Abstract

This document defines a SIP extension header, References, to be used within SIP messages to signify that the message (and the dialog containing it) is related to one or more other dialogs. It is expected to be used largely for diagnostic purposes.

Status of this Memo

This Internet-Draft is submitted in full conformance with the provisions of BCP 78 and BCP 79.

Internet-Drafts are working documents of the Internet Engineering Task Force (IETF). Note that other groups may also distribute working documents as Internet-Drafts. The list of current Internet-Drafts is at http://datatracker.ietf.org/drafts/current/.

Internet-Drafts are draft documents valid for a maximum of six months and may be updated, replaced, or obsoleted by other documents at any time. It is inappropriate to use Internet-Drafts as reference material or to cite them other than as "work in progress."

This Internet-Draft will expire on October 02, 2012.

Copyright Notice

Copyright (c) 2012 IETF Trust and the persons identified as the document authors. All rights reserved.

This document is subject to BCP 78 and the IETF Trust’s Legal Provisions Relating to IETF Documents (http://trustee.ietf.org/license-info) in effect on the date of publication of this document. Please review these documents carefully, as they describe your rights and restrictions with respect to this document. Code Components extracted from this document must include Simplified BSD License text as described in Section 4.e of the Trust Legal Provisions and are provided without warranty as described in the Simplified BSD License.

Table of Contents

1. Purpose of the References Header .................................. 2
2. Syntax and Semantics .............................................. 3
3. Examples .......................................................... 6
   3.1. B2BUA ....................................................... 6

Worley  Expires October 02, 2012
1. Purpose of the References Header

In many situations, the processing of a SIP "telephone call" involves a number of different SIP dialogs. Of course, the existing SIP headers provide adequate information for the SIP elements to carry out the needed operations. But in many cases, it is difficult for an observer to identify from a network trace the particular SIP dialogs that are involved in one operation.

For example, if a user agent receives a REFER message within one dialog, it sends an INVITE to establish a new dialog which replaces the previous one within the user interface of the user agent. But since the connection between the new dialog and the old dialog is only realized within the user agent, there is no algorithmic way to associate the two dialogs based on the SIP messages alone -- the best available technique is to extract all the messages to/from the particular user agent, and then observe the INVITE that is sent immediately after receipt of the REFER.
The purpose of the References header is to allow a SIP message to specify that the message carrying it (and by extension, the dialog that contains the message) is related to one or more other dialogs, specified by their Call-Id values. Ideally, when given a Call-Id, an automated process can use the connections between dialogs specified in References headers to determine the entire set of dialogs that are needed to understand a complete "telephone call" or other SIP interaction.

2. Syntax and Semantics

The syntax of the References header is as follows. (All rules not defined here are taken from section 25.1 of RFC 3261[sip].)

```plaintext
message-header  = References
References = "References" HCOLON reference *(COMMA reference)
reference = callid *( SEMI reference-param )
reference-param = rel-param / generic-param
rel-param = "rel" EQUAL rel-value
rel-value = "chain" / "inquiry" / "mixed" / "record"
            / "refer" / "service" / "sequel" / "xfer"
            / "-chain" / "-inquiry" / "-mixed" / "-record"
            / "-refer" / "-service" / "-sequel" / "-xfer"
            / gen-value
```

Multiple References headers may appear in a SIP message, and their values may be combined or separated as allowed by section 7.3 of RFC 3261[sip]. The ordering of References values is not significant.

The call-id values of the Replaces and Join headers are considered implicit References values and so SHOULD NOT be specified in References headers.

Similarly to the grammar for the Call-ID header, no escaping is defined for the call-id value in the References header.

The presence of a References header in a SIP message means that the message (and by implication, the dialog containing it) is related to the dialog(s) bearing the specified Call-Id(s). Note that since there is no way to specify the to-tag and from-tag of the referenced dialog, the References header does not distinguish different dialogs that have the same Call-Id, and all dialogs sharing a Call-Id are considered to be related a priori. The processor of References headers should consider the "related" relationship of dialogs to include the symmetric-transitive closure of the References relationship; that is, if a message in dialog A references dialog B, and a message in dialog B references dialog C, then all three dialogs should be considered related to each other.
The nature of the relationship between the message’s dialog and the referenced dialog(s) is indicated by the "rel" parameter (if it is present). That is, the dialog containing the message containing the References header is related to the dialog with the specified Call-Id in the manner specified by the "rel" parameter value, as described below.

Since the message containing the References header is likely to be constrained to be generated after the creation of the dialog mentioned by the header, and the UA may not have control over this time-ordering, each relationship nature defined below implicitly defines a reverse relationship, whose "rel" parameter value is prefixed with "-", in which the roles of the dialog containing the message containing the References header and the dialog specified by the callid value in the References header are reversed. E.g., a request with Call-Id A that performs an inquiry to assist in routing dialog B may contain

References: B;rel=inquiry

but the same meaning can be indicated by a message in dialog B containing

References: A;rel=-inquiry

The currently defined values of the "rel" parameter are:

"chain" meaning that this request is the logical continuation of the dialog with the specified Call-Id through a B2BUA or the like, in that it will carry media that have the same meaning to the user ("continuation of the dialog across space")

"inquiry" meaning that this request was generated to obtain information needed to properly process a request with the specified Call-Id. (For example, in section 2.16, "Call Pickup" of [service-examples], a SUBSCRIBE is generated to discover the UA which sent an INVITE to a designated AOR.)

"mixed" - indicates that this dialog and the dialog with the specified Call-Id are legs of a conference, videoconference, or the like, where the media outgoing on each dialog is expected to partially duplicate the media incoming on the other dialog, along with media incoming on other dialogs

"join" - this value is permanently reserved so that it may be used as a value of cognate data items when describing dialogs related by a "Join" header

"record" - indicates that this dialog carries a copy of the media of the dialog with the specified Call-Id

"refer" - this request was generated due to a REFER with the specified Call-Id
"replaces" - this value is permanently reserved so that it may be used as a value of cognate data items when describing dialogs related by a "Replaces" header

"service" means that this dialog is to obtain "service media" for use by the dialog with the specified Call-Id. "Service media" includes music-on-hold, alert tones, and the like.

"sequel" means that this dialog is the continuation of the conversation carried by the dialog with the specified Call-Id ("continuation of the dialog across time")

"xfer" meaning that the dialog of this message and the dialog with the specified Call-Id are the two legs of a consultative (or attended) transfer. One endpoint of each dialog will become an endpoint of the final dialog (which does not yet exist).

These values are case-sensitive (although the parameter name, "rel", is not).

The processor of the References header MUST remove any quoting from the "rel" parameter value before processing it. As shown in the ABNF, the quoting which may be applied to rel-value is the same as what may be applied to a gen-value, specifically, if it is surrounded by double-quotes, then any character may be quoted with a backslash. Thus the following are all equivalent:

References: 12345600@atlanta.example.com;rel=xfer

References: 12345600@atlanta.example.com;rel="xfer"

References: 12345600@atlanta.example.com;rel="\x\f\e\r"

It is expected that the References header will usually appear in the dialog-forming request of a dialog, but it may appear in any request or response. Since 1xx responses are not delivered reliably, a References header value that is present only in a 1xx response may not be seen by an element that ought in principle to see the response, and such a value SHOULD be present in another message of the dialog going to that element.

The semantics of some "rel" values (e.g., "chain" and "xfer") are inherently symmetric; in these cases the "reverse" value, prefixed with "-" is still valid, and the processor of the References header SHOULD treat the base relationship and the reverse relationship identically.

All parameters and parameter values that are not understood by the processor of the References header MUST be ignored.

Note that while the SIP References header is similar in function to
the Internet e-mail References header [message-format], they have different syntaxes and are not interchangeable.

3. Examples

3.1. B2BUA

One use of References is to connect the two "sides" of a single logical dialog that passes through a B2BUA (which might not have the same Call-Id).

```
Alice                B2BUA                 Bob
<p>| | |
|                    |                    |</p>
<table>
<thead>
<tr>
<th>INVITE F1</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>INVITE F2</td>
</tr>
<tr>
<td>-------------------</td>
<td>-------------------</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
F1 INVITE Alice -> B2BUA, en route to Bob

INVITE sips:bob@chicago.example.com SIP/2.0
Via: SIP/2.0/TLS client.atlanta.example.com:5061
 ;branch=z9hG4bKnash3c6h
Max-Forwards: 70
From: Alice <sips:alice@atlanta.example.com>;tag=867AB09
To: Bob <sips:bob@biloxi.example.com>
Call-ID: 2851866@atlanta.example.com
CSeq: 1 INVITE
Contact: <sips:alice@client.atlanta.example.com>
Allow: INVITE, ACK, CANCEL, OPTIONS, BYE, REFER, NOTIFY
Content-Type: application/sdp
Content-Length: ...

[SDP omitted]

F2 INVITE B2BUA -> Bob

INVITE sips:bob@chicago.example.com SIP/2.0
References: 2851866@atlanta.example.com;rel=chain
Via: SIP/2.0/TCP b2bua.example.com
 ;branch=z9hG4bKnqhsocn
Max-Forwards: 70
From: Alice <sips:alice@atlanta.example.com>;tag=7923480
To: Bob <sips:bob@biloxi.example.com>
Call-ID: 92060-25@b2bua.example.com
CSeq: 1 INVITE
Contact: <sips:b2bua.example.com>
Allow: INVITE, ACK, CANCEL, OPTIONS, BYE, REFER, NOTIFY
Content-Type: application/sdp
Content-Length: ...
3.2. REFER

One use of References is to connect a REFER to the INVITE that it causes to be sent. A typical use of REFER is to implement blind transfer. This example is taken from section 2.4, "Transfer - Unattended" of [service-examples].

In order to execute the blind transfer, Alice’s UA sends a REFER to
Bob’s UA:

F5 REFER Alice -> Bob

REFER sips:bob@client.biloxi.example.com SIP/2.0
Via: SIP/2.0/TLS client.biloxi.example.com:5061
;branch=z9hG4bKnashds8
Max-Forwards: 70
From: Alice <sips:alice@atlanta.example.com>;tag=1234567
To: Bob <sips:bob@biloxi.example.com>;tag=314159
Call-ID: 12345601@atlanta.example.com
CSeq: 101 REFER
Refer-To: <sips:carol@chicago.example.com>
Referred-By: <alice@atlanta.example.com>
Contact: <sips:alice@client.atlanta.example.com>
Content-Length: 0

Upon receipt of the REFER, Bob’s UA sends an INVITE to Carol’s UA. In order to make explicit the relationship between the REFER and the INVITE, the INVITE has a References header giving the Call-Id of the REFER:

F11 INVITE Bob -> Carol

INVITE sips:carol@chicago.example.com SIP/2.0
References: 12345601@atlanta.example.com;rel=refer
Via: SIP/2.0/TLS client.biloxi.example.com:5061
;branch=z9hG4bKnashds1
Max-Forwards: 70
From: Bob <sips:bob@biloxi.example.com>;tag=8675309
To: Carol <sips:carol@chicago.example.com>
Call-ID: 7436222@atlanta.example.com
CSeq: 1 INVITE
Contact: <sips:bob@client.biloxi.example.com>
Referred-By: <alice@atlanta.example.com>
Allow: INVITE, ACK, CANCEL, OPTIONS, BYE, REFER, NOTIFY
Supported: replaces
Content-Type: application/sdp
Content-Length: ...

[SDP omitted]

3.3. Attended Transfer

An attended transfer normally involves three different dialogs. If the transfer completes, and the REFER that completes the transfer has a References header, the References header in the REFER and the Replaces header in the resulting INVITE will suffice to connect the three dialogs. However, to provide complete information if the transfer does not complete, the INVITE that establishes the "second leg" of the transfer scenario should have a References header naming the "first leg". This example is taken from section 2.5, "Transfer - Attended" of [service-examples].
<table>
<thead>
<tr>
<th>Alice</th>
<th>Bob</th>
<th>Carol</th>
</tr>
</thead>
<tbody>
<tr>
<td>INVITE F1</td>
<td>180 Ringing F2</td>
<td></td>
</tr>
<tr>
<td>&lt;-&gt;</td>
<td>200 OK F3</td>
<td></td>
</tr>
<tr>
<td>200 OK F3</td>
<td>ACK F4</td>
<td></td>
</tr>
<tr>
<td>RTP</td>
<td>INVITE (hold) F5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>200 OK F6</td>
<td></td>
</tr>
<tr>
<td>ACK F7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No RTP</td>
<td>INVITE F8</td>
<td></td>
</tr>
<tr>
<td></td>
<td>180 Ringing F9</td>
<td></td>
</tr>
<tr>
<td></td>
<td>200 OK F10</td>
<td></td>
</tr>
<tr>
<td></td>
<td>ACK F11</td>
<td></td>
</tr>
<tr>
<td>RTP</td>
<td>INVITE (hold) F12</td>
<td></td>
</tr>
<tr>
<td></td>
<td>200 OK F13</td>
<td></td>
</tr>
<tr>
<td></td>
<td>ACK F14</td>
<td></td>
</tr>
<tr>
<td>REFER Refer-To: C F15</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>202 Accepted F16</td>
<td></td>
</tr>
<tr>
<td></td>
<td>NOTIFY F17</td>
<td></td>
</tr>
<tr>
<td></td>
<td>200 OK F18</td>
<td></td>
</tr>
<tr>
<td></td>
<td>INVITE Replaces: B F19</td>
<td></td>
</tr>
<tr>
<td></td>
<td>200 OK F20</td>
<td></td>
</tr>
<tr>
<td></td>
<td>ACK F21</td>
<td></td>
</tr>
<tr>
<td>RTP</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>BYE F22</td>
<td></td>
</tr>
</tbody>
</table>
The INVITE that establishes the second leg has a References header naming the first leg:

F8 INVITE Bob -> Carol

INVITE sips:carol@chicago.example.com SIP/2.0
References: 12345600@atlanta.example.com;rel=xfer
Via: SIP/2.0/TLS client.biloxi.example.com:5061
 ;branch=z9hG4bKnash
Max-Forwards: 70
From: Bob <sips:bob@biloxi.example.com>;tag=8675309
To: Carol <sips:carol@chicago.example.com>
Call-ID: sdjfdfsdfksdif@biloxi.example.com
CSeq: 42 INVITE
Contact: <sips:bob@client.biloxi.example.com>
Allow: INVITE, ACK, CANCEL, OPTIONS, BYE, REFER, NOTIFY
Supported: replaces
Content-Type: application/sdp
Content-Length: ...

[SDP omitted]

As described in Section 3.2, the INVITE that completes the transfer has a References header giving the dialog of the first leg, within which the REFER was sent. It also has a Replaces header giving the dialog of the second leg, which acts as an implicit References.
F19 INVITE Alice -> Carol

INVITE sips:39itp34klkd@chicago.example.com;gr SIP/2.0
References: 12345600@atlanta.example.com;rel=refer
Via: SIP/2.0/TLS chicago.example.com:5061;
branch=z9hG4bKadfe4ko
To: Carol <sips:39itp34klkd@chicago.example.com>
Max-Forwards: 70
From: Alice <sips:alice@atlanta.example.com>;tag=3461
Call-ID: 9435674543@atlanta.example.com
CSeq: 1 INVITE
Require: replaces
Referred-By: <sips:bob@biloxi.example.com>
Replaces: sdjfdjfskdf@biloxi.example.com
;to-tag=5f35a3;from-tag=8675309
Contact: <sips:alice@client.atlanta.example.com>
Allow: INVITE, ACK, CANCEL, OPTIONS, BYE, REFER, NOTIFY
Supported: replaces
Content-Type: application/sdp
Content-Length: ...

[SDP omitted]

3.4. Call Pickup

The References header can be used during a call pickup operation to connect the SUBSCRIBE that is used to locate the target dialog with the INVITE which is generated to execute the pickup. This example is taken from section 2.16, “Call Pickup” of [service-examples].
Bill’s UA sends a SUBSCRIBE to find the target dialog:
F3 SUBSCRIBE  Bill -> Bob

SUBSCRIBE sips:bob@biloxi.example.com SIP/2.0
Via: SIP/2.0/TLS pc.biloxi.example.com:5061
 ;branch=z9hG4bK74bf
Max-Forwards: 70
From: Bill <sips:bill@biloxi.example.com>;tag=8675309
To: Bob <sips:bill@biloxi.example.com>
Call-ID: rt4353gs2egg@pc.biloxi.example.com
CSeq: 1 SUBSCRIBE
Contact: <sips:bill@pc.biloxi.example.com>
Event: dialog
Expires: 0
Accept: application/dialog-info+xml
Content-Length: 0

After locating the target dialog, Bill’s UA generates an INVITE-with-Replaces to execute the pickup. The UA adds the References header to show the connection with the SUBSCRIBE, using the rel-value "-inquiry":

F7 INVITE  Bill -> Alice

INVITE sips:a8342043f@atlanta.example.com;gr SIP/2.0
References: rt4353gs2egg@pc.biloxi.example.com;rel=-inquiry
Via: SIP/2.0/TLS pc.biloxi.example.com:5061
 ;branch=z9hG4bK74HH
Max-Forwards: 70
From: Bill <sips:bill@biloxi.example.com>;tag=8675310
To: Alice <sips:alice@atlanta.example.com>
Call-ID: 563456212@b2.biloxi.example.com
CSeq: 1 INVITE
Require: replaces
Replaces: 12345600@atlanta.example.com
 ;from-tag=314578;to-tag=1234567;early-only
Contact: <sips:bill@pc.biloxi.example.com>
Allow: INVITE, ACK, CANCEL, OPTIONS, BYE, REFER, NOTIFY
Supported: replaces
Content-Type: application/sdp
Content-Length: ...

[SDP omitted]

Note that the executing INVITE F7 does not mention the Call-Id of the original INVITE F1 because it is mentioned in the Replaces header.

If the call pickup operation is done by an agent on behalf of Bill’s UA (as in the sipXecs open-source PBX), the executing INVITE is likely to exist before the SUBSCRIBE is generated. In that case, the SUBSCRIBE will have a References header giving the Call-Id of the INVITE:
F3 SUBSCRIBE  Bill -> Bob

SUBSCRIBE sips:bill@biloxi.example.com SIP/2.0
References: 563456212@b2.biloxi.example.com;rel=inquiry
Via: SIP/2.0/TLS pc.biloxi.example.com:5061
;branch=z9hG4bK74bf
Max-Forwards: 70
From: Bill <sips:bill@biloxi.example.com>;tag=8675309
To: Bob <sips:bill@biloxi.example.com>
Contact: <sips:bill@pc.biloxi.example.com>
Call-ID: rt4353gs2egg@pc.biloxi.example.com
CSeq: 1 SUBSCRIBE
Event: dialog
Expires: 0
Accept: application/dialog-info+xml
Content-Length: 0

4. Practical Experience

The current version of the sipXecs open-source PBX adds a References
header to the SUBSCRIBE of a call pickup as described in section
2.16, "Call Pickup" of [service-examples]. It has caused no observed
interoperability problem.

5. Related Work

This section discusses other Internet-drafts and their relationship
to this work.

5.1. draft-loreto-sipping-dialog-correlation

The Session Initiation Protocol (SIP) Dialog Correlation[loreto-
correlation]

This document defines a new header field for use with SIP. The Same-
Session header field is used to logically correlate an existing SIP
dialog with a new SIP dialog when the media sessions established by
both dialogs can be considered a single logical session. This
mechanism can be used to share the user interface and other resources
between all the media streams from both sessions.

The "Same-Session" header prescribes that the media sessions of two
INVITE dialog usages are to be considered part of the same session
from the users’ points of view. Because of this semantic, it cannot
be used in place of the References header, as References can be used
to express the relationship between two dialogs that are not
connected in any particular way in regard to user interface.
However, it would be possible to define a "parallel" value of the "rel" parameter to have the semantics of "Same-Session". This usage would require that the References header appears in the INVITE establishing the second dialog (and that the two INVITEs are properly time-sequenced, or that both INVITEs have a References header). But this still might be considered a conflation of mechanism that have different semantics.

5.2. draft-kaplan-sip-session-id

A Session Identifier for the Session Initiation Protocol (SIP) [kaplan-session]

There are several reasons for having a globally unique session identifier for the same SIP session, which can be maintained across B2BUA’s and other SIP middle-boxes. This draft proposes a new SIP header to carry such a value: Session-ID.

The semantics of "Session-ID" are close to those of References, and it would be reasonable to define a "rel" value that meant that the referenced Call-Id was "the other side" of a B2BUA connection. (This would require placing a References header in the INVITE request sent from the recipient side of the B2BUA and one in the response to the INVITE send from the originator side.) But since References contains the real Call-Id of a dialog, this use would not have the security properties described in section 5.1 of [kaplan-session].

A possible solution to this problem is for the B2BUA to create a "phantom" Call-Id that is suitably random, and use it in References headers sent in both the initial request and response. By the transitivity property Section 2, the dialogs on both sides of the B2BUA are declared to be related, even if the referenced dialog contains no messages.

For two chained B2BUAs with no forking, this would give a message flow like this:
UA 1            B2BUA 1         B2BUA 2         UA 2

--->
INVITE 123@aa.example.com
Call-Id: qwerty@aa

--->
INVITE 123@transit.example.com
Call-Id: asdfgh@transit
References: QAZWSXEDCRFV;rel=chain

--->
INVITE 123@bb.example.com
Call-Id: zxcvbn@bb
References: QAZWSXEDCRFV
;rel=chain

<---
SIP/2.0 200 OK
Call-Id: zxcvbn@bb

<---
SIP/2.0 200 OK
Call-Id: asdfgh@transit
References: QAZWSXEDCRFV;rel=chain

<---
SIP/2.0 200 OK
Call-Id: qwerty@aa
References: QAZWSXEDCRFV;rel=chain

Note that B2BUA 2 does not create a new "References chain" value, but rather reuses the value it received in the initial INVITE. (In principle, B2BUA 2 does not need to add References to the response it sends, as References is present in the request.)

6. Security Considerations

The specification of the relationship between two dialogs could in principle be a privacy issue. But these relationships can usually be discerned by heuristic processing of the stream of SIP messages, and (with one exception) the author knows of no instance where the security or privacy properties of SIP have been based on the inability of an eavesdropper to determine that two SIP dialogs or messages are related.
The one known privacy problem is the "service provider privacy" problem discussed in [kaplan-session]. This situation is different from conventional "user security" situations because the eavesdropper is assumed to be unable to tap multiple points of the network, and the goal is to prevent the eavesdropper from obtaining information about parts of the network that the eavesdropper cannot directly access. This sort of privacy can be provided by constructing artificial Call-Ids to use in References headers, if References is inserted in both requests and responses.

7. Revision History

7.1. Changes from draft-worley-references-07 to draft-worley-references-08

Add the "mixed" and "record" relationships. Improve the descriptions of the "chain" and "sequel" relationships.

7.2. Changes from draft-worley-references-06 to draft-worley-references-07

Refresh of expired Internet-Draft.

Clairfy the meaning of "reversed" relationship values.

7.3. Changes from draft-worley-references-05 to draft-worley-references-06

Update "sipX" to "sipXecs".

Remove the specification that parameters and values that start with "X-" are reserved for non-standardized purposes, to align with [change-process], section 4.

Update BNF to make explicit the possibility of "-" at the beginning of rel-value.

7.4. Changes from draft-worley-references-04 to draft-worley-references-05

Refresh of expired Internet-Draft.

Updated author’s contact information.

7.5. Changes from draft-worley-references-03 to draft-worley-references-04

Added the "rel=service" value.

Added the convention of naming the reversed relationships by prefixing the rel-value with "-".
7.6. Changes from draft-worley-references-02 to draft-worley-references-03

    Added the "rel=chain" and "rel=sequel" values.
    Reserved the "rel=replaces" and "rel=join" values.
    Added B2BUA example for "rel=chain".

7.7. Changes from draft-worley-references-01 to draft-worley-references-02

    Specified that the value of the "rel" parameter is not affected by any quoting which is applied.
    Specified that the value of the "rel" parameter is case-sensitive.
    Categorize the References header as experimental.

7.8. Changes from draft-worley-references-00 to draft-worley-references-01

    Add the "rel" parameter.
    Note that References will usually appear in the dialog-forming request.
    Note that References may appear in a response.
    Add the "Related Work" section.

7.9. draft-worley-references-00

    Initial version.

8. References

8.1. Normative References


8.2. Informative References


    [service-examples]


Author’s Address

Dale R. Worley
Avaya Inc.
600 Technology Park Dr.
Billerica, MA 01821
US

Phone: +1 978 288 5505
Email: dworley@avaya.com
URI: http://www.avaya.com