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P. Jones
G. Salgueiro
C. Pearce
Cisco Systems

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End-to-End Session Identification in IP-Based Multimedia Communication Networks
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Abstract

This document describes an end-to-end Session Identifier for use in IP-based multimedia communication systems that enables endpoints, intermediary devices, and management systems to identify a session end-to-end, associate multiple endpoints with a given multipoint conference, track communication sessions when they are redirected, and associate one or more media flows with a given communication session.

This document also describes a backwards compatibility mechanism for an existing (RFC 7329) session identifier implementation that is sufficiently different from the procedures defined in this document.

Status of this Memo

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1. Introduction

IP-based multimedia communication systems like SIP [RFC3261] and H.323 [H.323] have the concept of a "call identifier" that is globally unique. The identifier is intended to represent an end-to-end communication session from the originating device to the terminating device. Such an identifier is useful for troubleshooting, session tracking, and so forth.

For several reasons, however, the current call identifiers defined in SIP and H.323 are not suitable for end-to-end session identification. A fundamental issue in protocol interworking is the fact that the syntax for the call identifier in SIP and H.323 is different. Thus, if both protocols are used in a call, it is impossible to exchange the call identifier end-to-end.

Another reason why the current call identifiers are not suitable to identify a session end-to-end is that, in real-world deployments, devices like session border controllers [RFC7092] often change the session signaling as it passes through the device, including the value of the call identifier. While this is deliberate and useful, it makes it very difficult to track a session end-to-end.

This document defines a new identifier for SIP referred to as the Session Identifier that is intended to overcome the issues that exist with the currently defined call identifiers used in SIP. The procedures specified in this document attempt to comply with the requirements specified in [RFC7206]. The procedures also specify capabilities not mentioned in [RFC7206], shown in call flows in section 9. Additionally, the specification attempts to account for a previous, proprietary version of a SIP Session Identifier header [RFC7329], specifying a backwards compatibility approach in section 10.

2. Conventions used in this document

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in RFC 2119 [RFC2119] when they appear in ALL CAPS. These words may also appear in this document in lower case as plain English words, absent their normative meanings.

The term "Session Identifier" refers to the value of the identifier, whereas "Session-ID" refers to the header field used to convey the identifier. The Session Identifier is a set of two Universally

Unique Identifiers (UUIDs) and each element of that set is simply referred to herein as a UUID.

Throughout this document, the term "endpoint" refers to a SIP User Agent (UA) that either initiates or terminates a SIP session, such as a user's mobile phone or a conference server, but excludes entities like B2BUAs that are generally located along the call signaling path between endpoints. The term "intermediary" refers to any SIP entity along the call signaling path between the aforementioned endpoints, including Back-to-Back User Agents (B2BUAs) and SIP proxies.

3. Session Identifier Requirements and Use Cases

Requirements and use cases for the end-to-end Session Identifier, along with a definition of "session identifier" and "communication session", can be found in [RFC7206].

As mentioned in section 6.1 of RFC 7206, the ITU-T undertook a parallel effort to define compatible procedures for an H.323 Session Identifier. They are documented in [H.460.27].

4. Constructing and Conveying the Session Identifier

4.1. Constructing the Session Identifier

The Session Identifier comprises two UUIDs [RFC4122], with each UUID representing one of the endpoints participating in the session.

The version number in the UUID indicates the manner in which the UUID is generated, such as using random values or using the MAC address of the endpoint. To satisfy the requirement that no user or device information be conveyed, endpoints SHOULD generate version 4 (random) or version 5 (SHA-1) UUIDs to address privacy concerns related to use of MAC addresses in UUIDs.

When generating a version 5 UUID, endpoints or intermediaries MUST utilize the procedures defined in Section 4.3 of [RFC4122] and employ the following "name space ID":

```
uuid_t NameSpace_SessionID = {
    /* a58587da-c93d-11e2-ae90-f4ea67801e29 */
    0xa58587da,
    0xc93d,
    0x11e2,
    0xae, 0x90, 0xf4, 0xea, 0x67, 0x80, 0x1e, 0x29
}
```

Further, the "name" to utilize for version 5 UUIDs is the concatenation of the Call-ID header-value and the "tag" parameter that appears on the "From" or "To" line associated with the device for which the UUID is created. Once an endpoint generates a UUID for a session, the UUID never changes, even if values originally used as

input into its construction change over time.

Stateless intermediaries that insert a Session-ID header field into a SIP message on behalf of an endpoint MUST utilize version 5 UUIDs to ensure that UUIDs for the communication session are consistently generated. If a stateless intermediary does not know the tag value for the endpoint (e.g., a new INVITE without a To: tag value or an older SIP [RFC2543] implementation that did not include a tag parameter), the intermediary MUST NOT attempt to generate a UUID for that endpoint. Note that if an intermediary is stateless and the endpoint on one end of the call is replaced with another endpoint due to some service interaction, the values used to create the UUID should change and, if so, the intermediary will compute a different UUID.

4.2. Conveying the Session Identifier

The SIP User Agent (UA) initially transmitting the SIP request ("Alice"), i.e., a User Agent Client (UAC), will create a UUID and transmit that to the ultimate destination UA ("Bob"). Likewise, the destination UA ("Bob"), i.e., a User Agent Server (UAS), will create a UUID and transmit that to the first UA ("Alice"). These two distinct UUIDs form what is referred to as the Session Identifier and is represented in this document in set notation of the form {A,B}, where "A" is UUID value created by UA "Alice" and "B" is the UUID value created by UA "Bob". The Session Identifier {A,B} is equal to the Session Identifier {B,A}.

In the case where only one UUID is known, such as when a UA first initiates a SIP request, the Session Identifier would be {A,N}, where "A" represents the UUID value transmitted by the UA "Alice" and "N" is what is referred to as the null UUID (see section 5).

Since SIP sessions are subject to any number of service interactions, SIP INVITE messages might be forked as sessions are established, and since conferences might be established or expanded with endpoints calling in or the conference focus calling out, the construction of the Session Identifier as a set of UUIDs is important.

To understand this better, consider that an endpoint participating in a communication session might be replaced with another, such as the case where two "legs" of a call are joined together by a PBX. Suppose "Alice" and "Bob" both call UA C ("Carol"). There would be two distinctly identifiable Session Identifiers, namely {A,C} and {B,C}. Then suppose that "Carol" uses a local PBX function to join the call between herself and "Alice" with the call between herself and "Bob", resulting in a single remaining call between "Alice" and "Bob". This merged call can be identified using two UUID values assigned by each entity in the communication session, namely {A,B} in this example.

In the case of forking, "Alice" might send an INVITE that gets forked to several different endpoints. A means of identifying each of these

separate communication sessions is needed and, since each of the destination UAs will create its own UUID, each communication session would be uniquely identified by the values {A, B1}, {A, B2}, {A, B3}, and so on, where each of the Bn values refers to the UUID created by the different UAs to which the SIP session is forked.

For conferencing scenarios, it is also useful to have a two-part Session Identifier where the conference focus specifies the same UUID for each conference participant. This allows for correlation among the participants in a single conference. For example, in a conference with three participants, the Session Identifiers might be {A,M}, {B,M}, and {C,M}, where "M" is assigned by the conference focus. Only a conference focus will purposely utilize the same UUID for more than one SIP session and, even then, such reuse MUST be restricted to the participants in the same conference.

How a device acting on Session Identifiers stores, processes, or utilizes the Session Identifier is outside the scope of this document.

5. The Session-ID Header Field

The syntax specified here replaces the Session-ID header field syntax defined in RFC 7329 [RFC7329].

Each endpoint participating in a communication session has a distinct, preferably locally-generated, UUID associated with it. The endpoint's UUID value remains unchanged throughout the duration of the communication session. An intermediary MAY generate a UUID on behalf of an endpoint that did not include a UUID of its own.

The UUID values for each endpoint are inserted into the "Session-ID" header field of all transmitted SIP messages. The Session-ID header field has the following ABNF [RFC5234] syntax:

```
session-id          = "Session-ID" HCOLON session-id-value

session-id-value    = local-uuid *(SEMI sess-id-param)

local-uuid          = sess-uuid / null

remote-uuid         = sess-uuid / null

sess-uuid           = 32(DIGIT / %x61-66)  ;32 chars of [0-9a-f]

sess-id-param       = remote-param / generic-param

remote-param        = "remote" EQUAL remote-uuid
```

```
null                = 32("0")
```

The productions "SEMI", "EQUAL", and "generic-param" are defined in [RFC3261]. The production DIGIT is defined in [RFC5234].

The Session-ID header field MUST NOT have more than one "remote" parameter. In the case where an entity compliant with this specification is interworking with an entity that implemented [RFC7329], the "remote" parameter may be absent, but otherwise the remote parameter MUST be present. The details under which those conditions apply are described in Section 10. Except for backwards compatibility with [RFC7329], the "remote" parameter MUST be present.

A special null UUID value composed of 32 zeros is required in certain situations. A null UUID is expected as the "remote-uuid" of every initial standard SIP request since the initiating endpoint would not initially know the UUID value of the remote endpoint. This null value will get replaced by the ultimate destination UAS when that UAS generates response message. One caveat is explained in Section 10 for a possible backwards compatibility case. A null UUID value is also returned by some intermediary devices that send provisional responses as the "local-uuid" component of the Session-ID header field value, as described in Section 7.

The "local-uuid" in the Session-ID header field represents the UUID value of the endpoint transmitting a message and the "remote-uuid" in the Session-ID header field represents the UUID of the endpoint's peer. For example, a Session-ID header field might appear like this:

```
Session-ID: ab30317f1a784dc48ff824d0d3715d86;
            remote=47755a9de7794ba387653f2099600ef2
```

While this is the general form of the Session-ID header field, exceptions to syntax and procedures are detailed in subsequent sections.

The UUID values are presented as strings of lower-case hexadecimal characters, with the most significant octet of the UUID appearing first.

The Session-ID header field value is technically case-INSENSITIVE, but only lowercase characters are allowed in the sess-uuid components. Receiving entities MUST treat sess-uuid components as case-insensitive and not produce an error if an uppercase hexadecimal character is received.

6. Endpoint Behavior

To comply with this specification, endpoints (non-intermediaries) MUST include a Session-ID header field value in all SIP messages transmitted as a part of a communication session. The locally-

generated UUID of the transmitter of the message MUST appear in the "local-uuid" portion of the Session-ID header field value. The UUID

of the peer device, if known, MUST appear as the "remote" parameter following the transmitter's UUID. The null UUID value MUST be used if the peer device's UUID is not known.

Once an endpoint allocates a UUID value for a communication session, the endpoint MUST NOT change that UUID value for the duration of the session, including when

- communication attempts are retried due to receipt of 4xx messages or request timeouts;
- the session is redirected in response to a 3xx message; or
- a session is transferred via a REFER message [RFC3515]; or
- a SIP dialog is replaced via an INVITE with Replaces [RFC3891].

An endpoint that receives a Session-ID header field MUST take note of any non-null "local-uuid" value that it receives and assume that is the UUID of the peer endpoint within that communications session. Endpoints MUST include this received UUID value as the "remote" parameter when transmitting subsequent messages, making sure not to change this UUID value in the process of moving the value internally from the "local-uuid" field to the "remote-uuid" field.

If an endpoint receives a 3xx or 4xx message, receives a REFER that directs the endpoint to a different peer, or receives an INVITE with Replaces that also potentially results in communicating with a new peer, the endpoint MUST complete any message exchanges with its current peer using the existing Session Identifier, but MUST NOT use the current peer's UUID value when sending the first message to what it believes may be a new peer endpoint (even if the exchange results in communicating with the same physical or logical entity). The endpoint MUST retain its own UUID value, however, as described above.

It should be noted that messages received by an endpoint might contain a "local-uuid" value that does not match what the endpoint expected its peer's UUID to be. It is also possible for an endpoint to receive a "remote-uuid" value that does not match its generated UUID for the session. Either might happen as a result of service interactions by intermediaries and MUST NOT negatively affect the communication session. However, the endpoint may log this event for the purposes of troubleshooting.

An endpoint MUST assume that the UUID value of the peer endpoint MAY change at any time due to service interactions. If the UUID value of the peer changes, the endpoint MUST accept the new UUID as the peer's UUID and include this new UUID as the "remote" parameter in any subsequent messages.

It is also important to note that if an intermediary in the network forks a session, the endpoint initiating a session may receive multiple responses back from different endpoints, each of which contains a different UUID ("local-uuid") value. Endpoints MUST take care to ensure that the correct UUID value is returned in the "remote" parameter when interacting with each endpoint. The one exception is when the endpoint sends a CANCEL message, in which case the Session-ID header field value MUST be identical to the Session-ID header field value sent in the original INVITE.

If an endpoint receives a message that does not contain a Session-ID header field, that message MUST have no effect on what the endpoint believes is the UUID value of the remote endpoint. That is, the endpoint MUST NOT change the internally maintained "remote-uuid" value for the peer.

A Multipoint Control Unit (MCU) is a special type of conferencing endpoint and is discussed in Section 8.

7. Processing by Intermediaries

The following applies only to an intermediary that wishes to comply with this specification and does not impose a conformance requirement on intermediaries that elect to not provide any special treatment for the Session-ID header field.

The Call-ID often reveals personal, device, domain or other sensitive information associated with a user, which is why intermediaries, such as session border controllers, sometimes alter the Call-ID. In order to ensure the integrity of the end-to-end Session Identifier, it is constructed in a way which does not reveal such information, removing the need for intermediaries to alter it.

When an intermediary receives messages from one endpoint in a communication session that causes the transmission of one or more messages toward the second endpoint in a communication session, the intermediary MUST include the Session-ID header field in the transmitted messages with the same UUID values found in the received message, except as outlined in this section.

If the intermediary aggregates several responses from different endpoints, as described in Section 16.7 of [RFC3261], the intermediary MUST set the local-uuid field to the null UUID value when forwarding the aggregated response to the endpoint since the true UUID value of the peer is undetermined at that point.

Intermediary devices that transfer a call, such as by joining together two different "call legs", MUST properly construct a Session-ID header field that contains the correct UUID values and

correct placement of those values. As described in Section 6, the

endpoint receiving a message transmitted by the intermediary will assume that the first UUID value belongs to its peer endpoint.

If an intermediary receives a SIP message from an endpoint without a Session-ID header field or valid header field value, the intermediary MAY assign a "local-uuid" value to represent that endpoint and, having done so, MUST insert that assigned value into all signaling messages on behalf of the endpoint for that dialog. If the intermediary is aware of the UUID value that identifies the endpoint to which a message is directed, it MUST insert that UUID value into the Session-ID header field value as the "remote-uuid" value. If the intermediary is unaware of the UUID value that identifies the receiving endpoint, it MUST use the null UUID value as the "remote-uuid" value.

Whenever there is an endpoint communicating through a B2BUA that does not implement this specification, the B2BUA MAY become dialog stateful and insert a UUID value into the Session-ID header field value on behalf of the endpoint, at which point it MUST follow the endpoint procedures in Section 6 with respect to Session-ID header field value treatment with itself acting as the endpoint (for the purposes of the Session-ID header field) for which it inserted a component into the Session-ID header field value.

When an intermediary originates a response, such as a provisional response or a response to a CANCEL request, the "remote-uuid" field will contain the UUID value of the receiving endpoint. When the UUID of the peer endpoint is known, the intermediary MUST insert the UUID of the peer endpoint in the "local-uuid" field of the header value. Otherwise, the intermediary MAY set the "local-uuid" field of the header value to the "null" UUID value.

When an intermediary originates a request message without first having received a SIP message that triggered the transmission of the message (e.g., sending a BYE message to terminate a call for policy reasons), the intermediary MUST, if it has knowledge of the UUID values for the two communicating endpoints, insert a Session-ID header field with the "remote-uuid" field of the header value set to the UUID value of the receiving endpoint and the "local-uuid" field of the header value set to the UUID value of the other endpoint. When the intermediary does not have knowledge of the UUID value of am endpoint in the communication session, the intermediary SHOULD set the unknown UUID value(s) to the "null" UUID value. (If both are unknown, the Session-ID header value SHOULD NOT be included at all, since it would have no practical value.)

With respect to the previous two paragraphs, note that if an intermediary transmits a "null" UUID value, the receiving endpoint

might use that value in subsequent messages it sends. This effectively violates the requirement of maintaining an end-to-end Session Identifier value for the communication session if a UUID for

the peer endpoint had been previously conveyed. Therefore, an intermediary MUST only send the "null" UUID when the intermediary has not communicated with the peer endpoint to learn its UUID. This means that intermediaries SHOULD maintain state related to the UUID values for both ends of a communication session if it intends to originate messages (versus merely conveying messages). An intermediary that does not maintain this state and that originates a message as described in the previous two paragraph MUST NOT insert a Session-ID header field in order to avoid unintended, incorrect reassignment of a UUID value.

The Session-ID header field value included in a CANCEL request MUST be identical to the Session-ID header field value included in the corresponding INVITE.

If a SIP intermediary initiates a dialog between two endpoints in a 3PCC [RFC3725] scenario, the SIP request in the initial INVITE will have a non-null, locally-frabricated "local-uuid" value; call this temporary UUID X. The request will still have a null "remote-uuid" value; call this value N. The SIP server MUST be transaction stateful. The UUID pair in the INVITE will be {X,N}. A non-redirected or rejected response will have a UUID pair {A,X}. This transaction stateful, dialog initiating SIP server MUST replace its own UUID, i.e., X, with a null UUID (i.e., {A,N}) as expected by other UAS (see Section 9.7 for an example).

Intermediaries that manipulate messages containing a Session-ID header field SHOULD be aware of what UUID values it last sent towards an endpoint and, following any kind of service interaction initiated or affected by the intermediary, of what UUID values the receiving endpoint should have knowledge to ensure that both endpoints in the session have the correct and same UUID values. If an intermediary can determine that an endpoint might not have received a current, correct Session-ID field, the Intermediary SHOULD attempt to provide the correct Session-ID header field to the endpoint such as by sending a re-INVITE message.

8. Associating Endpoints in a Multipoint Conference

Multipoint Control Units (MCUs) group two or more sessions into a single multipoint conference and have a conference Focus responsible for maintaining the dialogs connected to it [RFC4353]. MCUs, including cascaded MCUs, MUST utilize the same UUID value ("local-uuid" portion of the Session-ID header field value) with all participants in the conference. In so doing, each individual session in the conference will have a unique Session Identifier (since each endpoint will create a unique UUID of its own), but will also have one UUID in common with all other participants in the conference.

When creating a cascaded conference, an MCU MUST convey the UUID value to utilize for a conference via the "local-uuid" portion of the

Session-ID header field value in an INVITE to a second MCU when using SIP to establish the cascaded conference. A conference bridge, or MCU, needs a way to identify itself when contacting another MCU. [RFC4579] defines the "isfocus" Contact header field value parameter just for this purpose. The initial MCU MUST include the UUID of that particular conference in the "local-uuid" of an INVITE to the other MCU(s) participating in that conference. Also included in this INVITE is an "isfocus" Contact header field value parameter identifying that this INVITE is coming from an MCU and that this UUID is to be given out in all responses from endpoints into those MCUs participating in this same conference. This ensures a single UUID is common across all participating MCUs of the same conference, but is unique between different conferences.

Intermediary devices or network diagnostics equipment might assume that when they see two or more sessions with different Session Identifiers, but with one UUID in common, that the sessions are part of the same conference. However, the assumption that two sessions having one common UUID being part of the same conference is not always correct. In a SIP forking scenario, for example, there might also be what appears to be multiple sessions with a shared UUID value; this is intended. The desire is to allow for the association of related sessions, regardless of whether a session is forked or part of a conference.

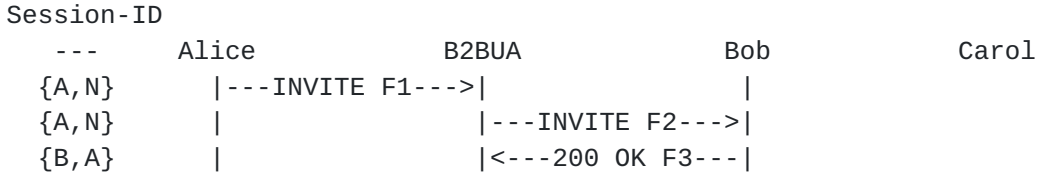
9. Examples of Various Call Flow Operations

Seeing something frequently makes understanding easier. With that in mind, this section includes several call flow examples with the initial UUID and the complete Session Identifier indicated per message, as well as when the Session Identifier changes according to the rules within this document during certain operations/functions.

This section is for illustrative purposes only and is non-normative. In the following flows, RTP refers to the Real-time Transport Protocol [RFC3550].

In the examples in this section, "N" represents a null UUID and other letters represents the unique UUID values corresponding to endpoints or MCUs.

9.1. Basic Call with 2 UUIDs



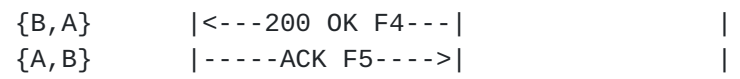

{B,A} |<---200 OK F4---| |
{A,B} |-----ACK F5---->| |

Figure 1 - Session-ID Creation when Alice calls Bob

General operation of this example:

- o UA-Alice populates the "local-uuid" portion of the Session-ID header field value.
- o UA-Alice sends its UUID in the SIP INVITE, and populates the "remote" parameter with a null value (32 zeros).
- o B2BUA receives an INVITE with both a "local-uuid" portion of the Session-ID header field value from UA-Alice as well as the null "remote-uuid" value, and transmits the INVITE towards UA-Bob with an unchanged Session-ID header field value.
- o UA-Bob receives Session-ID and generates its "local-uuid" portion of the Session-ID header field value UUID to construct the whole/complete Session-ID header field value, at the same time transferring Alice's UUID unchanged to the "remote-uuid" portion of the Session-ID header field value in the 200 OK SIP response.
- o B2BUA receives the 200 OK response with a complete Session-ID header field value from UA-Bob, and transmits 200 OK towards UA-Alice with an unchanged Session-ID header field value.
- o UA-Alice, upon reception of the 200 OK from the B2BUA, transmits the ACK towards the B2BUA. The construction of the Session-ID header field in this ACK is that of Alice's UUID is the "local-uuid", and Bob's UUID populates the "remote-uuid" portion of the header-value.
- o B2BUA receives the ACK with a complete Session-ID header field from UA-Alice, and transmits ACK towards UA-Bob with an unchanged Session-ID header field value.

Below is a complete SIP message exchange illustrating proper use of the Session-ID header field. For the sake of brevity, non-essential headers and message bodies are omitted.

F1 INVITE Alice -> B2BUA

```
INVITE sip:bob@biloxi.com SIP/2.0
Via: SIP/2.0/UDP pc33.atlanta.example.com
```

```
 ;branch=z9hG4bK776asdhds
Max-Forwards: 70
To: Bob <sip:bob@biloxi.example.com>
From: Alice <sip:alice@atlanta.example.com>;tag=1928301774
Call-ID: a84b4c76e66710@pc33.atlanta.example.com
Session-ID: ab30317f1a784dc48ff824d0d3715d86
 ;remote=00000000000000000000000000000000
CSeq: 314159 INVITE
Contact: <sip:alice@pc33.atlanta.example.com>
Content-Type: application/sdp
Content-Length: 142

(Alice's SDP not shown)
```

F2 INVITE B2BUA -> Bob

```
INVITE sip:bob@192.168.10.20 SIP/2.0
Via: SIP/2.0/UDP server10.biloxi.example.com
 ;branch=z9hG4bK4b43c2ff8.1
Via: SIP/2.0/UDP pc33.atlanta.example.com
 ;branch=z9hG4bK776asdhds;received=10.1.3.33
Max-Forwards: 69
To: Bob <sip:bob@biloxi.example.com>
From: Alice <sip:alice@atlanta.example.com>;tag=1928301774
Call-ID: a84b4c76e66710@pc33.atlanta.example.com
Session-ID: ab30317f1a784dc48ff824d0d3715d86
 ;remote=00000000000000000000000000000000
CSeq: 314159 INVITE
Contact: <sip:alice@pc33.atlanta.example.com>
Record-Route: <sip:server10.biloxi.example.com;lr>
Content-Type: application/sdp
Content-Length: 142

(Alice's SDP not shown)
```

F3 200 OK Bob -> B2BUA

```
SIP/2.0 200 OK
Via: SIP/2.0/UDP server10.biloxi.example.com
 ;branch=z9hG4bK4b43c2ff8.1;received=192.168.10.1
Via: SIP/2.0/UDP pc33.atlanta.example.com
```

```
    ;branch=z9hG4bK776asdhds;received=10.1.3.33
   To: Bob <sip:bob@biloxi.example.com>;tag=a6c85cf
```

```
From: Alice <sip:alice@atlanta.example.com>;tag=1928301774
Call-ID: a84b4c76e66710@pc33.atlanta.example.com
Session-ID: 47755a9de7794ba387653f2099600ef2
 ;remote=ab30317f1a784dc48ff824d0d3715d86
CSeq: 314159 INVITE
Contact: <sip:bob@192.168.10.20>
Record-Route: <sip:server10.biloxi.example.com;lr>
Content-Type: application/sdp
Content-Length: 131

(Bob's SDP not shown)
```

F4 200 OK B2BUA -> Alice

```
SIP/2.0 200 OK
Via: SIP/2.0/UDP pc33.atlanta.example.com
 ;branch=z9hG4bK776asdhds;received=10.1.3.33
To: Bob <sip:bob@biloxi.example.com>;tag=a6c85cf
From: Alice <sip:alice@atlanta.example.com>;tag=1928301774
Call-ID: a84b4c76e66710@pc33.atlanta.example.com
Session-ID: 47755a9de7794ba387653f2099600ef2
 ;remote=ab30317f1a784dc48ff824d0d3715d86
CSeq: 314159 INVITE
Contact: <sip:bob@192.168.10.20>
Record-Route: <sip:server10.biloxi.example.com;lr>
Content-Type: application/sdp
Content-Length: 131

(Bob's SDP not shown)
```

F5 ACK Alice -> B2BUA

```
ACK sip:bob@192.168.10.20 SIP/2.0
Via: SIP/2.0/UDP pc33.atlanta.example.com
 ;branch=z9hG4bKnashds8
Route: <sip:server10.biloxi.example.com;lr>
Max-Forwards: 70
To: Bob <sip:bob@biloxi.example.com>;tag=a6c85cf
From: Alice <sip:alice@atlanta.example.com>;tag=1928301774
Call-ID: a84b4c76e66710@pc33.atlanta.example.com
Session-ID: ab30317f1a784dc48ff824d0d3715d86
```

```
    ;remote=47755a9de7794ba387653f2099600ef2
   CSeq: 314159 ACK
```

```
Content-Length: 0
```

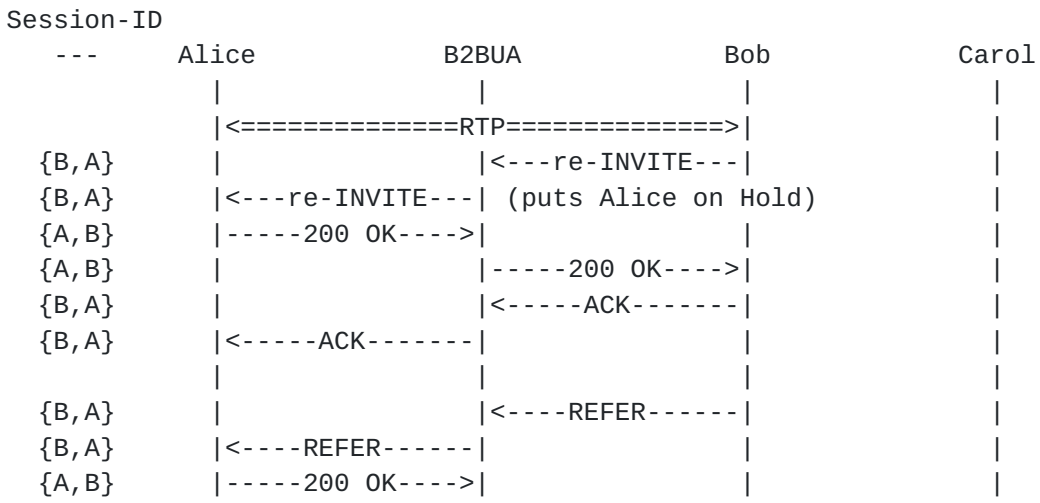
F6 ACK B2BUA -> Bob

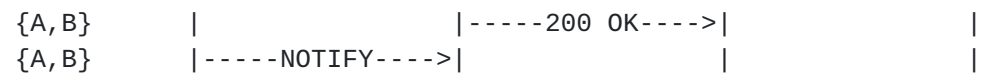
```
ACK sip:bob@192.168.10.20 SIP/2.0
Via: SIP/2.0/UDP server10.biloxi.example.com
 ;branch=z9hG4bK4b43c2ff8.2
Via: SIP/2.0/UDP pc33.atlanta.example.com
 ;branch=z9hG4bKnashds8;received=10.1.3.33
Max-Forwards: 70
To: Bob <sip:bob@biloxi.example.com>;tag=a6c85cf
From: Alice <sip:alice@atlanta.example.com>;tag=1928301774
Call-ID: a84b4c76e66710@pc33.atlanta.example.com
Session-ID: ab30317f1a784dc48ff824d0d3715d86
 ;remote=47755a9de7794ba387653f2099600ef2
CSeq: 314159 ACK
Content-Length: 0
```

The remaining examples in this Section do not display the complete SIP message exchange. Instead, they simply use the set notation described in Section 4.2 to show the Session Identifier exchange throughout the particular call flow being illustrated.

9.2. Basic Call Transfer using REFER

From the example built within Section 9.1, we proceed to this 'Basic Call Transfer using REFER' example. Note that this is a mid-dialog REFER in contrast with the out-of-dialog REFER in Section 9.9.




{A,B}
{A,B}
-----200 OK---->
-----NOTIFY---->
{A,B}
{A,B}

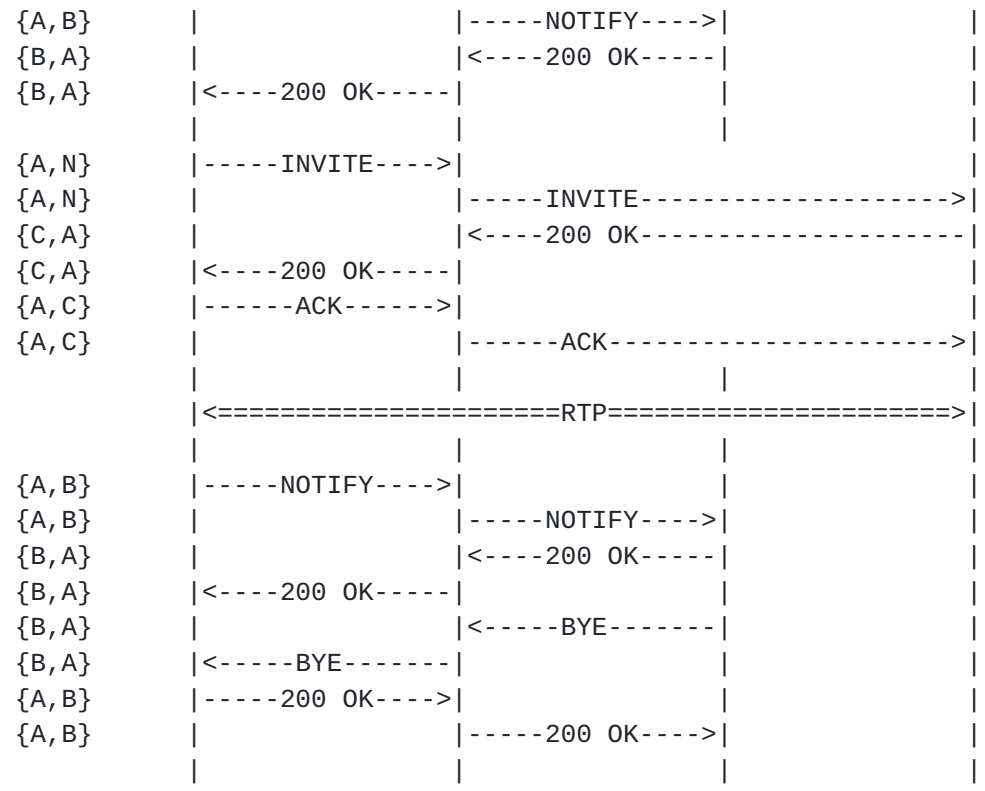


Figure 2 - Call Transfer using REFER

General operation of this example:

Starting from the existing Alice/Bob call described in Figure 1 of this document, which established an existing Session-ID header field value:

- UA-Bob requests Alice to call Carol, using a REFER transaction, as described in [RFC3515]. UA-Alice is initially put on hold, then told in the REFER who to contact with a new INVITE, in this case UA-Carol. This Alice-to-Carol dialog will have a new Call-ID, therefore it requires a new Session-ID header field value. The wrinkle here is we can, and will, use Alice's UUID from her existing dialog with Bob in the new INVITE to Carol.

- UA-Alice retains her UUID from the Alice-to-Bob call {A} when requesting a call with UA-Carol. This is placed in the "local-uuid" portion of the Session-ID header field value, at the same time inserting a null "remote-uuid" value (because Carol's UA has not yet received the UUID value). This same UUID traverses the B2BUA unchanged.

- UA-Carol receives the INVITE with a Session Identifier UUID {A,N}, replaces the A UUID value into the "remote-uuid" portion

of the Session-ID header field value and creates its own UUID {C} and places this value in the "local-uuid" portion of the Session-ID header field value, thereby removing the N (null)

value altogether. This combination forms a full Session Identifier {C,A} in the 200 OK to the INVITE. This Session-ID header field traverses the B2BUA unchanged towards UA-Alice.

- o UA-Alice receives the 200 OK with the Session Identifier {C,A} and responds to UA-Carol with an ACK (just as in Figure 1 - switches places of the two UUID fields), and generates a NOTIFY to Bob with a Session Identifier {A,B} indicating the call transfer was successful.

- o It does not matter which UA terminates the Alice-to-Bob call; Figure 2 shows UA-Bob doing this transaction.

9.3. Basic Call Transfer using re-INVITE

From the example built within Section 9.1, we proceed to this 'Basic Call Transfer using re-INVITE' example.

Alice is talking to Bob. Bob pushes a button on his phone to transfer Alice to Carol via the B2BUA (using re-INVITE).

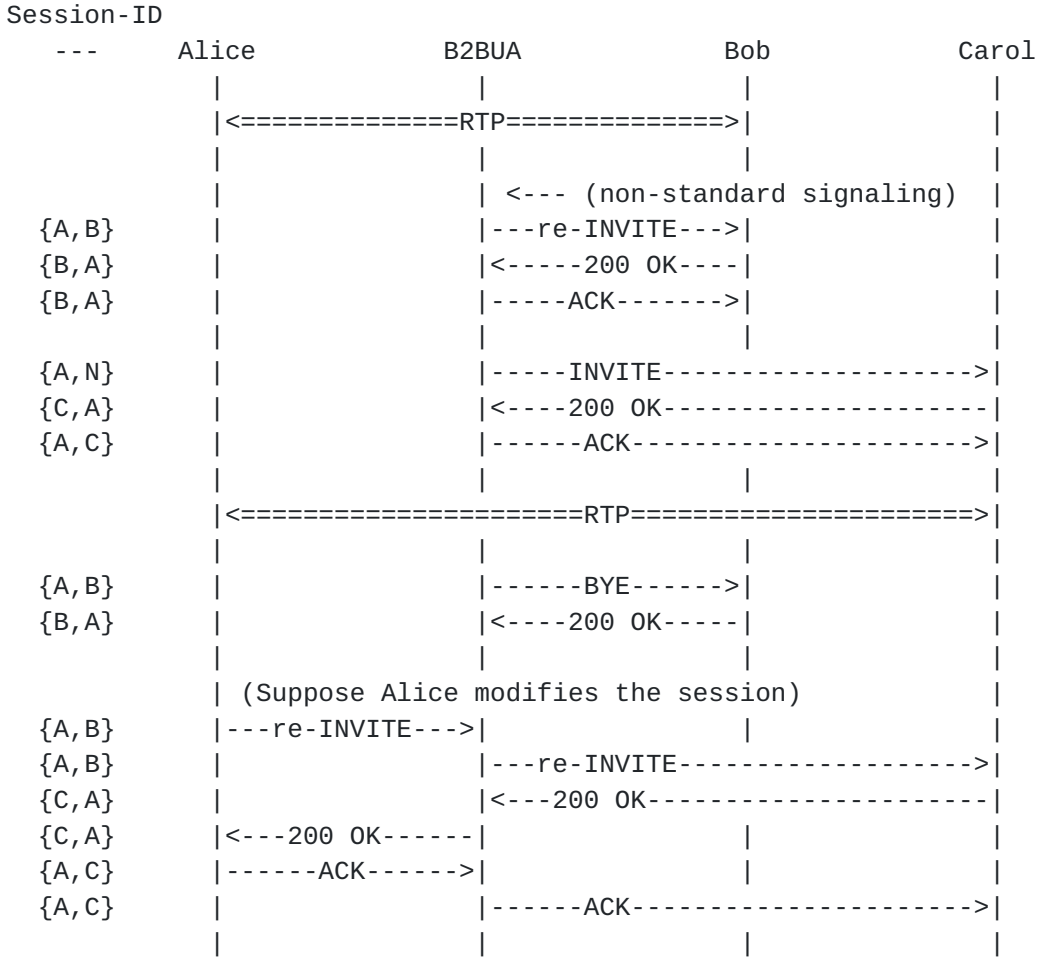


Figure 3 - Call transfer using re-INVITE

General operation of this example:

- We assume the call between Alice and Bob from Section 9.1 is operational with Session Identifier {A,B}.
- Bob uses non-standard signaling to the B2BUA to initiate a call transfer from Alice to Carol. This could also be initiated via a REFER message from Bob, but the signaling that follows might still be similar to the above flow. In either case, Alice is completely unaware of the call transfer until a future point in time when Alice receives a message from Carol.
- The B2BUA sends a new INVITE with Alice's UUID {"local-uuid" = "A"} to Carol.
- Carol receives the INVITE and accepts the request and adds her UUID {C} to the Session Identifier for this session {"local-uuid" = "C", "remote-uuid" = "A"}.
- The B2BUA then terminates the call to Bob with a BYE using the Session Identifier {"local-uuid" = "A", "remote-uuid" = "B"}.
- Since Alice never received Carol's UUID from the B2BUA, when Alice later attempts to modify the session with a re-INVITE, Alice would send the "remote-uuid" = "B" toward Carol. Carol replies with the "local-uuid" = "A", "remote-uuid" = "A" to reflect what was received in the INVITE (which Carol already knew from previous exchanges with the B2BUA). Alice then includes "remote-uuid" = "C" in the following ACK message.

9.4. Single Focus Conferencing

Multiple users call into a conference server (say, an MCU) to attend one of many conferences hosted on or managed by that server. Each user has to identify which conference they want to join, but this information is not necessarily in the SIP messaging. It might be done by having a dedicated address for the conference or via an IVR, as assumed in this example and depicted with the use of M1, M2, and M3. Each user in this example goes through a two-step process of signaling to gain entry onto their conference call, which the conference focus identifies as M'.

```
                  |<====RTP=======>|                |               |
         {M',A}   |<---re-INVITE---|                |               |
```

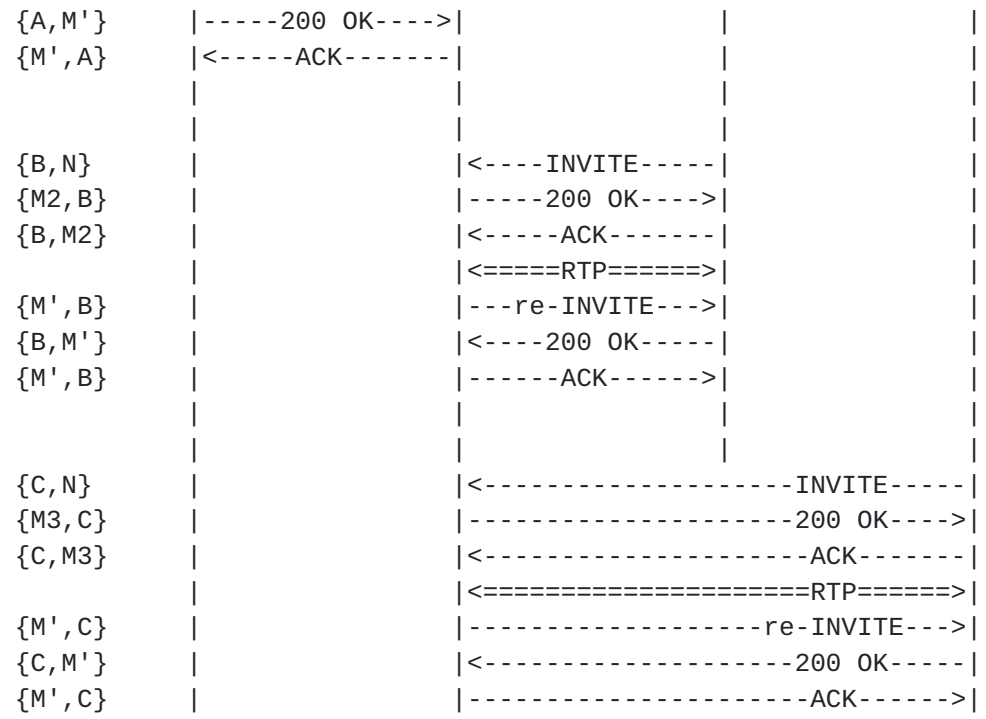


Figure 4 - Single Focus Conference Bridge

General operation of this example:

Alice calls into a conference server to attend a certain conference. This is a two-step operation since Alice cannot include the conference ID at this time and/or any passcode in the INVITE request. The first step is Alice's UA calling another UA to participate in a session. This will appear to be similar as the call-flow in Figure 1 (in section 9.1). What is unique about this call is the second step: the conference server sends a re-INVITE request with its second UUID, but maintaining the UUID Alice sent in the first INVITE. This subsequent UUID from the conference server will be the same for each UA that calls into this conference server participating in this same conference bridge/call, which is generated once Alice typically authenticates and identifies which bridge she wants to participate on.

- o Alice sends an INVITE to the conference server with her UUID {A} and a "remote-uuid" = N.

- o The conference server responds with a 200 OK response which replaces the N UUID with a temporary UUID ("M1") as the "local-uuid" and a "remote-uuid" = "A".

NOTE: this 'temporary' UUID is a real UUID; it is only temporary to the conference server because it knows that it is going to

generate another UUID to replace the one just send in the 200 OK.

- Once Alice, the user, gains access to the IVR for this conference server, she enters a specific conference ID and whatever passcode (if needed) to enter a specific conference call.

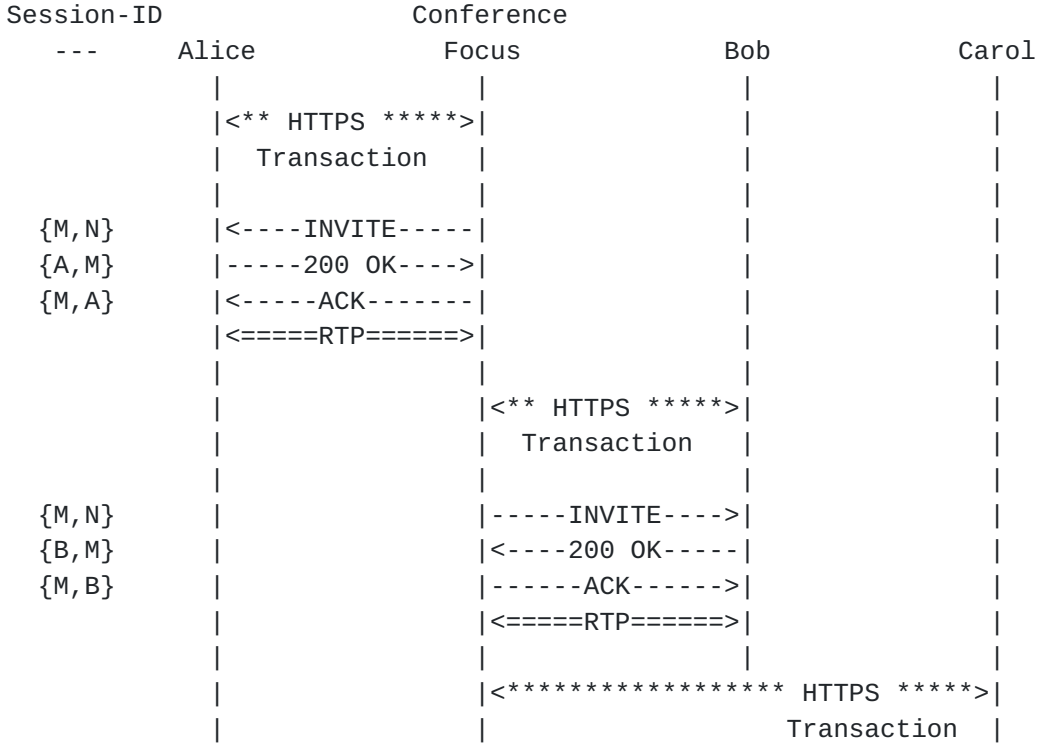
- Once the conference server is satisfied Alice has identified which conference she wants to attend (including any passcode verification), the conference server re-INVITEs Alice to the specific conference and includes the Session-ID header field value component "local-uuid" = "M'" (and "remote-uuid" = "A") for that conference. All valid participants in the same conference will receive this same UUID for identification purposes and to better enable monitoring, and tracking functions.

- Bob goes through this two-step process of an INVITE transaction, followed by a re-INVITE transaction to get this same UUID ("M'") for that conference.

- In this example, Carol (and each additional user) goes through the same procedures and steps as Alice and Bob to get on this same conference.

9.5. Single Focus Conferencing using WebEx

Alice, Bob and Carol call into same WebEx conference.




{M,N}
{C,M}
INVITE
200 OK

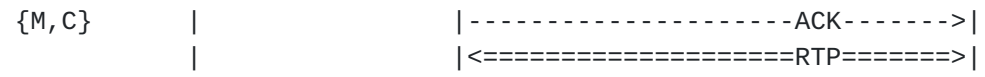


Figure 5 - Single Focus WebEx Conference

General operation of this example:

- Alice communicates with WebEx server with desire to join a certain meeting, by meeting number; also includes UA-Alice's contact information (phone number, URI and/or IP address, etc.) for each device she wants for this conference call. For example, the audio and video play-out devices could be separate units.

- Conference Focus server sends INVITE (Session-ID header field value components "local-uuid" = M and a remote UUID of N, where M equals the "local-uuid" for each participant on this conference bridge) to UA-Alice to start session with that server for this A/V conference call.

- Upon receiving the INVITE request from the conference focus server, Alice responds with a 200 OK. Her UA moves the "local-uuid" unchanged into the "remote-uuid" field, and generates her own UUID and places that into the "local-uuid" field to complete the Session-ID construction.

- Bob and Carol perform same function to join this same A/V conference call as Alice.

9.6. Cascading Conference Bridges

9.6.1. Establishing a Cascaded Conference

To expand conferencing capabilities requires cascading conference bridges. A conference bridge, or MCU, needs a way to identify itself when contacting another MCU. RFC 4579 [RFC4579] defines the 'isfocus' Contact: header parameter just for this purpose.

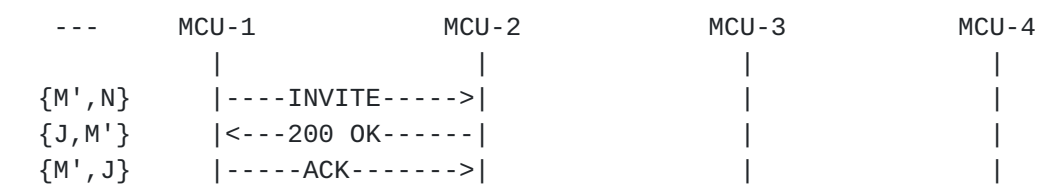


Figure 6 - MCUs Communicating Session Identifier UUID for Bridge

Regardless of which MCU (1 or 2) a UA contacts for this conference, once the above exchange has been received and acknowledged, the UA

will get the same {M',N} UUID pair from the MCU for the complete Session Identifier.

A more complex form would be a series of MCUs all being informed of the same UUID to use for a specific conference. This series of MCUs can either be informed

- All by one MCU (that initially generates the UUID for the conference).
- The MCU that generates the UUID informs one or several MCUs of this common UUID, and they inform downstream MCUs of this common UUID that each will be using for this one conference.

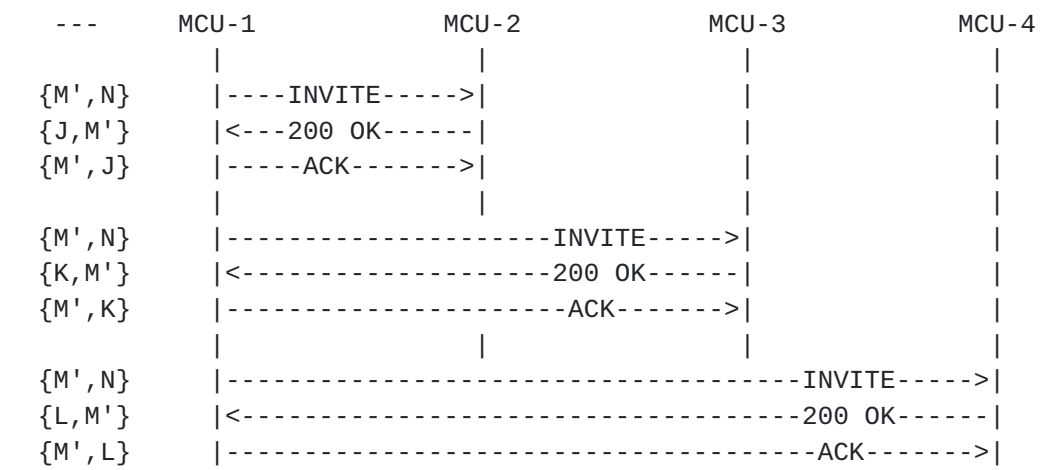


Figure 7 - MCU Communicating Session Identifier UUID to More than One MCU

General operation of this example:

- The MCU generating the Session Identifier UUID communicates this in a separate INVITE, having a Contact header with the 'isfocus' header parameter. This will identify the MCU as what RFC 4579 calls a conference-aware SIP entity.
- An MCU that receives this {M',N} UUID pair in an inter-MCU transaction can communicate the M' UUID in a manner in which it was received to construct a hierarchical cascade (though this time this second MCU would be the UAC MCU).
- Once the conference is terminated, the cascaded MCUs will receive a BYE message to terminate the cascade.

9.6.2. Calling into Cascaded Conference Bridges

Here is an example of how a UA, say Robert, calls into a cascaded conference focus. Because MCU-1 has already contacted MCU-3, the MCU where Robert is going to join the conference, MCU-3 already has the

Session-ID (M') for this particular conference call.

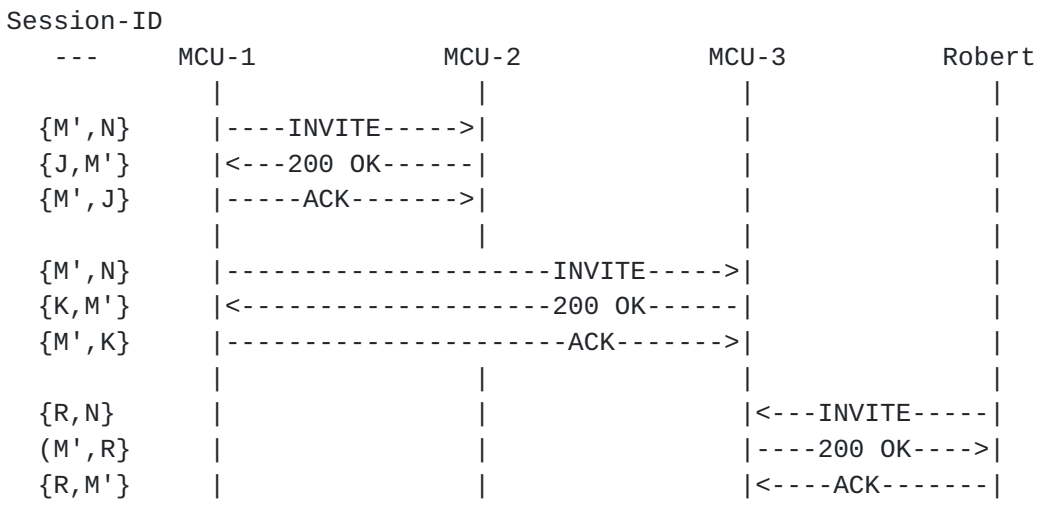


Figure 8 - A UA Calling into a Cascaded MCU UUID

General operation of this example:

- The UA, Robert in this case, INVITEs the MCU to join a particular conference call. Robert's UA does not know anything about whether this is the main MCU of the conference call, or a cascaded MCU. Robert likely does not know MCUs can be cascaded, he just wants to join a particular call. Like as with any standard implementation, he includes a null "remote-uuid".

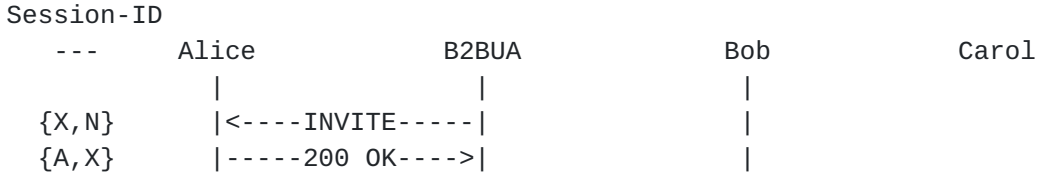
- The cascaded MCU, upon receiving this INVITE from Robert, replaces the null UUID with the UUID value communicated from MCU-1 for this conference call as the "local-uuid" in the SIP response. Thus, moving Robert's UUID "R" to the "remote-uuid" value.

- The ACK has the Session-ID {R,M'}, completing the 3-way handshake for this call establishment. Robert has now joined the conference call originated from MCU-1.

- Once the conference is terminated, the cascaded MCUs will receive a BYE message to terminate the cascade.

9.7. Basic 3PCC for two UAs

External entity sets up call to both Alice and Bob for them to talk to each other.




{A,N}
{B,A}
|----INVITE----->|
|<---200 OK------|

Figure 9 - 3PCC initiated call between Alice and Bob

General operation of this example:

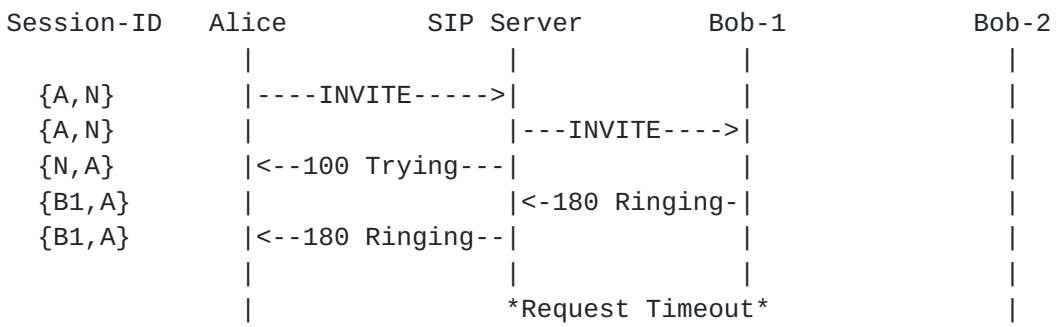
- Some out of band procedure directs a B2BUA (or other SIP server) to have Alice and Bob talk to each other. In this case, the SIP server has to be transaction stateful, if not dialog stateful.
- The SIP server INVITEs Alice to a session and uses a temporary UUID {X} and a null UUID pairing.
- Alice receives and accepts this call set-up and replaces the null UUID with her UUID {A} in the Session Identifier, now {A,X}.
- The transaction stateful SIP server receives Alice's UUID {A} in the local UUID portion and keeps it there, and discards its own UUID {X}, replacing this with a null UUID value in the INVITE to Bob as if this came from Alice originally.
- Bob receives and accepts this INVITE and adds his own UUID {B} to the Session Identifier, now {B,A} for the response.
- And the session is established.

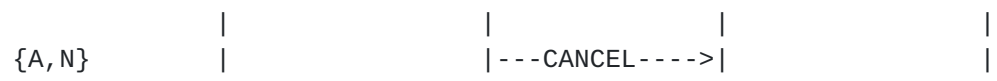
9.8. Handling in 100 Trying SIP Response and CANCEL Request

The following two subsections show examples of the Session Identifier for a 100 Trying response and a CANCEL request in a single call-flow.

9.8.1. Handling in a 100 Trying SIP Response

The following 100 Trying response is taken from an existing RFC, from [RFC5359] Section 2.9 ("Call Forwarding - No Answer").




{A,N}
---CANCEL---->

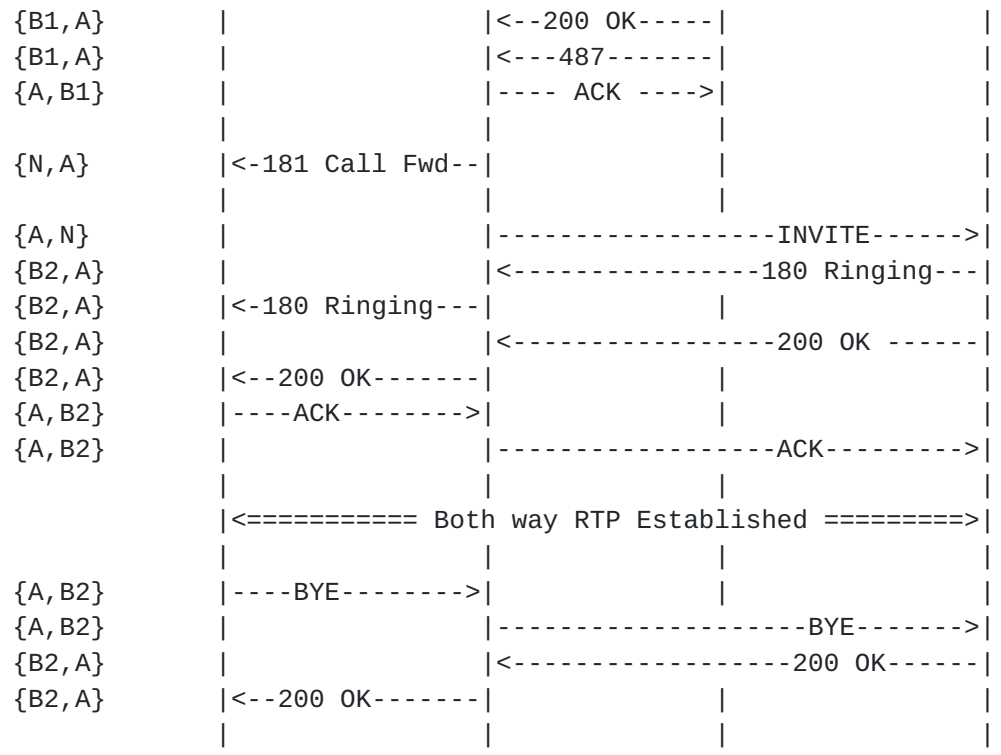


Figure 10 - Session Identifier in the 100 Trying and CANCEL Messaging

Below is the explanatory text from RFC 5359 Section 2.9 detailing what the desired behavior is in the above call flow (i.e., what the call-flow is attempting to achieve).

> "Bob wants calls to B1 forwarded to B2 if B1 is not answered (information is known to the SIP server). Alice calls B1 and no one answers. The SIP server then places the call to B2."

General operation of this example:

- Alice generates an INVITE request because she wants to invite Bob to join her session. She creates a UUID as described in section 9.1, and places that value in the "local-uuid" field of the Session-ID header field value. Alice also generates a "remote-uuid" of null and sends this along with the "local-uuid".

- The SIP server (imagine this is a B2BUA), upon receiving Alice's INVITE, generates the optional provisional response 100 Trying. Since the SIP server has no knowledge Bob's UUID for his part of the Session Identifier value, it cannot include his "local-uuid". Rather, any 100 Trying response includes Alice's UUID in the "remote-uuid" portion of the Session-ID header-value with a null "local-uuid" value in the response. This is

consistent with what Alice's UA expects to receive in any SIP response containing this UUID.

9.8.2. Handling a CANCEL SIP Request

In the same call-flow example as the 100 Trying response is a CANCEL request. Please refer to Figure 10 for the CANCEL request example.

General operation of this example:

- In Figure 10 above, Alice generates an INVITE with her UUID value in the Session-ID header field.
- Bob-1 responds to this INVITE with a 180 Ringing. In that response, he includes his UUID in the Session-ID header field value (i.e., {B1,A}); thus completing the Session-ID header field for this session, even though no final response has been generated by any of Bob's UAs.
- While this means that if the SIP server were to generate a SIP request within this session it could include the complete SessionID, the server sends a CANCEL and a CANCEL always uses the same Session-ID header field as the original INVITE. Thus, the CANCEL would have a Session Identifier with the "local-uuid" = "A", and the "remote-uuid" = "N".
- As it happens with this CANCEL, the SIP server intends to invite another UA of Bob (i.e., B2) for Alice to communicate with.
- In this example call-flow, taken from RFC 5359, Section 2.9, a 181 (Call is being Forwarded) response is sent to Alice. Since the SIP server generated this SIP request, and has no knowledge of Bob-2's UUID value, it cannot include that value in this 181. Thus, and for the exact reasons the 100 Trying including the Session Identifier value, only Alice's UUID is included in the remote-uuid component of the Session-ID header field value, with a null UUID present in the "local-uuid" component.

9.9. Out-of-dialog REFER Transaction

The following call-flow was extracted from Section 6.1 of [RFC5589] ("Successful Transfer"), with the only changes being the names of the UAs to maintain consistency within this document.

```
      Alice is the transferee
      Bob is the transferer
      and Carol is the transfer-target

  Session-ID     Bob                Alice                Carol
                  |                   |                   |
     {A,N}        |<-----INVITE-------|                   |
```


{B,A} |------200 OK------->| |
{A,B} |<------ACK----------| |

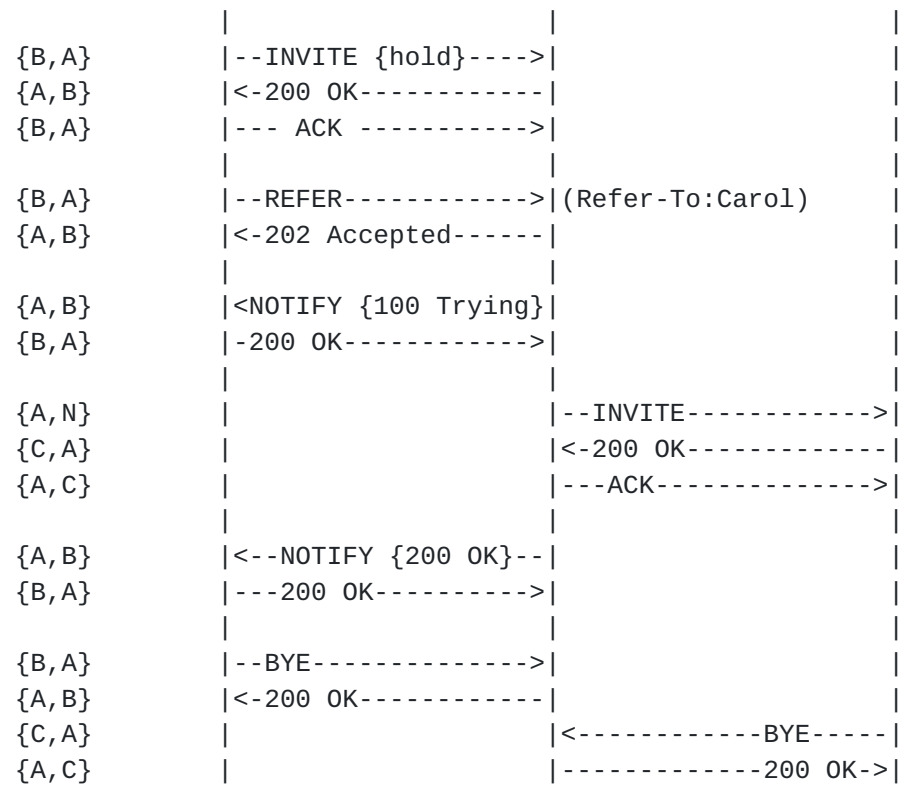


Figure 11: Out-Of-Dialog Call Transfer

General operation of this example:

- Just as in Section 9.2, Figure 2, Alice invites Bob to a session, and Bob eventually transfers Alice to communicate with Carol.

- What is different about the call-flow in Figure 11 is that Bob's REFER is not in-dialog. Even so, this is treated as part of the same communication session and, thus, the Session Identifier in those messages is {A,B}.

- Alice will use her existing UUID and the null UUID ({A,N}) in the INVITE towards Carol (who generates UUID "C" for this session), thus maintaining the common UUID within the Session Identifier for this new Alice-to-Carol session.

10. Compatibility with a Previous Implementation

There is a much earlier and proprietary document that specifies the use of a Session-ID header field (namely, [RFC7329]) that we will herewith attempt to achieve backwards compatibility. Neither Session-ID header field has any versioning information, so merely adding that this document describes "version 2" is insufficient.

Here are the set of rules for compatibility between the two specifications. For the purposes of this discussion, we will label

the proprietary specification of the Session-ID as the "old" version and this specification as the "new" version of the Session-ID.

The previous (i.e., "old") version only has a single UUID value as a Session-ID header field value, but has a generic-parameter value that can be of use.

In order to have an "old" version talk to an "old" version implementation, nothing needs to be done as far as the IETF is concerned.

In order to have a "new" version talk to a "new" version implementation, both implementations need to follow this document (to the letter) and everything should be just fine.

But that is where compatibility is not ensured, given the unknowns related to the behavior of entities implementing the pre-standard implementation. For this "new" implementation to work with the "old" implementation and an "old" implementation to work with "new" implementations, there needs to be a set of rules that all "new" implementations MUST follow.

- Since no option tags or feature tags are to be used for distinguishing versions, the presence and order of any "remote-uuid" value within the Session-ID header field value is to be used to distinguish implementation versions.

- If a SIP request has a "remote-uuid" value, this comes from a standard implementation, and not a pre-standard one.

- If a SIP request has no "remote-uuid" value, this comes from a pre-standard implementation, and not a standard one. In this case, one UUID is used to identify this dialog, even if the responder is a standard implementation of this specification.

- If a SIP response has a non-null "local-uuid" that is 32 octets long and differs from the endpoint's own UUID value, this response comes from a standard implementation.

- If a SIP response has a non-null "local-uuid" that is not 32 octets long, this response comes from a misbehaving implementation, and its Session-ID header field MUST be discarded. That said, the response might still be valid according to the rules within SIP [RFC3261], and SHOULD be checked further.

- If a SIP response arrives that has the same value of Session-ID UUIDs in the same order as was sent, this comes from a pre-standard implementation, and MUST NOT be discarded for not altering the null "remote-uuid". In this case, any new transaction within this

dialog MUST preserve the order of the two UUIDs within all Session-

ID header field, including the ACK, until this dialog is terminated.

- If a SIP response only contains the "local-uuid" that was sent originally, this comes from a pre-standard implementation and MUST NOT be discarded for removing the null "remote-uuid". In this case, all future transactions within this dialog MUST contain only the UUID received in the first SIP response. Any new transaction starting a new dialog from the standard Session-ID implementation MUST include a "local-uuid" and a null "remote-uuid", even if that new dialog is between the same two UAs.

- Standard implementations SHOULD NOT expect pre-standard implementations to be consistent in their implementation, even within the same dialog. For example, perhaps the first, third and tenth responses contain a "remote-uuid", but all the others do not. This behavior MUST be allowed by implementations of this specification.

- The foregoing does not apply to other, presently unknown parameters that might be defined in the future. They are ignored for the purposes of interoperability with previous implementations.

11. Security Considerations

When creating a UUID value, UAs MUST ensure that there is no user or device-identifying information contained within the UUID. In particular, this means that a UUID MUST NOT be constructed using a MAC address on the host.

The Session Identifier might be utilized for logging or troubleshooting, but MUST NOT be used for billing purposes.

The Session Identifier could be misused to discover relationships between two or more parties. For example, suppose that Alice calls Bob and Bob, via his PBX, forwards or transfers the call to Carol. Without use of the Session Identifier, an unauthorized third party that is observing the communications between Alice and Bob might not know that Alice is actually communicating with Carol. If Alice, Bob, and Carol include the Session Identifier as a part of the signaling messages, it is possible for the third party to observe that the UA associated with Bob changed to some other UA. If the third party also has access to signaling messages between Bob and Carol, the third party can then discover that Alice is communicating with Carol. This would be true even if all other information relating to the session is changed by the PBX, including both signaling information and media address information.

12. IANA Considerations

12.1. Registration of the "Session-ID" Header Field

The following is the registration for the 'Session-ID' header field to the "Header Name" registry at http://www.iana.org/assignments/sip-parameters:

RFC number: RFC XXXX

Header name: 'Session-ID'

Compact form: none

Note: This document replaces the "Session-ID" header originally registered via [RFC7329].

[RFC Editor: Please replace XXXX in this section and the next with the this RFC number of this document.]

12.2. Registration of the "remote" Parameter

The following parameter is to be added to the "Header Field Parameters and Parameter Values" section of the SIP parameter registry:

Header Field	Parameter Name	Predefined Values	Reference
Session-ID	remote	No	[RFCXXXX]

13. Acknowledgments

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14. Dedication

This document is dedicated to the memory of James Polk, a long-time friend and colleague. James made important contributions to this specification, including being one of its primary editors. The IETF global community mourns his loss and he will be missed dearly.

15. References

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Authors' Addresses

Paul E. Jones
Cisco Systems, Inc.
7025 Kit Creek Rd.
Research Triangle Park, NC 27709
USA

Phone: +1 919 476 2048
Email: paulej@packetizer.com
IM: xmpp:paulej@packetizer.com

Gonzalo Salgueiro
Cisco Systems, Inc.
7025 Kit Creek Rd.
Research Triangle Park, NC 27709
USA

Phone: +1 919 392 3266
Email: gsalguei@cisco.com
IM: xmpp:gsalguei@cisco.com

Chris Pearce
Cisco Systems, Inc.
2300 East President George Bush Highway
Richardson, TX 75082
USA

Phone: +1 972 813 5123
Email: chrep@cisco.com
IM: xmpp:chrep@cisco.com