Network Working Group
Internet-Draft
Expires: March 2, 2007

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August 29, 2006

Multiple Dialog Usages in the Session Initiation Protocol
draft-ietf-sipping-dialogusage-03

Status of this Memo

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Abstract

Several methods in the Session Initiation Protocol can create an association between endpoints known as a dialog. Some of these methods can also create a different, but related, association within an existing dialog. These multiple associations, or dialog usages, require carefully coordinated processing as they have independent life-cycles, but share common dialog state.

This memo argues that multiple dialog usages should be avoided. It discusses alternatives to their use and clarifies essential behavior

for elements that cannot currently avoid them.

This is an informative document and makes no normative statements of any kind.

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1. Introduction

Several methods in SIP can establish a dialog. When they do so, they also establish an association between the endpoints within that dialog. This association has been known for some time as a "dialog usage" in the developer community. A dialog initiated with an INVITE request has an invite usage. A dialog initiated with a SUBSCRIBE request has a subscribe usage. A dialog initiated with a REFER request has a subscribe usage.

Dialogs with multiple usages arise when a usage-creating action occurs inside an existing dialog. Such actions include accepting a REFER or SUBSCRIBE issued inside a dialog established with an INVITE request. Multiple REFERs within a dialog create multiple subscriptions, each of which is a new dialog usage sharing common dialog state. (Note that any REFER issued utilizing the subscription-suppression mechanism specified in [8] creates no new usage.)

The common state in the dialog shared by any usages is exactly:

- the Call-ID
- the local Tag
- the remote Tag
- the local CSeq
- the remote CSeq
- the Route-set
- the local contact
- the remote target
- the secure flag

Usages have state that is not shared in the dialog. For example, a subscription has a duration. Multiple subscriptions in the same dialog each have their own duration.

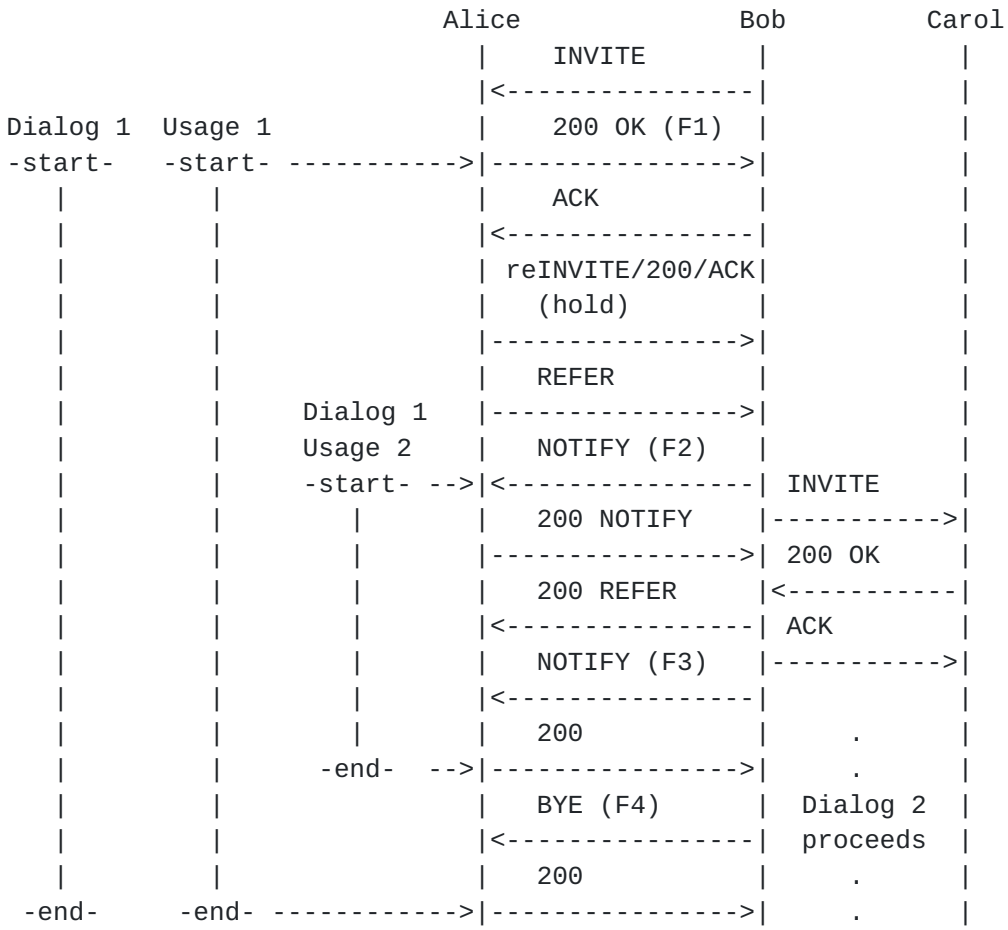
A dialog comes into existence with the creation of the first usage, and continues to exist until the last usage is terminated (reference counting). Unfortunately, many of the usage management aspects of SIP, such as authentication, were originally designed with the implicit assumption that there was one usage per dialog. The resulting mechanisms have mixed effects, some influencing the usage, and some influencing the entire dialog.

The current specifications define two usages, invite and subscribe. A dialog can share up to one invite usage and arbitrarily many subscribe usages. The pseudo-dialog behavior of REGISTER could be considered a third usage. Fortunately, no existing implementations have attempted to mix a registration usage with any other usage.

2. Examples of Multiple Usages

2.1. Transfer

In Figure 1, Alice transfers a call she received from Bob to Carol. A dialog (and an invite dialog usage) between Alice and Bob came into being with the 200 OK labeled F1. A second usage (a subscription to event refer) springs into being with the NOTIFY labeled F2. This second usage ends when the subscription is terminated by the NOTIFY transaction labeled F3. The dialog still has one usage (the invite usage), which lasts until the BYE transaction labeled F4. At this point, the dialog has no remaining usages, so it ceases to exist.



Message Details (abridged to show only dialog or usage details)

F1

```
SIP/2.0 200 OK
Call-ID: dialog1@bob.example.com
CSeq: 100 INVITE
To: <sip:Alice@alice.example.com>;tag=alicetag1
From: <sip:Bob@bob.example.com>;tag=bobtag1
Contact: <sip:aliceinstance@alice.example.com>
```

```
F2
  NOTIFY sip:aliceinstance@alice.example.com SIP/2.0
  Event: refer
  Call-ID: dialog1@bob.example.com
  CSeq: 101 NOTIFY
  To: <sip:Alice@alice.example.com>;tag=alicetag1
  From: <sip:Bob@bob.example.com>;tag=bobtag1
  Contact: <sip:bobinstance@bob.example.com>

F3
  NOTIFY sip:aliceinstance@alice.example.com SIP/2.0
  Event: refer
  Subscription-State: terminated;reason=noresource
  Call-ID: dialog1@bob.example.com
  CSeq: 102 NOTIFY
  To: <sip:Alice@alice.example.com>;tag=alicetag1
  From: <sip:Bob@bob.example.com>;tag=bobtag1
  Contact: <sip:bobinstance@bob.example.com>
  Content-Type: message/sipfrag

  SIP/2.0 200 OK

F4

  BYE sip:aliceinstance@alice.example.com SIP/2.0
  Call-ID: dialog1@bob.example.com
  CSeq: 103 BYE
  To: <sip:Alice@alice.example.com>;tag=alicetag1
  From: <sip:Bob@bob.example.com>;tag=bobtag1
  Contact: <sip:bobinstance@bob.example.com>
```

Figure 1

2.2. Reciprocal Subscription

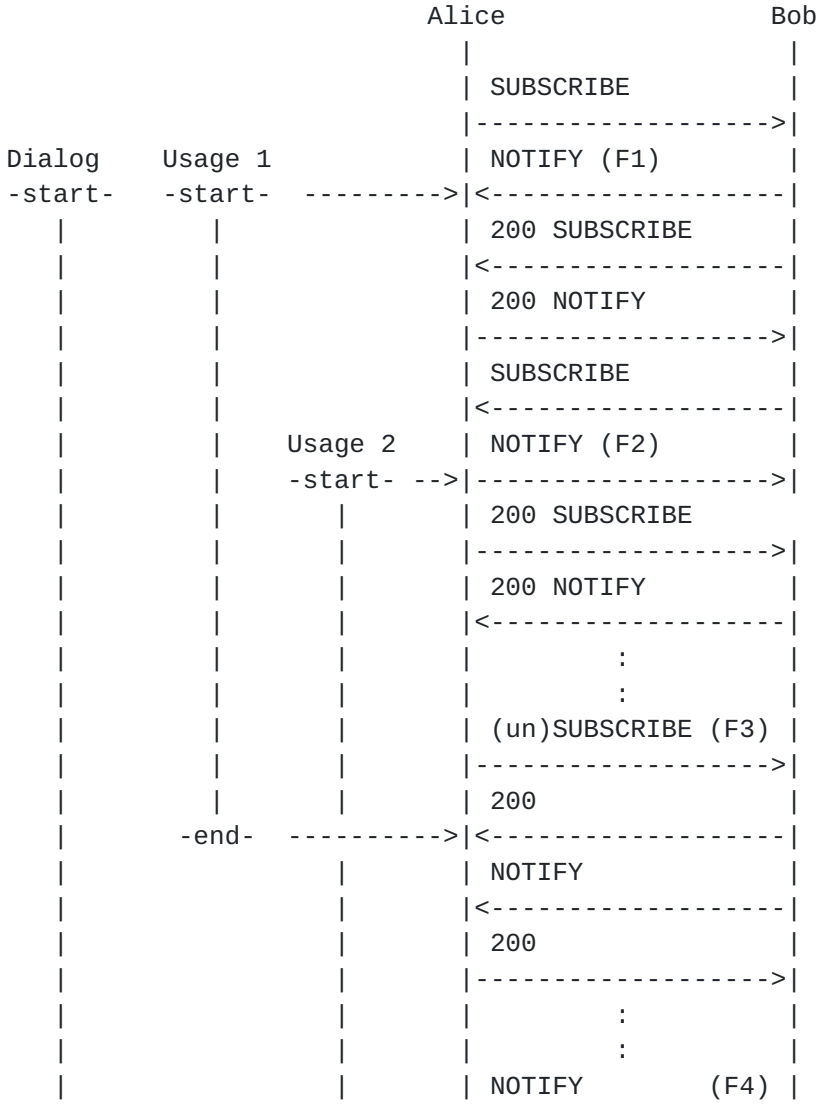
In Figure 2, Alice subscribes to Bob's presence. For simplicity, assume Bob and Alice are both serving their presence from their endpoints instead of a presence server. For space, the figure leaves out any rendezvous signaling through which Alice discovers Bob's endpoint.

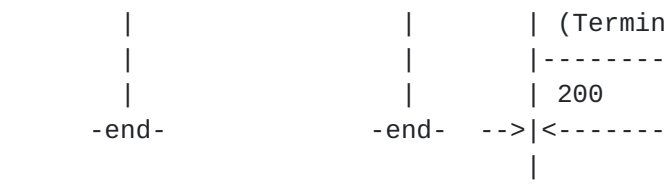
Bob is interested in Alice's presence too, so he subscribes to Alice (in most deployed presence/IM systems, people watch each other). He decides skip the rendezvous step since he's already in a dialog with Alice, and sends his SUBSCRIBE inside that dialog (a few early SIMPLE

clients behaved exactly this way).

The dialog and its first usage comes into being at F1, which establishes Alice's subscription to Bob. Its second usage begins at F2, which establishes Bob's subscription to Alice. These two subscriptions are independent - they have distinct and different expirations, but they share all the dialog state.

The first usage ends when Alice decides to unsubscribe at F3. Bob's subscription to Alice, and thus the dialog, continues to exist. Alice's UA must maintain this dialog state even though the subscription that caused it to exist in the first place is now over. The second usage ends when Alice decides to terminate Bob's subscription at F4 (she's probably going to reject any attempt on Bob's part to resubscribe until she's ready to subscribe to Bob again). Since this was the last usage, the dialog also terminates.





Message Details (abridged to show only dialog or usage details)

F1

```
NOTIFY sip:aliceinstance@alice.example.com SIP/2.0
Event: presence
Subscription-State: active;expires=600
Call-ID: alicecallid1@alice.example.com
From: <sip:Bob@bob.example.com>;tag=bobtag2
To: <sip:Alice@alice.example.com>;tag=alicetag2
CSeq: 100 NOTIFY
Contact: <sip:bobinstance@bob.example.com>
```

F2

```
NOTIFY sip:bobinstance@bob.example.com SIP/2.0
Event: presence
Subscription-State: active;expires=1200
Call-ID: alicecallid1@alice.example.com
To: <sip:Bob@bob.example.com>;tag=bobtag2
From: <sip:Alice@alice.example.com>;tag=alicetag2
CSeq: 500 NOTIFY
Contact: <sip:aliceinstance@alice.example.com>
```

F3

```
SUBSCRIBE sip:bobinstance@bob.example.com SIP/2.0
Event: presence
Expires: 0
Call-ID: alicecallid1@alice.example.com
To: <sip:Bob@bob.example.com>;tag=bobtag2
From: <sip:Alice@alice.example.com>;tag=alicetag2
CSeq: 501 SUBSCRIBE
Contact: <sip:aliceinstance@alice.example.com>
```

F4

```
NOTIFY sip:bobinstance@bob.example.com SIP/2.0
Event: presence
Subscription-State: terminated;reason=deactivated
Call-ID: alicecallid1@alice.example.com
To: <sip:Bob@bob.example.com>;tag=bobtag2
From: <sip:Alice@alice.example.com>;tag=alicetag2
CSeq: 502 NOTIFY
Contact: <sip:aliceinstance@alice.example.com>
```

Figure 2

3. Usage Creation and Destruction

Dialogs come into existence along with their first usage. Dialogs terminate when their last usage is destroyed. The messages that create and destroy usages vary per usage. This section provides a high-level categorization of those messages. The section does not attempt to explore the REGISTER pseudo-dialog.

3.1. Invite usages

Created by: non-100 provisional responses to INVITE; 200 response to INVITE

Destroyed by: 200 responses to BYE; certain failure responses to INVITE, UPDATE, PRACK, or INFO; anything that destroys a dialog and all its usages

3.2. Subscribe usages

Created by: 200 class responses to SUBSCRIBE; 200 class responses to REFER; NOTIFY requests

Destroyed by: 200 class responses to NOTIFY-terminated; NOTIFY or refresh-SUBSCRIBE request timeout; certain failure responses to NOTIFY or SUBSCRIBE; anything that destroys a dialog and all its usages

4. Proper Handling of Multiple Usages

The examples in Section 2 show straightforward cases where it is fairly obvious when the dialog begins and ends. Unfortunately, there are many scenarios where such clarity is not present. For instance, in Figure 1, what would it mean if the response to the NOTIFY (F2) were a 481? Does that simply terminate the refer subscription, or does it destroy the entire dialog? This section explores the problem spots with multiple usages that have been identified to date.

4.1. A survey of the effect of failure responses on usages and dialogs

For this survey, consider a subscribe usage inside a dialog established with an invite usage. Unless stated otherwise, we'll discuss the effect on each usage and the dialog when a client issuing a NOTIFY inside the subscribe usage receives a failure response (such as a transferee issuing a NOTIFY to event refer). Further, unless otherwise stated, the conclusions apply to arbitrary multiple-usages.

This survey is written from the perspective of a client receiving the error response. The effect on dialogs and usages at the server

issuing the response is the same.

3xx responses: Redirection mid-dialog is not well understood in SIP, but whatever effect it has impacts the entire dialog and all of its usages equally. In our example scenario, both the subscription and the invite usage would be redirected by this single response.

400 and unrecognized 4xx responses: These responses affect only the NOTIFY transaction, not the subscription, the dialog it resides in (beyond affecting the local CSeq), or any other usage of that dialog. In general, the response is a complaint about this transaction, not the usage or dialog the transaction occurs in.

401 Unauthorized ,407 Proxy Authentication Required: This request, not the subscription or dialog, is being challenged. The usages and dialog are not terminated.

402 Payment Required: This is a reserved response code. If encountered, it should be treated as an unrecognized 4xx.

403 Forbidden: This response concerns the transaction, not the usage. It has no effect on any other usages of the dialog. In our example scenario, the subscription remains, and is not affected in any way. The invite usage continues to exist. Similarly, if the 403 came in response to a reINVITE, the invite usage would continue to exist.

404 Not Found: This response destroys the dialog and all usages sharing it. The Request-URI that is being 404ed is the remote target set by the Contact provided by the peer. Getting this response means something has gone fundamentally wrong with the dialog state.

405 Method Not Allowed: In our example scenario, this response destroys the subscription, but not the invite usage or the dialog. It's an aberrant case for NOTIFYs to receive a 405 since they only come as a result to something that creates subscription. In general, a 405 within a given usage affects only that usage, but does not affect other usages of the dialog.

406 Not Acceptable: These responses concern details of the message in the transaction. Subsequent requests in this same usage may succeed. Neither the usage nor dialog is terminated, other usages sharing this dialog are unaffected.

408 Request Timeout: Receiving a 408 will have the same effect on usages and dialogs as a real transaction timeout as described in Section 4.2.

410 Gone: This response destroys the dialog and all usages sharing it. The Request-URI that is being rejected is the remote target set by the Contact provided by the peer. Similar to 404, getting this response means something has gone fundamentally wrong with the dialog state, its slightly less aberrant in that the other endpoint recognizes that this was once a valid URI that it isn't willing to respond to anymore.

412 Conditional Request Failed:
413 Request Entity Too Large:
414 Request-URI Too Long:
415 Unsupported Media Type: These responses concern details of the message in the transaction. Subsequent requests in this same usage may succeed. Neither the usage nor dialog is terminated, other usages sharing this dialog are unaffected.

416 Unsupported URI Scheme: Similar to 404 and 410, this response came to a request whose Request-URI was provided by the peer in a Contact header field. Something has gone fundamentally wrong, and the dialog and all of its usages are destroyed.

417 Unknown Resource-Priority: The effect of this response on usages and dialogs is analogous to that for 420 and 488. The usage is not affected. The dialog is only affected by a change in its local CSeq. No other usages of the dialog are affected.

420 Bad Extension, 421 Extension Required: These responses are objecting to the request, not the usage. The usage is not affected. The dialog is only affected by a change in its local CSeq. No other usages of the dialog are affected.

422 Session Interval Too Small: This response will not be returned to a NOTIFY in our example scenario. This response does not make sense for any mid-usage request. If it is received, an element in the path of the request is violating protocol, and the recipient should treat this as it would an unknown 4xx response. If the response came to a request that was attempting to establish a new usage in an existing dialog, no new usage is created and existing usages are unaffected.

423 Interval Too Brief: This response won't happen in our example scenario, but if it came in response to a reSUBSCRIBE, the subscribe usage is not destroyed (or otherwise affected). No other usages of the dialog are affected.

428 Use Identity Header: This response objects to the request, not the usage. The usage is not affected. The dialog is only affected by a change in its local CSeq. No other usages of the dialog are affected.

429 Provide Referrer Identity: This response won't be returned to a NOTIFY as in our example scenario, but when it is returned to a REFER, it is objecting only to the REFER request itself. Any usages sharing this dialog with that REFER request are unaffected. The dialog is only affected by a change in its local CSeq.

436 Bad Identity-Info, 437 Unsupported Certificate, 438 Invalid Identity Header These responses object to the request, not the usage. The usage is not affected. The dialog is only affected by a change in its local CSeq. No other usages of the dialog are affected.

480 Temporarily Unavailable: RFC 3261 is unclear on what this response means for mid-usage requests. Clarifications will be made to show that this response affects only the usage in which the request occurs. No other usages are affected. If the response included a Retry-After header field, further requests in that usage should not be sent until the indicated time has past. Requests in other usages may still be sent at any time.

481 Call/Transaction Does Not Exist: This response indicates that the peer has lost its copy of the dialog usage state. The dialog itself should not be destroyed unless this was the last usage. The effects of a 481 on a dialog and its usages are the most ambiguous of any final response. There are implementations that have chosen the meaning recommended here, and others that destroy the entire dialog without regard to the number of outstanding usages. Going forward with this clarification will allow those deployed implementations that assumed only the usage was destroyed to work with a wider number of implementations. Those that made the other choice will continue to function as they do now, suffering at most the same extra messages needed for a peer to discover that that other usages have gone away that they currently do. However, the necessary clarification to RFC 3261 needs to make it very clear that the ability to terminate usages independently from the overall dialog using a 481 is not justification for designing new applications that count on

multiple usages in a dialog.

482 Loop Detected: This response is aberrant mid-dialog. It will only occur if the Record-Route header field was improperly constructed by the proxies involved in setting up the dialog's initial usage, or if a mid-dialog request forks and merges (which should never happen). Future requests using this dialog state will also fail. The dialog and any usages sharing it are destroyed.

An edge condition exists during RFC3263 failover at the element sending a request where the request effectively forks to multiple destinations from the client. Some implementations increase risk entering this edge condition by trying the next potential location as determined by RFC3263 very rapidly if the first does not immediately respond. In any situation where a client sends the same request to more than one endpoint, it must be prepared to receive a response from each branch (and should choose a "best" response to act on following the same guidelines as a forking proxy). In this particular race condition, if multiple branches respond, all but one will most likely return a 482 Merged Request. The client should select the remaining non-482 response as the "best" response.

483 Too Many Hops: Similar to 482, receiving this mid-dialog is aberrant. Unlike 482, recovery may be possible by increasing Max-Forwards (assuming that the requester did something strange like using a smaller value for Max-Forwards in mid-dialog requests than it used for an initial request). If the request isn't tried with an increased Max-Forwards, then the agent should attempt to gracefully terminate this usage and all other usages that share its dialog.

484 Address Incomplete, 485 Ambiguous: Similar to 404 and 410, these responses came to a request whose Request-URI was provided by the peer in a Contact header field. Something has gone fundamentally wrong, and the dialog and all of its usages are destroyed.

486 Busy Here: This response is nonsensical in our example scenario, or in any scenario where this response comes inside an established usage. If it occurs in that context, it should be treated as an unknown 4xx response. The usage, and any other usages sharing its dialog are unaffected. The dialog is only affected by the change in its local CSeq. If this response is to a request that is attempting to establish a new usage within an existing dialog (such as an INVITE sent within a dialog established by a subscription), the request fails, no new usage is created, and no other usages are affected.

487 Request Terminated: This response speaks to the disposition of a particular request (transaction). The usage in which that request occurs is not affected by this response (it may be affected by another associated request within that usage). No other usages sharing this dialog are affected.

488 Not Acceptable Here: This response is objecting to the request, not the usage. The usage is not affected. The dialog is only affected by a change in its local CSeq. No other usages of the dialog are affected.

489 Bad Event: In our example scenario, [3] declares that the subscription usage in which the NOTIFY is sent is terminated. The invite usage is unaffected and the dialog continues to exist. This response is only valid in the context of SUBSCRIBE and NOTIFY. UAC behavior for receiving this response to other methods is not specified, but treating it as an unknown 4xx is a reasonable practice.

491 Request Pending: This response addresses in-dialog request glare. Its affect is scoped to the request. The usage in which the request occurs is not affected. The dialog is only affected by the change in its local CSeq. No other usages sharing this dialog are affected.

493 Undecipherable: This response objects to the request, not the usage. The usage is not affected. The dialog is only affected by a change in its local CSeq. No other usages of the dialog are affected.

494 Security Agreement Required: This response is objecting to the request, not the usage. The usage is not affected. The dialog is only affected by a change in its local CSeq. No other usages of the dialog are affected.

500 and 5xx unrecognized responses: These responses are complaints against the request (transaction), not the usage. If the response contains a Retry-After header field value, the server thinks the condition is temporary and the request can be retried after the indicated interval. This usage, and any other usages sharing the dialog are unaffected. If the response does not contain a Retry-After header field value, the UA may decide to retry after an interval of its choosing or attempt to gracefully terminate the usage. Whether or not to terminate other usages depends on the application. If the UA receives a 500 (or unrecognized 5xx) in response to an attempt to gracefully terminate this usage, it can treat this usage as terminated. If this is the last usage sharing

the dialog, the dialog is also terminated.

501 Not Implemented: This would be a degenerate response in our example scenario since the NOTIFY is being sent as part of an established subscribe usage. In this case, the UA knows the condition is unrecoverable and should stop attempting to send NOTIFYs on this usage. (It may or may not destroy the usage. If it remembers the bad behavior, it can reject any refresh subscription). In general, this response may or may not affect the usage (a 501 to an unknown method or an INFO will not end an invite usage). It will never affect other usages sharing this usage's dialog.

502 Bad Gateway: This response is aberrant mid-dialog. It will only occur if the Record-Route header field was improperly constructed by the proxies involved in setting up the dialog's initial usage. Future requests using this dialog state will also fail. The dialog and any usages sharing it are destroyed.

503 Service Unavailable: As per [2], the logic handling locating SIP servers for transactions may handle 503 requests (effectively sequentially forking at the endpoint based on DNS results). If this process does not yield a better response, a 503 may be returned to the transaction user. Like a 500 response, the error is a complaint about this transaction, not the usage. Because this response occurred in the context of an established usage (hence an existing dialog), the route-set has already been formed and any opportunity to try alternate servers (as recommended in [1] has been exhausted by the RFC3263 logic. The response should be handled as described for 500 earlier in this memo.

504 Server Time-out: It is not obvious under what circumstances this response would be returned to a request in an existing dialog. If it occurs it should have the same affect on the dialog and its usages as described for unknown 5xx responses.

505 Version Not Supported, 513 Message Too Large: These responses are objecting to the request, not the usage. The usage is not affected. The dialog is only affected by a change in its local CSeq. No other usages of the dialog are affected.

580 Precondition Failure: This response is objecting to the request, not the usage. The usage is not affected. The dialog is only affected by a change in its local CSeq. No other usages of the dialog are affected.

600 and 6xx unrecognized responses: Unlike 400 Bad Request, a 600 response code says something about the recipient user, not the request that was made. This end user is stating an unwillingness to communicate. If the response contains a Retry-After header field value, the user is indicating willingness to communicate later and the request can be retried after the indicated interval. This usage, and any other usages sharing the dialog are unaffected. If the response does not contain a Retry-After header field value, the UA may decide to retry after an interval of its choosing or attempt to gracefully terminate the usage. Whether or not to terminate other usages depends on the application. If the UA receives a 600 (or unrecognized 6xx) in response to an attempt to gracefully terminate this usage, it can treat this usage as terminated. If this is the last usage sharing the dialog, the dialog is also terminated.

603 Decline: This response declines the action indicated by the associated request. It can be used, for example, to decline a hold or transfer attempt. Receiving this response does NOT terminate the usage it occurs in. Other usages sharing the dialog are unaffected.

604 Does Not Exist Anywhere: Like 404, this response destroys the dialog and all usages sharing it. The Request-URI that is being 604ed is the remote target set by the Contact provided by the peer. Getting this response means something has gone fundamentally wrong with the dialog state.

606 Not Acceptable: This response is objecting to aspects of the associated request, not the usage the request appears in. The usage is unaffected. Any other usages sharing the dialog are unaffected. The only affect on the dialog is the change in the local CSeq.

4.2. Transaction timeouts

[1] states that a UAC should terminate a dialog (by sending a BYE) if no response is received for a request sent within a dialog. This recommendation should have been limited to the invite usage instead of the whole dialog. [3] states that a timeout for a NOTIFY removes a subscription, but a SUBSCRIBE that fails with anything other than a 481 does not. Given these statements, it is unclear whether a refresh SUBSCRIBE issued in a dialog shared with an invite usage destroys either usage or the dialog if it times out.

Generally, a transaction timeout should affect only the usage in which the transaction occurred. Other uses sharing the dialog should

not be affected. In the worst case of timeout due to total transport failure, it may require multiple failed messages to remove all usages from a dialog (at least one per usage).

There are some mid-dialog messages that never belong to any usage. If they timeout, they will have no effect on the dialog or its usages.

4.3. Matching requests to usages

For many mid-dialog requests, identifying the usage they belong to is obvious. A dialog can have at most one invite usage, so any INVITE, UPDATE, PRACK, ACK, CANCEL, BYE, or INFO requests belong to it. The usage (i.e. the particular subscription) SUBSCRIBE, NOTIFY, and REFER requests belong to can be determined from the Event header field of the request. REGISTER requests within a (pseudo)-dialog belong to the registration usage. (As mentioned before, implementations aren't mixing registration usages with other usages, so this document isn't exploring the consequences of that bad behavior).

According to [1], "an OPTIONS request received within a dialog generates a 200 OK response that is identical to one constructed outside a dialog and does not have any impact on that dialog". Thus OPTIONS does not belong to any usage. Only those failures discussed in Section 4.1 and Section 4.2 that destroy entire dialogs will have any effect on the usages sharing the dialog with a failed OPTIONS request.

MESSAGE requests are discouraged inside a dialog. Implementations are restricted from creating a usage for the purpose of carrying a sequence of MESSAGE requests (though some implementations use it that way, against the standard recommendation). A failed MESSAGE occurring inside an existing dialog will have similar effects on the dialog and its usages as a failed OPTIONS request.

Mid-dialog requests with unknown methods cannot be matched with a usage. Servers will return a failure response (likely a 501). The effect on the dialog and its usages at either the client or the server should be similar to that of a failed OPTIONS request.

These guidelines for matching messages to usages (or determining there is no usage) apply equally when acting as a UAS, a UAC, or any third party tracking usage and dialog state by inspecting all messages between two endpoints.

4.4. Target refresh requests

Target refresh requests update the remote target of a dialog when

they are successfully processed. The currently defined target refresh requests are INVITE, UPDATE, SUBSCRIBE and NOTIFY (clarified in a bug against RFC3565) and REFER (clarified in a bug against RFC3515 [4]).

The remote target is part of the dialog state. When a target refresh request affects it, it affects it for ALL usages sharing that dialog. If a subscription and invite usage are sharing a dialog, sending a refresh SUBSCRIBE with a different contact will cause reINVITEs from the peer to go to that different contact.

A UAS will only update the remote target if it sends a 200 class response to a target refresh request. A UAC will only update the remote target if it receives a 200 class response to a target refresh request. Again, any update to a dialog's remote target affects all usages of that dialog.

4.5. Refreshing and Terminating Usages

Subscription and registration usages expire over time and must be refreshed (with a refresh SUBSCRIBE for example). This expiration is usage state, not dialog state. If several subscriptions share a dialog, refreshing one of them has no effect on the expiration of the others.

Normal termination of a usage has no effect on other usages sharing the same dialog. For instance terminating a subscription with a NOTIFY/Subscription-State: terminated will not terminate an invite usage sharing its dialog. Likewise, ending an invite usage with a BYE does not terminate any active Event: refer subscriptions established on that dialog.

4.6. Refusing new usages

As the survey of the effect of failure responses shows, care must be taken when refusing a new usage inside an existing dialog. Choosing the wrong response code will terminate the dialog and all of its usages. Generally, returning a 603 Decline is the safest way to refuse a new usage.

4.7. Replacing usages

[6] defines a mechanism through which one usage can replace another. It can be used, for example, to associate the two dialogs a transfer target is involved in during an attended transfer. It is written using the term "dialog", but its intent was to only affect the invite usage of the dialog it targets. Any other usages inside that dialog are unaffected. For some applications, the other usages may no

longer make sense, and the application may terminate them as well.

However, the interactions between Replaces and multiple dialog usages have not been well explored. More discussion of this topic is needed. Implementers should avoid this scenario completely.

5. Avoiding Multiple Usages

Processing multiple usages correctly is not completely understood. What is understood is difficult to implement and is very likely to lead to interoperability problems. The best way to avoid the trouble that comes with such complexity is to avoid it altogether.

When designing new applications that use SIP dialogs, do not construct multiple usages. If a peer attempts to create a second usage inside a dialog, refuse it.

Unfortunately, there are existing applications, like transfer, that currently entail multiple usages, so the simple solution of "don't do it" will require some transitional work. This section looks at the pressures that led to these existing multiple usages and suggests alternatives.

When executing a transfer, the transferor and transferee currently share an invite usage and a subscription usage within the dialog between them. This is a result of sending the REFER request within the dialog established by the invite usage. Implementations were led to this behavior by two primary pressures:

1. There was no way to ensure that a REFER on a new dialog would reach the particular endpoint involved in a transfer. Many factors, including details of implementations and changes in proxy routing between an INVITE and a REFER could cause the REFER to be sent to the wrong place. Sending the REFER down the existing dialog ensured it got to the endpoint we were already talking to.
2. It was unclear how to associate an existing invite usage with a REFER arriving on a new dialog, where it was completely obvious what the association was when the REFER came on the invite usage's dialog.
3. There were concerns with authorizing out-of-dialog REFERs. The authorization policy for REFER in most implementations piggybacks on the authorization policy for INVITE (which is, in most cases, based simply on "I placed or answered this call").

GRUUs [7] have been defined specifically to address problem 1. Problem 2 can be addressed using a GRUU's grid parameter. However, this approach requires endpoints to create and maintain a GRUU per

dialog, something the working group is not comfortable recommending.

The Join [5] and Replaces [6] mechanisms address problem 1 differently. Here, a new request is sent outside any dialog with the expectation that it will fork to possibly many endpoints, including the one we're interested in. This request contains a header field listing the dialog identifiers of a dialog in progress. Only the endpoint holding a dialog matching those identifiers will accept the request. The other endpoints the request may have forked to will respond with an error. This mechanism is reasonably robust, failing only when the routing logic for out-of-dialog requests changes such that the new request does not arrive at the endpoint holding the dialog of interest.

The reachability aspects of using a GRUU to address problem 1 can be combined with the association-with-other-dialogs aspects of the Join/Replaces solution. A REFER request sent out-of-dialog can be sent towards a GRUU, and identify an existing dialog as part of the context the receiver should use. A new header, Target-Dialog: perhaps, would be included in the REFER listing the dialog this REFER is associated with. Figure 3 sketches how this could be used to achieve transfer without reusing a dialog.

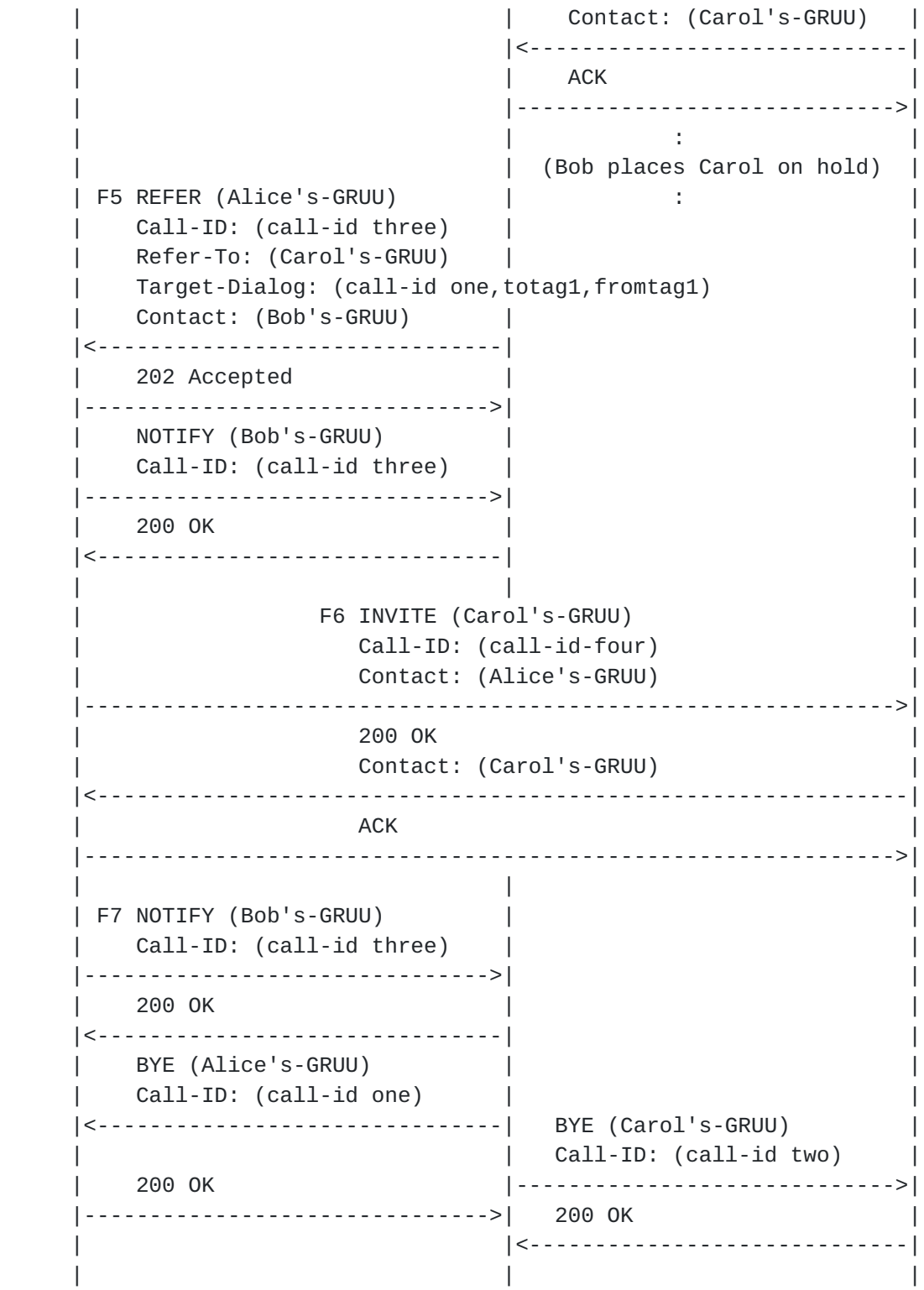


Figure 3: Transfer without dialog reuse

In message F1, Alice invites Bob indicating support for GRUUs (and

offering a GRUU for herself):

Message F1 (abridged, detailing pertinent fields)

```
INVITE sip:bob@example.com SIP/2.0
Call-ID: 13jfdwer230jsdw@alice.example.com
Supported: gruu
Contact: <sip:aanewmr203raswdf@example.com>
```

Message F2 lets Alice know that Bob understands GRUUs. If Bob did not indicate this support, the original multi-usage approach to transfer would have to be used.

Message F2 (abridged, detailing pertinent fields)

```
SIP/2.0 200 OK
Supported: gruu
To: <sip:bob@example.com>;tag=totag1
From: <sip:alice@example.com>;tag=fromtag1
Contact: <sip:boaiidfjjereis@example.com>
```

Bob decides to try to transfer Alice to Carol, so he puts Alice on hold and sends an INVITE to Carol. Carol and Bob negotiate GRUU support similar to what happened in F1 and F2.

Message F3 (abridged, detailing pertinent fields)

```
INVITE sip:carol@example.com SIP/2.0
Supported: gruu
Call-ID: 23rasdnfoa39i4jnasdf@bob.example.com
Contact: <sip:boaiidfjjereis@example.com>
```

Message F4 (abridged, detailing pertinent fields)

```
SIP/2.0 200 OK
Supported: gruu
To: <sip:carol@example.com>;tag=totag2
From: <sip:bob@example.com>;tag=fromtag2
Call-ID: 23rasdnfoa39i4jnasdf@bob.example.com
Contact: <sip:c239fniuweorw9sdfn@example.com>
```

After consulting Carol, Bob places her on hold and refers Alice to her using message F5. Notice that the Refer-To URI is Carol's GRUU, and that this is on a different Call-ID than message F1. (The URI in the Refer-To header is line-broken for readability in this draft, it

would not be valid to break the URI this way in a real message)

Message F5 (abridged, detailing pertinent fields)

```
REFER sip:aanewmr203raswdf@example.com SIP/2.0
Call-ID: 39fa99r0329493asdsf3n@bob.example.com
Refer-To: <sip:c239fniuweorw9sdfn@example.com
           ?Replaces=23rasdnfoa39i4jnasdf@bob.example.com;
            to-tag=totag2;from-tag=fromtag2>
Target-Dialog: 13jfdwer230jsdw@alice.example.com;
               local-tag=fromtag1;remote-tag=totag1
Supported: gruu
Contact: <sip:boaiidfjjereis@example.com>
```

Alice uses the information in the Target-Dialog header field to determine that this REFER is associated with the dialog she already has in place with Bob. Alice is now in a position to use the same admission policy she used for in-dialog REFERs: "Do I have a call with this person?". She accepts the REFER. sends Bob the obligatory immediate NOTIFY, and proceeds to INVITE Carol with message F6.

Message F6 (abridged, detailing pertinent fields)

```
INVITE sip:c239fniuweorw9sdfn@example.com SIP/2.0
Call-ID: 4zsd9f234jasdfasn3jsad@alice.example.com
Replaces: 23rasdnfoa39i4jnasdf@bob.example.com;
          to-tag=totag2;from-tag=fromtag2
Supported: gruu
Contact: <sip:aanewmr203raswdf@example.com>
```

Carol accepts Alice's invitation to replace her dialog (invite usage) with Bob and notifies him that the REFERenced INVITE succeeded with F7:

Message F7 (abridged, detailing pertinent fields)

```
NOTIFY sip:boaiidfjjereis@example.com SIP/2.0
Subscription-State: terminated;reason=noresource
Call-ID: 39fa99r0329493asdsf3n@bob.example.com
Contact: <sip:aanewmr203raswdf@example.com>
Content-Type: message/sipfrag

SIP/2.0 200 OK
```

Bob then ends his invite usages with both Alice and Carol using BYEs.

6. Security Considerations

Handling multiple usages within a single dialog is complex and introduces scenarios where the right thing to do is not clear. The ambiguities described here can result in unexpected disruption of communication if response codes are chosen carelessly. Furthermore, these ambiguities could be exploited, particularly by third-parties injecting unauthenticated requests or inappropriate responses. Implementations choosing to create or accept multiple usages within a dialog should give extra attention to the security considerations in [1], especially those concerning authenticity of requests and processing of responses.

Service implementations should carefully consider the effects on their service of peers making different choices in these areas of ambiguity. A service that requires multiple usages needs to pay particular attention to the effect on service and network utilization when a client fails to destroy a dialog the service believes should be destroyed. A service that disallows multiple usages should consider the effect on clients that, for instance, destroy the entire dialog when only a usage should be torn down. In the worst case of a service deployed into a network with a large number of misbehaving clients trying to create multiple usages in an automated fashion, a retry storm similar to an avalanche restart could be induced.

7. IANA Considerations

This document has no actions for IANA.

8. Conclusion

Handling multiple usages within a single dialog is complex and introduces scenarios where the right thing to do is not clear. Implementations should avoid entering into multiple usages whenever possible. New applications should be designed to never introduce multiple usages.

There are some accepted SIP practices, including transfer, that currently require multiple usages. Recent work, most notably GRUU, makes those practices unnecessary. The standardization of those practices and the implementations should be revised as soon as possible to use only single-usage dialogs.

9. Acknowledgments

The ideas in this draft have been refined over several IETF meetings with many participants. Significant contribution was provided by Adam Roach, Alan Johnston, Ben Campbell, Cullen Jennings, Jonathan Rosenberg, Paul Kyzivat, and Rohan Mahy. Members of the reSIProcate project also shared their difficulties and discoveries while implementing multiple-usage dialog handlers.

10. Informative References

[1] Rosenberg, J., Schulzrinne, H., Camarillo, G., Johnston, A., Peterson, J., Sparks, R., Handley, M., and E. Schooler, "SIP: Session Initiation Protocol", RFC 3261, June 2002.

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[5] Mahy, R. and D. Petrie, "The Session Initiation Protocol (SIP) "Join" Header", RFC 3911, October 2004.

[6] Mahy, R., Biggs, B., and R. Dean, "The Session Initiation Protocol (SIP) "Replaces" Header", RFC 3891, September 2004.

[7] Rosenberg, J., "Obtaining and Using Globally Routable User Agent (UA) URIs (GRUU) in the Session Initiation Protocol (SIP)", draft-ietf-sip-gruu-10 (work in progress), August 2006.

[8] Levin, O., "Suppression of Session Initiation Protocol (SIP) REFER Method Implicit Subscription", RFC 4488, May 2006.

Appendix A. Change Log

RFC-EDITOR: Please remove this entire Change Log section while formatting this document for publication.

A.1. draft-ietf-02->draft-ietf-03

- Removed discussion of the retargetting affect of provisional responses - that is a general problem that will now be addressed in SIP.

- Added a Security Considerations section (blush) summarizing points from the document and the list discussion.
- Added a no-op IANA Considerations section.

A.2. draft-ietf-01->draft-ietf-02

- Incorporated editorial-fix contributions from the list
- Noted that REFERs using norefersub (RFC4488) don't create a new subscribe usage
- Changed the affect of 403 to affect only the transaction, not the usage. This is motivated by text in 3261 (bottom of page 87 - pointed out by Brian Stucker) which states that a UA receiving a non-2xx final response to a re-INVITE must leave the session parameters unchanged as if the re-INVITE had not been issued. There are other recommendations in this document that violate that normative must (404,410, etc) but on review, I believe they are correct (except for 403) and that this text in 3261 needs to be updated to recognize the conditions under which they're sent.
- Added text concerning the race condition wherein endpoints failing over rapidly to 3263 destinations may stimulate a merged-request response.
- Corrected the 481 inconsistency Paul Kyzivat pointed out (by removing the inconsistent paragraph)

A.3. draft-ietf-00->draft-ietf-01

- Changed 481 to only affect the usage the response occurred in, closing the last open issue. Added some text justifying this recommendation.
- Added 422 Session Interval Too Small
- Added 417 Unknown Resource-Priority
- Added 428 Use Identity Header
- Added 436 Bad Identity-Info
- Added 437 Unsupported Certificate
- Added 438 Invalid Identity header
- Added a section categorizing messages that create and destroy usages
- Made sure all descriptions in Section 4 addressed the generic multi-usage case.
- Clarified that the mechanics described in matching messages to usages applied equally to UACs and UASs.
- More explicitly noted that REFER creates a subscribe-usage

A.4. draft-sparks-01->draft-ietf-00

- Draft rename

A.5. draft-sparks-00->01

- Changed 480 to affect only the usage the response occurred in.
- Closed the open issue on 482. Usages and dialogs are destroyed even though there is an edge condition in which the response is only stimulated by certain methods (due to method specific routing rules).
- Closed the open issue on 483. Usages are not terminated since the request might succeed if retried with a greater initial Max-Forwards
- Closed the open issue on 502, accepting -00s suggestion that the same reasoning used for 482 applies.
- Redid the transfer example to not require a GRUU per usage, but instead leverage the target-dialog concepts common to Join and Replaces.

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Acknowledgment

Funding for the RFC Editor function is currently provided by the Internet Society.