SDP conventions for describing ATM bearer connections [[RFC3108](#)] and the Message Session Relay Protocol [[RFC4975](#)].

SDP is commonly carried in Session Initiation Protocol (SIP) [[RFC3261](#)] messages in order to agree on a common media description among the endpoints. An Offer/Answer Model with Session Description Protocol (SDP) [[RFC3264](#)] defines a framework by which two endpoints can exchange SDP media descriptions and come to an agreement as to which media streams should be used, along with the media related parameters.

In some scenarios it might be desirable to establish the media stream over a circuit-switched bearer connection even if the signaling for the session is carried over an IP bearer. An example of such a scenario is illustrated with two mobile devices capable of both circuit-switched and packet-switched communication over a low-bandwidth radio bearer. The radio bearer may not be suitable for carrying real-time audio or video media, and using a circuit-switched bearer would offer a better perceived quality of service. So, according to this scenario, SDP and its higher layer session control protocol (e.g., the Session Initiation Protocol (SIP) [[RFC3261](#)]) are used over regular IP connectivity, while the audio or video is received through the classical circuit-switched bearer.

Setting up a signaling relationship in the IP domain instead of just setting up a circuit-switched call offers also the possibility of negotiating in the same session other IP based media that is not sensitive to jitter and delay, for example, text messaging or presence information.

At a later point in time the mobile device might move to an area where a high-bandwidth packet-switched bearer, for example a Wireless Local Area Network (WLAN) connection, is available. At this point the mobile device may perform a handover and move the audio or video media streams over to the high-speed bearer. This implies a new

exchange of SDP Offer/Answer that lead to a re-negotiation of the media streams.

Other use cases exist. For example, an endpoint might have at its disposal circuit-switched and packet-switched connectivity, but the same audio or video codecs are not feasible for both access networks. For example, the circuit-switched audio or video stream supports narrow-bandwidth codecs, while the packet-switched access allows any other audio or video codec implemented in the endpoint. In this case, it might be beneficial for the endpoint to describe different codecs for each access type and get an agreement on the bearer together with the remote endpoint.

There are additional use cases related to third party call control where the session setup time is improved when the circuit-switched bearer in the PSTN is described together with one or more codecs.

The rest of the document is structured as follows: [Section 2](#) provides the document conventions, [Section 3](#) introduces the requirements, [Section 4](#) presents an overview of the proposed solutions, and [Section 5](#) contains the protocol description. [Section 6](#) provides an example of descriptions of circuit-switched audio or video streams in SDP. [Section 8](#) and [Section 7](#) contain the IANA and Security considerations, respectively.

[2.](#) Conventions Used in This Document

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "NOT RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in [BCP 14](#), [RFC 2119](#) [[RFC2119](#)] and indicate requirement levels for compliant implementations.

[3.](#) Requirements

This section presents the general requirements that are specific for the audio or video media streams over circuit-switched bearers.

REQ-1: A mechanism for endpoints to negotiate and agree on an audio or video media stream established over a circuit-switched bearer MUST be available.

REQ-2: The mechanism MUST allow the endpoints to combine circuit-switched audio or video media streams with other complementary media streams, for example, text messaging.

- REQ-3: The mechanism MUST allow the endpoint to negotiate the direction of the circuit-switched bearer, i.e., which endpoint is active when initiating the circuit-switched bearer.
- REQ-4: The mechanism MUST be independent of the type of the circuit-switched access (e.g., Integrated Services Digital Network (ISDN), Global System for Mobile Communication (GSM), etc.)
- REQ-5: There MUST be a mechanism that helps an endpoint to correlate an incoming circuit-switched bearer with the one negotiated in SDP, as opposed to another incoming call that is not related to that.
- REQ-6: It MUST be possible for endpoints to advertise different list of audio or video codecs in the circuit-switched audio or video stream from those used in a packet-switched audio or video stream.
- REQ-7: It MUST be possible for endpoints to not advertise the list of available codecs for circuit-switched audio or video streams.

4. Overview of Operation

The mechanism defined in this memo extends SDP and allows describing an audio or video media stream established over a circuit-switched bearer. New tokens are registered in the "c=" and "m=" lines to be able to describe a media stream over a circuit-switched bearer. These SDP extensions are described in [Section 5.2](#). Since circuit-switched bearers are connection-oriented media streams, the mechanism re-uses the connection-oriented extensions defined in [RFC 4145](#) [[RFC4145](#)] to negotiate the active and passive sides of a connection setup. This is further described in [Section 5.3.1](#).

4.1. Example Call Flow

Consider the example presented in Figure 1. In this example, Alice is located in an environment where she has access to both IP and circuit-switched bearers for communicating with other endpoints. Alice decides that the circuit-switched bearer offers a better perceived quality of service for voice, and issues an SDP Offer containing the description of an audio media stream over circuit-switched bearer.

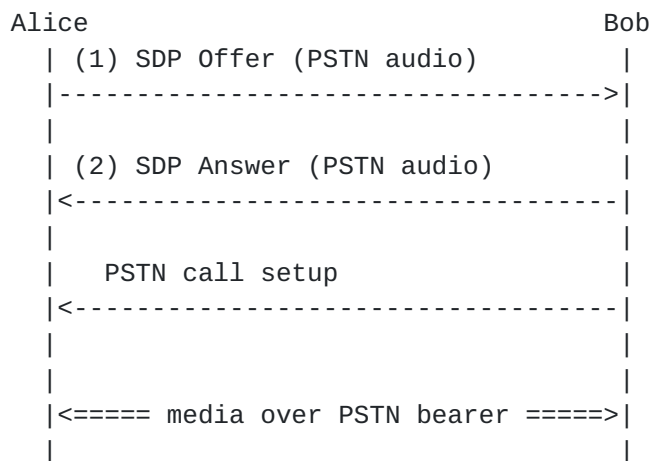


Figure 1: Example Flow

Bob receives the SDP offer and determines that he is located in an environment where the IP based bearer is not suitable for real-time audio media. However he also has PSTN circuit-switched bearer available for audio. Bob generates an SDP answer containing a description of the audio media stream over a circuit-switched bearer.

During the offer-answer exchange Alice and Bob also agree the direction in which the circuit-switched bearer should be established. In this example, Bob becomes the active party, in other words, he establishes the circuit-switched call to the other endpoint. The Offer/Answer exchange contains identifiers or references that can be used on the circuit-switched network for addressing the other endpoint, as well as information that is used to determine that the incoming circuit-switched bearer establishment is related to the ongoing session between Alice and Bob.

Bob establishes a circuit-switched bearer towards Alice using whatever mechanisms are defined for the network type in question. When receiving the incoming circuit-switched connection attempt, Alice is able to determine that the attempt is related to the session she is just establishing with Bob.

Alice accepts the circuit-switched connection; the circuit-switched bearer setup is completed. Bob and Alice can now use the circuit-switched connection for two-way audio media.

If, for some reason, Bob would like to reject the offered stream, he would set the port number of the specific stream to zero, as specified in [RFC3264](#) [RFC3264]. Also, if Bob does not understand some of the SDP attributes specified in this document, he would ignore them, as specified in [RFC4566](#) [RFC4566].

5. Protocol Description

5.1. Level of Compliance

Implementations according to this specification MUST implement the SDP extensions described in [Section 5.2](#), and MUST implement the considerations discussed in [Section 5.3](#), [Section 5.4](#) and [Section 5.6](#).

5.2. Extensions to SDP

This section provides the syntax and semantics of the extensions required for providing a description of audio or video media streams over circuit-switched bearers in SDP.

5.2.1. Connection Data

According to SDP [[RFC4566](#)], the connection data line in SDP has the following syntax:

```
c=<nettype> <addrtype> <connection-address>
```

where <nettype> indicates the network type, <addrtype> indicates the address type, and the <connection-address> is the connection address, which is dependent on the address type.

At the moment, the only network type defined is "IN", which indicates Internet network type. The address types "IP4" and "IP6" indicate the type of IP addresses.

This memo defines a new network type for describing a circuit-switched bearer network type in the PSTN. The mnemonic "PSTN" is used for this network type.

For the address type, we initially consider the possibility of describing E.164 telephone numbers. We define a new "E164" address type. When used, the "E164" address type indicates that the connection address contains an international E.164 number represented according to the ITU-T E.164 [[ITU.E164.1991](#)] recommendation.

It is a common convention that an international E.164 number contains a leading '+' sign. For consistency's sake, we also require the E.164 telephone is prepended with a '+', even if that is not necessary for routing of the call in the PSTN network.

There are cases, though, when the endpoint is merely aware of a circuit-switched bearer, without having further information about the address type or the E.164 number allocated to it. In these cases a dash "-" is used to indicate an unknown address type or connection

address. This makes the connection data line be according to the SDP syntax.

Note that <addrtype> and/or <connection-address> should not be omitted without being set to a "-" since this would violate basic syntax of SDP [[RFC4566](#)].

The following are examples of the extension to the connection data line:

```
c=PSTN E164 +35891234567
```

```
c=PSTN - -
```

When the <addrtype> is PSTN, the connection address is defined as follows:

- o an international E.164 number

When the <addrtype> is "-", the connection address is defined as follows:

- o the value "-", signifying that the address is unknown
- o any syntactically valid value, which is to be ignored

5.2.2. Media Descriptions

According to SDP [[RFC4566](#)], the media descriptions line in SDP has the following syntax:

```
m=<media> <port> <proto> <fmt> ...
```

The <media> subfield carries the media type. For establishing an audio bearer, the existing "audio" media type is used. For establishing a video bearer, the existing "video" media type is used.

The <port> subfield is the transport port to which the media stream is sent. Circuit-switched access lacks the concept of a port number, and therefore the <port> subfield does not carry any meaningful value. In order to be compliant with SDP syntax, implementations SHOULD set the <port> subfield to the discard port value "9" and MUST ignore it on reception.

According to [RFC 3264](#) [[RFC3264](#)], a port number of zero in the offer of a unicast stream indicates that the stream is offered but must not be used. If a port number of zero is present in the answer of a unicast stream, it indicates that the stream is rejected. These

rules are still valid when the media line in SDP represents a circuit-switched bearer.

The <proto> subfield is the transport protocol. The circuit-switched bearer uses whatever transport protocol it has available. This subfield SHOULD be set to the mnemonic "PSTN" to be syntactically correct with SDP [[RFC4566](#)] and to indicate the usage of circuit-switched protocols in the PSTN.

The <fmt> subfield is the media format description. In the classical usage of SDP to describe RTP-based media streams, when the <proto> subfield is set to "RTP/AVP" or "RTP/SAVP", the <fmt> subfield contains the payload types as defined in the RTP audio profile [[RFC3551](#)].

When "RTP/AVP" is used in the <proto> field, the <fmt> subfield contains the RTP payload type numbers. We use the <fmt> subfield to indicate the list of available codecs over the circuit-switched bearer, by re-using the conventions and payload type numbers defined for RTP/AVP. The RTP audio and video media types, which, when applied to PSTN circuit-switched bearers, represent merely an audio or video codec.

In some cases, the endpoint is not able to determine the list of available codecs for circuit-switched media streams. In this case, in order to be syntactically compliant with SDP [[RFC4566](#)], the endpoint MUST include a single dash "-" in the <fmt> subfield.

As per [RFC 4566](#) [[RFC4566](#)], the media format descriptions are listed in priority order.

Examples of media descriptions for circuit-switched audio streams are:

```
m=audio 9 PSTN 3 0 8
```

```
m=audio 9 PSTN -
```

Similarly, an example of a media description for circuit-switched video stream is:

```
m=video 9 PSTN 34
```

```
m=video 9 PSTN -
```


5.2.3. Correlating the PSTN Circuit-Switched Bearer with SDP

The endpoints should be able to correlate the circuit-switched bearer with the session negotiated with SDP in order to avoid ringing for an incoming circuit-switched bearer that is related to the session controlled with SDP (and SIP).

Several alternatives exist for performing this correlation. This memo provides three mutually non-exclusive correlation mechanisms. Other correlation mechanisms may exist, and their usage will be specified when need arises. All mechanisms share the same principle: some unique information is sent in the SDP and in the circuit-switched signaling protocol. If these pieces of information match, then the circuit-switched bearer is part of the session described in the SDP exchange. Otherwise, there is no guarantee that the circuit-switched bearer is related to such session.

The first mechanism is based on the exchange of PSTN caller-ID between the endpoints. The caller-ID is also available as the Calling Party ID in the circuit-switched signaling.

The second mechanism is based on the inclusion in SDP of a value that is also sent in the User-to-User Information Element that is part of the bearer setup signaling in the PSTN.

The third mechanism is based on sending in SDP a string that represents Dual Tone MultiFrequency (DTMF) digits that will be later sent right after the circuit-switched bearer is established. Implementations MAY use any of these mechanisms and MAY use two or more mechanisms simultaneously.

5.2.3.1. The "cs-correlation" attribute

In order to provide support for the correlation mechanisms, we define a new SDP attribute called "cs-correlation". This "cs-correlation" attribute can include any of the "callerid", "uuie", or "dtmf" subfields, which specify additional information required by the Caller-ID, User to User Information, or DTMF correlation mechanisms, respectively. The list of correlation mechanisms may be extended by other specifications.

The following sections provide more detailed information of these subfields. The "cs-correlation" attribute has the following format:


```
a=cs-correlation: <correlation-mechanisms>
correlation-mechanisms = corr-mech *(SP corr-mech)
corr-mech               = caller-id-mech / uuie-mech /
                        dfmt-mech / ext-mech
caller-id-mech           = "callerid" [":" caller-id-value]
uuie-mech                = "uuie" [":" uuie-value]
dtmf-mech                = "dtmf" [":" dtmf-value]
ext-mech                 = <ext-mech-name>[":"<ext-mech-value>]
```

The values "callerid", "uuie" and "dtmf" refer to the correlation mechanisms defined in [Section 5.2.3.2](#), [Section 5.2.3.3](#), and [Section 5.2.3.4](#), respectively. The formal Augmented Backus-Naur Format (ABNF) syntax of the "cs-correlation" attribute is presented in [Section 5.7](#).

5.2.3.2. Caller-ID Correlation Mechanism

The Caller-ID correlation mechanisms consists of an exchange of the calling party number as an international E.164 number in SDP, followed by the availability of the Calling Party Number information element in the call setup signaling of the circuit switched connection. If both pieces of information match, the circuit-switched bearer is correlated to the session described in SDP.

Example of inclusion of an international E.164 number in the "cs-correlation" attribute is:

```
a=cs-correlation:callerid:+35891234567
```

The presence of the "callerid" subfield indicates that the endpoint supports use of the calling party number as a means of correlating a PSTN call with the session being negotiated. The "callerid" subfield MAY be accompanied by the international E.164 number of the party inserting the parameter.

Note that there are no warranties that this correlation mechanism works or is even available, due a number of problems:

- o The endpoint might not be aware of its own E.164 number, in which case it cannot populate the SDP appropriately.
- o The Calling Party Number information element in the circuit-switched signaling might not be available, e.g., due to policy restrictions of the network operator or caller restriction due to privacy.
- o The Calling Party Number information element in the circuit-switched signaling might be available, but the digit

representation of the E.164 number might differ from the one expressed in the SDP. To mitigate this problem implementations should consider only some of the rightmost digits from the E.164 number for correlation. For example, the numbers +358-9-123-4567 and 09-123-4567 could be considered as the same number. This is also the behavior of some cellular phones, which correlate the incoming calling party with a number stored in the phone book, for the purpose of displaying the caller's name.

5.2.3.3. User-User Information Element Correlation Mechanism

A second correlation mechanism is based on including in SDP a string that represents the User-User Information Element that is part of the call setup signaling of the circuit-switched bearer. The User-User Information Element is specified in ITU-T Q.931 [[ITU.Q931.1998](#)] and 3GPP TS 24.008 [[TS.24.008](#)], among others. The User-User Information Element has a maximum size of 35 or 131 octets, depending on the actual message of the PSTN protocol where it is included and the network settings.

The mechanism works as follows: An endpoint creates a User-User Information Element, according to the requirements of the call setup signaling protocol. The same value is included in the SDP offer or SDP answer, in the "uuie" subfield of the "cs-correlation" attribute. When the SDP Offer/Answer exchange is completed, each endpoint has become aware of the value that will be used in the User-User Information Element of the call setup message of the PSTN protocol. The endpoint that initiates the call setup attempt includes this value in the User-User Information Element. The recipient of the call setup attempt can extract the User-User Information Element and correlate it with the value previously received in the SDP. If both values match, then the call setup attempt corresponds to that indicated in the SDP.

According to ITU-T Q.931 [[ITU.Q931.1998](#)], the User-User Information Element (UUIE) identifier is composed of a first octet identifying this as a User-User Information Element, a second octet containing the Length of the user-user contents, a third octet containing a Protocol Discriminator, and a value of up to 32 or 128 octets (depending on network settings) containing the actual User Information (see Figure 4-36 in ITU-T Q.931). The first two octets of the UUIE MUST NOT be used for correlation, only the octets carrying the Protocol Discriminator and the User Information value are input to the creation of the value of the "uuie" subfield in the "cs-correlation" attribute. Therefore, the value of the "uuie" subfield in the "cs-correlation" attribute MUST start with the the value starting at the Protocol Discriminator octet, followed by the User Information octets. The value of the Protocol Discriminator

octet is not specified in this document; it is expected that organizations using this technology will allocate a suitable value for the Protocol Discriminator.

Once the binary value of the "uuie" subfield in the "cs-correlation" attribute is created, it MUST be encoded in hexadecimal before it is inserted in SDP. Each octet of binary data to be represented in the hexadecimal encoding MUST be mapped to two hexadecimal digits (represented by ASCII characters 0-9, A-F and a-f), each representing four bits within the octet. The four bits appearing first in the binary data MUST be mapped to the first hexadecimal digit and the four subsequent bits in the binary data MUST be mapped to the second hexadecimal digit. When mapping 4 bits to a hexadecimal digit, the bit appearing first in the binary data shall be most significant. Thus, the resulting hexadecimal encoded value needs to have an even number of hexadecimal digits, and MUST be considered invalid if it has an odd number.

Note that the encoding of the "uuie" subfield of the "cs-correlation" attribute is largely inspired by the encoding of the same value in the User-to-User header field in SIP, according to the document A Mechanism for Transporting User to User Call Control Information in SIP [[I-D.ietf-cuss-sip-uu](#)].

As an example, an endpoint willing to send a UUIE containing a protocol discriminator with the hexadecimal value of %x56 and an hexadecimal User Information value of %xa390f3d2b7310023 would include a "cs-correlation" attribute line as follows:

```
a=cs-correlation:uuie:56a390f3d2b7310023
```

Note that, for correlation purposes, the value of the User-User Information Element is considered as a opaque string and only used for correlation purposes. Typically call signaling protocols impose requirements on the creation of User-User Information Element for end-user protocol exchange. The details regarding the generation of the User-User Information Element are outside the scope of this specification.

Please note that there are no warranties that this correlation mechanism works. On one side, policy restrictions might not make the User-User information available end to end in the PSTN. On the other hand, the generation of the User-User Information Element is controlled by the PSTN circuit-switched call protocol, which might not offer enough freedom for generating different values from one endpoint to another one, or from one call to another in the same endpoint. This might result in the same value of the User-User Information Element for all calls.

5.2.3.4. DTMF Correlation Mechanism

We introduce a third mechanism for correlating the circuit-switched bearer with the session described with SDP. This is based on agreeing on a sequence of digits that are negotiated in the SDP Offer/Answer exchange and sent as Dual Tone Multifrequency (DTMF) tones over the circuit-switched bearer once this bearer is established. If the DTMF digit sequence received through the circuit-switched bearer matches the digit string negotiated in the SDP, the circuit-switched bearer is correlated with the session described in the SDP. The mechanism is similar to many voice conferencing systems which require the user to enter a PIN code using DTMF tones in order to be accepted in a voice conference.

The mechanism works as follows: An endpoint selects a DTMF digit sequence. The same sequence is included in the SDP offer or SDP answer, in a "dtmf" subfield of the "cs-correlation" attribute. When the SDP Offer/Answer exchange is completed, each endpoint has become aware of the DTMF sequence that will be sent right after the circuit-switched bearer is set up. The endpoint that initiates the call setup attempt sends the DTMF digits according to the procedures defined for the circuit-switched bearer technology used. The recipient (passive side of the bearer setup) of the call setup attempt collects the digits and compares them with the value previously received in the SDP. If the digits match, then the call setup attempt corresponds to that indicated in the SDP.

Implementations are advised to select a number of DTMF digits that provide enough assurance that the call is related, but on the other hand do not prolong the bearer setup time unnecessarily.

As an example, an endpoint willing to send DTMF tone sequence "14D*3" would include a "cs-correlation" attribute line as follows:

```
a=cs-correlation:dtmf:14D*3
```

If the endpoints successfully agree on the usage of the DTMF digit correlation mechanism, but the passive side does not receive any DTMF digits after successful circuit-switched bearer setup, or receives a set of DTMF digits that do not match the value of the "dtmf" attribute (including receiving too many digits), the passive side SHOULD treat the circuit-switched bearer as not correlated to the ongoing session.

DTMF digits can only be sent once the circuit-switched bearer is set up. In order to suppress alerting for an incoming circuit-switched call, implementations may choose various mechanisms. For example, alerting may be suppressed for a certain time period for

incoming call attempts that originate from the number that was observed during the offer/answer negotiation.

5.3. Negotiating the correlation mechanisms

The three correlation mechanisms presented above (based on called party number, User-User Information Element and DTMF digit sending) are non-exclusive, and can be used independently of each other. In order to know how to populate the "a=cs-correlation" attribute, the endpoints need to agree which endpoint will become the active party, i.e. the one that will set up the circuit-switched bearer.

5.3.1. Determining the Direction of the Circuit-Switched Bearer Setup

In order to avoid a situation where both endpoints attempt to initiate a connection simultaneously, the direction in which the circuit-switched bearer is set up should be negotiated during the Offer/Answer exchange.

The framework defined in [RFC 4145](#) [[RFC4145](#)] allows the endpoints to agree which endpoint acts as the active endpoint when initiating a TCP connection. While [RFC 4145](#) [[RFC4145](#)] was originally designed for establishing TCP connections, it can be easily extrapolated to the connection establishment of circuit-switched bearers. This specification uses the concepts specified in [RFC 4145](#) [[RFC4145](#)] for agreeing on the direction of establishment of a circuit-switched bearer.

[RFC 4145](#) [[RFC4145](#)] defines two new attributes in SDP: "setup" and "connection". The "setup" attribute indicates which of the endpoints should initiate the connection establishment of the PSTN circuit-switched bearer. Four values are defined in [Section 4 of RFC 4145](#) [[RFC4145](#)]: "active", "passive", "actpass", "holdconn". Please refer to [Section 4 of RFC 4145](#) [[RFC4145](#)] for a detailed description of this attribute.

The "connection" attribute indicates whether a new connection is needed or an existing connection is reused. The attribute can take the values "new" or "existing". Please refer to [Section 5 of RFC 4145](#) [[RFC4145](#)] for a detailed description of this attribute.

Implementations according to this specification MUST support the "setup" and "connection" attributes specified in [RFC 4145](#) [[RFC4145](#)], but applied to circuit-switched bearers in the PSTN.

We define the active party as the one that initiates the circuit-switched bearer after the Offer/Answer process. The passive party is the one receiving the circuit-switched bearer. Either party may

indicate its desire to become the active or passive party during the Offer/Answer exchange using the procedures described in [Section 5.6](#).

5.3.2. Populating the cs-correlation attribute

By defining values for the subfields in the "a=cs-correlation" attribute, the endpoint indicates that it is willing to become the active party, and that it can use those values in the Calling party number, User-User Information Element, or as DTMF tones during the circuit-switched bearer setup.

Thus, the following rules apply:

An endpoint that can only become the active party in the circuit-switched bearer setup MUST include all correlation mechanisms it supports in the "a=cs-correlation" attribute, and MUST also specify values for the subfields.

An endpoint that can only become the passive party in the circuit-switched bearer setup MUST include all correlation mechanisms it supports in the "a=cs-correlation" attribute, but MUST NOT specify values for the subfields.

An endpoint that is willing to become either the active or passive party (by including the "a=setup:actpass" attribute in the Offer), MUST include all correlation mechanisms it supports in the "a=cs-correlation" attribute, and MUST also specify values for the subfields.

5.3.3. Considerations on successful correlation

Note that, as stated above, it cannot be guaranteed that any given correlation mechanism will succeed even if the usage of those was agreed beforehand. This is due to the fact that the correlation mechanisms require support from the circuit-switched bearer technology used.

Therefore, even a single positive indication using any of these mechanisms SHOULD be interpreted by the passive endpoint so that the circuit-switched bearer establishment is related to the ongoing session, even if the other correlation mechanisms fail.

If, after negotiating one or more correlation mechanisms in the SDP offer/answer exchange, an endpoint receives a circuit-switched bearer with no correlation information present, the endpoint has two choices: it can either treat the call as unrelated, or treat the call as related to the ongoing session in the IP domain.

An endpoint may for example specify a time window after SDP offer/answer exchange during which received calls are treated as correlated even if the signaling in the circuit-switched domain does not carry any correlation information. In this case, there is a chance that the call is erroneously treated as related to the ongoing session.

An endpoint may also choose to always treat an incoming call as unrelated if the signaling in the circuit-switched domain does not carry any correlation information. In this case, there is a chance that the call is erroneously treated as unrelated.

Since, in these cases, no correlation information can be deduced from the signaling, it is up to the implementation to decide how to behave. One option is also to let the user decide whether to accept the call as related, or to treat the call as unrelated.

5.4. Considerations for Usage of Existing SDP

5.4.1. Originator of the Session

According to SDP [[RFC4566](#)], the origin line in SDP has the following syntax:

```
o=<username> <sess-id> <sess-version> <nettype> <addrtype>  
<unicast-address>
```

Of interest here are the <nettype> and <addrtype> fields, which indicate the type of network and type of address, respectively. Typically, this field carries the IP address of the originator of the session. Even if the SDP was used to negotiate an audio or video media stream transported over a circuit-switched bearer, the originator is using SDP over an IP bearer. Therefore, <nettype> and <addrtype> fields in the "o=" line should be populated with the IP address identifying the source of the signaling.

5.4.2. Contact information

SDP [[RFC4566](#)] defines the "p=" line which may include the phone number of the person responsible for the conference. Even though this line can carry a phone number, it is not suited for the purpose of defining a connection address for the media. Therefore, we have selected to define the PSTN specific connection addresses in the "c=" line.

5.5. Considerations for Usage of Third Party Call Control (3PCC)

Best Current Practices for Third Party Call Control (3pcc) in the Session Initiation Protocol (SIP) [[RFC3725](#)] outlines several flows

which are possible in third party call control scenarios and recommends some flows for specific situations.

One of the assumptions in [[RFC3725](#)] is that an SDP Offer may include a "black hole" connection address, which has the property that packets sent to it will never leave the host which sent them. For IPv4, this "black hole" connection address is 0.0.0.0, or a domain name within the .invalid DNS top level domain.

When using an E.164 address scheme in the context of third-party call control, when the User Agent needs to indicate an unknown phone number, it MUST populate the <addrtype> of the SDP "c=" line with a "-" string.

Note that this may result in the recipient of the initial Offer in rejecting the Offer if the recipient of the Offer is not aware of its own E.164 number, and thus concluding that it will not be possible to establish a circuit-switched bearer since neither party is aware of their E.164 number.

5.6. Offer/Answer mode extensions

In this section, we define extensions to the Offer/Answer model defined in The Offer/Answer Model in SDP [[RFC3264](#)] and extended in the SDP Capability Negotiation [[RFC5939](#)] to allow for PSTN addresses to be used with the Offer/Answer model.

5.6.1. Generating the Initial Offer

The Offerer, wishing to use PSTN audio or video stream, MUST populate the "c=" and "m=" lines as follows.

The endpoint MUST set the <nettype> in the "c=" line to "PSTN", and the <addrtype> to "E164". Furthermore, the endpoint SHOULD set the <connection-address> field to its own international E.164 number (with a leading "+"). If the endpoint is not aware of its own E.164 number, it MUST set the <connection-address> to "-".

In the "m=" line, the endpoint MUST set the <media> subfield to "audio" or "video", depending on the media type, and the <proto> subfield to "PSTN". The <port> subfield SHOULD be set to "9" (the discard port).

The <fmt> subfield carries the payload type number(s) the endpoint is wishing to use. Payload type numbers in this case refer to the codecs that the endpoint wishes to use. For example, if the endpoint wishes to use the GSM codec, it would add payload type number 3 in the list of codecs.

For dynamic payload types, the endpoint MUST define the set of valid encoding names and related parameters using the "a=rtpmap" attribute line. See [Section 6](#) of SDP [[RFC4566](#)] for details.

When generating the Offer, if the Offerer supports any of the correlation mechanisms defined in this memo, it MUST include an attribute line "a=cs-correlation" in the SDP offer. The "a=cs-correlation" line contains an enumeration of the correlation mechanisms supported by the Offerer, in the format of subfields.

The current list of subfields include "callerid", "uuie" and "dtmf" and they refer to the correlation mechanisms defined in [Section 5.2.3.2](#), [Section 5.2.3.3](#), and [Section 5.2.3.4](#), respectively.

If the Offerer supports any of the correlation mechanisms defined in this memo, and is willing to become the active party, the Offerer MUST add the "callerid", "uuie", and/or "dtmf" subfields and MUST specify values for those subfields.

- o the international E.164 number as the value in the "callerid" subfield,
- o the contents of the User-User information element as the value of the "uuie" subfield, and/or
- o the DTMF tone string as the value of the "dtmf" subfield

If the Offerer is only able to become the passive party in the circuit-switched bearer setup, it MUST add the "callerid", "uuie" and/or "dtmf" subfields, but MUST NOT specify values for those subfields.

For example, if the Offerer is willing to use the User-User Information element and DTMF digit sending mechanisms, but can only become the passive party, it includes the following lines to the SDP:

```
a=cs-correlation:uuie dtmf
```

```
a=setup:passive
```

If, on the other hand, the Offerer is willing to use the User-User Information element and the DTMF correlation mechanisms, and is able to become the active or passive side, it includes the following lines to the SDP:

```
a=cs-correlation:uuie:56a390f3d2b7310023 dtmf:14D*3
```


a=setup:actpass

The negotiation of the value of the 'setup' attribute takes place as defined in [Section 4.1](#) of TCP-Based Media Transport in the SDP [[RFC4145](#)].

The Offerer states which role or roles it is willing to perform; and the Answerer, taking the Offerer's willingness into consideration, chooses which roles both endpoints will actually perform during the circuit-switched bearer setup.

By 'active' endpoint, we refer to an endpoint that will establish the circuit-switched bearer; and by 'passive' endpoint, we refer to an endpoint that will receive a circuit-switched bearer.

If an Offerer does not know its international E.164 number, it MUST set the 'a=setup' attribute to the value 'active'. If the Offerer knows its international E.164 number, it MUST set the value to either 'actpass' or 'passive'.

Also 'holdconn' is a permissible value in the 'a=setup' attribute. It indicates that the connection is not established for the time being.

The Offerer uses the "a=connection" attribute to decide whether a new circuit-switched bearer is to be established or not. For the initial Offer, the Offerer MUST use value 'new'.

[5.6.2](#). Generating the Answer

If the Offer contained a circuit-switched audio or video stream, the Answerer first determines whether it is able to accept and use such streams. If the Answerer is not willing to use circuit-switched media for the session, it MUST construct an Answer where the port number for such media stream(s) is set to zero, according to [Section 6](#) of An Offer/Answer Model with the Session Description Protocol (SDP) [[RFC3264](#)]. If the Answerer is willing to use circuit-switched media for the session, it MUST ignore the received port number (unless the port number is set to zero).

If the Offer included a "-" as the payload type number, it indicates that the Offerer is not willing or able to define any specific payload type. Most often, a "-" is expected to be used instead of the payload type when the endpoint is not aware of or not willing to define the codecs which will eventually be used on the circuit-switched bearer. The circuit-switched signaling protocols have their own means of negotiating or indicating the codecs, therefore an Answerer SHOULD accept such Offers, and SHOULD set the payload type

to "-" also in the Answer.

If the Answerer explicitly wants to specify a codec for the circuit-switched media, it MAY set the respective payload numbers in the <fmt> subfield in the answer. This behavior, however, is NOT RECOMMENDED.

When receiving the Offer, the Answerer MUST determine whether it becomes the active or passive party.

If the SDP in the Offer indicates that the Offerer is only able to become the active party, the Answerer needs to determine whether it is able to become the passive party. If this is not possible e.g. due to the Answerer not knowing its international E.164 number, the Answerer MUST reject the circuit-switched media by setting the port number to zero on the Answer. If the Answerer is aware of its international E.164 number, it MUST include the "a=setup" attribute in the Answer and set it to value "passive" or "holdconn".

If the SDP in the Offer indicates that the Offerer is only able to become the passive party, the Answerer MUST verify that the Offerer's E.164 number is included in the "c=" line of the Offer. If the number is included, the Answerer MUST include the "a=setup" attribute in the Answer and set it to value "active" or "holdconn". If the number is not included, call establishment is not possible, and the Answerer MUST reject the circuit-switched media by setting the port number to zero in the Answer.

If the SDP in the Offer indicates that the Offerer is able to become either the active or passive party, the Answerer needs to determine which role it would like to take. If the Offer includes an international E.164 number in the "c=" line, the Answerer SHOULD become the active party. If the Offer does not include an E.164 number, and if the Answerer is aware of its international E.164 number, it MUST become the passive party. If the Offer does not include an E.164 number in the "c=" line and the Answerer is not aware of its E.164 number, it MUST reject the circuit-switched media by setting the port number to zero in the Answer.

The Answerer MUST select those correlation mechanisms from the Offer it supports, and include an "a=cs-correlation" attribute line in the Answer containing those mechanisms it supports. The Answerer MUST NOT add any mechanisms which were not included in the offer.

If the Answerer becomes the active party, it MUST add any of the "callerid", "uuie" or "dtmf" subfield values.

If the Answerer becomes the passive party, it MUST NOT add values to

the "callerid", "uuie" and/or "dtmf" subfields.

After generating and sending the Answer, if the Answerer became the active party, it

- o MUST extract the E.164 number from the "c=" line of the Offer and MUST establish a circuit-switched bearer to that address.
- o if the SDP Answer contained a value for the "callerid" subfield, must set the Calling Party Number Information Element to that number,
- o if the SDP Answer contained a value for the "uuie" subfield, MUST send the User-User Information element according to the rules defined for the circuit-switched technology used, and set the value of the Information Element to that received in the SDP Offer,
- o if the SDP Answer contained a value for the "dtmf" subfield, MUST send those DTMF digits according to the circuit-switched technology used.

If, on the other hand, the Answerer became the passive party, it

- o MUST be prepared to receive a circuit-switched bearer,
- o if the Offer contained a value for the "callerid" subfield, MUST compare that value to the Calling Party Number Information Element of the circuit-switched bearer,
- o if the Offer contained a value for the "dtmf" subfield, MUST be prepared to receive and collect DTMF digits once the circuit-switched bearer is set up. The Answerer MUST compare the received DTMF digits to the value of the "dtmf" subfield. If the received DTMF digits match the value of the "dtmf" subfield in the "cs-correlation" attribute, the call SHOULD be treated as correlated to the ongoing session.
- o if the Offer contained a value for the "uuie" subfield, MUST be prepared to receive a User-User Information element once the circuit-switched bearer is set up. The Answerer MUST compare the received UUI to the value of the "uuie" subfield. If the value of the received UUI matches the value of the "uuie" subfield, the call SHOULD be treated as correlated to the ongoing session.

5.6.3. Offerer processing the Answer

When receiving the Answer, if the SDP does not contain "a=cs-correlation" attribute line, the Offerer should take that as an indication that the other party does not support or is not willing to use the procedures defined in the document for this session, and MUST revert to normal processing of SDP.

When receiving the Answer, the Offerer MUST first determine whether it becomes the active or passive party, as described in [Section 5.3.1](#).

If the Offerer becomes the active party, it

- o MUST extract the E.164 number from the "c=" line and MUST establish a circuit-switched bearer to that address.
- o if the SDP Answer contained a value for the "uuie" subfield, MUST send the User-User Information element according to the rules defined for the circuit-switched technology used, and set the value of the Information Element to that received in the SDP Answer,
- o if the SDP Answer contained a value for the "dtmf" subfield, MUST send those DTMF digits according to the circuit-switched technology used.

If the Offerer becomes the passive party, it

- o MUST be prepared to receive a circuit-switched bearer,
- o if the Answer contained a value for the "dtmf" subfield, MUST be prepared to receive and collect DTMF digits once the circuit-switched bearer is set up. The Offerer SHOULD compare the received DTMF digits to the value of the "dtmf" subfield. If the received DTMF digits match the value of the "dtmf" subfield in the "cs-correlation" attribute, the call SHOULD be treated as correlated to the ongoing session.
- o if the Answer contained a value for the "uuie" subfield, MUST be prepared to receive a User-User Information element once the circuit-switched bearer is set up. The Offerer SHOULD compare the received UUI to the value of the "uuie" subfield. If the value of the received UUI matches the value of the "uuie" subfield, the call SHOULD be treated as correlated to the ongoing session.

5.6.4. Modifying the session

If, at a later time, one of the parties wishes to modify the session, e.g., by adding new media stream, or by changing properties used on an existing stream, it may do so via the mechanisms defined for An Offer/Answer Model with SDP [[RFC3264](#)].

If there is an existing circuit-switched bearer between the endpoints, and the Offerer wants to reuse that the Offerer MUST set the value of the "a=connection" attribute to 'existing'.

If either party removes the circuit-switched media from the session (by setting the port number to zero), it MUST terminate the circuit-switched bearer using whatever mechanism is appropriate for the technology in question.

If either party wishes to drop and reestablish an existing call, that party MUST first remove the circuit-switched media from the session by setting the port number to zero, and then use another Offer/Answer exchange where it MUST set the "a=connection" attribute to 'new'. If the media types are different (for example, a different codec will be used for the circuit-switched bearer), the media descriptions for terminating the existing bearer and the new bearer can be in the same Offer.

5.7. Formal Syntax

The following is the formal Augmented Backus-Naur Form (ABNF) [[RFC5234](#)] syntax that supports the extensions defined in this specification. The syntax is built above the SDP [[RFC4566](#)] grammar. Implementations according to this specification MUST be compliant with this syntax.

Figure 2 shows the formal syntax of the extensions defined in this memo.


```

; extension to the connection field originally specified
; in RFC 4566

connection-field = [%x63 "=" nettype SP addrtype SP
connection-address CRLF]
;nettype and addrtype are defined in RFC 4566

connection-address /= e164-address / "-"
e164-address       = "+" 1*15DIGIT
; DIGIT is specified in RFC 5234

;subrules for correlation attribute
attribute          /= cs-correlation-attr
; attribute defined in RFC 4566
cs-correlation-attr= "cs-correlation:" corr-mechanisms
corr-mechanisms    = corr-mech *(SP corr-mech)
corr-mech          = caller-id-mech / uuie-mech /
                    dtmf-mech / ext-mech
caller-id-mech     = "callerid" [":" caller-id-value]
caller-id-value    = "+" 1*15DIGIT
uuie-mech          = "uuie" [":" uuie-value]
uuie-value         = 1*130(HEXDIG / %x61-66)
                    ;0-9, A-F, and a-f
                    ;HEXDIG defined in RFC5234
dtmf-mech          = "dtmf" [":" dtmf-value]
dtmf-value         = 1*32(DIGIT / %x41-44 / %x23 / %x2A )
                    ;0-9, A-D, '#' and '*'
ext-mech           = ext-mech-name[":" ext-mech-value]
ext-mech-name      = token
ext-mech-value     = token
; token is specified in RFC4566

```

Figure 2: Syntax of the SDP extensions

6. Examples

In the examples below, where an SDP line is too long to be displayed as a single line, a braking character "\" indicates continuation in the following line. Note that this is character is included for displaying purposes. Implementation MUST write a single line without brakes.

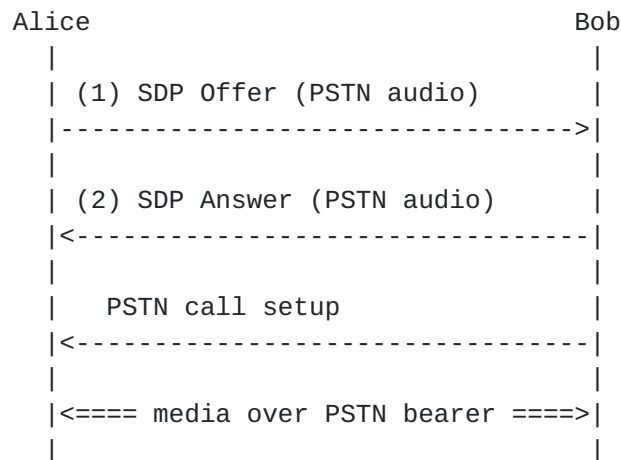
6.1. Single PSTN audio stream

Figure 3: Basic flow

Figure 3 shows a basic example that describes a single audio media stream over a circuit-switched bearer. Alice generates a SDP Offer which is shown in Figure 4. The Offer describes a PSTN circuit-switched bearer in the "m=" and "c=" line where it also indicates its international E.164 number format. Additionally, Alice expresses that she can initiate the circuit-switched bearer or be the recipient of it in the "a=setup" attribute line. The SDP Offer also includes correlation identifiers that this endpoint will be inserting the Calling Party Number and/or User-User Information Element of the PSTN call setup if eventually this endpoint initiates the PSTN call.

```

v=0
o=jdoe 2890844526 2890842807 IN IP4 192.0.2.5
s=
t=0 0
m=audio 9 PSTN -
c=PSTN E164 +35891234567
a=setup:actpass
a=connection:new
a=cs-correlation:callerid:+15551234 \
uuie:56a390f3d2b7310023

```

Figure 4: SDP offer (1)

Bob generates a SDP Answer (Figure 5), describing a PSTN audio media on port 9 without information on the media sub-type on the "m=" line. The "c=" line contains Bob's international E.164 number. In the "a=setup" line Bob indicates that he is willing to become the active endpoint when establishing the PSTN call, and he also includes the "a=cs-correlation" attribute line containing the values he is going

to include in the Calling Party Number and User-User IE of the PSTN call establishment.

```
v=0
o=- 2890973824 2890987289 IN IP4 192.0.2.7
s=
t=0 0
m=audio 9 PSTN -
c=PSTN E164 +35897654321
a=setup:active
a=connection:new
a=cs-correlation:callerid:+15554321 \
uuie:56a390f3d2b7310023
```

Figure 5: SDP Answer with circuit-switched media

When Alice receives the Answer, she examines that Bob is willing to become the active endpoint when setting up the PSTN call. Alice temporarily stores Bob's E.164 number and the User-User IE value of the "cs-correlation" attribute, and waits for a circuit-switched bearer establishment.

Bob initiates a circuit-switched bearer using whatever circuit-switched technology is available for him. The called party number is set to Alice's number, and calling party number is set to Bob's own number. Bob also sets the User-User Information Element value to the one contained in the SDP Answer.

When Alice receives the circuit-switched bearer establishment, she examines the UUIE and the calling party number, and by comparing those received during O/A exchange determines that the call is related to the SDP session.

It may also be that neither the UUIE nor the calling party number is received by the called party, or the format of the calling party number is changed by the PSTN. Implementations may still accept such call establishment attempts as being related to the session that was established in the IP network. As it cannot be guaranteed that the values used for correlation are always passed intact through the network, they should be treated as additional hints that the circuit-switched bearer is actually related to the session.

6.2. Advanced SDP example: Circuit-Switched Audio and Video Streams

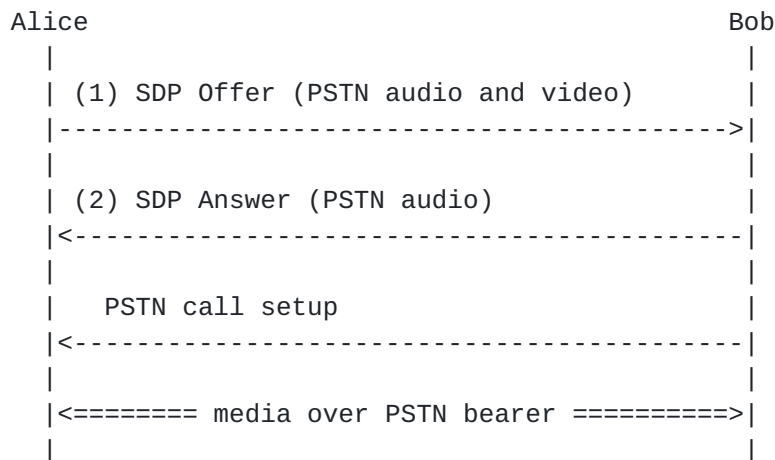


Figure 6: Circuit-Switched Audio and Video streams

Figure 6 shows an example of negotiating audio and video media streams over circuit-switched bearers.

```

v=0
o=jdoe 2890844526 2890842807 IN IP4 192.0.2.5
s=
t=0 0
a=setup:actpass
a=connection:new
a=cs-correlation:dtmf:112233
c=PSTN E164 +35891234567
m=audio 9 PSTN -
m=video 9 PSTN 34
a=rtpmap:34 H263/90000
  
```

Figure 7: SDP offer with circuit-switched audio and video (1)

Upon receiving the SDP offer described in Figure 7, Bob rejects the video stream as his device does not currently support video, but accepts the circuit-switched audio stream. As Alice indicated that she is able to become either the active, or passive party, Bob gets to select which role he would like to take. Since the Offer contained the international E.164 number of Alice, Bob decides that he becomes the active party in setting up the circuit-switched bearer. Bob includes a new value in the "dtmf" subfield of the "cs-correlation" attribute, which he is going to send as DTMF tones once the bearer setup is complete. The Answer is described in Figure 8


```
v=0
o=- 2890973824 2890987289 IN IP4 192.0.2.7
s=
t=0 0
a=setup:active
a=connection:new
a=cs-correlation:dtmf:332211
c=PSTN E164 +35897654321
m=audio 9 PSTN -
m=video 0 PSTN 34
```

Figure 8: SDP answer with circuit-switched audio and video (2)

7. Security Considerations

This document provides an extension on top of [RFC 4566](#) [[RFC4566](#)], and [RFC 3264](#) [[RFC3264](#)]. As such, the security considerations of those documents apply.

This memo provides mechanisms to agree on a correlation identifier or identifiers that are used to evaluate whether an incoming circuit-switched bearer is related to an ongoing session in the IP domain. If an attacker replicates the correlation identifier and establishes a call within the time window the receiving endpoint is expecting a call, the attacker may be able to hijack the circuit-switched bearer. These types of attacks are not specific to the mechanisms presented in this memo. For example, caller ID spoofing is a well known attack in the PSTN. Users are advised to use the same caution before revealing sensitive information as they would on any other phone call. Furthermore, users are advised that mechanisms that may be in use in the IP domain for securing the media, like Secure RTP (SRTP) [[RFC3711](#)], are not available in the CS domain.

For the purposes of establishing a circuit-switched bearer, the active endpoint needs to know the passive endpoint's phone number. Phone numbers are sensitive information, and some people may choose not to reveal their phone numbers when calling using supplementary services like Calling Line Identification Restriction (CLIR) in GSM. Implementations should take the caller's preferences regarding calling line identification into account if possible, by restricting the inclusion of the phone number in SDP "c=" line if the caller has chosen to use CLIR. If this is not possible, implementations may present a prompt informing the user that their phone number may be transmitted to the other party.

Similarly as with IP addresses, if there is a desire to protect the SDP containing phone numbers carried in SIP, implementers are advised

to follow the security mechanisms defined in [[RFC3261](#)].

8. IANA Considerations

This document instructs IANA to register a number of SDP tokens according to the following data.

8.1. Registration of new cs-correlation SDP attribute

Contact: Miguel Garcia <miguel.a.garcia@ericsson.com>

Attribute name: cs-correlation

Long-form attribute name: PSTN Correlation Identifier

Type of attribute: media level only

This attribute is subject to the charset attribute

Description: This attribute provides the Correlation Identifier used in PSTN signaling

Specification: RFC XXXX

The IANA is requested to create a subregistry for 'cs-correlation' attribute under the Session Description Protocol (SDP) Parameters registry. The initial values for the subregistry are presented in the following, and IANA is requested to add them into its database:

Value of 'cs-correlation' attribute Reference Description

-----	-----	-----	callerid
RFC XXXX	Caller ID	uuie	RFC XXXX User-User Information Element dtmf
RFC XXXX	Dual-tone	Multifrequency	

Note for the RFC Editor: 'RFC XXXX' above should be replaced by a reference to the RFC number of this draft.

As per the terminology in [[RFC2434](#)], the registration policy for new values of 'cs-correlation' parameter is 'Specification Required'.

8.2. Registration of a new "nettype" value

This memo provides instructions to IANA to register a new "nettype" in the Session Description Protocol Parameters registry [[1](#)]. The registration data, according to [RFC 4566](#) [[RFC4566](#)] follows.

Type	SDP Name	Reference
----	-----	-----
nettype	PSTN	[RFCxxxx]

8.3. Registration of new "addrtype" values

This memo provides instructions to IANA to register a new "addrtype" in the Session Description Protocol Parameters registry [1]. The registration data, according to [RFC 4566](#) [RFC4566] follows.

Type	SDP Name	Reference
----	-----	-----
addrtype	E164	[RFCxxxx]
	-	[RFCxxxx]

8.4. Registration of a new "proto" value

This memo provides instructions to IANA to register a new "proto" in the Session Description Protocol Parameters registry [1]. The registration data, according to [RFC 4566](#) [RFC4566] follows.

Type	SDP Name	Reference
-----	-----	-----
proto	PSTN	[RFCxxxx]

9. Acknowledgments

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