SIPPING WG
Internet-Draft
Expires: September 6, 2006

R. Mahy
Plantronics
March 5, 2006

A Solution to the Heterogeneous Error Response Forking Problem (HERFP) in the Session Initiation Protocol (SIP)
draft-mahy-sipping-herfp-fix-01.txt

Status of this Memo

Copyright Notice

Abstract

The SIP protocol defines a role for proxy servers which can forward requests to multiple contacts associated with a specific resource or person. While each of these contacts is expected to send a response of some kind, responses for each branch are not necessarily sent back to the original requester. The proxy server forwards only the "best" final response back to the original request. This behavior causes a situation known as the Herterogeneous Error Response Forking Problem (HERFP) in which the original requester has no opportunity to see or

fix a variety of potentially repairable errors. This document describes a backwards compatible solution to the HERFP problem for INVITE transactions.

Table of Contents

1. Conventions

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 [3].

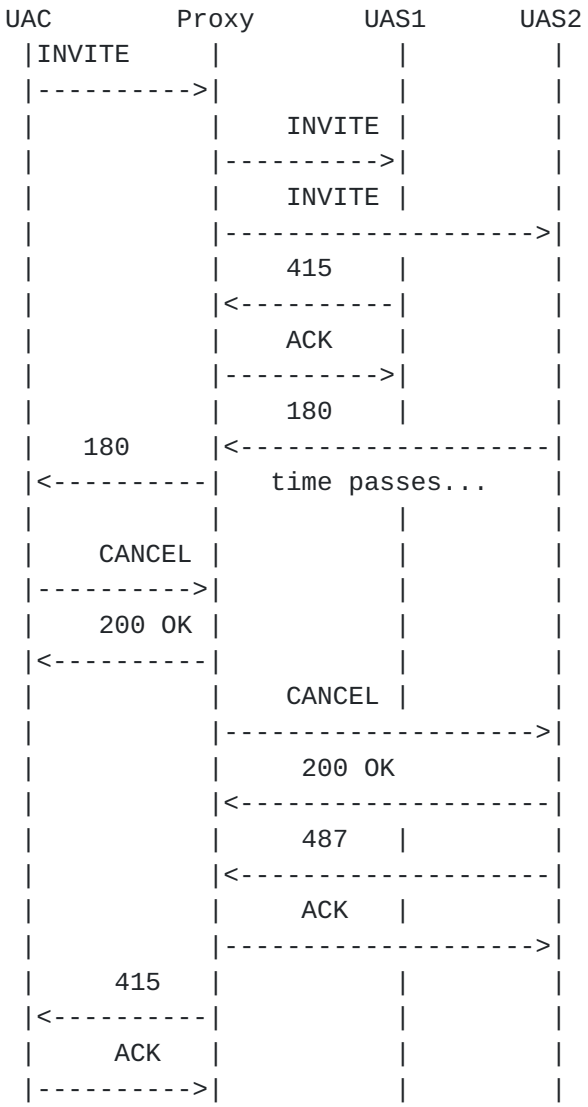
2. Background

The Session Initiation Protocol (SIP) [1] defines several logical roles, including proxy servers (which forward requests toward their destination), and User Agents (which originate and respond to requests). In addition to transparently forwarding requests, SIP proxy servers can also "fork" requests to multiple User Agent Servers (UAS) if the proxy is authoritative for the domain portion of the Request URI. When forking, proxies forward the same request to multiple contacts which typically have registered as instances of a particular user or service. A proxy can forward requests simultaneously (parallel forking), in series (serial forking), or in combination. As a request is forwarded to a set of contacts, each UAS that receives the request is expected to send a response.

When a proxy forks, it first builds a "target set", a list of User Agent Servers to whom requests will be forwarded. Once forwarding a request, the proxy collects responses from each UAS in a "response context". For INVITE requests, proxies immediately forward all provisional responses and 200-class (success) final responses back to the UAC. For other final responses (regardless of the method of the request), only a single "best" response is sent back to the UAC. The proxy has to delay sending the final response until all branches have completed. This is especially problematic for INVITE transactions, since they can theoretically pend for several minutes, after which most humans have given up attempting communication. In addition, many common SIP error responses are automatically repairable and are used extensively to allow User Agents to negotiate capabilities. These repairable errors are often completely lost if another User Agent finds the request acceptable or returns a "better" error response.

For non-INVITE requests (for example, a SUBSCRIBE request) provisional responses are practically non-existent and only one final response is sent, even if multiple branches returned a 200 response. The SIP events framework (RFC 3265 [6]) effectively deals with HERFP by using NOTIFY requests to convey the success or failure of a SUBSCRIBE request. The single response to a SUBSCRIBE might even arrive after the corresponding NOTIFY request making it effectively redundant. Consequently, this document only addresses HERFP for INVITE transactions. Sending requests other than INVITE and SUBSCRIBE in a manner which causes them to fork is contraindicated.

To illustrate a simple case of HERFP, the UAC below sends a request which includes a body format which is understood by UAS2, but not by UAS1. For example, the UAC might have used a multipart/mixed with a session description and an optional image or sound. UAC1 does not support multipart/mixed, so it returns a 415 response. The UAC can trivially repair this 415 response by resending the request with just the session description. Unfortunately, the proxy has to wait until all branches generate a final response before forwarding the best response. Since the request was acceptable to UAS2, the proxy waits for that branch to finish before it can repair the error. In many cases, the proxy will wait for a long enough amount of time that the human operating the UAC gives up and abandons the call.



3. Overview of Solution

HERFP was first described in late 2001. It has remained one of the most challenging problems remaining for the SIP protocol. To effectively address the problem, it is useful to examine the overall goals for a solution to HERFP.

- Convey the semantics of repairable error responses directly to the sender of a (dialog-forming) INVITE request.
- Provide an opportunity for a UAC to retry an INVITE to one branch without canceling other pending branches.
- Do not require modification of the SIP transaction state machine.
- Work through existing RFC 3261 compliant proxy servers.
- Allow the forking proxy to still add or cancel branches.
- Work consistently with unmodified User Agent Servers.

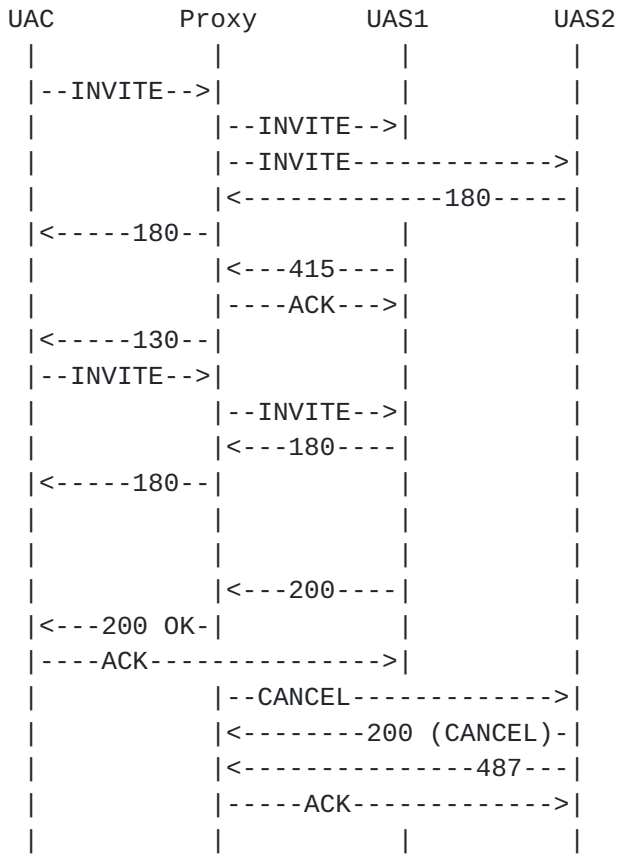
A previous attempt [7] to solve HERFP required each UAS to generate a new provisional response encapsulating the actual final response. However the entire HERFP problem stems from the fact that different UAS implementations will behave differently and frequently implement different sets of extensions. The last goal reflects that a satisfactory solution should work with unmodified User Agent Servers.

Instead of requiring new UAS behavior, this solution enlists the services of the proxy to generate a provisional response of its own (a 130 Repairable Error response) for each branch. Each 130 response encapsulates the repairable final response from one branch. The proxy acts temporarily as a UAS to send these provisional responses. The proxy generates and provides a new URI that the UAC will contact after repairing the error. This URI is similar in spirit to a Globally Routable UA URI (GRUU) [5], except that the URI refers to a specific branch of a specific target set only. Each new URI refers only to one specific failed branch, but is still associated with the list of candidate recipients of the original transaction (the target set).

A UAC which supports this extension reacts to a 130 response by sending a new INVITE request (with the same Call-ID) to the URI in the Contact header of the 130 response. This new request is generated in the same context as the original INVITE request, which is unaffected by the new request. The proxy can still try new branches in the candidate set or cancel old ones. Using this technique, the original requester can immediately fix repairable error responses. If the UAC decides it cannot repair an error, it sends a DECLINE request (a new method defined here) to indicate to the Proxy that it can eliminate the corresponding branch from best-response matching.

Now consider the same example described above but employing the

solution described in this document. The UAC sends a request with a multipart/mixed body. The Proxy forwards this request to UAS1 and UAS2. UAS1 sends the proxy a 415 response. The proxy generates a URI with the appropriate properties, and generates a 130 Repairable Error response with the 415 response embedded as a message/sip body. The UAC sends a new INVITE to the URI that the proxy generated with only a session description in the body. The proxy forwards the INVITE to UAS1, but manages the forking logic as if the new request was in the original target set. When UAS1 sends a 200 OK, the proxy cancels the branch with UAS2.



4. Proxy Behavior

4.1 Handling repairable errors

A proxy which supports this extension performs the following steps when receiving a repairable error:

- Determine if the UAC supports this extension
- Determine if the proxy is awaiting pending responses to complete the response context.

- o Generate a URI which identifies this specific branch
- o Encapsulate the original response in a message/sip body
- o Generate a 130 Repairable Error provisional response
- o Add an Identity header or its equivalent for responses
- o Send the 130 response appropriately

To determine if the UAC supports this extension, the proxy needs to check for the presence of the "herf" option-tag in the original INVITE request (typically in a Supported header). If the UAC does not advertise support for this option, response processing continues normally. The proxy also checks the response context of the request. If there are no more branches pending in the response context of this transaction, processing continues normally. The rest of this section assumes that the UAC supports this extension, and that there are pending branches remaining in the response context.

When a proxy receives a 400-class or 500-class response other than a 503, 487, or 408, the proxy SHOULD generate a 130 Repairable Error response as a User Agent Server. If the proxy receives a 300-class response, the proxy can decide based on local policy whether to recurse, or generate a 130 Repairable Error response.

To generate a 130 response, the proxy first creates a message/sip body containing the original (3xx, 4xx, or 5xx) response. The Content-Disposition header for this for this body MUST be "signal" [or we could define a new disposition called "error"]. The proxy does not add the response to the response context for the purpose of returning the best response. The proxy generates a unique To tag for the response. The response context continues to pend until the proxy has positive knowledge that the 130 response was successfully received by the UAC (either the corresponding 130 response is acknowledged or the single-branch URI is contacted).

Next, the proxy generates a "single-branch" URI which corresponds to this branch of this target set. The hostport production of the single-branch URI MUST be identical to the hostport production from the Request URI of the original request. If the Request URI of the original request was a SIPS URI, the single-branch URI MUST be a SIPS URI as well unless the error response was a 416 Unsupported URI Scheme, in which case the proxy SHOULD generate a single-branch URI using the SIP scheme. Otherwise the construction of a single-branch URI is local policy of the proxy and is not subject to standardization.

The proxy SHOULD embed a To header in the single-branch URI that corresponds to the Identity of the branch. Typically, this identity is the same identity which was in the original request. The scheme of the embedded To URI MUST match the scheme of the single-branch

URI. The hostport of the embedded To URI MUST be a domain for which the proxy can provide the Identity service.

The proxy now generates a 130 Repairable Error provisional response and adds a Contact header field containing the single-branch URI (including the embedded To header), and the message/sip body containing the original response.

The proxy SHOULD add an Identity header or its equivalent used for response identity. This insures the integrity and authenticity of the 130 response and protects from tampering the linkage between the URI provided in the Contact header of the 130 response and the original request.

At this point, the proxy is ready to send the provisional response. If the original INVITE included the 100rel option-tag, the proxy temporarily acts as a UAS and sends the 130 response reliably according to the rules in RFC 3262 [2]. Whether the 130 was sent reliably or unreliably, the proxy MUST retransmit the 130 response every 60 seconds until the proxy has positive knowledge that the 130 response was successfully received by the UAC (either the corresponding 130 response is acknowledged or the single-branch URI is contacted).

Note that provisional responses in SIP can be sent reliably or unreliably. This mechanism can be used in either case. The proxy MUST support the ability to send provisional reliable responses (RFC 3262). Whether the proxy sends 130 Repairable Error responses reliably or unreliably is up to the UAC. If the UAC indicates that it supports reliable provisional responses, the proxy server sends them reliably. Otherwise the proxy sends them unreliably. In most networks the unreliable provisionals will arrive and provide the desired behavior. This represents a significant improvement over current behavior. If the unreliable provisionals do not arrive, we have not solved HERFP, but the situation is no worse than with existing implementations.

If the proxy responds reliably it MUST include an answer (if the INVITE contained an offer) or an offer (otherwise) in the 130 response. The proxy can satisfy this requirement by generating a minimal offer or answer. A minimally appropriate answer declines all media lines in the offer. A minimally appropriate offer includes no media lines. When a 130 is sent reliably, the message/sip body containing the error and the session description are placed into a multipart/mixed body in the 130 response. UACs which support this extension and provisional reliability MUST support the multipart/ mixed MIME type.

4.2 Receiving subsequent requests with the single-branch property

As soon as the proxy is contacted at a single-branch URI for the first time, the proxy tries to find the appropriate branch. If the proxy cannot find the appropriate branch it MUST return a 481 response. If the proxy finds the branch, it marks the original response context for that branch as if the branch returned a 487 response. If the request is a PRACK, the proxy returns a 200 OK response to the PRACK with an appropriate RAck header. If the request is a DECLINE, the proxy returns a 200 OK response to the DECLINE and notes that this branch has been terminated. If the request is an INVITE, the proxy generates a response context for the new request consisting of one target and forwards the INVITE to the UAS for that target.

The proxy forwards provisional response for the new response context normally. When a final response to the new request is received it is forwarded immediately since the new response context consists of only one branch. If the final response to the new INVITE request is a 200-class or 600-class response, the proxy MUST CANCEL all other pending branches which were created from or related to the original INVITE request. In other words, the proxy must find all pending branches of both the "parent" transaction and all pending "sibling" transactions. In addition, the proxy MUST invalidate all the single-branch URIs associated with the original request.

Note that for a particular branch, the proxy might receive a new INVITE request which repairs one error, but for which there are other unresolved, but repairable error responses. While this situation is currently rare, proxy server MUST NOT invalidate single-branch URIs until Timer C expires for that branch, the branch is cancelled by the UAC, or a 200-class or 600-class response has been received on a parent or sibling transaction.

5. User Agent Client Behavior

A User Agent Client which supports this extension SHOULD advertise for this extension by including the "herf" option-tag in a Supported header field value in dialog-forming INVITE requests. The UAC needs the ability to send multiple invitations in the same user interface context, for example as if the UAC tried multiple contacts from a 300-class response simultaneously.

When a User Agent which supports this extension receives a 130 Repairable Error response to an INVITE request, it performs the following steps.

o Verify the validity of the Identity headers (if present)

- o Send a PRACK request if reliability was requested
- o Determine if the error is repairable
- o Either generate a new INVITE to repair the error, or generate a DECLINE request to acknowledge receipt of the 130 response.

The UAC SHOULD first verify that the 130 response was sent by a host which is authoritative for the domain of the original request and that the 130 response was not tampered with en route. The UAC checks that the Identity hash verifies and that the signer of the Identity header corresponds to the hostport production from the Request URI of the original request.

If the 130 response was sent reliably, the UAC MUST send a PRACK request to the URI in the Contact header field of the 130 response.

Next the UAC determines if it can and is willing to repair the error by examining the message/sip body (which may be a MIME part inside a multipart/mixed body). UACs which support this extension and provisional reliability MUST support the multipart/mixed MIME type. The UAC MAY decide based on local policy not to repair the error or it may be unable to do so. In that case, the UAC MUST send a DECLINE request to the URI in the Contact header field of the 130 response. Note that this DECLINE only terminates a single branch.

If the UAC is willing and able to repair the error, it generates a new INVITE request using the same Call-ID, but a different from-tag. It then sends this new INVITE to the URI in the Contact header field of the 130 response. If an embedded To header is present in the Contact URI, the UAC MUST override the To header of the new INVITE to use the value provided in the Contact header.

6. User Agent Server Behavior

This document requires no new behavior by User Agent Servers. It was designed to work only if the User Agent Client and the Proxy support this extension. There is an opportunity to improve the current situation when only the UAC and one UAS cooperate. Such behavior is potentially complimentary, but out of scope of this document.

7. Security Considerations

An attacker that maliciously injects 130 responses could theoretically direct a large number of new requests towards a specific proxy. To prevent this attack, the UAC SHOULD verify that a 130 response has a valid Identity header (or its response equivalent) signed using a key from a certificate whose subjectAltName is equivalent to the hostport production from the Request URI, and that the certificate is rooted in a trusted certificate chain. The

security considerations of a 130 response in this context are identical to injecting a malicious 300-class response.

A UAS that maliciously injects a 130 could theoretically downgrade the security of a dialog from SIPS to SIP. The UAC SHOULD include configurable policy to automatically repair or ignore 416 responses or to prompt the user.

A UAS that maliciously injects a 130 could selectively disable capabilities or extensions. The security considerations of such an attack are similar to injecting the corresponding 400-class response.

8. IANA Considerations

The following entries should be added to the registries for SIP option-tags and response-codes, respectively.

8.1 The "herf" option-tag

Name of option:	herf
Description:	Support for safe forking in the face of heterogeneous error responses
SIP headers defined:	none
Normative description:	This document

8.2 The "130 Repairable Error" response-code

Response Code Number: 130
Default Reason Phrase: Repairable Error

8.3 The "DECLINE" method

Method Name: DECLINE

9. Acknowledgments

This idea was the result of 1) participating in discussions with Jonathan Rosenberg, Paul Kyzivat, Jon Peterson, and Cullen Jennings on the properties of URIs in conjunction with the GRUU extension; 2) thoughts I had while implementing best response matching in the repro open-source SIP proxy, 3) numerous discussions about response Identity with Jon Peterson and Cullen Jennings, 4) and a discussion

with Mark Eastman about a solution to the Early Attended Transfer problem.

10. References

10.1 Normative 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.

[2] Rosenberg, J. and H. Schulzrinne, "Reliability of Provisional Responses in Session Initiation Protocol (SIP)", RFC 3262, June 2002.

[3] Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", BCP 14, RFC 2119, March 1997.

[4] Peterson, J. and C. Jennings, "Enhancements for Authenticated Identity Management in the Session Initiation Protocol (SIP)", draft-ietf-sip-identity-06 (work in progress), October 2005.

10.2 Informational References

[5] Rosenberg, J., "Obtaining and Using Globally Routable User Agent (UA) URIs (GRUU) in the Session Initiation Protocol (SIP)", draft-ietf-sip-gruu-06 (work in progress), October 2005.

[6] Roach, A., "Session Initiation Protocol (SIP)-Specific Event Notification", RFC 3265, June 2002.

URIs

[7] <http://scm.sipfoundry.org/rep/ietf-drafts/rohan/herf-fix/draft-rosenberg-sip-unify-00.txt>

[8] <http://scm.sipfoundry.org/rep/ietf-drafts/rohan/herfp/draft-rosenberg-sip-unify-00.txt>

Author's Address

Rohan Mahy
Plantronics
345 Encincal Street
Santa Cruz, CA
USA

Email: rohan@ekabal.com

Appendix A. Historical Context

The Heterogeneous Error Response Forking Problem (HERFP) was described in various SIP working group mailing list threads in late 2001 and then described more formally in a long expired Internet Draft (draft-rosenberg-sip-unify-00.txt [8]) in January of 2002. The problem description from the draft is copied here:

HERFP, as it is called, is, in our opinion, the most complex remaining problem with the SIP specification.

It relates to the rules for response processing at a forking proxy. A proxy never forwards more than one error response back to the [User Agent Client (UAC)]. This is needed to prevent response implosion, but more importantly, to support services at proxies. A forking proxy only returns an error response upstream if all forked requests generate an error response. However, a 200 OK [to an INVITE] is always forwarded upstream immediately.

The problem is that if a request forks, and one UAS generates an error because the INVITE is not acceptable for some reason (no credentials, bad , bad body type, unsupported extension, etc.), that response is held at the forking proxy until the other forks respond. Of course, another branch may find the request acceptable, and therefore never generate an error response. The effect is to cancel out the benefits of forking.

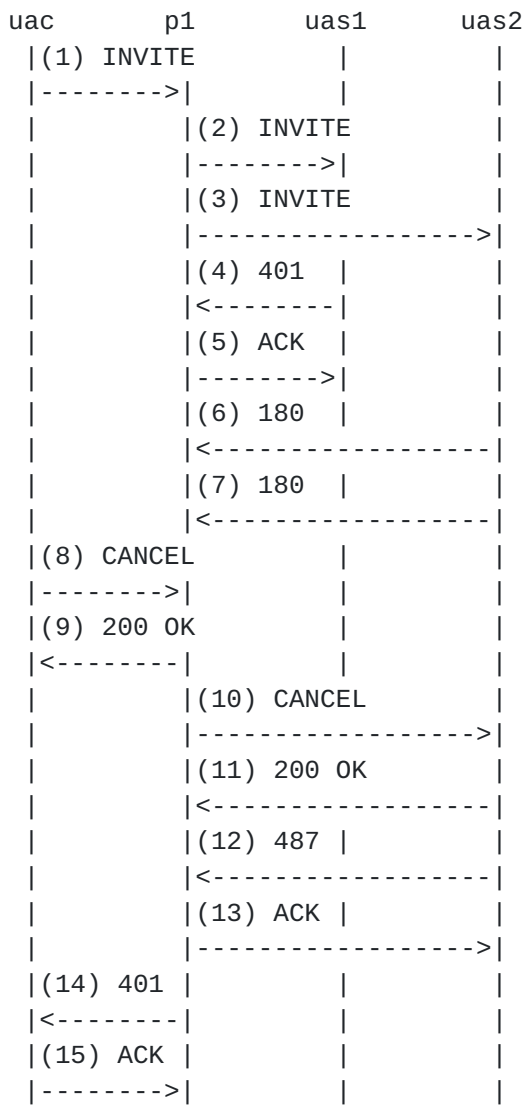


Figure 2: Basic HERFP Case

Figure 2 shows the simplest form of the problem. In this flow, the UAC sends an INVITE to proxy P1, which forks to UAS1 and UAS2. UAS1 might be a cell phone, and UAS2 a business phone. UAS1 rejects with a 401, and so never rings. However, UAS2 does not require credentials (or the request already had them), and therefore it rings. However, the user is not at their business phone, although they are available at the cell phone. After ringing for 20s, the caller gives up, and therefore sends CANCEL. This stops UAS2 from ringing, and results in the proxy forwarding the now-old 401 to the UAC. The UAC is not likely to retry, since the user just hung up. Thus, no call is setup.

Intellectual Property Statement

Disclaimer of Validity

Copyright Statement

Acknowledgment

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