MEDIACTRL	A. Amirante
Internet-Draft	University of Napoli
Expires: January 12, 2012	T. Castaldi
	L. Miniero
	Meetecho
	S P. Romano
	University of Napoli
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Media Control Channel Framework (CFW) Call Flow Examples
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Abstract

This document provides a list of typical Media Control Channel Framework [RFC6230] call flows. It aims at being a simple guide to the use of the interface between Application Servers and MEDIACTRL-based Media Servers, as well as a base reference documentation for both implementors and protocol researchers.

Status of this Memo

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This Internet-Draft will expire on January 12, 2012.

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1. Introduction

This document provides a list of typical MEDIACTRL Media Control Channel Framework [RFC6230] call flows. The motivation for this comes from our implementation experience with the framework and its protocol. This drove us to writing a simple guide to the use of the several interfaces between Application Servers and MEDIACTRL-based Media Servers and a base reference documentation for other implementors and protocol researchers.
Following this spirit, this document covers several aspects of the interaction between Application Servers and Media Servers. However, in

the context of this document, the call flows almost always depict the interaction between a single Application Server (which, for the sake of conciseness, is called AS from now on) and a single Media Server (MS). In Section 7 some flows involving more entities by means of a Media Resource Broker compliant with [I-D.ietf-mediactrl-mrb] are presented. To ease the understanding of all the flows (for what concerns both SIP dialogs and CFW transactions), the domains hosting the AS and the MS in all the scenarios are called, respectively, 'as.example.com' and 'ms.example.net'.

In the next paragraphs a brief overview of our implementation approach is described, with particular focus on protocol-related aspects. This involves state diagrams for what concerns both the client side (the AS) and the server side (the MS). Of course, this section is not at all to be considered a mandatory approach to the implementation of the framework. It is only meant to ease the understanding of how the framework works from a practical point of view.

Once done with these preliminary considerations, in the subsequent sections real-life scenarios are faced. In this context, first of all, the establishment of the Control Channel is dealt with: after that, some use case scenarios, involving the most typical multimedia applications, are depicted and described.

It is worth pointing out that this document is not meant in any way to be a self-sustained guide to implementing a MEDIACTRL-compliant framework. The specifications are a mandatory read for all implementors, especially considering that this document by itself follows their guidelines but does not delve into the details of every aspect of the protocol.

2. Conventions

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

Besides, note that due to RFC formatting conventions, this document often splits SIP/SDP and CFW across lines whose content would exceed 72 characters. A backslash character marks where this line folding has taken place. This backslash and its trailing CRLF and whitespace would not appear in the actual protocol contents. Besides, also note that the indentation of the XML content is only provided for readability: actual messages will follow strict XML syntax, which allows for, but does not require, indentation.

3. Terminology

This document makes use of the same terminology as the one that can be found in the referenced documents. The following terms are only a

summarization of the most commonly used ones in this context, mostly derived from the terminology used in the related documents:

Application Server: an entity that requests media processing and manipulation from a Media Server; typical examples are Back to Back User Agents (B2BUA) and endpoints requesting manipulation of a third-party's media stream.

Media Server: an entity that performs a service, such as media processing, on behalf of an Application Server; typical provided functions are mixing, announcement, tone detection and generation, and play and record services.

Control Channel: a reliable connection between an Application Server and a Media Server that is used to exchange Framework messages.

4. A Practical Approach

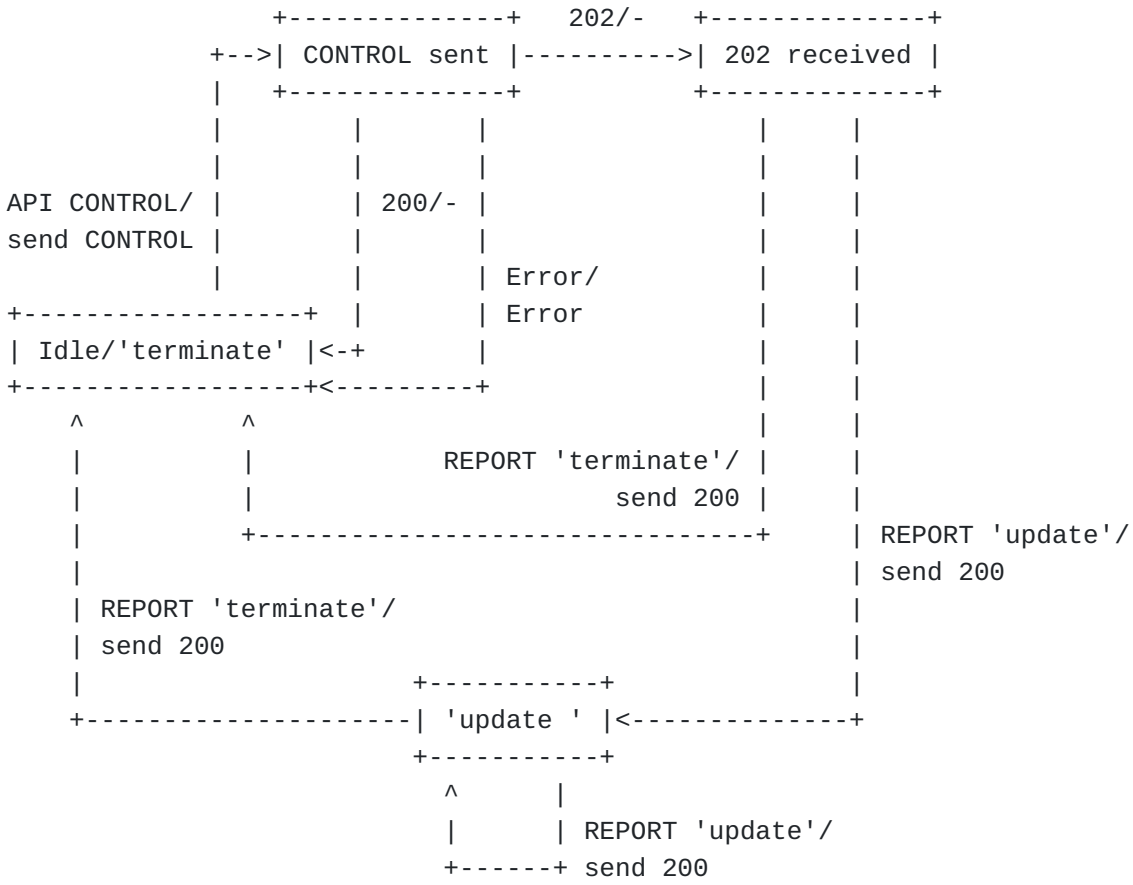
In this document we embrace an engineering approach to the description of a number of interesting scenarios that can be realized through the careful orchestration of the Media Control Channel Framework entities, namely the Application Server and the Media Server. We will demonstrate, through detailed call flows, how a variegated bouquet of services (ranging from very simple scenarios to much more complicated ones) can be implemented with the functionality currently offered, within the main MEDIACTRL framework, by the control packages that have been made available to date. The document aims at representing a useful guide for those interested in investigating the inter-operation among MEDIACTRL components, as well as for application developers willing to build advanced services on top of the base infrastructure made available by the framework.

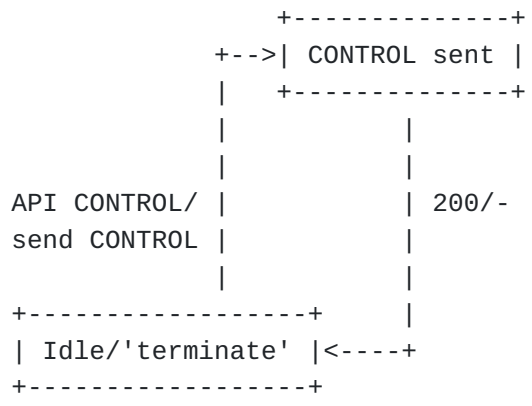
4.1. State Diagrams

In this section we present an "informal" view of the main MEDIACTRL protocol interactions, in the form of state diagrams. Each diagram is indeed a classical representation of a Mealy automaton, comprising a number of possible protocol states, indicated with rectangular boxes. Transitions between states are indicated through edges, with each edge labeled with a slash-separated pair representing a specific input together with the associated output (a dash in the output position means that, for that particular input, no output is generated from the automaton). Some of the inputs are associated with MEDIACTRL protocol messages arriving at a MEDIACTRL component while it is in a certain state: this is the case of 'CONTROL', 'REPORT' (in its various "flavors" -- pending, terminate, etc.), '200', '202', as well as 'Error'. Further inputs represent triggers arriving at the MEDIACTRL automaton from the upper layer, namely the Application Programming Interface used by programmers while implementing MEDIACTRL-enabled

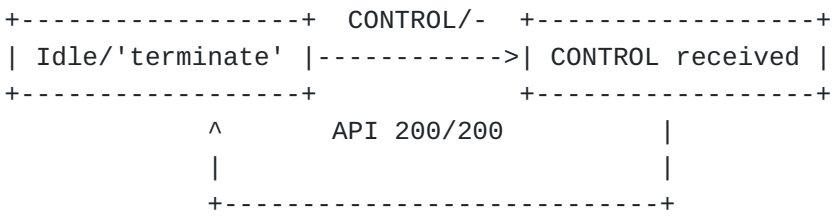
services: such inputs have been indicated with the term 'API' followed by the message that the API itself is triggering (as an example, 'API terminate' is a request to send a 'REPORT' message with a status of 'terminate' to the peering component). Four diagrams are provided, which can be divided in two main categories, associated, respectively, with normal operation of the framework (Figure 1 and Figure 2) and with asynchronous event notifications (Figure 3). As to the former category, in Figure 1 we embrace the MS perspective, whereas in Figure 2 we stand on the AS side. The latter category is dealt with in Figure 3, which illustrates how notifications are managed. In particular, the upper part of the figure shows how events are generated, on the MS side, by issuing a CONTROL message addressed to the AS; events are acknowledged by the AS through standard 200 responses. Hence, the behavior of the AS, which mirrors that of the MS, is depicted in the lower part of the picture. Coming back to Figure 1, the diagram shows that the MS activates upon reception of CONTROL messages coming from the AS, which typically instruct it about the execution of a specific command, belonging to one of the available control packages. The execution of the received command can either be quick, or require some time. In the former case, right after completing its operation, the MS sends back to the AS a 200 message, which basically acknowledges correct termination of the invoked task. In the latter case, the MS first sends back an interlocutory 202 message, which lets it enter a different state ('202' sent). While in the new state, the MS keeps on performing the invoked task: if such task does not complete in a predefined timeout, the server will update the AS on the other side of the control channel by periodically issuing 'REPORT/update' messages; each such message has to be acknowledged by the AS (through a '200' response). Eventually, when the MS is done with the required service, it sends to the AS a 'REPORT/terminate' message, whose acknowledgment receipt concludes a transaction. Again, the AS behavior, depicted in Figure 2, mirrors the above described actions undertaken at the MS side. Figures also show the cases in which transactions cannot be successfully completed due to abnormal conditions, which always trigger the creation and expedition of a specific 'Error' message.


Idle/'terminate'
CONTROL/-
CONTROL received
API 202/202
API 200/200
API Error/Error
200/-
Waiting for
last 200
'202' sent
API terminate/
REPORT terminate
API terminate/
REPORT termnate
'update' confirmed
API update/
REPORT update
API update/
REPORT update
200/-
'update' sent


CONTROL sent
202/-
202 received
API CONTROL/
send CONTROL
200/-
Error/
Error
Idle/'terminate'
REPORT 'terminate'/
send 200
REPORT 'update'/
send 200
REPORT 'terminate'/
send 200
'update '
REPORT 'update'/
send 200



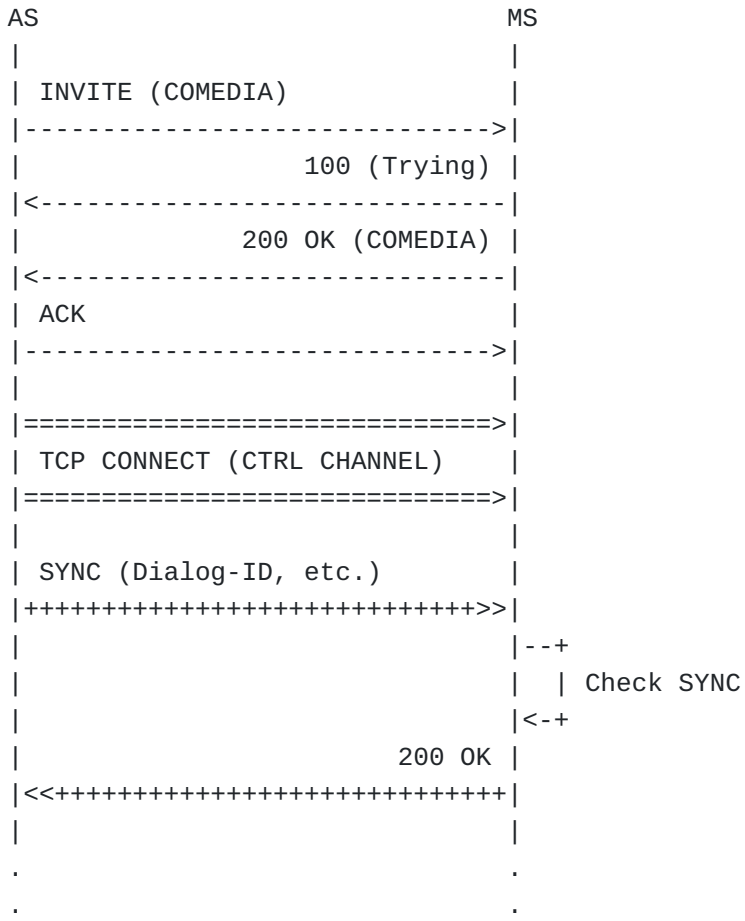
(Media Server perspective)



(Application Server perspective)

5. Control Channel Establishment

As specified in [RFC6230], the preliminary step to any interaction between an AS and a MS is the establishment of a control channel between the two. As explained in the next subsection, this is accomplished by means of a so-called COMEDIA [RFC4145] negotiation. This negotiation allows for a reliable connection to be created between the AS and the MS: it is here that the AS and the MS agree on the transport level protocol to use (TCP/SCTP) and whether any application level security is needed or not (e.g. TLS). For the sake of simplicity, we assume that an unencrypted TCP connection is negotiated between the two involved entities. Once they have connected, a SYNC message sent by the AS to the MS consolidates the control channel. An example of how a keep-alive message is triggered is also presented in the following paragraphs. For the sake of completeness, this section also includes a couple of common mistakes that can occur when dealing with the Control Channel establishment.



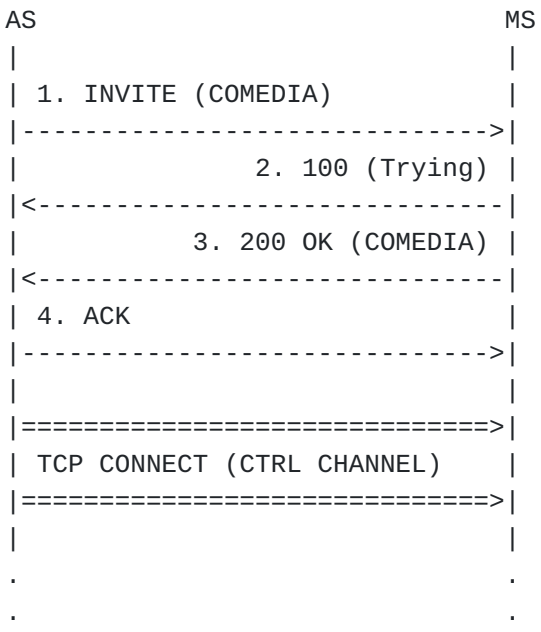
5.1. COMEDIA Negotiation

As a first step, the AS and the MS establish a Control SIP dialog. This is usually originated by the AS itself. The AS generates a SIP INVITE message containing in its SDP body information about the TCP connection it wants to establish with the MS. In the provided example (see Figure 5 and the attached call flow), the AS wants to actively open a new TCP connection, which on his side will be bound to port 5757. If the request is fine, the MS answers with its own offer, by communicating to the AS the transport address to connect to in order to establish the TCP connection. In the provided example, the MS will listen on port 7575. Once this negotiation is over, the AS can effectively connect to the MS.

The negotiation includes additional attributes, the most important being the 'cfw-id' attribute, since it specifies the Dialog-ID which will be subsequently referred to by both the AS and the MS, as specified in the core framework draft.

Note that the provided example also includes the indication, from both the AS and the MS, of the supported control packages. This is achieved by means of a series of 'ctrl-package' attributes as specified in [I-

D.boulton-mmusic-sdp-control-package-attribute]. In the example, the AS supports (or is only interested to) two packages: IVR (Interactive Voice Response) and Mixer (Conferencing and Bridging). The MS replies with the list of packages it supports, by adding a dummy example package to the list provided by the AS. It is worth noting that this exchange of information is not meant as a strict or formal negotiation of packages: in case the AS realizes that one or more packages it needs are not supported according to the indications sent by the MS, it may, or may not, choose not to open a control channel with the MS at all, if its application logic leads to such a decision. The actual negotiation of control packages is done subsequenty through the use of the framework SYNC transaction.



```
1. AS -> MS (SIP INVITE)
------------------------
   INVITE sip:MediaServer@ms.example.net:5060 SIP/2.0
   Via: SIP/2.0/UDP 1.2.3.4:5060;\
           branch=z9hG4bK-d8754z-9b07c8201c3aa510-1---d8754z-;rport=5060
   Max-Forwards: 70
   Contact: <sip:ApplicationServer@1.2.3.4:5060>
   To: <sip:MediaServer@ms.example.net:5060>
   From: <sip:ApplicationServer@as.example.com:5060>;tag=4354ec63
   Call-ID: MDk2YTk1MDU3YmVkZjgzYTQwYmJlNjE5NTA4ZDQ1OGY.
   CSeq: 1 INVITE
   Allow: INVITE, ACK, CANCEL, OPTIONS, BYE, UPDATE, REGISTER
   Content-Type: application/sdp
   Content-Length: 263

   v=0
   o=lminiero 2890844526 2890842807 IN IP4 as.example.com
   s=MediaCtrl
   c=IN IP4 as.example.com
   t=0 0
   m=application 5757 TCP cfw
   a=connection:new
   a=setup:active
   a=cfw-id:5feb6486792a
   a=ctrl-package:msc-ivr/1.0
   a=ctrl-package:msc-mixer/1.0


2. AS <- MS (SIP 100 Trying)
----------------------------
   SIP/2.0 100 Trying
   Via: SIP/2.0/UDP 1.2.3.4:5060; \
           branch=z9hG4bK-d8754z-9b07c8201c3aa510-1---d8754z-;rport=5060
   To: <sip:MediaServer@ms.example.net:5060>;tag=499a5b74
   From: <sip:ApplicationServer@as.example.com:5060>;tag=4354ec63
   Call-ID: MDk2YTk1MDU3YmVkZjgzYTQwYmJlNjE5NTA4ZDQ1OGY.
   CSeq: 1 INVITE
   Content-Length: 0


3. AS <- MS (SIP 200 OK)
------------------------
   SIP/2.0 200 OK
   Via: SIP/2.0/UDP 1.2.3.4:5060; \
           branch=z9hG4bK-d8754z-9b07c8201c3aa510-1---d8754z-;rport=5060
   Contact: <sip:MediaServer@ms.example.net:5060>
   To: <sip:MediaServer@ms.example.net:5060>;tag=499a5b74
   From: <sip:ApplicationServer@as.example.com:5060>;tag=4354ec63
```

```
   Call-ID: MDk2YTk1MDU3YmVkZjgzYTQwYmJlNjE5NTA4ZDQ1OGY.
   CSeq: 1 INVITE
   Allow: INVITE, ACK, CANCEL, OPTIONS, BYE, UPDATE, REGISTER
   Content-Type: application/sdp
   Content-Length: 296

   v=0
   o=lminiero 2890844526 2890842808 IN IP4 ms.example.net
   s=MediaCtrl
   c=IN IP4 ms.example.net
   t=0 0
   m=application 7575 TCP cfw
   a=connection:new
   a=setup:passive
   a=cfw-id:5feb6486792a
   a=ctrl-package:msc-ivr/1.0
   a=ctrl-package:msc-example-pkg/1.0
   a=ctrl-package:msc-mixer/1.0


4. AS -> MS (SIP ACK)
---------------------
   ACK sip:MediaServer@ms.example.net:5060 SIP/2.0
   Via: SIP/2.0/UDP 1.2.3.4:5060; \
                branch=z9hG4bK-d8754z-22940f5f4589701b-1---d8754z-;rport
   Max-Forwards: 70
   Contact: <sip:ApplicationServer@1.2.3.4:5060>
   To: <sip:MediaServer@ms.example.net:5060>;tag=499a5b74
   From: <sip:ApplicationServer@as.example.com:5060>;tag=4354ec63
   Call-ID: MDk2YTk1MDU3YmVkZjgzYTQwYmJlNjE5NTA4ZDQ1OGY.
   CSeq: 1 ACK
   Content-Length: 0
```

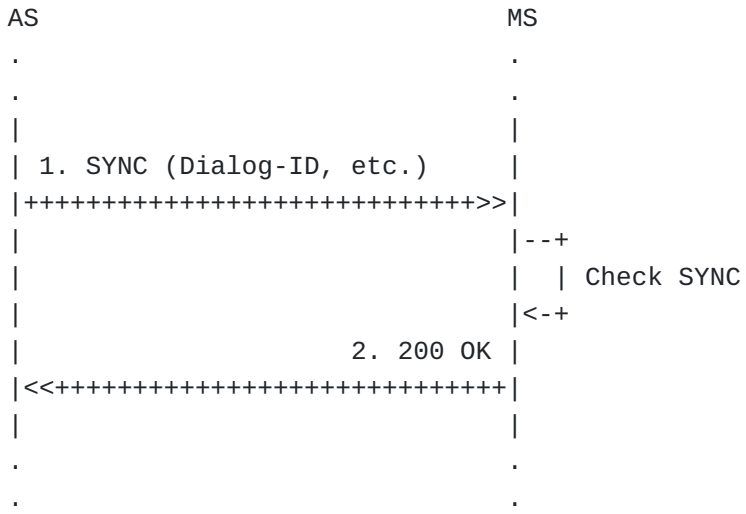
5.2. SYNC

Once the AS and the MS have successfully established a TCP connection, an additional step is needed before the control channel can be used. In fact, as seen in the previous subsection, the first interaction between the AS and the MS happens by means of a SIP dialog, which in turns allows for the creation of the TCP connection. This introduces the need for a proper correlation between the above mentioned entities (SIP dialog and TCP connection), so that the MS can be sure the connection came from the AS which requested it. This is accomplished by means of a dedicated framework message called SYNC. This SYNC message makes use of a unique identifier called Dialog-ID to validate the control channel. This identifier, as introduced in the previous paragrah, is meant to be globally unique and as such is properly generated by the caller (the AS

in the call flow), and added as an SDP media attribute (cfw-id) to the COMEDIA negotiation in order to make both entities aware of its value:

```
a=cfw-id:5feb6486792a
         ^^^^^^^^^^^^
```

Besides, it offers an additional negotiation mechanism. In fact, the AS uses the SYNC not only to properly correlate as explained before, but also to negotiate with the MS the control packages it is interested in, as well as to agree on a Keep-Alive timer needed by both the AS and the MS to understand if problems on the connection occur. In the provided example (see Figure 8 and the related call flow), the AS sends a SYNC with a Dialog-ID constructed as needed (using the 'cfw-id' attribute from the SIP dialog) and requests access to two control packages, specifically the IVR and the Mixer package (the same packages the AS previously indicated in its SDP as specified in [I-D.boulton-mmusic-sdp-control-package-attribute], with the difference that this time they are reported in the context of a binding negotiation). Besides, it instructs the MS that a 100 seconds timeout is to be used for Keep-Alive messages. The MS validates the request by matching the received Dialog-ID with the SIP dialog values and, assuming it supports the control packages the AS requested access to (and for the sake of this document we assume it does), it answers with a 200 message. Additionally, the MS provides the AS with a list of other unrequested packages it supports (in this case just a dummy package providing testing functionality).



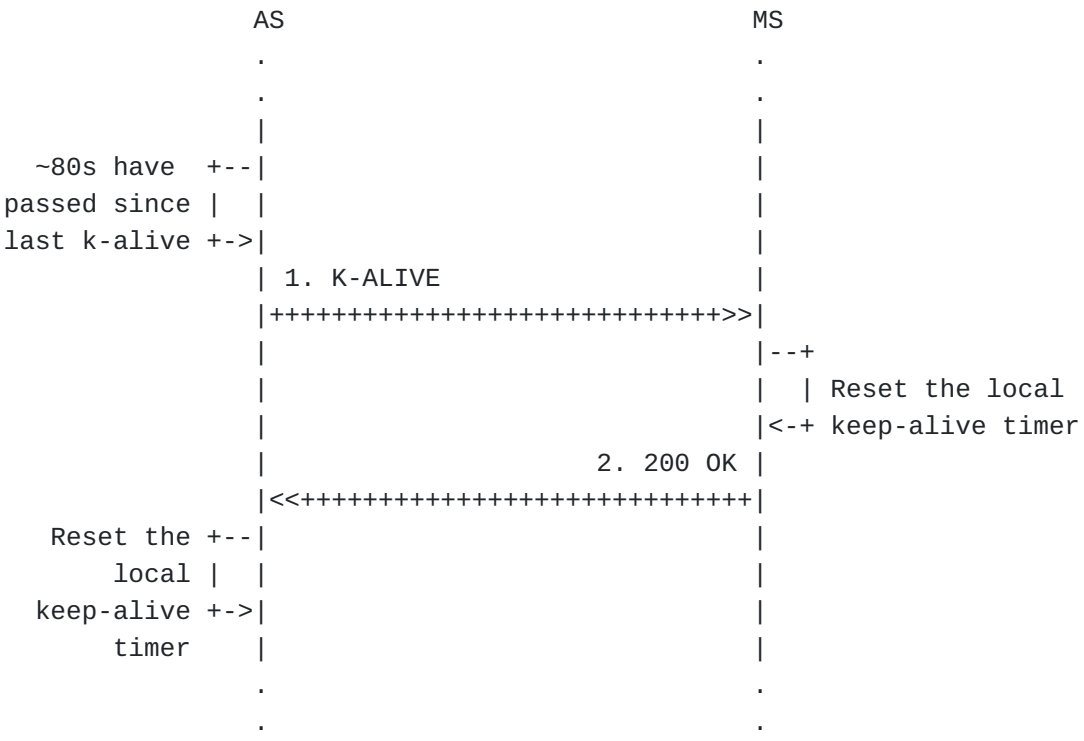
```
1. AS -> MS (CFW SYNC)
----------------------
   CFW 6e5e86f95609 SYNC
   Dialog-ID: 5feb6486792a
   Keep-Alive: 100
   Packages: msc-ivr/1.0,msc-mixer/1.0


2. AS <- MS (CFW 200)
---------------------
   CFW 6e5e86f95609 200
   Keep-Alive: 100
   Packages: msc-ivr/1.0,msc-mixer/1.0
   Supported: msc-example-pkg/1.0
```

The framework level transaction identifier is obviously the same in both the request and the response (6e5e86f95609), since the AS needs to be able to match the response to the original request. At this point, the control channel is finally established, and it can be used by the AS to request services from the MS.

5.3. K-ALIVE

The Control Framework provides a mechanism for implementing a keep-alive functionality. Such a mechanism is especially useful whenever any NAT or firewall sits in the path between an AS and a MS. In fact, NATs and firewalls may have timeout values for the TCP connections they handle, which means that, if no traffic is detected on these connections within a specific time, they could be shut down. This could be the case of a Control Channel established between an AS and a MS but not used for some time. For this reason, the Control Framework specifies a dedicated framework message (K-ALIVE) that the AS and MS can make use of in order to generate traffic on the TCP connection and keep it alive.
In the previous section it has been described how a timeout value for the keep alive mechanism is negotiated. Specifically, in the example the AS and the MS agreed on a value of 100 seconds. This is compliant with how NATs and firewalls are usually implemented, since in most cases the timeout value they use before shutting TCP connections down is around 2 minutes. Such value has a strong meaning within the context of this mechanism. In fact, it means that the active role (in this case the AS) has to send a K-ALIVE message before those 100 seconds pass, otherwise the passive role (the MS) will tear down the connection treating it like a timeout. The Control Framework document suggests a more conservative approach towards handling this timeout value, suggesting to trigger the K-ALIVE message before 80% of the negotiated

time passes (in this case, 80 seconds). This is exactly the case presented in Figure 10.



After the Control Channel has been established (COMEDIA+SYNC) both the AS and the MS start local keep-alive timers mapped to the negotiated keep alive timeout value (100 seconds). When about 80 seconds have passed since the start of the timer (80% of 100 seconds), the AS sends the MS a framework level K-ALIVE message. As it can be seen in the protocol message dump, the message is very lightweight, since it only includes a single line with no additional header. When the MS receives the K-ALIVE message, it resets its local keep-alive timer and sends a 200 message back as confirmation. As soon as the AS receives the 200 message, it resets its local keep-alive timer as well and the mechanism starts over again.
The actual transaction steps are presented in the next figure.

```
1. AS -> MS (K-ALIVE)
---------------------
   CFW 518ba6047880 K-ALIVE


2. AS <- MS (CFW 200)
---------------------
   CFW 518ba6047880 200
```

In case the timer expired either in the AS or in the MS (i.e. the K-ALIVE or the 200 arrived after the 100 seconds) the connection and the associated SIP Control Dialog would be torn down by the entity detecting the timeout, thus ending the interaction between the AS and the MS.

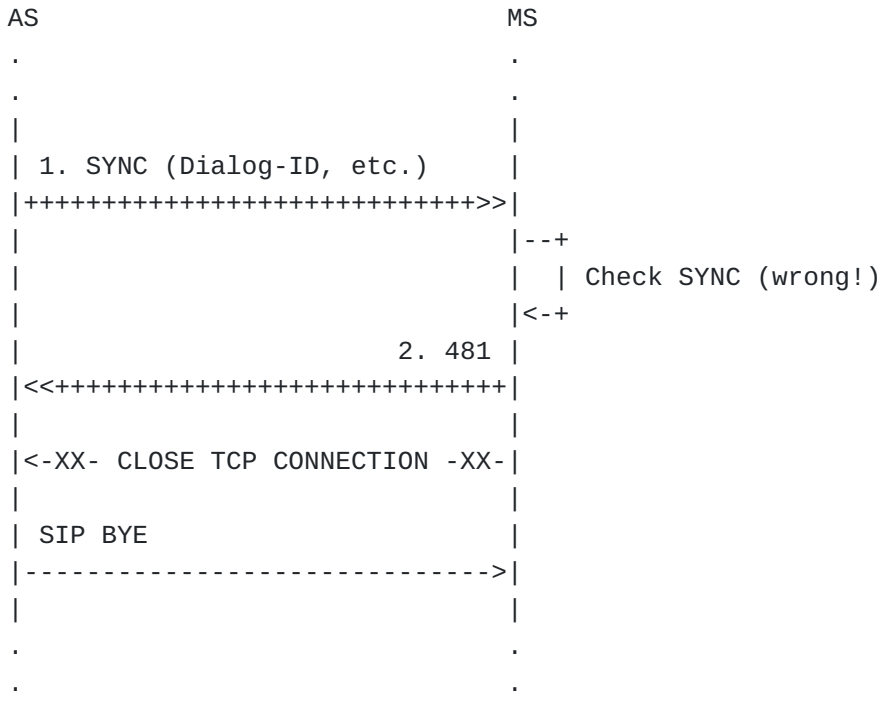
5.4. Wrong behaviour

This section will briefly address some of those which could represent the most common mistakes when dealing with the establishment of a Control Channel between an AS and a MS. These scenarios are obviously of interest, since they result in the AS and the MS being unable to interact with each other. Specifically, these simple scenarios will be described:

1. an AS providing the MS with a wrong Dialog-ID in the initial SYNC;

2. an AS sending a generic CONTROL message instead of SYNC as a first transaction.

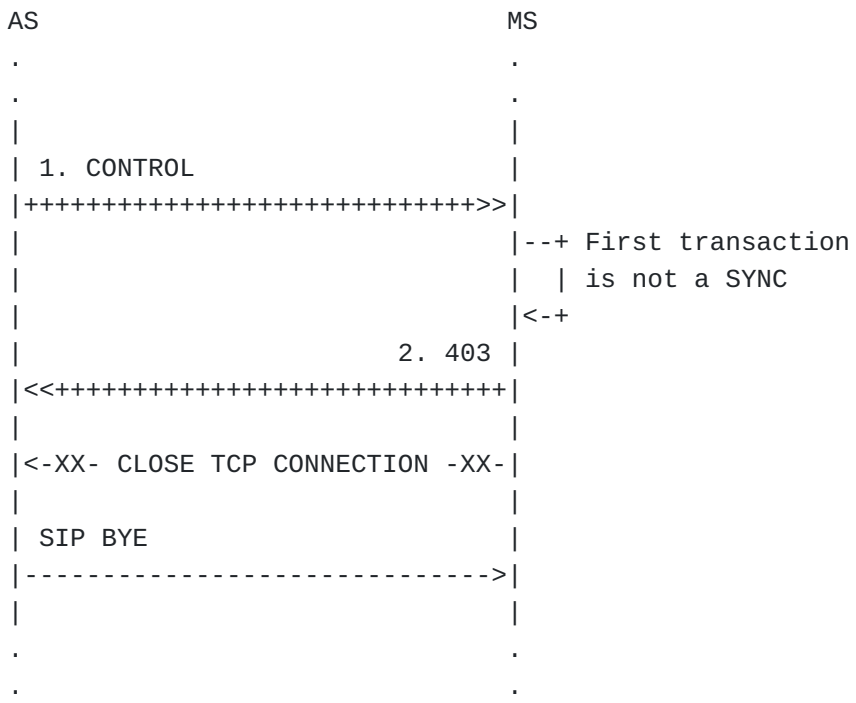
The first scenario is depicted in Figure 12.



The scenario is similar to the one presented in Section 5.2 but with a difference: instead of using the correct, expected, Dialog-ID in the SYNC message (5feb6486792a, the one negotiated via COMEDIA), the AS uses a wrong value (4hrn7490012c). This causes the SYNC transaction to fail. First of all, the MS sends a framework level 481 message. This response, when given in reply to a SYNC message, means that the SIP dialog associated with the provided Dialog-ID (the wrong identifier) does not exist. Besides, the Control Channel must be torn down as a consequence, and so the MS also closes the TCP connection it received the SYNC message from. The AS at this point is supposed to tear down its SIP Control Dialog as well, and so sends a SIP BYE to the MS. The actual transaction is presented in the next picture.

```
1. AS -> MS (CFW SYNC with wrong Dialog-ID)
-------------------------------------------
   CFW 2b4dd8724f27 SYNC
   Dialog-ID: 4hrn7490012c
   Keep-Alive: 100
   Packages: msc-ivr/1.0,msc-mixer/1.0


2. AS <- MS (CFW 481)
---------------------
   CFW 2b4dd8724f27 481
```

The second scenario instead is depicted in Figure 14.

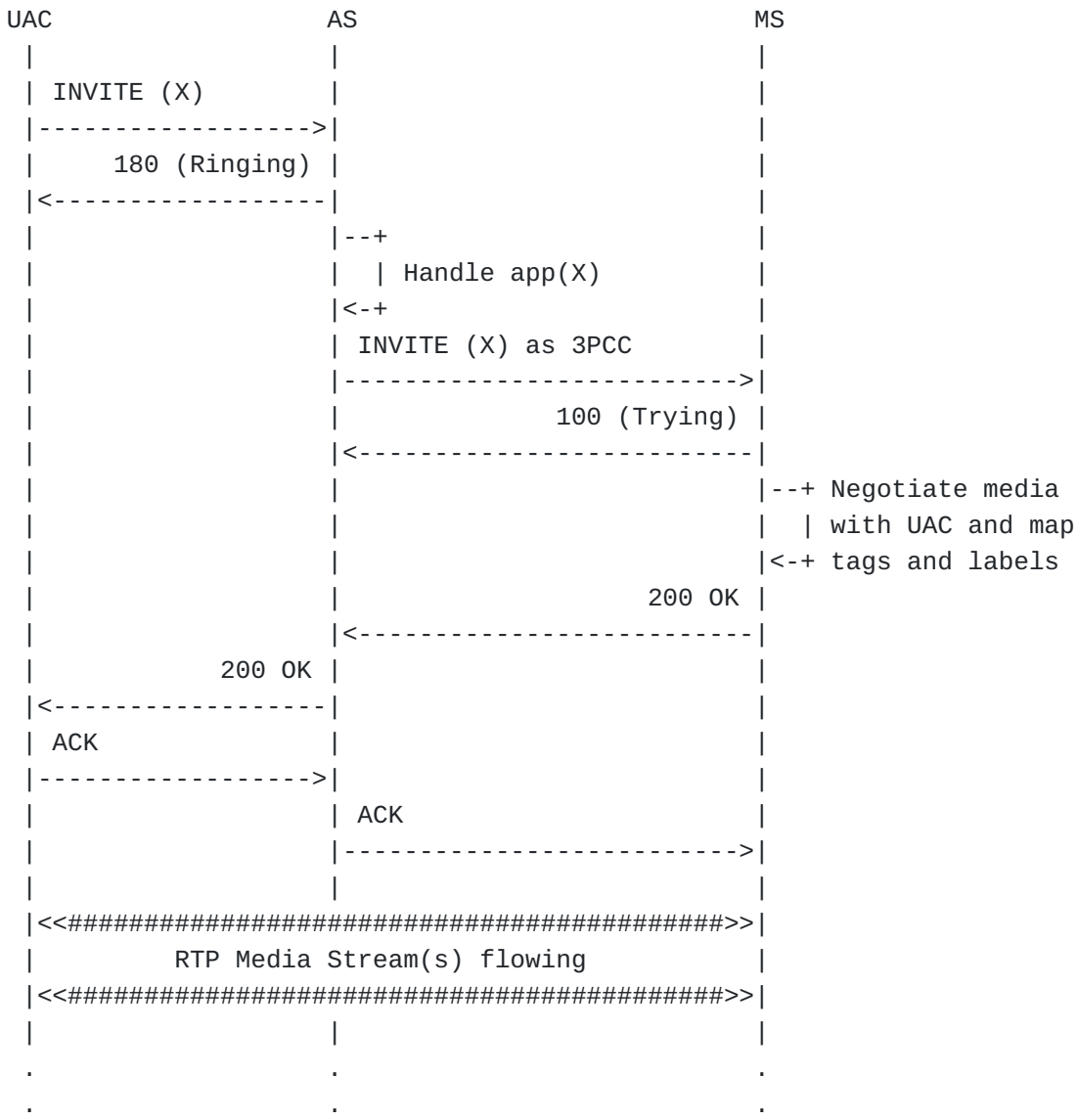


This scenario is another common mistake that could occur when trying to setup a Control Channel. In fact, the Control Framework mandates that the first transaction after the COMEDIA negotiation be a SYNC to conclude the setup. In case the AS, instead of triggering a SYNC message as expected, sends a different message to the MS (in the example, it tries to send an <audit> message addressed to the IVR Control Package), the MS treats it like an error. As a consequence, the MS replies with a framework level 403 message (Forbidden) and, just as before, closes the TCP connection and waits for the related SIP Control Dialog to be torn down.
The actual transaction is presented in the next picture.

```
1. AS -> MS (CFW CONTROL instead of SYNC)
-----------------------------------------
   CFW 101fbbd62c35 CONTROL
   Control-Package: msc-ivr/1.0
   Content-Type: application/msc-ivr+xml
   Content-Length: 78

   <mscivr version="1.0" xmlns="urn:ietf:params:xml:ns:msc-ivr">
      <audit/>
   </mscivr>


2. AS <- MS (CFW 403 Forbidden)
-------------------------------
   CFW 101fbbd62c35 403
```

6. Use-case scenarios and examples

The following scenarios have been chosen for their common presence in many rich real-time multimedia applications. Each scenario is depicted as a set of call flows, involving both the SIP/SDP signaling (UACs<->AS<->MS) and the Control Channel communication (AS<->MS).
All the examples assume that a Control Channel has already been correctly established and SYNCed between the reference AS and MS. Besides, unless stated otherwise, the same UAC session is referenced in all the above mentioned examples. The UAC session is assumed to have been created as the described Figure 16:



Note well: this is only an example of a possible approach involving a 3PCC negotiation among the UAC, the AS and the MS, and as such is not at all to be considered as the mandatory way or as best common practice either in the presented scenario. [RFC3725] provides several different solutions and many details about how 3PCC can be realized, with pros and cons.

The UAC first places a call to a SIP URI the AS is responsible of. The specific URI is not relevant to the examples, since the application logic behind the mapping between a URI and the service it provides is a matter that is important only to the AS: so, a generic 'sip:mediactrlDemo@as.example.com' is used in all the examples, whereas the service this URI is associated with in the AS logic is mapped scenario by scenario to the case under exam. The UAC INVITE is treated as envisaged in [RFC5567]: the INVITE is forwarded by the AS to the MS

in a 3PCC fashion, without the SDP provided by the UAC being touched, so to have the session fully negotiated by the MS for what concerns its description. The MS matches the UAC's offer with its own capabilities and provides its answer in a 200 OK. This answer is then forwarded, again without the SDP contents being touched, by the AS to the UAC it is intended for. This way, while the SIP signaling from the UAC is terminated in the AS, all the media would start flowing directly between the UAC and the MS.

As a consequence of this negotiation, one or more media connections are created between the MS and the UAC. They are then addressed, when needed, by the AS and the MS by means of the tags concatenation as specified in [RFC6230]. How the identifiers are created and addressed is explained by making use of the sample signaling provided in Figure 17.

```
1. UAC -> AS (SIP INVITE)
-------------------------
   INVITE sip:mediactrlDemo@as.example.com SIP/2.0
   Via: SIP/2.0/UDP 4.3.2.1:5063;rport;branch=z9hG4bK1396873708
   From: <sip:lminiero@users.example.com>;tag=1153573888
   To: <sip:mediactrlDemo@as.example.com>
   Call-ID: 1355333098
   CSeq: 20 INVITE
   Contact: <sip:lminiero@4.3.2.1:5063>
   Content-Type: application/sdp
   Max-Forwards: 70
   User-Agent: Linphone/2.1.1 (eXosip2/3.0.3)
   Subject: Phone call
   Expires: 120
   Content-Length: 330

   v=0
   o=lminiero 123456 654321 IN IP4 4.3.2.1
   s=A conversation
   c=IN IP4 4.3.2.1
   t=0 0
   m=audio 7078 RTP/AVP 0 3 8 101
   a=rtpmap:0 PCMU/8000/1
   a=rtpmap:3 GSM/8000/1
   a=rtpmap:8 PCMA/8000/1
   a=rtpmap:101 telephone-event/8000
   a=fmtp:101 0-11
   m=video 9078 RTP/AVP 98
   a=rtpmap:98 H263-1998/90000
   a=fmtp:98 CIF=1;QCIF=1


2. UAC <- AS (SIP 180 Ringing)
------------------------------
   SIP/2.0 180 Ringing
   Via: SIP/2.0/UDP 4.3.2.1:5063;rport=5063; \
                                              branch=z9hG4bK1396873708
   Contact: <sip:mediactrlDemo@as.example.com>
   To: <sip:mediactrlDemo@as.example.com>;tag=bcd47c32
   From: <sip:lminiero@users.example.com>;tag=1153573888
   Call-ID: 1355333098
   CSeq: 20 INVITE
   Content-Length: 0


3. AS -> MS (SIP INVITE)
------------------------
   INVITE sip:MediaServer@ms.example.net:5060;transport=UDP SIP/2.0
```

```
   Via: SIP/2.0/UDP 1.2.3.4:5060; \
                branch=z9hG4bK-d8754z-8723e421ebc45f6b-1---d8754z-;rport
   Max-Forwards: 70
   Contact: <sip:ApplicationServer@1.2.3.4:5060>
   To: <sip:MediaServer@ms.example.net:5060>
   From: <sip:ApplicationServer@as.example.com:5060>;tag=10514b7f
   Call-ID: NzI0ZjQ0ZTBlMTEzMGU1ZjVhMjk5NTliMmJmZjE0NDQ.
   CSeq: 1 INVITE
   Allow: INVITE, ACK, CANCEL, OPTIONS, BYE, UPDATE, REGISTER
   Content-Type: application/sdp
   Content-Length: 330

   v=0
   o=lminiero 123456 654321 IN IP4 4.3.2.1
   s=A conversation
   c=IN IP4 4.3.2.1
   t=0 0
   m=audio 7078 RTP/AVP 0 3 8 101
   a=rtpmap:0 PCMU/8000/1
   a=rtpmap:3 GSM/8000/1
   a=rtpmap:8 PCMA/8000/1
   a=rtpmap:101 telephone-event/8000
   a=fmtp:101 0-11
   m=video 9078 RTP/AVP 98
   a=rtpmap:98 H263-1998/90000
   a=fmtp:98 CIF=1;QCIF=1


4. AS <- MS (SIP 100 Trying)
----------------------------
   SIP/2.0 100 Trying
   Via: SIP/2.0/UDP 1.2.3.4:5060; \
           branch=z9hG4bK-d8754z-8723e421ebc45f6b-1---d8754z-;rport=5060
   To: <sip:MediaServer@ms.example.net:5060>;tag=6a900179
   From: <sip:ApplicationServer@as.example.com:5060>;tag=10514b7f
   Call-ID: NzI0ZjQ0ZTBlMTEzMGU1ZjVhMjk5NTliMmJmZjE0NDQ.
   CSeq: 1 INVITE
   Content-Length: 0


5. AS <- MS (SIP 200 OK)
------------------------
   SIP/2.0 200 OK
   Via: SIP/2.0/UDP 1.2.3.4:5060; \
           branch=z9hG4bK-d8754z-8723e421ebc45f6b-1---d8754z-;rport=5060
   Contact: <sip:MediaServer@ms.example.net:5060>
   To: <sip:MediaServer@ms.example.net:5060>;tag=6a900179
   From: <sip:ApplicationServer@as.example.com:5060>;tag=10514b7f
   Call-ID: NzI0ZjQ0ZTBlMTEzMGU1ZjVhMjk5NTliMmJmZjE0NDQ.
```

```
   CSeq: 1 INVITE
   Allow: INVITE, ACK, CANCEL, OPTIONS, BYE, UPDATE, REGISTER
   Content-Type: application/sdp
   Content-Length: 374

   v=0
   o=lminiero 123456 654322 IN IP4 ms.example.net
   s=MediaCtrl
   c=IN IP4 ms.example.net
   t=0 0
   m=audio 63442 RTP/AVP 0 3 8 101
   a=rtpmap:0 PCMU/8000
   a=rtpmap:3 GSM/8000
   a=rtpmap:8 PCMA/8000
   a=rtpmap:101 telephone-event/8000
   a=fmtp:101 0-15
   a=ptime:20
   a=label:7eda834
   m=video 33468 RTP/AVP 98
   a=rtpmap:98 H263-1998/90000
   a=fmtp:98 CIF=2
   a=label:0132ca2


6. UAC <- AS (SIP 200 OK)
-------------------------
   SIP/2.0 200 OK
   Via: SIP/2.0/UDP 4.3.2.1:5063;rport=5063; \
                                                  branch=z9hG4bK1396873708
   Contact: <sip:mediactrlDemo@as.example.com>
   To: <sip:mediactrlDemo@as.example.com>;tag=bcd47c32
   From: <sip:lminiero@users.example.com>;tag=1153573888
   Call-ID: 1355333098
   CSeq: 20 INVITE
   Allow: INVITE, ACK, CANCEL, OPTIONS, BYE, UPDATE, REGISTER
   Content-Type: application/sdp
   Content-Length: 374

   v=0
   o=lminiero 123456 654322 IN IP4 ms.example.net
   s=MediaCtrl
   c=IN IP4 ms.example.net
   t=0 0
   m=audio 63442 RTP/AVP 0 3 8 101
   a=rtpmap:0 PCMU/8000
   a=rtpmap:3 GSM/8000
   a=rtpmap:8 PCMA/8000
   a=rtpmap:101 telephone-event/8000
   a=fmtp:101 0-15
```

```
   a=ptime:20
   a=label:7eda834
   m=video 33468 RTP/AVP 98
   a=rtpmap:98 H263-1998/90000
   a=fmtp:98 CIF=2
   a=label:0132ca2
```

```
7. UAC -> AS (SIP ACK)
----------------------
   ACK sip:mediactrlDemo@as.example.com SIP/2.0
   Via: SIP/2.0/UDP 4.3.2.1:5063;rport;branch=z9hG4bK1113338059
   From: <sip:lminiero@users.example.com>;tag=1153573888
   To: <sip:mediactrlDemo@as.example.com>;tag=bcd47c32
   Call-ID: 1355333098
   CSeq: 20 ACK
   Contact: <sip:lminiero@4.3.2.1:5063>
   Max-Forwards: 70
   User-Agent: Linphone/2.1.1 (eXosip2/3.0.3)
   Content-Length: 0
```

```
8. AS -> MS (SIP ACK)
---------------------
   ACK sip:MediaServer@ms.example.net:5060;transport=UDP SIP/2.0
   Via: SIP/2.0/UDP 1.2.3.4:5060; \
                branch=z9hG4bK-d8754z-5246003419ccd662-1---d8754z-;rport
   Max-Forwards: 70
   Contact: <sip:ApplicationServer@1.2.3.4:5060>
   To: <sip:MediaServer@ms.example.net:5060;tag=6a900179
   From: <sip:ApplicationServer@as.example.com:5060>;tag=10514b7f
   Call-ID: NzI0ZjQ0ZTBlMTEzMGU1ZjVhMjk5NTliMmJmZjE0NDQ.
   CSeq: 1 ACK
   Content-Length: 0
```

As a result of the 3PCC negotiation depicted in Figure 17, the following relevant information is retrieved:

```
  From: <sip:ApplicationServer@as.example.com:5060>;tag=10514b7f
                                                    ^^^^^^^^
  To: <sip:MediaServer@ms.example.net:5060>;tag=6a900179
                                              ^^^^^^^^
```

```
m=audio 63442 RTP/AVP 0 3 8 101
[..]
a=label:7eda834
        ^^^^^^^
m=video 33468 RTP/AVP 98
[..]
a=label:0132ca2
        ^^^^^^^
```

1. The 'From' and 'To' tags (10514b7f and 6a900179 respectively) of the AS<->MS session:

2. the labels associated with the negotiated media connections, in this case an audio stream (7eda834) and a video stream (0132ca2).

These three identifiers allow the AS and MS to univocally and unambiguously address to each other the connections associated with the related UAC, specifically:

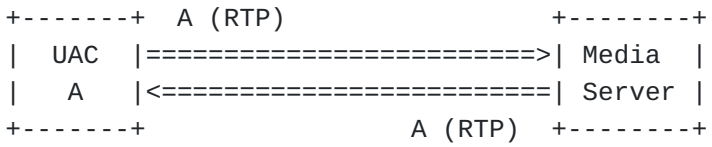
1. 10514b7f:6a900179, the concatenation of the 'From' and 'To' tags through a colon (':') token, addresses all the media connections between the MS and the UAC;

2. 10514b7f:6a900179 <-> 7eda834, the association of the previous value with the label attribute, addresses only one of the media connections of the UAC session (in this case, the audio stream); since, as it will be clearer in the scenario examples, the explicit identifiers in requests can only address 'from:tag' connections, additional mechanism will be required to have a finer control upon individual media streams (i.e. by means of the <stream> element in package level requests).

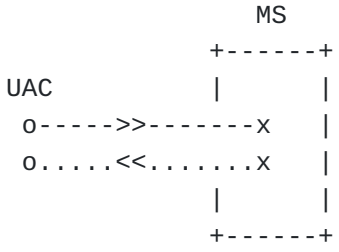
The mapping the AS makes between the UACs<->AS and the AS<->MS SIP dialogs is instead out of scope for this document: we just assume that the AS knows how to address the right connection according to the related session it has with a UAC (e.g. to play an announcement to a specific UAC), which is obviously very important considering the AS is responsible for all the business logic of the multimedia application it provides.

6.1. Echo Test

The echo test is the simpliest example scenario that can be achieved by means of a Media Server. It basically consists of a UAC directly or indirectly "talking" to itself. A media perspective of such a scenario is depicted in Figure 20.



From the framework point of view, when the UAC's leg is not attached to anything yet, what appears is described in Figure 21: since there's no connection involving the UAC yet, the frames it might be sending are discarded, and nothing is sent to it (except for silence, if it is requested to be transmitted).



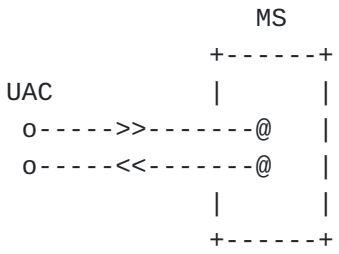
Starting from these considerations, two different approaches to the Echo Test scenario are explored in this document in the following paragraphs:

1. a Direct Echo Test approach, where the UAC directly talks to itself;

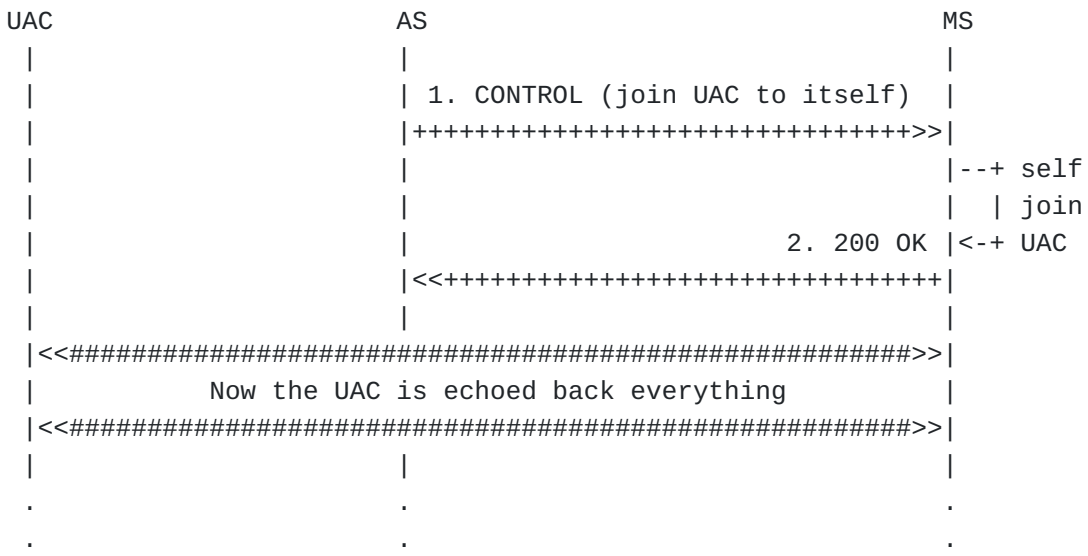
2. a Recording-based Echo Test approach, where the UAC indirectly talks to itself.

6.1.1. Direct Echo Test

In the Direct Echo Test approach, the UAC is directly connected to itself. This means that, as depicted in Figure 22, each frame the MS receives from the UAC is sent back to it in real-time.



In the framework this can be achieved by means of the conference control package, which is in charge of joining connections and conferences.
A sequence diagram of a potential transaction is depicted in Figure 23:



All the transaction steps have been numbered to ease the understanding. A reference to the above numbered messages is in fact made in the following explanation lines:

- The AS requests the joining of the connection to itself by sending a CONTROL request (1), specifically meant for the conferencing control package (msc-mixer/1.0), to the MS: since the connection must be attached to itself, both id1 and id2 attributes are set to the same value, i.e. the connectionid;

- The MS, having checked the validity of the request, enforces the joining of the connection to itself; this means that all the frames sent by the UAC are sent back to it; to report the result of the operation, the MS sends a 200 OK (2) in reply to the AS, thus ending the transaction; the transaction ended successfully,

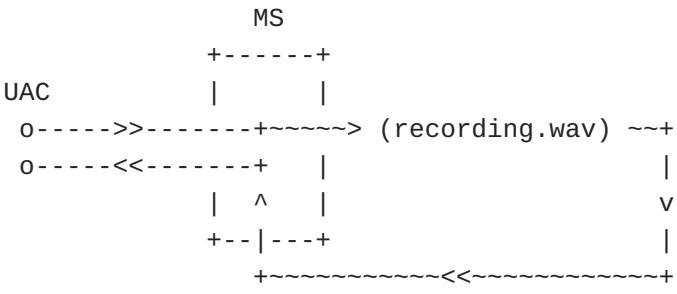
as testified by the body of the message (the 200 status code in the <response> tag).

The complete transaction, that is the full bodies of the exchanged messages, is provided in the following lines:

```
1. AS -> MS (CFW CONTROL)
-------------------------
   CFW 4fed9bf147e2 CONTROL
   Control-Package: msc-mixer/1.0
   Content-Type: application/msc-mixer+xml
   Content-Length: 130

   <mscmixer version="1.0" xmlns="urn:ietf:params:xml:ns:msc-mixer">
      <join id1="10514b7f:6a900179" id2="10514b7f:6a900179"/>
   </mscmixer>


2. AS <- MS (CFW 200 OK)
------------------------
   CFW 4fed9bf147e2 200
   Timeout: 10
   Content-Type: application/msc-mixer+xml
   Content-Length: 125

   <mscmixer version="1.0" xmlns="urn:ietf:params:xml:ns:msc-mixer">
      <response status="200" reason="Join successful"/>
   </mscmixer>
```

6.1.2. Echo Test based on Recording

In the Recording-based Echo Test approach, instead, the UAC is NOT directly connected to itself, but rather indirectly. This means that, as depicted in Figure 25, each frame the MS receives from the UAC is first recorded: then, when the recording process is ended, the whole recorded frames are played back to the UAC as an announcement.

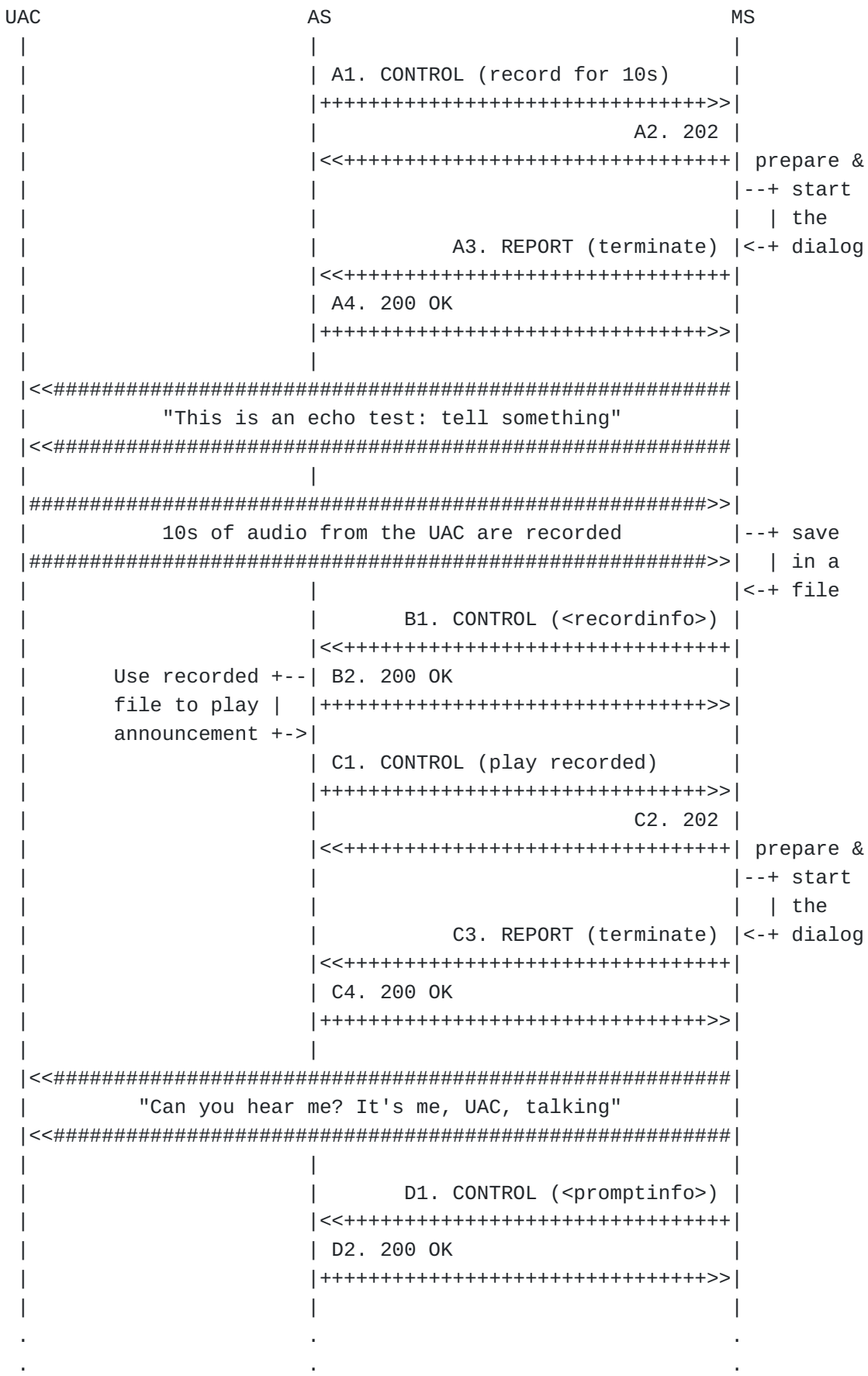


In the framework this can be achieved by means of the IVR control package, which is in charge of both the recording and the playout phases. However, the whole scenario cannot be accomplished in a single transaction; at least two steps, in fact, need to be performed:

1. first, a recording (preceded by an announcement, if requested) must take place;

2. then, a playout of the previously recorded media must occur.

This means that two separate transactions need to be invoked. A sequence diagram of a potential multiple transaction is depicted in Figure 26:


UAC
AS
MS
A1. CONTROL (record for 10s)
A2. 202
prepare &
start
the
dialog
A3. REPORT (terminate)
A4. 200 OK
"This is an echo test: tell something"
10s of audio from the UAC are recorded
save
in a
file
B1. CONTROL (<recordinfo>)
B2. 200 OK
Use recorded
file to play
announcement
C1. CONTROL (play recorded)
C2. 202
prepare &
start
the
dialog
C3. REPORT (terminate)
C4. 200 OK
"Can you hear me? It's me, UAC, talking"
D1. CONTROL (<promptinfo>)
D2. 200 OK

The first, obvious difference that comes out when looking at the diagram is that, unlike what happened in the Direct Echo example, the MS does not reply with a 200 message to the CONTROL request originated by the AS. Instead, a 202 provisional message is sent first, followed by a REPORT message. The 202+REPORT(s) mechanism is used whenever the MS wants to tell the AS that the requested operation might take some more time than expected. So, while the <join> operation in the Direct Echo scenario was expected to be fulfilled in a very short time, the IVR request was assumed to last longer instead. A 202 message provides a timeout value and tells the AS to wait a bit, since the preparation of the dialog might not be an immediate task. In this example, the preparation ends before the timeout, and so the transaction is concluded with a 'REPORT terminate', which acts as the 200 message in the previous example. In case the preparation took longer than the timeout, an additional 'REPORT update' would have been sent with a new timeout value, and so on until completion by means of a 'REPORT terminate'.
Notice that the REPORT mechanism depicted is only shown to clarify its behaviour. In fact, the 202+REPORT mechanism is assumed to be involved only when the requested transaction is expected to take a long time (e.g. retrieving a large media file for a prompt from an external server). In this scenario the transaction would be prepared in much less time, and as a consequence would very likely be completed within the context of a simple CONTROL+200 request/response. The following scenarios will only involve 202+REPORTs when they are strictly necessary.
About the dialog itself, notice how the AS-originated CONTROL transactions are terminated as soon as the requested dialogs start: as specified in [RFC6231], the MS makes use of a framework CONTROL message to report the result of the dialog and how it has proceeded. The two transactions (the AS-generated CONTROL request and the MS-generated CONTROL event) are correlated by means of the associated dialog identifier, as it will be clearer from the following lines. As before, all the transaction steps have been numbered to ease the understanding and the following of the subsequent explanation lines. Besides, the two transactions are distinguished by the preceding letter (A,B=recording, C,D=playout).

*The AS, as a first transaction, invokes a recording on the UAC connection by means of a CONTROL request (A1); the body is for the IVR package (msc-ivr/1.0), and requests the start (dialogstart) of a new recording context (<record>); the recording must be preceded by an announcement (<prompt>), must not last longer than 10s (maxtime), and cannot be interrupted by a DTMF tone (dtmfterm=false); this has only to be done once (repeatCount), which means that if the recording does not succeed

the first time, the transaction must fail; a video recording is requested (considering the associated connection includes both audio and video and no restriction is enforced on streams to record), which is to be fed by both the negotiated media streams; a beep has to be played (beep) right before the recording starts to notify the UAC;

*As seen before, the MS sends a provisional 202 response, to let the AS know the operation might need some time;

*In the meanwhile, the MS prepares the dialog (e.g. by retrieving the announcement file, for which a HTTP URL is provided, and by checking that the request is well formed) and if all is fine it starts it, notifying the AS about it with a new REPORT (A3) with a terminated status; as explained previously, interlocutory REPORT messages with an update status would have been sent in case the preparation took longer than the timeout provided in the 202 message (e.g. if retrieving the resource via HTTP took longer than expected); once the dialog has been prepared and started, the UAC connection is then passed to the IVR package, which first plays the announcement on the connection, followed by a beep, and then records all the incoming frames to a buffer; the MS also provides the AS with an unique dialog identifier (dialogid) which will be used in all subsequent event notifications concerning the dialog it refers to;

*The AS acks the latest REPORT (A4), thus terminating this transaction, waiting for the result to come;

*Once the recording is over, the MS prepares a notification CONTROL (B1); the <event> body is prepared with an explicit reference to the previously provided dialogid identifier, in order to make the AS aware of the fact that the notification is related to that specific dialog; the event body is then completed with the recording related information (<recordinfo>) , in this case the path to the recorded file (here a HTTP URL) which can be used by the AS for whatever it needs to; the payload also contains information about the prompt (<promptinfo>), which is however not relevant to the scenario;

*The AS concludes this first recording transaction by acking the CONTROL event (B2).

Now that the first transaction has ended, the AS has the 10s recording of the UAC talking. It can let the UAC hear it by having the MS play it to the MS as an announcement:

*The AS, as a second transaction, invokes a playout on the UAC connection by means of a new CONTROL request (C1); the body is

once againg for the IVR package (msc-ivr/1.0), but this time it requests the start (dialogstart) of a new announcement context (<prompt>); the file to be played is the one recorded before (prompts), and has only to be played once (iterations);

*Again, the usual provisional 202 (C2) takes place;

*In the meanwhile, the MS prepares the new dialog and starts it, notifying the AS about it with a new REPORT (C3) with a terminated status: the connection is then passed to the IVR package, which plays the file on it;

*The AS acks the terminating REPORT (C4), now waiting for the announcement to end;

*Once the playout is over, the MS sends a CONTROL event (D1) which contains in its body (<promptinfo>) information about the just concluded announcement; as before, the proper dialogid is used as a reference to the correct dialog;

*The AS concludes this second and last transaction by acking the CONTROL event (D2).

As in the previous paragraph, the whole CFW interaction is provided for a more in depth evaluation of the protocol interaction.

```
A1. AS -> MS (CFW CONTROL, record)
---------------------------------
   CFW 796d83aa1ce4 CONTROL
   Control-Package: msc-ivr/1.0
   Content-Type: application/msc-ivr+xml
   Content-Length: 265

   <mscivr version="1.0" xmlns="urn:ietf:params:xml:ns:msc-ivr">
     <dialogstart connectionid="10514b7f:6a900179">
       <dialog>
         <prompt>
           <media \
             loc="http://www.example.com/demo/echorecord.mpg"/>
         </prompt>
         <record beep="true" maxtime="10s"/>
       </dialog>
     </dialogstart>
   </mscivr>


A2. AS <- MS (CFW 202)
----------------------
   CFW 796d83aa1ce4 202


A3. AS <- MS (CFW REPORT terminate)
-----------------------------------
   CFW 796d83aa1ce4 REPORT
   Seq: 1
   Status: terminate
   Timeout: 25
   Content-Type: application/msc-ivr+xml
   Content-Length: 137

   <mscivr version="1.0" xmlns="urn:ietf:params:xml:ns:msc-ivr">
      <response status="200" reason="Dialog started" \
                dialogid="68d6569"/>
   </mscivr>


A4. AS -> MS (CFW 200, ACK to 'REPORT terminate')
-------------------------------------------------
   CFW 796d83aa1ce4 200
   Seq: 1


B1. AS <- MS (CFW CONTROL event)
--------------------------------
   CFW 0eb1678c0bfc CONTROL
```

```
   Control-Package: msc-ivr/1.0
   Content-Type: application/msc-ivr+xml
   Content-Length: 403

   <mscivr version="1.0" xmlns="urn:ietf:params:xml:ns:msc-ivr">
     <event dialogid="68d6569">
       <dialogexit status="1" reason="Dialog successfully completed">
         <promptinfo duration="9987" termmode="completed"/>
         <recordinfo duration="10017" termmode="maxtime">
           <mediainfo \
  loc="http://www.example.net/recordings/recording-68d6569.mpg" \
  type="video/mpeg" size="591872"/>
         </recordinfo>
       </dialogexit>
     </event>
   </mscivr>


B2. AS -> MS (CFW 200, ACK to 'CONTROL event')
----------------------------------------------
   CFW 0eb1678c0bfc 200


C1. AS -> MS (CFW CONTROL, play)
--------------------------------
   CFW 1632eead7e3b CONTROL
   Control-Package: msc-ivr/1.0
   Content-Type: application/msc-ivr+xml
   Content-Length: 241

   <mscivr version="1.0" xmlns="urn:ietf:params:xml:ns:msc-ivr">
     <dialogstart connectionid="10514b7f:6a900179">
       <dialog>
         <prompt>
           <media \
  loc="http://www.example.net/recordings/recording-68d6569.mpg"/>
         </prompt>
       </dialog>
     </dialogstart>
   </mscivr>


C2. AS <- MS (CFW 202)
----------------------
   CFW 1632eead7e3b 202


C3. AS <- MS (CFW REPORT terminate)
-----------------------------------
   CFW 1632eead7e3b REPORT
```

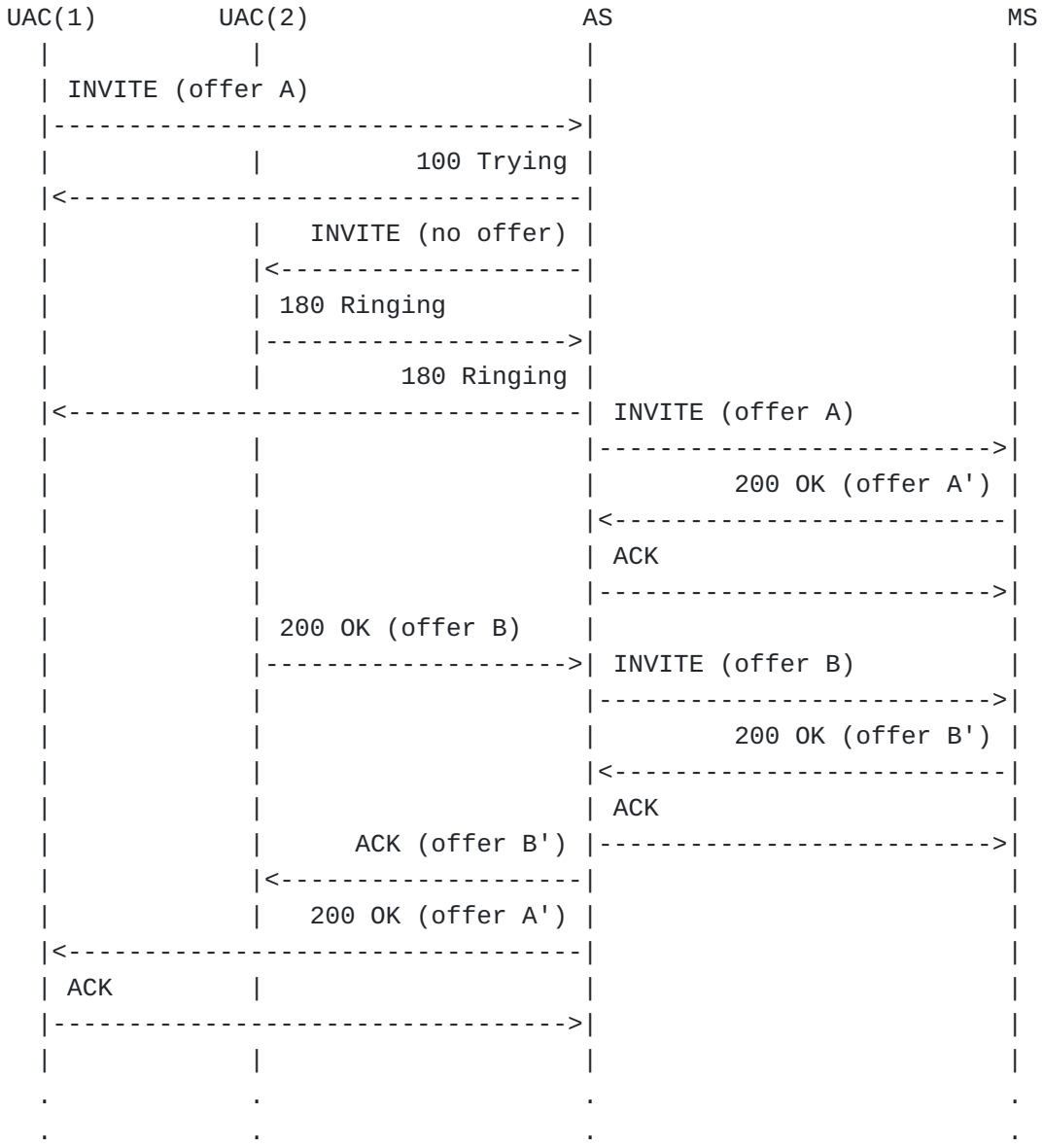
```
   Seq: 1
   Status: terminate
   Timeout: 25
   Content-Type: application/msc-ivr+xml
   Content-Length: 137

   <mscivr version="1.0" xmlns="urn:ietf:params:xml:ns:msc-ivr">
      <response status="200" reason="Dialog started" \
                dialogid="5f5cb45"/>
   </mscivr>


C4. AS -> MS (CFW 200, ACK to 'REPORT terminate')
-------------------------------------------------
   CFW 1632eead7e3b 200
   Seq: 1


D1. AS <- MS (CFW CONTROL event)
--------------------------------
   CFW 502a5fd83db8 CONTROL
   Control-Package: msc-ivr/1.0
   Content-Type: application/msc-ivr+xml
   Content-Length: 230

   <mscivr version="1.0" xmlns="urn:ietf:params:xml:ns:msc-ivr">
     <event dialogid="5f5cb45">
       <dialogexit status="1" reason="Dialog successfully completed">
         <promptinfo duration="10366" termmode="completed"/>
       </dialogexit>
     </event>
   </mscivr>


D2. AS -> MS (CFW 200, ACK to 'CONTROL event')
----------------------------------------------
   CFW 502a5fd83db8 200
```

6.2. Phone Call

Another scenario that might involve the interaction between an AS and a MS is the classic phone call between two UACs. In fact, even though the most straightforward way to achieve this would be to let the UACs negotiate the session and the media to make use of between themselves, there are cases when the services provided by a MS might prove useful for phone calls as well.
One of these cases is when the two UACs have no common supported codecs: having the two UACs directly negotiate the session would result

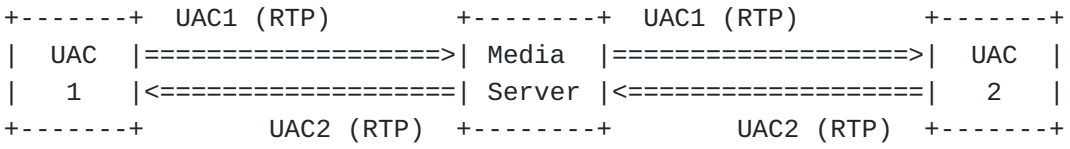
in a session with no available media. Involving the MS as a transcoder would instead allow the two UACs to communicate anyway. Another interesting case is when the AS (or any other entity the AS is working in behalf of) is interested in manipulating or monitoring the media session between the UACs, e.g. to record the conversation: a similar scenario will be dealt with in Section 6.2.2.

Before proceeding in looking at how such a scenario might be accomplished by means of the Media Control Channel Framework, it is worth spending a couple of words upon how the SIP signaling involving all the interested parties might look like. In fact in such a scenario a 3PCC approach is absolutely needed. An example is provided in Figure 28. Again, the presented example is not at all to be considered best common practice when 3PCC is needed in a MediaCtrl-based framework. It is only described in order to let the reader more easily understand what are the requirements on the MS side, and as a consequence which information might be required. [RFC3725] provides a much more detailed overview on 3PCC patterns in several use cases. Only an explanatory sequence diagram is provided, without delving into the details of the exchanged SIP messages.

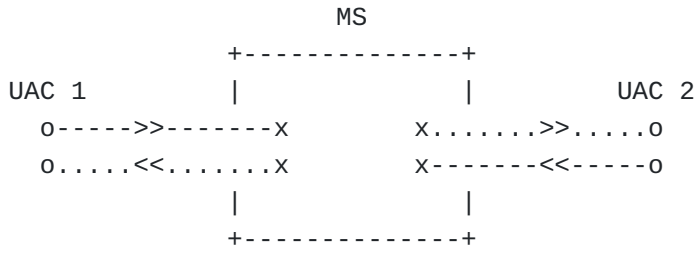


In the example, the UAC1 wants to place a phone call to UAC2. To do so, it sends an INVITE to the AS with its offer A. The AS sends an offerless INVITE to UAC2. When the UAC2 responds with a 180, the same message is forwarded by the AS to the UAC1 to notify it the callee is ringing. In the meanwhile, the AS also adds a leg to the MS for UAC1, as explained in the previous sections: to do so it of course makes use of the offer A the UAC1 made. Once the UAC2 accepts the call, by providing its own offer B in the 200, the AS adds a leg for it too to the MS. At this point, the negotiation can be completed by providing the two UACs with the SDP answer negotiated by the MS with them (A' and B' respectively).
This is only one way to deal with the signaling, and shall not absolutely be considered as a mandatory approach of course.

Once the negotiation is over, the two UACs are not in communication yet. In fact, it's up to the AS now to actively trigger the MS into attaching their media streams to each other someway, by referring to the connection identifiers associated with the UACs as explained previously. This document presents two different approaches that might be followed, according to what needs to be accomplished. A generic media perspective of the phone call scenario is depicted in Figure 29: the MS is basically in the media path between the two UACs.

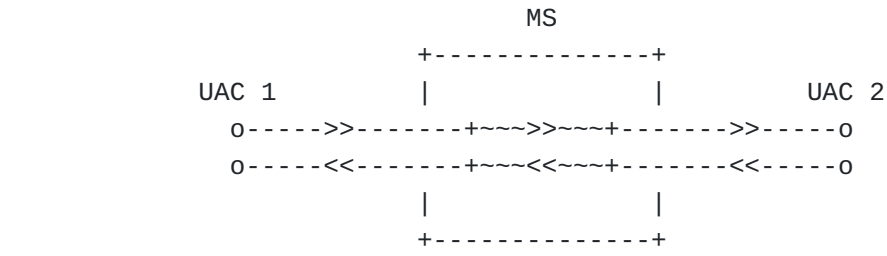


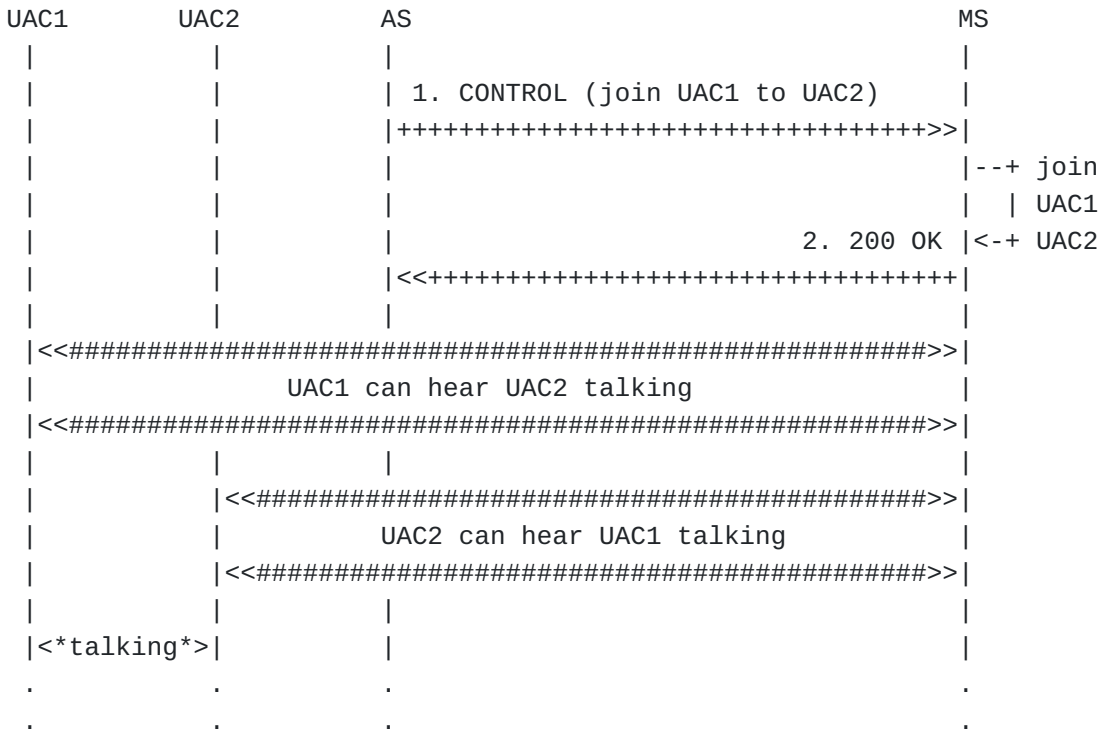
From the framework point of view, when the UACs' legs are not attached to anything yet, what appears is described in Figure 30: since there are no connections involving the UACs yet, the frames they might be sending are discarded, and nothing is sent to them (except for silence, if it is requested to be transmitted).



6.2.1. Direct Connection

The Direct Connection is the easiest and more straightforward approach to get the phone call between the two UACs to work. The idea is basically the same as the one in the Direct Echo approach: a <join> directive is used to directly attach one UAC to the other, by exploiting the MS to only deal with the transcoding/adaption of the flowing frames, if needed.
This approach is depicted in Figure 31.





The framework transactions needed to accomplish this scenario are very trivial and easy to understand. They basically are the same as the ones presented in the Direct Echo Test scenario, with the only difference being in the provided identifiers. In fact, this time the MS is not supposed to attach the UACs' media connections to themselves, but has to join the media connections of two different UACs, i.e. UAC1 and UAC2. This means that, in this transaction, id1 and i2 will have to address the media connections of UAC1 and UAC2. In case of a successful transaction, the MS takes care of forwarding all media coming from UAC1 to UAC2 and vice versa, transparently taking care of any required transcoding steps, if necessary.

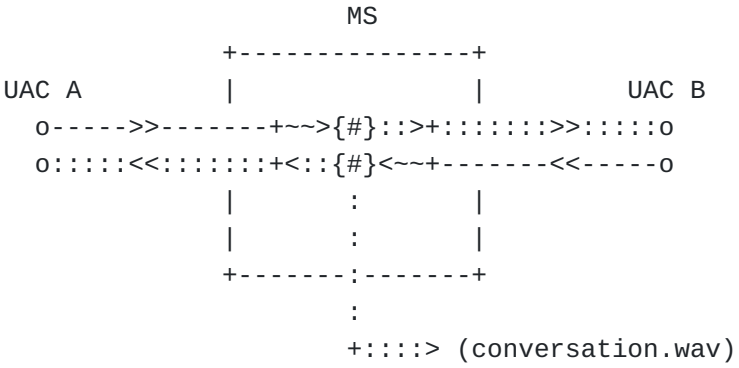
```
1. AS -> MS (CFW CONTROL)
-------------------------
   CFW 0600855d24c8 CONTROL
   Control-Package: msc-mixer/1.0
   Content-Type: application/msc-mixer+xml
   Content-Length: 130

   <mscmixer version="1.0" xmlns="urn:ietf:params:xml:ns:msc-mixer">
      <join id1="10514b7f:6a900179" id2="e1e1427c:1c998d22"/>
   </mscmixer>


2. AS <- MS (CFW 200 OK)
------------------------
   CFW 0600855d24c8 200
   Timeout: 10
   Content-Type: application/msc-mixer+xml
   Content-Length: 125

   <mscmixer version="1.0" xmlns="urn:ietf:params:xml:ns:msc-mixer">
      <response status="200" reason="Join successful"/>
   </mscmixer>
```

Such a simple approach has its drawbacks. For instance, with such an approach recording a conversation between two users might be tricky to accomplish. In fact, since no mixing would be involved, only the single connections (UAC1<->MS and UAC2<->MS) could be recorded. If the AS wants a conversation recording service to be provided anyway, it needs additional business logic on its side. An example of such a use case is provided in Section 6.2.3.

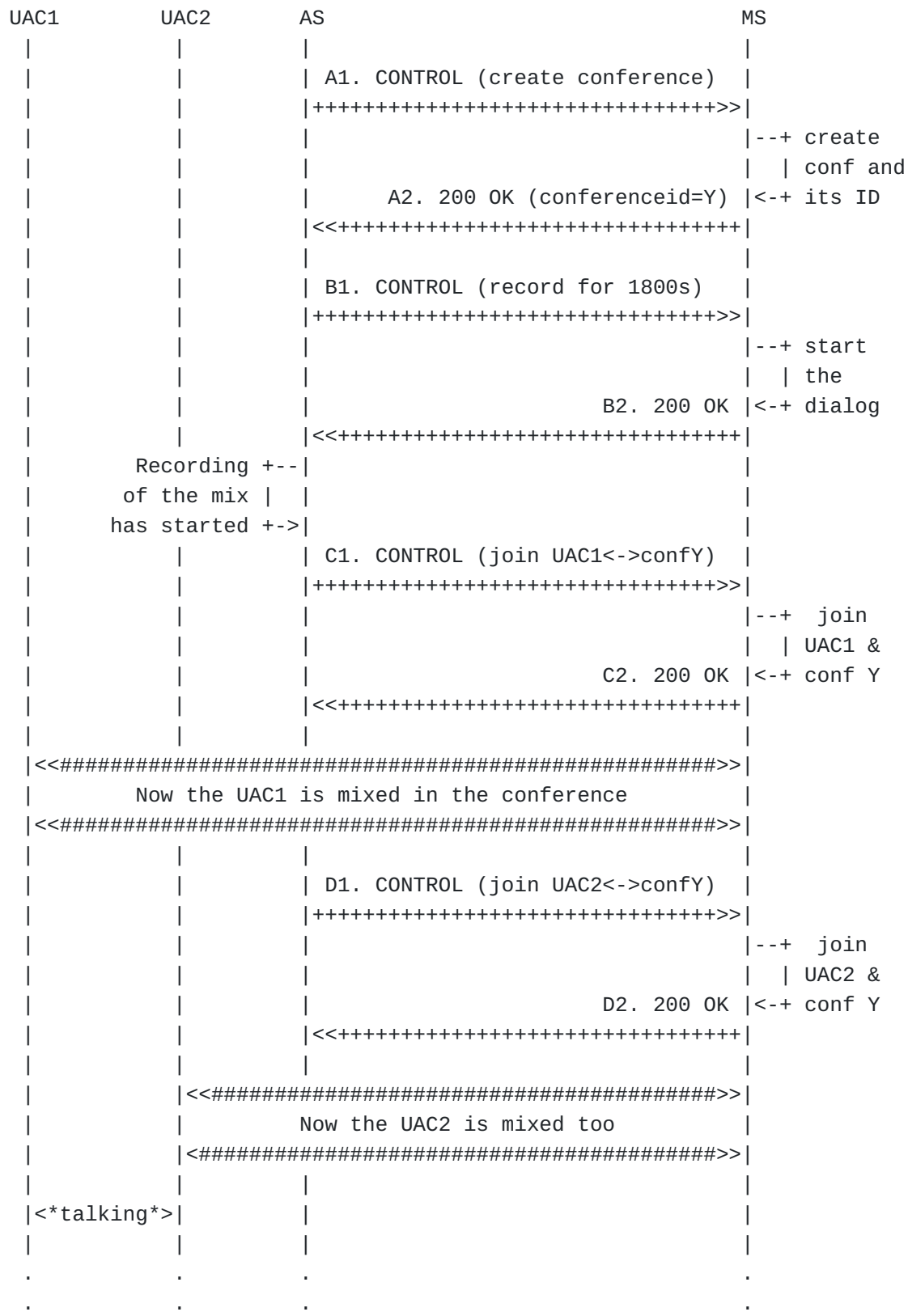
6.2.2. Conference-based Approach

The approach described in Section 6.2.1 surely works for a basic phone call, but as already explained might have some drawbacks whenever more advanced features are needed. For intance, you can't record the whole conversation, only the single connections, since no mixing is involved. Besides, even the single task of playing an announcement over the conversation could be complex, especially if the MS does not support implicit mixing over media connections. For this reason, in more advanced cases a different approach might be taken, like the conference-based approach described in this section.
The idea is to make use of a mixing entity in the MS that acts as a bridge between the two UACs: the presence of this entity allows for more customization on what needs to be done on the conversation, like the recording of the conversation that has been provided as an example. The approach is depicted in Figure 34. The mixing functionality in the

MS will be described in more detail in the following section (which deals with many conference-related scenarios), so only some hints will be provided here for a basic comprehension of the approach.



To identify a single sample scenario, let's consider a phone call the AS wants to be recorded.
Figure 35 shows how this could be accomplished in the Media Control Channel Framework: the example, as usual, hides the previous interaction between the UACs and the AS, and instead focuses on the control channel operations and what follows.


UAC1
UAC2
AS
MS
A1. CONTROL (create conference)
create conf and its ID
A2. 200 OK (conferenceid=Y)
B1. CONTROL (record for 1800s)
start the dialog
B2. 200 OK
Recording of the mix has started
C1. CONTROL (join UAC1<->confY)
join UAC1 & conf Y
C2. 200 OK
Now the UAC1 is mixed in the conference
D1. CONTROL (join UAC2<->confY)
join UAC2 & conf Y
D2. 200 OK
Now the UAC2 is mixed too
<*talking*>

The AS makes use of two different packages to accomplish this scenario: the mixer package (to create the mixing entity and join the UACs) and the IVR package (to record what happens in the conference). The framework transaction steps can be described as follows:

*First of all, the AS creates a new hidden conference by means of a 'createconference' request (A1); this conference is properly configured according to the use it is assigned to; in fact, since only two participants will be joined to it, both 'reserved-talkers' and 'reserved-listeners' are set to 2, just as the 'n' value for the N-best audio mixing algorithm; besides, the video layout as well is set accordingly (single-view/dual-view);

*the MS notifies the successful creation of the new conference in a 200 framework message (A2); the identifier assigned to the conference, which will be used in subsequent requests addressed to it, is 6013f1e;

*the AS requests a new recording upon the newly created conference; to do so, it places a proper request to the IVR package (B1); the AS is interested in a video recording (type=video/mpeg), which must not last longer than 3 hours (maxtime=1800s), after which the recording must end; besides, no beep must be played on the conference (beep=false), and the recording must start immediately whether or not any audio activity has been reported (vadinitial=false);

*the transaction is handled by the MS, and when the dialog has been successfully started, a 200 OK is issued to the AS (B2); the message contains the dialogid associated with the dialog (00b29fb), which the AS must refer to for later notifications;

*at this point, the AS attaches both UACs to the conference with two separate 'join' directives (C1/D1); when the MS confirms the success of both operations (C2/D2), the two UACs are actually in contact with each other (even though indirectly, since a hidden conference they're unaware of is on their path) and their media contribution is recorded.

```
A1. AS -> MS (CFW CONTROL, createconference)
-------------------------------------------
   CFW 238e1f2946e8 CONTROL
   Control-Package: msc-mixer
   Content-Type: application/msc-mixer+xml
   Content-Length: 395

   <mscmixer version="1.0" xmlns="urn:ietf:params:xml:ns:msc-mixer">
      <createconference reserved-talkers="2" reserved-listeners="2">
         <audio-mixing type="nbest" n="2"/>
         <video-layouts>
            <video-layout min-participants='1'>
               <single-view/>
            </video-layout>
            <video-layout min-participants='2'>
               <dual-view/>
            </video-layout>
         </video-layouts>
         <video-switch>
            <controller/>
         </video-switch>
      </createconference>
   </mscmixer>


A2. AS <- MS (CFW 200 OK)
-------------------------
   CFW 238e1f2946e8 200
   Timeout: 10
   Content-Type: application/msc-mixer+xml
   Content-Length: 151

   <mscmixer version="1.0" xmlns="urn:ietf:params:xml:ns:msc-mixer">
      <response status="200" reason="Conference created" \
                conferenceid="6013f1e"/>
   </mscmixer>


B1. AS -> MS (CFW CONTROL, record)
----------------------------------
   CFW 515f007c5bd0 CONTROL
   Control-Package: msc-ivr
   Content-Type: application/msc-ivr+xml
   Content-Length: 207

   <mscivr version="1.0" xmlns="urn:ietf:params:xml:ns:msc-ivr">
      <dialogstart conferenceid="6013f1e">
         <dialog>
            <record beep="false" maxtime="1800s"/>
```

```
         </dialog>
      </dialogstart>
   </mscivr>
```

B2. AS <- MS (CFW 200 OK)

```
   CFW 515f007c5bd0 200
   Timeout: 10
   Content-Type: application/msc-ivr+xml
   Content-Length: 137

   <mscivr version="1.0" xmlns="urn:ietf:params:xml:ns:msc-ivr">
     <response status="200" reason="Dialog started" dialogid="00b29fb"/>
   </mscivr>
```

C1. AS -> MS (CFW CONTROL, join)

```
   CFW 0216231b1f16 CONTROL
   Control-Package: msc-mixer
   Content-Type: application/msc-mixer+xml
   Content-Length: 123

   <mscmixer version="1.0" xmlns="urn:ietf:params:xml:ns:msc-mixer">
      <join id1="10514b7f:6a900179" id2="6013f1e"/>
   </mscmixer>
```

C2. AS <- MS (CFW 200 OK)

```
   CFW 0216231b1f16 200
   Timeout: 10
   Content-Type: application/msc-mixer+xml
   Content-Length: 125

   <mscmixer version="1.0" xmlns="urn:ietf:params:xml:ns:msc-mixer">
      <response status="200" reason="Join successful"/>
   </mscmixer>
```

D1. AS -> MS (CFW CONTROL, join)

```
   CFW 140e0f763352 CONTROL
   Control-Package: msc-mixer
   Content-Type: application/msc-mixer+xml
   Content-Length: 124

   <mscmixer version="1.0" xmlns="urn:ietf:params:xml:ns:msc-mixer">
      <join id1="219782951:0b9d3347" id2="6013f1e"/>
```

```
   </mscmixer>


D2. AS <- MS (CFW 200 OK)
-------------------------
   CFW 140e0f763352 200
   Timeout: 10
   Content-Type: application/msc-mixer+xml
   Content-Length: 125

   <mscmixer version="1.0" xmlns="urn:ietf:params:xml:ns:msc-mixer">
      <response status="200" reason="Join successful"/>
   </mscmixer>
```

The recording of the conversation can subsequently be accessed by the AS by waiting for an event notification from the MS: this event, which will be associated with the previously started recording dialog, will contain the URI to the recorded file. Such an event may be triggered either by a natural completion of the dialog (e.g. the dialog has reached its programmed 3 hours) or by any interruption of the dialog itself (e.g. the AS actively requests the recording to be interrupted since the call between the UACs ended).

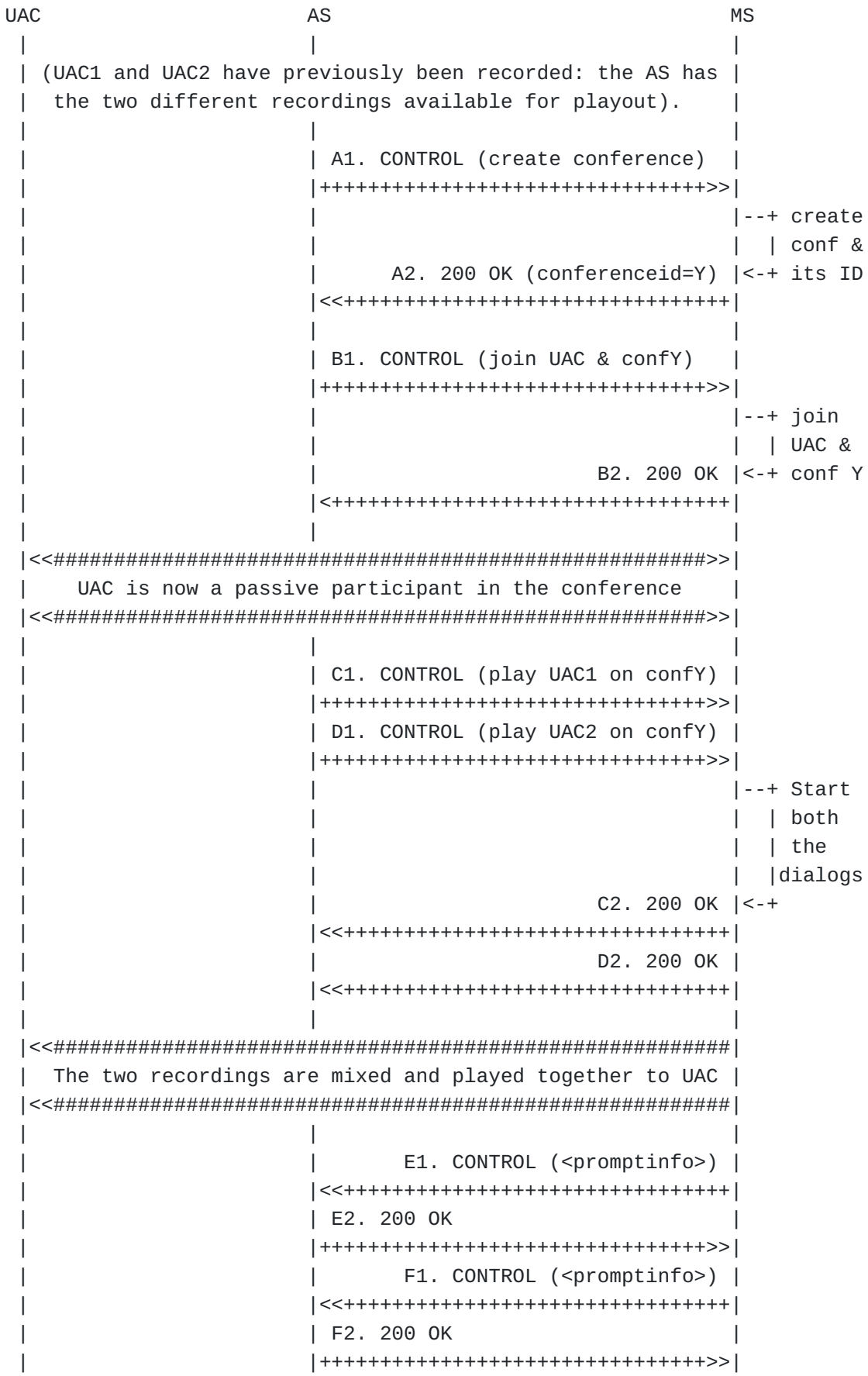
6.2.3. Recording a conversation

The previous section described how to take advantage of the conferencing functionality of the mixer package in order to allow the recording of phone calls in a simple way. However, making use of a dedicated mixer just for a phone call might be considered overkill. This section shows how recording a conversation and playing it out subsequently can be accomplished without a mixing entity involved in the call, that is by using the direct connection approach as described in Section 6.2.1.
As already explained previously, in case the AS wants to record a phone call between two UACs, the use of just the <join> directive without a mixer forces the AS to just rely on separate recording commands. That is, the AS can only instruct the MS to separately record the media flowing on each media leg: a recording for all the data coming from UAC1, and a different recording for all the data coming from UAC2. In case someone wants to access the whole conversation subsequently, the AS may take at least two different approaches:

1. it may mix the two recordings itself (e.g. by delegating it to an offline mixing entity) in order to obtain a single file containing the combination of the two recordings; this way, a simple playout as described in Section 6.1.2 would suffice;

2. alternatively, it may take advantage of the mixing functionality provided by the MS itself; a way to do so is to create a hidden conference on the MS, attach the UAC as a passive participant to it, and play the separate recordings on the conference as announcements; this way, the UAC accessing the recording would experience both the recordings at the same time.

It is of course option 2 that is considered in this section. The framework transaction as described in Figure 37 assumes that a recording has already been requested for both UAC1 and UAC2, that the phone call has ended and that the AS has successfully received the URIs to both the recordings from the MS. Such steps are not described again since they would be quite similar to the ones described in Section 6.1.2. As anticipated, the idea is to make use of a properly constructed hidden conference to mix the two separate recordings on the fly and present them to the UAC. It is of course up to the AS to subsequently unjoin the user from the conference and destroy the conference itself once the playout of the recordings ends for any reason.


UAC
AS
MS
(UAC1 and UAC2 have previously been recorded: the AS has the two different recordings available for playout).
A1. CONTROL (create conference)
create conf & its ID
A2. 200 OK (conferenceid=Y)
B1. CONTROL (join UAC & confY)
join UAC & conf Y
B2. 200 OK
UAC is now a passive participant in the conference
C1. CONTROL (play UAC1 on confY)
D1. CONTROL (play UAC2 on confY)
Start both the dialogs
C2. 200 OK
D2. 200 OK
The two recordings are mixed and played together to UAC
E1. CONTROL (<promptinfo>)
E2. 200 OK
F1. CONTROL (<promptinfo>)
F2. 200 OK

The diagram above assumes a recording of both the channels has already taken place. It may have been requested by the AS either shortly before joining UAC1 and UAC2, or shortly after that transaction. Whenever that happened, a recording is assumed to have taken place, and so the AS is supposed to have both the recordings available for playback. Once a new user, UAC, wants to access the recorded conversation, the AS takes care of the presented transactions. The framework transaction steps are only apparently more complicated than the ones presented so far. The only difference, in fact, is that transactions C and D are concurrent, since the recordings must be played together.

*First of all, the AS creates a new conference to act as a mixing entity (A1); the settings for the conference are chosen according to the use case, e.g. the video layout which is fixed to 'dual-view' and the switching type to 'controller'; when the conference has been successfully created (A2) the AS takes note of the conference identifier;

*At this point, the UAC is attached to the conference as a passive user (B1); there would be no point in letting the user contribute to the conference mix, since he will only need to watch a recording; in order to specify his passive status, both the audio and video streams for the user are set to 'recvonly'; in case the transaction succeeds, the MS notifies it to the AS (B2);

*Once the conference has been created and UAC has been attached to it, the AS can request the playout of the recordings; in order to do so, it requests two concurrent <prompt> directives (C1 and D1), addressing respectively the recording of UAC1 and UAC2; both the prompts must be played on the previously created conference and not to UAC directly, as can be deduced from the 'conferenceid' attribute of the <dialog> element;

*The transactions live their life exactly as explained for previous <prompt> examples; the originating transactions are first prepared and started (C2, D2), and then, as soon as any of the playout ends, a realted CONTROL message to notify this is triggered by the MS (E1, F1); the notification may contain a <promptinfo> element with information about how the playout proceeded (e.g. whether the playout completed normally, or interrupted by a DTMF tone, etc.).

A1. AS -> MS (CFW CONTROL, createconference)

```
   CFW 506e039f65bd CONTROL
   Control-Package: msc-mixer/1.0
   Content-Type: application/msc-mixer+xml
   Content-Length: 312

   <mscmixer version="1.0" xmlns="urn:ietf:params:xml:ns:msc-mixer">
      <createconference reserved-talkers="0" reserved-listeners="1">
         <audio-mixing type="controller"/>
         <video-layouts>
            <video-layout min-participants='1'>
               <dual-view/>
            </video-layout>
         </video-layouts>
         <video-switch>
            <controller/>
         </video-switch>
      </createconference>
   </mscmixer>
```

A2. AS <- MS (CFW 200 OK)

```
   CFW 506e039f65bd 200
   Timeout: 10
   Content-Type: application/msc-mixer+xml
   Content-Length: 151

   <mscmixer version="1.0" xmlns="urn:ietf:params:xml:ns:msc-mixer">
      <response status="200" reason="Conference created" \
                conferenceid="2625069"/>
   </mscmixer>
```

B1. AS -> MS (CFW CONTROL, join)

```
   CFW 09202baf0c81 CONTROL
   Control-Package: msc-mixer/1.0
   Content-Type: application/msc-mixer+xml
   Content-Length: 214

   <mscmixer version="1.0" xmlns="urn:ietf:params:xml:ns:msc-mixer">
      <join id1="aafaf62d:0eac5236" id2="2625069">
         <stream media="audio" direction="recvonly"/>
         <stream media="video" direction="recvonly"/>
      </join>
   </mscmixer>
```

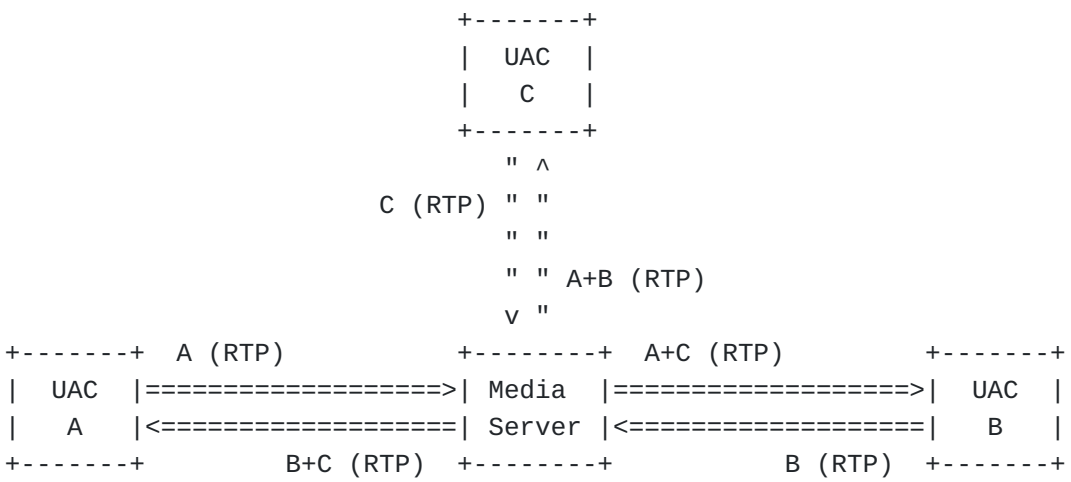
```
B2. AS <- MS (CFW 200 OK)
-------------------------
   CFW 09202baf0c81 200
   Timeout: 10
   Content-Type: application/msc-mixer+xml
   Content-Length: 125

   <mscmixer version="1.0" xmlns="urn:ietf:params:xml:ns:msc-mixer">
      <response status="200" reason="Join successful"/>
   </mscmixer>


C1. AS -> MS (CFW CONTROL, play recording from UAC1)
----------------------------------------------------
   CFW 3c2a08be4562 CONTROL
   Control-Package: msc-ivr/1.0
   Content-Type: application/msc-ivr+xml
   Content-Length: 229

   <mscivr version="1.0" xmlns="urn:ietf:params:xml:ns:msc-ivr">
      <dialogstart conferenceid="2625069">
         <dialog>
            <prompt>
               <media \
  loc="http://www.example.net/recordings/recording-4ca9fc2.mpg"/>
            </prompt>
         </dialog>
      </dialogstart>
   </mscivr>


D1. AS -> MS (CFW CONTROL, play recording from UAC2)
----------------------------------------------------
   CFW 1c268d810baa CONTROL
   Control-Package: msc-ivr/1.0
   Content-Type: application/msc-ivr+xml
   Content-Length: 229

   <mscivr version="1.0" xmlns="urn:ietf:params:xml:ns:msc-ivr">
      <dialogstart conferenceid="2625069">
         <dialog>
            <prompt>
               <media \
  loc="http://www.example.net/recordings/recording-39dfef4.mpg"/>
            </prompt>
         </dialog>
      </dialogstart>
   </mscivr>
```

```
C2. AS <- MS (CFW 200 OK)
-------------------------
   CFW 1c268d810baa 200
   Timeout: 10
   Content-Type: application/msc-ivr+xml
   Content-Length: 137

   <mscivr version="1.0" xmlns="urn:ietf:params:xml:ns:msc-ivr">
      <response status="200" reason="Dialog started" \
                dialogid="7a457cc"/>
   </mscivr>


D2. AS <- MS (CFW 200 OK)
-------------------------
   CFW 3c2a08be4562 200
   Timeout: 10
   Content-Type: application/msc-ivr+xml
   Content-Length: 137

   <mscivr version="1.0" xmlns="urn:ietf:params:xml:ns:msc-ivr">
      <response status="200" reason="Dialog started" \
                dialogid="1a0c7cf"/>
   </mscivr>


E1. AS <- MS (CFW CONTROL event, playout of recorded UAC1 ended)
----------------------------------------------------------------
   CFW 77aec0735922 CONTROL
   Control-Package: msc-ivr/1.0
   Content-Type: application/msc-ivr+xml
   Content-Length: 230

   <mscivr version="1.0" xmlns="urn:ietf:params:xml:ns:msc-ivr">
      <event dialogid="7a457cc">
         <dialogexit status="1" reason="Dialog successfully completed">
            <promptinfo duration="10339" termmode="completed"/>
         </dialogexit>
      </event>
   </mscivr>


E2. AS -> MS (CFW 200, ACK to 'CONTROL event')
----------------------------------------------
   CFW 77aec0735922 200


F1. AS <- MS (CFW CONTROL event, playout of recorded UAC2 ended)
----------------------------------------------------------------
```

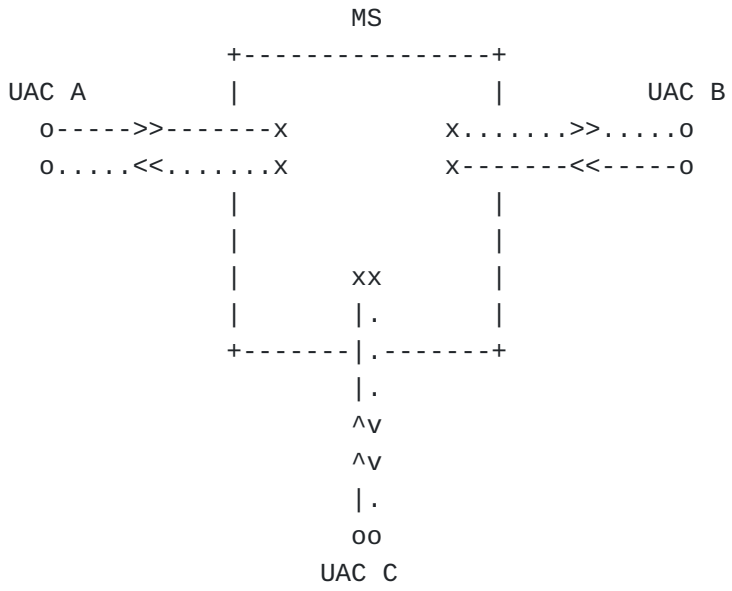
```
   CFW 62726ace1660 CONTROL
   Control-Package: msc-ivr/1.0
   Content-Type: application/msc-ivr+xml
   Content-Length: 230

   <mscivr version="1.0" xmlns="urn:ietf:params:xml:ns:msc-ivr">
      <event dialogid="1a0c7cf">
         <dialogexit status="1" reason="Dialog successfully completed">
            <promptinfo duration="10342" termmode="completed"/>
         </dialogexit>
      </event>
   </mscivr>


F2. AS -> MS (CFW 200, ACK to 'CONTROL event')
-----------------------------------------------
   CFW 62726ace1660 200
```

6.3. Conferencing

One of the most important services the MS must be able to provide is mixing. This involves mixing media streams from different sources, and delivering the resulting mix(es) to each interested party, often according to per-user policies, settings and encoding. A typical scenario involving mixing is of course media conferencing. In such a scenario, the media sent by each participant is mixed, and each participant typically receives the overall mix excluding its own contribtion and encoded in the format it negotiated. This example points out in a quite clear way how mixing must take care of the profile of each involved entity.
A media perspective of such a scenario is depicted in Figure 39.



From the framework point of view, when the UACs' legs are not attached to anything yet, what appears is described in Figure 40: since there are no connections involving the UACs yet, the frames they might be sending are discarded, and nothing is sent back to them either (except for silence, if it is requested to be transmitted).



The next subsections will cover several typical scenarios involving mixing and conferencing as a whole, specifically:

1. Simple Bridging, where the scenario will be a very basic (i.e. no "special effects", just mixing involved) conference involving one or more participants;

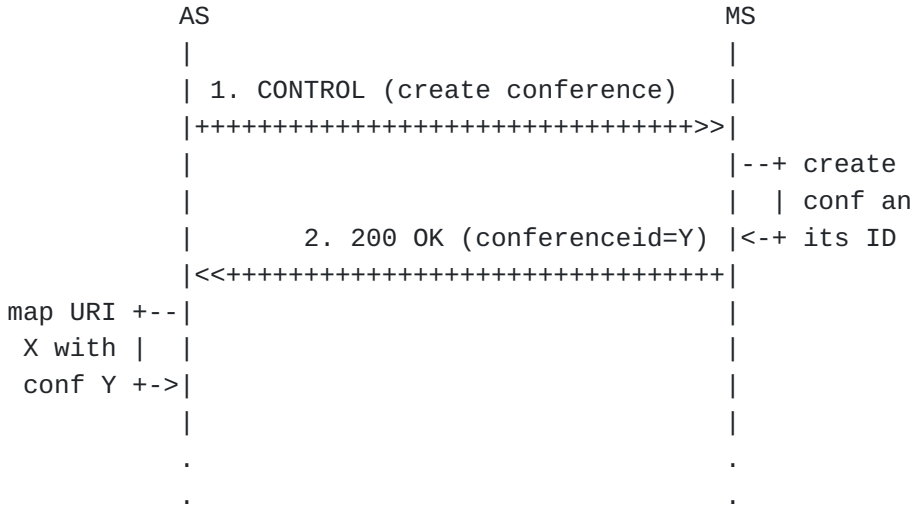
2. Rich Conference Scenario, which enriches the Simple Bridging scenario by adding additional features typically found in conferencing systems (e.g. DTMF collection for PIN-based conference access, private and global announcements, recordings and so on);

3. Coaching Scenario, a more complex scenario which involves per-user mixing (customers, agents and coaches don't get all the same mixes);

4. Sidebars Scenario, which adds more complexity to the previous conferencing scenarios by involving sidebars (i.e. separate conference instances that only exist within the context of a parent conference instance) and the custom media delivery that follows;

5. Floor Control Scenario, which provides some guidance on how floor control could be involved in a MEDIACTRL-based media conference.

All of the above mentioned scenarios depend on the availability of a mixing entity. Such an entity is provided in the Media Control Channel Framework by the conferencing package. This package in fact, besides allowing for the interconnection of media sources as seen in the Direct Echo Test section, enables the creation of abstract connections that can be joined to multiple connections: these abstract connections, called conferences, mix the contribution of each attached connection and feed them accordingly (e.g. a connection with 'sendrecv' property would be able to contribute to the mix and to listen to it, while a connection with a 'recvonly' property would only be able to listen to the overall mix but not to actively contribute to it).
That said, each of the above mentioned scenarios will start more or less in the same way: by the creation of a conference connection (or more than one, as needed in some cases) to be subsequently referred to when it comes to mixing. A typical framework transaction to create a new conference instance in the Media Control Channel Framework is depicted in Figure 41:



The call flow is quite straightforward, and can typically be summarized in the following steps:

*The AS invokes the creation of a new conference instance by means of a CONTROL request (1); this request is addressed to the conferencing package (msc-mixer/1.0) and contains in the body the directive (createconference) with all the desired settings for it; in the example, the mixing policy is to mix the five (reserved-talkers) loudest speakers (nbest), while ten listeners

at max are allowed; video settings are configured, including the mechanism used to select active video sources (controller, meaning the AS will explicitly instruct the MS about it) and details about the video layouts to make available; in this example, the AS is instructing the MS to use a single-view layout when only one video source is active, to pass to a quad-view layout when at least two video sources are active, and to use a 5x1 layout whenever the number of sources is at least five; finally, the AS also subscribes to the "active-talkers" event, which means it wants to be informed (at a rate of 4 seconds) whenever an active participant is speaking;

*The MS creates the conference instance assigning a unique identifier to it (6146dd5), and completes the transaction with a 200 response (2);

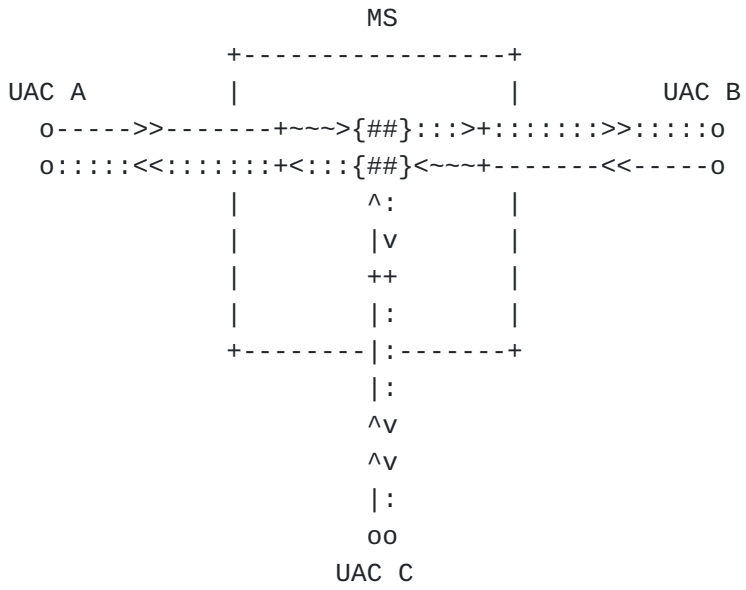
*At this point, the requested conference instance is active and ready to be used by the AS; it is then up to the AS to integrate the use of this identifier in its application logic.

```
1. AS -> MS (CFW CONTROL)
-------------------------
   CFW 3032e5fb79a1 CONTROL
   Control-Package: msc-mixer/1.0
   Content-Type: application/msc-mixer+xml
   Content-Length: 489

   <mscmixer version="1.0" xmlns="urn:ietf:params:xml:ns:msc-mixer">
     <createconference reserved-talkers="5" reserved-listeners="10">
        <audio-mixing type="nbest"/>
        <video-layouts>
          <video-layout min-participants='1'>
             <single-view/>
          </video-layout>
          <video-layout min-participants='2'>
             <quad-view/>
          </video-layout>
          <video-layout min-participants='5'>
             <multiple-5x1/>
          </video-layout>
        </video-layouts>
        <video-switch>
           <controller/>
        </video-switch>
        <subscribe>
           <active-talkers-sub interval="4"/>
        </subscribe>
     </createconference>
   </mscmixer>


2. AS <- MS (CFW 200)
---------------------
   CFW 3032e5fb79a1 200
   Timeout: 10
   Content-Type: application/msc-mixer+xml
   Content-Length: 151

   <mscmixer version="1.0" xmlns="urn:ietf:params:xml:ns:msc-mixer">
      <response status="200" reason="Conference created" \
                conferenceid="6146dd5"/>
   </mscmixer>
```

6.3.1. Simple Bridging

As already introduced before, the simplest use an AS can make of a conference instance is simple bridging. In this scenario, the

conference instance just acts as a bridge for all the participants that are attached to it. The bridge takes care of transcoding, if needed (in general, different participants may make use of different codecs for their streams), echo cancellation (each participant will receive the overall mix excluding its own contribution) and per-participant mixing (each participant may receive different mixed streams, according to what it needs/is allowed to send/receive). This assumes of course that each interested participant must be joined somehow to the bridge in order to indirectly communicate with the other paricipants. From the media perspective, the scenario can be seen as depicted in Figure 43.



In the framework, the first step is obviously to create a new conference instance as seen in the introductory section (Figure 41). Assuming a conference instance has already been created, bridging participants to it is quite straightforward, and can be accomplished as already seen in the Direct Echo Test Scenario: the only difference here is that each participant is not directly connected to itself (Direct Echo) or another UAC (Direct Connection) but to the bridge instead. Figure 44 shows the example of two different UACs joining the same conference: the example, as usual, hides the previous interaction between each of the two UACs and the AS, and instead focuses on what the AS does in order to actually join the participants to the bridge so that they can interact in a conference.

The framework transaction steps are actually quite trivial to understand, since they're very similar to some previously described scenarios. What the AS does is just joining both UAC1 (id1 in A1) and UAC2 (id1 in B1) to the conference (id2 in both transactions). As a result of these two operations, both UACs are mixed in the conference. Since no <stream> is explicitly provided in any of the transactions, all the media from the UACs (audio/video) are attached to the conference (as long as the conference has been properly configured to support both, of course).

A1. AS -> MS (CFW CONTROL)

```
   CFW 434a95786df8 CONTROL
   Control-Package: msc-mixer/1.0
   Content-Type: application/msc-mixer+xml
   Content-Length: 120

   <mscmixer version="1.0" xmlns="urn:ietf:params:xml:ns:msc-mixer">
      <join id1="e1e1427c:1c998d22" id2="6146dd5"/>
   </mscmixer>
```

A2. AS <- MS (CFW 200 OK)

```
   CFW 434a95786df8 200
   Timeout: 10
   Content-Type: application/msc-mixer+xml
   Content-Length: 125

   <mscmixer version="1.0" xmlns="urn:ietf:params:xml:ns:msc-mixer">
      <response status="200" reason="Join successful"/>
   </mscmixer>
```

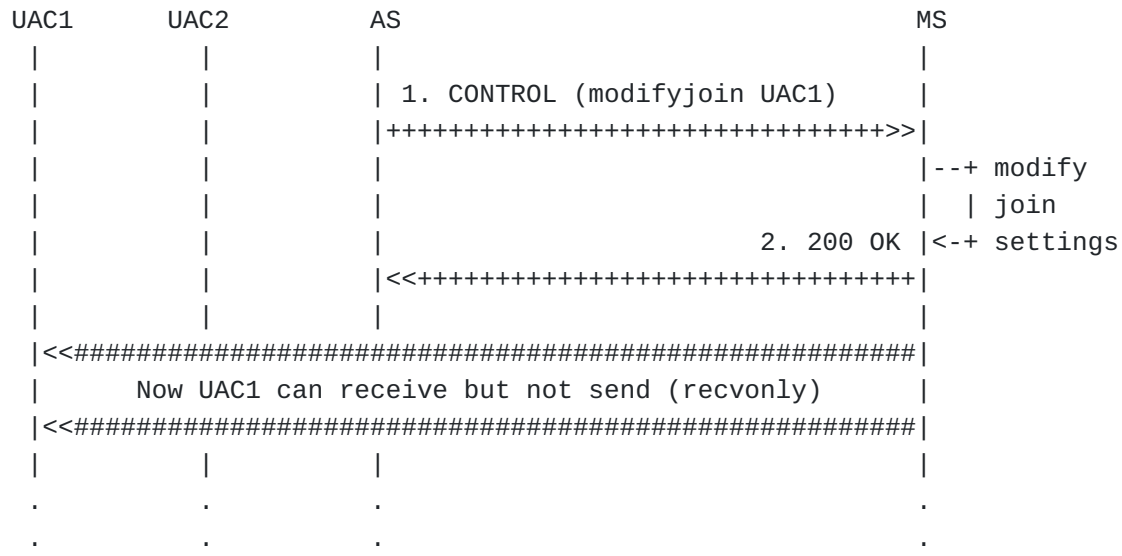
B1. AS -> MS (CFW CONTROL)

```
   CFW 5c0cbd372046 CONTROL
   Control-Package: msc-mixer/1.0
   Content-Type: application/msc-mixer+xml
   Content-Length: 120

   <mscmixer version="1.0" xmlns="urn:ietf:params:xml:ns:msc-mixer">
      <join id1="10514b7f:6a900179" id2="6146dd5"/>
   </mscmixer>
```

B2. AS <- MS (CFW 200 OK)

```
   CFW 5c0cbd372046 200
   Timeout: 10
   Content-Type: application/msc-mixer+xml
   Content-Length: 125

   <mscmixer version="1.0" xmlns="urn:ietf:params:xml:ns:msc-mixer">
      <response status="200" reason="Join successful"/>
   </mscmixer>
```

Once one or more participants have been attached to the bridge, their connections and how their media are handled by the bridge can be dynamically manipulated by means of another directive, called <modifyjoin>: a typical use case for this directive is the change of direction of an existing media (e.g. a previously speaking participant is muted, which means its media direction changes from 'sendrecv' to 'recvonly'). Figure 46 shows how a framework transaction requesting such a directive might appear.



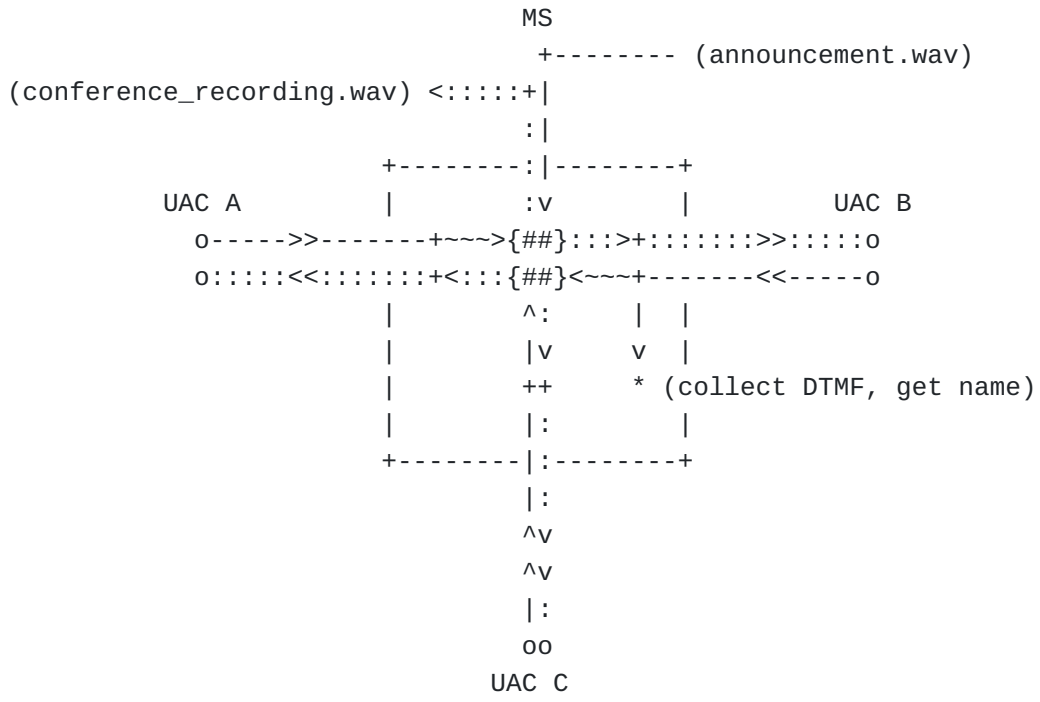
The directive used to modify an existing join configuration is <modifyjoin>, and its syntax is exactly the same as the one required in <join> instructions. In fact, the same syntax is used for identifiers (id1/id2). Whenever a modifyjoin is requested and id1 and id2 address one or more joined connections, the AS is requesting a change of the join configuration. In this case, the AS instructs the MS to mute (stream=audio, direction=recvonly) UAC1 (id1=UAC1) in the conference (id2) it has been attached to previously. Any other connection existing between them is left untouched.
It is worth noticing that the <stream> settings are enforced according to both the provided direction AND the id1 and id2 identifiers. For instance, in this example id1 refers to UAC1, while id2 to the conference in the MS. This means that the required modifications have to be applied to the stream specified in the <stream> element of the message, along the direction which goes from 'id1' to 'id2' (as specified in the <modifyjoin> element of the message). In the provided example, the AS wants to mute UAC1 with respect to the conference. To do so, the direction is set to 'recvonly', meaning that, for what concerns id1, the media stream is only to be received. If id1 referred to the conference and id2 to the UAC1, to achieve the same result the direction would have to be set to 'sendonly', meaning 'id1 (the

conference) can only send to id2 (UAC1), and no media stream must be received'. Additional settings upon a <stream> (e.g. audio volume, region assignments and so on) follow the same approach, as it is presented in subsequent sections.

```
1. AS -> MS (CFW CONTROL)
-------------------------
   CFW 57f2195875c9 CONTROL
   Control-Package: msc-mixer/1.0
   Content-Type: application/msc-mixer+xml
   Content-Length: 182

   <mscmixer version="1.0" xmlns="urn:ietf:params:xml:ns:msc-mixer">
      <modifyjoin id1="e1e1427c:1c998d22" id2="6146dd5">
         <stream media="audio" direction="recvonly"/>
      </modifyjoin>
   </mscmixer>


2. AS <- MS (CFW 200 OK)
------------------------
   CFW 57f2195875c9 200
   Timeout: 10
   Content-Type: application/msc-mixer+xml
   Content-Length: 123

   <mscmixer version="1.0" xmlns="urn:ietf:params:xml:ns:msc-mixer">
      <response status="200" reason="Join modified"/>
   </mscmixer>
```

6.3.2. Rich Conference Scenario

The previous scenario can be enriched with additional features often found in existing conferencing systems. Typical examples include IVR-based menus (e.g. the DTMF collection for PIN-based conference access), partial and complete recordings in the conference (e.g. for the "state your name" functionality and recording of the whole conference), private and global announcements and so on. All of this can be achieved by means of the functionality provided by the MS. In fact, even if the conferencing and IVR features come from different packages, the AS can interact with both of them and achieve complex results by correlating the effects of different transactions in its application logic.
From the media and framework perspective, a typical rich conferencing scenario can be seen as it is depicted in Figure 48.



To identify a single sample scenario, let's consider this sequence for a participant joining a conference (which again we assume has already been created):

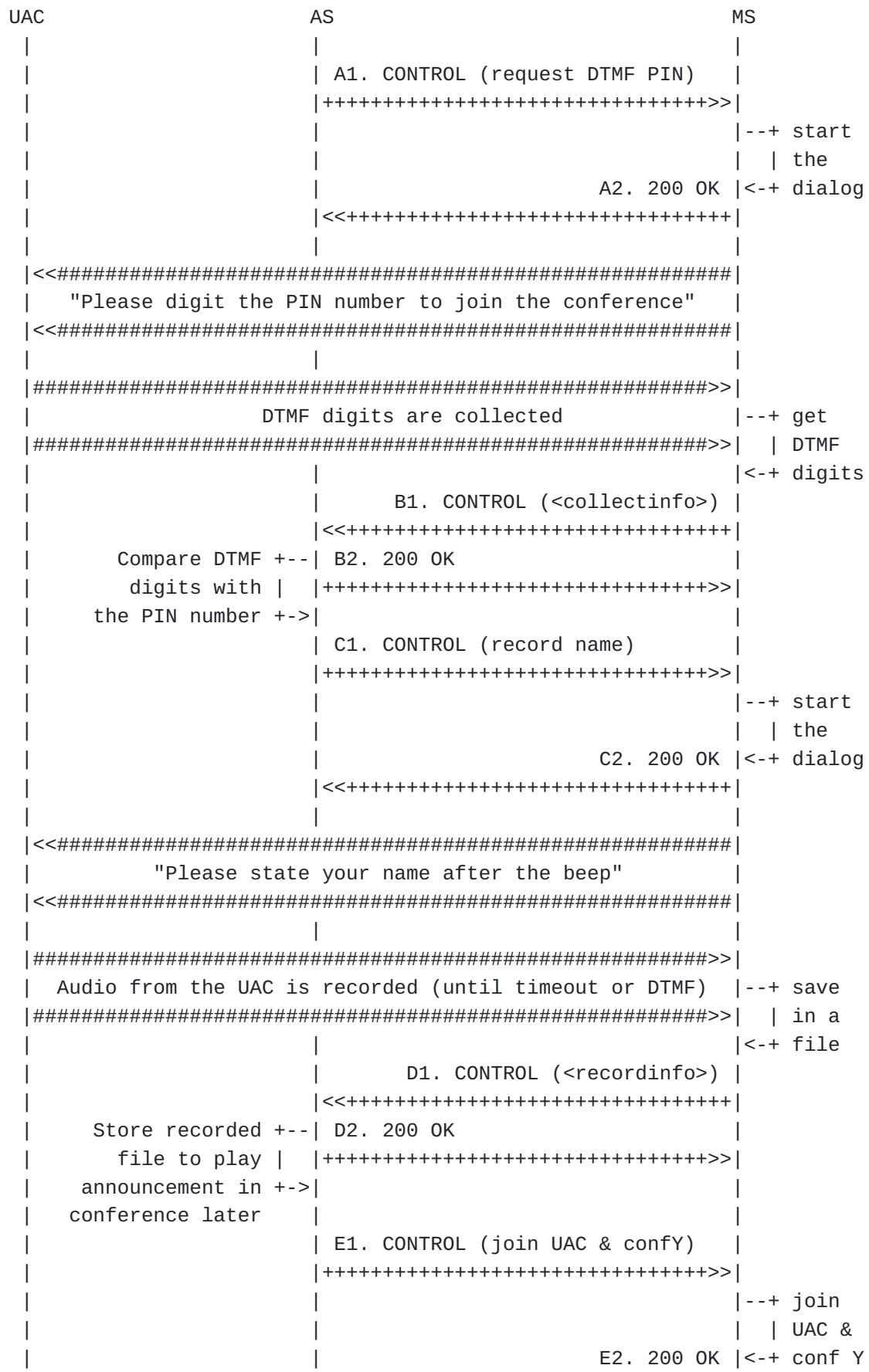
1. The UAC as usual INVITEs a URI associated with a conference, and the AS follows the already explained procedure to have the UAC negotiate a new media session with the MS;

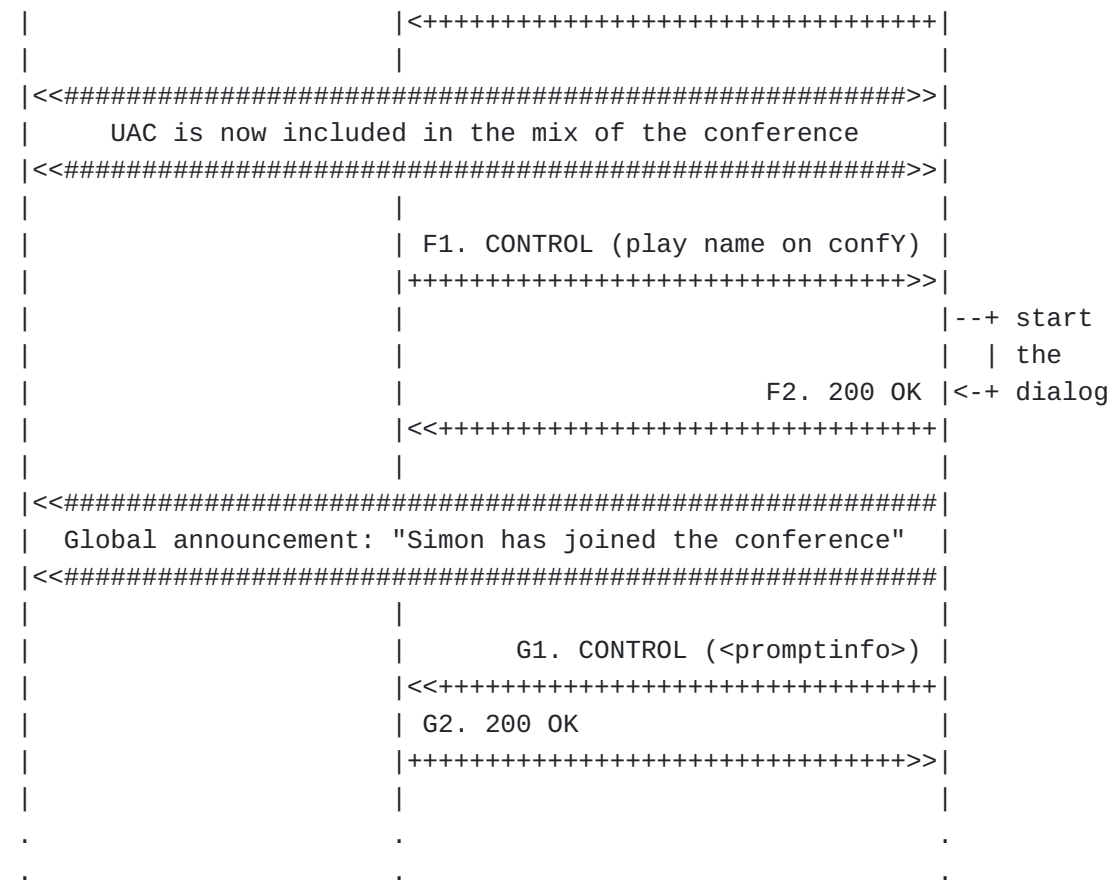
2. The UAC is presented with an IVR menu, in which it is requested to digit a PIN code to access the conference;

3. If the PIN is correct, the UAC is asked to state its name so that it can be recorded;

4. The UAC is attached to the conference, and the previously recorded name is announced globally to the conference to advertise its arrival.

Figure 49 shows a single UAC joining a conference: the example, as usual, hides the previous interaction between the UAC and the AS, and instead focuses on what the AS does to actually interact with the participant and join it to the conference bridge.


UAC
AS
MS
A1. CONTROL (request DTMF PIN)
start the dialog
A2. 200 OK
"Please digit the PIN number to join the conference"
DTMF digits are collected
get DTMF digits
B1. CONTROL (<collectinfo>)
Compare DTMF digits with the PIN number
B2. 200 OK
C1. CONTROL (record name)
start the dialog
C2. 200 OK
"Please state your name after the beep"
Audio from the UAC is recorded (until timeout or DTMF)
save in a file
D1. CONTROL (<recordinfo>)
Store recorded file to play announcement in conference later
D2. 200 OK
E1. CONTROL (join UAC & confY)
join UAC & conf Y
E2. 200 OK



As it can be deduced from the sequence diagram above, the AS, in its business logic, correlates the results of different transactions, addressed to different packages, to implement a more complex conferencing scenario than the Simple Bridging previously described. The framework transaction steps are the following:

Since this is a private conference, the UAC is to be presented with a request for a password, in this case a PIN number; to do so, the AS instructs the MS (A1) to collect a series of DTMF digits from the specified UAC (connectionid=UAC); the request includes both a voice message (<prompt>) and the described digit collection context (<collect>); the PIN is assumed to be a 4-digit number, and so the MS has to collect at max 4 digits (maxdigits=4); the DTMF digit buffer must be cleared before collecting (cleardigitbuffer=true) and the UAC can make use of the star key to restart the collection (escapekey=), e.g. in case it is aware he miswrote any of the digits and wants to start again;

*the transaction goes on as usual (A2), with the transaction being handled, and the dialog start being notified in a 200 OK; after

that, the UAC is actually presented with the voice message, and is subsequently requested to insert the required PIN number;

*we assume UAC wrote the correct PIN number (1234), which is reported by the MS to the AS by means of the usual MS-generated CONTROL event (B1); the AS correlates this event to the previously started dialog by checking the referenced dialogid (06d1bac) and acks the event (B2); it then extracts the information it needs from the event (in this case, the digits provided by the MS) from the <controlinfo> container (dtmf=1234) and verifies if it is correct;

*since the PIN is correct, the AS can proceed towards the next step, that is asking the UAC to state his name, in order to play the recording subsequently on the conference to report the new participant; again, this is done with a request to the IVR package (C1); the AS instructs the MS to play a voice message ("say your name after the beep"), to be followed by a recording of only the audio from the UAC (in stream, media=audio/sendonly, while media=video/inactive); a beep must be played right before the recording starts (beep=true), and the recording must only last 3 seconds (maxtime=3s) since it is only needed as a brief announcement;

*without delving again into the details of a recording-related transaction (C2), the AS finally gets an URI to the requested recording (D1, acked in D2);

*at this point, the AS attaches the UAC (id1) to the conference (id2) just as explained for Simple Bridging (E1/E2);

*finally, to notify the other participants that a new participant has arrived, the AS requests a global announcement on the conference; this is a simple <prompt> request to the IVR package (F1) just as the ones explained in previous sections, but with a slight difference: the target of the prompt is not a connectionid (a media connection) but the conference itself (conferenceid=6146dd5); as a result of this transaction, the announcement would be played on all the media connections attached to the conference which are allowed to receive media from it; the AS specifically requests two media files to be played:

1. the media file containing the recorded name of the new user as retrieved in D1 ("Simon...");

2. a pre-recorded media file explaining what happened ("... has joined the conference");

the transaction then takes its usual flow (F2), and the event notifying the end of the announcement (G1, acked in G2) concludes the scenario.

A1. AS -> MS (CFW CONTROL, collect)

```
   CFW 50e56b8d65f9 CONTROL
   Control-Package: msc-ivr/1.0
   Content-Type: application/msc-ivr+xml
   Content-Length: 311

   <mscivr version="1.0" xmlns="urn:ietf:params:xml:ns:msc-ivr">
     <dialogstart connectionid="10514b7f:6a900179">
        <dialog>
          <prompt>
              <media \
           loc="http://www.example.net/prompts/conf-getpin.wav" \
           type="audio/x-wav"/>
          </prompt>
          <collect maxdigits="4" escapekey="*" cleardigitbuffer="true"/>
        </dialog>
     </dialogstart>
   </mscivr>
```

A2. AS <- MS (CFW 200 OK)

```
   CFW 50e56b8d65f9 200
   Timeout: 10
   Content-Type: application/msc-ivr+xml
   Content-Length: 137

   <mscivr version="1.0" xmlns="urn:ietf:params:xml:ns:msc-ivr">
     <response status="200" reason="Dialog started" dialogid="06d1bac"/>
   </mscivr>
```

B1. AS <- MS (CFW CONTROL event)

```
   CFW 166d68a76659 CONTROL
   Control-Package: msc-ivr/1.0
   Content-Type: application/msc-ivr+xml
   Content-Length: 272

   <mscivr version="1.0" xmlns="urn:ietf:params:xml:ns:msc-ivr">
      <event dialogid="06d1bac">
         <dialogexit status="1" reason="Dialog successfully completed">
            <promptinfo duration="2312" termmode="completed"/>
            <collectinfo dtmf="1234" termmode="match"/>
         </dialogexit>
      </event>
   </mscivr>
```

```
B2. AS -> MS (CFW 200, ACK to 'CONTROL event')
-----------------------------------------------
   CFW 166d68a76659 200


C1. AS -> MS (CFW CONTROL, record)
----------------------------------
   CFW 61fd484f196e CONTROL
   Control-Package: msc-ivr/1.0
   Content-Type: application/msc-ivr+xml
   Content-Length: 373

   <mscivr version="1.0" xmlns="urn:ietf:params:xml:ns:msc-ivr">
      <dialogstart connectionid="10514b7f:6a900179">
         <dialog>
            <prompt>
               <media \
         loc="http://www.example.net/prompts/conf-rec-name.wav" \
         type="audio/x-wav"/>
            </prompt>
            <record beep="true" maxtime="3s"/>
         </dialog>
         <stream media="audio" direction="sendonly"/>
         <stream media="video" direction="inactive"/>
      </dialogstart>
   </mscivr>


C2. AS <- MS (CFW 200 OK)
-------------------------
   CFW 61fd484f196e 200
   Timeout: 10
   Content-Type: application/msc-ivr+xml
   Content-Length: 137

   <mscivr version="1.0" xmlns="urn:ietf:params:xml:ns:msc-ivr">
     <response status="200" reason="Dialog started" dialogid="1cf0549"/>
   </mscivr>


D1. AS <- MS (CFW CONTROL event)
--------------------------------
   CFW 3ec13ab96224 CONTROL
   Control-Package: msc-ivr/1.0
   Content-Type: application/msc-ivr+xml
   Content-Length: 402

   <mscivr version="1.0" xmlns="urn:ietf:params:xml:ns:msc-ivr">
     <event dialogid="1cf0549">
```

```
       <dialogexit status="1" reason="Dialog successfully completed">
         <promptinfo duration="4988" termmode="completed"/>
         <recordinfo duration="3000" termmode="maxtime">
           <mediainfo
  loc="http://www.example.net/recordings/recording-1cf0549.wav" \
  type="audio/x-wav" size="48044"/>
         </recordinfo>
       </dialogexit>
     </event>
   </mscivr>


D2. AS -> MS (CFW 200, ACK to 'CONTROL event')
----------------------------------------------
   CFW 3ec13ab96224 200


E1. AS -> MS (CFW CONTROL, join)
--------------------------------
   CFW 261d188b63b7 CONTROL
   Control-Package: msc-mixer/1.0
   Content-Type: application/msc-mixer+xml
   Content-Length: 120

   <mscmixer version="1.0" xmlns="urn:ietf:params:xml:ns:msc-mixer">
      <join id1="10514b7f:6a900179" id2="6146dd5"/>
   </mscmixer>


E2. AS <- MS (CFW 200 OK)
-------------------------
   CFW 261d188b63b7 200
   Timeout: 10
   Content-Type: application/msc-mixer+xml
   Content-Length: 125

   <mscmixer version="1.0" xmlns="urn:ietf:params:xml:ns:msc-mixer">
      <response status="200" reason="Join successful"/>
   </mscmixer>


F1. AS -> MS (CFW CONTROL, play)
--------------------------------
   CFW 718c30836f38 CONTROL
   Control-Package: msc-ivr/1.0
   Content-Type: application/msc-ivr+xml
   Content-Length: 334

   <mscivr version="1.0" xmlns="urn:ietf:params:xml:ns:msc-ivr">
     <dialogstart conferenceid="6146dd5">
```

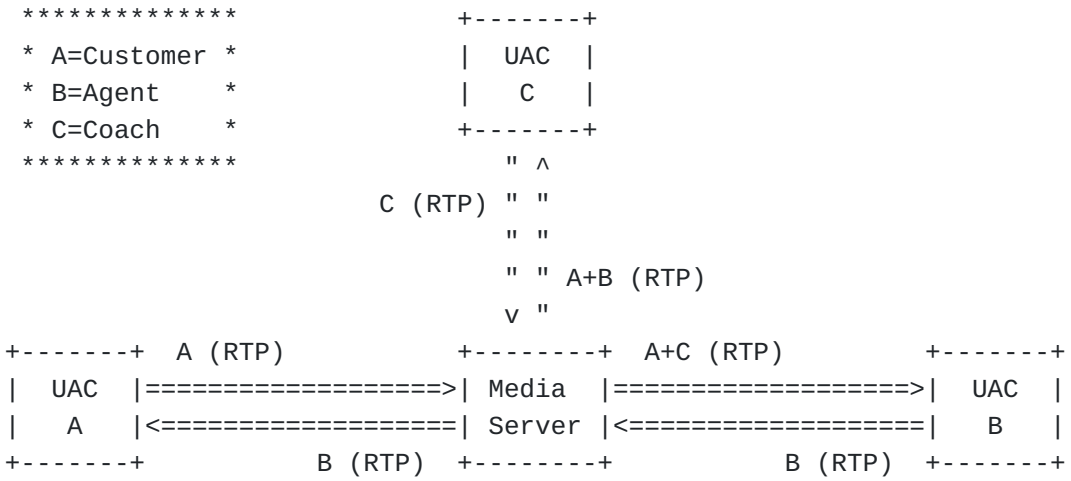
```
       <dialog>
         <prompt>
           <media
  loc="http://www.example.net/recordings/recording-1cf0549.wav" \
  type="audio/x-wav"/>
              <media \
  loc="http://www.example.net/prompts/conf-hasjoin.wav" \
  type="audio/x-wav"/>
         </prompt>
       </dialog>
     </dialogstart>
   </mscivr>


F2. AS <- MS (CFW 200 OK)
-------------------------
   CFW 718c30836f38 200
   Timeout: 10
   Content-Type: application/msc-ivr+xml
   Content-Length: 137

   <mscivr version="1.0" xmlns="urn:ietf:params:xml:ns:msc-ivr">
     <response status="200" reason="Dialog started" dialogid="5f4bc7e"/>
   </mscivr>


G1. AS <- MS (CFW CONTROL event)
--------------------------------
   CFW 6485194f622f CONTROL
   Control-Package: msc-ivr/1.0
   Content-Type: application/msc-ivr+xml
   Content-Length: 229

   <mscivr version="1.0" xmlns="urn:ietf:params:xml:ns:msc-ivr">
      <event dialogid="5f4bc7e">
         <dialogexit status="1" reason="Dialog successfully completed">
            <promptinfo duration="1838" termmode="completed"/>
         </dialogexit>
      </event>
   </mscivr>


G2. AS -> MS (CFW 200, ACK to 'CONTROL event')
----------------------------------------------
   CFW 6485194f622f 200
```

6.3.3. Coaching Scenario

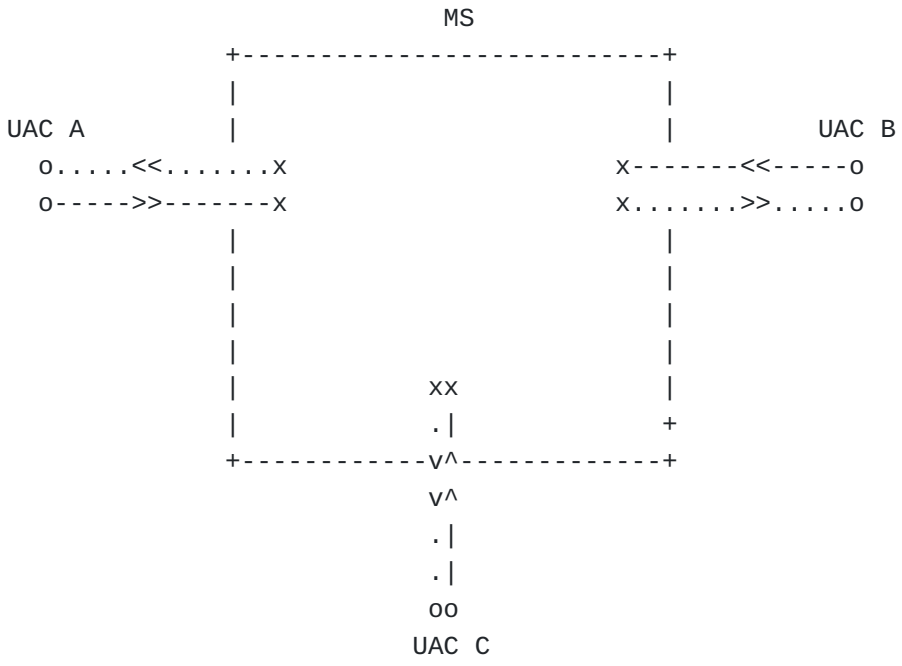
Another typical conference-based use case is the so called Coaching Scenario. In such a scenario, a customer (called A in the following example) places a call to a business call center. An agent (B) is assigned to the customer. Besides, a coach (C), unheard from the customer, provides the agent with whispered suggestions about what to say. This scenario is also described in RFC4597 [RFC4597].
As it can be deduced from the scenario description, per-user policies for media mixing and delivery, i.e who can hear what, are very important. The MS must make sure that only the agent can hear the coach's suggestions. Since this is basically a multiparty call (despite what the customer might be thinking), a mixing entity is needed in order to accomplish the scenario requirements. To summarize:

- the customer (A) must only hear what the agent (B) says;
- the agent (B) must be able to hear both the customer (A) and the coach (C);
- the coach (C) must be able to hear both the customer (A), in order to give the right suggestions, and the agent (B), in order to be aware of the whole conversation.

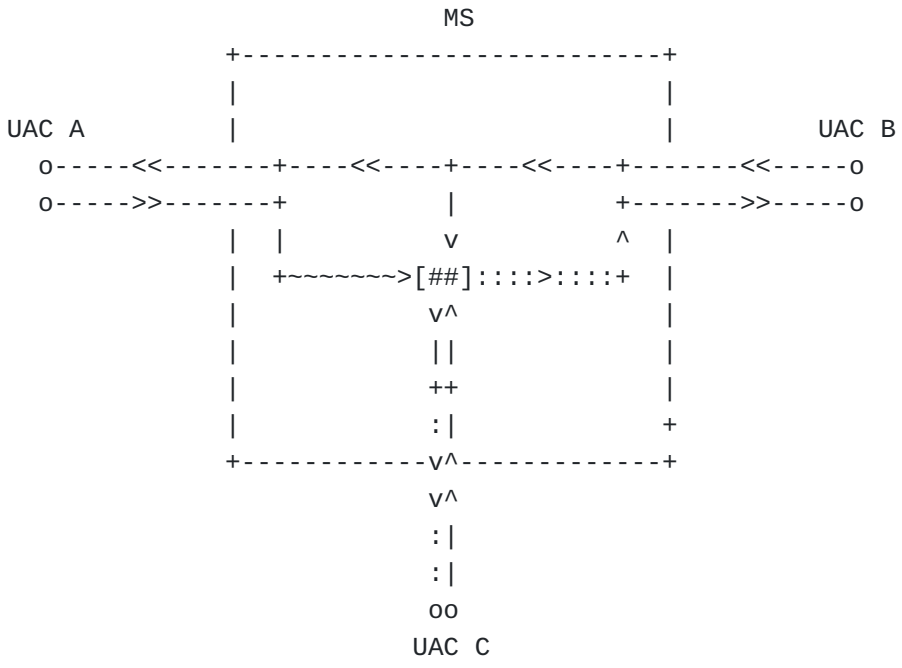
From the media and framework perspective, such a scenario can be seen as it is depicted in Figure 51.



From the framework point of view, when the mentioned legs are not attached to anything yet, what appears is described in Figure 52.



What the scenario should look like is instead depicted in Figure 53. The customer receives media directly from the agent (recvonly), while all the three involved participants contribute to a hidden conference: of course the customer is not allowed to receive the mixed flows from the conference (sendonly), unlike the agent and the coach which must both be aware of the whole conversation (sendrecv).



In the framework this can be achieved by means of the mixer control package, which, as already explained in previous sections, can be exploited whenever mixing and joining entities are needed. The needed steps can be summarized in the following list:

1. first of all, a hidden conference is created;

2. then, all the three participants are attached to it, each with a custom mixing policy, specifically:

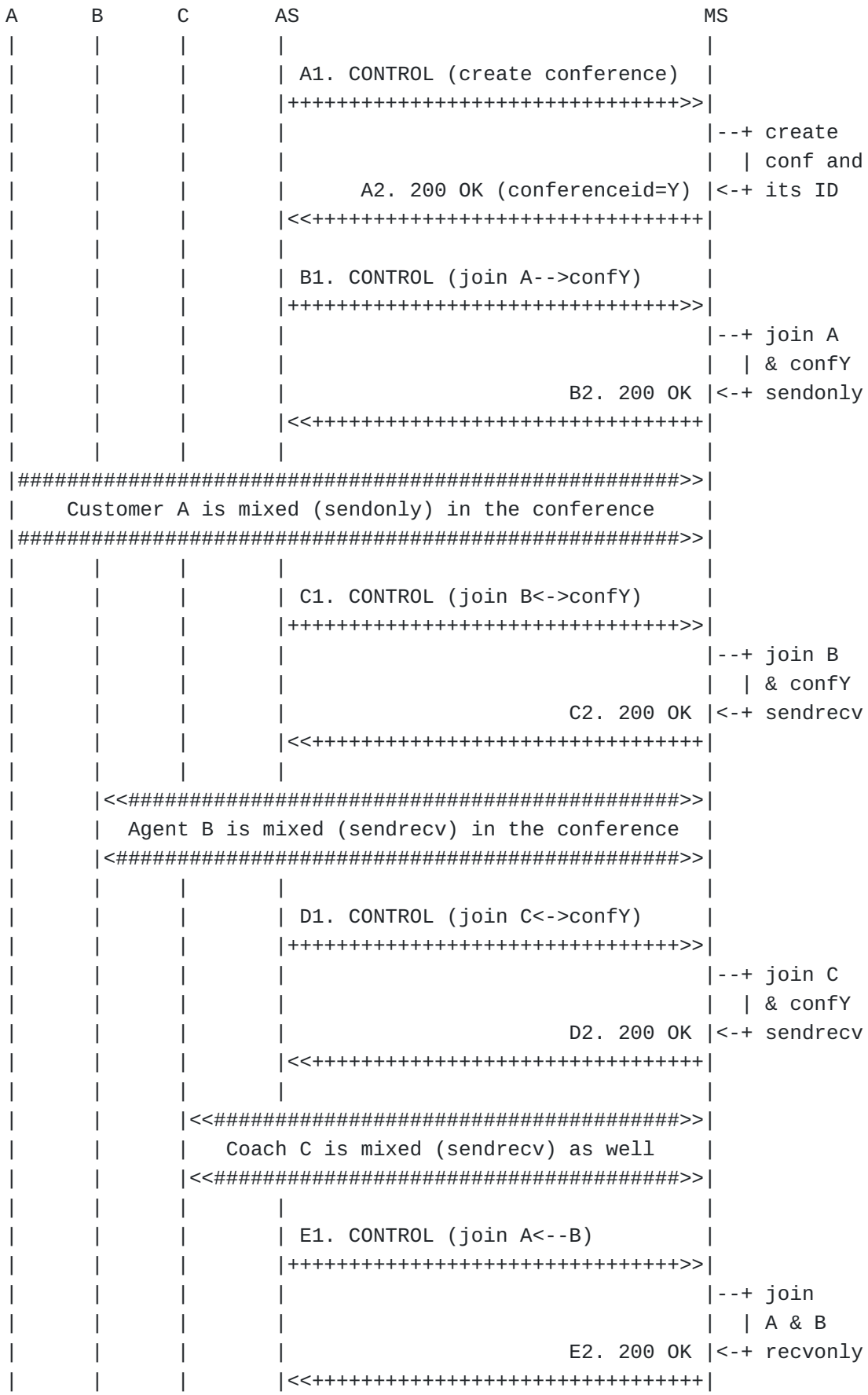
   *the customer (A) as 'sendonly';

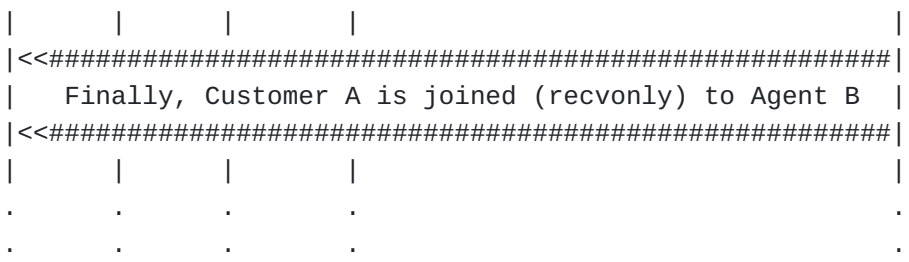
   *the agent (B) as 'sendrecv';

   *the coach (C) as 'sendrecv' and with a -3dB gain to halve the volume of its own contribution (so that the agent actually hears the customer louder, and the coach whispering);

3. finally, the customer is joined to the agent as a passive receiver (recvonly).

A sequence diagram of such a sequence of transactions is depicted in Figure 54:


A
B
C
AS
MS
A1. CONTROL (create conference)
create conf and its ID
A2. 200 OK (conferenceid=Y)
B1. CONTROL (join A-->confY)
join A & confY
B2. 200 OK
sendonly
Customer A is mixed (sendonly) in the conference
C1. CONTROL (join B<->confY)
join B & confY
C2. 200 OK
sendrecv
Agent B is mixed (sendrecv) in the conference
D1. CONTROL (join C<->confY)
join C & confY
D2. 200 OK
sendrecv
Coach C is mixed (sendrecv) as well
E1. CONTROL (join A<--B)
join A & B
E2. 200 OK
recvonly



*First of all, the AS creates a new hidden conference by means of a 'createconference' request (A1); this conference is properly configured according to the use it is assigned to, that is to mix all the involved parties accordingly; since only three participants will be joined to it, 'reserved-talkers' is set to 3; 'reserved-listeners', instead, is set to 2, since only the agent and the coach must receive a mix, while the customer must be unaware of the coach; finally, the video layout is set to dual-view for the same reason, since only the customer and the agent must appear in the mix;

*the MS notifies the successful creation of the new conference in a 200 framework message (A2); the identifier assigned to the conference, which will be used in subsequent requests addressed to it, is 1df080e;

*now that the conference has been created, the AS joins the three actors to it with different policies, namely: (i) the customer A is joined as sendonly to the conference (B1), (ii) the agent B is joined as sendrecv to the conference (C1) and (iii) the coach is joined as sendrecv (but audio only) to the conference and with a lower volume (D1); the custom policies are enforced by means of properly constructed <stream> elements;

*the MS takes care of the requests and acks them (B2, C2, D2); at this point, the conference will receive media from all the actors, but only provide the agent and the coach with the resulting mix;

*to complete the scenario, the AS joins the customer A with the agent B directly as recvonly (E1); the aim of this request is to provide customer A with media too, namely the media contributed by agent B; this way, customer A is unaware of the fact that its media are accessed by coach C by means of the hidden mixer;

*the MS takes care of this request too and acks it (E2), concluding the scenario.

A1. AS -> MS (CFW CONTROL, createconference)

```
   CFW 238e1f2946e8 CONTROL
   Control-Package: msc-mixer
   Content-Type: application/msc-mixer+xml
   Content-Length: 329

   <mscmixer version="1.0" xmlns="urn:ietf:params:xml:ns:msc-mixer">
      <createconference reserved-talkers="3" reserved-listeners="2">
         <audio-mixing type="nbest"/>
         <video-layouts>
            <video-layout min-participants='1'>
               <dual-view/>
            </video-layout>
         </video-layouts>
         <video-switch>
            <controller/>
         </video-switch>
      </createconference>
   </mscmixer>
```

A2. AS <- MS (CFW 200 OK)

```
   CFW 238e1f2946e8 200
   Timeout: 10
   Content-Type: application/msc-mixer+xml
   Content-Length: 151

   <mscmixer version="1.0" xmlns="urn:ietf:params:xml:ns:msc-mixer">
      <response status="200" reason="Conference created" \
                conferenceid="1df080e"/>
   </mscmixer>
```

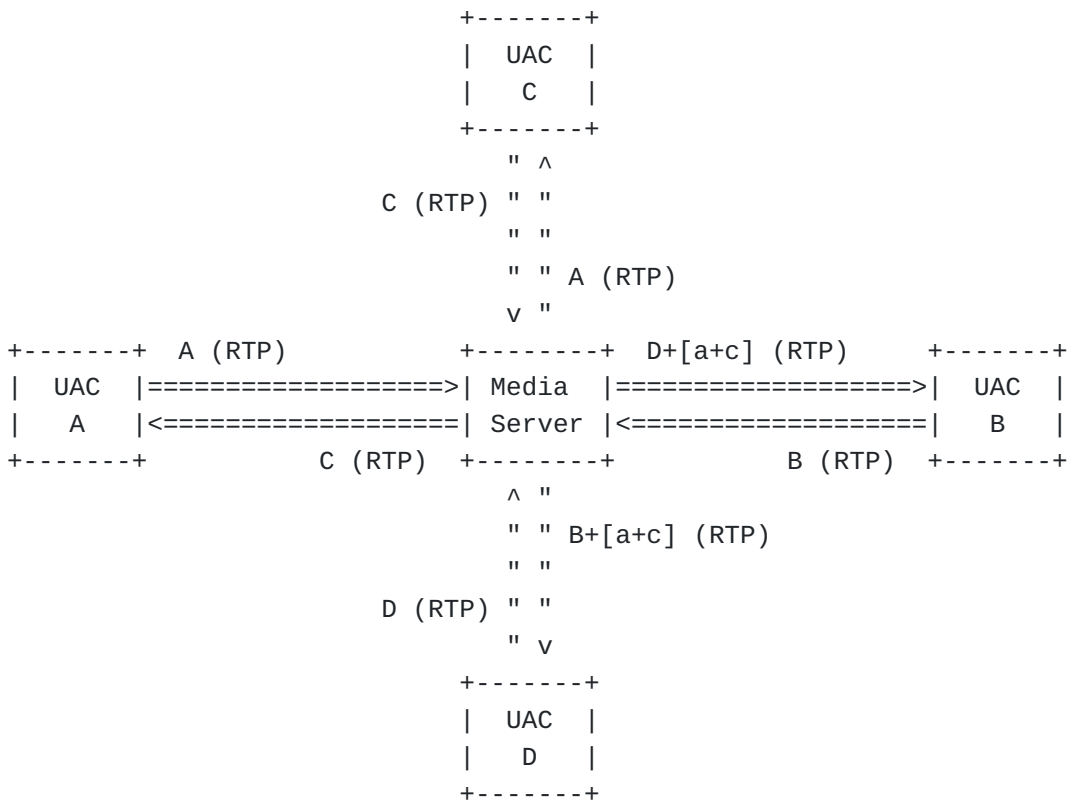
B1. AS -> MS (CFW CONTROL, join)

```
   CFW 2eb141f241b7 CONTROL
   Control-Package: msc-mixer
   Content-Type: application/msc-mixer+xml
   Content-Length: 226

   <mscmixer version="1.0" xmlns="urn:ietf:params:xml:ns:msc-mixer">
      <join id1="10514b7f:6a900179" id2="1df080e">
         <stream media="audio" direction="sendonly"/>
         <stream media="video" direction="sendonly"/>
      </join>
   </mscmixer>
```

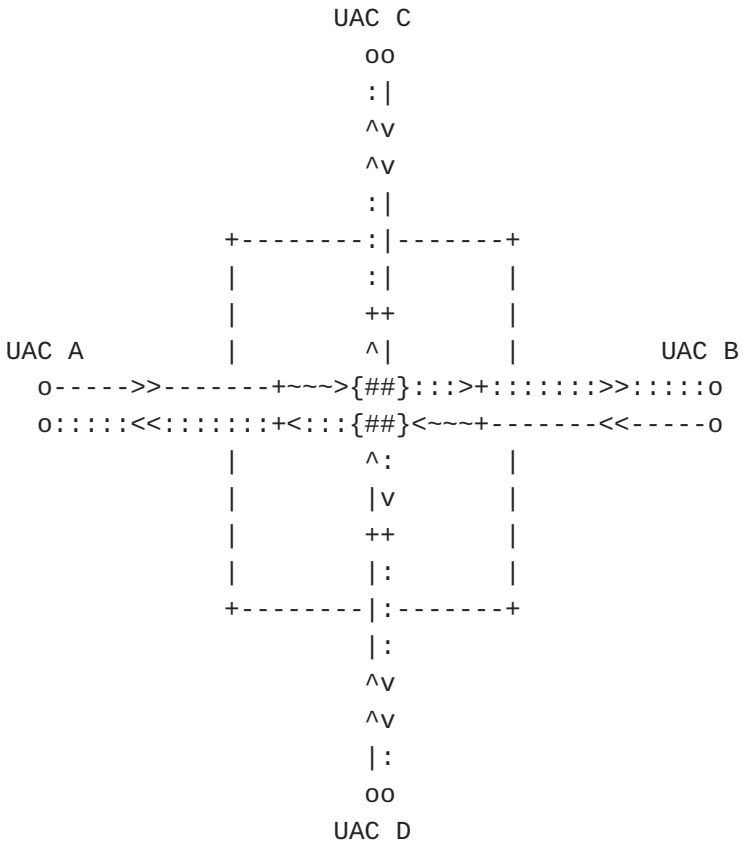
```
B2. AS <- MS (CFW 200 OK)
-------------------------
   CFW 2eb141f241b7 200
   Timeout: 10
   Content-Type: application/msc-mixer+xml
   Content-Length: 125

   <mscmixer version="1.0" xmlns="urn:ietf:params:xml:ns:msc-mixer">
      <response status="200" reason="Join successful"/>
   </mscmixer>


C1. AS -> MS (CFW CONTROL, join)
--------------------------------
   CFW 515f007c5bd0 CONTROL
   Control-Package: msc-mixer
   Content-Type: application/msc-mixer+xml
   Content-Length: 122

   <mscmixer version="1.0" xmlns="urn:ietf:params:xml:ns:msc-mixer">
      <join id1="756471213:c52ebf1b" id2="1df080e"/>
   </mscmixer>


C2. AS <- MS (CFW 200 OK)
-------------------------
   CFW 515f007c5bd0 200
   Timeout: 10
   Content-Type: application/msc-mixer+xml
   Content-Length: 125

   <mscmixer version="1.0" xmlns="urn:ietf:params:xml:ns:msc-mixer">
      <response status="200" reason="Join successful"/>
   </mscmixer>


D1. AS -> MS (CFW CONTROL, join)
--------------------------------
   CFW 0216231b1f16 CONTROL
   Control-Package: msc-mixer
   Content-Type: application/msc-mixer+xml
   Content-Length: 221

   <mscmixer version="1.0" xmlns="urn:ietf:params:xml:ns:msc-mixer">
      <join id1="z9hG4bK19461552:1353807a" id2="1df080e">
         <stream media="audio">
            <volume controltype="setgain" value="-3"/>
         </stream>
      </join>
```

```
   </mscmixer>


D2. AS <- MS (CFW 200 OK)
-------------------------
   CFW 0216231b1f16 200
   Timeout: 10
   Content-Type: application/msc-mixer+xml
   Content-Length: 125

   <mscmixer version="1.0" xmlns="urn:ietf:params:xml:ns:msc-mixer">
      <response status="200" reason="Join successful"/>
   </mscmixer>


E1. AS -> MS (CFW CONTROL, join)
--------------------------------
   CFW 140e0f763352 CONTROL
   Control-Package: msc-mixer
   Content-Type: application/msc-mixer+xml
   Content-Length: 236

   <mscmixer version="1.0" xmlns="urn:ietf:params:xml:ns:msc-mixer">
      <join id1="10514b7f:6a900179" id2="756471213:c52ebf1b">
         <stream media="audio" direction="recvonly"/>
         <stream media="video" direction="recvonly"/>
      </join>
   </mscmixer>


E2. AS <- MS (CFW 200 OK)
-------------------------
   CFW 140e0f763352 200
   Timeout: 10
   Content-Type: application/msc-mixer+xml
   Content-Length: 125

   <mscmixer version="1.0" xmlns="urn:ietf:params:xml:ns:msc-mixer">
      <response status="200" reason="Join successful"/>
   </mscmixer>
```

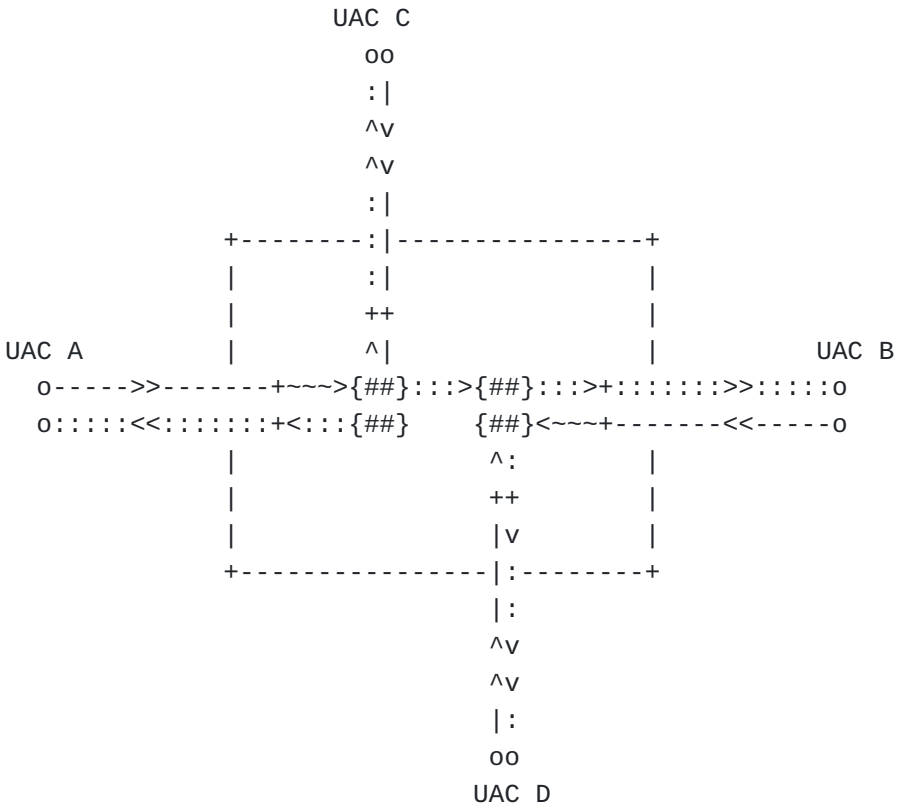
6.3.4. Sidebars



From the framework point of view, when all the participants are attached to the main conference, what appears is described in Figure 57.



What the scenario should look like is instead depicted in Figure 58. A new mixer is created to host the sidebar. The main mix is then attached as 'sendonly' to the sidebar mix at a lower volume (in order to provide the sidebar users with a background of the main conference). The two interested participants (B and D) have their audio leg detached from the main conference and attached to the sidebar. This detach can be achieved either by actually detaching the leg or by just modifying the status of the leg to inactive. Notice that this only affects the audio stream: the video of the two users is still attached to the main conference, and what happens at the application level may or may not have been changed accordingly (e.g. XCON protocol interactions). Please notice that the main conference is assumed to be already in place, and the involved participants (A, B, C and D) to be already attached (sendrecv) to it.



The situation may subsequently be reverted (e.g. destroying the sidebar conference and reattaching B and D to the main conference mix) in the same way. The AS would just need to unjoin B and D from the hidden conference and change their connection with the main conference back to 'sendrecv'. After unjoining the main mix and the sidebar mix, the sidebar conference could then be destroyed. Anyway, these steps are not described for brevity, considering similar transactions have already been presented.
In the framework the presented scenario can be achieved by means of the mixer control package, which, as already explained in previous sections, can be exploited whenever mixing and joining entities are needed. The needed steps can be summarized in the following list:

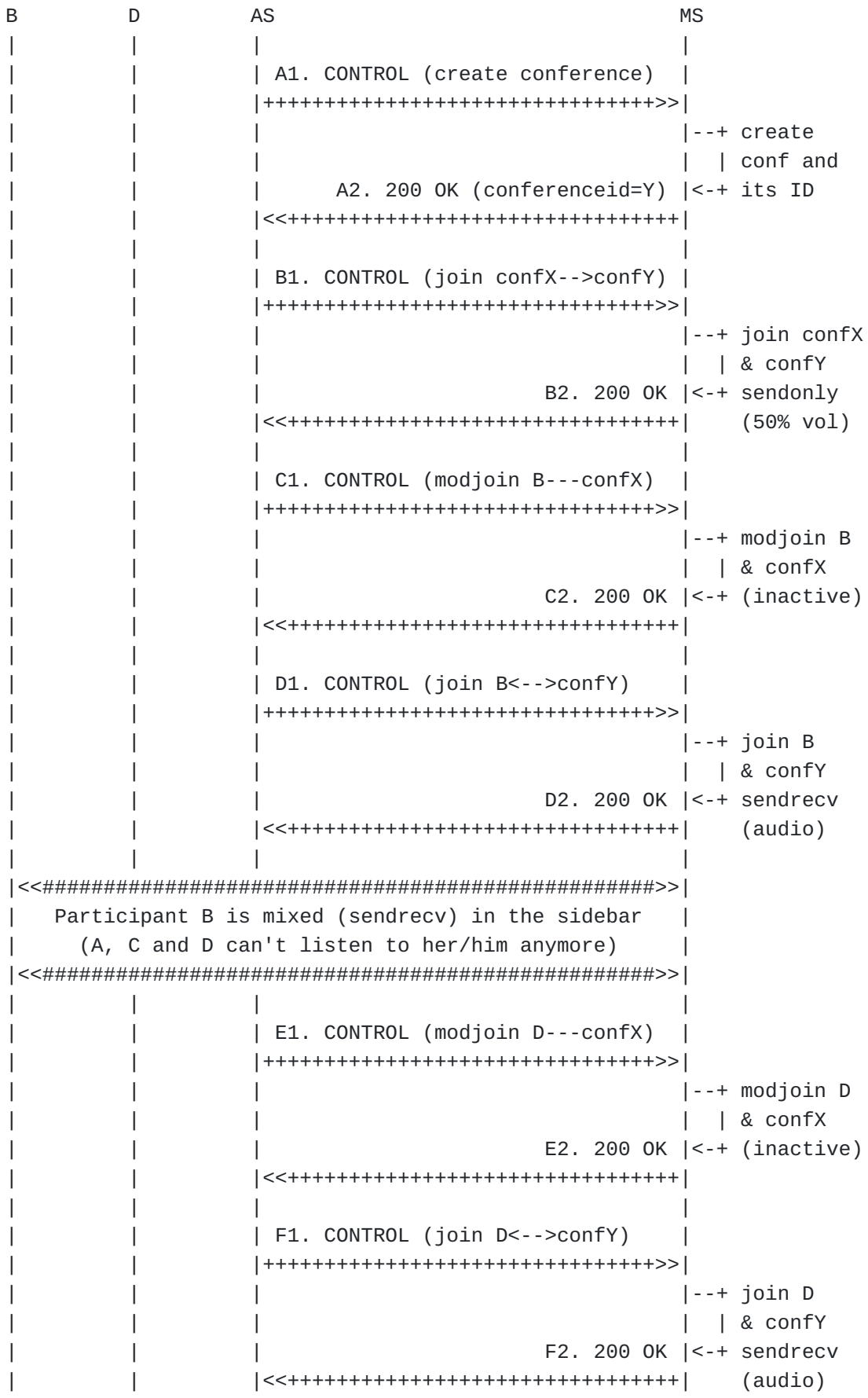
1. first of all, a hidden conference is created (the sidebar mix);

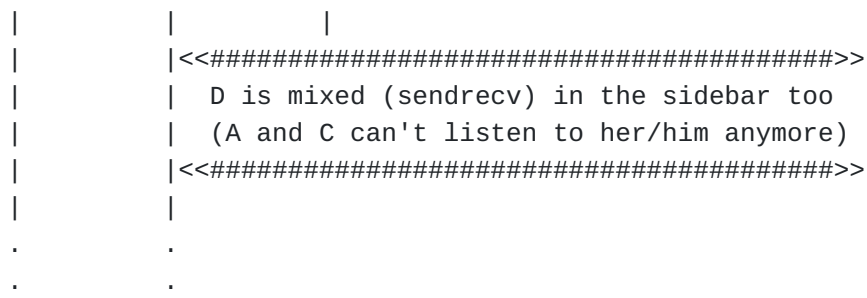
2. then, the main conference mix is attached to it as 'sendonly' and with a -5dB gain to limit the volume of its own contribution to 30% (so that B and D can hear each other louder, while still listening to what's happening in the main conference in background);

3. B and D are detached from the main mix for what concerns audio (modifyjoin with inctive status);

4. B and D are attached to the hidden sidebar mixfor what concerns audio.

Note that for detaching B and D from the main mix, a <modifyjoin> with an 'inactive' status is used, instead of an <unjoin>. The motivation for this is related to how a subsequent rejoining of B and D to the main mix could take place. In fact, by using <modifyjoin> the resources created when first joining B and D to the main mix remain in place, even if marked as unused at the moment. An <unjoin>, instead, would actually free those resources, which could be granted to other participants joining the conference in the meanwhile. This means that, when needing to reattach B and D to the main mix, the MS could not have the resources to do so, resulting in an undesired failure.
A sequence diagram of such a sequence of transactions (where confX is the identifier of the pre-existing main conference mix) is depicted in Figure 59:


B
D
AS
MS
A1. CONTROL (create conference)
--+ create conf and its ID
A2. 200 OK (conferenceid=Y)
B1. CONTROL (join confX-->confY)
--+ join confX & confY
B2. 200 OK
<-+ sendonly (50% vol)
C1. CONTROL (modjoin B---confX)
--+ modjoin B & confX
C2. 200 OK
<-+ (inactive)
D1. CONTROL (join B<-->confY)
--+ join B & confY
D2. 200 OK
<-+ sendrecv (audio)
Participant B is mixed (sendrecv) in the sidebar
(A, C and D can't listen to her/him anymore)
E1. CONTROL (modjoin D---confX)
--+ modjoin D & confX
E2. 200 OK
<-+ (inactive)
F1. CONTROL (join D<-->confY)
--+ join D & confY
F2. 200 OK
<-+ sendrecv (audio)



*First of all, the hidden conference mix is created (A1); the request is basically the same already presented in previous sections, that is a <createconference> request addressed to the Mixer package; the request is very lightweight, and asks the MS to only reserve two listener seats (reserved-listeners, since only B and D have to hear something) and three talker seats (reserved-listeners, considering that besides B and D also the main mix is an active contributor to the sidebar); the mixing will be driven by directives from the AS (mix-type=controller); when the mix is successfully created, the MS provides the AS with its identifier (519c1b9);

*as a first transaction after that, the AS joins the audio from the main conference and the newly created sidebar conference mix (B1); only audio needs to be joined (media=audio), with a sendonly direction (i.e. only flowing from the main conference to the sidebar and not viceversa) and at a 30% volume with respect to the original stream (setgain=-5dB); a successful completion of the transaction is reported to the AS (B2);

*at this point, the AS makes the connection of B (2133178233:18294826) and the main conference (2f5ad43) inactive by means of a <modifyjoin> directive (C1); the request is taken care of by the MS (C2) and B is actually excluded from the mix for what concerns both sending and receiving;

*after that, the AS (D1) joins B (2133178233:18294826) to the sidebar mix created previously (519c1b9); the MS attaches the requested connections and sends confirmation to the AS (D2);

*the same transactions already done for B are placed for D as well (id1=1264755310:2beeae5b), that is the <modifyjoin> to make the connection in the main conference inactive (E1-2) and the <join> to attach D to the sidebar mix (F1-2); at the end of these transactions, A and C will only listen to each other, while B and D will listen to each other and to the conference mix as a comfortable background.

A1. AS -> MS (CFW CONTROL, createconference)

```
   CFW 7fdcc2331bef CONTROL
   Control-Package: msc-mixer/1.0
   Content-Type: application/msc-mixer+xml
   Content-Length: 198

   <mscmixer version="1.0" xmlns="urn:ietf:params:xml:ns:msc-mixer">
      <createconference reserved-talkers="3" reserved-listeners="2">
         <audio-mixing type="controller"/>
      </createconference>
   </mscmixer>
```

A2. AS <- MS (CFW 200 OK)

```
   CFW 7fdcc2331bef 200
   Timeout: 10
   Content-Type: application/msc-mixer+xml
   Content-Length: 151

   <mscmixer version="1.0" xmlns="urn:ietf:params:xml:ns:msc-mixer">
      <response status="200" reason="Conference created" \
                conferenceid="519c1b9"/>
   </mscmixer>
```

B1. AS -> MS (CFW CONTROL, join with setgain)

```
   CFW 4e6afb6625e4 CONTROL
   Control-Package: msc-mixer/1.0
   Content-Type: application/msc-mixer+xml
   Content-Length: 226

   <mscmixer version="1.0" xmlns="urn:ietf:params:xml:ns:msc-mixer">
      <join id1="2f5ad43" id2="519c1b9">
         <stream media="audio" direction="sendonly">
            <volume controltype="setgain" value="-5"/>
         </stream>
      </join>
   </mscmixer>
```

B2. AS <- MS (CFW 200 OK)

```
   CFW 4e6afb6625e4 200
   Timeout: 10
   Content-Type: application/msc-mixer+xml
   Content-Length: 125
```

```
   <mscmixer version="1.0" xmlns="urn:ietf:params:xml:ns:msc-mixer">
      <response status="200" reason="Join successful"/>
   </mscmixer>


C1. AS -> MS (CFW CONTROL, modifyjoin with inactive status)
-----------------------------------------------------------
   CFW 3f2dba317c83 CONTROL
   Control-Package: msc-mixer/1.0
   Content-Type: application/msc-mixer+xml
   Content-Length: 193

   <mscmixer version="1.0" xmlns="urn:ietf:params:xml:ns:msc-mixer">
      <modifyjoin id1="2133178233:18294826" id2="2f5ad43">
         <stream media="audio" direction="inactive"/>
      </modifyjoin>
   </mscmixer>


C2. AS <- MS (CFW 200 OK)
-------------------------
   CFW 3f2dba317c83 200
   Timeout: 10
   Content-Type: application/msc-mixer+xml
   Content-Length: 123

   <mscmixer version="1.0" xmlns="urn:ietf:params:xml:ns:msc-mixer">
      <response status="200" reason="Join modified"/>
   </mscmixer>


D1. AS -> MS (CFW CONTROL, join to sidebar)
-------------------------------------------
   CFW 2443a8582d1d CONTROL
   Control-Package: msc-mixer/1.0
   Content-Type: application/msc-mixer+xml
   Content-Length: 181

   <mscmixer version="1.0" xmlns="urn:ietf:params:xml:ns:msc-mixer">
      <join id1="2133178233:18294826" id2="519c1b9">
         <stream media="audio" direction="sendrecv"/>
      </join>
   </mscmixer>


D2. AS <- MS (CFW 200 OK)
-------------------------
   CFW 2443a8582d1d 200
   Timeout: 10
```

```
   Content-Type: application/msc-mixer+xml
   Content-Length: 125

   <mscmixer version="1.0" xmlns="urn:ietf:params:xml:ns:msc-mixer">
      <response status="200" reason="Join successful"/>
   </mscmixer>
```

E1. AS -> MS (CFW CONTROL, modifyjoin with inactive status)

```
   CFW 436c6125628c CONTROL
   Control-Package: msc-mixer/1.0
   Content-Type: application/msc-mixer+xml
   Content-Length: 193

   <mscmixer version="1.0" xmlns="urn:ietf:params:xml:ns:msc-mixer">
      <modifyjoin id1="1264755310:2beeae5b" id2="2f5ad43">
         <stream media="audio" direction="inactive"/>
      </modifyjoin>
   </mscmixer>
```

E2. AS <- MS (CFW 200 OK)

```
   CFW 436c6125628c 200
   Timeout: 10
   Content-Type: application/msc-mixer+xml
   Content-Length: 123

   <mscmixer version="1.0" xmlns="urn:ietf:params:xml:ns:msc-mixer">
      <response status="200" reason="Join modified"/>
   </mscmixer>
```

F1. AS -> MS (CFW CONTROL, join to sidebar)

```
   CFW 7b7ed00665dd CONTROL
   Control-Package: msc-mixer/1.0
   Content-Type: application/msc-mixer+xml
   Content-Length: 181

   <mscmixer version="1.0" xmlns="urn:ietf:params:xml:ns:msc-mixer">
      <join id1="1264755310:2beeae5b" id2="519c1b9">
         <stream media="audio" direction="sendrecv"/>
      </join>
   </mscmixer>
```

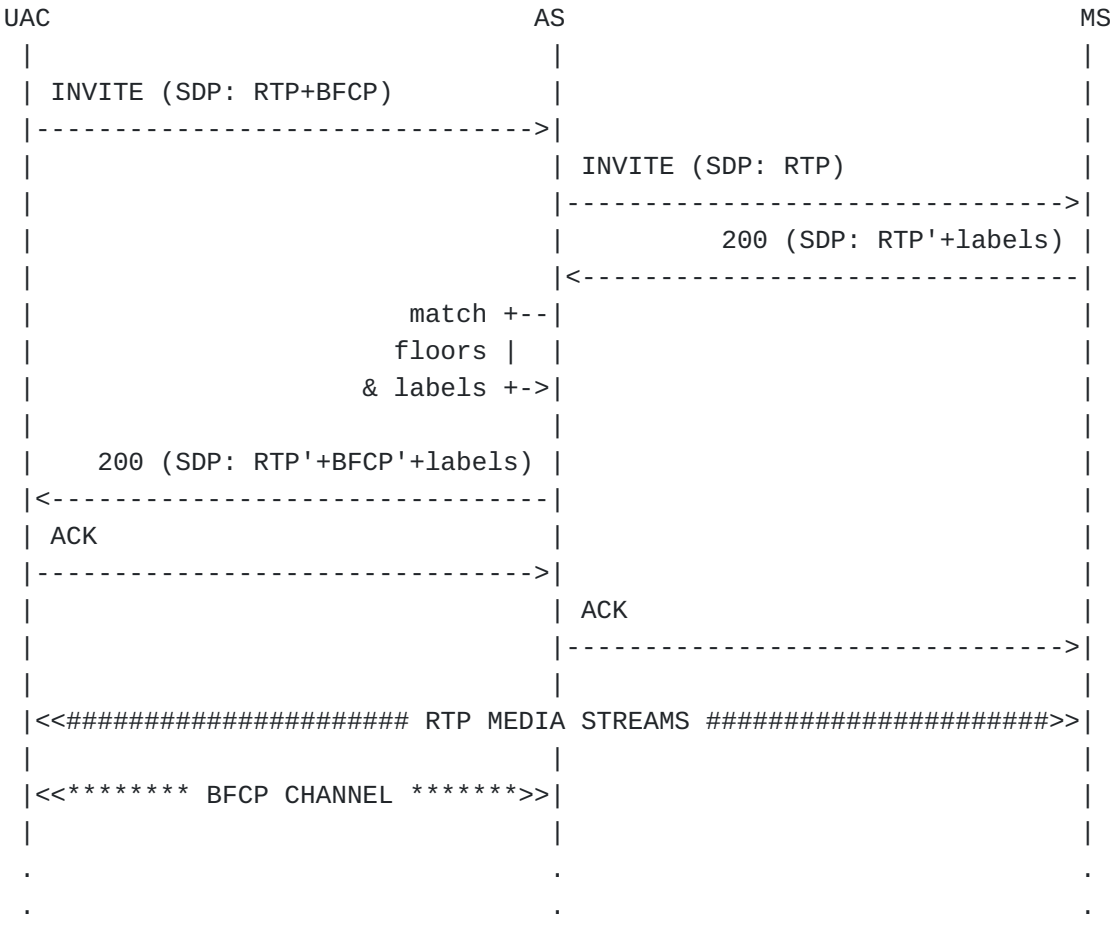
F2. AS <- MS (CFW 200 OK)

```
CFW 7b7ed00665dd 200
Timeout: 10
Content-Type: application/msc-mixer+xml
Content-Length: 125

<mscmixer version="1.0" xmlns="urn:ietf:params:xml:ns:msc-mixer">
   <response status="200" reason="Join successful"/>
</mscmixer>
```

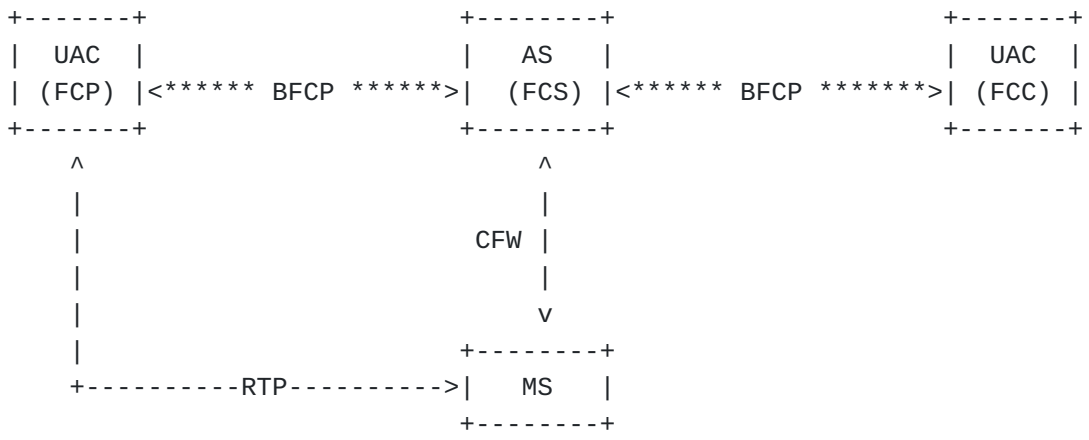
6.3.5. Floor Control

As described in [RFC4597], floor control is a feature typically needed and employed in most conference scenarios. In fact, while not a mandatory feature to implement when realizing a conferencing application, it provides additional control on the media streams contributed by participants, thus allowing for moderation of the available resources. The Centralized Conferencing (XCON) framework [RFC5239] suggests the use of the Binary Floor Control Protocol (BFCP) [RFC4582] to achieve the aforementioned functionality. That said, a combined use of floor control functionality and the tools made available by the MEDIACTRL specification for conferencing would definitely be interesting to investigate. [RFC5567] introduces two different approaches to integrating floor control with the MEDIACTRL architecture: (i) a topology where the floor control server is co-located with the AS; (ii) a topology where the floor control server is instead co-located with the MS. The two approaches are obviously different with respect to the amount of information the AS and the MS have to deal with, especially when thinking about the logic behind the floor queues and automated decisions. Nevertheless, considering how the Media Control Channel Framework is conceived, the topology (ii) would need a dedicated package (be it an extension or a totally new package) in order to make the MS aware of floor control, and allow it to interact with the interested UAC accordingly. At the time of writing such a package doesn't exist yet, and as a consequence only the topology (i) will be dealt with in the presented scenario.
The scenario will then assume the Floor Control Server (FCS) to be co-located with the AS. This means that all the BFCP requests will be sent by Floor Control Participants (FCP) to the FCS, which will make the AS directly aware of the floor statuses. The scenario for simplicity assumes the involved participants are already aware of all the identifiers needed in order to make BFCP requests for a specific conference. Such information may have been carried according to the COMEDIA negotiation as specified in [RFC4583]. It is important to notice that such information must not reach the MS: this means that, within the context of the 3PCC mechanism that may have been used in order to attach a UAC to the MS, all the BFCP-related information negotiated by the AS and the UAC must be removed before making the

negotiation available to the MS, which may be unable to understand the specification. A simplified example of how this could be achieved is presented in Figure 61.



From the media and framework perspective, such a scenario doesn't differ much from the already presented conferencing scenarios. It is more interesting to focus on the chosen topology for the scenario, which can seen as it is depicted in Figure 62.



The AS, besides mantaining the already known SIP signaling among the involved parties, also acts as FCS for the participants in the conferences it is responsible of. In the scenario, two Floor Control Participants are involved: a basic Participant (FCP) and a Chair (FCC). In the framework this can be achieved by means of the mixer control package, which, as already explained in previous sections, can be exploited whenever mixing and joining entities are needed. Assuming the conference has already been created, the participant has already been attached (recvonly) to it, and that the participant is aware of the involved BFCP identifiers, the needed steps can be summarized in the following list:

1. the assigned chair, FCC, sends a subscription for events related to the floor it is responsible of (FloorQuery);

2. the FCP sends a BFCP request (FloorRequest) to get access to the audio resource ("I want to speak");

3. the FCS (AS) sends a provisional response to the FCP (FloorRequestStatus PENDING), and handles the request in its queue; since a chair is assigned to this floor, the request is forwarded to the FCC for a decision (FloorStatus);

4. the FCC takes a decision and sends it to the FCS (ChairAction ACCEPTED);

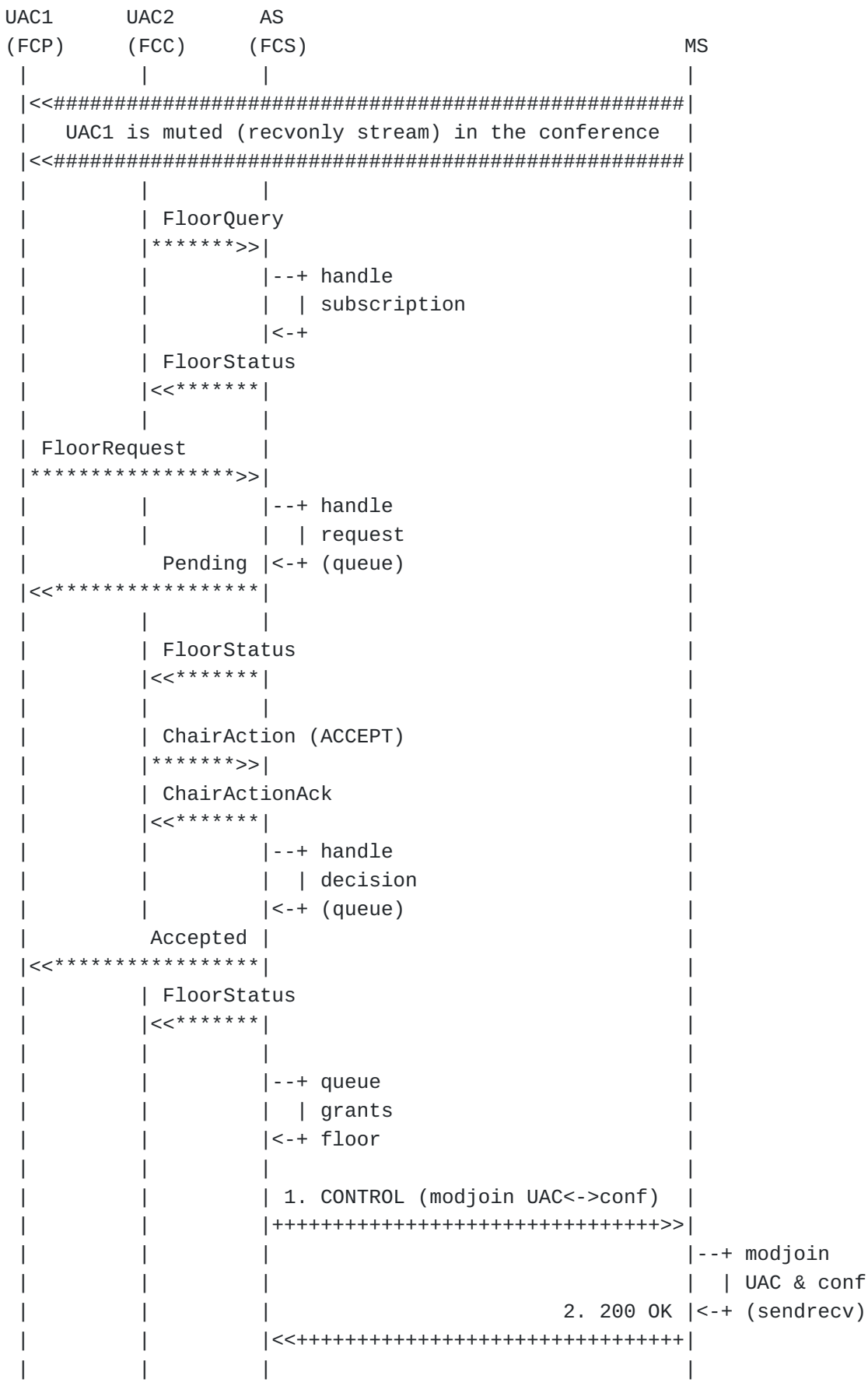
5. the FCS takes note of the decision and updates the queue accordingly; the decision is sent to the FCP (FloorRequestStatus ACCEPTED); anyway, the floor has not been granted yet;

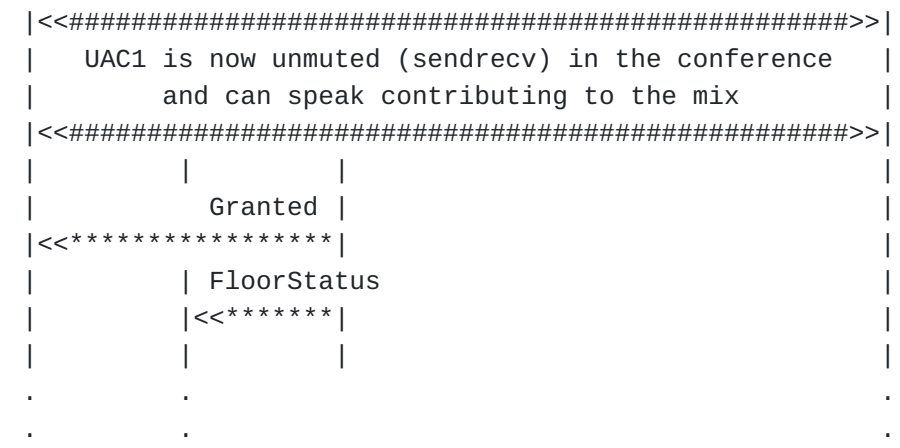
6. as soon as the queue allows it, the floor is actually granted to FCP; the AS, which is co-located with the FCS, understands in its business logic that such an event is associated with the

audio resource being granted to FCP; as a consequence, a <modifyjoin> (sendrecv) is sent through the Control Channel to the MS in order to unmute the FCP UAC in the conference;

7. the event is notified to FCP (FloorRequestStatus GRANTED), thus ending the scenario.

A sequence diagram of such a sequence of transactions (also involving the BFCP message flow at a higher level) is depicted in Figure 63:


UAC1
(FCP)
UAC2
(FCC)
AS
(FCS)
MS
UAC1 is muted (recvonly stream) in the conference
FloorQuery
handle
subscription
FloorStatus
FloorRequest
handle
request
Pending
(queue)
FloorStatus
ChairAction (ACCEPT)
ChairActionAck
handle
decision
Accepted
(queue)
FloorStatus
queue
grants
floor
1. CONTROL (modjoin UAC<->conf)
modjoin
UAC & conf
2. 200 OK
(sendrecv)



As it can easily be evinced from the above diagram, the complex interaction at the BFCP level only results in a single transaction at the MEDIACTRL level. In fact, the purpose of the BFCP transactions is to moderate access to the audio resource, which means providing the event trigger to MEDIACTRL-based conference manipulation transactions. Before being granted the floor, the FCP UAC is excluded from the conference mix at the MEDIACTRL level (recvonly). As soon as the floor has been granted, the FCP UAC is included in the mix. In MEDIACTRL words:

*since the FCP UAC must be included in the audio mix, a <modifyjoin> is sent to the MS in a CONTROL directive; the <modifyjoin> has as identifiers the connectionid associated with the FCP UAC (e1e1427c:1c998d22) and the conferenceid of the mix (cf45ee2); the <stream> element tells the MS that the audio media stream between the two must become bidirectional (sendrecv), changing the previous status (recvonly); please notice that in this case only audio was involed in the conference; in case video was involved as well, and video had not to be changed, a <stream> directive for video had to be placed in the request as well in order to mantain its current status.

```
1. AS -> MS (CFW CONTROL)
-------------------------
   CFW gh67ffg56w21 CONTROL
   Control-Package: msc-mixer/1.0
   Content-Type: application/msc-mixer+xml
   Content-Length: 182

   <mscmixer version="1.0" xmlns="urn:ietf:params:xml:ns:msc-mixer">
      <modifyjoin id1="e1e1427c:1c998d22" id2="cf45ee2">
         <stream media="audio" direction="sendrecv"/>
      </modifyjoin>
   </mscmixer>


2. AS <- MS (CFW 200 OK)
------------------------
   CFW gh67ffg56w21 200
   Timeout: 10
   Content-Type: application/msc-mixer+xml
   Content-Length: 123

   <mscmixer version="1.0" xmlns="urn:ietf:params:xml:ns:msc-mixer">
      <response status="200" reason="Join modified"/>
   </mscmixer>
```

6.4. Additional Scenarios

This section includes additional scenarios that can be of interest when dealing with AS<->MS flows. The aim of the following subsections is to present the use of peculiar features provided by the IVR package, specifically variable announcements, VCR prompts, parallel playback, recurring dialogs and custom grammars. To describe how call flows involving such features might happen, three sample scenarios have been chosen:

1. Voice Mail (variable announcements for digits, VCR controls);

2. Current Time (variable announcements for date and time, parallel playback).

3. DTMF-driven Conference Manipulation (recurring dialogs, custom grammars).

6.4.1. Voice Mail

An application that typically makes use of the services an MS can provide is Voice Mail. In fact, while it is clear that many of its

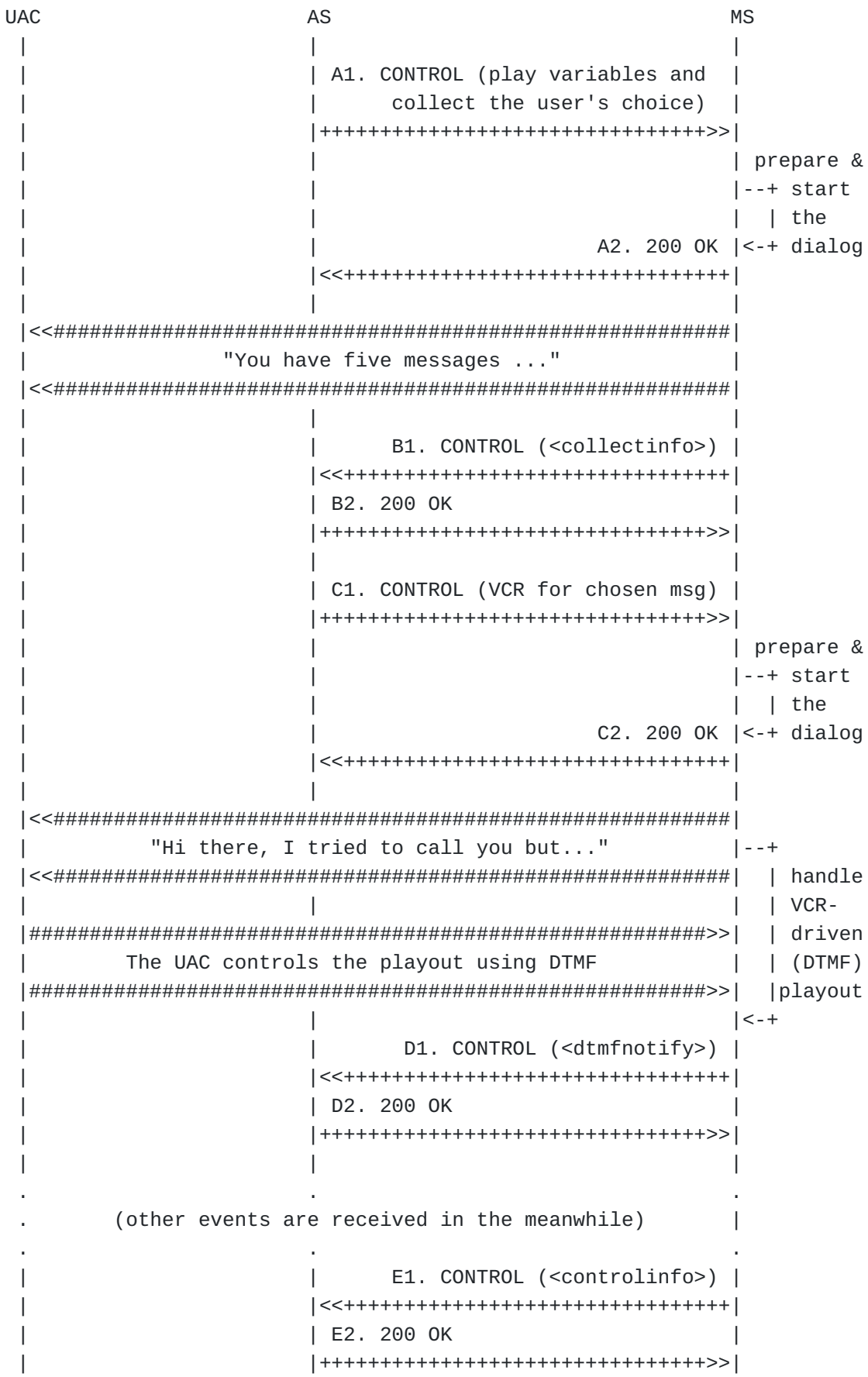
features are part of the application logic (e.g. the mapping of a URI with a specific user's voice mailbox, the list of messages and their properties, and so on), the actual media work is accomplished through the MS. Features needed by a VoiceMail application include the ability to record a stream and play it back anytime later, give verbose announcements regarding the status of the application, control the playout of recorded messages by means of VCR controls and so on, all features which are supported by the MS through the IVR package. Without delving into the details of a full VoiceMail application and all its possible use cases, this section will cover a specific scenario, trying to deal with as many interactions as possible that may happen between the AS and the MS in such a context. The covered scenario, depicted as a sequence diagram in Figure 65, will be the following:

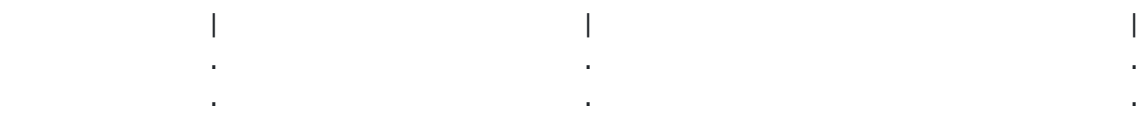
1. The UAC INVITEs a URI associated with his mailbox, and the AS follows the already explained procedure to have the UAC negotiate a new media session with the MS;

2. The UAC is first prompted with an announcement giving him the amount of available new messages in the mailbox; after that, the UAC can choose which message to access by sending a DTMF tone;

3. The UAC is then presented with a VCR controlled announcement, in which the chosen received mail is played back to him; VCR controls allow him to navigate through the prompt.

This is a quite oversimplified scenario, considering it doesn't even allow the UAC to delete old messages or organize them, but just to choose which received message to play. Nevertheless, it gives us the chance to deal with variable announcements and VCR controls, two typical features a Voice Mail application would almost always take advantage of. Besides, other features a Voice Mail application would rely upon (e.g. recording streams, event driven IVR menus and so on) have aready been introduced in previous sections, and so representing them would be redundant. This means the presented call flows assume that some messages have already been recorded, and that they are available at reachable locations. The example also assumes that the AS has placed the recordings in its own storage facilities, considering it is not safe to rely upon the internal MS storage which is likely to be temporary.


UAC
AS
MS
A1. CONTROL (play variables and collect the user's choice)
prepare & start the dialog
A2. 200 OK
"You have five messages ..."
B1. CONTROL (<collectinfo>)
B2. 200 OK
C1. CONTROL (VCR for chosen msg)
prepare & start the dialog
C2. 200 OK
"Hi there, I tried to call you but..."
handle VCR-driven (DTMF) playout
The UAC controls the playout using DTMF
D1. CONTROL (<dtmfnotify>)
D2. 200 OK
(other events are received in the meanwhile)
E1. CONTROL (<controlinfo>)
E2. 200 OK



The framework transaction steps are described in the following:

*The first transaction (A1) is addressed to the IVR package (msc-ivr); it is basically a 'promptandcollect' dialog, but with a slight difference: some of the prompts to play are actual audio files, for which a URI is provided (media loc="xxx"), while others are so-called 'variable' prompts; these 'variable' prompts are actually constructed by the MS itself according to the directives provided by the AS; in this example, this is the sequence of prompts that is requested by the AS:

1. play a wav file ("you have...");

2. play a digit ("five..."), by building it (variable: digit=5);

3. play a wav file ("messages...");

a DTMF collection is requested as well (<collect>) to be taken after the prompts have been played; the AS is only interested in a single digit (maxdigits=1);

*the transaction is handled by the MS and, in case everything works fine (i.e. the MS retrieved all the audio files and successfully built the variable ones), the dialog is started; its start is reported, together with the associated identifier (5db01f4) to the AS in a terminating 200 OK message (A2);

*the AS then waits for the dialog to end in order to retrieve the results it is interested in (in this case, the DTMF tone the UAC chooses, since it will affect which message will have to be played subsequently);

*the UAC hears the prompts and chooses a message to play; in this example, he wants to listen to the first message, and so digits 1; the MS intercepts this tone, and notifies it to the AS in a newly created CONTROL event message (B1); this CONTROL includes information about how each single requested operation ended (<promptinfo> and <collectinfo>); specifically, the event states that the prompt ended normally (termmode=completed) and that the subsequently collected tone is 1 (dtmf=1); the AS acks the event (B2), since the dialogid provided in the message is the same as the one of the previously started dialog;

*at this point, the AS makes use of the value retrieved from the event to proceed in its business logic; it decides to present the UAC with a VCR-controllable playout of the requested message; this is done with a new request to the IVR package (C1), which contains two operations: <prompt> to address the media file to play (an old recording), and <control> to instruct the MS about how the playout of this media file shall be controlled via DTMF tones provided by the UAC (in this example, different DTMF digits are associated with different actions, e.g. pause/resume, fast forward, rewind and so on); besides, the AS also subscribes to DTMF events related to this control operation (matchmode=control), which means that the MS is to trigger an event anytime a DTMF associated with a control operation (e.g. 7=pause) is intercepted;

*the MS prepares the dialog and, when the playout starts, notifies it in a terminating 200 OK message (C2); at this point, the UAC is presented with the prompt, and can make use of DTMF digits to control the playback;

*as explained previously, any DTMF associated with a VCR operation is then reported to the AS, together with a timestamp stating when the event happened; an example is provided (D1) in which the UAC pressed the fast forward key (6) at a specific time; of course, as for any other MS-generated event, the AS acks it (D2);

*when the playback ends (whether because the media reached its termination, or because any other interruption occurred), the MS triggers a concluding event with information about the whole dialog (E1); this event, besides including information about the prompt itself (<promptinfo>), also includes information related to the VCR operations (<controlinfo>), that is, all the VCR controls the UAC made use of (in the example fastforward/rewind/ pause/resume) and when it happened; the final ack by the AS (E2) concludes the scenario.

```
A1. AS -> MS (CFW CONTROL, play and collect)
-------------------------------------------
   CFW 2f931de22820 CONTROL
   Control-Package: msc-ivr/1.0
   Content-Type: application/msc-ivr+xml
   Content-Length: 429

   <mscivr version="1.0" xmlns="urn:ietf:params:xml:ns:msc-ivr">
      <dialogstart connectionid="10514b7f:6a900179">
         <dialog>
            <prompt>
               <media \
            loc="http://www.example.net/prompts/vm-youhave.wav" \
            type="audio/x-wav"/>
               <variable value="5" type="digits"/>
               <media \
           loc="http://www.example.net/prompts/vm-messages.wav" \
           type="audio/x-wav"/>
            </prompt>
            <collect maxdigits="1" escapekey="*" \
                     cleardigitbuffer="true"/>
         </dialog>
      </dialogstart>
   </mscivr>


A2. AS <- MS (CFW 200 OK)
-------------------------
   CFW 2f931de22820 200
   Timeout: 10
   Content-Type: application/msc-ivr+xml
   Content-Length: 137

   <mscivr version="1.0" xmlns="urn:ietf:params:xml:ns:msc-ivr">
     <response status="200" reason="Dialog started" dialogid="5db01f4"/>
   </mscivr>


B1. AS <- MS (CFW CONTROL event)
--------------------------------
   CFW 7c97adc41b3e CONTROL
   Control-Package: msc-ivr/1.0
   Content-Type: application/msc-ivr+xml
   Content-Length: 270

   <mscivr version="1.0" xmlns="urn:ietf:params:xml:ns:msc-ivr">
      <event dialogid="5db01f4">
         <dialogexit status="1" reason="Dialog successfully completed">
            <promptinfo duration="11713" termmode="completed"/>
```

```
            <collectinfo dtmf="1" termmode="match"/>
         </dialogexit>
      </event>
   </mscivr>


B2. AS -> MS (CFW 200, ACK to 'CONTROL event')
----------------------------------------------
   CFW 7c97adc41b3e 200


C1. AS -> MS (CFW CONTROL, VCR)
-------------------------------
   CFW 3140c24614bb CONTROL
   Control-Package: msc-ivr/1.0
   Content-Type: application/msc-ivr+xml
   Content-Length: 423

   <mscivr version="1.0" xmlns="urn:ietf:params:xml:ns:msc-ivr">
      <dialogstart connectionid="10514b7f:6a900179">
         <dialog>
            <prompt bargein="false">
               <media \
  loc="http://www.example.com/messages/recording-4ca9fc2.mpg"/>
            </prompt>
            <control gotostartkey="1" gotoendkey="3" \
                     ffkey="6" rwkey="4" pausekey="7" resumekey="9" \
                     volupkey="#" voldnkey="*"/>
            </dialog>
         <subscribe>
            <dtmfsub matchmode="control"/>
         </subscribe>
      </dialogstart>
   </mscivr>


C2. AS <- MS (CFW 200 OK)
-------------------------
   CFW 3140c24614bb 200
   Timeout: 10
   Content-Type: application/msc-ivr+xml
   Content-Length: 137

   <mscivr version="1.0" xmlns="urn:ietf:params:xml:ns:msc-ivr">
     <response status="200" reason="Dialog started" dialogid="3e936e0"/>
   </mscivr>


D1. AS <- MS (CFW CONTROL event, dtmfnotify)
--------------------------------------------
```

```
   CFW 361840da0581 CONTROL
   Control-Package: msc-ivr/1.0
   Content-Type: application/msc-ivr+xml
   Content-Length: 179

   <mscivr version="1.0" xmlns="urn:ietf:params:xml:ns:msc-ivr">
      <event dialogid="3e936e0">
         <dtmfnotify matchmode="control" dtmf="6" \
                     timestamp="2008-12-16T12:58:36Z"/>
      </event>
   </mscivr>


D2. AS -> MS (CFW 200, ACK to 'CONTROL event')
-----------------------------------------------
   CFW 361840da0581 200


      [..] The other VCR DTMF notifications are skipped for brevity [..]


E1. AS <- MS (CFW CONTROL event, dialogexit)
-----------------------------------------------
   CFW 3ffab81c21e9 CONTROL
   Control-Package: msc-ivr/1.0
   Content-Type: application/msc-ivr+xml
   Content-Length: 485

   <mscivr version="1.0" xmlns="urn:ietf:params:xml:ns:msc-ivr">
      <event dialogid="3e936e0">
         <dialogexit status="1" reason="Dialog successfully completed">
            <promptinfo duration="10270" termmode="completed"/>
            <controlinfo>
               <controlmatch dtmf="6" timestamp="2008-12-16T12:58:36Z"/>
               <controlmatch dtmf="4" timestamp="2008-12-16T12:58:37Z"/>
               <controlmatch dtmf="7" timestamp="2008-12-16T12:58:38Z"/>
               <controlmatch dtmf="9" timestamp="2008-12-16T12:58:40Z"/>
            </controlinfo>
         </dialogexit>
      </event>
   </mscivr>


E2. AS -> MS (CFW 200, ACK to 'CONTROL event')
-----------------------------------------------
   CFW 3ffab81c21e9 200
```

6.4.2. Current Time

An interesting scenario to realize with the help of the MS provided features is what is typically called 'Current Time'. A UAC calls a URI, which presents the caller with the current date and time. As it can easily be deduced by the very nature of the application, variable announcements play an important role in this scenario. In fact, rather than having the AS build different framework messages according to the current time to build an announcement, it is much easier to rely upon the variable announcements mechanism provided by the IVR package, which includes ways to deal with dates and times in several fashions.
To make the scenario more interesting and have it cover more functionality, the application is also assumed to have a background music played during the announcement. Considering that most of the announcements will be variable, a means is needed to have more streams played in parallel on the same connection. This can be achieved in two different ways:

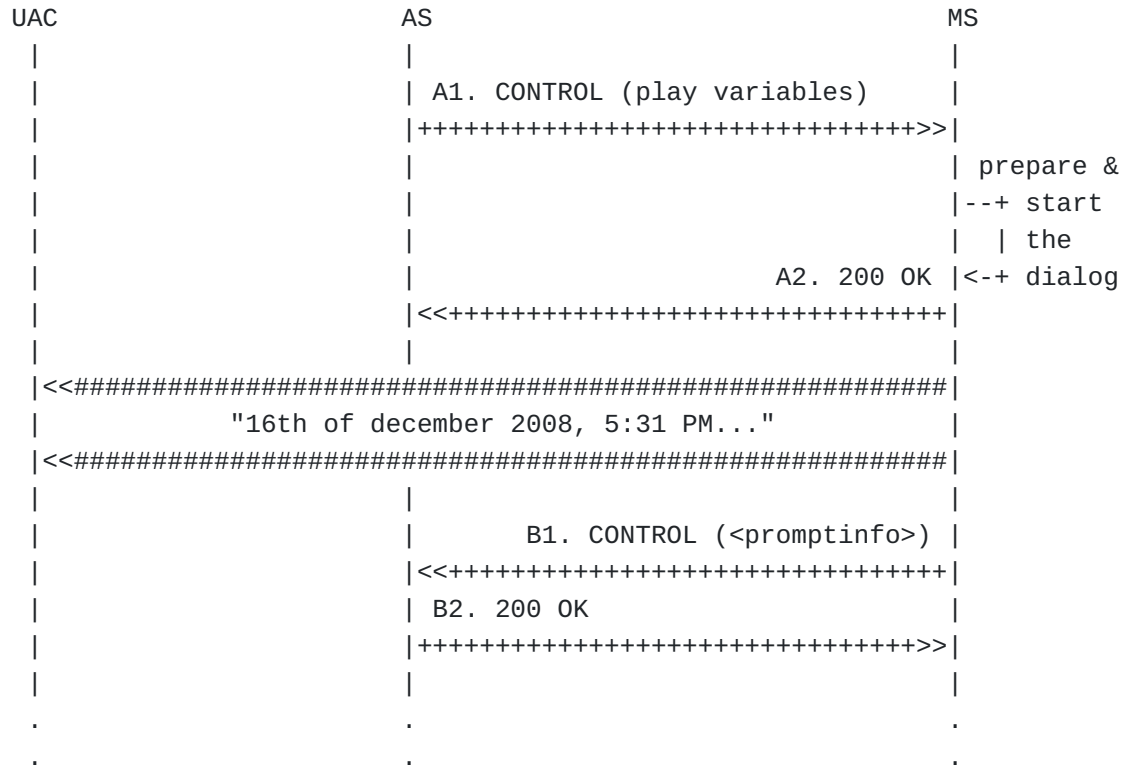
1. two separate and different dialogs, playing respectively the variable announcements and the background track;

2. a single dialog implementing a parallel playback.

The first approach assumes the available MS implements implicit mixing, which may or may not be supported, since it's a recommended feature but not a mandatory one. The second approach instead assumes the MS implements support for more streams of the same media type (in this case audio) in the same dialog, which, exactly as implicit mixing, is not to be given for granted. Considering the first approach is quite straightforward to understand, the presented scenario makes use of the second one, and assumes the available MS supports parallel playback of more audio tracks within the context of the same dialog.
That said, the covered scenario, depicted as a sequence diagram in Figure 67, will be the following:

1. The UAC INVITEs a URI associated with the Current Time application, and the AS follows the already explained procedure to have the UAC negotiate a new media session with the MS;

2. The UAC is presented with an announcement including: (i) a voice stating the current date and time; (ii) a background music track; (iii) a mute background video track.



The framework transaction steps are described in the following:

*The first transaction (A1) is addressed to the IVR package (msc-ivr); it is basically a 'playannouncement' dialog, but, unlike all the scenarios presented so far, it includes directives for a parallel playback, as indicated by the 'par' element; there are three flows to play in parallel:

-a sequence ('seq') of variable and static announcements (the actual time and date);

-a music track ('media=music.wav') to be played in background at a lower volume (soundLevel=50%);

-a mute background video track (media=clock.mpg).

The global announcement ends when the longest of the three parallel steps ends (endsync=last); this means that, if one of the steps ends before the others, the step is muted for the rest of the playback. About the series of static and variable announcements, in this example this is requested by the AS:

-play a wav file ("Tuesday...");

-play a date ("16th of december 2008..."), by building it (variable: date with a ymd=year/month/day format);

-play a time ("5:31 PM..."), by building it (variable: time with a t12=12 hour day format, am/pm).

*the transaction is extended by the MS (A2) and, in case everything went fine (i.e. the MS retrieved all the audio files and successfully built the variable ones, and it supports parallel playback as requested), the dialog is started; its start is reported, together with the associated identifier (415719e) to the AS in a terminating REPORT message (A3);

*the AS acks the REPORT (A4), and waits for the dialog to end in order to conclude the application, or proceed to further steps if required by the application itself;

*when the last of the three parallel announcements ends, the dialog terminates, and an event (B1) is triggered to the AS with the relevant information (promptinfo); the AS acks (B2) and terminates the scenario.

A1. AS -> MS (CFW CONTROL, play)
```
   CFW 0c7680191bd2 CONTROL
   Control-Package: msc-ivr/1.0
   Content-Type: application/msc-ivr+xml
   Content-Length: 506

   <mscivr version="1.0" xmlns="urn:ietf:params:xml:ns:msc-ivr">
     <dialogstart connectionid="21c8e07b:055a893f">
       <dialog>
         <prompt bargein="true">
           <par endsync="last">
             <seq>
               <media loc="http://www.example.com/day-2.wav"/>
               <variable value="2008-12-16" type="date" format="ymd"/>
               <variable value="17:31" type="time" format="t12"/>
             </seq>
             <media loc="http://www.example.com/music.wav" \
                    soundLevel="50%"/>
             <media loc="http://www.example.com/clock.mpg"/>
           </par>
         </prompt>
       </dialog>
     </dialogstart>
   </mscivr>
```

A2. AS <- MS (CFW 200 OK)
```
   CFW 0c7680191bd2 200
   Timeout: 10
   Content-Type: application/msc-ivr+xml
   Content-Length: 137

   <mscivr version="1.0" xmlns="urn:ietf:params:xml:ns:msc-ivr">
     <response status="200" reason="Dialog started" dialogid="415719e"/>
   </mscivr>
```

B1. AS <- MS (CFW CONTROL event)
```
   CFW 4481ca0c4fca CONTROL
   Control-Package: msc-ivr/1.0
   Content-Type: application/msc-ivr+xml
   Content-Length: 229

   <mscivr version="1.0" xmlns="urn:ietf:params:xml:ns:msc-ivr">
      <event dialogid="5db01f4">
         <dialogexit status="1" reason="Dialog successfully completed">
```

```
            <promptinfo duration="8046" termmode="completed"/>
         </dialogexit>
      </event>
   </mscivr>
```

```
B2. AS -> MS (CFW 200, ACK to 'CONTROL event')
-----------------------------------------------
   CFW 4481ca0c4fca 200
```

6.4.3. DTMF-driven Conference Manipulation

To complete the scenarios presented in Section 6.3, this section deals with how the AS can make use of the MS in order to detect DTMF tones from conference participants, and take actions on the conference accordingly. A typical example is when participants in a conference are provided with specific codes to:

- mute/unmute themselves in the conference;
- change their volume in the conference, or the volume of the conference itself;
- change the video layout in the conference, if allowed;
- kick abusing users from the conference;

and so on. To achieve all this, the simpliest thing an AS can do is to prepare a recurring DTMF collection for each participant with specific grammars to match. In case the collected tones match the grammar, the MS would notify them to the AS, and start the collection again. Upon receival of <collectinfo> events, the AS would in turn originate the proper related request, e.g. a <modifyjoin> on the participant's stream with the conference. This is made possible by three features provided by the IVR package:

1. the 'repeatCount' attribute;
2. the subscription mechanism;
3. the Speech Recognition Grammar Specification (SRGS) [SRGS].

The first allows for recurring instances of the same dialog without the need of additional requests upon completion of the dialog itself. In fact, the 'repeatCount' attribute indicates how many times the dialog has to be repeated: when the attribute has the value 0, it means that the dialog has to be repeated indefinitely, meaning that it's up to the AS to destroy it by means of a <dialogterminate> request when the

dialog isn't needed anymore. The second, instead, allows the AS to subscribe to events related to the IVR package without waiting for the dialog to end, e.g. matching DTMF collections in this case. The last, finally, allows for custom matching grammars to be specified: this way, only a subset of the possible DTMF strings can be specified, so that only the matches the AS is interested in are reported. Different grammars other than SRGS may be supported by the MS, which achieve the same result: anyway, this document will only describe the use of an SRGS grammar, since support for SRGS is mandated in the IVR package specification.
To identify a single sample scenario, we assume a participant has already successfully joined a conference, e.g. as detailed in Figure 49. Besides, we assume the following codes are to be provided within the conference to participants in order to let them take advantage of advanced features:

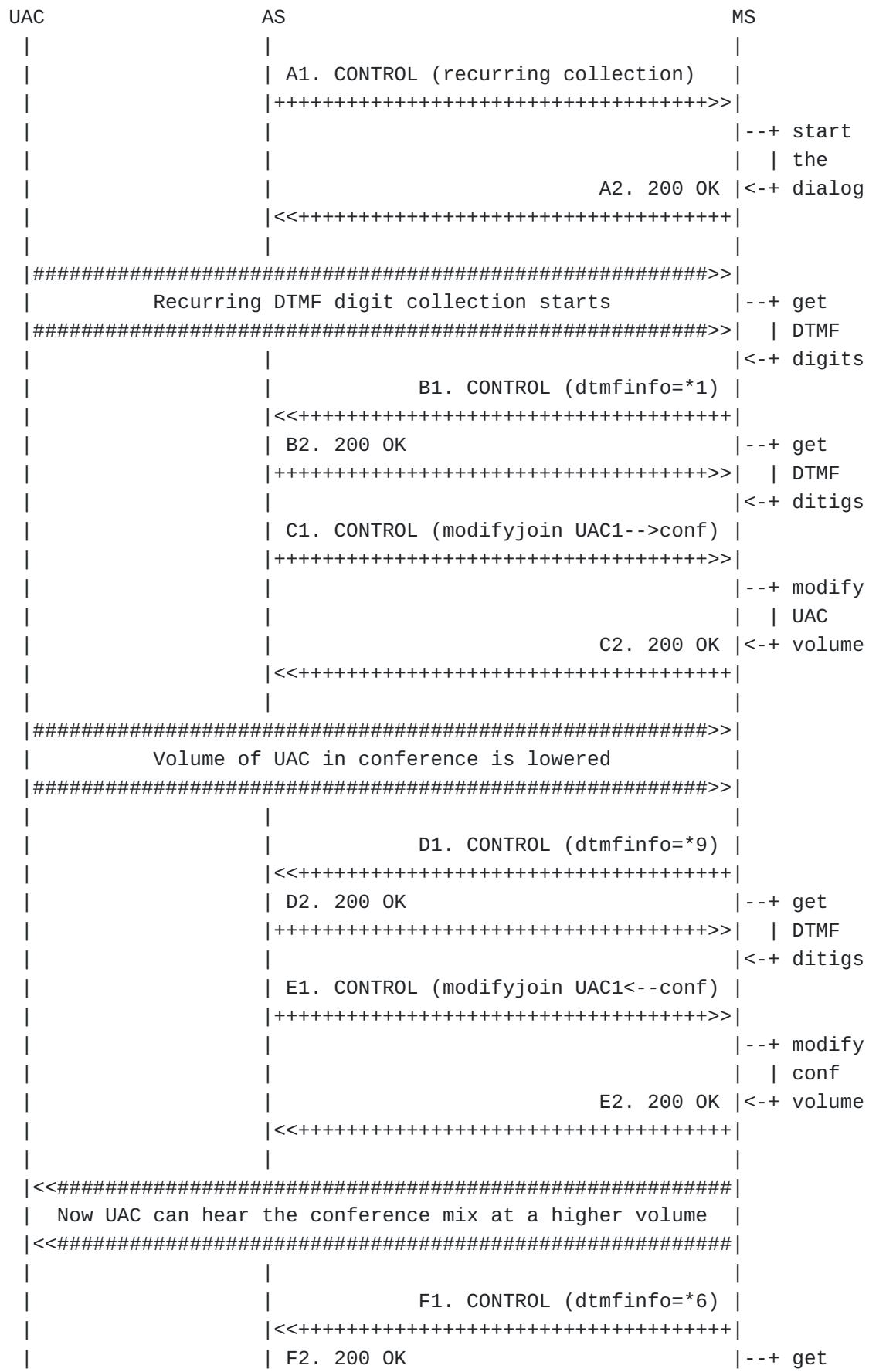
1. *6 to mute/unmute themselves (on/off trigger);
2. *1 to lower their own volume in the conference, and *3 to raise it;
3. *7 to lower the volume of the conference stream they are receiving, and *9 to raise it;
4. *0 to leave the conference.

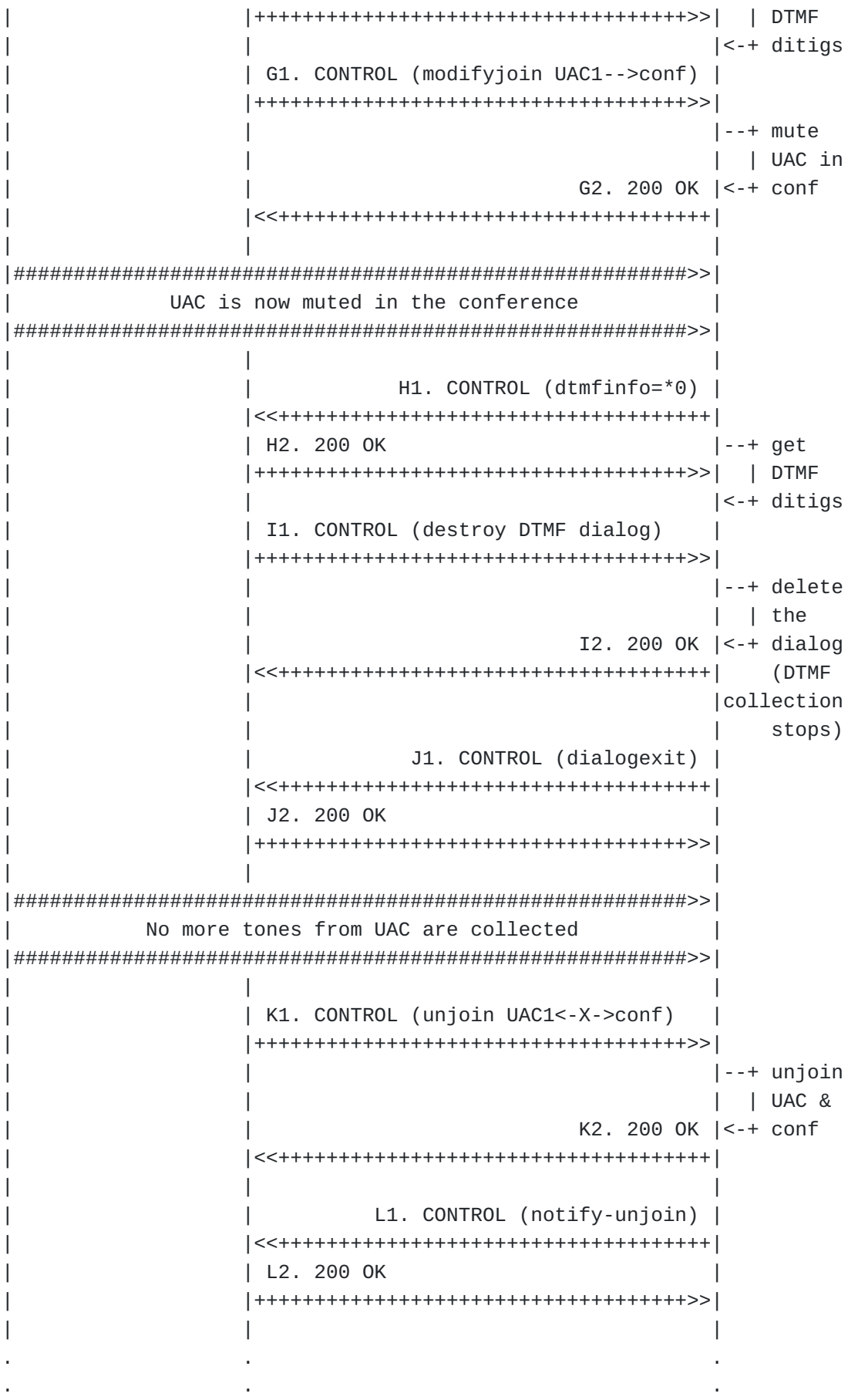
This means that six different codes are supported, and are to be matched in the requested DTMF collection. All other codes are collected by the MS, but discarded, and no event is triggered to the AS.
Considering all the codes have the '*' (star) DTMF code in common, the following is an example of an SRGS grammar that may be used in the request by the AS:

```
<grammar mode="dtmf" version="1.0" \
         xmlns="http://www.w3.org/2001/06/grammar">
  <rule id="digit">
    <one-of>
      <item>0</item>
      <item>1</item>
      <item>3</item>
      <item>6</item>
      <item>7</item>
      <item>9</item>
    </one-of>
  </rule>
  <rule id="action" scope="public">
    <item>
      *
      <item><ruleref uri="#digit"/></item>
    </item>
  </rule>
</grammar>
```

As it can be deduced by looking at the grammar, the presented SRGS XML code specifies exactly the requirements for the collections to match: the rule is to match any string which has a star ('*') followed by just one of any supported digit (0, 1, 3, 6, 7, 9). Such grammar, as stated in the IVR package specification, may be provided either inline in the request itself or referenced externally by means of the 'src' attribute. In the scenario example, we'll put it inline, but an external reference to the same document would achieve exactly the same result.

Figure 70 shows how the AS might request the recurring collection for a UAC: as already anticipated before, the example assumes the UAC is already a participant in the conference.


UAC
AS
MS
A1. CONTROL (recurring collection)
start the dialog
A2. 200 OK
Recurring DTMF digit collection starts
get DTMF digits
B1. CONTROL (dtmfinfo=*1)
B2. 200 OK
get DTMF ditigs
C1. CONTROL (modifyjoin UAC1-->conf)
modify UAC volume
C2. 200 OK
Volume of UAC in conference is lowered
D1. CONTROL (dtmfinfo=*9)
D2. 200 OK
get DTMF ditigs
E1. CONTROL (modifyjoin UAC1<--conf)
modify conf volume
E2. 200 OK
Now UAC can hear the conference mix at a higher volume
F1. CONTROL (dtmfinfo=*6)
F2. 200 OK
get


G1. CONTROL (modifyjoin UAC1-->conf)
DTMF ditigs
mute UAC in conf
G2. 200 OK
UAC is now muted in the conference
H1. CONTROL (dtmfinfo=*0)
H2. 200 OK
get DTMF ditigs
I1. CONTROL (destroy DTMF dialog)
delete the dialog
I2. 200 OK
(DTMF collection stops)
J1. CONTROL (dialogexit)
J2. 200 OK
No more tones from UAC are collected
K1. CONTROL (unjoin UAC1<-X->conf)
unjoin UAC & conf
K2. 200 OK
L1. CONTROL (notify-unjoin)
L2. 200 OK

As it can be deduced from the sequence diagram above, the AS, in its business logic, correlates the results of different transactions, addressed to different packages, to implement a more complex conferencing scenario: in fact, 'dtmfnotify' events are used to take actions according to the purpose the DTMF codes are meant for. The framework transaction steps are the following:

* The UAC is already in the conference, and so the AS starts a recurring collect with a grammar to match; this is done by placing a CONTROL request addressed to the IVR package (A1); the operation to implement is a <collect>, and we are only interested in two-digits DTMF strings (maxdigits); the AS is not interested in a DTMF terminator (termchar is set to a non-conventional DTMF character), and the DTMF escape key is set to '#' (the default is '*', which would conflict with the code syntax for the conference, and so needs to be changed); a custom SRGS grammar is provided inline (<grammar> with mode=dtmf); the whole dialog is to be repeated indefinitely (dialog has repeatCount=0), and the AS wants to be notified when matching collections occur (dtmfsub with matchmode=collect);

* the request is handled by the MS as already explained in previous sections (A2), and then successfully started (dialogid=01d1b38); this means the MS has started collecting DTMF tones from UAC;

* the MS collects a matching DTMF string from UAC (*1); since the AS subscribed to this kind of event, a CONTROL event notification (dtmfnotify) is triggered by the MS (B1), including the collected tones; since the dialog is recurring, the MS immediately restarts the collection;

* the AS acks the event (B2), and in its business logic understands that the code '*1' means that the UAC wants its own volume to be lowered in the conference mix; the AS is able to associate the event with the right UAC by referring to the attached dialogid (01d1b38); it then acts accordingly, by sending a <modifyjoin> (C1) which does exactly this: the provided <stream> child element instructs the MS into modifying the volume of the UAC-->conference audio flow (setgain=-5dB sendonly); notice how the request also includes directives upon the inverse direction; this verbose approach is needed, since otherwise the MS would not only change the volume in the requested direction, but also disable the media flow in the other direction; having a proper <stream> addressing the UAC<--conf media flow as well ensures that this doesn't happen;

*the MS successfully enforces the requested operation (C2), changing the volume;

*a new matching DTMF string from UAC is collected (*9); as before, an event is triggered to the AS (D1);

*the AS acks the event (D2), and matches the new code ('*9') with its related operation (raise the volume of the conference mix for UAC), taking the proper action; a different <modifyjoin> is sent (E1) with the new instructions (setgain=+3dB recvonly); notice how a <stream> for the inverse direction (sendonly) is provided again just as a placeholder, which basically instructs the MS that the settings for that direction are not to be changed, maintaining the previous directives of (C1);

*the MS successfully enforces this requested operation as well (E2), changing the volume in the specified direction;

*at this point, a further matching DTMF string from UAC is collected (*6), and sent to the AS (F1);

*after the rquired ack (F2), the AS reacts by implementing the action associated with the new code ('*6'), by which UAC requested to be muted within the conference; a new <modifyjoin> is sent (G1) with a properly constructed payload (setstate=mute sendonly), and the MS enforces it (G2);

*a last (in the scenario) matching DTMF string is collected by the MS (*0); as with all the previous codes, this string is notified to the AS (H1);

*the AS acks the event (H2), and understands the UAC wants to leave the conference now (since the code is *0); this means that a series of actions must be taken, namely:

  -actually stopping the recurring collection, since it's not needed anymore;

  -unjoin UAC from the conference it is in;

  -additional operations might be considered, e.g. a global announcement stating UAC is leaving, but are left out for the sake of conciseness);

 the former is accomplished by means of a <dialogterminate> request (I1) to the IVR package (dialogid=01d1b38); the latter by means of an 'unjoin' request (K1) to the Mixer package instead;

*the <dialogterminate> request is handled by the MS (I2), and the dialog is terminated successfully; as soon as the dialog has

actually been terminated, a 'dialogexit' event is triggered as well to the AS (J1); this event has no report upon the result of the last iteration (since the dialog was terminated abruptly with an immediate=true) and is acked by the AS (J2) to finally complete the dialog lifetime;

*the <unjoin> request, instead, is immediately enforced (K2); as a consequence of the unjoin operation, an 'unjoin-notify' event notification is triggered by the MS (L1) to confirm to the AS that the requested entities are not attached to each other anymore; the status in the event is set to 0 which, as stated in the specification, means the join has been terminated by an <unjoin> request; the ack of the AS (L2) concludes this scenario.

A1. AS -> MS (CFW CONTROL, recurring collect with grammar)

```
   CFW 238e1f2946e8 CONTROL
   Control-Package: msc-ivr/1.0
   Content-Type: application/msc-ivr+xml
   Content-Length: 809

   <mscivr version="1.0" xmlns="urn:ietf:params:xml:ns:msc-ivr">
     <dialogstart connectionid="14849028:37fc2523">
       <dialog repeatCount="0">
         <collect maxdigits="2" termchar="A" escapekey="#">
           <grammar>
             <grammar version="1.0" mode="dtmf" \
                      xmlns="http://www.w3.org/2001/06/grammar">
               <rule id="digit">
                 <one-of>
                   <item>0</item>
                   <item>1</item>
                   <item>3</item>
                   <item>6</item>
                   <item>7</item>
                   <item>9</item>
                 </one-of>
               </rule>
               <rule id="action" scope="public">
                 <example>*3</example>
                 <one-of>
                   <item>
                     *
                     <ruleref uri="#digit"/>
                   </item>
                 </one-of>
               </rule>
             </grammar>
           </grammar>
         </collect>
       </dialog>
       <subscribe>
         <dtmfsub matchmode="collect"/>
       </subscribe>
     </dialogstart>
   </mscivr>
```

A2. AS <- MS (CFW 200 OK)

```
   CFW 238e1f2946e8 200
   Timeout: 10
```

```
   Content-Type: application/msc-ivr+xml
   Content-Length: 137

   <mscivr version="1.0" xmlns="urn:ietf:params:xml:ns:msc-ivr">
     <response status="200" reason="Dialog started" dialogid="01d1b38"/>
   </mscivr>


B1. AS <- MS (CFW CONTROL dtmfnotify event)
-------------------------------------------
   CFW 1dd62e043c00 CONTROL
   Control-Package: msc-ivr/1.0
   Content-Type: application/msc-ivr+xml
   Content-Length: 180

   <mscivr version="1.0" xmlns="urn:ietf:params:xml:ns:msc-ivr">
     <event dialogid="01d1b38">
       <dtmfnotify matchmode="collect" dtmf="*1" \
                   timestamp="2008-12-17T17:20:53Z"/>
     </event>
   </mscivr>


B2. AS -> MS (CFW 200, ACK to 'CONTROL event')
----------------------------------------------
   CFW 1dd62e043c00 200


C1. AS -> MS (CFW CONTROL, modifyjoin with setgain)
---------------------------------------------------
   CFW 0216231b1f16 CONTROL
   Control-Package: msc-mixer/1.0
   Content-Type: application/msc-mixer+xml
   Content-Length: 290

   <mscmixer version="1.0" xmlns="urn:ietf:params:xml:ns:msc-mixer">
     <modifyjoin id1="873975758:a5105056" id2="54b4ab3">
       <stream media="audio" direction="sendonly">
         <volume controltype="setgain" value="-3"/>
       </stream>
       <stream media="audio" direction="recvonly"/>
     </modifyjoin>
   </mscmixer>


C2. AS <- MS (CFW 200 OK)
-------------------------
   CFW 0216231b1f16 200
   Timeout: 10
   Content-Type: application/msc-mixer+xml
```

```
   Content-Length: 123

   <mscmixer version="1.0" xmlns="urn:ietf:params:xml:ns:msc-mixer">
     <response status="200" reason="Join modified"/>
   </mscmixer>


D1. AS <- MS (CFW CONTROL dtmfnotify event)
-------------------------------------------
   CFW 4d674b3e0862 CONTROL
   Control-Package: msc-ivr/1.0
   Content-Type: application/msc-ivr+xml
   Content-Length: 180

   <mscivr version="1.0" xmlns="urn:ietf:params:xml:ns:msc-ivr">
     <event dialogid="01d1b38">
       <dtmfnotify matchmode="collect" dtmf="*9" \
                   timestamp="2008-12-17T17:20:57Z"/>
     </event>
   </mscivr>


D2. AS -> MS (CFW 200, ACK to 'CONTROL event')
----------------------------------------------
   CFW 4d674b3e0862 200


E1. AS -> MS (CFW CONTROL, modifyjoin with setgain)
---------------------------------------------------
   CFW 140e0f763352 CONTROL
   Control-Package: msc-mixer/1.0
   Content-Type: application/msc-mixer+xml
   Content-Length: 292

   <mscmixer version="1.0" xmlns="urn:ietf:params:xml:ns:msc-mixer">
     <modifyjoin id1="873975758:a5105056" id2="54b4ab3">
       <stream media="audio" direction="recvonly">
         <volume controltype="setgain" value="+3"/>
       </stream>
       <stream media="audio" direction="sendonly"/>
     </modifyjoin>
   </mscmixer>


E2. AS <- MS (CFW 200 OK)
-------------------------
   CFW 140e0f763352 200
   Timeout: 10
   Content-Type: application/msc-mixer+xml
   Content-Length: 123
```

```
   <mscmixer version="1.0" xmlns="urn:ietf:params:xml:ns:msc-mixer">
     <response status="200" reason="Join modified"/>
   </mscmixer>


F1. AS <- MS (CFW CONTROL dtmfnotify event)
-------------------------------------------
   CFW 478ed6f1775b CONTROL
   Control-Package: msc-ivr/1.0
   Content-Type: application/msc-ivr+xml
   Content-Length: 180

   <mscivr version="1.0" xmlns="urn:ietf:params:xml:ns:msc-ivr">
     <event dialogid="01d1b38">
       <dtmfnotify matchmode="collect" dtmf="*6" \
                   timestamp="2008-12-17T17:21:02Z"/>
     </event>
   </mscivr>


F2. AS -> MS (CFW 200, ACK to 'CONTROL event')
----------------------------------------------
   CFW 478ed6f1775b 200


G1. AS -> MS (CFW CONTROL, modifyjoin with setstate)
----------------------------------------------------
   CFW 7fdcc2331bef CONTROL
   Control-Package: msc-mixer/1.0
   Content-Type: application/msc-mixer+xml
   Content-Length: 295

   <mscmixer version="1.0" xmlns="urn:ietf:params:xml:ns:msc-mixer">
     <modifyjoin id1="873975758:a5105056" id2="54b4ab3">
       <stream media="audio" direction="sendonly">
         <volume controltype="setstate" value="mute"/>
       </stream>
       <stream media="audio" direction="recvonly"/>
     </modifyjoin>
   </mscmixer>


G2. AS <- MS (CFW 200 OK)
-------------------------
   CFW 7fdcc2331bef 200
   Timeout: 10
   Content-Type: application/msc-mixer+xml
   Content-Length: 123
```

```
   <mscmixer version="1.0" xmlns="urn:ietf:params:xml:ns:msc-mixer">
     <response status="200" reason="Join modified"/>
   </mscmixer>


H1. AS <- MS (CFW CONTROL dtmfnotify event)
-------------------------------------------
   CFW 750b917a5d4a CONTROL
   Control-Package: msc-ivr/1.0
   Content-Type: application/msc-ivr+xml
   Content-Length: 180

   <mscivr version="1.0" xmlns="urn:ietf:params:xml:ns:msc-ivr">
     <event dialogid="01d1b38">
       <dtmfnotify matchmode="collect" dtmf="*0" \
                   timestamp="2008-12-17T17:21:05Z"/>
     </event>
   </mscivr>


H2. AS -> MS (CFW 200, ACK to 'CONTROL event')
----------------------------------------------
   CFW 750b917a5d4a 200


I1. AS -> MS (CFW CONTROL, dialogterminate)
-------------------------------------------
   CFW 515f007c5bd0 CONTROL
   Control-Package: msc-ivr/1.0
   Content-Type: application/msc-ivr+xml
   Content-Length: 128

   <mscivr version="1.0" xmlns="urn:ietf:params:xml:ns:msc-ivr">
     <dialogterminate dialogid="01d1b38" immediate="true"/>
   </mscivr>


I2. AS <- MS (CFW 200 OK)
-------------------------
   CFW 515f007c5bd0 200
   Timeout: 10
   Content-Type: application/msc-ivr+xml
   Content-Length: 140

   <mscivr version="1.0" xmlns="urn:ietf:params:xml:ns:msc-ivr">
     <response status="200" reason="Dialog terminated" \
               dialogid="01d1b38"/>
   </mscivr>
```

```
J1. AS <- MS (CFW CONTROL dialogexit event)
-------------------------------------------
   CFW 76adc41122c1 CONTROL
   Control-Package: msc-ivr/1.0
   Content-Type: application/msc-ivr+xml
   Content-Length: 155

   <mscivr version="1.0" xmlns="urn:ietf:params:xml:ns:msc-ivr">
     <event dialogid="01d1b38">
       <dialogexit status="0" reason="Dialog terminated"/>
     </event>
   </mscivr>


J2. AS -> MS (CFW 200, ACK to 'CONTROL event')
----------------------------------------------
   CFW 76adc41122c1 200


K1. AS -> MS (CFW CONTROL, unjoin)
----------------------------------
   CFW 4e6afb6625e4 CONTROL
   Control-Package: msc-mixer/1.0
   Content-Type: application/msc-mixer+xml
   Content-Length: 127

   <mscmixer version="1.0" xmlns="urn:ietf:params:xml:ns:msc-mixer">
     <unjoin id1="873975758:a5105056" id2="54b4ab3"/>
   </mscmixer>


K2. AS <- MS (CFW 200 OK)
-------------------------
   CFW 4e6afb6625e4 200
   Timeout: 10
   Content-Type: application/msc-mixer+xml
   Content-Length: 122

   <mscmixer version="1.0" xmlns="urn:ietf:params:xml:ns:msc-mixer">
     <response status="200" reason="Join removed"/>
   </mscmixer>


L1. AS <- MS (CFW CONTROL unjoin-notify event)
----------------------------------------------
   CFW 577696293504 CONTROL
   Control-Package: msc-mixer/1.0
   Content-Type: application/msc-mixer+xml
   Content-Length: 157
```

```
   <mscmixer version="1.0" xmlns="urn:ietf:params:xml:ns:msc-mixer">
     <event>
       <unjoin-notify status="0" \
                      id1="873975758:a5105056" id2="54b4ab3"/>
     </event>
   </mscmixer>
```

```
L2. AS -> MS (CFW 200, ACK to 'CONTROL event')
-----------------------------------------------
   CFW 577696293504 200
```

7. Media Resource Brokering

All the flows presented so far describe the interaction between a single AS and a single MS. This is the most simple topology that can be envisaged in a MEDIACTRL-compliant architecture, but it's not the only allowed one. [RFC5567] presents several possible topologies, potentially involving several AS and several MS as well. To properly allow for such topologies, an additional element has been introduced in the MEDIACTRL architecture, called Media Resource Broker (MRB). Such an entity, and the protocols needed to interact with it, has been standardized in [I-D.ietf-mediactrl-mrb].
A MRB is basically a locator that is aware of a pool of MS, and makes them available to interested AS according to their requirements. For this reason, two different interfaces have been introduced:

*Publishing Interface (Section 7.1), which allows an MRB to subscribe for notifications at the MS it is handling (e.g. available and occupied resources, current state, etc.);

*Consumer Interface (Section 7.2), which allows an interested AS to query an MRB for a MS capable to fulfill its requirements.

The flows in the following sections will present some typical use case scenarios involving a MRB, and the different topologies it has been conceived to work in.
Additionally, a few considerations on the handling of call legs whenever an MRB is involved are presented in Section 7.3.

7.1. Publishing Interface

Each MS makes use of the publishing interface to provide an MRB with relevant information. This publishing interface, as specified in [I-D.ietf-mediactrl-mrb], is made available as a control package for the Media Control Channel Framework. This means that, in order to receive information from a MS, an MRB must negotiate a control channel as explained in Section 5. This package allows a MRB to request

information from a MS, be it as a direct request/answer or by subscribing for events.
Of course, considering the MRB is interested in the publishing interface, the already mentioned negotiation must be changed in order to take into account the need for the MRB control package. The name of this package is 'mrb-publish/1.0', which means the SYNC might look like the following:

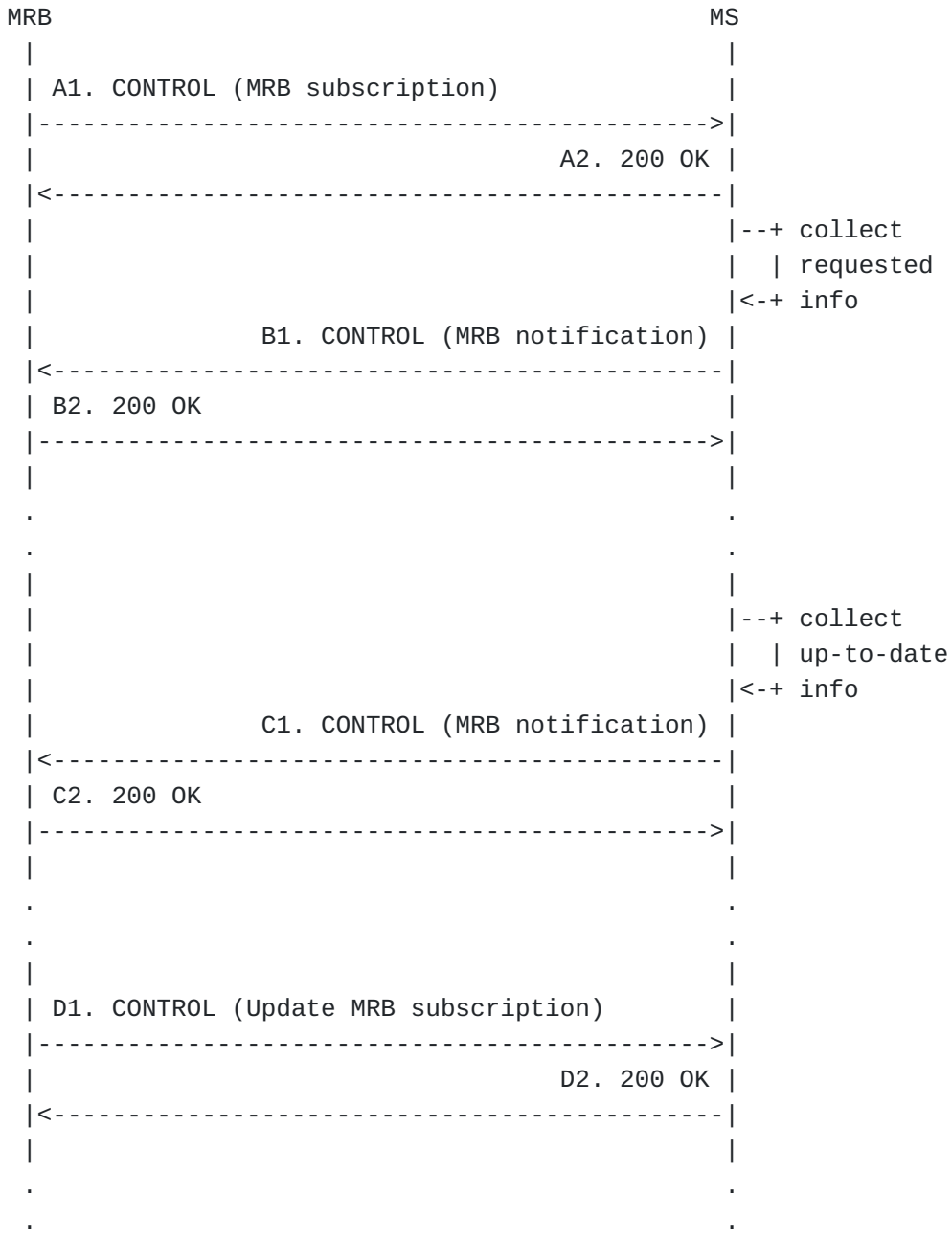
```
1. MRB -> MS (CFW SYNC)
-----------------------
   CFW 6b8b4567327b SYNC
   Dialog-ID: z9hG4bK-4542-1-0
   Keep-Alive: 100
   Packages: msc-ivr/1.0,msc-mixer/1.0,mrb-publish/1.0
```

```
2. MRB <- MS (CFW 200)
----------------------
   CFW 6b8b4567327b 200
   Keep-Alive: 100
   Packages: msc-ivr/1.0,msc-mixer/1.0,mrb-publish/1.0
   Supported: msc-example-pkg/1.0
```

The meaning of this negotiation has already been presented. It is enough to point out that, in this case, the MRB adds a new voice to the 'Packages' it needs support for (mrb-publish/1.0). In this case, the MS supports it, and in fact it is added to the negotiated packages in the reply:

```
        Packages: msc-ivr/1.0,msc-mixer/1.0,mrb-publish/1.0
                                            ^^^^^^^^^^^^^^^
```

The MS of Section 5, instead, did not have support for that package, since only 'msc-example-pkg/1.0' was part of the 'Supported' list. Figure 74 presents a ladder diagram of a typical interaction based on the MRB control package.



In this example, the MRB subscribes for information at the specified MS, and events are triggered at a regular, negotiated, basis. All this messages flow through the control channel as all the messages in this document. The framework transaction steps are the following:

*The MRB sends a new CONTROL message (A1) addressed to the MRB package (mrb-publish/1.0); it is a subscribtion for information (<subscription>), and the MRB is asking to be notified at least every 10 minutes (<minfrequency>), or if required every 30

seconds at max; besides, the subscription must last 30 minutes (<expires>) after which no notification must be sent anymore;

*The MS acknowledges the request (A2), and notifies the success of the request in a 200 OK message (<mrbresponse>);

*The MS prepares and sends the first notification to the MRB (B1); as what happened with other packages as well, the notification has been sent as a MS-generated CONTROL message; it is a notification related to the request in the first message, considering the 'id' matches (p0T65U) that one; all the info the MRB subscribed for is provided in the payload;

*the MRB acknowledges the notification (B2), and uses the retrieved info to update its information as part of its business logic;

*the same happens at the required frequency, with up-to-date information;

*after a while, the MRB updates its subscription (D1) to get more frequent updates (minfrequency=1, an update every second at least); the MS accepts the update (D2), even if it adjusts the frequency in the reply according to its policies (minfrequency=30, lower rate); the notifications keep on going, but at the newer frequency rate; the expiration is also updated accordingly (600 seconds again, since the update refreshes it).

```
A1. MRB -> MS (CONTROL, publish request)
----------------------------------------
   CFW lidc30BZObiC CONTROL
   Control-Package: mrb-publish/1.0
   Content-Type: application/mrb-publish+xml
   Content-Length: 337

   <mrbpublish version="1.0" xmlns="urn:ietf:params:xml:ns:mrb-publish">
      <mrbrequest>
         <subscription action="create" seqnumber="1" id="p0T65U">
            <expires>60</expires>
            <minfrequency>600</minfrequency>
            <maxfrequency>30</maxfrequency>
         </subscription>
      </mrbrequest>
   </mrbpublish>


A2. MRB <- MS (200 to CONTROL, request accepted)
------------------------------------------------
   CFW lidc30BZObiC 200
   Timeout: 10
   Content-Type: application/mrb-publish+xml
   Content-Length: 139

   <mrbpublish version="1.0" xmlns="urn:ietf:params:xml:ns:mrb-publish">
           <mrbresponse status="200" reason="OK: Request accepted"/>
   </mrbpublish>



B1. MRB <- MS (CONTROL, event notification from MS)
---------------------------------------------------
   CFW 03fff52e7b7a CONTROL
   Control-Package: mrb-publish/1.0
   Content-Type: application/mrb-publish+xml
   Content-Length: 4242

   <mrbpublish version="1.0" \
             xmlns="urn:ietf:params:xml:ns:mrb-publish">
    <mrbnotification seqnumber="1" id="p0T65U">
        <media-server-id>a1b2c3d4</media-server-id>
        <supported-packages>
            <package name="msc-ivr/1.0"/>
            <package name="msc-mixer/1.0"/>
            <package name="mrb-publish/1.0"/>
            <package name="msc-example-pkg/1.0"/>
        </supported-packages>
        <active-rtp-sessions>
```

```
    <rtp-codec name="audio/basic">
        <decoding>10</decoding>
        <encoding>20</encoding>
    </rtp-codec>
</active-rtp-sessions>
<active-mixer-sessions>
    <active-mix conferenceid="7cfgs43">
        <rtp-codec name="audio/basic">
            <decoding>3</decoding>
            <encoding>3</encoding>
        </rtp-codec>
    </active-mix>
</active-mixer-sessions>
<non-active-rtp-sessions>
    <rtp-codec name="audio/basic">
        <decoding>50</decoding>
        <encoding>40</encoding>
    </rtp-codec>
</non-active-rtp-sessions>
<non-active-mixer-sessions>
    <non-active-mix available="15">
        <rtp-codec name="audio/basic">
            <decoding>15</decoding>
            <encoding>15</encoding>
        </rtp-codec>
    </non-active-mix>
</non-active-mixer-sessions>
<media-server-status>active</media-server-status>
<supported-codecs>
    <supported-codec name="audio/basic">
        <supported-codec-package name="msc-ivr/1.0">
            <supported-actions>encoding</supported-actions>
            <supported-actions>decoding</supported-actions>
        </supported-codec-package>
        <supported-codec-package name="msc-mixer/1.0">
            <supported-actions>encoding</supported-actions>
            <supported-actions>decoding</supported-actions>
        </supported-codec-package>
    </supported-codec>
</supported-codecs>
<application-data>TestbedPrototype</application-data>
<file-formats>
    <supported-format name="audio/x-wav">
        <supported-file-package>
            msc-ivr/1.0
        </supported-file-package>
    </supported-format>
</file-formats>
<max-prepared-duration>
```

```
    <max-time max-time-seconds="3600">
        <max-time-package>msc-ivr/1.0</max-time-package>
    </max-time>
</max-prepared-duration>
<dtmf-support>
    <detect>
        <dtmf-type package="msc-ivr/1.0" name="RFC4733"/>
        <dtmf-type package="msc-mixer/1.0" name="RFC4733"/>
    </detect>
    <generate>
        <dtmf-type package="msc-ivr/1.0" name="RFC4733"/>
        <dtmf-type package="msc-mixer/1.0" name="RFC4733"/>
    </generate>
    <passthrough>
        <dtmf-type package="msc-ivr/1.0" name="RFC4733"/>
        <dtmf-type package="msc-mixer/1.0" name="RFC4733"/>
    </passthrough>
</dtmf-support>
<mixing-modes>
    <audio-mixing-modes>
        <audio-mixing-mode package="msc-ivr/1.0">
             nbest
        </audio-mixing-mode>
    </audio-mixing-modes>
    <video-mixing-modes activespeakermix="true" vas="true">
        <video-mixing-mode package="msc-mixer/1.0">
             single-view
        </video-mixing-mode>
        <video-mixing-mode package="msc-mixer/1.0">
             dual-view
        </video-mixing-mode>
        <video-mixing-mode package="msc-mixer/1.0">
             dual-view-crop
        </video-mixing-mode>
        <video-mixing-mode package="msc-mixer/1.0">
             dual-view-2x1
        </video-mixing-mode>
        <video-mixing-mode package="msc-mixer/1.0">
             dual-view-2x1-crop
        </video-mixing-mode>
        <video-mixing-mode package="msc-mixer/1.0">
             quad-view
        </video-mixing-mode>
        <video-mixing-mode package="msc-mixer/1.0">
             multiple-5x1
        </video-mixing-mode>
        <video-mixing-mode package="msc-mixer/1.0">
             multiple-3x3
        </video-mixing-mode>
```

```
        <video-mixing-mode package="msc-mixer/1.0">
             multiple-4x4
        </video-mixing-mode>
    </video-mixing-modes>
</mixing-modes>
<supported-tones>
    <supported-country-codes>
        <country-code package="msc-ivr/1.0">GB</country-code>
        <country-code package="msc-ivr/1.0">IT</country-code>
        <country-code package="msc-ivr/1.0">US</country-code>
    </supported-country-codes>
    <supported-h248-codes>
        <h248-code package="msc-ivr/1.0">cg/*</h248-code>
        <h248-code package="msc-ivr/1.0">biztn/ofque</h248-code>
        <h248-code package="msc-ivr/1.0">biztn/erwt</h248-code>
        <h248-code package="msc-mixer/1.0">conftn/*</h248-code>
    </supported-h248-codes>
</supported-tones>
<streaming-modes>
    <stream-mode package="msc-ivr/1.0" name="HTTP"/>
</streaming-modes>
<asr-tts-support>
    <asr-support>
        <language xml:lang="en"/>
    </asr-support>
    <tts-support>
        <language xml:lang="en"/>
    </tts-support>
</asr-tts-support>
<vxml-support support="true">
    <vxml-mode package="msc-ivr/1.0" support="IVR-Package"/>
</vxml-support>
<media-server-location>
    <civicAddress xml:lang="it">
        <country>IT</country>
        <A1>Campania</A1>
        <A3>Napoli</A3>
        <A6>Via Claudio</A6>
        <HNO>21</HNO>
        <LMK>University of Napoli Federico II</LMK>
        <NAM>Dipartimento di Informatica e Sistemistica</NAM>
        <PC>80210</PC>
    </civicAddress>
</media-server-location>
<label>TestbedPrototype-01</label>
<media-server-address>
    sip:MediaServer@ms.example.net
</media-server-address>
<encryption>false</encryption>
```

```
    </mrbnotification>
   </mrbpublish>
```

B2. MRB -> MS (200 to CONTROL)

```
   CFW 03fff52e7b7a 200
```

(C1 and C2 omitted for brevity)

D1. MRB -> MS (CONTROL, publish request)

```
CFW pyu788fc32wa CONTROL
Control-Package: mrb-publish/1.0
Content-Type: application/mrb-publish+xml
Content-Length: 342

<?xml version="1.0" encoding="UTF-8" standalone="yes"?>
<mrbpublish version="1.0" xmlns="urn:ietf:params:xml:ns:mrb-publish">
    <mrbrequest>
        <subscription action="update" seqnumber="2" id="p0T65U">
            <expires>600</expires>
            <minfrequency>1</minfrequency>
        </subscription>
    </mrbrequest>
</mrbpublish>
```

D2. MRB <- MS (200 to CONTROL, request accepted)

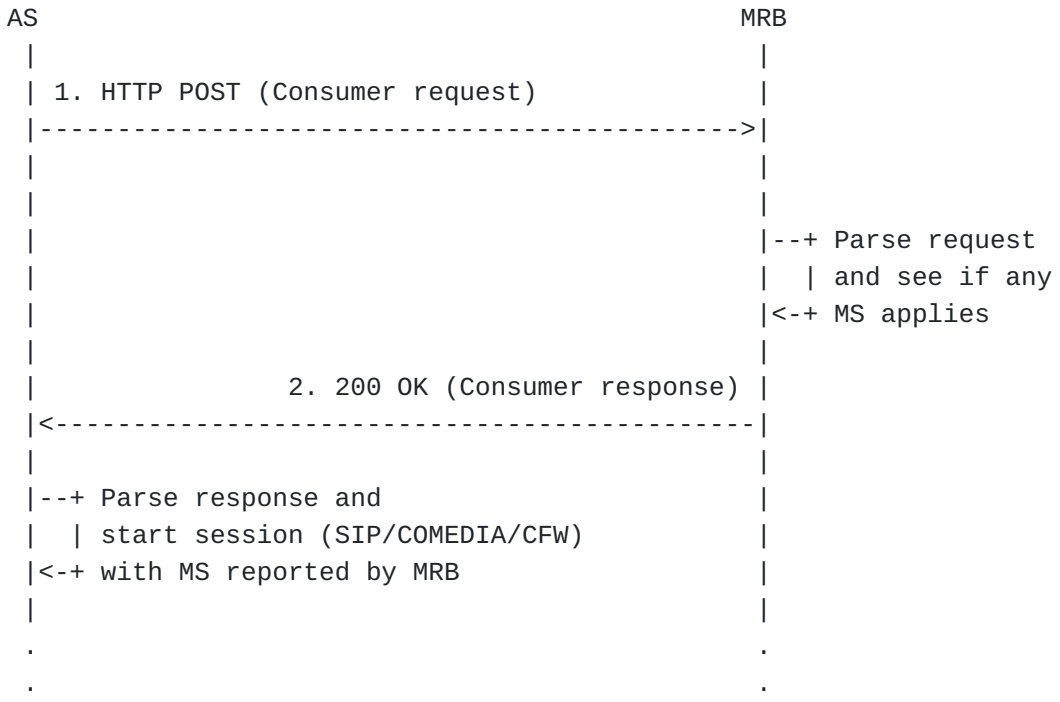
```
CFW pyu788fc32wa 200
Timeout: 10
Content-Type: application/mrb-publish+xml
Content-Length: 332

<mrbpublish version="1.0" xmlns="urn:ietf:params:xml:ns:mrb-publish">
    <mrbresponse status="200" reason="OK: Request accepted">
        <subscription action="create" seqnumber="2" id="p0T65U">
            <expires>600</expires>
            <minfrequency>30</minfrequency>
        </subscription>
    </mrbresponse>
</mrbpublish>
```

7.2. Consumer Interface

While the Publishing interface is used by a MS to publish its functionality and up-to-date information to an MRB, the Consumer interface is used by an interested AS to get access to a resource. An AS can make use of the Consumer interface to contact an MRB and describe the resources it needs: the MRB then replies with the needed information, specifically the address of an MS that is capable to meet the requirements.
However, unlike the Publishing interface, the Consumer interface is not specified as a Control Package. It is, instead, conceived as an XML-based protocol that can be transported by means of either HTTP or SIP, as it will be shown in the following sections.
As specified in [I-D.ietf-mediactrl-mrb], the Consumer interface can be involved in basically two topologies: a Query mode and an Inline mode. In the Query mode (Section 7.2.1), the Consumer requests and responses are conveyed by means of HTTP: once the AS gets the answer, the usual MEDIACTRL interactions occur between the AS and the MS chosen by the MRB. In the Inline mode, instead, the MRB is in the path between the AS and the pool of MSs it is handling. In this case, an AS can place Consumer requests using SIP as a transport, by means of a multipart payload (Section 7.2.2) containing the Consumer request itself and an SDP related to related to either the creation of a control channel or to a UAC call leg. This is called Inline-aware mode, since it assumes that the interested AS knows a MRB is in place and knows how to talk to it. Anyway, the MRB is also conceived to work with ASs that are unaware of its functionality, i.e. which are not aware of the Consumer interface: in this kind of scenario, the Inline mode is still used, but with the AS thinking the MRB it is talking to is actually an MS. This approach is called Inline-unaware mode (Section 7.2.3).

7.2.1. Query Mode

As anticipated in the previous section, in the Query mode the AS sends Consumer requests by means of HTTP. Specifically, an HTTP POST is used to convey the request. The MRB is assumed to send its response by means of an HTTP 200 OK reply. Since a successfull Consumer response contains information to contact a specific MS (the MS the MRB has deemed better capable to fulfill the AS requirements), an AS can subsequently directly contact the MS as already described in the previous sections of the document. This means that, in the Query mode, the MRB acts purely as a locator, and then the AS and the MS can talk 1:1.
Figure 76 presents a ladder diagram of a typical Consumer request in the Query topology:



In this example, the AS is interested in an MS meeting a defined set of requirements:

1. it must support both the IVR and Mixer packages;

2. it must provide at least 10 G.711 encoding/decoding RTP sessions for IVR purposes;

3. it must support HTTP-based streaming and support for the audio/x-wav file format in the IVR package.

These requirements are properly formatted according to the MRB Consumer syntax. The framework transaction steps are the following:

*The AS sends an HTTP POST message to the MRB (1); the payload is, of course, the Consumer request, which is reflected by the Content-Type header (application/mrb-consumer+xml); the Consumer request (<mediaResourceRequest>) includes some general requirements (<generalInfo>) and some IVR-specific requirements (<ivrInfo>); the general part of the requests contains the set of required packages (<packages>); the IVR-specific section, instead, contains requirements concerning the number of required IVR sessions (<ivr-sessions>), the file formats that are to be supported (<file-formats>) and the required streaming capabilities (<streaming-modes>);

*the MRB gets the request and parses it; then, according to its business logic, it realizes it can't find a single MS capable of targeting the request, and as a consequence picks up two MS which can handle respectively 60 and 40 of the requested sessions; it prepares a Consumer response (2) to provide the AS with the requested information; the response (<mediaResourceResponse>) is a success (status=200), and includes the relevant information (<response-session-info>); specifically, the response includes transaction-related information (the same session-id and seq provided by the AS in its request, to allow proper request/response matching) together with information on the duration of the reservation (expires=3600, after an hour the request will expire) and the SIP addresses of the chosen MSs.

```
1. AS -> MRB (HTTP POST, Consumer request)
-----------------------------------------
 POST /Mrb/Consumer HTTP/1.1
 Content-Length: 879
 Content-Type: application/mrb-consumer+xml
 Host: mrb.example.com:8080
 Connection: Keep-Alive
 User-Agent: Apache-HttpClient/4.0.1 (java 1.5)

 <?xml version="1.0" encoding="UTF-8" standalone="yes"?>
 <mrbconsumer version="1.0" xmlns="urn:ietf:params:xml:ns:mrb-consumer">
    <mediaResourceRequest>
        <generalInfo>
            <packages>
                <package>msc-ivr/1.0</package>
                <package>msc-mixer/1.0</package>
            </packages>
        </generalInfo>
        <ivrInfo>
            <ivr-sessions>
                <rtp-codec name="audio/basic">
                    <decoding>100</decoding>
                    <encoding>100</encoding>
                </rtp-codec>
            </ivr-sessions>
            <file-formats>
                <required-format name="audio/x-wav"/>
            </file-formats>
            <streaming-modes>
                <stream-mode package="msc-ivr/1.0" name="HTTP"/>
            </streaming-modes>
        </ivrInfo>
    </mediaResourceRequest>
 </mrbconsumer>


2. AS <- MRB (200 to POST, Consumer response)
-------------------------------------------
 HTTP/1.1 200 OK
 X-Powered-By: Servlet/2.5
 Server: Sun GlassFish Communications Server 1.5
 Content-Type: application/mrb-consumer+xml;charset=ISO-8859-1
 Content-Length: 1132
 Date: Thu, 28 Jul 2011 10:34:45 GMT

 <?xml version="1.0" encoding="UTF-8" standalone="yes"?>
 <mrbconsumer version="1.0" xmlns="urn:ietf:params:xml:ns:mrb-consumer">
    <mediaResourceResponse reason="Resource found" status="200">
```

```
        <response-session-info>
            <session-id>z603G3yaUzM8</session-id>
            <seq>1</seq>
            <expires>3600</expires>
            <media-server-address \
                            uri="sip:MediaServer@ms.example.com:5080">
                <ivr-sessions>
                    <rtp-codec name="audio/basic">
                        <decoding>60</decoding>
                        <encoding>60</encoding>
                    </rtp-codec>
                </ivr-sessions>
            </media-server-address>
            <media-server-address \
                       uri="sip:OtherMediaServer@pool.example.net:5080">
                <ivr-sessions>
                    <rtp-codec name="audio/basic">
                        <decoding>40</decoding>
                        <encoding>40</encoding>
                    </rtp-codec>
                </ivr-sessions>
            </media-server-address>
        </response-session-info>
    </mediaResourceResponse>
 </mrbconsumer>
```

For the sake of conciseness, the subsequent steps are not presented. They are, however, very trivial, since they basically consist in the AS issuing a COMEDIA negotiation with either of the obtained MS, as already presented in the first part of the document. The same can be said with respect to attaching UAC call legs: in fact, since after the Query the AS<->interaction becomes 1:1, UAC call legs can be redirected directly to the proper MS using the 3PCC approach, e.g. as in Figure 16.

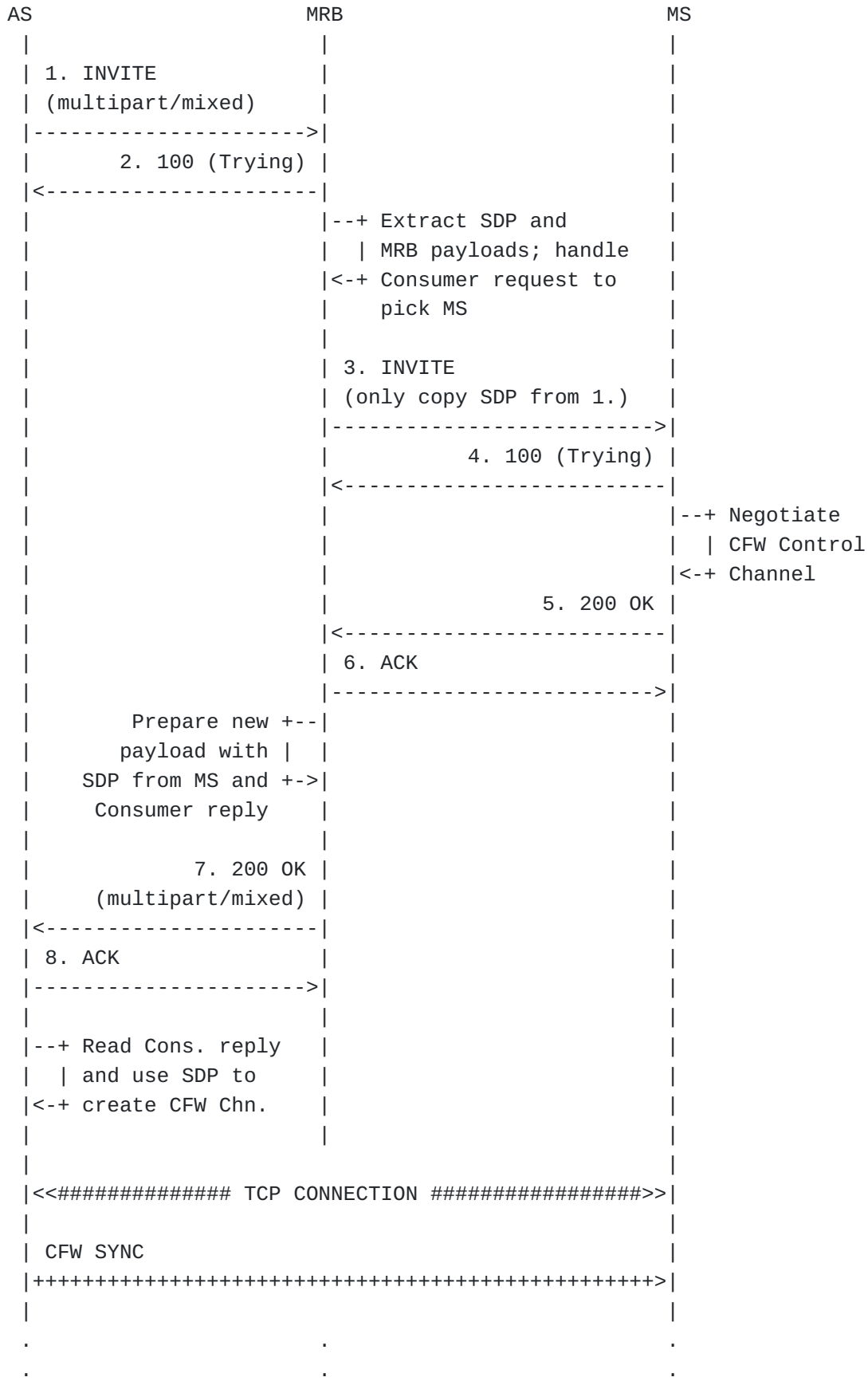
7.2.2. Inline-aware Mode

Unlike the Query mode, in the Inline-aware mode the AS sends Consumer requests by means of SIP. Of course, saying that the transport changes from HTTP to SIP is not as trivial as it seems. In fact, HTTP and SIP behave in a very different way, and this is reflected in the way the Inline-aware mode is conceived.
An AS willing to issue a Concumer request by means of SIP, has to do so by means of an INVITE. As specified in [I-D.ietf-mediactrl-mrb], the payload of the INVITE can't only contain the Consumer request itself: in fact, the Consumer request is assumed to be carried within a SIP transaction. Besides, a Consumer session is not strictly associated

with the lifetime of any SIP transaction, meaning Consumer requests belonging to the same session may be transported over different SIP messages. An hangup on any of these SIP dialogs would not affect the Consumer session by itself.
That said, as documented in [RFC6230], [I-D.ietf-mediactrl-mrb] envisages two kind of SIP dialogs a Consumer request may be sent over: a SIP control dialog (a SIP dialog the AS sends in order to setup a control channel) or a UAC call leg (a SIP dialog the AS sends to attach a UAC to a MS). In both cases, the AS would prepare a multipart/mixed payload to achieve both ends, i.e., receiving a reply to its Consumer request and effectively carrying on the negotiation described in the SDP payload.
The behaviour in the two cases, which are called respectively CFW-based and Call leg-based approach, is only slightly different, but both will be presented to clarify how they could be exploited. To make things clearer for the reader, the same consumer request as the one presented in the Query mode will be sent, in order to clarify how the behaviour of the involved parties may differ.

7.2.2.1. Inline-aware Mode: CFW-based approach

Figure 78 presents a ladder diagram of a typical Consumer request in the CFW-based Inline-aware topology:


AS
MRB
MS
1. INVITE
(multipart/mixed)
2. 100 (Trying)
Extract SDP and
MRB payloads; handle
Consumer request to
pick MS
3. INVITE
(only copy SDP from 1.)
4. 100 (Trying)
Negotiate
CFW Control
Channel
5. 200 OK
6. ACK
Prepare new
payload with
SDP from MS and
Consumer reply
7. 200 OK
(multipart/mixed)
8. ACK
Read Cons. reply
and use SDP to
create CFW Chn.
TCP CONNECTION
CFW SYNC

As anticipated, to make the understanding of the scenario easier we assume the AS is interested in exactly the same set of requirements as presented in Section 7.2.1. This means that the Consumer request originated by the AS will be the same as before, with only the transport/topology changing.
Please note that, to ease the reading of the protocol contents, a simple '=_Part' is used whenever a boundary for a 'multipart/mixed' payload is provided, instead of the actual boundary that would be inserted in the SIP messages.
The framework transaction steps (for simplicity only the payloads and not the complete SIP transactions are reported) are the following:

*

1. AS -> MRB (INVITE multipart/mixed)

```
   [..]
   Content-Type: multipart/mixed;boundary="=_Part"

   =_Part
   Content-Type: application/sdp

   v=0
   o=- 2890844526 2890842807 IN IP4 as.example.com
   s=MediaCtrl
   c=IN IP4 as.example.com
   t=0 0
   m=application 48035 TCP cfw
   a=connection:new
   a=setup:active
   a=cfw-id:vF0zD4xzUAW9
   a=ctrl-package:msc-mixer/1.0
   a=ctrl-package:msc-ivr/1.0

   =_Part
   Content-Type: application/mrb-consumer+xml

   <?xml version="1.0" encoding="UTF-8" standalone="yes"?>
   <mrbconsumer version="1.0"
                xmlns="urn:ietf:params:xml:ns:mrb-consumer">
     <mediaResourceRequest>
        <generalInfo>
            <packages>
                <package>msc-ivr/1.0</package>
                <package>msc-mixer/1.0</package>
            </packages>
        </generalInfo>
        <ivrInfo>
            <ivr-sessions>
                <rtp-codec name="audio/basic">
                    <decoding>100</decoding>
                    <encoding>100</encoding>
                </rtp-codec>
            </ivr-sessions>
            <file-formats>
                <required-format name="audio/x-wav"/>
            </file-formats>
            <streaming-modes>
                <stream-mode package="msc-ivr/1.0" name="HTTP"/>
            </streaming-modes>
        </ivrInfo>
     </mediaResourceRequest>
```

```
   </mrbconsumer>

   =_Part
```

3. MRB -> MS (INVITE sdp only)

```
   [..]
   Content-Type: application/sdp

   v=0
   o=- 2890844526 2890842807 IN IP4 as.example.com
   s=MediaCtrl
   c=IN IP4 as.example.com
   t=0 0
   m=application 48035 TCP cfw
   a=connection:new
   a=setup:active
   a=cfw-id:vF0zD4xzUAW9
   a=ctrl-package:msc-mixer/1.0
   a=ctrl-package:msc-ivr/1.0
```

5. MRB <- MS (200 OK sdp)

```
   [..]
   Content-Type: application/sdp

   v=0
   o=lminiero 2890844526 2890842808 IN IP4 ms.example.net
   s=MediaCtrl
   c=IN IP4 ms.example.net
   t=0 0
   m=application 7575 TCP cfw
   a=connection:new
   a=setup:passive
   a=cfw-id:vF0zD4xzUAW9
   a=ctrl-package:msc-mixer/1.0
   a=ctrl-package:msc-ivr/1.0
   a=ctrl-package:mrb-publish/1.0
   a=ctrl-package:msc-example-pkg/1.0
```

7. AS <- MRB (200 OK multipart/mixed)

```
   [..]
   Content-Type: multipart/mixed;boundary="=_Part"
```

```
=_Part
Content-Type: application/sdp

v=0
o=lminiero 2890844526 2890842808 IN IP4 ms.example.net
s=MediaCtrl
c=IN IP4 ms.example.net
t=0 0
m=application 7575 TCP cfw
a=connection:new
a=setup:passive
a=cfw-id:vF0zD4xzUAW9
a=ctrl-package:msc-mixer/1.0
a=ctrl-package:msc-ivr/1.0
a=ctrl-package:mrb-publish/1.0
a=ctrl-package:msc-example-pkg/1.0

=_Part
Content-Type: application/mrb-consumer+xml

<?xml version="1.0" encoding="UTF-8" standalone="yes"?>
<mrbconsumer version="1.0" \
             xmlns="urn:ietf:params:xml:ns:mrb-consumer">
  <mediaResourceResponse reason="Resource found" status="200">
     <response-session-info>
         <session-id>z603G3yaUzM8</session-id>
         <seq>1</seq>
         <expires>3600</expires>
         <media-server-address \
                          uri="sip:MediaServer@ms.example.com:5080">
             <connection-id>32pbdxZ8:KQw677BF</connection-id>
             <ivr-sessions>
                 <rtp-codec name="audio/basic">
                     <decoding>60</decoding>
                     <encoding>60</encoding>
                 </rtp-codec>
             </ivr-sessions>
         </media-server-address>
         <media-server-address \
                    uri="sip:OtherMediaServer@pool.example.net:5080">
             <ivr-sessions>
                 <rtp-codec name="audio/basic">
                     <decoding>40</decoding>
                     <encoding>40</encoding>
                 </rtp-codec>
             </ivr-sessions>
         </media-server-address>
     </response-session-info>
```

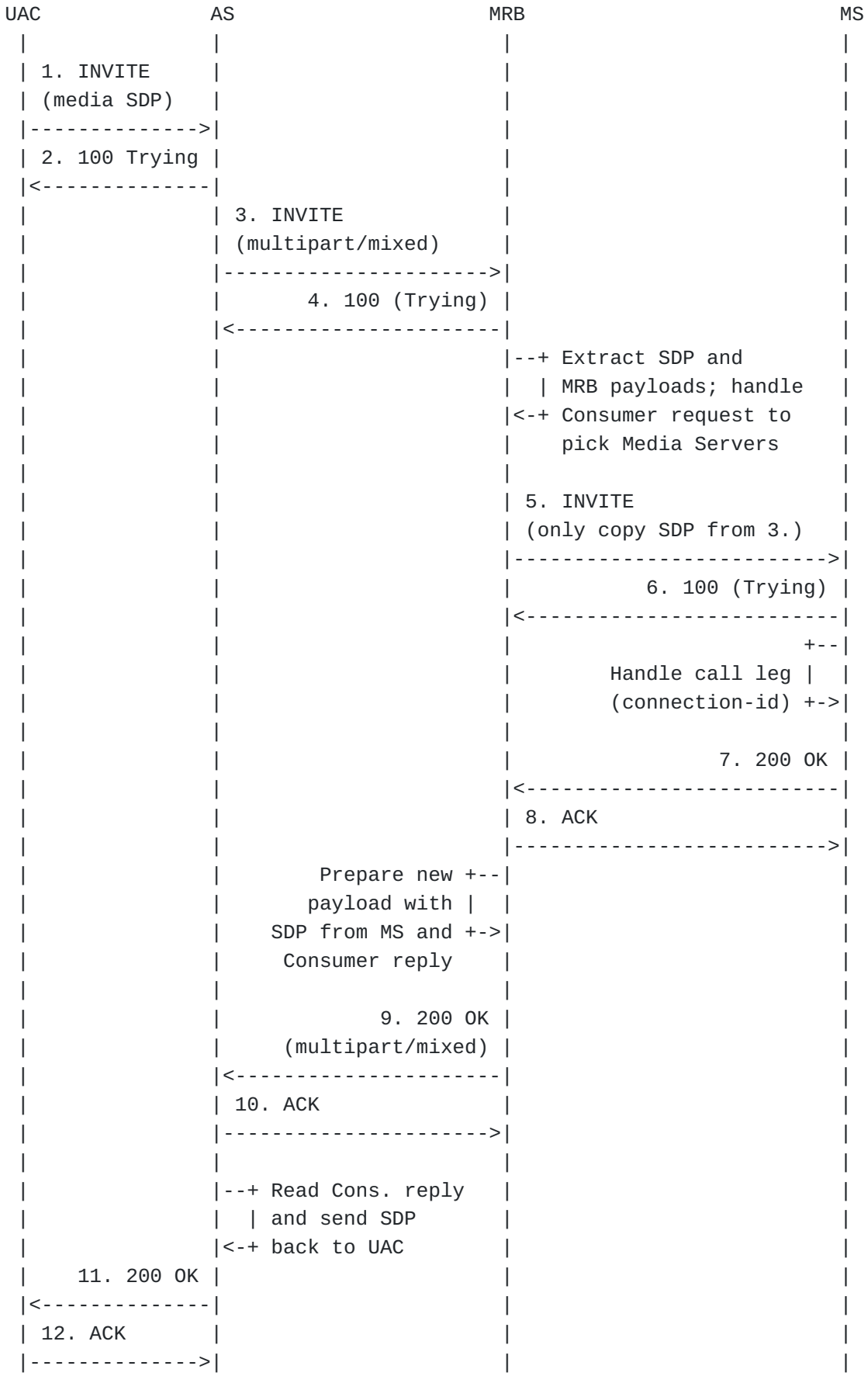
```
    </mediaResourceResponse>
  </mrbconsumer>

  =_Part
```

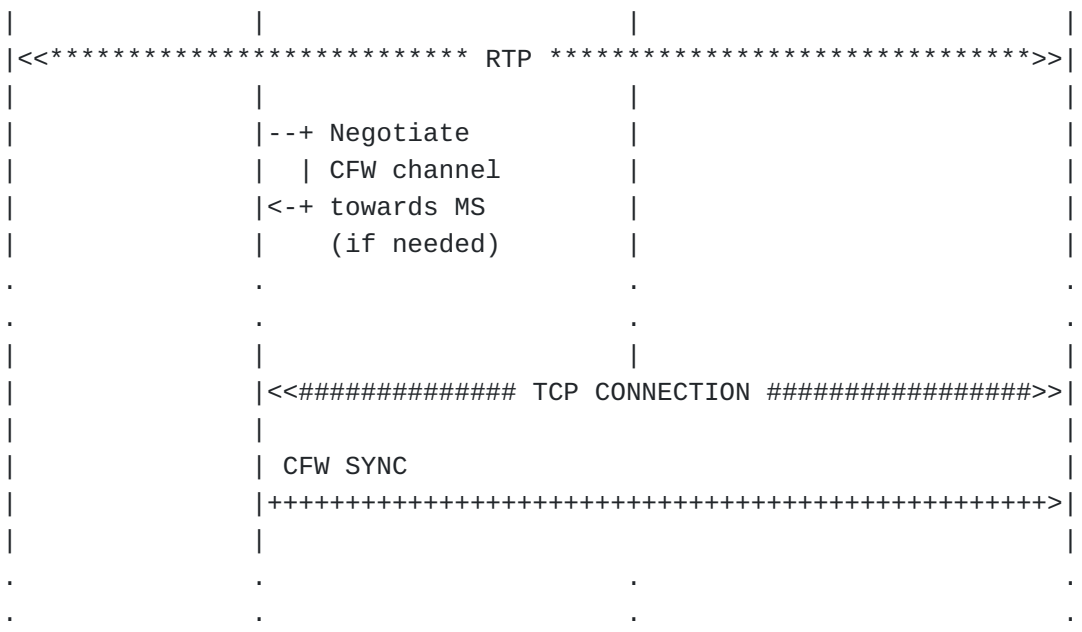
The sequence diagram and the dumps effectively show the different approach with respect with the Query mode: the SIP INVITE the AS sends (1.) includes both a Consumer request (the same as before), and an SDP to negotiate a CFW channel with a MS. The MRB takes care of the request exactly as before (provisioning two MS instances) but with a remarkable difference: first of all it picks up one of the two MS on behalf of the AS (negotiating the control channel in steps 3 to 6) and only then replies to the AS with both the MS-side of the SDP negotiation (with info on how to setup the control channel) and the Consumer response itself.
The Consumer response is also slightly different by itself: in fact, as it can be seen in 7., there's an additional element (<connection-id>) the MRB has added to the message. This element contains the 'connection-id' the AS and MS would have build out of the From and To tags as explained in the previous sections, had the AS contacted the MS directly: since the MRB has actually done the negotiation on the AS behalf, without this information the AS and MS would refer to dfferent connectionid attributes to target the same dialog, thus causing the CFW protocol not to behave as expected. This aspect will be more carefully described in the next section, for the call leg-based approach, since the 'connection-id' attribute is strictly related to media sessions.
For the sake of conciseness, the following steps are not presented. Anyway, they are quite trivial: in fact, as shown in the flow, the SIP negotiation has resulted in both the AS and the chosen MS negotiating a Control Channel. This means that the AS is only left to instantiate the Control Channel and sending CFW requests according to its application logic.
Besides, it is worthwhile to highlight the fact that, as in the Query example, the AS gets the addresses of both the chosen MS in this example as well, since a Consumer transaction has taken place. This means that, just as in the Query case, any UAC call leg can be redirected directly to the proper MS using the 3PCC approach, e.g. as in Figure 16, rather than using the MRB again as a Proxy/B2BUA. Of course, a separate SIP control dialog would be needed before attempting to use the second MS instance.

7.2.2.2. Inline-aware Mode: Call leg-based approach

As anticipated, there's a second way to take advantage of the IAMM mode, that is exploiting SIP dialogs related to UAC call legs as 'vessels' for Consumer messages. As it will be clearer in the sequence

diagram and protocol dumps, the scenario does not differ much from the one presented in Section 7.2.2.1 with respect to the Consumer request/response, but a dedicated paragraph may be useful in order to understand how they may differ with respect to the management of the call leg itself and any CFW control channel that may be involved. Figure 80 presents a ladder diagram of a typical Consumer request in the call leg-based Inline-aware topology:


UAC
AS
MRB
MS
1. INVITE
(media SDP)
2. 100 Trying
3. INVITE
(multipart/mixed)
4. 100 (Trying)
--+ Extract SDP and
| MRB payloads; handle
<-+ Consumer request to
pick Media Servers
5. INVITE
(only copy SDP from 3.)
6. 100 (Trying)
+--
Handle call leg |
(connection-id) +->
7. 200 OK
8. ACK
Prepare new +--
payload with |
SDP from MS and +->
Consumer reply
9. 200 OK
(multipart/mixed)
10. ACK
--+ Read Cons. reply
| and send SDP
<-+ back to UAC
11. 200 OK
12. ACK



As anticipated, to make the understanding of the scenario easier we assume the AS is interested in exactly the same set of requirements as presented in Section 7.2.1. This means that the Consumer request originated by the AS will be the same as before, with only the transport/topology changing.
Again, please note that, to ease the reading of the protocol contents, a simple '=_Part' is used whenever a boundary for a 'multipart/mixed' payload is provided, instead of the actual boundary that would be inserted in the SIP messages.
The framework transaction steps (for simplicity only the the relevant headers and payloads, and not the complete SIP transactions, are reported) are the following:

*

1. UAC -> AS (INVITE with media SDP)

```
   [..]
   From: <sip:lminiero@users.example.com>;tag=1153573888
   To: <sip:mediactrlDemo@as.example.com>
   [..]
   Content-Type: application/sdp

   v=0
   o=lminiero 123456 654321 IN IP4 4.3.2.1
   s=A conversation
   c=IN IP4 4.3.2.1
   t=0 0
   m=audio 7078 RTP/AVP 0 3 8 101
   a=rtpmap:0 PCMU/8000/1
   a=rtpmap:3 GSM/8000/1
   a=rtpmap:8 PCMA/8000/1
   a=rtpmap:101 telephone-event/8000
   a=fmtp:101 0-11
   m=video 9078 RTP/AVP 98
```

3. AS -> MRB (INVITE multipart/mixed)

```
   [..]
   From: <sip:ApplicationServer@as.example.com>;tag=fd4fush5
   To: <sip:Mrb@mrb.example.org>
   [..]
   Content-Type: multipart/mixed;boundary="=_Part"

   =_Part
   Content-Type: application/sdp

   v=0
   o=lminiero 123456 654321 IN IP4 4.3.2.1
   s=A conversation
   c=IN IP4 4.3.2.1
   t=0 0
   m=audio 7078 RTP/AVP 0 3 8 101
   a=rtpmap:0 PCMU/8000/1
   a=rtpmap:3 GSM/8000/1
   a=rtpmap:8 PCMA/8000/1
   a=rtpmap:101 telephone-event/8000
   a=fmtp:101 0-11
   m=video 9078 RTP/AVP 98

   =_Part
   Content-Type: application/mrb-consumer+xml
```

```
   <?xml version="1.0" encoding="UTF-8" standalone="yes"?>
   <mrbconsumer version="1.0" \
               xmlns="urn:ietf:params:xml:ns:mrb-consumer">
    <mediaResourceRequest>
        <generalInfo>
            <packages>
                <package>msc-ivr/1.0</package>
                <package>msc-mixer/1.0</package>
            </packages>
        </generalInfo>
        <ivrInfo>
            <ivr-sessions>
                <rtp-codec name="audio/basic">
                    <decoding>100</decoding>
                    <encoding>100</encoding>
                </rtp-codec>
            </ivr-sessions>
            <file-formats>
                <required-format name="audio/x-wav"/>
            </file-formats>
            <streaming-modes>
                <stream-mode package="msc-ivr/1.0" name="HTTP"/>
            </streaming-modes>
        </ivrInfo>
    </mediaResourceRequest>
   </mrbconsumer>

   =_Part
```

5. MRB -> MS (INVITE sdp only)

```
   [..]
   From: <sip:Mrb@mrb.example.org:5060>;tag=32pbdxZ8
   To: <sip:MediaServer@ms.example.com:5080>
   [..]
   Content-Type: application/sdp

   v=0
   o=lminiero 123456 654321 IN IP4 4.3.2.1
   s=A conversation
   c=IN IP4 4.3.2.1
   t=0 0
   m=audio 7078 RTP/AVP 0 3 8 101
   a=rtpmap:0 PCMU/8000/1
   a=rtpmap:3 GSM/8000/1
   a=rtpmap:8 PCMA/8000/1
```

```
   a=rtpmap:101 telephone-event/8000
   a=fmtp:101 0-11
   m=video 9078 RTP/AVP 98
```

7. MRB <- MS (200 OK sdp)

```
   [..]
   From: <sip:Mrb@mrb.example.org:5060>;tag=32pbdxZ8
   To: <sip:MediaServer@ms.example.com:5080>;tag=KQw677BF
   [..]
   Content-Type: application/sdp

   v=0
   o=lminiero 123456 654322 IN IP4 1.2.3.4
   s=MediaCtrl
   c=IN IP4 1.2.3.4
   t=0 0
   m=audio 63442 RTP/AVP 0 3 8 101
   a=rtpmap:0 PCMU/8000
   a=rtpmap:3 GSM/8000
   a=rtpmap:8 PCMA/8000
   a=rtpmap:101 telephone-event/8000
   a=fmtp:101 0-15
   a=ptime:20
   a=label:7eda834
   m=video 33468 RTP/AVP 98
   a=rtpmap:98 H263-1998/90000
   a=fmtp:98 CIF=2
   a=label:0132ca2
```

9. AS <- MRB (200 OK multipart/mixed)

```
   [..]
   From: <sip:ApplicationServer@as.example.com>;tag=fd4fush5
   To: <sip:Mrb@mrb.example.org>;tag=117652221
   [..]
   Content-Type: multipart/mixed;boundary="=_Part"

   =_Part
   Content-Type: application/sdp

   v=0
   o=lminiero 123456 654322 IN IP4 1.2.3.4
   s=MediaCtrl
   c=IN IP4 1.2.3.4
   t=0 0
```

```
m=audio 63442 RTP/AVP 0 3 8 101
a=rtpmap:0 PCMU/8000
a=rtpmap:3 GSM/8000
a=rtpmap:8 PCMA/8000
a=rtpmap:101 telephone-event/8000
a=fmtp:101 0-15
a=ptime:20
a=label:7eda834
m=video 33468 RTP/AVP 98
a=rtpmap:98 H263-1998/90000
a=fmtp:98 CIF=2
a=label:0132ca2

=_Part
Content-Type: application/mrb-consumer+xml

<?xml version="1.0" encoding="UTF-8" standalone="yes"?>
<mrbconsumer version="1.0" \
             xmlns="urn:ietf:params:xml:ns:mrb-consumer" >
 <mediaResourceResponse reason="Resource found" status="200">
     <response-session-info>
         <session-id>z1skKYZQ3eFu</session-id>
         <seq>1</seq>
         <expires>3600</expires>
         <media-server-address \
                          uri="sip:MediaServer@ms.example.com:5080">
             <connection-id>32pbdxZ8:KQw677BF</connection-id>
             <ivr-sessions>
                 <rtp-codec name="audio/basic">
                     <decoding>60</decoding>
                     <encoding>60</encoding>
                 </rtp-codec>
             </ivr-sessions>
         </media-server-address>
         <media-server-address \
                    uri="sip:OtherMediaServer@pool.example.net:5080">
             <ivr-sessions>
                 <rtp-codec name="audio/basic">
                     <decoding>40</decoding>
                     <encoding>40</encoding>
                 </rtp-codec>
             </ivr-sessions>
         </media-server-address>
     </response-session-info>
 </mediaResourceResponse>
</mrbconsumer>

=_Part
```

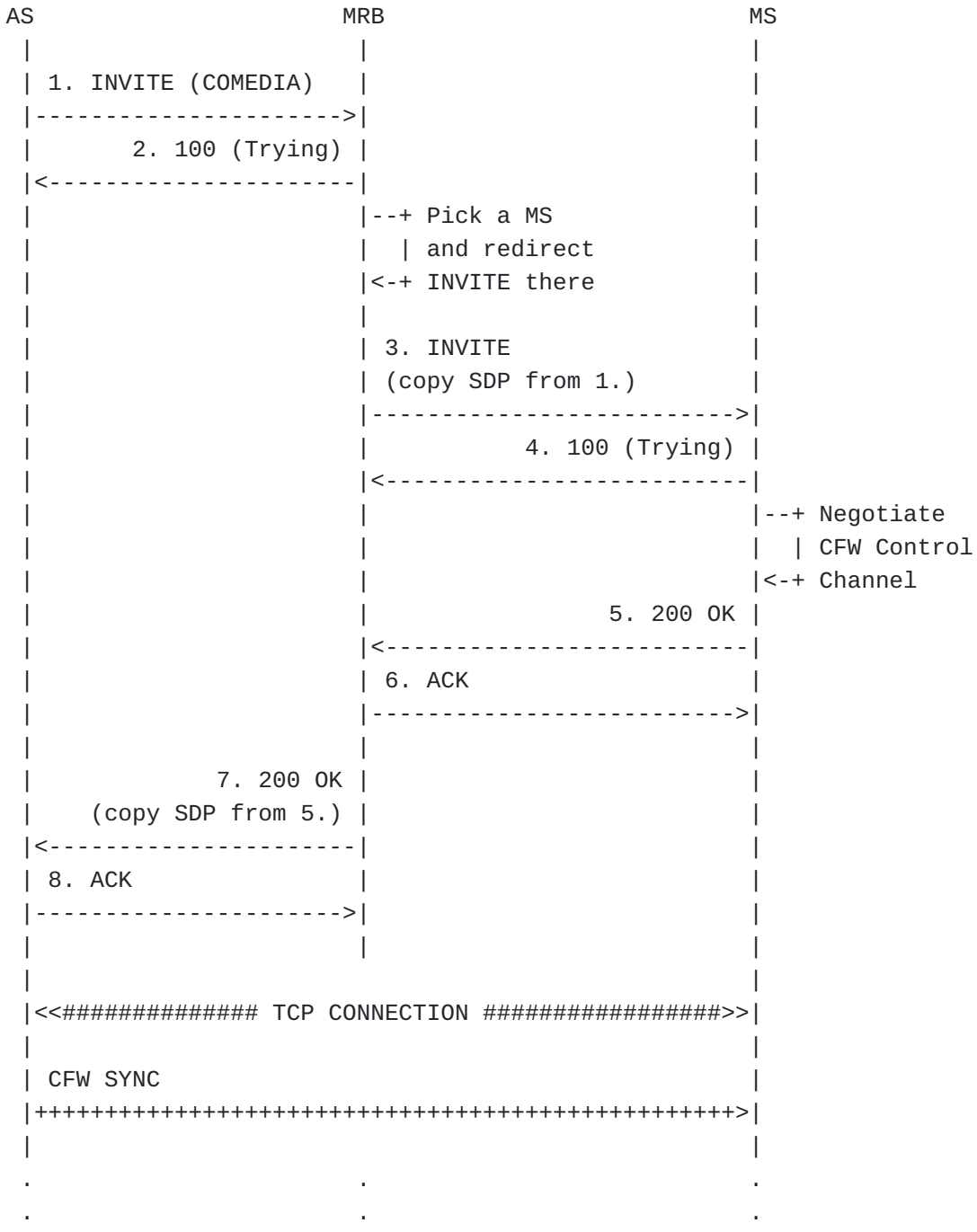
```
11. UAC <- AS (200 OK sdp)
--------------------------
   [..]
   From: <sip:lminiero@users.example.com>;tag=1153573888
   To: <sip:mediactrlDemo@as.example.com>;tag=bcd47c32
   [..]
   Content-Type: application/sdp

   v=0
   o=lminiero 123456 654322 IN IP4 1.2.3.4
   s=MediaCtrl
   c=IN IP4 1.2.3.4
   t=0 0
   m=audio 63442 RTP/AVP 0 3 8 101
   a=rtpmap:0 PCMU/8000
   a=rtpmap:3 GSM/8000
   a=rtpmap:8 PCMA/8000
   a=rtpmap:101 telephone-event/8000
   a=fmtp:101 0-15
   a=ptime:20
   a=label:7eda834
   m=video 33468 RTP/AVP 98
   a=rtpmap:98 H263-1998/90000
   a=fmtp:98 CIF=2
   a=label:0132ca2
```

The first obvious difference is that the first INVITE (1.) is not originated by the AS itself (willing to setup a control channel in the previous example) but by an authorized UAC (e.g., to take advantage of a media service provided by the AS). As such, the first INVITE only contains an SDP to negotiate an audio and video channel. The AS in its business logic needs to attach this UAC to a MS according to some specific requirements (e.g., the called URI is associated to a specific service), and as such prepares a Consumer request to be sent to the MRB in order to obtain a valid MS for the purpose: as before, the Consumer request is sent together with the SDP to the MRB (3.). The MRB extracts the Consumer payload and takes care of it as usual: it picks two MS instances, and attaches the UAC to the first one (5.). Once the MS has successfully negotiated the audio and video streams (7.), the MRB takes note of the 'connection-id' associated with this call (which will be needed afterwards in order to manipulate the audio and video streams for this user) and sends back to the AS both the SDP returned by the MS and the Consumer response (9.). The AS extracts the Consumer response and takes note of both the MS instances it has been given and the

connection-id information: it then completes the scenario by sending back to the UAC the MS returned by the MS (11.).
At this point, the UAC has successfully been attached to a MS. The AS only needs to setup a control channel to that MS, if needed; this step may not be required, especially if the Consumer request is an update to an existing session rather than the preparation of a new one. Assuming a control channel towards that MS doesn't exist yet, the AS creates it as usual, by sending an INVITE directly to the MS it has the address of. Once done with that, it can start manipulating the audio and video streams of the UAC: to do so, it refers to the 'connection-id' element as reported by the MRB, rather than relying on the one it is aware of. In fact, the AS is aware of a connection-id (fd4fush5:117652221, built out of the messages exchanged with the MRB), while the MS is aware of another one (32pbdxZ8:KQw677BF, built out of the MRB-MS interaction). The right one is of course the one the MS is aware of, and as such the AS refers to that one, which the MRB added to the Consumer response just for the purpose.

7.2.3. Inline-unaware Mode

While in the Inline-aware mode the AS knows it is sending an INVITE to a MRB and not to a MS, and acts accordingly (using the multipart/mixed payload to query for a MS able to fulfill its requirements) in the Inline-unaware mode it is not. This means that a MRB-unaware AS having access to a MRB talks to it as if it were a generic MEDIACTRL MS: i.e. the AS negotiates a Control Channel directly with the MRB, and attaches its call legs there as well. Of course, considering the MRB doesn't provide any MS functionality by itself, it must act as a Proxy/B2BUA between the AS and a MS for what concerns both the Control Channel Dialog and the Media Dialogs. According to implementation or deployment choices, simple redirects could also be exploited for the purpose.
The problem is that, without any Consumer request being placed by the MRB-unaware AS, the MRB can't rely on AS-originated directives to pick a MS rather than another. In fact, the MRB can't know what the AS is looking for. The MRB is then assumed to pick one according to its logic, which is implementation specific.
Figure 82 presents a ladder diagram of a typical Consumer request in the Inline-unaware topology:



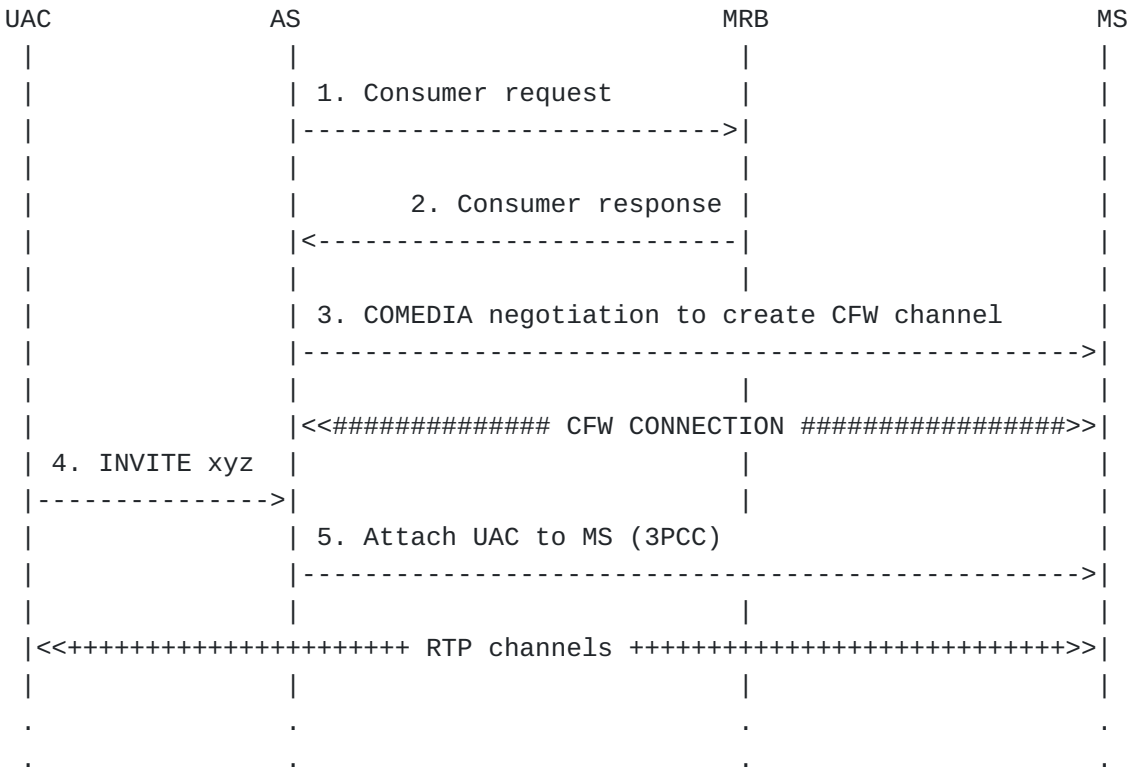
As it can be evinced from the diagram, in this topology the MRB basically acts as a 3PCC between the AS and the chosen MS.
The same can be said with respect to attaching UAC call legs. The MRB remembers the MS it has chosen for the AS and, for every UAC call leg the AS tries to attach to the MRB, it makes sure it is actually redirected to the MS somehow.

7.3. Handling call legs

It is worthwile to spend a few words to address how call legs would be managed whenever an MRB is involved in the scenarios. In fact, the presence of an MRB may introduce an additional complexity compared to the quite straightforward 1:1 AS-MS topology.

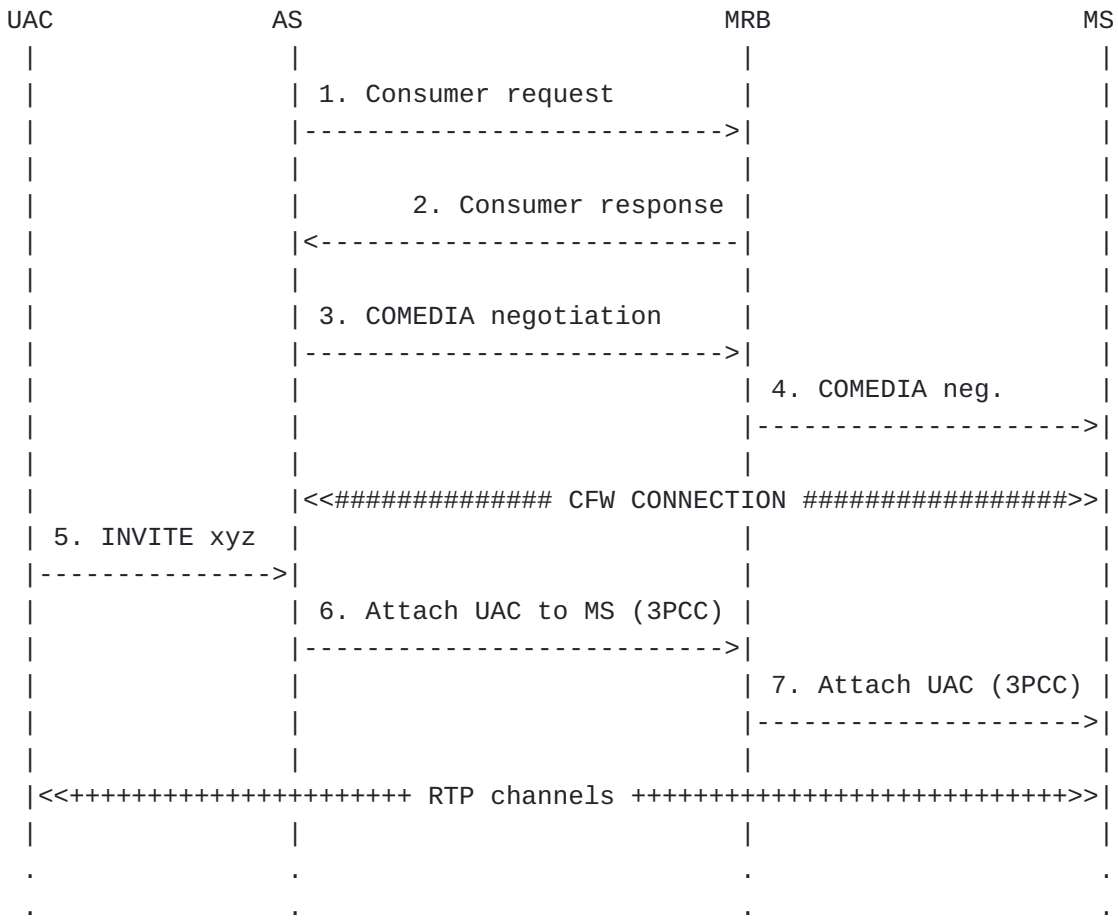
7.3.1. Query/IAMM

Normally, especially in the Query and IAMM case, the MRB would only handle Consumer requests by an AS, and after that the AS and the Media Server picked by the MRB for a specific request would talk directly to each other by means of SIP. This is made possible by the fact that the AS gets the MS SIP URI in reply to its request. In this case, an AS can simply relay call legs associated with that session to the right MS to have them handled accordingly.
An example of such scenario is presented in Figure 83. Please notice that this diagram, as the ones that will follow in this section, is simplified with respect to the actual protocol interactions: for instance, the whole SIP transactions are not presented, and only the originating messages are presented in order to clarify the scenario in a simple way.



As it can be evinced by looking at the diagram, the interactions among the components is quite straightforward: the AS knows which MS it has

been assigned to (as a consequence of the MRB Consumer Request, whether it has been achieved by means of HTTP or SIP) and so it can easily attach any UAC accessing its functionality to the MS itself, and manipulate its media connections by making use of the CFW control channel as usual.
In such a scenario, the MRB is only involved as a locator: once the MRB provides the AS with the URI to the required resource, it doesn't interfere with the following interactions, if not for monitoring (e.g., by exploiting the Publishing information reported by the MS). As a consequence, the scenario basically becomes 1:1 between the AS and the MS again.
Nevertheless, there are cases when having an MRB in the signalling path as well might be a desired feature: e.g., for more control over the use of the resources. Considering how the Consumer interface has been envisaged, this feature is easily achievable, with no change on the protocol required at all. Specifically, in order to achieve such a functionality, in response to a Consumer request the MRB may reply with, instead of the MS SIP URI as before, a URI it is responsible for, and map it with the actual MS URI in its business logic, transparently to the AS itself. This way the AS would interact with the MRB as if it were the MS itself.
With respect to the previous figure, Figure 84 shows how the scenario would change in that case.



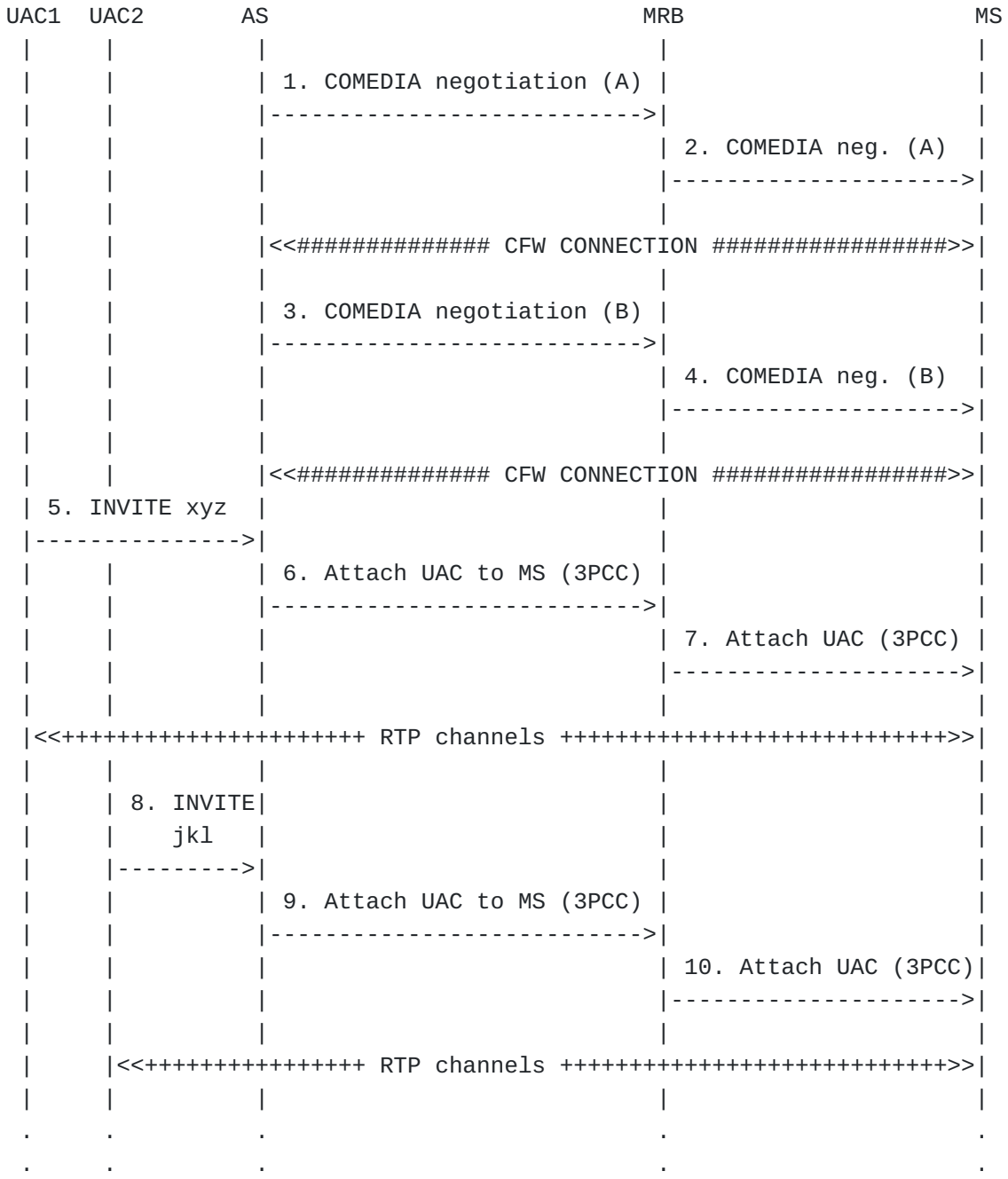
This time, even though the MRB has picked a specific MS after a request from an AS, it replies with another SIP URI, an URI it would reply to itself: the AS would contact that URI in order to negotiate the control channel, and the MRB would proxy/forward the request to the actual MS transparently. Eventually, the control channel would be instantiated between the AS and the MS. The same happens for UACs handled by the AS: the AS would forward the calls to the URI it has been provided with, the one handled by the MRB, which would in turn relay the call to the MS in order to have the proper RTP channels created between the UAC and the MS.

This scenario is not very different from the previous one: what changes is that the MRB is now on the signalling path for both the SIP control dialog and the SIP media dialogs, allowing it to have more control on the resources (e.g., triggering a BYE if a resource has expired). There are several possible approaches an MRB might take to allocate URIs to map with a requested MS. An example might be making use of SIP URI parameters to generate multiple SIP URIs that are unique but which all route to the same host and port, e.g., sip:MrbToMs@mrb.example.com:5080;p=1234567890. Alternatively, the MRB might simply allocate a pool

of URIs it would be responsible of, and manage the associations with the requested MS services accordingly.

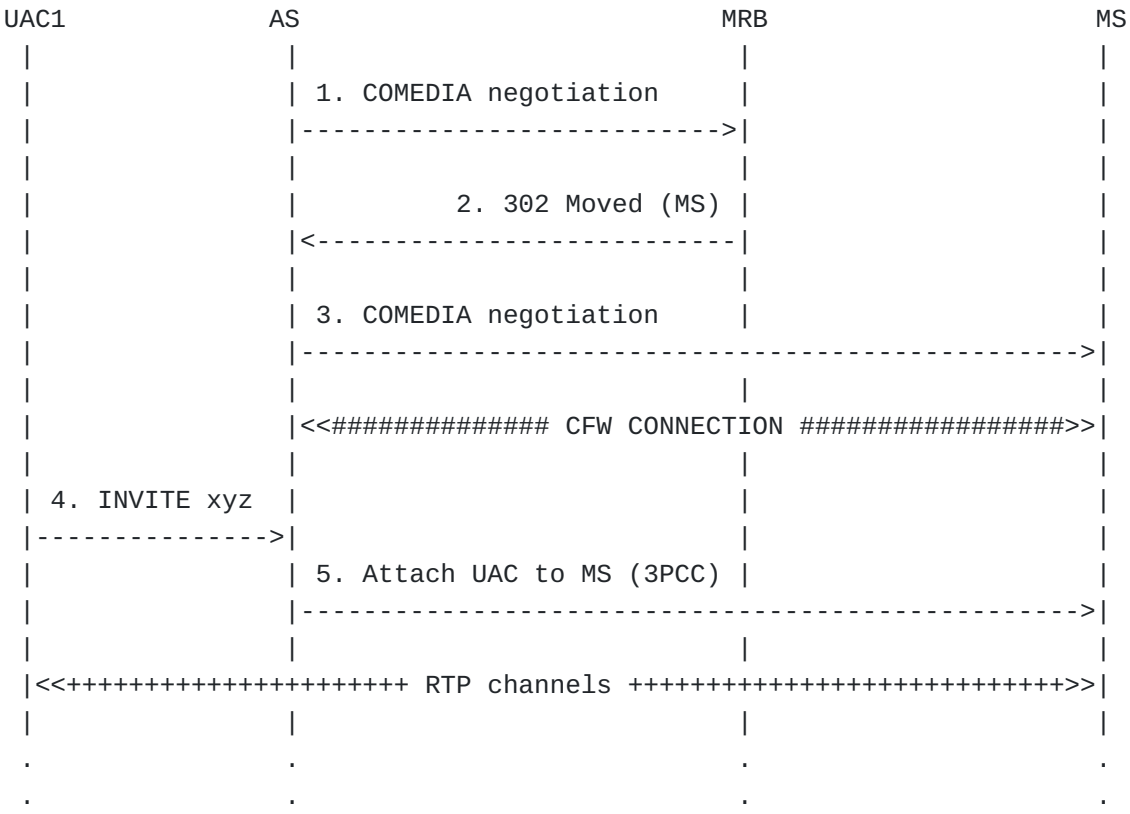
7.3.2. IUMM

As mentioned previously, in such a case the AS would interact with the MRB as if it were the MS itself. One might argue that this would make the AS act as in the IUMM case: nevertheless, this is not the case, considering the AS actually provided the MRB with information about the resources it required, and as such a proper MS has been picked, while in the IUMM case the MRB would have to pick a MS with no help from the AS at all.
That said, the IUMM case is also very interesting with respect to the call legs management. In fact, in the MRB-unaware mode there would be no Consumer request and an AS would actually see the MRB as an MS. This means that, unlike the previous scenarios, there is actually no choice, meaning the MRB would likely be in the signaling path anyway. The MRB could either redirect the AS to a MS directly or transparently act a proxy/B2BUA and contact a MS (according to implementation-specific policies) on behalf of the unaware AS.
While apparently not a problem, this raises an issue when the same unaware AS has several sessions with different MS: the AS would only see one "virtual" MS (the MRB) and so it would relay all calls there, making it hard for the MRB to understand where these call legs should belong: specifically, whether the UAC calling belongs to the AS application logic leading to MS1 or MS2, or wherever else.
One possible approach to take care of this issue, is to always relay the SIP dialogs from the same unaware AS to the same MS. It is depicted in Figure 85.



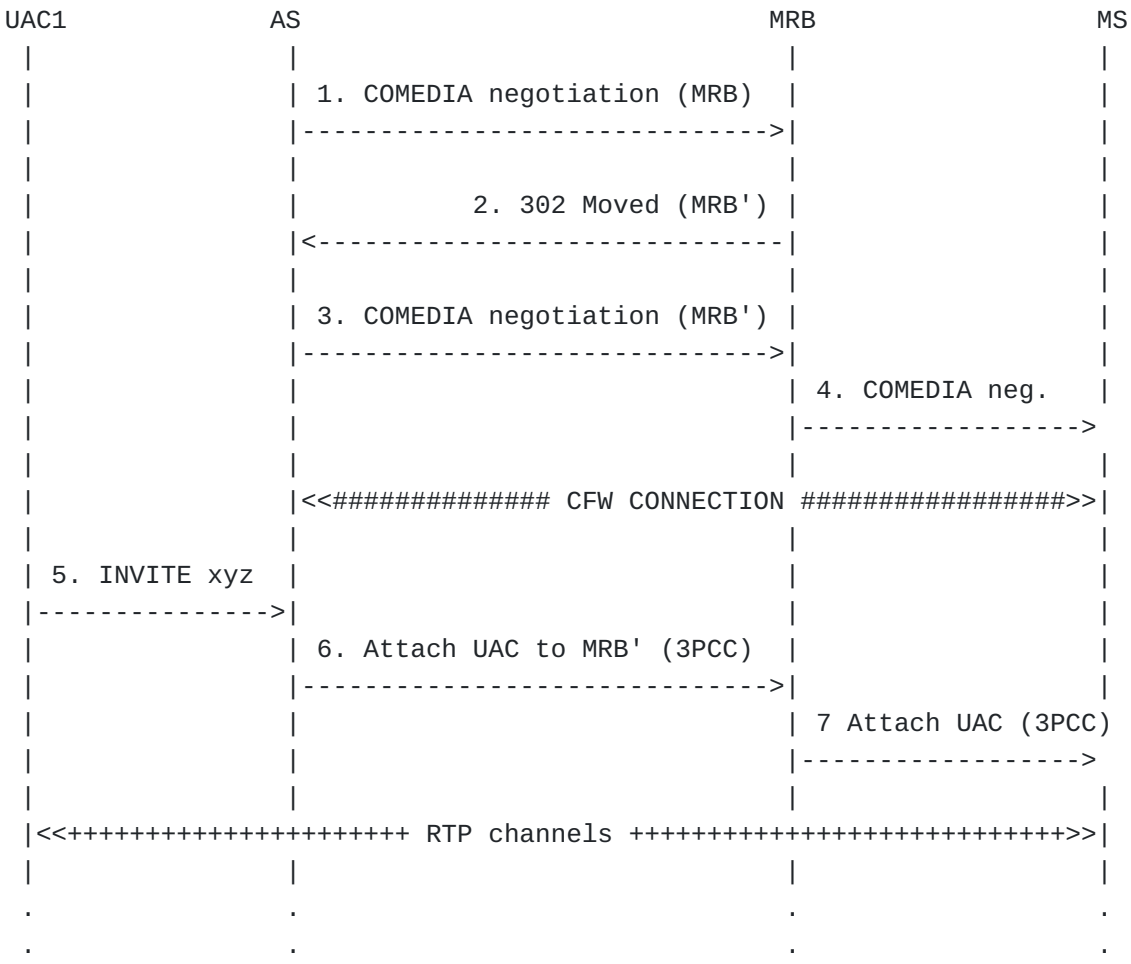
In this example, the AS creates two different Control Channels sessions (A and B) to address two different business logic implementations: e.g., the AS SIP URI 'xyz' (associated with CFW session A) may be an IVR pizza ordering application, while the AS SIP URI 'jkl' (associated with CFW session B) may be associated with a conference room. It's quite clear, then, that if the MRB forwarded the two CFW sessions to two different MS, the handling of UAC call legs would prove troublesome, considering the MRB would have an hard way figuring out whether UAC1 should be attached to the MS managing CFW session A or the

MS managing CFW session B. Forwarding all CFW sessions and UAC call legs coming from the same MRB-unaware AS to the same MS would instead work as expected: the MRB would in fact leave the mapping of call legs and CFW sessions up to the AS.
This approach, while very simple and potentially not very scalable, would actually help take care of the issue: in fact, no matter how many separate control channels the AS might have with the MRB/MS (in this example, the control channel A would be mapped to application xyz, and B to application jkl), the termination point would still always be the same MS, which would consequently be the destination for all call legs as well.
To overcome the scalability limitations of such an approach, the MRB could instead make use of redirection, as depicted in Figure 86.



With this approach, the MRB might redirect the AS to a specific MS whenever a new control channel is to be created, and as a consequence the AS would redirect the related calls there. This is similar to the first approach of the Query/IAMM case, with the difference that no Consumer request would be involved. The scenario would again fallback to a 1:1 topology between the AS and the MS, making the interactions quite simple.
Just as before, anyway, the MRB might be interested in being in the signalling path for the SIP dialogs, instead of just acting as a

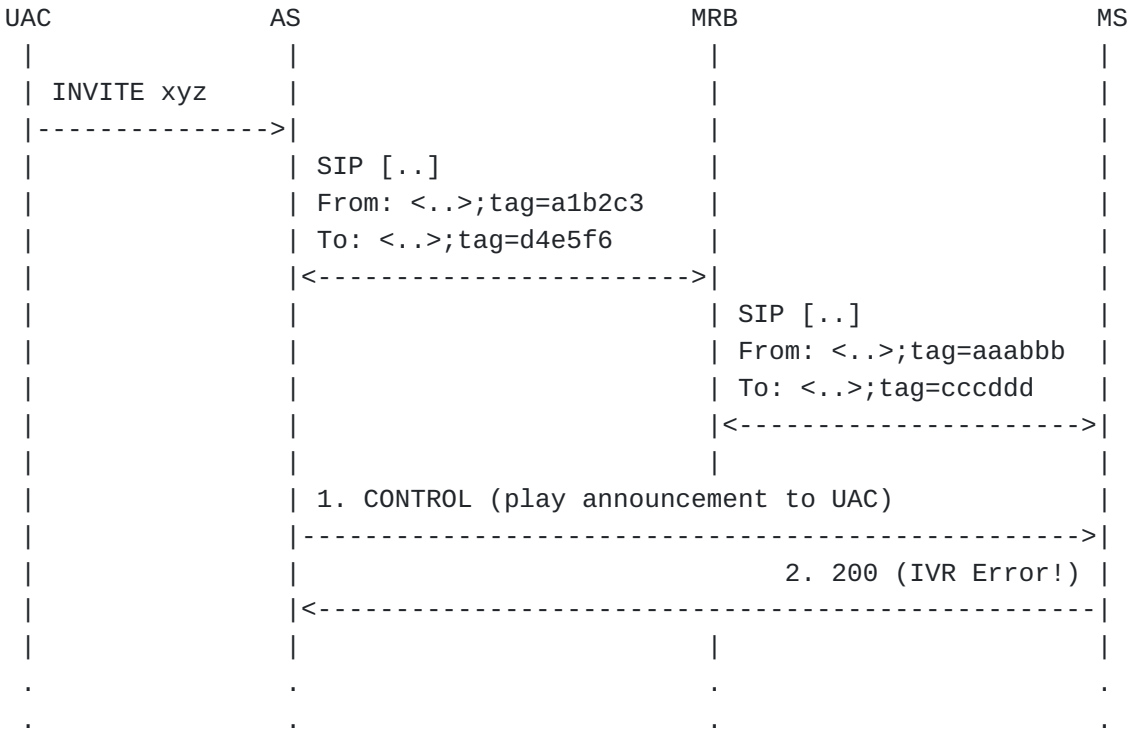
locator. A third potential approach could be implementing the "virtual" URIs handled by the MRB, as described in the previous section. Rather than recurring to explicit redirection, or always using the same MS, the MRB may redirect new SIP control dialogs to one of its own URIs, using the same approach previously presented in Figure 84. Such an approach applied to the IUMM case is depicted in Figure 87.



7.3.3. CFW Protocol Bhaviour

As shown in the previous diagrams, no matter what the topology, the AS and MS usually end up with a direct connection with respect to the CFW control channel. As such, it can be expected that the CFW protocol continue to work as it should, and as a consequence all the call flows presented in this document can easily be reproduced in those circumstances as well.
One aspect needs to be taken in very good care, nevertheless. It's worthwile to remind that both the AS and the MS make use of some SIP-related information to address the entities they manipulate. It's the case, for instance, of the 'connectionid' element both the AS and the

MS refer to when addressing a specific UAC: this 'connectionid', as explained at the beginning of this draft, is constructed by concatenating the From: and To: tags extracted from a SIP header, specifically from the headers of the AS<->MS leg that allows an UAC to be attached to the MS. The presence of an additional component in the path between the AS and the MS, the MRB, might alter these tags, thus causing the AS to make use of tags (AS<->MRB) different than the ones used by the MS (MRB<->MS). This would result in the AS and MS using different 'connectionid' identifiers to address actually the same UAC, thus preventing the protocol to work as expected. As a consequence, it's very important that any MRB implementation take very good care of preserving the integrity of the involved SIP headers when proxying/ forwarding SIP dialogs between AS and MS, in order not to break the protocol behaviour.
Let's take, for instance, the scenario depicted in Figure 84, especially steps 6 and 7 which specifically address an UAC being attached by an AS to a MS via the MRB. Let's assume that what is presented in Figure 88 is what happens to the From: and To: headers when dealing with the 3PCC approach to attach a specific UAC to the MS in that case.



In the example, once done with the 3PCC and the UAC being attached to the MS, the AS and the MS end up with different assumptions with respect to the 'connectionid' addressing UAC. In fact, the AS builds a 'connectionid' using the tags it is aware of (a1b2c3:d4e5f6), while the

MS builds a different one, considering it got different information
from the MRB (aaabbb:cccddd).
As a consequence, when the AS tries to play an announcement to the UAC
using the connectionid it correctly constructed, the MS just as
correctly replies with an error, since it doesn't know that identifier.
This is the correct protocol behaviour, caused by a misuse of the
information needed for it to work as expected.

```
1. AS -> MS (CFW CONTROL, play)
-------------------------------
   CFW ffhg45dzf123 CONTROL
   Control-Package: msc-ivr/1.0
   Content-Type: application/msc-ivr+xml
   Content-Length: 284

   <mscivr version="1.0" xmlns="urn:ietf:params:xml:ns:msc-ivr">
     <dialogstart connectionid="a1b2c3:d4e5f6">
       <dialog>
         <prompt>
           <media loc="http://www.example.net/hello.wav"/>
         </prompt>
       </dialog>
     </dialogstart>
   </mscivr>


2. AS <- MS (CFW 200 OK)
------------------------
   CFW ffhg45dzf123 200
   Timeout: 10
   Content-Type: application/msc-ivr+xml
   Content-Length: 148

   <mscivr version="1.0" xmlns="urn:ietf:params:xml:ns:msc-ivr">
     <response status="407" reason="connectionid does not exist" \
               dialogid=""/>
   </mscivr>
```

In an even worse scenario, the connectionid might actually exist but
mapped to a different UAC: in such a case, the transaction would
succeed, but a completely different UAC would be involved in the
scenarios, thus causing a silent failure neither the AS nor the MS
would be aware of.
That said, a proper management of these sensitive pieces of information
by the MRB would prevent such failure scenarios to happen. It has
aready been described how this issue is taken care of in the IAMM case
(both CFW-based and Call leg-based). Addressing this issue for the IUMM

case is not documented in [I-D.ietf-mediactrl-mrb] as explicitly out of purpose, and as such may be implementation specific.
The same applies to SDP fields as well: in fact, the AS and MS make use of ad-hoc SDP attributes to instantiate a control channel, as they make use of SDP labels to address specific media connections of a UAC call leg when a fine-grain approach is needed. As a consequence, any MRB implementation should limit any SDP manipulation as much as possible, or at least take very good care in not causing changes that could break the expected CFW protocol behaviour.

8. Security Considerations

All the MEDIACTRL documents have strong statements regarding security considerations within the context of the interactions occurring at all the levels among the involved parties. Considering the sensitive nature of the interaction between AS and MS, particular efforts have been devoted in providing guidance upon securing what flows through a Control Channel. In fact, transactions concerning dialogs, connections and mixes are quite strongly related to resources actually being deployed and made use of in the MS. This means that it is in the interest of both AS and MS that resources created and handled by an entity are not unwillingly manipulated by a potentially malicious third party.
Considering that strong statements are already provided in the aforementioned documents, and that these documents already give good guidance to implementors with respect to these issues, this section will only provide the reader with some MEDIACTRL call flows, showing how a single secured MS is assumed to reply to different AS when receiving requests that may cross the bounds each AS is constrained into. It is the case, for instance, of generic auditing requests, or explicit conference manipulation requests where the involved identifiers are not part of the context of the originating AS.
To address a very specific scenario, let's assume that two different AS, AS1 and AS2, have established a Control Channel with the same MS. Let's also assume that AS1 has created a conference mix (confid=74b6d62) to which it has attached some participants within the context of its business logic, while AS2 has created a currently active IVR dialog (dialogid=dfg3252) with a user agent it is handling (237430727:a338e95f); besides, AS2 has also joined two connections to each other (1:75d4dd0d and 1:b9e6a659). As it is clear, it is highly desirable that AS1 is not aware of what AS2 is doing with the MS and viceversa, and that they are not allowed to manipulate the other's resources. The following transactions will occur, and it will be shown how the MS is assumed to reply in all the cases in order to avoid security issues:

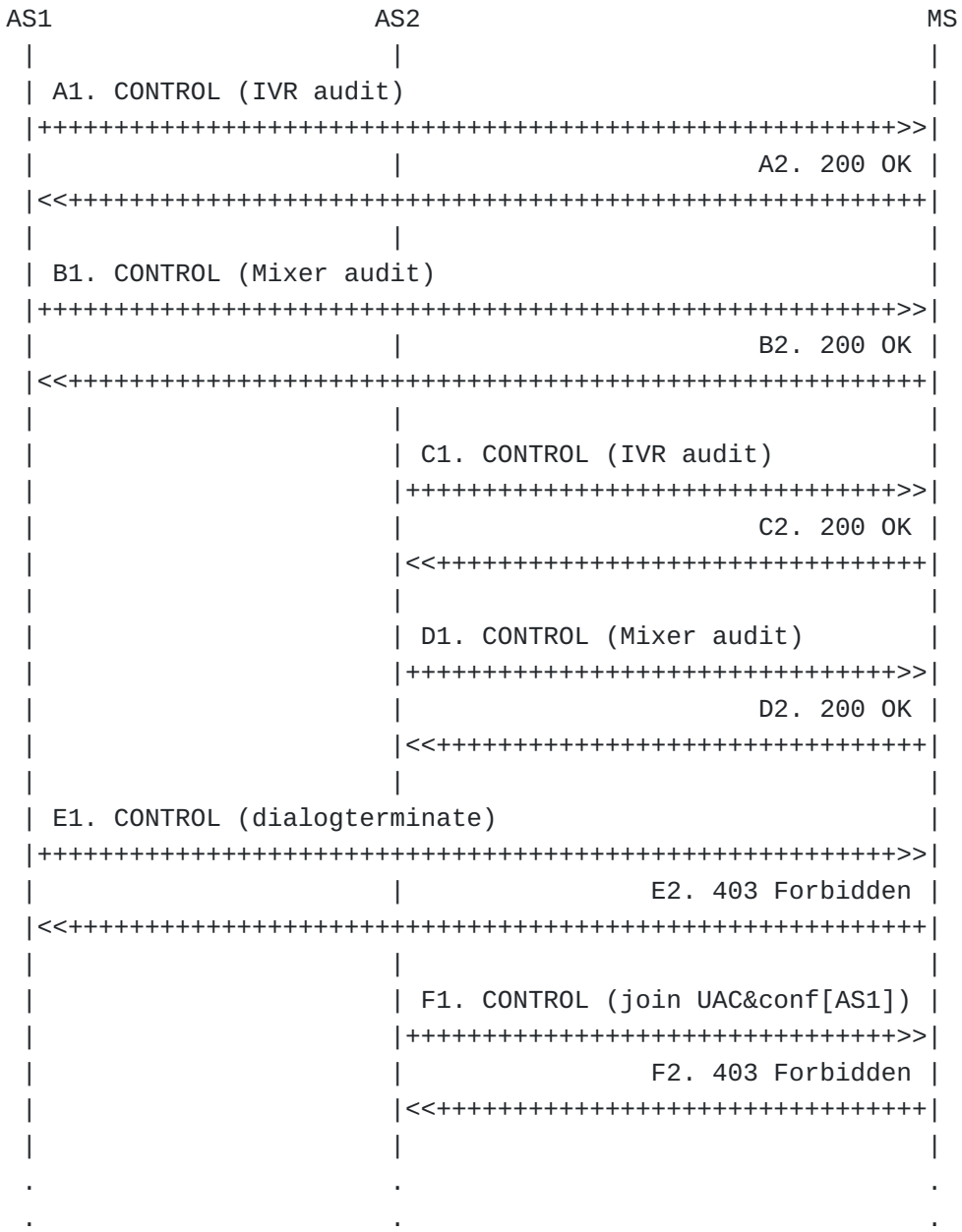
1. AS1 places a generic audit request to both the mixer and IVR packages;

2. AS2 places a generic audit request to both the mixer and IVR packages;

3. AS1 tries to terminate the dialog created by AS2 (6791fee);

4. AS2 tries to join a user agent it handles (1:272e9c05) to the conference mix created by AS1 (74b6d62);

A sequence diagram of the mentioned transactions is depicted in Figure 90:



The expected outcome of the transaction is the MS partially "lying" to both AS1 and AS2 when replying to the audit requests (not all the identifiers are reported, but only the ones each AS is directly involved in), and the MS denying the requests for the unauthorized operations (403). Looking at each transaction separately:

- In the first transaction (A1), AS1 places a generic <audit> request to the IVR package; the request is generic since no attributes are passed as part of the request, meaning AS1 is interested to both the MS capabilities and all the dialogs the MS is currently handling; as it can be seen in the reply (A2), the MS only reports in the <auditresponse> the package capabilities, while the <dialogs> element is empty; this is because the only dialog the MS is handling has actually been created by AS2, which causes the MS not to report the related identifier (6791fee) to AS1; in fact, AS1 could use that identifier to manipulate the dialog, e.g. by tearing it down thus causing the service to be interrupted without AS2's intervention;

- In the second transaction, instead (B1), AS1 places an identical <audit> request to the mixer package; the request is again generic, meaning AS1 is interested to both the package capabilities and all the mixers and connections the package is handling at the moment; this time, the MS does not only report capabilities (B2), but information about mixers and connections as well; nevertheless, this information is not complete; in fact, only information about mixers and connections originated by AS1 are reported (mixer 74b6d62 and its participants), while the ones originated by AS2 are omitted in the report; the motivation is the same as before;

- In the third and fourth transactions (C1 and D1), it's AS2 placing an <audit> request to both the IVR and mixer packages; just as for what happened in the previous transactions, the audit requests are generic; looking at the replies (C2 and D2), it's obvious that the capabilities section is identical to the replies given to AS1; in fact, the MS has no reason to "lie" about what it can do; the <dialogs> and <mixers> sections, instead, are totally different; AS2 in fact receives information about its own IVR dialog (6791fee), which was omitted in the reply to AS1, while it only receives information about the only connection it created (1:75d4dd0d and 1:b9e6a659) without any details related to the mixers and connections originated by AS1;

- In the fifth transaction (E1) AS1, instead of just auditing the packages, tries to terminate (<dialogterminate>) the dialog created by AS2 (6791fee); since the identifier has not been reported by the MS in the reply to the previous audit request, we assume AS1 got it by a different out of band mechanism; this is

assumed to be an unauthorized operation, considering the mentioned dialog is outside the bounds of AS1; for this reason MS, instead of handling the syntactically correct request, replies (E2) with a framework level 403 message (Forbidden), leaving the dialog untouched;

*Similarly in the sixth and last transaction (F1) AS2 tries to attach (<join>) one of the UACs it is handling to the conference mix created by AS1 (74b6d62); just as in the previous transaction, the identifier is assumed to have been accessed by AS2 through some out of band mechanism, considering that MS didn't report it in the reply to the previous audit request; while one of the identifiers (the UAC) is actually handled by AS2, the other (the conference mix) is not, and this is again considered by the MS as AS2 stepping outside of its bounds; for the same reason as before, MS replies again (F2) with a framework level 403 message (Forbidden), leaving the mix and the UAC unjoined.

A1. AS1 -> MS (CFW CONTROL, audit IVR)

```
   CFW 140e0f763352 CONTROL
   Control-Package: msc-ivr/1.0
   Content-Type: application/msc-ivr+xml
   Content-Length: 81

   <mscivr version="1.0" xmlns="urn:ietf:params:xml:ns:msc-ivr">
      <audit/>
   </mscivr>
```

A2. AS1 <- MS (CFW 200, auditresponse)

```
   CFW 140e0f763352 200
   Timeout: 10
   Content-Type: application/msc-ivr+xml
   Content-Length: 1419

   <mscivr version="1.0" xmlns="urn:ietf:params:xml:ns:msc-ivr">
   <auditresponse status="200">
      <capabilities>
         <dialoglanguages/>
         <grammartypes/>
         <recordtypes>
            <mimetype>audio/x-wav</mimetype>
            <mimetype>video/mpeg</mimetype>
         </recordtypes>
         <prompttypes>
            <mimetype>audio/x-wav</mimetype>
            <mimetype>video/mpeg</mimetype>
         </prompttypes>
         <variables>
            <variabletype type="date" \
                          desc="value formatted as YYYY-MM-DD">
               <format desc="month year day">mdy</format>
               <format desc="year month day">ymd</format>
               <format desc="day month year">dmy</format>
               <format desc="day month">dm</format>
            </variabletype>
            <variabletype type="time" desc="value formatted as HH:MM">
               <format desc="24 hour format">t24</format>
               <format desc="12 hour format with am/pm">t12</format>
            </variabletype>
            <variabletype type="digits" desc="value formatted as D+">
               <format desc="general digit string">gen</format>
               <format desc="cardinal">crn</format>
               <format desc="ordinal">ord</format>
```

```
            </variabletype>
          </variables>
          <maxpreparedduration>60s</maxpreparedduration>
          <maxrecordduration>1800s</maxrecordduration>
          <codecs>
             <codec name="audio"><subtype>basic</subtype></codec>
             <codec name="audio"><subtype>gsm</subtype></codec>
             <codec name="video"><subtype>h261</subtype></codec>
             <codec name="video"><subtype>h263</subtype></codec>
             <codec name="video"><subtype>h263-1998</subtype></codec>
             <codec name="video"><subtype>h264</subtype></codec>
          </codecs>
       </capabilities>
       <dialogs>
       </dialogs>
    </auditresponse>
    </mscivr>


B1. AS1 -> MS (CFW CONTROL, audit mixer)
----------------------------------------
    CFW 0216231b1f16 CONTROL
    Control-Package: msc-mixer/1.0
    Content-Type: application/msc-mixer+xml
    Content-Length: 87

    <mscmixer version="1.0" xmlns="urn:ietf:params:xml:ns:msc-mixer">
       <audit/>
    </mscmixer>


B2. AS1 <- MS (CFW 200, auditresponse)
--------------------------------------
    CFW 0216231b1f16 200
    Timeout: 10
    Content-Type: application/msc-mixer+xml
    Content-Length: 903

    <mscmixer version="1.0" xmlns="urn:ietf:params:xml:ns:msc-mixer">
    <auditresponse status="200">
      <capabilities>
         <codecs>
            <codec name="audio"><subtype>basic</subtype></codec>
            <codec name="audio"><subtype>gsm</subtype></codec>
            <codec name="video"><subtype>h261</subtype></codec>
            <codec name="video"><subtype>h263</subtype></codec>
            <codec name="video"><subtype>h263-1998</subtype></codec>
            <codec name="video"><subtype>h264</subtype></codec>
         </codecs>
```

```
     </capabilities>
     <mixers>
       <conferenceaudit conferenceid="74b6d62">
         <participants>
           <participant id="1864574426:e2192766"/>
           <participant id="1:5a97fd79"/>
         </participants>
         <video-layout min-participants="1">
           <quad-view/>
         </video-layout>
       </conferenceaudit>
       <joinaudit id1="1864574426:e2192766" id2="74b6d62"/>
       <joinaudit id1="1:5a97fd79" id2="74b6d62"/>
     </mixers>
   </auditresponse>
   </mscmixer>


C1. AS2 -> MS (CFW CONTROL, audit IVR)
--------------------------------------
   CFW 0216231b1f16 CONTROL
   Control-Package: msc-ivr/1.0
   Content-Type: application/msc-ivr+xml
   Content-Length: 81

   <mscivr version="1.0" xmlns="urn:ietf:params:xml:ns:msc-ivr">
      <audit/>
   </mscivr>


C2. AS2 <- MS (CFW 200, auditresponse)
--------------------------------------
   CFW 0216231b1f16 200
   Timeout: 10
   Content-Type: application/msc-ivr+xml
   Content-Length: 1502

   <mscivr version="1.0" xmlns="urn:ietf:params:xml:ns:msc-ivr">
   <auditresponse status="200">
      <capabilities>
         <dialoglanguages/>
         <grammartypes/>
         <recordtypes>
            <mimetype>audio/wav</mimetype>
            <mimetype>video/mpeg</mimetype>
         </recordtypes>
         <prompttypes>
            <mimetype>audio/wav</mimetype>
            <mimetype>video/mpeg</mimetype>
```

```
         </prompttypes>
         <variables>
            <variabletype type="date" \
                          desc="value formatted as YYYY-MM-DD">
               <format desc="month year day">mdy</format>
               <format desc="year month day">ymd</format>
               <format desc="day month year">dmy</format>
               <format desc="day month">dm</format>
            </variabletype>
            <variabletype type="time" desc="value formatted as HH:MM">
               <format desc="24 hour format">t24</format>
               <format desc="12 hour format with am/pm">t12</format>
            </variabletype>
            <variabletype type="digits" desc="value formatted as D+">
               <format desc="general digit string">gen</format>
               <format desc="cardinal">crn</format>
               <format desc="ordinal">ord</format>
            </variabletype>
         </variables>
         <maxpreparedduration>60s</maxpreparedduration>
         <maxrecordduration>1800s</maxrecordduration>
         <codecs>
            <codec name="audio"><subtype>basic</subtype></codec>
            <codec name="audio"><subtype>gsm</subtype></codec>
            <codec name="video"><subtype>h261</subtype></codec>
            <codec name="video"><subtype>h263</subtype></codec>
            <codec name="video"><subtype>h263-1998</subtype></codec>
            <codec name="video"><subtype>h264</subtype></codec>
         </codecs>
      </capabilities>
      <dialogs>
         <dialogaudit dialogid="6791fee" state="started" \
                      connectionid="237430727:a338e95f"/>
      </dialogs>
   </auditresponse>
   </mscivr>
```

D1. AS2 -> MS (CFW CONTROL, audit mixer)

```
   CFW 515f007c5bd0 CONTROL
   Control-Package: msc-mixer/1.0
   Content-Type: application/msc-mixer+xml
   Content-Length: 87

   <mscmixer version="1.0" xmlns="urn:ietf:params:xml:ns:msc-mixer">
      <audit/>
   </mscmixer>
```

D2. AS2 <- MS (CFW 200, auditresponse)

```
   CFW 515f007c5bd0 200
   Timeout: 10
   Content-Type: application/msc-mixer+xml
   Content-Length: 548

   <mscmixer version="1.0" xmlns="urn:ietf:params:xml:ns:msc-mixer">
   <auditresponse status="200">
      <capabilities>
         <codecs>
            <codec name="audio"><subtype>basic</subtype></codec>
            <codec name="audio"><subtype>gsm</subtype></codec>
            <codec name="video"><subtype>h261</subtype></codec>
            <codec name="video"><subtype>h263</subtype></codec>
            <codec name="video"><subtype>h263-1998</subtype></codec>
            <codec name="video"><subtype>h264</subtype></codec>
         </codecs>
      </capabilities>
      <mixers>
         <joinaudit id1="1:75d4dd0d" id2="1:b9e6a659"/>
      </mixers>
   </auditresponse>
   </mscmixer>
```

E1. AS1 -> MS (CFW CONTROL, dialogterminate)

```
   CFW 7fdcc2331bef CONTROL
   Control-Package: msc-ivr/1.0
   Content-Type: application/msc-ivr+xml
   Content-Length: 127

   <mscivr version="1.0" xmlns="urn:ietf:params:xml:ns:msc-ivr">
      <dialogterminate dialogid="6791fee" immediate="true"/>
   </mscivr>
```

E2. AS1 <- MS (CFW 403 Forbidden)

```
   CFW 7fdcc2331bef 403
```

F1. AS2 -> MS (CFW CONTROL, join to conference)

```
   CFW 140e0f763352 CONTROL
   Control-Package: msc-mixer/1.0
   Content-Type: application/msc-mixer+xml
   Content-Length: 117
```

```
   <mscmixer version="1.0" xmlns="urn:ietf:params:xml:ns:msc-mixer">
      <join id1="1:272e9c05" id2="74b6d62"/>
   </mscmixer>
```

```
F2. AS2 <- MS (CFW 403 Forbidden)
---------------------------------
   CFW 140e0f763352 403
```

9. Change Summary

Note to RFC Editor: Please remove this whole section.
The following are the major changes between the 06 and the 07 versions of the draft:

- *Updated references: RFC6230 (was control framework draft) and RFC6231 (was IVR package).

- *Aligned all the examples to the latest package schemas (MRB in particular), and validated them.

- *Modified Publish example by showing the use of the new minfrequency and maxfrequency elements.

- *Modified IAMM Consumer example to show two different approaches, CFW-based and Call-leg based.

- *Enriched the connection-id issue section, by providing examples on the Consumer connection-id element.

- *Clarified that solving the connection-id issue in the IUMM case is implementation specific.

The following are the major changes between the 05 and the 06 versions of the draft:

- *Aligned all the examples to the latest package schemas, and validated them.

The following are the major changes between the 04 and the 05 versions of the draft:

- *Added the missing <encoding> and <decoding> elements to the <rtp-codec> instances, where needed (MRB section);

- *Validated all the examples according to the schemas, and fixed implementation and snippets where needed.

The following are the major changes between the 03 and the 04 versions of the draft:

- corrected flow in Section 6.3.2;
- updated examples with respect to package names (version added) and codec names (MIME type);
- added a new Publishing request to the existing dump to address a subscription update;
- added a completely new section (Section 7.3) to address the call legs management in presence of MRBs;

The following are the major changes between the 02 and the 03 versions of the draft:

- enriched MRB section text;
- updated MRB Publishing scenario;
- added MRB Consumer scenarios, both Inline and Query (Section 7);

The following are the major changes between the 01 and the 02 versions of the draft:

- changed the m-line of COMEDIA negotiation according to [RFC6230];
- changed the token used to build connection identifiers from '~' to ':';
- corrected the flow presented in Section 6.4.3, where messages E1 and G1 were more verbose than needed;
- added placeholder section for Media Resource Brokering (Section 7)

The following are the major changes between the 00 and the 01 versions of the draft:

- updated the flows according to the latest drafts;
- corrected the reference to the Conferencing Scenarios RFC (4597 instead of 4579);
- added K-ALIVE example and some common mistakes in the Control Channel Establishment section;
- added text, diagrams and flows to the Sidebars scenario;

*added text, diagrams and flows to the Floor Control scenario; Floor Control scenario moved at the end of the conferencing section;

*added text to the Security Considerations;

10. Acknowledgements

The authors would like to thank...

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Authors' Addresses

Alessandro Amirante Amirante University of Napoli Via Claudio 21 Napoli, 80125 Italy EMail: alessandro.amirante@unina.it

Tobia Castaldi Castaldi Meetecho Via Carlo Poerio 89 Napoli, 80100 Italy EMail: tcastaldi@meetecho.com

Lorenzo Miniero Miniero Meetecho Via Carlo Poerio 89 Napoli, 80100 Italy EMail: lorenzo@meetecho.com

Simon Pietro Romano Romano University of Napoli Via Claudio 21 Napoli, 80125 Italy EMail: spromano@unina.it