                 Miscellaneous Capabilities Negotiation in the
                     Session Description Protocol (SDP)

Abstract

   The Session Description Protocol (SDP) has been extended with a
   capability negotiation mechanism framework that allows the endpoints
   to negotiate transport protocols and attributes. This framework has
   been extended with a media capabilities negotiation mechanism that
   allows endpoints to negotiate additional media-related capabilities.
   This negotiation is embedded into the widely used SDP offer/answer
   procedures.

   This memo extends the SDP capability negotiation framework to allow
   endpoints to negotiate three additional SDP capabilities. In
   particular, this memo provides a mechanism to negotiate bandwidth
   ("b=" line), connection data ("c=" line), and session or media titles
   ("i=" line for each session or media).

Status of This Memo

   This is an Internet Standards Track document.

   This document is a product of the Internet Engineering Task Force
   (IETF). It represents the consensus of the IETF community. It has
   received public review and has been approved for publication by the
   Internet Engineering Steering Group (IESG). Further information on
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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 has been extended with an SDP Capability
   Negotiation Mechanism Framework [RFC5939] that allows the endpoints
   to negotiate capabilities, such as support for the Real-time
   Transport Protocol (RTP) [RFC3550] and the Secure Real-time Transport
   Protocol (SRTP) [RFC3711]. The SDP Media Capabilities Negotiation
   [RFC6871] provides negotiation capabilities to media lines as well.

   The capability negotiation is embedded into the widely used SDP
   offer/answer procedure [RFC3264]. This memo provides the means to
   negotiate further capabilities than those specified in the SDP
   Capability Negotiation Mechanism Framework [RFC5939] and the SDP
   Media Capabilities Negotiation [RFC6871]. In particular, this memo
   provides a mechanism to negotiate bandwidth ("b="), connection data
   ("c="), and session or media titles ("i=").

   Since the three added capabilities are independent, it is not
   expected that implementations will necessarily support all of them at
   the same time. Instead, it is expected that applications will choose
   their needed capability for their specific purpose. For this reason,
   the normative part pertaining to each capability is in a self-
   contained section: Section 3.1.1 describes the bandwidth capability
   extension, Section 3.1.2 describes the connection data capability
   extension, and Section 3.1.3 describes the title capability
   extension. Separate SDP Capability Negotiation option tags are
   defined for each capability, allowing endpoints to indicate and/or
   require support for these extensions according to procedures defined
   in SDP Capability Negotiation [RFC5939].

2. Conventions Used in This Document

   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 BCP 14, RFC 2119
   [RFC2119] and indicate requirement levels for compliant
   implementations.

3. Protocol Description

3.1. Extensions to SDP

   The SDP Capability Negotiation Framework [RFC5939] and the SDP Media
   Capabilities Negotiation [RFC6871] specify attributes for negotiating
   SDP capabilities. These documents specify new attributes (e.g.,
   "acap", "tcap", "rmcap", and "omcap") for achieving their purpose.
   In this document, we define three new additional capability
   attributes for SDP lines of the general form:

      type=value

   for types "b", "c", and "i". The corresponding capability attributes
   are respectively defined as:

   o "bcap": bandwidth capability

   o "ccap": connection data capability

   o "icap": title capability

   From the sub-rules of the attribute ("a=") line in SDP [RFC4566], SDP
   attributes are of the form:

         attribute   = (att-field ":" att-value) / att-field
         att-field   = token
         att-value   = byte-string

   Capability attributes use only the "att-field:att-value" form.

   The new capabilities may be referenced in potential configurations
   ("a=pcfg") or in latent configurations ("a=lcfg") as productions
   conforming to the <extension-config-list>, as respectively defined in
   RFC 5939 [RFC5939] and RFC 6871 [RFC6871].

      extension-config-list = ["+"] ext-cap-name "=" ext-cap-list
      ext-cap-name   = 1*(ALPHA / DIGIT)
                                ; ALPHA and DIGIT defined in RFC 5234
      ext-cap-list   = 1*VCHAR ; VCHAR defined in RFC 5234

   The optional "+" is used to indicate that the extension is mandatory
   and MUST be supported in order to use that particular configuration.

   The new capabilities may also be referenced in actual configurations
   ("a=acfg") as productions conforming to the <sel-extension-config>
   defined in RFC 5939 [RFC5939].

         sel-extension-config = ext-cap-name "=" 1*VCHAR

   The specific parameters are defined in the individual description of
   each capability below.

   The "bcap", "ccap", and "icap" capability attributes can be provided
   at the SDP session and/or media level. According to the SDP
   Capability Negotiation [RFC5939], each extension capability must
   specify the implication of making it part of a configuration at the
   media level.

   According to SDP [RFC4566], "b=", "c=", and "i=" lines may appear at
   either session or media level. In line with this, the "bcap",
   "ccap", and "icap" capability attributes, when declared at session
   level, are to be interpreted as if that attribute was provided with
   that value at the session level. The "bcap", "ccap", and "icap"
   capability attributes declared at media level are to be interpreted
   as if that capability attribute was declared at the media level.

   For example, extending the example in [RFC6871] with "icap" and
   "bcap" capability attributes, we get the following SDP:

         v=0
         o=- 25678 753849 IN IP4 192.0.2.1
         s=
         c=IN IP4 192.0.2.1
         t=0 0
         a=bcap:1 CT:200
         a=icap:1 Video conference
         m=audio 54320 RTP/AVP 0
         a=rmcap:1 L16/8000/1
         a=rmcap:2 L16/16000/2
         a=pcfg:1 m=1|2 pt=1:99,2:98
         m=video 66544 RTP/AVP 100
         a=rmcap:3 H263-1998/90000
         a=rtpmap:100 H264/90000
         a=pcfg:10 m=3 pt=3:101 b=1 i=1

                Figure 1: Example SDP offer with bcap and icap
                          defined at session level

The above SDP defines one PCMU audio stream and one H.264 video
stream. It also defines two RTP-based media capabilities ("rmcap"
numbered 1 and 2), using 16-bit linear (L16) audio at 8 kbps and 16
kbps, respectively, as well as an RTP-based media capability for
H.263 video ("rmcap" numbered 3). The RTP-based media capabilities
all appear at the media level. The example also contains a single
bandwidth capability ("bcap") and a single title capability ("icap"),
both defined at session level. According to the definition above,
when the capabilities defined in the "bcap" and "icap" attributes are
referenced from the potential configuration, in the resulting SDP
they are to be interpreted as session level attributes (but the
RTP-based media capabilities are to be interpreted as media-level
attributes).

3.1.1. Bandwidth Capability

According to RFC 4566 [RFC4566], the bandwidth field denotes the
proposed bandwidth to be used by the session or media. In this memo,
we specify the bandwidth capability attribute, which can also appear
at the SDP session and/or media level. The bandwidth field is
specified in RFC 4566 [RFC4566] with the following syntax:

   b=<bwtype>:<bandwidth>

where <bwtype> is an alphanumeric modifier giving the meaning of the
<bandwidth> figure.

In this document, we define a new capability attribute: the bandwidth
capability attribute "bcap". This attribute lists bandwidth as
capabilities, according to the following definition:

   "a=bcap:" bw-cap-num 1*WSP bwtype ":" bandwidth CRLF

where <bw-cap-num> is a unique integer within all the bandwidth
capabilities in the entire SDP, which is used to number the bandwidth
capability and can take a value between 1 and 2^31-1 (both included).
The other elements are as defined for the "b=" field in SDP
[RFC4566].

This format satisfies the general attribute production rules in SDP
[RFC4566], according to the following Augmented Backus-Naur Form
(ABNF) [RFC5234] syntax:

        att-field   =/ "bcap"
        att-value   =/ bw-cap-num 1*WSP bwtype ":" bandwidth
        bw-cap-num   = 1*10(DIGIT)   ; DIGIT defined in RFC 5234

              Figure 2: Syntax of the "bcap" attribute

   Negotiation of bandwidth per media stream can be useful when
   negotiating media encoding capabilities with different bandwidths.

3.1.1.1. Configuration Parameters

   The SDP Capability Negotiation Framework [RFC5939] provides for the
   existence of the "pcfg" and "acfg" attributes. The concept is
   extended by the SDP Media Capabilities Negotiation [RFC6871] with an
   "lcfg" attribute that conveys latent configurations.

   Extensions to the "pcfg" and "lcfg" attributes are defined through
   <extension-config-list>, and extensions to the "acfg" attribute are
   defined through the <sel-extension-config>, as defined in the SDP
   Capability Negotiation [RFC5939].

   In this document, we extend the <extension-config-list> field to be
   able to convey lists of bandwidth capabilities in latent or potential
   configurations, according to the following Augmented Backus-Naur Form
   (ABNF) [RFC5234] syntax:

     extension-config-list =/ bandwidth-config-list
     bandwidth-config-list = ["+"] "b=" bw-cap-list *(BAR bw-cap-list)
                                ; BAR defined in RFC 5939
     bw-cap-list   = bw-cap-num *("," bw-cap-num)
     bw-cap-num   = 1*10(DIGIT)   ; DIGIT defined in RFC 5234

                  Figure 3: Syntax of the bandwidth parameter
                     in "lcfg" and "pcfg" attributes

   Each bandwidth capability configuration is a comma-separated list of
   bandwidth capability attribute numbers where <bw-cap-num> refers to
   the <bw-cap-num> bandwidth capability numbers defined explicitly
   earlier in this document, and hence MUST be between 1 and 2^31-1
   (both included). Alternative bandwidth configurations are separated
   by a vertical bar ("|").

   The above syntax is very flexible, allowing referencing to multiple
   "b=" lines per configuration, even for the same <bwtype>. While the
   need for such definitions is not seen, we have not restricted this,
   as it is not restricted in SDP [RFC4566] either.

The bandwidth parameter to the actual configuration attribute
("a=acfg") is formulated as a <sel-extension-config> with

      ext-cap-name = "b"

   hence

      sel-extension-config =/ sel-bandwidth-config
      sel-bandwidth-config = "b=" bw-cap-list ; bw-cap-list as above.

      Figure 4: Syntax of the bandwidth parameter in "acfg" attributes

3.1.1.2. Option Tag

   The SDP Capability Negotiation Framework [RFC5939] allows for
   capability negotiation extensions to be defined. Associated with
   each such extension is an option tag that identifies the extension in
   question. Hereby, we define a new option tag "bcap-v0" that
   identifies support for the bandwidth capability. The endpoints using
   the "bcap" capability attribute SHOULD add the option tag to other
   existing option tags present in the "csup" and "creq" attributes in
   SDP, according to the procedures defined in the SDP Capability
   Negotiation Framework [RFC5939].

3.1.2. Connection Data Capability

   According to SDP [RFC4566], the connection data field in SDP contains
   the connection data, and it 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, network types already defined include "IN", which
   indicates Internet network type, and "ATM" (see RFC 3108 [RFC3108]),
   used for describing Asynchronous Transfer Mode (ATM) bearer
   connections. The Circuit-Switched (CS) descriptions in the SDP
   document [SDP-CS] adds a "PSTN" network type for expressing a Public
   Switched Telephone Network (PSTN) circuit switch.

SDP [RFC4566] permits specification of connection data at the SDP
session and/or media level. In order to permit negotiation of
connection data at the media level, we define the connection data
capability attribute ("a=ccap") in the form:

    "a=ccap:" conn-cap-num 1*WSP nettype SP addrtype SP
    connection-address CRLF

where <conn-cap-num> is a unique integer within all the connection
capabilities in the entire SDP, which is used to identify the
connection data capability and can take a value between 1 and 2^31-1
(both included). The other elements are as defined in [RFC4566].

This format corresponds to the [RFC4566] attribute production rules,
according to the following Augmented Backus-Naur Form (ABNF)
[RFC5234] syntax:

```
        att-field        =/ "ccap"
        att-value        =/ conn-cap-num 1*WSP nettype SP addrtype
                            SP connection-address
        conn-cap-num     = 1*10(DIGIT)    ; 1 to 2^31-1, inclusive
                                          ; DIGIT defined in RFC 5234
```

            Figure 5: Syntax of the "ccap" attribute

The "ccap" capability attribute allows for expressing alternative
connections address ("c=") lines in SDP as part of the SDP Capability
Negotiation process. One of the primary use cases for this is
offering alternative connection addresses where the <nettype> is "IN"
or "PSTN", i.e., selecting between an IP-based bearer or a
circuit-switched bearer.

By supporting the "IN" <nettype>, the "ccap" attribute enables the
signaling of multiple IPv4 and IPv6 addresses; however, the Standards
Track mechanism for negotiation of alternative IP addresses in SDP is
Interactive Connectivity Establishment (ICE) [RFC5245]. The "ccap"
attribute does not change that; hence, the combined set of actual and
potential configurations (as defined in [RFC5939]) for any given
media description MUST NOT use the "ccap" attribute to negotiate more
than one address with an IN network type (i.e., it is not permissible
to select between "IPv4" and "IPv6" address families or different IP
addresses within the same IP address family.

Figure 6 is an example of an SDP offer that includes a "ccap"
capability attribute. An audio stream can be set up with an RTP flow
or by establishing a circuit-switched audio stream:

```
v=0
o=2987933123 2987933123 IN IP4 198.51.100.7
s=-
t=0 0
a=creq:med-v0,ccap-v0
m=audio 38902 RTP/AVP 0 8
c=IN IP4 198.51.100.7
a=ccap:1 PSTN E164 +15555556666
a=tcap:2 PSTN
a=omcap:1 -
a=acap:1 setup:actpass
a=acap:2 connection:new
a=acap:3 cs-correlation:callerid:+15555556666
a=pcfg:1 c=1 t=2 m=1 a=1,2,3
```

           Figure 6: Example SDP offer with a "ccap" attribute

   The example in Figure 6 represents an SDP offer indicating an audio
   flow using RTP, such as the one represented in Figure 7, or an audio
   flow using a circuit-switched connection, such as the one represented
   in Figure 8.

```
v=0
o=2987933123 2987933123 IN IP4 198.51.100.7
s=-
t=0 0
m=audio 38902 RTP/AVP 0 8
c=IN IP4 198.51.100.7
```

           Figure 7: Equivalent SDP offer with the RTP flow

```
v=0
o=2987933123 2987933123 IN IP4 198.51.100.7
s=-
t=0 0
m=audio 9 PSTN -
c=PSTN E164 +15555556666
a=setup:actpass
a=connection:new
a=cs-correlation:callerid:+15555556666
```

       Figure 8: Equivalent SDP offer with the circuit-switched flow

   This document does not define any mechanism for negotiating or
   describing different port numbers; hence, the port number from the
   "m=" line MUST be used by default. Exceptions to this default can be
   provided by extension mechanisms or network type specific rules.
   This document defines an exception when the network type is "PSTN",

in which case the port number is replaced with 9 (the "discard"
port), as described in "Session Description Protocol (SDP) Extension
for Setting Audio and Video Media Streams over Circuit-Switched
Bearers in the Public Switched Telephone Network (PSTN)" [SDP-CS].
An endpoint offering alternative IP and PSTN bearers MUST include the
IP media description in the actual configuration (IP address in the
"c=" line and port number in the "m=" line) and the PSTN media
description in the potential configuration.

Exceptions for other network types, such as for the "ATM" network
type defined in [RFC3108], require additional specifications.

3.1.2.1. Configuration Parameters

The SDP Capability Negotiation Framework [RFC5939] provides for the
existence of the "pcfg" and "acfg" attributes, which can convey one
or more configurations to be negotiated. The concept is extended by
the SDP Media Capabilities Negotiation [RFC6871] with an "lcfg"
attribute that conveys latent configurations.

In this document, we define a <connection-config> parameter to be
used to specify a connection data capability in a potential or latent
configuration attribute. The parameter follows the form of an
<extension-config-list> with

    ext-cap-name = "c"

    ext-cap-list = conn-cap-list

where, according to the following Augmented Backus-Naur Form (ABNF)
[RFC5234] syntax:

        extension-config-list =/ conn-config-list
        conn-config-list   = ["+"] "c=" conn-cap-list
        conn-cap-list   = conn-cap-num *(BAR conn-cap-num)
        conn-cap-num   = 1*10(DIGIT)   ; 1 to 2^32-1 inclusive

                 Figure 9: Syntax of the connection data
               parameter in "lcfg" and "pcfg" attributes

Each capability configuration alternative contains a single
connection data capability attribute number and refers to the
conn-cap-num capability number defined explicitly earlier in this
document; hence, the values MUST be between 1 and 2^31-1 (both
included). The connection data capability allows the expression of
only a single capability in each alternative, rather than a list of
capabilities, since no more than a single connection data field is

permitted per media block. Nevertheless, it is still allowed to
express alternative potential connection configurations separated by
a vertical bar ("|").

An endpoint includes a plus sign ("+") in the configuration attribute
to mandate support for this extension. An endpoint that receives
this parameter prefixed with a plus sign and does not support this
extension MUST treat that potential configuration as not valid.

The connection data parameter to the actual configuration attribute
("a=acfg") is formulated as a <sel-extension-config> with

    ext-cap-name = "c"

hence

        sel-extension-config =/ sel-connection-config
        sel-connection-config = "c=" conn-cap-num ; as defined above.

        Figure 10: Syntax of the connection data parameter
                        in "acfg" attributes

3.1.2.2. Option Tag

The SDP Capability Negotiation Framework [RFC5939] solution allows
for capability negotiation extensions to be defined. Associated with
each such extension is an option tag that identifies the extension in
question. Hereby, we define a new option tag of "ccap-v0" that
identifies support for the connection data capability. This option
tag SHOULD be added to other existing option tags present in the
"csup" and "creq" attributes in SDP, according to the procedures
defined in the SDP Capability Negotiation Framework [RFC5939].

3.1.3. Title Capability

SDP [RFC4566] provides for the existence of an information field
expressed in the format of the "i=" line, which can appear at the SDP
session and/or media level. An "i=" line that is present at the
session level is known as the "session name", and its purpose is to
convey human-readable textual information about the session.

The "i=" line in SDP can also appear at the media level, in which
case it is used to provide human-readable information about the media
stream to which it is related; for example, it may indicate the
purpose of the media stream. The "i=" line is not to be confused
with the label attribute ("a=label:", [RFC4574]), which provides a
machine-readable tag. It is foreseen that applications declaring
capabilities related to different configurations of a media stream

may need to provide different identifying information for each of
those configurations. That is, a party might offer alternative media
configurations for a stream, each of which represents a different
presentation of the same or similar information. For example, an
audio stream might offer English or Spanish configurations, or a
video stream might offer a choice of video source such as speaker
camera, group camera, or document viewer. The title capability is
needed to inform the answering user in order to select the proper
choice, and the label is used to inform the offering machine which
choice the answerer has selected. Hence, there is value in defining
a mechanism to provide titles of media streams as capabilities.

As defined in SDP [RFC4566], the session information field ("i=",
referred to as "title" in this document) is subject to the
"a=charset" attribute in order to support different character sets
and hence internationalization. The title capability attribute
itself ("a=icap") is, however, not subject to the "a=charset"
attribute as this would preclude the inclusion of alternative
session/title information each using different character sets.
Instead, the session/title value embedded in an "a=icap" attribute
(title capability) will be subject to the "a=charset" value used
within a configuration that includes that title capability. This
provides for consistent SDP operation while allowing for capabilities
and configurations with different session/title information values
with different character set encodings (with each such configuration
including an "a=charset" value with the relevant character set for
the session/title information in question).

According to SDP [RFC4566], the session information ("i=") line has
the following syntax:

    "i=" text

where "text" represents a human-readable text indicating the purpose
of the session or media stream.

In this document, we define a new capability attribute: the title
capability "icap". This attribute lists session or media titles as
capabilities, according to the following definition:

    "a=icap:" title-cap-num 1*WSP text

where <title-cap-num> is a unique integer within all the connection
capabilities in the entire SDP, which is used to identify the
particular title capability and can take a value between 1 and 2^31-1
(both included). <text> is a human-readable text that indicates the
purpose of the session or media stream it is supposed to
characterize.

As an example, one might use:

    a=icap:1 Document Camera

to define a title capability number 1 to identify a particular source
of a media stream.

Or, in another example, one might offer two title capabilities with
different character encodings (using the charset attribute defined in
"SDP: Session Description Protocol" [RFC4566] and the generic
attribute capability attribute ("a=acap:") defined in "Session
Description Protocol (SDP) Capability Negotiation" [RFC5939]).

            a=icap:1 El bar y la cafetería de José
            a=acap:1 charset:ISO-8859-1
            a=icap:2 Joe's Café & Bar
            a=acap:2 charset:UTF-8

The title capability attribute satisfies the general attribute
production rules in SDP [RFC4566], according to the following
Augmented Backus-Naur Form (ABNF) [RFC5234] syntax:

    att-field   =/ "icap"
    att-value   =/ title-cap-num 1*WSP text
                                ; text defined in RFC 4566
    title-cap-num   = 1*10(DIGIT)   ; DIGIT defined in RFC 5234

            Figure 11: Syntax of the "icap" attribute

3.1.3.1. Configuration Parameters

   The SDP Capability Negotiation Framework [RFC5939] provides for the
   existence of the "pcfg" and "acfg" attributes. The concept is
   extended by the SDP Media Capabilities Negotiation [RFC6871] with an
   "lcfg" attribute that conveys latent configurations.

In this document, we define a <title-config-list> parameter to be
used to convey title capabilities in a potential or latent
configuration. This parameter is defined as an
<extension-config-list> with the following associations:

    ext-cap-name = "i"

    ext-cap-list = title-cap-list

This leads to the following definition for the title capability
parameter:

```
        extension-config-list =/ title-config-list
        title-config-list    = ["+"] "i=" title-cap-list
        title-cap-list       = title-cap-num *(BAR title-cap-num)
                                     ; BAR defined in RFC 5939
        title-cap-num        = 1*10(DIGIT) ; DIGIT defined in RFC 5234
```

             Figure 12: Syntax of the title capability parameter
                       in "lcfg" and "pcfg" attributes

Each potential capability configuration contains a single title
capability attribute number where "title-cap-num" is the title
capability number defined explicitly earlier in this document, and
hence must be between 1 and 2^31-1 (both included). The title
capability allows the expression of only a single capability in each
alternative, since no more than a single-title field is permitted per
block. Nevertheless, it is still allowed to express alternative
potential title configurations separated by a vertical bar ("|").

An endpoint includes a plus sign ("+") in the configuration attribute
to mandate support for this extension. An endpoint that receives
this parameter prefixed with a plus sign and does not support this
extension MUST treat that potential configuration as not valid.

The title parameter to the actual configuration attribute ("a=acfg")
is formulated as a <sel-extension-config> with

    ext-cap-name = "i"

hence

```
        sel-extension-config =/ sel-title-config
        sel-title-config = "i=" title-cap-num  ; as defined above.
```

      Figure 13: Syntax of the title parameter in "acfg" attributes

3.1.3.2. Option Tag

   At present, it is difficult to envision a scenario in which the
   "icap" attribute must be supported or the offer must be rejected. In
   most cases, if the icap attribute or its contents were to be ignored,
   an offered configuration could still be chosen based on other
   criteria such as configuration numbering. However, one might imagine
   an SDP offer that contained English and Spanish potential
   configurations for an audio stream. The session might be
   unintelligible if the choice is based on configuration numbering,
   rather than informed user selection. Based on such considerations,
   it may well prove useful to announce the ability to use the icap
   attribute and its contents to select media configurations, or to
   inform the user about the selected configuration(s). Therefore, we
   define a new option tag of "icap-v0" that identifies support for the
   title capability. This option tag SHOULD be added to other existing
   option tags present in the "csup" and/or "creq" attributes in SDP,
   according to the procedures defined in the SDP Capability Negotiation
   Framework [RFC5939]. The discussion above suggests that "icap-v0"
   will typically appear in a "csup" attribute, but rarely in a "creq"
   attribute.

3.2. Session Level versus Media Level

   The "bcap", "ccap", and "icap" attributes can appear at the SDP
   session and/or media level. Endpoints MUST interpret capabilities
   declared at session level as part of the session level in the
   resulting SDP for that particular configuration. Endpoints MUST
   interpret capabilities declared at media description as part of the
   media level in the resulting SDP for that particular configuration.

   The presence of the "bcap" capability for the same <bwtype> at both
   the session and media level is subject to the same constraints and
   restrictions specified in RFC 4566 [RFC4566] for the bandwidth
   attribute "b=".

   To avoid confusion, the <type-attr-num> for each "a=bcap", "a=ccap",
   and "a=icap" line MUST be unique across all capability attributes of
   the same type within the entire session description.

3.3. Offer/Answer Model Extensions

   In this section, we define extensions to the offer/answer model
   defined in SDP Offer/Answer Model [RFC3264] and extended in the SDP
   Capability Negotiation [RFC5939] to allow for bandwidth, connection,
   and title capabilities to be used with the SDP Capability Negotiation
   Framework.

3.3.1. Generating the Initial Offer

   When an endpoint generates an initial offer and wants to use the
   functionality described in the current document, it first defines
   appropriate values for the bandwidth, connection data, and/or title
   capability attributes according to the rules defined in [RFC4566] for
   "b=", "c=", and "i=" lines. The endpoint then MUST include the
   respective capability attributes and associated values in the SDP
   offer. The preferred configurations for each media stream are
   identified following the media line in a "pcfg" attribute. Bandwidth
   and title capabilities may also be referenced in latent
   configurations in an "lcfg" attribute, as defined in the SDP Media
   Capabilities Negotiation [RFC6871].

   Implementations are advised to pay attention to the port number that
   is used in the "m=" line. By default, a potential configuration that
   includes a connection data capability will use the port number from
   the "m=" line, unless the network type is "PSTN", in which case the
   default port number used will be 9.

   The offer SHOULD include the level of capability negotiation
   extensions needed to support this functionality in a "creq"
   attribute.

3.3.2. Generating the Answer

   When the answering party receives the offer, and if it supports the
   required capability negotiation extensions, it SHOULD select the most
   preferred configuration it can support for each media stream and
   build the answer accordingly, as defined in Section 3.6.2 of the SDP
   Capability Negotiation [RFC5939].

   If the connection data capability is used in a selected potential
   configuration chosen by the answerer, that offer configuration MUST
   by default use the port number from the actual offer configuration
   (i.e., the "m=" line), unless the network type is "PSTN", in which
   case the default port MUST be assumed to be 9. Extensions may be
   defined to negotiate the port number explicitly instead.

3.3.3. Offerer Processing of the Answer

   When the offerer receives the answer, it MUST process the media lines
   according to normal SDP processing rules to identify the media
   stream(s) accepted by the answer, if any, as defined in Section 3.6.3
   of the SDP Capability Negotiation [RFC5939]. The "acfg" attribute,
   if present, MUST be used to verify the proposed configuration used to
   form the answer and to infer the lack of acceptability of
   higher-preference configurations that were not chosen.

3.3.4. Modifying the Session

   If, at a later time, one of the parties wishes to modify the
   operating parameters of a session, e.g., by adding a new media stream
   or by changing the properties used on an existing stream, it may do
   so via the mechanisms defined for SDP offer/answer [RFC3264] and in
   accordance with the procedures defined in Section 3.6.4 of the SDP
   Capability Negotiation [RFC5939].

4. Field Replacement Rules

   To simplify the construction of SDP records, given the need to
   include fields within the media description in question for endpoints
   that do not support capabilities negotiation, we define some simple
   field-replacement rules for those fields invoked by potential or
   latent configurations. In particular, any "i=" or "c=" lines invoked
   by a configuration MUST replace the corresponding line, if present
   within the media description in question. Any "b=" line invoked by a
   configuration MUST replace any "b=" of the same bandwidth type at the
   media level, but not at the session level.

5. Security Considerations

   This document provides an extension on top of the SDP [RFC4566], SDP
   Offer/Answer Model [RFC3264], SDP Capability Negotiation Framework
   [RFC5939], and SDP Media Capabilities Negotiation [RFC6871]. As
   such, the security considerations of those documents apply.

   The bandwidth capability attribute may be used for reserving
   resources at endpoints and intermediaries that inspect SDP.
   Modification of the bandwidth value by an attacker can lead to the
   network being underutilized (too high bandwidth value) or congested
   (too low bandwidth value).

Similarly, by modifying the alternative connection address(es), an attacker would be able to direct media streams to a desired endpoint, thus launching a version of the well-known voice hammer attack (see Section 18.5.1 of [RFC5245]).

The title capability provides for alternative "i=" line information, which is intended for human consumption. However, manipulating the textual information could be misused to provide false information, leading to a bad user experience or the person using the service making a wrong choice regarding the available media streams.

In case it is essential to protect the capability attribute values, one of the security mechanisms proposed in [RFC5939] SHOULD be used.

The "i=" line, and thus the value carried in the title capability attribute, is intended for human-readable description only. It should not be parsed programmatically.

6. IANA Considerations

6.1. New SDP Attributes

IANA has registered new attributes in the "att-field (both session and media level)" subregistry of the "Session Description Protocol (SDP) Parameters" registry, according to the following registration form:

```
    Attribute name:       bcap
    Long form name:       Bandwidth Capability
    Type of attribute:    Both media and session level
    Subject to charset:   No
    Purpose:              Negotiate session or media-level bandwidths
    Appropriate values:   See RFC 7066, Section 3.1.1
    Contact name:         Miguel A. Garcia
                          Miguel.A.Garcia@ericsson.com


    Attribute name:       ccap
    Long form name:       Connection Data Capability
    Type of attribute:    Both media and session level
    Subject to charset:   No
    Purpose:              Negotiate media-level connection data
    Appropriate values:   See RFC 7066, Section 3.1.2
    Contact name:         Miguel A. Garcia
                          Miguel.A.Garcia@ericsson.com
```

```
Attribute name:       icap
Long form name:       Title Capability
Type of attribute:    Both media and session level
Subject to charset:   Yes
Purpose:              Negotiate human-readable information
                      describing the session or media
Appropriate values:  See RFC 7066, Section 3.1.3
Contact name:         Miguel A. Garcia
                      Miguel.A.Garcia@ericsson.com
```

6.2. New Option Tags

   IANA has added the new option tags "bcap-v0", "ccap-v0", and "icap-
   v0", defined herein, to the "SDP Capability Negotiation Option Tag"
   subregistry of the "Session Description Protocol (SDP) Parameters"
   registry.

6.3. New SDP Capability Negotiation Configuration Parameters

   IANA has added the new parameter identifiers "b" for "Bandwidth", "c"
   for "Connection Data", and "i" for "Title" to the "SDP Capability
   Negotiation Configuration Parameters" subregistry of the "Session
   Description Protocol (SDP) Parameters" registry. These parameters
   are permitted in "lcfg", "acfg", and "pcfg" attributes.

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