        Session Description Protocol (SDP) Media Capabilities Negotiation

Abstract

   Session Description Protocol (SDP) capability negotiation provides a
   general framework for indicating and negotiating capabilities in SDP.
   The base framework defines only capabilities for negotiating
   transport protocols and attributes. This documents extends the
   framework by defining media capabilities that can be used to
   negotiate media types and their associated parameters.

   This document updates the IANA Considerations of RFC 5939.

Status of This Memo

   This is an Internet Standards Track document.

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   Internet Engineering Steering Group (IESG). Further information on
   Internet Standards is available in Section 2 of RFC 5741.

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1. Introduction

   "Session Description Protocol (SDP) Capability Negotiation" [RFC5939]
   provides a general framework for indicating and negotiating
   capabilities in SDP [RFC4566]. The base framework defines only
   capabilities for negotiating transport protocols and attributes.

   RFC 5939 [RFC5939] lists some of the issues with the current SDP
   capability negotiation process. An additional real-life problem is
   to be able to offer one media stream (e.g., audio) but list the
   capability to support another media stream (e.g., video) without
   actually offering it concurrently.

   In this document, we extend the framework by defining media
   capabilities that can be used to indicate and negotiate media types
   and their associated format parameters. This document also adds the
   ability to declare support for media streams, the use of which can be
   offered and negotiated later, and the ability to specify session
   configurations as combinations of media stream configurations. The
   definitions of new attributes for media capability negotiation are
   chosen to make the translation from these attributes to
   "conventional" SDP [RFC4566] media attributes as straightforward as
   possible in order to simplify implementation. This goal is intended
   to reduce processing in two ways: each proposed configuration in an
   offer may be easily translated into a conventional SDP media stream
   record for processing by the receiver and the construction of an
   answer based on a selected proposed configuration would be
   straightforward.

   This document updates RFC 5939 [RFC5939] by updating the IANA
   considerations. All other extensions defined in this document are
   considered extensions above and beyond RFC 5939 [RFC5939].

2. Terminology

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

   Actual Configuration: An actual configuration specifies which
   combinations of SDP session parameters and media stream components
   can be used in the current offer/answer exchange and with what
   parameters. Use of an actual configuration does not require any
   further negotiation in the offer/answer exchange. See RFC 5939
   [RFC5939] for further details.

   Base Attributes: Conventional SDP attributes appearing in the base
   configuration of a media block.

   Base Configuration: The media configuration represented by a media
   block exclusive of all the capability negotiation attributes defined
   in this document, the base capability negotiation document [RFC5939],
   or any other capability negotiation document. In an offer SDP, the
   base configuration corresponds to the actual configuration as defined
   in RFC 5939 [RFC5939].

   Conventional Attribute: Any SDP attribute other than those defined by
   the series of capability negotiation specifications.

   Conventional SDP: An SDP record devoid of capability negotiation
   attributes.

   Media Format Capability: A media format, typically a media subtype
   such as PCMU, H263-1998, or T38, expressed in the form of a
   capability.

   Media Format Parameter Capability: A media format parameter ("a=fmtp"
   in conventional SDP) expressed in the form of a capability. The
   media format parameter capability is associated with a media format
   capability.

   Media Capability: The combined set of capabilities associated with
   expressing a media format and its relevant parameters (e.g., media
   format parameters and media specific parameters).

   Potential Configuration: A potential configuration indicates which
   combinations of capabilities can be used for the session and its
   associated media stream components. Potential configurations are not
   ready for use; however, they are offered for potential use in the
   current offer/answer exchange. They provide an alternative that may
   be used instead of the actual configuration, subject to negotiation
   in the current offer/answer exchange. See RFC 5939 [RFC5939] for
   further details.

   Latent Configuration: A latent configuration indicates which
   combinations of capabilities could be used in a future negotiation
   for the session and its associated media stream components. Latent
   configurations are neither ready for use nor offered for actual or
   potential use in the current offer/answer exchange. Latent
   configurations merely inform the other side of possible
   configurations supported by the entity. Those latent configurations
   may be used to guide subsequent offer/answer exchanges, but they are
   not offered for use as part of the current offer/answer exchange.

3. SDP Media Capabilities

   The SDP capability negotiation [RFC5939] discusses the use of any SDP
   [RFC4566] attribute (a=) under the attribute capability "acap". The
   limitations of using "acap" for "fmtp" and "rtpmap" in a potential
   configuration are described in RFC 5939 [RFC5939]; for example, they
   can be used only at the media level since they are media-level
   attributes. RFC 5939 [RFC5939] does not provide a way to exchange
   media-level capabilities prior to the actual offer of the associated
   media stream. This section provides an overview of extensions
   providing an SDP media capability negotiation solution offering more
   robust capabilities negotiation. This is followed by definitions of
   new SDP attributes for the solution and its associated updated
   offer/answer procedures [RFC3264].

3.1. Requirements

   The capability negotiation extensions requirements considered herein
   are as follows.

   REQ-01: Support the specification of alternative (combinations of)
            media formats (codecs) in a single media block.

   REQ-02: Support the specification of alternative media format
            parameters for each media format.

   REQ-03: Retain backward compatibility with conventional SDP. Ensure
            that each and every offered configuration can be easily
            translated into a corresponding SDP media block expressed
            with conventional SDP lines.

   REQ-04: Ensure that the scheme operates within the offer/answer
            model in such a way that media formats and parameters can be
            agreed upon with a single exchange.

   REQ-05: Provide the ability to express offers in such a way that the
            offerer can receive media as soon as the offer is sent.
            (Note that the offerer may not be able to render received
            media prior to exchange of keying material.)

   REQ-06: Provide the ability to offer latent media configurations for
            future negotiation.

   REQ-07: Provide reasonable efficiency in the expression of
            alternative media formats and/or format parameters,
            especially in those cases in which many combinations of
            options are offered.

   REQ-08: Retain the extensibility of the base capability negotiation
            mechanism.

   REQ-09: Provide the ability to specify acceptable combinations of
            media streams and media formats. For example, offer a PCMU
            audio stream with an H264 video stream or a G729 audio
            stream with an H263 video stream. This ability would give
            the offerer a means to limit processing requirements for
            simultaneous streams. This would also permit an offer to
            include the choice of an audio/T38 stream or an image/T38
            stream, but not both.

   Other possible extensions have been discussed, but have not been
   treated in this document. They may be considered in the future.
   Three such extensions are:

   FUT-01: Provide the ability to mix, or change, media types within a
            single media block. Conventional SDP does not support this
            capability explicitly; the usual technique is to define a
            media subtype that represents the actual format within the
            nominal media type. For example, T.38 FAX as an alternative
            to audio/PCMU within an audio stream is identified as
            audio/T38; a separate FAX stream would use image/T38.

   FUT-02: Provide the ability to support multiple transport protocols
            within an active media stream without reconfiguration. This
            is not explicitly supported by conventional SDP.

   FUT-03: Provide capability negotiation attributes for all media-
            level SDP line types in the same manner as already done for
            the attribute type, with the exception of the media line
            type itself. The media line type is handled in a special
            way to permit compact expression of media coding/format
            options. The line types are bandwidth ("b="), information
            ("i="), connection data ("c="), and, possibly, the
            deprecated encryption key ("k=").

3.2. Solution Overview

   The solution consists of new capability attributes corresponding to
   conventional SDP line types, new parameters for the "pcfg", "acfg",
   and the new "lcfg" attributes extending the base attributes from RFC
   5939 [RFC5939], and a use of the "pcfg" attribute to return
   capability information in the SDP answer.

   Several new attributes are defined in a manner that can be related to
   the capabilities specified in a media line, and its corresponding
   "rtpmap" and "fmtp" attributes.

o A new attribute ("a=rmcap") defines RTP-based media format
   capabilities in the form of a media subtype (e.g., "PCMU"), and
   its encoding parameters (e.g., "/8000/2"). Each resulting media
   format type/subtype capability has an associated handle called a
   media capability number. The encoding parameters are as specified
   for the "rtpmap" attribute defined in SDP [RFC4566], without the
   payload type number part.

o A new attribute ("a=omcap") defines other (non-RTP-based) media
   format capabilities in the form of a media subtype only (e.g.,
   "T38"). Each resulting media format type/subtype capability has
   an associated handle called a media capability number.

o A new attribute ("a=mfcap") specifies media format parameters
   associated with one or more media format capabilities. The
   "mfcap" attribute is used primarily to associate the media format
   parameters normally carried in the "fmtp" attribute. Note that
   media format parameters can be used with RTP and non-RTP-based
   media formats.

o A new attribute ("a=mscap") specifies media parameters associated
   with one or more media format capabilities. The "mscap" attribute
   is used to associate capabilities with attributes other than
   "fmtp" or "rtpmap", for example, the "rtcp-fb" attribute defined
   in RFC 4585 [RFC4585].

o A new attribute ("a=lcfg") specifies latent media stream
   configurations when no corresponding media line ("m=") is offered.
   An example is the offer of latent configurations for video even
   though no video is currently offered. If the peer indicates
   support for one or more offered latent configurations, the
   corresponding media stream(s) may be added via a new offer/answer
   exchange.

o A new attribute ("a=sescap") is used to specify an acceptable
   combination of simultaneous media streams and their configurations
   as a list of potential and/or latent configurations.

New parameters are defined for the potential configuration ("pcfg"),
latent configuration ("lcfg"), and accepted configuration ("acfg")
attributes to associate the new attributes with particular
configurations.

o A new parameter type ("m=") is added to the potential
   configuration ("a=pcfg:") attribute and the actual configuration
   ("a=acfg:") attribute defined in RFC 5939 [RFC5939] and to the new
   latent configuration ("a=lcfg:") attribute. This permits
   specification of media capabilities (including their associated

   parameters) and combinations thereof for the configuration. For
   example, the "a=pcfg:" line might specify PCMU and telephone
   events [RFC4733] or G.729B and telephone events as acceptable
   configurations. The "a=acfg:" line in the answer would specify
   the configuration chosen.

   o A new parameter type ("pt=") is added to the potential
      configuration, actual configuration, and latent configuration
      attributes. This parameter associates RTP payload type numbers
      with the referenced RTP-based media format capabilities and is
      appropriate only when the transport protocol uses RTP.

   o A new parameter type ("mt=") is used to specify the media type for
      latent configurations.

Special processing rules are defined for capability attribute
arguments in order to reduce the need to replicate essentially
identical attribute lines for the base configuration and potential
configurations.

   o A substitution rule is defined for any capability attribute to
      permit the replacement of the (escaped) media capability number
      with the media format identifier (e.g., the payload type number in
      audio/video profiles).

   o Replacement rules are defined for the conventional SDP equivalents
      of the "mfcap" and "mscap" capability attributes. This reduces
      the necessity to use the deletion qualifier in the "a=pcfg"
      parameter in order to ignore "rtpmap", "fmtp", and certain other
      attributes in the base configuration.

   o An argument concatenation rule is defined for "mfcap" attributes
      that refer to the same media capability number. This makes it
      convenient to combine format options concisely by associating
      multiple mfcap lines with multiple media format capabilities.

This document extends the base protocol extensions to the
offer/answer model that allow for capabilities and potential
configurations to be included in an offer. Media capabilities
constitute capabilities that can be used in potential and latent
configurations. Whereas potential configurations constitute
alternative offers that may be accepted by the answerer instead of
the actual configuration(s) included in the "m=" line(s) and
associated parameters, latent configurations merely inform the other
side of possible configurations supported by the entity. Those
latent configurations may be used to guide subsequent offer/answer
exchanges, but they are not part of the current offer/answer
exchange.

The mechanism is illustrated by the offer/answer exchange below,
where Alice sends an offer to Bob:

```
              Alice                          Bob
               | (1) Offer (SRTP and RTP)     |
               |----------------------------->|
               |                              |
               | (2) Answer (RTP)             |
               |<-----------------------------|
               |                              |
```
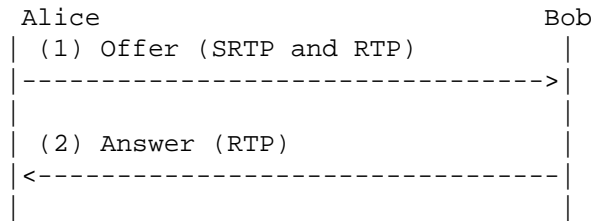
Alice's offer includes RTP and Secure Real-time Transport Protocol
(SRTP) as alternatives. RTP is the default, but SRTP is the
preferred one (long lines are folded to fit the margins):

```
   v=0
   o=- 25678 753849 IN IP4 192.0.2.1
   s=
   c=IN IP4 192.0.2.1
   t=0 0
   a=creq:med-v0
   m=audio 3456 RTP/AVP 0 18
   a=tcap:1 RTP/SAVP RTP/AVP
   a=rtpmap:0 PCMU/8000/1
   a=rtpmap:18 G729/8000/1
   a=fmtp:18 annexb=yes
   a=rmcap:1,4 G729/8000/1
   a=rmcap:2 PCMU/8000/1
   a=rmcap:5 telephone-event/8000
   a=mfcap:1 annexb=no
   a=mfcap:4 annexb=yes
   a=mfcap:5 0-11
   a=acap:1 crypto:1 AES_CM_128_HMAC_SHA1_32 \
   inline:NzB4d1BINUAvLEw6UzF3WSJ+PSdFcGdUJShpX1Zj|2^20|1:32
   a=pcfg:1 m=4,5|1,5 t=1 a=1 pt=1:100,4:101,5:102
   a=pcfg:2 m=2 t=1 a=1 pt=2:103
   a=pcfg:3 m=4 t=2 pt=4:18
```

The required base and extensions are provided by the "a=creq"
attribute defined in RFC 5939 [RFC5939], with the option tag
"med-v0", which indicates that the extension framework defined here
must be supported. The base-level capability negotiation support
("cap-v0" [RFC5939]) is implied since it is required for the
extensions.

The "m=" line indicates that Alice is offering to use plain RTP with
PCMU or G.729B. The media line implicitly defines the default

transport protocol (RTP/AVP in this case) and the default actual
configuration.

The "a=tcap:1" line, specified in the SDP capability negotiation base
protocol [RFC5939], defines transport protocol capabilities, in this
case Secure RTP (SAVP profile) as the first option and RTP (AVP
profile) as the second option.

The "a=rmcap:1,4" line defines two G.729 RTP-based media format
capabilities, numbered 1 and 4, and their encoding rate. The
capabilities are of media type "audio" and subtype G729. Note that
the media subtype is explicitly specified here, rather than RTP
payload type numbers. This permits the assignment of payload type
numbers in the media stream configuration specification. In this
example, two G.729 subtype capabilities are defined. This permits
the declaration of two sets of formatting parameters for G.729.

The "a=rmcap:2" line defines a G.711 mu-law capability, numbered 2.

The "a=rmcap:5" line defines an audio telephone-event capability,
numbered 5.

The "a=mfcap:1" line specifies the "fmtp" formatting parameters for
capability 1 (offerer will not accept G.729 Annex B packets).

The "a=mfcap:4" line specifies the "fmtp" formatting parameters for
capability 4 (offerer will accept G.729 Annex B packets).

The "a=mfcap:5" line specifies the "fmtp" formatting parameters for
capability 5 (the dual-tone multi-frequency (DTMF) touchtones
0-9,*,#).

The "a=acap:1" line specified in the base protocol provides the
"crypto" attribute that provides the keying material for SRTP using
SDP security descriptions.

The "a=pcfg:" attributes provide the potential configurations
included in the offer by reference to the media capabilities,
transport capabilities, attribute capabilities, and specified payload
type number mappings. Three explicit alternatives are provided; the
lowest-numbered one is the preferred one. The "a=pcfg:1 ..." line
specifies media capabilities 4 and 5, i.e., G.729B and DTMF
(including their associated media format parameters), or media
capability 1 and 5, i.e., G.729 and DTMF (including their associated
media format parameters). Furthermore, it specifies transport
protocol capability 1 (i.e., the RTP/SAVP profile - secure RTP), and
the attribute capability 1, i.e., the "crypto" attribute provided.
Last, it specifies a payload type number mapping for (RTP-based)

   media capabilities 1, 4, and 5, thereby permitting the offerer to
   distinguish between encrypted media and unencrypted media received
   prior to receipt of the answer.

   Use of unique payload type numbers in alternative configurations is
   not required; codecs such as Adaptive Multi-Rate Wideband (AMR-WB)
   [RFC4867] have the potential for so many combinations of options that
   it may be impractical to define unique payload type numbers for all
   supported combinations. If unique payload type numbers cannot be
   specified, then the offerer will be obliged to wait for the SDP
   answer before rendering received media. For SRTP using Security
   Descriptions (SDES) inline keying [RFC4568], the offerer will still
   need to receive the answer before being able to decrypt the stream.

   The second alternative ("a=pcfg:2 ...") specifies media capability 2,
   i.e., PCMU, under the RTP/SAVP profile, with the same SRTP key
   material.

   The third alternative ("a=pcfg:3 ...") offers G.729B unsecured; its
   only purpose in this example is to show a preference for G.729B over
   PCMU.

   Per RFC 5939 [RFC5939], the media line, with any qualifying
   attributes such as "fmtp" or "rtpmap", is itself considered a valid
   configuration (the current actual configuration); it has the lowest
   preference (per RFC 5939 [RFC5939]).

   Bob receives the SDP offer from Alice. Bob supports G.729B, PCMU,
   and telephone events over RTP, but not SRTP, hence he accepts the
   potential configuration 3 for RTP provided by Alice. Bob generates
   the following answer:

```
   v=0
   o=- 24351 621814 IN IP4 192.0.2.2
   s=
   c=IN IP4 192.0.2.2
   t=0 0
   a=csup:med-v0
   m=audio 4567 RTP/AVP 18
   a=rtpmap:18 G729/8000
   a=fmtp:18 annexb=yes
   a=acfg:3 m=4 t=2 pt=4:18
```

   Bob includes the "a=csup" and "a=acfg" attributes in the answer to
   inform Alice that he can support the med-v0 level of capability
   negotiations. Note that in this particular example, the answerer
   supported the capability extensions defined here; however, had he
   not, he would simply have processed the offer based on the offered

   PCMU and G.729 codecs under the RTP/AVP profile only. Consequently,
   the answer would have omitted the "a=csup" attribute line and chosen
   one or both of the PCMU and G.729 codecs instead. The answer carries
   the accepted configuration in the "m=" line along with corresponding
   "rtpmap" and/or "fmtp" parameters, as appropriate.

   Note that per the base protocol, after the above, Alice MAY generate
   a new offer with an actual configuration ("m=" line, etc.)
   corresponding to the actual configuration referenced in Bob's answer
   (not shown here).

3.3. New Capability Attributes

   In this section, we present the new attributes associated with
   indicating the media capabilities for use by the SDP capability
   negotiation. The approach taken is to keep things similar to the
   existing media capabilities defined by the existing media
   descriptions ("m=" lines) and the associated "rtpmap" and "fmtp"
   attributes. We use media subtypes and "media capability numbers" to
   link the relevant media capability parameters. This permits the
   capabilities to be defined at the session level and be used for
   multiple streams, if desired. For RTP-based media formats, payload
   types are then specified at the media level (see Section 3.3.4.2).

   A media capability merely indicates possible support for the media
   type and media format(s) and parameters in question. In order to
   actually use a media capability in an offer/answer exchange, it MUST
   be referenced in a potential configuration.

   Media capabilities, i.e., the attributes associated with expressing
   media capability formats, parameters, etc., can be provided at the
   session level and/or the media level. Media capabilities provided at
   the session level may be referenced in any "pcfg" or "lcfg" attribute
   at the media level (consistent with the media type), whereas media
   capabilities provided at the media level may be referenced only by
   the "pcfg" or "lcfg" attribute within that media stream. In either
   case, the scope of the <med-cap-num> is the entire session
   description. This enables each media capability to be uniquely
   referenced across the entire session description (e.g., in a
   potential configuration).

3.3.1. The Media Format Capability Attributes

   Media subtypes can be expressed as media format capabilities by use
   of the "a=rmcap" and "a=omcap" attributes. The "a=rmcap" attribute
   MUST be used for RTP-based media, whereas the "a=omcap" attribute
   MUST be used for non-RTP-based (other) media formats. The two
   attributes are defined as follows:

```
a=rmcap:<media-cap-num-list> <encoding-name>/<clock-rate>
                            [/<encoding-parms>]

a=omcap:<media-cap-num-list> <format-name>
```

where <media-cap-num-list> is a (list of) media capability number(s)
used to number a media format capability, the <encoding name> or
<format-name> is the media subtype, e.g., H263-1998, PCMU, or T38,
<clock rate> is the encoding rate, and <encoding parms> are the media
encoding parameters for the media subtype. All media format
capabilities in the list are assigned to the same media type/subtype.
Each occurrence of the "rmcap" and "omcap" attribute MUST use unique
values in their <media-cap-num-list>; the media capability numbers
are shared between the two attributes and the numbers MUST be unique
across the entire SDP session. In short, the "rmcap" and "omcap"
attributes define media format capabilities and associate them with a
media capability number in the same manner as the "rtpmap" attribute
defines them and associates them with a payload type number.
Additionally, the attributes allow multiple capability numbers to be
defined for the media format in question by specifying a range of
media capability numbers. This permits the media format to be
associated with different media parameters in different
configurations. When a range of capability numbers is specified, the
first (leftmost) capability number MUST be strictly smaller than the
second (rightmost), i.e., the range increases and covers at least two
numbers.

In ABNF [RFC5234], we have:

```
media-capability-line = rtp-mcap / non-rtp-mcap

rtp-mcap            = "a=rmcap:" media-cap-num-list
                         1*WSP encoding-name "/" clock-rate
                         ["/" encoding-parms]
non-rtp-mcap        = "a=omcap:" media-cap-num-list 1*WSP format-name
media-cap-num-list = media-cap-num-element
                     *("," media-cap-num-element)
media-cap-num-element = media-cap-num
                           / media-cap-num-range
media-cap-num-range = media-cap-num "-" media-cap-num
media-cap-num       = NonZeroDigit *9(DIGIT)
encoding-name       = token ;defined in RFC 4566
clock-rate          = NonZeroDigit *9(DIGIT)
encoding-parms      = token
format-name         = token ;defined in RFC 4566
NonZeroDigit        = %x31-39    ; 1-9
```

The encoding-name, clock-rate, and encoding-params are as defined to
appear in an "rtpmap" attribute for each media type/subtype. Thus,
it is easy to convert an "rmcap" attribute line into one or more
"rtpmap" attribute lines, once a payload type number is assigned to a
media-cap-num (see Section 3.3.5).

The format-name is a media format description for non-RTP-based media
as defined for the <fmt> part of the media description ("m=" line) in
SDP [RFC4566]. In simple terms, it is the name of the media format,
e.g., "t38". This form can also be used in cases such as Binary
Floor Control Protocol (BFCP) [RFC4585] where the fmt list in the
"m=" line is effectively ignored (BFCP uses "*").

The "rmcap" and "omcap" attributes can be provided at the session
level and/or the media level. There can be more than one "rmcap" and
more than one "omcap" attribute at both the session and media levels
(i.e., more than one of each at the session level and more than one
of each in each media description). Media capability numbers cannot
include leading zeroes, and each media-cap-num MUST be unique within
the entire SDP record; it is used to identify that media capability
in potential, latent, and actual configurations, and in other
attribute lines as explained below. Note that the media-cap-num
values are shared between the "rmcap" and "omcap" attributes; hence,
the uniqueness requirement applies to the union of them. When the
media capabilities are used in a potential, latent, or actual
configuration, the media formats referred by those configurations
apply at the media level, irrespective of whether the media
capabilities themselves were specified at the session or media level.
In other words, the media capability applies to the specific media
description associated with the configuration that invokes it.

For example:

```
v=0
o=- 24351 621814 IN IP4 192.0.2.2
s=
c=IN IP4 192.0.2.2
t=0 0
a=rmcap:1 L16/8000/1
a=rmcap:2 L16/16000/2
a=rmcap:3 H263-1998/90000
a=omcap:4 example
m=audio 54320 RTP/AVP 0
a=pcfg:1 m=1|2, pt=1:99,2:98
m=video 66544 RTP/AVP 100
a=rtpmap:100 H264/90000
a=pcfg:10 m=3 pt=3:101
a=tcap:1 TCP
a=pcfg:11 m=4 t=1
```

3.3.2. The Media Format Parameter Capability Attribute

   This attribute is used to associate media format specific parameters
   with one or more media format capabilities. The form of the
   attribute is

      a=mfcap:<media-caps> <list of parameters>

   where <media-caps> permits the list of parameters to be associated
   with one or more media format capabilities and the format parameters
   are specific to the type of media format. The mfcap lines map to a
   single traditional SDP "fmtp" attribute line (one for each entry in
   <media-caps>) of the form

      a=fmtp:<fmt> <list of parameters>

   where <fmt> is the media format parameter defined in RFC 4566
   [RFC4566], as appropriate for the particular media stream. The
   "mfcap" attribute MUST be used to encode attributes for media
   capabilities, which would conventionally appear in an "fmtp"
   attribute. The existing "acap" attribute MUST NOT be used to encode
   "fmtp" attributes.

   The "mfcap" attribute adheres to SDP [RFC4566] attribute production
   rules with

      media-format-parameter-capability =
             "a=mfcap:" media-cap-num-list 1*WSP fmt-specific-param-list
      fmt-specific-param-list = text ; defined in RFC 4566

   Note that media format parameters can be used with RTP-based and non-
   RTP-based media formats.

3.3.2.1. Media Format Parameter Concatenation Rule

   The appearance of media subtypes with a large number of formatting
   options (e.g., AMR-WB [RFC4867]), coupled with the restriction that
   only a single "fmtp" attribute can appear per media format, suggests
   that it is useful to create a combining rule for "mfcap" parameters
   that are associated with the same media capability number.
   Therefore, different mfcap lines MAY include the same media-cap-num
   in their media-cap-num-list. When a particular media capability is
   selected for processing, the parameters from each mfcap line that
   references the particular capability number in its media-cap-num-list
   are concatenated together via ";", in the order the "mfcap"
   attributes appear in the SDP record, to form the equivalent of a
   single "fmtp" attribute line. This permits one to define a separate
   mfcap line for a single parameter and value that is to be applied to
   each media capability designated in the media-cap-num-list. This
   provides a compact method to specify multiple combinations of format
   parameters when using codecs with multiple format options. Note that
   order-dependent parameters SHOULD be placed in a single mfcap line to
   avoid possible problems with line rearrangement by a middlebox.

   Format parameters are not parsed by SDP; their content is specific to
   the media type/subtype. When format parameters for a specific media
   capability are combined from multiple "a=mfcap" lines that reference
   that media capability, the format-specific parameters are
   concatenated together and separated by ";" for construction of the
   corresponding format attribute ("a=fmtp"). The resulting format
   attribute will look something like the following (without line
   breaks):

        a=fmtp:<fmt> <fmt-specific-param-list1>;
                     <fmt-specific-param-list2>;
                     ...

   where <fmt> depends on the transport protocol in the manner defined
   in RFC 4566 [RFC4566]. SDP cannot assess the legality of the
   resulting parameter list in the "a=fmtp" line; the user must take
   care to ensure that legal parameter lists are generated.

   The "mfcap" attribute can be provided at the session level and the
   media level. There can be more than one "mfcap" attribute at the
   session or media level. The unique media-cap-num is used to
   associate the parameters with a media capability.

   As a simple example, a G.729 capability is, by default, considered to
   support comfort noise as defined by Annex B. Capabilities for G.729
   with and without comfort noise support may thus be defined by:

      a=rmcap:1,2 G729/8000
      a=mfcap:2 annexb:no

   Media capability 1 supports G.729 with Annex B, whereas media
   capability 2 supports G.729 without Annex B.

   Example for H.263 video:

      a=rmcap:1 H263-1998/90000
      a=rmcap:2 H263-2000/90000
      a=mfcap:1 CIF=4;QCIF=2;F=1;K=1
      a=mfcap:2 profile=2;level=2.2

   Finally, for six format combinations of the Adaptive Multi-Rate
   codec:

      a=rmcap:1-3 AMR/8000/1
      a=rmcap:4-6 AMR-WB/16000/1
      a=mfcap:1,2,3,4 mode-change-capability=1
      a=mfcap:5,6 mode-change-capability=2
      a=mfcap:1,2,3,5 max-red=220
      a=mfcap:3,4,5,6 octet-align=1
      a=mfcap:1,3,5 mode-set=0,2,4,7
      a=mfcap:2,4,6 mode-set=0,3,5,6

   So that AMR codec #1, when specified in a "pcfg" attribute within an
   audio stream block (and assigned payload type number 98) as in:

      a=pcfg:1 m=1 pt=1:98

   is essentially equivalent to the following:

      m=audio 49170 RTP/AVP 98
      a=rtpmap:98 AMR/8000/1
      a=fmtp:98 mode-change-capability=1; \
      max-red=220; mode-set=0,2,4,7

   and AMR codec #4 with payload type number 99, depicted by the
   potential configuration:

      a=pcfg:4 m=4, pt=4:99

   is equivalent to the following:

      m=audio 49170 RTP/AVP 99
      a=rtpmap:99 AMR-WB/16000/1
      a=fmtp:99 mode-change-capability=1; octet-align=1; \
      mode-set=0,3,5,6

   and so on for the other four combinations. SDP could thus convert
   the media capabilities specifications into one or more alternative
   media stream specifications, one of which can be chosen for the
   answer.

3.3.3. The Media-Specific Capability Attribute

   Attributes and parameters associated with a media format are
   typically specified using the "rtpmap" and "fmtp" attributes in SDP,
   and the similar "rmcap" and "mfcap" attributes in SDP media
   capabilities. Some SDP extensions define other attributes that need
   to be associated with media formats, for example, the "rtcp-fb"
   attribute defined in RFC 4585 [RFC4585]. Such media-specific
   attributes, beyond the "rtpmap" and "fmtp" attributes, may be
   associated with media capability numbers via a new media-specific
   attribute, "mscap", of the following form:

        a=mscap:<media caps star> <att field> <att value>

   where <media caps star> is a (list of) media capability number(s),
   <att field> is the attribute name, and <att value> is the value field
   for the named attribute. Note that the media capability numbers
   refer to media format capabilities specified elsewhere in the SDP
   ("rmcap" and/or "omcap"). If a range of capability numbers is
   specified, the first (leftmost) capability number MUST be strictly
   smaller than the second (rightmost). The media capability numbers
   may include a wildcard ("*"), which will be used instead of any
   payload type mappings in the resulting SDP (see, e.g., RFC 4585
   [RFC4585] and the example below). In ABNF, we have:

         media-specific-capability = "a=mscap:"
                                      media-caps-star
                                      1*WSP att-field ; from RFC 4566
                                      1*WSP att-value ; from RFC 4566
         media-caps-star   = media-cap-star-element
                                       *("," media-cap-star-element)
         media-cap-star-element   = (media-cap-num [wildcard])
                                    / (media-cap-num-range [wildcard])
         wildcard   = "*"

Given an association between a media capability and a payload type
number as specified by the "pt=" parameters in a "pcfg" attribute
line, a mscap line may be translated easily into a conventional SDP
attribute line of the form:

    a=<att field>":"<fmt> <att value> ; <fmt> defined in SDP [RFC4566]

A resulting attribute that is not a legal SDP attribute, as specified
by RFC 4566, MUST be ignored by the receiver.

If a media capability number (or range) contains a wildcard character
at the end, any payload type mapping specified for that media-
specific capability (or range of capabilities) will use the wildcard
character in the resulting SDP instead of the payload type specified
in the payload type mapping ("pt" parameter) in the configuration
attribute.

A single mscap line may refer to multiple media capabilities by use
of a capability number range; this is equivalent to multiple mscap
lines, each with the same attribute values (but different media
capability numbers), one line per media capability.

Multiple mscap lines may refer to the same media capability, but,
unlike the "mfcap" attribute, no concatenation operation is defined.
Hence, multiple mscap lines applied to the same media capability are
equivalent to multiple lines of the specified attribute in a
conventional media record.

Here is an example with the "rtcp-fb" attribute, modified from an
example in RFC 5104 [RFC5104] (with the session level and audio media
omitted). If the offer contains a media block like the following
(note the wildcard character),

    m=video 51372 RTP/AVP 98
    a=rtpmap:98 H263-1998/90000
    a=tcap:1 RTP/AVPF
    a=rmcap:1 H263-1998/90000
    a=mscap:1 rtcp-fb ccm tstr
    a=mscap:1 rtcp-fb ccm fir
    a=mscap:1* rtcp-fb ccm tmmbr smaxpr=120
    a=pcfg:1 t=1 m=1 pt=1:98

and if the proposed configuration is chosen, then the equivalent
media block would look like the following

```
      m=video 51372 RTP/AVPF 98
      a=rtpmap:98 H263-1998/90000
      a=rtcp-fb:98 ccm tstr
      a=rtcp-fb:98 ccm fir
      a=rtcp-fb:* ccm tmmbr smaxpr=120
```

3.3.4. New Configuration Parameters

   Along with the new attributes for media capabilities, new extension
   parameters are defined for use in the potential configuration, the
   actual configuration, and/or the new latent configuration defined in
   Section 3.3.5.

3.3.4.1. The Media Configuration Parameter (m=)

   The media configuration parameter is used to specify the media
   format(s) and related parameters for a potential, actual, or latent
   configuration. Adhering to the ABNF for extension-config-list in RFC
   5939 [RFC5939] with

```
            ext-cap-name = "m"
            ext-cap-list = media-cap-num-list
                           [*(BAR media-cap-num-list)]
```

   we have

```
             media-config-list = ["+"] "m=" media-cap-num-list
                                         *(BAR media-cap-num-list)
                                     ;BAR is defined in RFC 5939
                                     ;media-cap-num-list is defined above
```

   Alternative media configurations are separated by a vertical bar
   ("|"). The alternatives are ordered by preference, most-preferred
   first. When media capabilities are not included in a potential
   configuration at the media level, the media type and media format
   from the associated "m=" line will be used. The use of the plus sign
   ("+") is described in RFC 5939.

3.3.4.2. The Payload Type Number Mapping Parameter (pt=)

   The payload type number mapping parameter is used to specify the
   payload type number to be associated with each RTP-based media format
   in a potential, actual, or latent configuration. We define the
   payload type number mapping parameter, payload-number-config-list, in
   accordance with the extension-config-list format defined in RFC 5939
   [RFC5939]. In ABNF:

```
payload-number-config-list = ["+"] "pt=" media-map-list
media-map-list      = media-map *("," media-map)
media-map           = media-cap-num ":" payload-type-number
                         ; media-cap-num is defined in Section 3.3.1
payload-type-number = NonZeroDigit *2(DIGIT) ; RTP payload
                                             ; type number
```

The example in Section 3.3.7 shows how the parameters from the rmcap
line are mapped to payload type numbers from the "pcfg" "pt"
parameter. The use of the plus sign ("+") is described in RFC 5939
[RFC5939].

A latent configuration represents a future capability; hence, the
"pt=" parameter is not directly meaningful in the "lcfg" attribute
because no actual media session is being offered or accepted. It is
permitted in order to tie any payload type number parameters within
attributes to the proper media format. A primary example is the case
of format parameters for the Redundant Audio Data (RED) [RFC2198]
payload, which are payload type numbers. Specific payload type
numbers used in a latent configuration MAY be interpreted as
suggestions to be used in any future offer based on the latent
configuration, but they are not binding; the offerer and/or answerer
may use any payload type numbers each deems appropriate. The use of
explicit payload type numbers for latent configurations can be
avoided by use of the parameter substitution rule of Section 3.3.7.
Future extensions are also permitted. Note that leading zeroes are
not permitted.

3.3.4.3. The Media Type Parameter

When a latent configuration is specified (always at the media level),
indicating the ability to support an additional media stream, it is
necessary to specify the media type (audio, video, etc.) as well as
the format and transport type. The media type parameter is defined
in ABNF as

          media-type = ["+"] "mt=" media; media defined in RFC 4566

At present, the media-type parameter is used only in the latent
configuration attribute, and the use of the "+" prefix to specify
that the entire attribute line is to be ignored if the mt= parameter
is not understood is unnecessary. However, if the media-type
parameter is later added to an existing capability attribute such as
"pcfg", then the "+" would be useful. The media format(s) and
transport type(s) are specified using the media configuration
parameter ("+m=") defined above, and the transport parameter ("t=")
defined in RFC 5939 [RFC5939], respectively.

3.3.5. The Latent Configuration Attribute

   One of the goals of this work is to permit the exchange of
   supportable media configurations in addition to those offered or
   accepted for immediate use. Such configurations are referred to as
   "latent configurations". For example, a party may offer to establish
   a session with an audio stream, and, at the same time, announce its
   ability to support a video stream as part of the same session. The
   offerer can supply its video capabilities by offering one or more
   latent video configurations along with the media stream for audio;
   the responding party may indicate its ability and willingness to
   support such a video session by returning a corresponding latent
   configuration.

   Latent configurations returned in SDP answers MUST match offered
   latent configurations (or parameter subsets thereof). Therefore, it
   is appropriate for the offering party to announce most, if not all,
   of its capabilities in the initial offer. This choice has been made
   in order to keep the size of the answer more compact by not requiring
   acap, rmcap, tcap, etc. lines in the answer.

   Latent configurations may be announced by use of the latent
   configuration attribute, which is defined in a manner very similar to
   the potential configuration attribute. The latent configuration
   attribute combines the properties of a media line and a potential
   configuration. A latent configuration MUST include a media type
   (mt=) and a transport protocol configuration parameter since the
   latent configuration is independent of any media line present. In
   most cases, the media configuration (m=) parameter needs to be
   present as well (see Section 4 for examples). The "lcfg" attribute
   is a media-level attribute.

      The "lcfg" attribute is defined as a media-level attribute since
      it specifies a possible future media stream. However, the "lcfg"
      attribute is not necessarily related to the media description
      within which it is provided. Session capability attributes
      ("a=sescap") may be used to indicate supported media stream
      configurations.

   Each media line in an SDP description represents an offered
   simultaneous media stream, whereas each latent configuration
   represents an additional stream that may be negotiated in a future
   offer/answer exchange. Session capability attributes may be used to
   determine whether a latent configuration may be used to form an offer
   for an additional simultaneous stream or to reconfigure an existing
   stream in a subsequent offer/answer exchange.

The latent configuration attribute is of the form:

        a=lcfg:<config-number> <latent-cfg-list>

which adheres to the SDP [RFC4566] "attribute" production with
att-field and att-value defined as:

    att-field = "lcfg"
    att-value = config-number 1*WSP lcfg-cfg-list
    config-number = NonZeroDigit *9(DIGIT) ;DIGIT defined in RFC 5234
    lcfg-cfg-list = media-type 1*WSP pot-cfg-list
                              ; as defined in RFC 5939
                              ; and extended herein

The media-type (mt=) parameter identifies the media type (audio,
video, etc.) to be associated with the latent media stream, and it
MUST be present. The pot-cfg-list MUST contain a transport-protocol-
config-list (t=) parameter and a media-config-list (m=) parameter.
The pot-cfg-list MUST NOT contain more than one instance of each type
of parameter list. As specified in RFC 5939 [RFC5939], the use of
the "+" prefix with a parameter indicates that the entire
configuration MUST be ignored if the parameter is not understood;
otherwise, the parameter itself may be ignored.

Media stream payload numbers are not assigned by a latent
configuration. Assignment will take place if and when the
corresponding stream is actually offered via an "m=" line in a later
exchange. The payload-number-config-list is included as a parameter
to the "lcfg" attribute in case it is necessary to tie payload
numbers in attribute capabilities to specific media capabilities.

If an "lcfg" attribute invokes an "acap" attribute that appears at
the session level, then that attribute will be expected to appear at
the session level of a subsequent offer when and if a corresponding
media stream is offered. Otherwise, "acap" attributes that appear at
the media level represent media-level attributes. Note, however,
that "rmcap", omcap, "mfcap", "mscap", and "tcap" attributes may
appear at the session level because they always result in media-level
attributes or "m=" line parameters.

The configuration numbers for latent configurations do not imply a
preference; the offerer will imply a preference when actually
offering potential configurations derived from latent configurations
negotiated earlier. Note, however, that the offerer of latent
configurations MAY specify preferences for combinations of potential
and latent configurations by use of the "sescap" attribute defined in
Section 3.3.8. For example, if an SDP offer contains, say, an audio

stream with "pcfg:1", and two latent video configurations, "lcfg:2"
and "lcfg:3", then a session with one audio stream and one video
stream could be specified by including "a=sescap:1 1,2|3". One audio
stream and two video streams could be specified by including
"a=sescap:2 1,2,3" in the offer. In order to permit combinations of
latent and potential configurations in session capabilities, latent
configuration numbers MUST be different from those used for potential
configurations. This restriction is especially important if the
offerer does not require cmed-v0 capability and the recipient of the
offer doesn't support it. If the "lcfg" attribute is not recognized,
the capability attributes intended to be associated with it may be
confused with those associated with a potential configuration of some
other media stream. Note also that leading zeroes are not permitted
in configuration numbers.

If a cryptographic attribute, such as the SDES "a=crypto:" attribute
[RFC4568], is referenced by a latent configuration through an "acap"
attribute, any keying material required in the conventional
attribute, such as the SDES key/salt string, MUST be included in
order to satisfy formatting rules for the attribute. Since the
keying material will be visible but not actually used at this stage
(since it's a latent configuration), the value(s) of the keying
material MUST NOT be a real value used for real exchange of media,
and the receiver of the "lcfg" attribute MUST ignore the value(s).

3.3.6. Enhanced Potential Configuration Attribute

The present work requires new extensions (parameters) for the "pcfg"
attribute defined in the SDP capability negotiation base protocol
[RFC5939]. The parameters and their definitions are "borrowed" from
the definitions provided for the latent configuration attribute in
Section 3.3.5. The expanded ABNF definition of the "pcfg" attribute
is

        a=pcfg: <config-number> [<pot-cfg-list>]

where

        config-number = 1*DIGIT ;defined in [RFC5234]
        pot-cfg-list = pot-config *(1*WSP pot-config)
        pot-config   = attribute-config-list / ;def in [RFC5939]
             transport-protocol-config-list / ;defined in [RFC5939]
             extension-config-list / ;[RFC5939]
             media-config-list / ; Section 3.3.4.1
             payload-number-config-list ; Section 3.3.4.2

Except for the extension-config-list, the pot-cfg-list MUST NOT
contain more than one instance of each parameter list.

3.3.6.1. Returning Capabilities in the Answer

   Potential and/or latent configuration attributes may be returned
   within an answer SDP to indicate the ability of the answerer to
   support alternative configurations of the corresponding stream(s).
   For example, an offer may include multiple potential configurations
   for a media stream and/or latent configurations for additional
   streams. The corresponding answer will indicate (via an "acfg"
   attribute) the configuration accepted and used to construct the base
   configuration for each active media stream in the reply, but the
   reply MAY also contain potential and/or latent configuration
   attributes, with parameters, to indicate which other offered
   configurations would be acceptable. This information is useful if it
   becomes desirable to reconfigure a media stream, e.g., to reduce
   resource consumption.

   When potential and/or latent configurations are returned in an
   answer, all numbering MUST refer to the configuration and capability
   attribute numbering of the offer. The offered capability attributes
   need not be returned in the answer. The answer MAY include
   additional capability attributes and/or configurations (with distinct
   numbering). The parameter values of any returned "pcfg" or "lcfg"
   attributes MUST be a subset of those included in the offered
   configurations and/or those added by the answerer; values MAY be
   omitted only if they were indicated as alternative sets, or optional,
   in the original offer. The parameter set indicated in the returned
   "acfg" attribute need not be repeated in a returned "pcfg" attribute.
   The answerer MAY return more than one "pcfg" attribute with the same
   configuration number if it is necessary to describe selected
   combinations of optional or alternative parameters.

   Similarly, one or more session capability attributes ("a=sescap") MAY
   be returned to indicate which of the offered session capabilities
   is/are supportable by the answerer (see Section 3.3.8).

   Note that, although the answerer MAY return capabilities beyond those
   included by the offerer, these capabilities MUST NOT be used to form
   any base level media description in the answer. For this reason, it
   is advisable for the offerer to include most, if not all, potential
   and latent configurations it can support in the initial offer, unless
   the size of the resulting SDP is a concern. Either party MAY later
   announce additional capabilities by renegotiating the session in a
   second offer/answer exchange.

3.3.6.2. Payload Type Number Mapping

   When media format capabilities defined in "rmcap" attributes are used
   in potential configuration lines, the transport protocol uses RTP and
   it is necessary to assign payload type numbers. In some cases, it is
   desirable to assign different payload type numbers to the same media
   format capability when used in different potential configurations.
   One example is when configurations for AVP and SAVP are offered: the
   offerer would like the answerer to use different payload type numbers
   for encrypted and unencrypted media, so the offerer can decide
   whether or not to render early media that arrives before the answer
   is received.

      For example, if use of AVP was selected by the answerer, then
      media received by the offerer is not encrypted; hence, it can be
      played out prior to receiving the answer. Conversely, if SAVP was
      selected, cryptographic parameters and keying material present in
      the answer may be needed to decrypt received media. If the offer
      configuration indicated that AVP media uses one set of payload
      types and SAVP a different set, then the offerer will know whether
      media received prior to the answer is encrypted or not by simply
      looking at the RTP payload type number in the received packet.

   This association of distinct payload type number(s) with different
   transport protocols requires a separate pcfg line for each protocol.
   Clearly, this technique cannot be used if the number of potential
   configurations exceeds the number of possible payload type numbers.

3.3.6.3. Processing of Media-Format-Related Conventional Attributes for
          Potential Configurations

   When media capabilities negotiation is employed, SDP records are
   likely to contain conventional attributes such as "rtpmap", "fmtp",
   and other media-format-related lines, as well as capability
   attributes such as "rmcap", omcap, "mfcap", and "mscap" that map into
   those conventional attributes when invoked by a potential
   configuration. In such cases, it MAY be appropriate to employ the
   delete-attributes option [RFC5939] in the attribute configuration
   list parameter in order to avoid the generation of conflicting "fmtp"
   attributes for a particular configuration. Any media-specific
   attributes in the media block that refer to media formats not used by
   the potential configuration MUST be ignored.

For example:

```
v=0
o=- 25678 753849 IN IP4 192.0.2.1
s=
c=IN IP4 192.0.2.1
t=0 0
a=creq:med-v0
m=audio 3456 RTP/AVP 0 18 100
a=rtpmap:100 telephone-event
a=fmtp:100 0-11
a=rmcap:1 PCMU/8000
a=rmcap:2 G729/8000
a=rmcap:3 telephone-event/8000
a=mfcap:3 0-15
a=pcfg:1 m=2,3|1,3 a=-m pt=1:0,2:18,3:100
a=pcfg:2
```

In this example, PCMU is media capability 1, G729 is media capability
2, and telephone-event is media capability 3. The a=pcfg:1 line
specifies that the preferred configuration is G.729 with extended
DTMF events, second is G.711 mu-law with extended DTMF events, and
the base media-level attributes are to be deleted. Intermixing of
G.729, G.711, and "commercial" DTMF events is least preferred (the
base configuration provided by the "m=" line, which is, by default,
the least preferred configuration). The "rtpmap" and "fmtp"
attributes of the base configuration are replaced by the "rmcap" and
"mfcap" attributes when invoked by the proposed configuration.

If the preferred configuration is selected, the SDP answer will look
like the following

```
v=0
o=- 25678 753849 IN IP4 192.0.2.1
s=
c=IN IP4 192.0.2.1
t=0 0
a=csup:med-v0
m=audio 3456 RTP/AVP 18 100
a=rtpmap:100 telephone-event/8000
a=fmtp:100 0-15
a=acfg:1 m=2,3 pt=1:0,2:18,3:100
```

3.3.7. Substitution of Media Payload Type Numbers in Capability
        Attribute Parameters

   In some cases, for example, when an RFC 2198 [RFC2198] redundancy
   audio subtype (RED) capability is defined in an "mfcap" attribute,
   the parameters to an attribute may contain payload type numbers. Two
   options are available for specifying such payload type numbers. They
   may be expressed explicitly, in which case they are bound to actual
   payload types by means of the payload type number parameter (pt=) in
   the appropriate potential or latent configuration. For example, the
   following SDP fragment defines a potential configuration with
   redundant G.711 mu-law

      m=audio 45678 RTP/AVP 0
      a=rtpmap:0 PCMU/8000
      a=rmcap:1 PCMU/8000
      a=rmcap:2 RED/8000
      a=mfcap:2 0/0
      a=pcfg:1 m=2,1 pt=2:98,1:0

   The potential configuration is then equivalent to

      m=audio 45678 RTP/AVP 98 0
      a=rtpmap:0 PCMU/8000
      a=rtpmap:98 RED/8000
      a=fmtp:98 0/0

   A more general mechanism is provided via the parameter substitution
   rule. When an "mfcap", "mscap", or "acap" attribute is processed,
   its arguments will be scanned for a payload type number escape
   sequence of the following form (in ABNF):

      ptn-esc = "%m=" media-cap-num "%" ; defined in Section 3.3.1

   If the sequence is found, the sequence is replaced by the payload
   type number assigned to the media capability number, as specified by
   the "pt=" parameter in the selected potential configuration; only
   actual payload type numbers are supported -- wildcards are excluded.
   The sequence "%%" (null digit string) is replaced by a single percent
   sign and processing continues with the next character, if any.

   For example, the above offer sequence could have been written as

      m=audio 45678 RTP/AVP 0
      a=rtpmap:0 PCMU/8000
      a=rmcap:1 PCMU/8000
      a=rmcap:2 RED/8000
      a=mfcap:2 %m=1%/%m=1%
      a=pcfg:1 m=2,1 pt=2:98,1:0

   and the equivalent SDP is the same as above.

3.3.8. The Session Capability Attribute

   Potential and latent configurations enable offerers and answerers to
   express a wide range of alternative configurations for current and
   future negotiation. However, in practice, it may not be possible to
   support all combinations of these configurations.

   The session capability attribute provides a means for the offerer
   and/or the answerer to specify combinations of specific media stream
   configurations that it is willing and able to support. Each session
   capability in an offer or answer MAY be expressed as a list of
   required potential configurations, and MAY include a list of optional
   potential and/or latent configurations.

   The choices of session capabilities may be based on processing load,
   total bandwidth, or any other criteria of importance to the
   communicating parties. If the answerer supports media capabilities
   negotiation, and session configurations are offered, it MUST accept
   one of the offered configurations, or it MUST refuse the session.
   Therefore, if the offer includes any session capabilities, it SHOULD
   include all the session capabilities the offerer is willing to
   support.

   The session capability attribute is a session-level attribute
   described by

      "a=sescap:" <session num> <list of configs>

which corresponds to the standard value attribute definition with

```
     att-field       = "sescap"
     att-value       = session-num 1*WSP list-of-configs
                         [1*WSP optional-configs]
     session-num     = NonZeroDigit *9(DIGIT)  ; DIGIT defined
                                               ; in RFC 5234
     list-of-configs = alt-config *("," alt-config)
     optional-configs = "[" list-of-configs "]"
     alt-config      = config-number *("|" config-number)
```

The session-num identifies the session: a lower-number session is
preferred over a higher-number session, and leading zeroes are not
permitted. Each alt-config list specifies alternative media
configurations within the session; preference is based on config-num
as specified in RFC 5939 [RFC5939]. Note that the session preference
order, when present, takes precedence over the individual media
stream configuration preference order.

Use of session capability attributes requires that configuration
numbers assigned to potential and latent configurations MUST be
unique across the entire session; RFC 5939 [RFC5939] requires only
that "pcfg" configuration numbers be unique within a media
description. Also, leading zeroes are not permitted.

As an example, consider an endpoint that is capable of supporting an
audio stream with either one H.264 video stream or two H.263 video
streams with a floor control stream. In the latter case, the second
video stream is optional. The SDP offer might look like the
following (offering audio, an H.263 video streams, BFCP and another
optional H.263 video stream) -- the empty lines are added for
readability only (not part of valid SDP):

```
   v=0
   o=- 25678 753849 IN IP4 192.0.2.1
   s=
   c=IN IP4 192.0.2.1
   t=0 0
   a=creq:med-v0
   a=sescap:2 1,2,5,[3]
   a=sescap:1 1,4

   m=audio 54322 RTP/AVP 0
   a=rtpmap:0 PCMU/8000
   a=pcfg:1
```

```
m=video 22344 RTP/AVP 102
a=rtpmap:102 H263-1998/90000
a=fmtp:102 CIF=4;QCIF=2;F=1;K=1
i=main video stream
a=label:11
a=pcfg:2
a=rmcap:1 H264/90000
a=mfcap:1 profile-level-id=42A01E; packetization-mode=2
a=acap:1 label:13
a=pcfg:4 m=1 a=1 pt=1:104

m=video 33444 RTP/AVP 103
a=rtpmap:103 H263-1998/90000
a=fmtp:103 CIF=4;QCIF=2;F=1;K=1
i=secondary video (slides)
a=label:12
a=pcfg:3

m=application 33002 TCP/BFCP *
a=setup:passive
a=connection:new
a=floorid:1 m-stream:11 12
a=floor-control:s-only
a=confid:4321
a=userid:1234
a=pcfg:5
```

   If the answerer understands MediaCapNeg, but cannot support the
   Binary Floor Control Protocol, then it would respond with (invalid
   empty lines in SDP included again for readability):

```
v=0
o=- 25678 753849 IN IP4 192.0.2.1
s=
c=IN IP4 192.0.2.22
t=0 0
a=csup:med-v0
a=sescap:1 1,4

m=audio 23456 RTP/AVP 0
a=rtpmap:0 PCMU/8000
a=acfg:1

m=video 41234 RTP/AVP 104
a=rtpmap:104 H264/90000
a=fmtp:104 profile-level-id=42A01E; packetization-mode=2
a=acfg:4 m=1 a=1 pt=1:104
```

```
   m=video 0 RTP/AVP 103
   a=acfg:3

   m=application 0 TCP/BFCP *
   a=acfg:5
```

An endpoint that doesn't support media capabilities negotiation, but
does support H.263 video, would respond with one or two H.263 video
streams. In the latter case, the answerer may issue a second offer
to reconfigure the session to one audio and one video channel using
H.264 or H.263.

Session capabilities can include latent capabilities as well. Here's
a similar example in which the offerer wishes to initially establish
an audio stream, and prefers to later establish two video streams
with chair control. If the answerer doesn't understand Media CapNeg,
or cannot support the dual video streams or flow control, then it may
support a single H.264 video stream. Note that establishment of the
most favored configuration will require two offer/answer exchanges.

```
   v=0
   o=- 25678 753849 IN IP4 192.0.2.1
   s=
   c=IN IP4 192.0.2.1
   t=0 0
   a=creq:med-v0
   a=sescap:1 1,3,4,5
   a=sescap:2 1,2
   a=sescap:3 1

   a=rmcap:1 H263-1998/90000
   a=mfcap:1 CIF=4;QCIF=2;F=1;K=1
   a=tcap:1 RTP/AVP TCP/BFCP
   m=audio 54322 RTP/AVP 0
   a=rtpmap:0 PCMU/8000
   a=pcfg:1
   m=video 22344 RTP/AVP 102
   a=rtpmap:102 H264/90000
   a=fmtp:102 profile-level-id=42A01E; packetization-mode=2
   a=label:11
   a=content:main
   a=pcfg:2
   a=lcfg:3 mt=video t=1 m=1 a=31,32
   a=acap:31 label:12
   a=acap:32 content:main
   a=lcfg:4 mt=video t=1 m=1 a=41,42
   a=acap:41 label:13
   a=acap:42 content:slides
```

```
      a=lcfg:5 mt=application m=51 t=51
      a=tcap:51 TCP/BFCP
      a=omcap:51 *
      a=acap:51 setup:passive
      a=acap:52 connection:new
      a=acap:53 floorid:1 m-stream:12 13
      a=acap:54 floor-control:s-only
      a=acap:55 confid:4321
      a=acap:56 userid:1234
```

   In this example, the default offer, as seen by endpoints that do not
   understand capabilities negotiation, proposes a PCMU audio stream and
   an H.264 video stream. Note that the offered lcfg lines for the
   video streams don't carry "pt=" parameters because they're not needed
   (payload type numbers will be assigned in the offer/answer exchange
   that establishes the streams). Note also that the three "rmcap",
   "mfcap", and "tcap" attributes used by "lcfg:3" and "lcfg:4" are
   included at the session level so they may be referenced by both
   latent configurations. As per Section 3.3, the media attributes
   generated from the "rmcap", "mfcap", and "tcap" attributes are always
   media-level attributes. If the answerer supports Media CapNeg, and
   supports the most desired configuration, it would return the
   following SDP:

```
      v=0
      o=- 25678 753849 IN IP4 192.0.2.1
      s=
      c=IN IP4 192.0.2.22
      t=0 0
      a=csup:med-v0
      a=sescap:1 1,3,4,5
      a=sescap:2 1,2
      a=sescap:3 1
      m=audio 23456 RTP/AVP 0
      a=rtpmap:0 PCMU/8000
      a=acfg:1
      m=video 0 RTP/AVP 102
      a=pcfg:2
      a=lcfg:3 mt=video t=1 m=1 a=31,32
      a=lcfg:4 mt=video t=1 m=1 a=41,42
      a=lcfg:5 mt=application t=2
```

   This exchange supports immediate establishment of an audio stream for
   preliminary conversation. This exchange would presumably be followed
   at the appropriate time with a "reconfiguration" offer/answer
   exchange to add the video and chair control streams.

3.4. Offer/Answer Model Extensions

   In this section, we define extensions to the offer/answer model
   defined in RFC 3264 [RFC3264] and RFC 5939 [RFC5939] to allow for
   media format and associated parameter capabilities, latent
   configurations, and acceptable combinations of media stream
   configurations to be used with the SDP capability negotiation
   framework. Note that the procedures defined in this section extend
   the offer/answer procedures defined in RFC 5939 [RFC5939] Section 6;
   those procedures form a baseline set of capability negotiation
   offer/answer procedures that MUST be followed, subject to the
   extensions defined here.

   SDP capability negotiation [RFC5939] provides a relatively compact
   means to offer the equivalent of an ordered list of alternative
   configurations for offered media streams (as would be described by
   separate "m=" lines and associated attributes). The attributes
   "acap", "mscap", "mfcap", "omcap", and "rmcap" are designed to map
   somewhat straightforwardly into equivalent "m=" lines and
   conventional attributes when invoked by a "pcfg", "lcfg", or "acfg"
   attribute with appropriate parameters. The "a=pcfg:" lines, along
   with the "m=" line itself, represent offered media configurations.
   The "a=lcfg:" lines represent alternative capabilities for future
   use.

3.4.1. Generating the Initial Offer

   The media capabilities negotiation extensions defined in this
   document cover the following categories of features:

   o Media format capabilities and associated parameters ("rmcap",
      "omcap", "mfcap", and "mscap" attributes)

   o Potential configurations using those media format capabilities and
      associated parameters

   o Latent media streams ("lcfg" attribute)

   o Acceptable combinations of media stream configurations ("sescap"
      attribute).

   The high-level description of the operation is as follows:

   When an endpoint generates an initial offer and wants to use the
   functionality described in the current document, it SHOULD identify
   and define the media formats and associated parameters it can support
   via the "rmcap", "omcap", "mfcap", and "mscap" attributes. The SDP
   media line(s) ("m=") should be made up with the actual configuration

to be used if the other party does not understand capability
negotiations (by default, this is the least preferred configuration).
Typically, the media line configuration will contain the minimum
acceptable configuration from the offerer's point of view.

Preferred configurations for each media stream are identified
following the media line. The present offer may also include latent
configuration ("lcfg") attributes, at the media level, describing
media streams and/or configurations the offerer is not now offering
but that it is willing to support in a future offer/answer exchange.
A simple example might be the inclusion of a latent video
configuration in an offer for an audio stream.

Lastly, if the offerer wishes to impose restrictions on the
combinations of potential configurations to be used, it will include
session capability ("sescap") attributes indicating those.

If the offerer requires the answerer to understand the media
capability extensions, the offerer MUST include a "creq" attribute
containing the value "med-v0". If media capability negotiation is
required only for specific media descriptions, the "med-v0" value
MUST be provided only in "creq" attributes within those media
descriptions, as described in RFC 5939 [RFC5939].

Below, we provide a more detailed description of how to construct the
offer SDP.

3.4.1.1. Offer with Media Capabilities

For each RTP-based media format the offerer wants to include as a
media format capability, the offer MUST include an "rmcap" attribute
for the media format as defined in Section 3.3.1.

For each non-RTP-based media format the offer wants to include as a
media format capability, the offer MUST include an "omcap" attribute
for the media format as defined in Section 3.3.1.

Since the media capability number space is shared between the "rmcap"
and "omcap" attributes, each media capability number provided
(including ranges) MUST be unique in the entire SDP.

If an "fmtp" parameter value is needed for a media format (whether or
not it is RTP based) in a media capability, then the offer MUST
include one or more "mfcap" parameters with the relevant "fmtp"
parameter values for that media format as defined in Section 3.3.2.
When multiple "mfcap" parameters are provided for a given media
capability, they MUST be provided in accordance with the
concatenation rules in Section 3.3.2.1.

For each of the media format capabilities above, the offer MAY
include one or more "mscap" parameters with attributes needed for
those specific media formats as defined in Section 3.3.3. Such
attributes will be instantiated at the media level; hence, session-
level-only attributes MUST NOT be used in the "mscap" parameter. The
"mscap" parameter MUST NOT include an "rtpmap" or "fmtp" attribute
("rmcap" and "mfcap" are used instead).

If the offerer wants to limit the relevance (and use) of a media
format capability or parameter to a particular media stream, the
media format capability or parameter MUST be provided within the
corresponding media description. Otherwise, the media format
capabilities and parameters MUST be provided at the session level.
Note, however, that the attribute or parameter embedded in these will
always be instantiated at the media level.

   This is due to those parameters being effectively media-level
   parameters. If session-level attributes are needed, the "acap"
   attribute defined in RFC 5939 [RFC5939] can be used; however, it
   does not provide for media-format-specific instantiation.

Inclusion of the above does not constitute an offer to use the
capabilities; a potential configuration is needed for that. If the
offerer wants to offer one or more of the media capabilities above,
they MUST be included as part of a potential configuration ("pcfg")
attribute as defined in Section 3.3.4. Each potential configuration
MUST include a config-number, and each config-number MUST be unique
in the entire SDP (note that this differs from RFC 5939 [RFC5939],
which only requires uniqueness within a media description). Also,
the config-number MUST NOT overlap with any config-number used by a
latent configuration in the SDP. As described in RFC 5939 [RFC5939],
lower config-numbers indicate a higher preference; the ordering still
applies within a given media description only though.

For a media capability to be included in a potential configuration,
there MUST be an "m=" parameter in the "pcfg" attribute referencing
the media capability number in question. When one or more media
capabilities are included in an offered potential configuration
("pcfg"), they completely replace the list of media formats offered
in the actual configuration ("m=" line). Any attributes included for
those formats remain in the SDP though (e.g., "rtpmap", "fmtp",
etc.). For non-RTP-based media formats, the format-name (from the
"omcap" media capability) is simply added to the "m=" line as a media
format (e.g., t38). For RTP-based media, payload type mappings MUST
be provided by use of the "pt" parameter in the potential
configuration (see Section 3.3.4.2); payload type escaping may be
used in "mfcap", "mscap", and "acap" attributes as defined in Section
3.3.7.

Note that the "mt" parameter MUST NOT be used with the "pcfg"
attribute (since it is defined for the "lcfg" attribute only); the
media type in a potential configuration cannot be changed from that
of the encompassing media description.

3.4.1.2. Offer with Latent Configuration

If the offerer wishes to offer one or more latent configurations for
future use, the offer MUST include a latent configuration attribute
("lcfg") for each as defined in Section 3.3.6.

Each "lcfg" attribute

o MUST be specified at the media level

o MUST include a config-number that is unique in the entire SDP
   (including for any potential configuration attributes). Note that
   config-numbers in latent configurations do not indicate any
   preference order

o MUST include a media type ("mt")

o MUST reference a valid transport capability ("t")

Each "lcfg" attribute MAY include additional capability references,
which may refer to capabilities anywhere in the session description,
subject to any restrictions normally associated with such
capabilities. For example, a media-level attribute capability must
be present at the media level in some media description in the SDP.
Note that this differs from the potential configuration attribute,
which cannot validly refer to media-level capabilities in another
media description (per RFC 5939 [RFC5939], Section 3.5.1).

   Potential configurations constitute an actual offer and may
   instantiate a referenced capability. Latent configurations are
   not actual offers; hence, they cannot instantiate a referenced
   capability. Therefore, it is safe for those to refer to
   capabilities in another media description.

3.4.1.3. Offer with Configuration Combination Restrictions

If the offerer wants to indicate restrictions or preferences among
combinations of potential and/or latent configurations, a session
capability ("sescap") attribute MUST be provided at the session level
for each such combination as described in Section 3.3.8. Each
"sescap" attribute MUST include a session-num that is unique in the

   entire SDP; the lower the session-num the more preferred that
   combination is. Furthermore, "sescap" preference order takes
   precedence over any order specified in individual "pcfg" attributes.

      For example, if we have pcfg-1 and pcfg-2, and sescap-1 references
      pcfg-2, whereas sescap-2 references pcfg-1, then pcfg-2 will be
      the most preferred potential configuration. Without the sescap,
      pcfg-1 would be the most preferred.

3.4.2. Generating the Answer

   When receiving an offer, the answerer MUST check the offer for "creq"
   attributes containing the value "med-v0"; answerers compliant with
   this specification will support this value in accordance with the
   procedures specified in RFC 5939 [RFC5939].

   The SDP MAY contain

   o Media format capabilities and associated parameters ("rmcap",
      "omcap", "mfcap", and "mscap" attributes)

   o Potential configurations using those media format capabilities and
      associated parameters

   o Latent media streams ("lcfg" attribute)

   o Acceptable combinations of media stream configurations ("sescap"
      attribute)

   The high-level informative description of the operation is as
   follows:

   When the answering party receives the offer, if it supports the
   required capability negotiation extensions, it should select the
   most-preferred configuration it can support for each media stream,
   and build its answer accordingly. The configuration selected for
   each accepted media stream is placed into the answer as a media line
   with associated parameters and attributes. If a proposed
   configuration is chosen for a given media stream, the answer must
   contain an actual configuration ("acfg") attribute for that media
   stream to indicate which offered "pcfg" attribute was used to build
   the answer. The answer should also include any potential or latent
   configurations the answerer can support, especially any
   configurations compatible with other potential or latent
   configurations received in the offer. The answerer should make note
   of those configurations it might wish to offer in the future.

Below we provide a more detailed normative description of how the
answerer processes the offer SDP and generates an answer SDP.

3.4.2.1. Processing Media Capabilities and Potential Configurations

The answerer MUST first determine if it needs to perform media
capability negotiation by examining the SDP for valid and preferred
potential configuration attributes that include media configuration
parameters (i.e., an "m" parameter in the "pcfg" attribute).

Such a potential configuration is valid if

1. It is valid according to the rules defined in RFC 5939 [RFC5939].

2. It contains a config-number that is unique in the entire SDP and
    does not overlap with any latent configuration config-numbers.

3. All media format capabilities ("rmcap" or "omcap"), media format
    parameter capabilities ("mfcap"), and media-specific capabilities
    ("mscap") referenced by the potential configuration ("m"
    parameter) are valid themselves (as defined in Sections 3.3.1,
    3.3.2, and 3.3.3) and each of them is provided either at the
    session level or within this particular media description.

4. All RTP-based media format capabilities ("rmcap") have a
    corresponding payload type ("pt") parameter in the potential
    configuration that results in mapping to a valid payload type
    that is unique within the resulting SDP.

5. Any concatenation (see Section 3.3.2.1) and substitution (see
    Section 3.3.7) applied to any capability ("mfcap", "mscap", or
    "acap") referenced by this potential configuration results in a
    valid SDP.

Note that since SDP does not interpret the value of "fmtp"
parameters, any resulting "fmtp" parameter value will be considered
valid.

Secondly, the answerer MUST determine the order in which potential
configurations are to be negotiated. In the absence of any session
capability ("sescap") attributes, this simply follows the rules of
RFC 5939 [RFC5939], with a lower config-number within a media
description being preferred over a higher one. If a valid "sescap"
attribute is present, the preference order provided in the "sescap"
attribute MUST take precedence. A "sescap" attribute is considered
valid if

   1. It adheres to the rules provided in Section 3.3.8.

   2. All the configurations referenced by the "sescap" attribute are
       valid themselves (note that this can include the actual,
       potential, and latent configurations).

   The answerer MUST now process the offer for each media stream based
   on the most preferred valid potential configuration in accordance
   with the procedures specified in RFC 5939 [RFC5939], Section 3.6.2,
   and further extended below:

   o If one or more media format capabilities are included in the
      potential configuration, then they replace all media formats
      provided in the "m=" line for that media description. For non-
      RTP-based media formats ("omcap"), the format-name is added. For
      RTP-based media formats ("rmcap"), the payload-type specified in
      the payload-type mapping ("pt") is added and a corresponding
      "rtpmap" attribute is added to the media description.

   o If one or more media format parameter capabilities are included in
      the potential configuration, then the corresponding "fmtp"
      attributes are added to the media description. Note that this
      inclusion is done indirectly via the media format capability.

   o If one or more media-specific capabilities are included in the
      potential configuration, then the corresponding attributes are
      added to the media description. Note that this inclusion is done
      indirectly via the media format capability.

   o When checking to see if the answerer supports a given potential
      configuration that includes one or more media format capabilities,
      the answerer MUST support at least one of the media formats
      offered. If he does not, the answerer MUST proceed to the next
      potential configuration based on the preference order that
      applies.

   o If session capability ("sescap") preference ordering is included,
      then the potential configuration selection process MUST adhere to
      the ordering provided. Note that this may involve coordinated
      selection of potential configurations between media descriptions.
      The answerer MUST accept one of the offered sescap combinations
      (i.e., all the required potential configurations specified) or it
      MUST reject the entire session.

   Once the answerer has selected a valid and supported offered
   potential configuration for all of the media streams (or has fallen
   back to the actual configuration plus any added session attributes),
   the answerer MUST generate a valid answer SDP as described in RFC
   5939 [RFC5939], Section 3.6.2, and further extended below:

   o Additional answer capabilities and potential configurations MAY be
      returned in accordance with Section 3.3.6.1. Capability numbers
      and configuration numbers for those MUST be distinct from the ones
      used in the offer SDP.

   o Latent configuration processing and answer generation MUST be
      performed, as specified below.

   o Session capability specification for the potential and latent
      configurations in the answer MAY be included (see Section 3.3.8).

3.4.2.2. Latent Configuration Processing

   The answerer MUST determine if it needs to perform any latent
   configuration processing by examining the SDP for valid latent
   configuration attributes ("lcfg"). An "lcfg" attribute is considered
   valid if:

   o It adheres to the description in Section 3.3.5.

   o It includes a config-number that is unique in the entire SDP and
      does not overlap with any potential configuration config-number.

   o It includes a valid media type ("mt=").

   o It references a valid transport capability ("t=").

   o All other capabilities referenced by it are valid.

   For each such valid latent configuration in the offer, the answerer
   checks to see if it could support the latent configuration in a
   subsequent offer/answer exchange. If so, it includes the latent
   configuration with the same configuration number in the answer,
   similar to the way potential configurations are processed and the
   selected one returned in an actual configuration attribute (see RFC
   5939 [RFC5939]). If the answerer supports only a (non-mandatory)
   subset of the parameters offered in a latent configuration, the
   answer latent configuration will include only those parameters
   supported (similar to "acfg" processing). Note that latent
   configurations do not constitute an actual offer at this point in
   time; they merely indicate additional configurations that could be
   supported.

If a session capability ("sescap") attribute is included and it
references a latent configuration, then the answerer processing of
that latent configuration must be done within the constraints
specified by that session capability. That is, it must be possible
to support it at the same time as any required (i.e., non-optional)
potential configurations in the session capability. The answerer may
in turn add his own sescap indications in the answer as well.

3.4.3. Offerer Processing of the Answer

The offerer MUST process the answer in accordance with Section 3.6.3
of RFC 5939 [RFC5939] and the further explanation below.

When the offerer processes the answer SDP based on a valid actual
configuration attribute in the answer, and that valid configuration
includes one or more media capabilities, the processing MUST
furthermore be done as if the offer was sent using those media
capabilities instead of the actual configuration. In particular, the
media formats in the "m=" line, and any associated payload type
mappings ("rtpmap"), "fmtp" parameters ("mfcap"), and media-specific
attributes ("mscap") MUST be used. Note that this may involve use of
concatenation and substitution rules (see Sections 3.3.2.1 and
3.3.7). The actual configuration attribute may also be used to infer
the lack of acceptability of higher-preference configurations that
were not chosen, subject to any constraints provided by a session
capability ("sescap") attribute in the offer. Note that the SDP
capability negotiation base specification [RFC5939] requires the
answerer to choose the highest-preference configuration it can
support, subject to local policies.

When the offerer receives the answer, it SHOULD furthermore make note
of any capabilities and/or latent configurations included for future
use, and any constraints on how those may be combined.

3.4.4. 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
can do so via the mechanisms defined for offer/answer [RFC3264]. If
the initiating party has remembered the codecs, potential
configurations, latent configurations, and session capabilities
provided by the other party in the earlier negotiation, it MAY use
this knowledge to maximize the likelihood of a successful
modification of the session. Alternatively, the initiator MAY
perform a new capabilities exchange as part of the reconfiguration.

   In such a case, the new capabilities will replace the previously
   negotiated capabilities. This may be useful if conditions change on
   the endpoint.

4. Examples

   In this section, we provide examples showing how to use the media
   capabilities with the SDP capability negotiation.

4.1. Alternative Codecs

   This example provides a choice of one of six variations of the
   Adaptive Multi-Rate codec. In this example, the default
   configuration as specified by the media line is the same as the most
   preferred configuration. Each configuration uses a different payload
   type number so the offerer can interpret early media.

```
   v=0
   o=- 25678 753849 IN IP4 192.0.2.1
   s=
   c=IN IP4 192.0.2.1
   t=0 0
   a=creq:med-v0
   m=audio 54322 RTP/AVP 96
   a=rtpmap:96 AMR-WB/16000/1
   a=fmtp:96 mode-change-capability=1; max-red=220; \
   mode-set=0,2,4,7
   a=rmcap:1,3,5 audio AMR-WB/16000/1
   a=rmcap:2,4,6 audio AMR/8000/1
   a=mfcap:1,2,3,4 mode-change-capability=1
   a=mfcap:5,6 mode-change-capability=2
   a=mfcap:1,2,3,5 max-red=220
   a=mfcap:3,4,5,6 octet-align=1
   a=mfcap:1,3,5 mode-set=0,2,4,7
   a=mfcap:2,4,6 mode-set=0,3,5,6
   a=pcfg:1 m=1 pt=1:96
   a=pcfg:2 m=2 pt=2:97
   a=pcfg:3 m=3 pt=3:98
   a=pcfg:4 m=4 pt=4:99
   a=pcfg:5 m=5 pt=5:100
   a=pcfg:6 m=6 pt=6:101
```

   In the above example, media capability 1 could have been excluded
   from the first "rmcap" declaration and from the corresponding "mfcap"
   attributes, and the "pcfg:1" attribute line could have been simply
   "pcfg:1".

The next example offers a video stream with three options of H.264
and four transports. It also includes an audio stream with different
audio qualities: four variations of AMR, or AC3. The offer looks
something like the following:

```
v=0
o=- 25678 753849 IN IP4 192.0.2.1
s=An SDP Media NEG example
c=IN IP4 192.0.2.1
t=0 0
a=creq:med-v0
a=ice-pwd:speEc3QGZiNWpVLFJhQX
m=video 49170 RTP/AVP 100
c=IN IP4 192.0.2.56
a=maxprate:1000
a=rtcp:51540
a=sendonly
a=candidate 12345 1 UDP 9 192.0.2.56 49170 host
a=candidate 23456 2 UDP 9 192.0.2.56 51540 host
a=candidate 34567 1 UDP 7 198.51.100.1 41345 srflx raddr \
192.0.2.56 rport 49170
a=candidate 45678 2 UDP 7 198.51.100.1 52567 srflx raddr \
192.0.2.56 rport 51540
a=candidate 56789 1 UDP 3 192.0.2.100 49000 relay raddr \
192.0.2.56 rport 49170
a=candidate 67890 2 UDP 3 192.0.2.100 49001 relay raddr \
192.0.2.56 rport 51540
b=AS:10000
b=TIAS:10000000
b=RR:4000
b=RS:3000
a=rtpmap:100 H264/90000
a=fmtp:100 profile-level-id=42A01E; packetization-mode=2; \
sprop-parameter-sets=Z0IACpZTBYmI,aMljiA==; \
sprop-interleaving-depth=45; sprop-deint-buf-req=64000; \
sprop-init-buf-time=102478; deint-buf-cap=128000
a=tcap:1 RTP/SAVPF RTP/SAVP RTP/AVPF
a=rmcap:1-3,7-9 H264/90000
a=rmcap:4-6 rtx/90000
a=mfcap:1-9 profile-level-id=42A01E
a=mfcap:1-9 aMljiA==
a=mfcap:1,4,7 packetization-mode=0
a=mfcap:2,5,8 packetization-mode=1
a=mfcap:3,6,9 packetization-mode=2
a=mfcap:1-9 sprop-parameter-sets=Z0IACpZTBYmI
a=mfcap:1,7 sprop-interleaving-depth=45; \
sprop-deint-buf-req=64000; sprop-init-buf-time=102478; \
deint-buf-cap=128000
```

```
        a=mfcap:4 apt=100
        a=mfcap:5 apt=99
        a=mfcap:6 apt=98
        a=mfcap:4-6 rtx-time=3000
        a=mscap:1-6 rtcp-fb nack
        a=acap:1 crypto:1 AES_CM_128_HMAC_SHA1_80 \
        inline:d0RmdmcmVCspeEc3QGZiNWpVLFJhQX1cfHAwJSoj|220|1:32
        a=pcfg:1 t=1 m=1,4 a=1 pt=1:100,4:97
        a=pcfg:2 t=1 m=2,5 a=1 pt=2:99,4:96
        a=pcfg:3 t=1 m=3,6 a=1 pt=3:98,6:95
        a=pcfg:4 t=2 m=7 a=1 pt=7:100
        a=pcfg:5 t=2 m=8 a=1 pt=8:99
        a=pcfg:6 t=2 m=9 a=1 pt=9:98
        a=pcfg:7 t=3 m=1,3 pt=1:100,4:97
        a=pcfg:8 t=3 m=2,4 pt=2:99,4:96
        a=pcfg:9 t=3 m=3,6 pt=3:98,6:95
        m=audio 49176 RTP/AVP 101 100 99 98
        c=IN IP4 192.0.2.56
        a=ptime:60
        a=maxptime:200
        a=rtcp:51534
        a=sendonly
        a=candidate 12345 1 UDP 9 192.0.2.56 49176 host
        a=candidate 23456 2 UDP 9 192.0.2.56 51534 host
        a=candidate 34567 1 UDP 7 198.51.100.1 41348 srflx \
        raddr 192.0.2.56 rport 49176
        a=candidate 45678 2 UDP 7 198.51.100.1 52569 srflx \
        raddr 192.0.2.56 rport 51534
        a=candidate 56789 1 UDP 3 192.0.2.100 49002 relay \
        raddr 192.0.2.56 rport 49176
        a=candidate 67890 2 UDP 3 192.0.2.100 49003 relay \
        raddr 192.0.2.56 rport 51534
        b=AS:512
        b=TIAS:512000
        b=RR:4000
        b=RS:3000
        a=maxprate:120
        a=rtpmap:98 AMR-WB/16000
        a=fmtp:98 octet-align=1; mode-change-capability=2
        a=rtpmap:99 AMR-WB/16000
        a=fmtp:99 octet-align=1; crc=1; mode-change-capability=2
        a=rtpmap:100 AMR-WB/16000/2
        a=fmtp:100 octet-align=1; interleaving=30
        a=rtpmap:101 AMR-WB+/72000/2
        a=fmtp:101 interleaving=50; int-delay=160000;
        a=rmcap:14 ac3/48000/6
        a=acap:23 crypto:1 AES_CM_128_HMAC_SHA1_80 \
        inline:d0RmdmcmVCspeEc3QGZiNWpVLFJhQX1cfHAwJSoj|220|1:32
```

```
   a=tcap:4 RTP/SAVP
   a=pcfg:10 t=4 a=23
   a=pcfg:11 t=4 m=14 a=23 pt=14:102
```

   This offer illustrates the advantage in compactness that arises if
   one can avoid deleting the base configuration attributes and
   recreating them in "acap" attributes for the potential
   configurations.

4.2. Alternative Combinations of Codecs (Session Configurations)

   If an endpoint has limited signal processing capacity, it might be
   capable of supporting, say, a G.711 mu-law audio stream in
   combination with an H.264 video stream, or a G.729B audio stream in
   combination with an H.263-1998 video stream. It might then issue an
   offer like the following:

```
   v=0
   o=- 25678 753849 IN IP4 192.0.2.1
   s=
   c=IN IP4 192.0.2.1
   t=0 0
   a=creq:med-v0
   a=sescap:1 2,4
   a=sescap:2 1,3
   m=audio 54322 RTP/AVP 18
   a=rtpmap:18 G729/8000
   a=fmtp:18 annexb=yes
   a=rmcap:1 PCMU/8000
   a=pcfg:1 m=1 pt=1:0
   a=pcfg:2
   m=video 54344 RTP/AVP 100
   a=rtpmap:100 H263-1998/90000
   a=rmcap:2 H264/90000
   a=mfcap:2 profile-level-id=42A01E; packetization-mode=2
   a=pcfg:3 m=2 pt=2:101
   a=pcfg:4
```

   Note that the preferred session configuration (and the default as
   well) is G.729B with H.263. This overrides the individual media
   stream preferences that are PCMU and H.264 by the potential
   configuration numbering rule.

4.3. Latent Media Streams

   Consider a case in which the offerer can support either G.711 mu-law
   or G.729B, along with DTMF telephony events for the 12 common
   touchtone signals, but is willing to support simple G.711 mu-law

audio as a last resort. In addition, the offerer wishes to announce
its ability to support video and Message Session Relay Protocol
(MSRP) in the future, but does not wish to offer a video stream or an
MSRP stream at present. The offer might look like the following:

```
v=0
o=- 25678 753849 IN IP4 192.0.2.1
s=
c=IN IP4 192.0.2.1
t=0 0
a=creq:med-v0
m=audio 23456 RTP/AVP 0
a=rtpmap:0 PCMU/8000
a=rmcap:1 PCMU/8000
a=rmcap:2 G729/8000
a=rmcap:3 telephone-event/8000
a=mfcap:3 0-11
a=pcfg:1 m=1,3|2,3 pt=1:0,2:18,3:100
a=lcfg:2 mt=video t=1 m=10|11
a=rmcap:10 H263-1998/90000
a=rmcap:11 H264/90000
a=tcap:1 RTP/AVP
a=lcfg:3 mt=message t=2 m=20
a=tcap:2 TCP/MSRP
a=omcap:20 *
```

The first "lcfg" attribute line ("lcfg:2") announces support for
H.263 and H.264 video (H.263 preferred) for future negotiation. The
second "lcfg" attribute line ("lcfg:3") announces support for MSRP
for future negotiation. The "m=" line and the "rtpmap" attribute
offer an audio stream and provide the lowest precedence configuration
(PCMU without any DTMF encoding). The rmcap lines define the RTP-
based media format capabilities (PCMU, G729, telephone-event,
H263-1998, and H264) and the omcap line defines the non-RTP-based
media format capability (wildcard). The "mfcap" attribute provides
the format parameters for telephone-event, specifying the 12
commercial DTMF 'digits'. The "pcfg" attribute line defines the
most-preferred media configuration as PCMU plus DTMF events and the
next-most-preferred configuration as G.729B plus DTMF events.

If the answerer is able to support all the potential configurations,
and also support H.263 video (but not H.264), it would reply with an
answer like the following:

```
v=0
o=- 24351 621814 IN IP4 192.0.2.2
s=
c=IN IP4 192.0.2.2
t=0 0
a=csup:med-v0
m=audio 54322 RTP/AVP 0 100
a=rtpmap:0 PCMU/8000
a=rtpmap:100 telephone-event/8000
a=fmtp:100 0-11
a=acfg:1 m=1,3 pt=1:0,3:100
a=pcfg:1 m=2,3 pt=2:18,3:100
a=lcfg:2 mt=video t=1 m=10
```

The "lcfg" attribute line announces the capability to support H.263
video at a later time. The media line and subsequent "rtpmap" and
"fmtp" attribute lines present the selected configuration for the
media stream. The "acfg" attribute line identifies the potential
configuration from which it was taken, and the "pcfg" attribute line
announces the potential capability to support G.729 with DTMF events
as well. If, at some later time, congestion becomes a problem in the
network, either party may, with expectation of success, offer a
reconfiguration of the media stream to use G.729 in order to reduce
packet sizes.

5. IANA Considerations

5.1. New SDP Attributes

   IANA has registered the following new SDP attributes:

      Attribute name: rmcap
      Long form name: RTP-based media format capability
      Type of attribute: session-level and media-level
      Subject to charset: no
      Purpose: associate RTP-based media capability number(s) with
      media subtype and encoding parameters
      Appropriate Values: see Section 3.3.1
      Contact name: Flemming Andreasen, fandres@cisco.com

      Attribute name: omcap
      Long form name: non-RTP-based media format capability
      Type of attribute: session-level and media-level
      Subject to charset: no
      Purpose: associate non-RTP-based media capability number(s) with
      media subtype and encoding parameters
      Appropriate Values: see Section 3.3.1
      Contact name: Flemming Andreasen, fandreas@cisco.com

        Attribute name: mfcap
        Long form name: media format parameter capability
        Type of attribute: session-level and media-level
        Subject to charset: no
        Purpose: associate media format attributes and
        parameters with media format capabilities
        Appropriate Values: see Section 3.3.2
        Contact name: Flemming Andreasen, fandreas@cisco.com

        Attribute name: mscap
        Long form name: media-specific capability
        Type of attribute: session-level and media-level
        Subject to charset: no
        Purpose: associate media-specific attributes and
        parameters with media capabilities
        Appropriate Values: see Section 3.3.3
        Contact name: Flemming Andreasen, fandreas@cisco.com

        Attribute name: lcfg
        Long form name: latent configuration
        Type of attribute: media-level
        Subject to charset: no
        Purpose: to announce supportable media streams
        without offering them for immediate use.
        Appropriate Values: see Section 3.3.5
        Contact name: Flemming Andreasen, fandreas@cisco.com

        Attribute name: sescap
        Long form name: session capability
        Type of attribute: session-level
        Subject to charset: no
        Purpose: to specify and prioritize acceptable
        combinations of media stream configurations.
        Appropriate Values: see Section 3.3.8
        Contact name: Flemming Andreasen, fandreas@cisco.com

5.2. New SDP Capability Negotiation Option Tag

   IANA has added the new option tag "med-v0", defined in this document,
   to the "SDP Capability Negotiation Option Capability Tags" registry
   created for RFC 5939 [RFC5939].

5.3. SDP Capability Negotiation Configuration Parameters Registry

   IANA has changed the "SDP Capability Negotiation Potential
   Configuration Parameters" registry, currently registered and defined
   by RFC 5939 [RFC5939], as follows:

The name of the registry should be "SDP Capability Negotiation
Configuration Parameters Registry" and it should contain a table with
the following column headings:

o Encoding Name: The syntactical value used for the capability
   negotiation configuration parameter, as defined in RFC 5939
   [RFC5939], Section 3.5.

o Descriptive Name: The name commonly used to refer to the
   capability negotiation configuration parameter.

o Potential Configuration Definition: A reference to the RFC that
   defines the configuration parameter in the context of a potential
   configuration attribute. If the configuration parameter is not
   defined for potential configurations, the string "N/A" (Not
   Applicable) MUST be present instead.

o Actual Configuration Definition: A reference to the RFC that
   defines the configuration parameter in the context of an actual
   configuration attribute. If the configuration parameter is not
   defined for actual configurations, the string "N/A" (Not
   Applicable) MUST be present instead.

o Latent Configuration Definition: A reference to the RFC that
   defines the configuration parameter in the context of a latent
   configuration attribute. If the configuration parameter is not
   defined for latent configurations, the string "N/A" (Not
   Applicable) MUST be present instead.

An IANA SDP Capability Negotiation Configuration registration MUST be
documented in an RFC in accordance with the IETF Review policy
[RFC5226]. Furthermore:

o The RFC MUST define the syntax and semantics of each new potential
   configuration parameter.

o The syntax MUST adhere to the syntax provided for extension
   configuration lists in RFC 5939 [RFC5939], Section 3.5.1, and the
   semantics MUST adhere to the semantics provided for extension
   configuration lists in RFC 5939 [RFC5939], Sections 3.5.1 and
   3.5.2.

o Configuration parameters that apply to latent configurations MUST
   furthermore adhere to the syntax provided in Section 3.3.5 and the
   semantics defined overall in this document.

o Associated with each registration MUST be the encoding name for
   the parameter as well as a short descriptive name for it.

      o Each registration MUST specify if it applies to

         * Potential configurations

         * Actual configurations

         * Latent configurations

5.4. SDP Capability Negotiation Configuration Parameter Registrations

   IANA has registered the following capability negotiation
   configuration parameters:

      Encoding Name: a
      Descriptive Name: Attribute Configuration
      Potential Configuration Definition: [RFC5939]
      Actual Configuration Definition: [RFC5939]
      Latent Configuration Definition: [RFC6871]

      Encoding Name: t
      Descriptive Name: Transport Protocol Configuration
      Potential Configuration Definition: [RFC5939]
      Actual Configuration Definition: [RFC5939]
      Latent Configuration Definition: [RFC6871]

      Encoding Name: m
      Descriptive Name: Media Configuration
      Potential Configuration Definition: [RFC6871]
      Actual Configuration Definition: [RFC6871]
      Latent Configuration Definition: [RFC6871]

      Encoding Name: pt
      Descriptive Name: Payload Type Number Mapping
      Potential Configuration Definition: [RFC6871]
      Actual Configuration Definition: [RFC6871]
      Latent Configuration Definition: [RFC6871]

      Encoding Name: mt
      Descriptive Name: Media Type
      Potential Configuration Definition: N/A
      Actual Configuration Definition: N/A
      Latent Configuration Definition: [RFC6871]

6. Security Considerations

   The security considerations of RFC 5939 [RFC5939] apply for this
   document.

In RFC 5939 [RFC5939], it was noted that negotiation of transport
protocols (e.g., secure and non-secure) and negotiation of keying
methods and material are potential security issues that warrant
integrity protection to remedy. Latent configuration support
provides hints to the other side about capabilities supported for
further offer/answer exchanges, including transport protocols and
attribute capabilities, e.g., for keying methods. If an attacker can
remove or alter latent configuration information to suggest that only
non-secure or less-secure alternatives are supported, then he may be
able to force negotiation of a less secure session than would
otherwise have occurred. While the specific attack, as described
here, differs from those described in RFC 5939 [RFC5939], the
considerations and mitigation strategies are similar to those
described in RFC 5939 [RFC5939].

Another variation on the above attack involves the session capability
("sescap") attribute defined in this document. The "sescap" enables
a preference order to be specified for all the potential
configurations, and that preference will take precedence over any
preference indication provided in individual potential configuration
attributes. Consequently, an attacker that can insert or modify a
"sescap" attribute may be able to force negotiation of an insecure or
less secure alternative than would otherwise have occurred. Again,
the considerations and mitigation strategies are similar to those
described in RFC 5939 [RFC5939].

The addition of negotiable media formats and their associated
parameters, defined in this specification can cause problems for
middleboxes that attempt to control bandwidth utilization, media
flows, and/or processing resource consumption as part of network
policy, but that do not understand the media capability negotiation
feature. As for the initial SDP capability negotiation work
[RFC5939], the SDP answer is formulated in such a way that it always
carries the selected media encoding for every media stream selected.
Pending an understanding of capabilities negotiation, the middlebox
should examine the answer SDP to obtain the best picture of the media
streams being established. As always, middleboxes can best do their
job if they fully understand media capabilities negotiation.

7. Acknowledgements

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herein: Cullen Jennings, Matt Lepinski, Joerg Ott, Colin Perkins, and
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