SIP J. Rosenberg
Internet-Draft Cisco Systems
Expires: January 15, 2006 July 14, 2005

Obtaining and Using Globally Routable User Agent (UA) URIs (GRUU) in the Session Initiation Protocol (SIP)

draft-ietf-sip-gruu-04

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Abstract

Several applications of the Session Initiation Protocol (SIP) require a user agent (UA) to construct and distribute a URI which can be used by anyone on the Internet to route a call to that specific UA instance. A URI which routes to a specific UA instance is called a Globally Routable UA URI (GRUU). This document describes an extension to SIP for obtaining a GRUU from a server, and for communicating a GRUU to a peer within a dialog.

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1. Introduction

The Session Initiation Protocol, RFC 3261 [1] is used to establish and maintain a dialog between a pair of user agents in order to manage a communications session. Messages within the dialog are sent from one user agent to another using a series of proxy hops called the route set, eventually being delivered to the remote target - the user agent on the other side of the dialog. This remote target is a SIP URI obtained from the value of the Contact header field in INVITE requests and responses.

RFC 3261 mandates that a user agent populate the Contact header field in INVITE requests and responses with a URI that is global (meaning that it can be used from any element connected to the Internet), and that routes to the user agent which inserted it. RFC 3261 also mandates that this URI be valid for requests sent outside of the dialog in which the Contact URI was inserted.

In practice, these requirements have proven very difficult to meet. Endpoints often have only an IP address and not a hostname that is present in DNS, and this IP address is frequently a private address, because the client is behind a NAT. Techniques like the Simple Traversal of UDP Through NAT (STUN) [15] can be used to obtain IP addresses on the public Internet. However, many firewalls will prohibit incoming SIP requests from reaching a client unless they first pass through a proxy sitting in the DMZ of the network. Thus URIs using STUN-obtained IP addresses often do not work.

Because of these difficulties, most clients have actually been inserting URIs into the Contact header field of requests and responses with the form sip:<IP-address>. These have the property of routing to the client, but they are generally only reachable from the proxy to which the user is directly connected. This limitation does not prevent normal SIP calls from proceeding, since the user's proxy can usually reach these private addresses, and the proxy itself is generally reachable over the public network. However, this issue has impacted the ability of several other SIP mechanisms and applications to work properly.

An example of such an application is call transfer [24], based on the REFER method [7]. Another application is the usage of endpoint-hosted conferences within the conferencing framework [17]. Both of these mechanisms require the endpoint to be able to construct a URI that not only routes to that user agent, but is usable by other entities anywhere on the Internet as a target for new SIP requests.

This specification formally defines a type of URI called a Globally Routable User Agent URI (GRUU) which has the properties of routing to

the UA and being reachable from anywhere. Furthermore, it defines a new mechanism by which a client can obtain a GRUU from its SIP provider, allowing it to use that URI in the Contact header fields of its dialog forming requests and responses. Since the GRUU is provided by the user's SIP provider, the GRUU properties can be guaranteed by the provider. As a result, the various applications which require the GRUU property, including transfer, presence, and conferencing, can work reliably.

2. Terminology

In this document, the key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" are to be interpreted as described in RFC 2119 [5] and indicate requirement levels for compliant implementations.

This specification also defines the following additional terms:

contact: The term "contact", when used in all lowercase, refers to a URI that is bound to an AOR or GRUU by means of a registration. A contact is usually a SIP URI, and is bound to the AOR and GRUU through a REGISTER request by appearing as the value of the Contact header field.

remote target: The term "remote target" refers to a URI that a user agent uses to identify itself for receipt of subsequent requests mid-dialog. A remote target is established by placing a URI in the Contact header field of a dialog forming request or response.

Contact header field: The term "Contact header field", with a capitalized C, refers to the header field which can appear in REGISTER requests and responses, redirects, or in dialog creating requests and responses. Depending on the semantics, the Contact header field sometimes conveys a contact, and sometimes conveys a remote target.

3. Defining a GRUU

URIs have properties. Those properties are granted to the URI based on the policies of the domain that owns the URI, and those properties are not visible by inspection of the URI. Some of the properties that a domain can confer upon a URI are:

The AOR property: A URI has the Address of Record (AOR) property if a domain will allow it to appear in the To header field of REGISTER request.

The alias property: A URI is an alias if its treatment by the domain is identical to another URI.

The service treatment property: A URI has the service treatment property if the domain will apply applications, features, and services to calls made by, or made to, that URI, possibly based on associating that URI with a user that has "subscribed" to various features.

The anonymous property: A URI has the anonymous property when it is not possible, by inspection of the URI, to discern the user with whom the URI is associated.

The identity property: A URI is considered an identity when it is one that the domain will authorize as a valid value in the From header field of a request, such that an authentication service will sign a request with that URI [19].

This specification focuses on a property, called the Globally Routable User Agent URI (GRUU) property. A URI possesses this property when the following is true:

Global: It can be used by any UAC connected to the Internet. In that regard, it is like the address-of-record (AOR) property. A URI with the AOR property (for example, sip:joe@example.com), is meant to be used by anyone to reach that user. The same is true for a URI with the GRUU property.

Routes to a Single Instance: A request sent to that URI will be routed to a specific UA instance. In that regard, it is unlike the address-of-record property. When a request is sent to a URI with the AOR property, routing logic is applied in proxies to deliver the request to one or more UAs. That logic can result in a different routing decision based on the time-of-day, or the identity of the caller. However, when a request is made to a URI with the GRUU property, the routing logic is dictated by the GRUU property. The request has to be delivered to a very specific UA instance. That UA instance has to be the same UA instance for all requests sent to that URI.

Long Lived: The URI with the GRUU property persists for relatively long periods of time, ideally being valid for the duration of existence of the AOR itself. This property cannot be completely guaranteed, but providers are supposed to do their best to make sure that a GRUU remains viable indefinitely.

A URI can have any combination of these properties. It is the responsibility of the domain which mints the URI to determine what

properties are conferred upon that URI. This specification imposes requirements on a domain that mints a URI with the GRUU property.

For convenience, a URI that possesses the GRUU property is also referred to as a GRUU.

4. Use Cases

There are several use cases where the GRUU properties are truly needed in order for a SIP application to operate.

4.1 REFER

Consider a blind transfer application [24]. User A is talking to user B. User A wants to transfer the call to user C. So, user A sends a REFER to user C. That REFER looks like, in part:

```
REFER sip:C@example.com SIP/2.0
From: sip:A@example.com;tag=99asd
To: sip:C@example.com
Refer-To: (URI that identifiers B's UA)
```

The Refer-To header field needs to contain a URI that can be used by user C to place a call to user B. However, this call needs to route to the specific UA instance which user B is using to talk to user A. If it didn't, the transfer service would not execute properly. This URI is provided to user A by user B. Because user B doesn't know who user A will transfer the call to, the URI has to be usable by anyone. Therefore, it needs to be a GRUU.

4.2 Conferencing

A similar need arises in conferencing [17]. In that framework, a conference is described by a URI which identifies the focus of the conference. The focus is a SIP UA that acts as the signaling hub for the conference. Each conference participant has a dialog with the focus. One case described in the framework is where a user A has made a call to user B. User A puts user B on hold, and calls user C. Now, user A has two separate dialogs for two separate calls - one to user B, and one to user C. User A would like to conference them. To do this, user A's user agent morphs itself into a focus. It sends a re-INVITE or UPDATE [4] on both dialogs, and provides user B and user C with an updated remote target that now holds the conference URI. The URI in the Contact header field also has a callee capabilities [11] parameter which indicates that this URI is a conference URI. User A proceeds to mix the media streams received from user B and user C. This is called an ad-hoc conference.

At this point, normal conferencing features can be applied. That means that user B can send another user, user D, the conference URI, perhaps in an email. User D can send an INVITE to that URI, and join the conference. For this to work, the conference URI used by user A in its re-INVITE or UPDATE has to be usable by anyone, and it has to route to the specific UA instance of user A that is acting as the focus. If it didn't, basic conferencing features would fail. Therefore, this URI has to be a GRUU.

4.3 Presence

In a SIP-based presence [25] system, the Presence Agent (PA) generates notifications about the state of a user. This state is represented with the Presence Information Document Format (PIDF) [23]. In a PIDF document, a user is represented by a series of tuples, each of which describes the services that the user has. Each tuple also has a URI in the <contact> element, which is a SIP URI representing that device. A watcher can make a call to that URI, with the expectation that the call is routed to the service whose presence is represented in the tuple.

In some cases, the service represented by a tuple may exist on only a single user agent associated with a user. In such a case, the URI in the presence document has to route to that specific UA instance. Furthermore, since the presence document could be used by anyone who subscribes to the user, the URI has to be usable by anyone. As a result, it has to be a GRUU.

It is interesting to note that the GRUU may need to be constructed by a presence agent, depending on how the presence document is computed by the server.

5. Overview of Operation

This section is tutorial in nature, and does not specify any normative behavior.

This extension allows a UA to obtain a GRUU, and to use a GRUU. These two mechanisms are separate, in that a UA can obtain a GRUU in any way it likes, and use the mechanisms in this specification to use them. This specification defines two mechanisms for obtaining a GRUU - through registrations, and through administrative operation. Only the former requires protocol operations.

A UA can obtain a GRUU by generating a normal REGISTER request, as specified in RFC 3261 [1]. This request contains a Supported header field with the value "gruu", indicating to the registrar that the UA supports this extension. The UA includes a "sip.instance" media

feature tag in the Contact header field of each contact for which a GRUU is desired. This media feature tag contains a globally unique ID that identifies the UA instance. If the domain that the user is registering against also supports GRUU, the REGISTER responses will contain the "gruu" parameter in each Contact header field. This parameter contains a GRUU which the domain guarantees will route to that UA instace. The GRUU is associated with the UA instace. Should the client change its contact, but indicate that it represents the same instance ID, the server would provide the same GRUU. Furthermore, if the registration for the contact expires, and the UA registers the contact at a later time with the same instance identifier, the server would provide the same GRUU.

Since the GRUU is a URI like any other, it can be handed out by a UA by placing it in any header field which can contain a URI. A UA will place the GRUU into the Contact header field of dialog creating requests and responses it generates; RFC 3261 mandates that the Contact header field have the GRUU property, and this specification provides a reliable way for a UA to obtain one. In other words, clients use the GRUU as a remote target. However, since the remote target used by clients to date has typically not had the GRUU properties, implementations have adapted their behaviors (oftentimes in proprietary ways) to compensate. To facilitate a transition away from these behaviors, it is necessary for a UA receiving the message to know whether the remote target is a GRUU or not. To make this determination, the UA looks for the presence of the Supported header field in the request or response. If it is present with a value of "gruu", it means that the remote target is a GRUU.

A domain can construct a GRUU in any way it chooses. However, it is sometimes desirable to construct them in a way which allows for any entity that receives the GRUU to determine the AOR for the subscriber associated with the UA instance. To facilitate that, the GRUU can be constructed by adding the "opaque" URI parameter to the subscriber's AOR. This parameter would contain the context needed for the domain to recognize and treat the URI as a GRUU.

When a UA uses a GRUU, it has the option of adding the "grid" URI parameter to the GRUU. This parameter is opaque to the proxy server handling the domain. However, when the server maps the GRUU to the contact bound to it, the server will add the grid parameter into the registered contact, and use the result in the Request URI. As a result, when the UA receives the request, the Request URI will contain the grid parameter it placed in the corresponding GRUU.

The "grid" and "opaque" URI parameters play similar roles, but complement each other. The "opaque" parameter is added by the owner of the domain in order to ensure that the URI has the GRUU property.

The "grid" parameter is added by the UA instance so that, when a request is received by that instance, it can determine the context of the request.

6. Creation of a GRUU

A GRUU is a URI that is created and maintained by a server authoritative for the domain in which the GRUU resides. Independently of whether the GRUU is created as a result of a registration or some other means, a server maintains certain information associated with the GRUU. This information, and its relationship with the GRUU, is modeled in Figure 2.

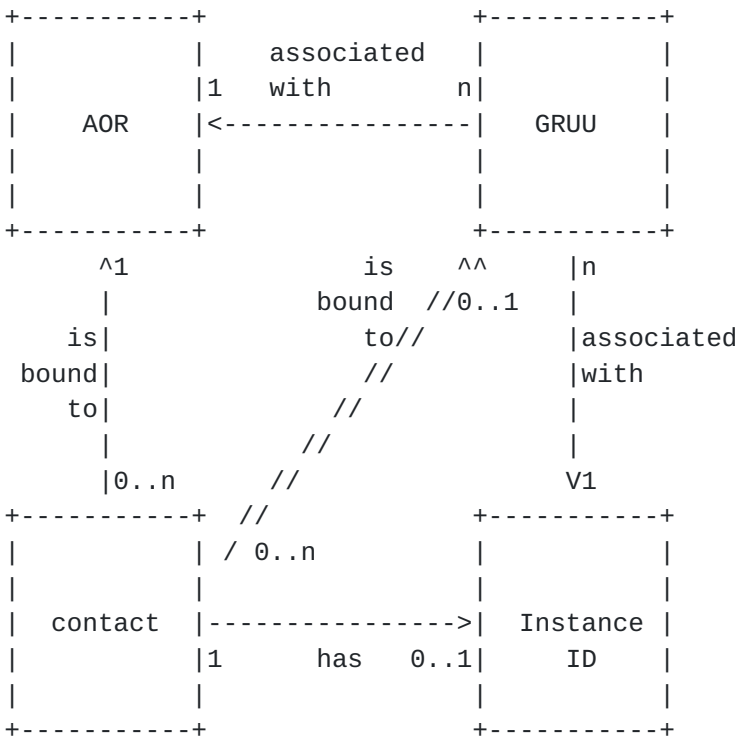


Figure 2

The instance ID plays a key role in this specification. It is an identifier, represented as a URN, that uniquely identifies a SIP user agent amongst all other user agents associated with an AOR. For hardware-based user agents, the instance ID would typically be burned into the device in the factory, similar to the way a unique serial

number is encoded into each device. For software-based user agents, each installation represents a unique instance. As such, the identifier could be generated on installation and then stored on disk for persistence.

A GRUU is associated, in a one-to-one fashion, with the combination of an AOR and instance ID. This combination is referred to as an instance ID/AOR pair. For each GRUU, there is one instance ID/AOR pair, and for each instance ID/AOR pair, there is one GRUU. The instance ID/AOR pair serves to uniquely identify a user agent instance servicing a specific AOR. The AOR identifies a resource, such as a user or service within a domain, and the instance ID identifies a specific UA instance servicing requests for that resource.

It is important to understand that GRUU is associated with the instance ID/AOR pair, not just the instance ID. For example, if a user registered the contact sip:ua@pc.example.com to the AOR sip:user@example.com, and included a +sip.instance="urn:foo:1" parameter in the Contact header field, and also registered the contact sip:ua-112@pc.example.com with the same +sip.instance Contact header field parameter to a second AOR, say sip:boss@example.com, each of those UA instances would have a different GRUU, since they belong to different AORs. That is the reason why a single instance ID can be associated with multiple GRUU; there would be one such association for each AOR. The same goes for the association of AOR to GRUU; there would be one such association for each instance ID.

In many ways, a GRUU is a parallel to an AOR. A URI cannot have both the AOR property and the GRUU property. Just as a contact can be bound to an AOR, a contact can be bound to a GRUU. Any number of contacts can be bound to an AOR, but only those contacts for a particular instance are bound to the GRUU. As discussed in Section 8.4.1 If there are more than one contacts of a particular instance bound to the AOR, only the most recently registered one is used. Similarly, if there are more than one contacts of a particular instance bound to the GRUU, only the most recently registered one is used. Using only the most recently registered contact from an instance ensures that, upon failure and reboot, an instance that obtains and registers a new IP address immediately renders its previous one inactive. Multiple active registrations from a single instance is useful for certain high availability scenarios, and mechanisms for achieving that using a GRUU are described in [18].

The contacts that are bound to the GRUU are always the ones that have an instance ID associated with that GRUU. If none of the contacts bound to the AOR have the instance ID associated with the GRUU, then there are no contacts bound to the GRUU. If a contact should become

registered to the AOR that has an instance ID equal to the one associated with the GRUU, that contact also becomes bound to the GRUU. If that contact should expire, it will no longer be bound to the AOR, and similarly, it will no longer be bound to the GRUU. The URI of the contact is irrelevant in determining whether it is bound to a particular GRUU; only the instance ID and AOR are important.

This specification does not mandate a particular mechanism for construction of the GRUU. Several example approaches are given in Appendix A. However, the GRUU MUST exhibit the following properties:

- The domain part of the URI is an IP address present on the public Internet, or, if it is a host name, the resolution procedures of RFC 3263 [2], once applied, result in an IP address on the public Internet.

- When a request is sent to the GRUU, it routes to a server that can make sure the request is delivered to the UA instance. For GRUU created through registrations, this means that the GRUU has to route to a proxy server with access to registration data.

- A server in the domain can determine that the URI is a GRUU.

- For each GRUU, both the SIP and SIPS versions MUST exist.

Section 8.4 defines additional behaviors that a proxy must exhibit on receipt of a GRUU.

When a domain constructs a URI with the GRUU properties, it MAY confer other properties upon this URI as a matter of domain policy. Of course, the AOR property cannot also be provided, since the GRUU and AOR properties are mututally exclusive. However, a domain can elect to confer properties like identity, anonymity, and service treatment. There is nothing in this specification that can allow the recipient of the GRUU to determine which of these properties besides the GRUU property itself have been conferred to the URI.

The service treatment property merits further discussion. Typically, the services a proxy executes upon receipt of a request sent to a GRUU will be a subset of those executed when a request is sent to the AOR. For requests that are outside of a dialog, it is RECOMMENDED to apply screening types of functions, both automated (such as black and white list screening) and interactive (such as interactive voice response (IVR) applications which confer with the user to determine whether to accept a call). However, forwarding services, such as call forwarding, SHOULD NOT be provided for requests sent to a GRUU. The intent of the GRUU is to target a specific UA instance, and this is incompatible with forwarding operations.

Mid-dialog requests will also be sent to GRUUs, as they are included as the remote-target in dialog forming requests and responses. In those cases, however, a proxy SHOULD only apply services that are meaningful for mid-dialog requests generally speaking. This excludes screening functions, as well as forwarding ones.

The "opaque" URI parameter, defined in Section 9 provides a means for a domain to construct a GRUU such that the AOR associated with the GRUU is readily extractable from the GRUU. Unless the GRUU is meant to also possess the anonymity property, it is RECOMMENDED that GRUUs be constructed using this parameter.

Since the GRUU is associated with both the instance ID and AOR, for any particular AOR there can be a potentially infinite number of GRUU, one for each instance ID. However, the instance IDs are only known to the network when an instance actually registers with one. As a result, it is RECOMMENDED that a GRUU exist from the time a contact with an instance ID is first registered to an AOR, until the time that the AOR is no longer valid in the domain. In this context, the GRUU exists if the domain, upon receiving a request for that GRUU, recognizes it as a GRUU, can determine the AOR and instance ID associated with it, and translate the GRUU to a contact if there is one with that instance ID currently registered. This property of the GRUU can be difficult to achieve through software failures and power outages within a network, and for this reason, the requirement is at RECOMMENDED strength, and not MUST.

7. Obtaining a GRUU

A GRUU can be obtained in many ways. This document defines two - through registrations, and through administrative operation.

7.1 Through Registrations

When a GRUU is associated with a user agent that comes and goes, and therefore registers to the network to bind itself to an AOR, a GRUU is provided to the user agent through SIP REGISTER messages.

7.1.1 User Agent Behavior

7.1.1.1 Generating a REGISTER Request

When a UA compliant to this specification generates a REGISTER request (initial or refresh), it MUST include the Supported header field in the request. The value of that header field MUST include "gruu" as one of the option tags. This alerts the registrar for the domain that the UA supports the GRUU mechanism.

Furthermore, for each contact for which the UA desires to obtain a GRUU, the UA MUST include a "sip.instance" media feature tag as a UA characteristic [11]. As described in [11], this media feature tag will be encoded in the Contact header field as the "+sip.instance" Contact header field parameter. The value of this parameter MUST be a URN [10]. [11] defines equality rules for callee capabilities parameters, and according to that specification, the "sip.instance" media feature tag will be compared by case sensitive string comparison. This means that the URN will be encapsulated by angle brackets ("<" and ">") when it is placed within the quoted string value of the +sip.instance contact parameter. The case sensitive matching rules apply only to the generic usages defined there and in the caller preferences specification [22]. When the instance ID is used in this specification, it is effectively "extracted" from the value in the "sip.instance" media feature tag, and thus equality comparisons are performed using the rules for URN equality specific to the scheme in the URN. If the element performing the comparisons does not understand the URN scheme, it performs the comparisons using the lexical equality rules defined in RFC 2141. Lexical equality may result in two URN being considered unequal when they are actually equal. In this specific usage of URNs, the only element which provides the URN is the SIP UA instance identified by that URN. As a result, the UA instance SHOULD provide lexically equivalent URNs in each registration it generates. This is likely to be normal behavior in any case; clients are not likely to modify the value of the instance ID so that it remains functionally equivalent to previous registrations, but lexigraphically different.

This specification makes no normative recommendation on the specific URN that is to be used in the "+sip.instance" Contact header field parameter. However, the URI MUST be selected such that the instance can be certain that no other instance registering against the same AOR would choose the same URI value. Usage of a URN is a MUST since it provides a persistent and unique name for the UA instance, allowing it to obtain the same GRUU over time. It also provides an easy way to guarantee uniquess within the AOR. However, this specification does not require a long-lived and persistent instance identifier to properly function, and in some cases, there may be cause to use an identifier with weaker temporal persistence.

One URN that readily meets the requirements of this specification is the UUID URN [26], which allows for non-centralized computation of a URN based on time, unique names (such as a MAC address) or a random number generator. An example of a URN that would not meet the requirements of this specification is the national bibliographic number [16]. Since there is no clear relationship between an SIP UA instance and a URN in this namespace, there is no way a selection of a value can be performed that guarantees that another UA instance

doesn't choose the same value.

If a UA instance is registering against multiple AOR, it is RECOMMENDED that a UA instance provide a different contact URI for each AOR. This is needed for the UA to determine which GRUU to use as the remote target in responses to incoming dialog forming requests, as discussed in Section 8.1.

Besides the procedures discussed above, the REGISTER request is constructed identically to the case where this extension was not understood. Specifically, the contact in the REGISTER request SHOULD NOT contain the gruu Contact header field parameter, and the contact URI itself SHOULD NOT contain the grid parameter defined below. Any such parameters are ignored by the registrar, as the UA cannot propose a GRUU for usage with the contact.

If a UA wishes to guarantee that the request is not processed unless the domain supports and uses this extension, it MAY include a Require header field in the request with a value that contains the "gruu" option tag.

7.1.1.2 Processing the REGISTER Response

If the response is a 2xx, each Contact header field that contained the "+sip.instance" Contact header field parameter may also contain a "gruu" parameter. This parameter contains a SIP or SIPS URI that represents a GRUU corresponding to the UA instance that registered the contact. The URI will be a SIP URI if the To header field in the REGISTER request contained a SIP URI, else it will be a SIPS URI if the To header field in the REGISTER request contained a SIPS URI. Any requests sent to the GRUU URI will be routed by the domain to the contact with that instance ID. The GRUU will not normally change in subsequent 2xx responses to REGISTER. Indeed, even if the UA lets the contact expire, when it re-registers it at any later time, the registrar will normally provide the same GRUU for the same address-of-record and instance ID. However, as discussed above, this property cannot be completely guaranteed, as network failures may make it impossible to provide an identifier that persists for all time. As a result, a UA MUST be prepared to receive a different GRUU for the same instance ID/AOR pair in a subsequent registration response.

A non-2xx response to the REGISTER request has no impact on any existing GRUU previously provided to the UA. Specifically, if a previously successful REGISTER request provided the UA with a GRUU, a subsequent failed request does not remove, delete, or otherwise invalidate the GRUU.

7.1.2 Registrar Behavior

A registrar MAY create a GRUU for a particular instance ID/AOR pair at any time. Of course, if a UA requests a GRUU in a registration, and the registrar has not yet created one, it will need to do so in order to respond to the registration request. However, the registrar can create the GRUU in advance of any request from a UA.

A registrar MUST create both the SIP and SIPS versions of the GRUU, such that if the GRUU exists, both URI exist.

7.1.2.1 Processing a REGISTER Request

When a registrar compliant to this specification receives a REGISTER request, it checks for the presence of the Require header field in the request. If present, and if it contains the "gruu" option tag, the registrar MUST follow the procedures in the remainder of this section and Section 7.1.2.2 (that is, the procedures which result in the creation of new GRUUs for contacts indicating an instance ID, and the listing of GRUUs in the REGISTER response). If not present, but a Supported header field was present with the "gruu" option tag, the registrar SHOULD follow the procedures in the remainder of this section and Section 7.1.2.2. If the Supported header field was not present, or it if was present but did not contain the value "gruu", the registrar SHOULD NOT follow the procedures in the remainder of this section or Section 7.1.2.2.

As the registrar is processing the contacts in the REGISTER request according to the procedures of step 7 in Section 10.3 of RFC 3261, the registrar additionally checks whether each Contact header field in the REGISTER message contains a "+sip.instance" header field parameter. If present, the contact is processed further. If the registrar had not yet created a GRUU for that instance ID/AOR pair, it MUST do so at this time according to the procedures of Section 6. If the contact contained a "gruu" Contact header field parameter, it MUST be ignored by the registrar. A UA cannot suggest or otherwise provide a GRUU to the registrar.

Registration processing then continues as defined in RFC 3261. If, after that processing, that contact is bound to the AOR, it also becomes bound to the GRUU associated with that instance ID/AOR pair. If, after that processing, the contact was not bound to the AOR (due, for example, to an expires value of zero), the contact is not bound to the GRUU either. The registrar MUST store the instance ID along with the contact.

When generating the 200 (OK) response to the REGISTER request, the procedures of step 8 of Section 10.3 of RFC 3261 are followed.

Furthermore, for each Contact header field value placed in the response, if the registrar has stored an instance ID associated with that contact, that instance ID is returned as a Contact header field parameter, and furthermore, the server MUST add a "gruu" Contact header field parameter. The value of the gruu parameter is a quoted string containing the URI that is the GRUU for the associated instance ID/AOR pair. If the To header field in the REGISTER request had contained a SIP URI, the SIP version of the GRUU is returned. If the To header field in the REGISTER request had contained a SIPS URI, the SIPS version of the GRUU is returned.

The REGISTER response MUST contain a Require header field with the value "gruu". This is because the client needs to extract its GRUU from the REGISTER response, and utilize them as the remote target of dialog initiating requests and responses.

Note that handling of a REGISTER request containing a Contact header field with value "*" and an expiration of 0 still retains the meaning defined in RFC 3261 - all contacts, not just ones with a specific instance ID, are deleted. This removes their binding to the AOR and to any GRUU.

Inclusion of a GRUU in the "gruu" Contact header field parameter of a REGISTER response is separate from the computation and storage of the GRUU. It is possible that the registrar has computed a GRUU for one UA, but a different UA that queries for the current set of registrations doesn't understand GRUU. In that case, the REGISTER response sent to that second UA would not contain the "gruu" Contact header field parameter, even though the UA has a GRUU for that contact.

7.1.2.2 Timing Out a Registration

When a registered contact expires, its binding to the AOR is removed as normal. In addition, its binding to the GRUU is removed at the same time.

7.2 Administratively

Administrative creation of GRUUs is useful when a UA instance is a network server that is always available, and therefore doesn't register to the network. Examples of such servers are voicemail servers, application servers, and gateways.

There are no protocol operations required to administratively create a GRUU. The proxy serving the domain is configured with the GRUU, and with the contact it should be translated to. It is not strictly necessary to also configure the instance ID and AOR, since the

translation can be done directly. However, they serve as a useful tool for determining which resource and UA instance the GRUU is supposed to map to.

In addition to configuring the GRUU and its associated contact in the proxy serving the domain, the GRUU will also need to be configured into the UA instance associated with the GRUU.

It is also reasonable to model certain network servers as logically containing both a proxy and a UA instance. The proxy receives the request from the network, and passes it internally to the UA instance. In such a case, the GRUU routes directly to the server, and there is no need for a translation of the GRUU to a contact. The server itself would construct its own GRUU.

8. Using the GRUU

8.1 Sending a Message Containing a GRUU

A UA first obtains a GRUU using the procedures of Section 7, or by other means outside the scope of this specification.

A UA can use the GRUU in the same way it would use any other SIP or SIPS URI. However, a UA compliant to this specification MUST use a GRUU when populating the Contact header field of dialog-creating requests and responses. In other words, a UA compliant to this specification MUST use its GRUU as its remote target. This includes the INVITE request and its 2xx response, the SUBSCRIBE [6] request, its 2xx response, the NOTIFY request, and the REFER [7] request and its 2xx response.

If the UA instance has obtained multiple GRUUs (each for a different AOR) through a registration, it MUST use the one corresponding to the AOR used to send or receive the request. For sending a request, this means that the GRUU corresponds to the AOR present in the From header field, and furthermore the credentials used for authentication of the request correspond to the ones associated with that AOR. When receiving a request, the GRUU in the response corresponds to the AOR to which the original request was targeted. That AOR, however, will be rewritten by the proxy to correspond to the UA's registered contact. It is for this reason that different contacts are needed for each AOR that an instance registers against. In this way, when an incoming request arrives, the Request URI can be examined. It will be equal to a registered contact. That contact can be used to map directly to the AOR, and from there, the correct GRUU can be selected.

In those requests and responses where the GRUU is used as the remote

target, the UA MUST include a Supported header field that contains the option tag "gruu". However, it is not necessary for a UA to know whether or not its peer in the dialog supports this specification before using one as a remote target.

When using the GRUU as a remote target, a UA MAY add the "grid" URI parameter to the GRUU. This parameter MAY take on any value permitted by the grammar for the parameter. Note that there are no limitations on the size of this parameter. When a UA sends a request to the GRUU, the proxy for the domain that owns the GRUU will translate the GRUU in the Request-URI, replacing it with the URI bound to that GRUU. However, it will retain the "grid" parameter when this translation is performed. As a result, when the UA receives the request, the Request-URI will contain the "grid" created by the UA. This allows the UA to effectively manufacture an infinite supply of GRUU, each of which differs by the value of the "grid" parameter. When a UA receives a request that was sent to the GRUU, it will be able to tell which GRUU was invoked by the "grid" parameter.

An implication of this behavior is that all mid-dialog requests will be routed through intermediate proxies. There will never be direct, UA to UA signaling. It is anticipated that this limitation will be addressed in future specifications.

Once a UA knows that the remote target provided by its peer is a GRUU, it can use it in any application or SIP extension which requires a globally routable URI to operate. One such example is assisted call transfer.

8.2 Sending a Message to a GRUU

There is no new behavior associated with sending a request to a GRUU. A GRUU is a URI like any other. When a UA receives a request or response, it can know that the remote target is a GRUU if the request or response had a Supported header field that included the value "gruu". The UA can take the GRUU, and send a request to it, and then be sure that it is delivered to the UA instance which sent the request or response.

If the GRUU contains the "opaque" URI parameter, a UA can obtain the AOR for the user by stripping the parameter. The resulting URI is the AOR. If the GRUU does not have the "opaque" URI parameter, there is no mechanism defined for determining the AOR from the GRUU. Extraction of the AOR from the GRUU is useful for call logs and other accounting functions, where it is desirable to know the user to whom the request was directed.

Since the instance ID is a callee capabilities parameter, a UA might be tempted to send a request to the AOR of a user, and include an Accept-Contact header field [22] which indicates a preference for routing the request to a UA with a specific instance ID. Although this would appear to have the same effect as sending a request to the GRUU, it does not. The caller preferences expressed in the Accept-Contact header field are just preferences. Its efficacy depends on a UA constructing an Accept-Contact header field that interacts with domain processing logic for an AOR, to cause it to route to a particular instance. Given the variability in routing logic in a domain (for example, time based routing to only selected contacts), this doesn't work for many domain routing policies. However, this specification does not forbid a client from attempting such a request, as there may be cases where the desired operation truly is a preferential routing request.

8.3 Receiving a Request Sent to a GRUU

When a UAS receives a request sent to its GRUU, the incoming request URI will be equal to the contact that was registered (through REGISTER or some other action) by that UA instance. If the user agent had previously handed out its GRUU with a grid parameter, the incoming request URI may contain that parameter. This indicates to the UAS that the request is being received as a result of a request sent by the UAC to that GRUU/grid combination. This specification makes no normative statements about when to use a grid parameter, or what to do when receiving a request made to a GRUU/grid combination. Generally, any differing behaviors are a matter of local policy.

It is important to note that, when a user agent receives a request, and the request URI does not have a grid parameter, the user agent cannot tell whether the request was sent to the AOR or to the GRUU. As such, the UAS will process such requests identically. If a user agent needs to differentiate its behavior based on these cases, it will need to use a grid parameter.

8.4 Proxy Behavior

Proxy behavior is fully defined in Section 16 of RFC 3261. GRUU processing impacts that processing in two places - request targeting and record-routing.

8.4.1 Request Targeting

When a proxy server receives a request, and the proxy owns the domain in the Request URI, and the proxy is supposed to access a Location Service in order to compute request targets (as specified in Section 16.5 of RFC 3261 [1]), the proxy examines the Request URI. If the

Request URI is an AOR against which there are multiple registered contacts with the same instance ID parameter, the proxy MUST use only the most recently registered contact for inclusion in the target set. The contact that is the most recently registered is the one that has been bound to the AOR is the shortest period of time. This corresponds to the minimum value for the "duration-registered" attribute from the registration event package [27]. It is important to note that a refresh of the contact in a REGISTER message does not reset the duration it has been registered to zero. For example, if a softphone is started at 9am when a user logs into their computer, and the softphone refreshes its registration every hour, by 1230pm the contact has been registered for three and a half hours.

If the request URI is within the domain of the proxy, and the URI has been constructed by the domain such that the proxy is able to determine that it has the form of a GRUU for an AOR that is unknown within the domain, the proxy rejects the request with a 404. If the request URI is within the domain of the proxy, and the URI has been constructed by the domain such that the proxy is able to determine that it has the form of a GRUU for an AOR that known within the domain, but the instance ID is unknown, the proxy SHOULD generate a 480.

If the GRUU does exist, handling of the GRUU proceeds as specified in RFC 3261 Section 16. For GRUUs, the abstract location service described in Section 16.5 is utilized, producing a set of zero or more contacts, each of which is associated with the same instance ID. If there are more than one contacts bound to the GRUU, the proxy MUST select the one that has been most recently registered, as defined above. This produces zero or one contacts. The request target MUST be obtained by taking that one contact, and if the GRUU in the Request URI contained a "grid" URI parameter, adding that parameter to the request target. If the grid was already present in the contact bound to the GRUU, it is overwritten in this process. If no contacts were bound to the GRUU, the lookup of the GRUU in the abstract location service will result in zero target URI, eventually causing the proxy to reject the request with a 480 (Temorarily Unavailable) response.

If the contact had been registered using a Path header field [3], then that Path is used to construct the route set for reaching that contact through the GRUU as well as through the AOR, using the procedures specified in RFC 3327.

A proxy MAY apply other processing to the request, such as execution of called party features, as discussed in Section 6.

A request sent to a GRUU SHOULD NOT be redirected. In many

instances, a GRUU is used by a UA in order to assist in the traversal of NATs and firewalls, and a redirection may prevent such a case from working.

8.4.2 Record Routing

As described above, a user agent uses its GRUU as a remote target. This has an impact on the path taken by subsequent mid-dialog requests. Depending on the desires of the proxies involved, this may impact record route processing.

Two cases can be considered. The first is shown in Figure 3. In this case, there is a single proxy in the user's domain. An incoming INVITE request arrives for the users AOR (1) and is forwarded to the user agent at its registered contact C1 (2). The proxy inserts a Record-Route header field into the proxied request, with a value of R1. The user agent generates a 200 OK to the request, using its GRUU G1 as the remote target.

(1) + (2): initial INVITE
(3) + (4): mid-dialog request

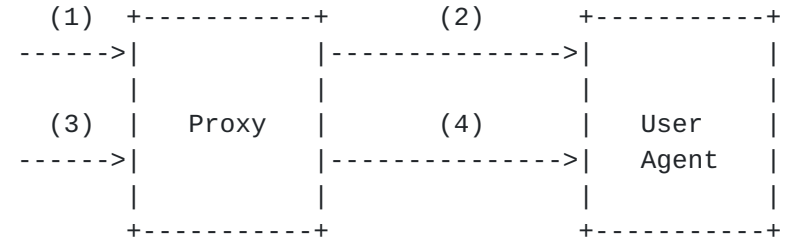


Figure 3

When a mid-dialog request shows up destined for the user agent (message 3), it will arrive at the proxy in the following form:

```
INVITE G1
Route: R1
```

Since the top Route header field value identifies the proxy, the proxy removes it. As there are no more Route header field values, the proxy processes the request URI. However, the request URI is a GRUU, and is therefore a domain under the control of the proxy. The proxy will need to perform the processing of Section 8.4.1, which

will result in the translation of the GRUU into the contact C1, followed by transmission of the request to the user agent (message 4).

This sequence of processing in the proxy is somewhat unusual, in that mid-dialog requests (that is, requests with a Route header field that a proxy inserted as a result of a Record-Route operation) do not normally cause a proxy to have to invoke a location service to process the request URI. It is for this reason that this is called out here.

The previous case assumed that there was a single proxy in the domain. In more complicated cases, there can be two or more proxies within a domain on the initial request path. This is shown in Figure 5. In this figure, there is a home proxy, to which requests targeted to the AOR are sent. The home proxy executes the abstract location service and runs user features. The edge proxy acts as the outbound proxy for users, performs authentication, manages TCP/TLS connections to the client, and does other functions associated with the transition from the provider proxy network to the client. This specific division of responsibilities between home and edge proxy is just for the purposes of illustration; the discussion applies to a disaggregation of proxy logic into any number of proxies. In such a configuration, registrations from the user agent would pass through the edge proxy, which would insert a Path header field [3] for itself.

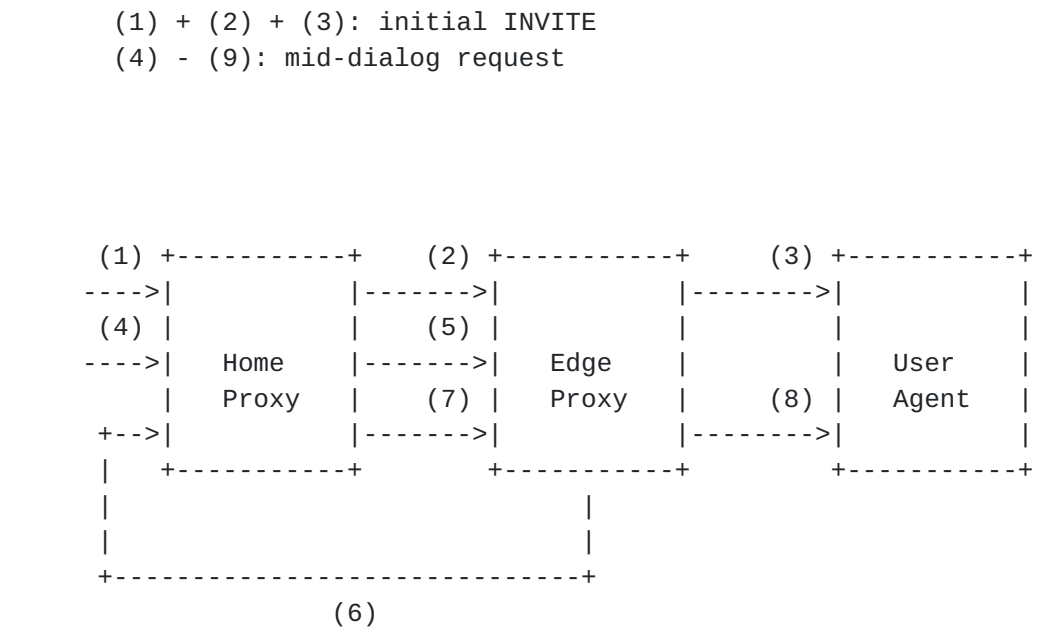


Figure 5

When an incoming request arrives for the AOR (message 1), the home proxy would look it up, discover the registered contact and Path, and then send the request to the edge proxy as a result of the Route header field inserted with the Path value. The home proxy record routes with the URI H1. The edge proxy would forward the request to the request URI (which points to the client), and insert a Record-Route header field value with the URI E1 (message 2). This request is accepted by the user agent, which inserts its GRUU G1 as the remote target.

When the peer in the dialog sends a mid-dialog request, it will have the following form:

```
INVITE G1
Route: H1, E1
```

This request will arrive at the home proxy (due to H1 in the Route header field) (message 4). The home proxy will forward it to the edge proxy (due to E1 in the Route header field) (message 5). The edge proxy, seeing no more Route header field values, sends the request to the Request URI. This is a GRUU, and like an AOR, will route to the home proxy. This causes the request to loop back around (message 6). The home proxy performs the GRUU processing of Section 8.4.1, causing the request to be forwarded to the edge proxy a second time (this time, as a result of a Route header field value obtained from the Path header in the registration) (message 7), and then delivered to the client (message 8).

While this flow works, it is highly inefficient, as it causes each mid-dialog request to spiral route. If this behavior is not desirable. To prevent it, the following procedures SHOULD be followed. When a client generates a REGISTER request, this request passes through the edge proxy on its way to the home proxy. The REGISTER request will contain the AOR of the user (in the To header field) and also indicate whether or not the GRUU extension is supported. The proxy can decide to insert itself on the Path on a case by case basis. However, if it does so for one registration, it SHOULD do so for all registrations for the same AOR. The value of the Path header field inserted by the proxy SHOULD be constructed so that it indicates whether or not the proxy inserted itself on the Path for this AOR.

When a request arrives from the home proxy towards the client, the proxy inspects the Route header field. This header field will contain the URI the edge proxy had placed into the Path. If the value indicates that the edge proxy had put itself on the Path for the registration from this client, there is no need for the proxy to

retain its record-route in the response. The proxy MAY remove its record-route value from the 200 OK response in this case. If the value indicates that the proxy had not put itself on the Path, it would retain the Record-Route in the response.

Similarly, if a request arrives from the client towards the home proxy, the edge proxy would look at the identity of the sender of the request. If the proxy knows that it is placing itself on the Path for registrations from that AOR, the edge proxy would insert a Record-Route into the request, and then remove it in the response. Similarly, if the identity of the sender of the request is one for which the client has not put itself on the Path, the edge proxy would keep its Record-Route in the response.

Removing its Record-Route value from the response will result in a different route set as seen by the caller and callee; the callee (which is the user agent in the figure) will have a route set entry for its edge proxy, while the caller will not. The caller will have a route set entry for its edge proxy, while the callee will not.

In such a case, a mid-dialog request that arrives at the home proxy will be of the form:

```
INVITE G1
Route: H1
```

This does the "right thing" and causes the request to be routed from the home proxy to the edge proxy to the client, without the additional spiral.

9. The opaque SIP URI Parameter

This specification defines a new SIP URI parameter, "opaque". This parameter is useful for constructing GRUUs, but is a generally valuable tool for building URI that are linked to another URI in some way.

The "opaque" parameter has no explicit semantics. It is merely a repository of information whose interpretation is at the discretion of the entity that creates the URI. This means that an element that constructs a URI with the "opaque" parameter MUST ensure that it routes back to itself or another element that can interpret the content of the parameter. The "opaque" parameter can be viewed as a form of cookie for this reason.

If the "opaque" parameter in the URI is removed, the resulting URI MUST correspond to a valid resource in the domain to which the URI

with the "opaque" parameter is associated. The nature of the association is determined from the context in which the URI was obtained. When used to construct a GRUU, it means that the URI formed by stripping the "opaque" parameter MUST correspond to the AOR associated with the GRUU. The recipient of a GRUU cannot determine that it is a GRUU by direct examination of the URI. However, the recipient may know if it received the GRUU in the Contact header field of a SIP request or response that contained a Supported header field with the option tag "gruu". If it knows its a GRUU through such context, and the GRUU contains the "opaque" parameter, the UA knows it can obtain the AOR by removing the "opaque" parameter.

Other possible uses of the "opaque" URI parameter include constructing of service URIs for a user, such as their voicemail inbox or personal conference bridge.

10. Grammar

This specification defines two new Contact header field parameters, gruu and +sip.instance, and two new URI parameters, "grid" and "opaque". The grammar for string-value is obtained from [11], and the grammar for uric is defined in RFC 3986 [9].

```
contact-params    =  c-p-q / c-p-expires / c-p-gruu / cp-instance
                      / contact-extension
c-p-gruu          =  "gruu" EQUAL DQUOTE (SIP-URI / SIPS-URI) DQUOTE
cp-instance       =  "+sip.instance" EQUAL LDQUOT "<"
                     instance-val ">" RDQUOT
uri-parameter     =  transport-param / user-param / method-param
                     / ttl-param / maddr-param / lr-param / grid-param
                     / opaque-param / other-param
grid-param        = "grid=" pvalue        ; defined in RFC3261
opaque-param      = "opaque=" pvalue      ; defined in RFC3261
instance-val      = *uric ; defined in RFC 2396
```

11. Requirements

This specification was created in order to meet the following requirements:

REQ 1: When a UA invokes a GRUU, it MUST cause the request to be routed to the specific UA instance to which the GRUU refers.

REQ 2: It MUST be possible for a GRUU to be invoked from anywhere on the Internet, and still cause the request to be routed appropriately. That is, a GRUU MUST NOT be restricted to use within a specific addressing realm.

REQ 3: It MUST be possible for a GRUU to be constructed without requiring the network to store additional state.

REQ 4: It MUST be possible for a UA to obtain a multiplicity of GRUUs, each one of which routes to that UA instance. This is needed to support ad-hoc conferencing, for example, where a UA instance needs a different URI for each conference it is hosting.

REQ 5: When a UA receives a request sent to a GRUU, it MUST be possible for the UA to know the GRUU which was used to invoke the request. This is necessary as a consequence of requirement 4.

REQ 6: It MUST be possible for a UA to add opaque content to a GRUU, which is not interpreted or altered by the network, and used only by the UA instance to whom the GRUU refers. This provides a basic cookie type of functionality, allowing a UA to build a GRUU with state embedded within it.

REQ 7: It MUST be possible for a proxy to execute services and features on behalf of a UA instance represented by a GRUU. As an example, if a user has call blocking features, a proxy may want to apply those call blocking features to calls made to the GRUU in addition to calls made to the user's AOR.

REQ 8: It MUST be possible for a UA in a dialog to inform its peer of its GRUU, and for the peer to know that the URI represents a GRUU. This is needed for the conferencing and dialog reuse applications of GRUUs, where the URIs are transferred within a dialog.

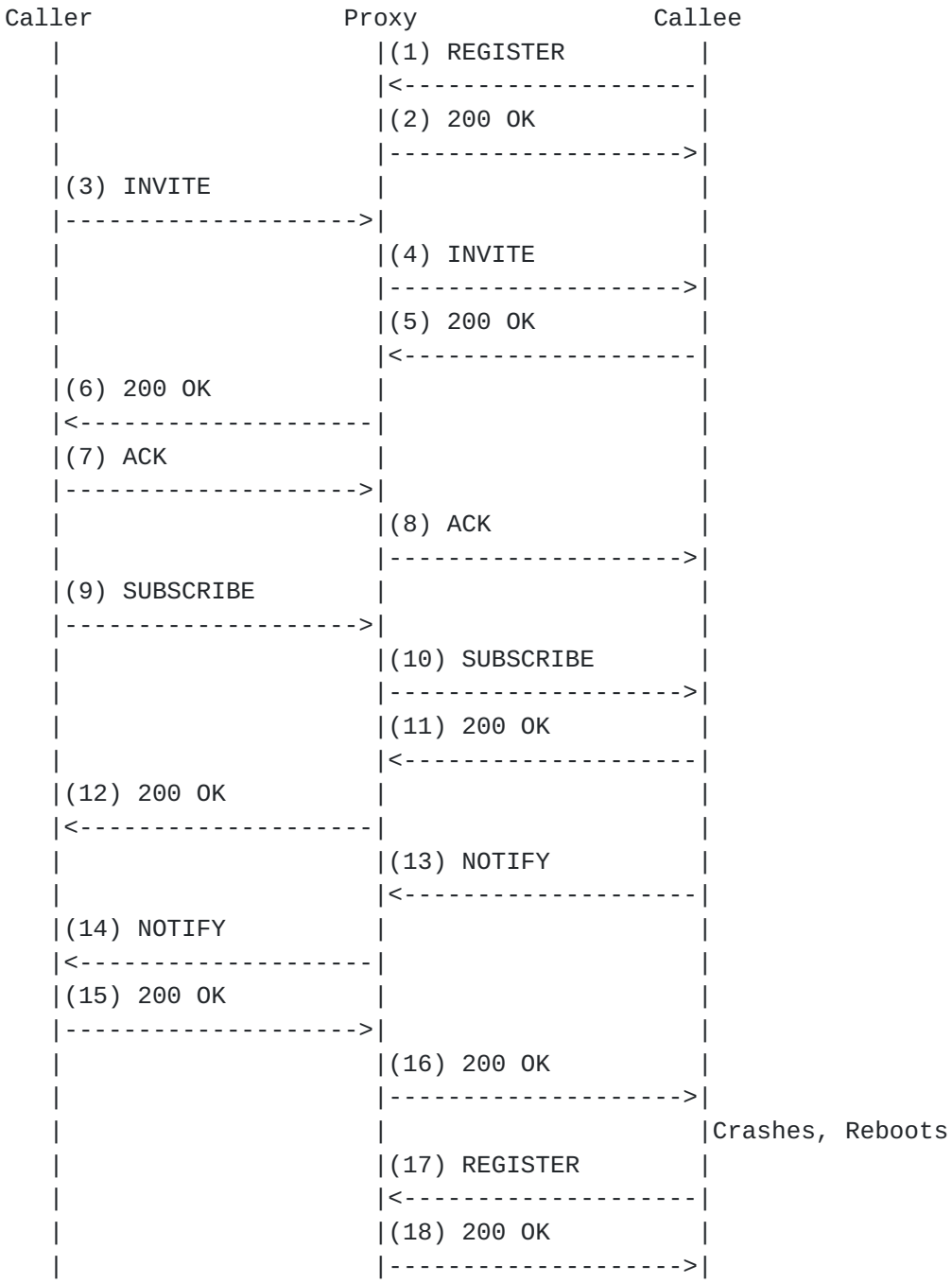
REQ 9: When transferring a GRUU per requirement 8, it MUST be possible for the UA receiving the GRUU to be assured of its integrity and authenticity.

REQ 10: It MUST be possible for a server, authoritative for a domain, to construct a GRUU which routes to a UA instance bound to an AOR in that domain. In other words, the proxy can construct a GRUU too. This is needed for the presence application.

12. Example Call Flow

The following call flow shows a basic registration and call setup, followed by a subscription directed to the GRUU. It then shows a

failure of the callee, followed by a re-registration. The conventions of [21] are used to describe representation of long message lines.



The Callee supports the GRUU extension. As such, its REGISTER (1) looks like:

```
REGISTER sip:example.com SIP/2.0
Via: SIP/2.0/UDP 192.0.2.1;branch=z9hG4bKnashds7
Max-Forwards: 70
From: Callee <sip:callee@example.com>;tag=a73kszlfl
Supported: gruu
To: Callee <sip:callee@example.com>
Call-ID: 1j9FpLxk3uxtm8tn@192.0.2.1
CSeq: 1 REGISTER
Contact: <sip:callee@192.0.2.1>
  ;+sip.instance="<urn:uuid:f81d4fae-7dec-11d0-a765-00a0c91e6bf6>"
Content-Length: 0
```

The REGISTER response would look like:

```
SIP/2.0 200 OK
Via: SIP/2.0/UDP 192.0.2.1;branch=z9hG4bKnashds7
From: Callee <sip:callee@example.com>;tag=a73kszlfl
To: Callee <sip:callee@example.com> ;tag=b88sn
Require: gruu
Call-ID: 1j9FpLxk3uxtm8tn@192.0.2.1
CSeq: 1 REGISTER
<allOneLine>
Contact: <sip:callee@192.0.2.1>
 ;gruu="sip:callee@example.com;
opaque=urn:uuid:f81d4fae-7dec-11d0-a765-00a0c91e6bf6"
;+sip.instance="<urn:uuid:f81d4fae-7dec-11d0-a765-00a0c91e6bf6>"
;expires=3600
</allOneLine>
Content-Length: 0
```

Note how the Contact header field in the REGISTER response contains the gruu parameter with the URI sip:callee@example.com;opaque=urn:uuid:f81d4fae-7dec-11d0-a765-00a0c91e6bf6. This represents a GRUU that translates to the contact sip:callee@192.0.2.1.

The INVITE from the caller is a normal SIP INVITE. The 200 OK generated by the callee (message 5), however, now contains a GRUU as the remote target. The UA has also chosen to include a grid URI parameter into the GRUU.

```
SIP/2.0 200 OK
Via: SIP/2.0/UDP proxy.example.com;branch=z9hG4bKnaa8
Via: SIP/2.0/UDP host.example.com;branch=z9hG4bK99a
From: Caller <sip:caller@example.com>;tag=n88ah
To: Callee <sip:callee@example.com> ;tag=a0z8
Call-ID: 1j9FpLxk3uxtma7@host.example.com
CSeq: 1 INVITE
Supported: gruu
Allow: INVITE, OPTIONS, CANCEL, BYE, ACK
<allOneLine>
Contact:
<sip:callee@example.com
;opaque=urn:uuid:f81d4fae-7dec-11d0-a765-00a0c91e6bf6;grid=99a>
</allOneLine>
Content-Length: --
Content-Type: application/sdp

[SDP Not shown]
```

At some point later in the call, the caller decides to subscribe to the dialog event package [20] at that specific UA. To do that, it generates a SUBSCRIBE request (message 9), but directs it towards the remote target, which is a GRUU:

```
<allOneLine>
SUBSCRIBE sip:callee@example.com;opaque=urn:uuid:f8
1d4fae-7dec-11d0-a765-00a0c91e6bf6;grid=99a
 SIP/2.0
</allOneLine>
Via: SIP/2.0/UDP host.example.com;branch=z9hG4bK9zz8
From: Caller <sip:caller@example.com>;tag=kkaz-
To: Callee <sip:callee@example.com>
Call-ID: faif9a@host.example.com
CSeq: 2 SUBSCRIBE
Supported: gruu
Event: dialog
Allow: INVITE, OPTIONS, CANCEL, BYE, ACK
Contact: <sip:caller@example.com;opaque=hdg7777ad7aflzig8sf7>
Content-Length: 0
```

In this example, the caller itself supports the GRUU extension, and is using its own GRUU to populate its remote target.

This request is routed to the proxy, which proceeds to perform a location lookup on the request URI. It is translated into the contact for that instance, and then proxied there (message 10 below). Note how the grid parameter is maintained.

```
SUBSCRIBE sip:callee@192.0.2.1;grid=99a SIP/2.0
Via: SIP/2.0/UDP proxy.example.com;branch=z9hG4bK9555
Via: SIP/2.0/UDP host.example.com;branch=z9hG4bK9zz8
From: Caller <sip:caller@example.com>;tag=kkaz-
To: Callee <sip:callee@example.com>
Call-ID: faif9a@host.example.com
CSeq: 2 SUBSCRIBE
Supported: gruu
Event: dialog
Allow: INVITE, OPTIONS, CANCEL, BYE, ACK
Contact: <sip:caller@example.com;opaque=hdg7777ad7aflzig8sf7>
Content-Length: 0
```

At some point after message 16 is received, the callee's machine crashes and recovers. It obtains a new IP address, 192.0.2.2. Unaware that it had previously had an active registration, it creates a new one (message 17 below). Notice how the instance ID remains the same, as it persists across reboot cycles:

```
REGISTER sip:example.com SIP/2.0
Via: SIP/2.0/UDP 192.0.2.2;branch=z9hG4bKnasbba
Max-Forwards: 70
From: Callee <sip:callee@example.com>;tag=ha8d777f0
Supported: gruu
To: Callee <sip:callee@example.com>
Call-ID: hf8asxzff8s7f@192.0.2.2
CSeq: 1 REGISTER
Contact: <sip:callee@192.0.2.2>
  ;+sip.instance="<urn:uuid:f81d4fae-7dec-11d0-a765-00a0c91e6bf6>"
Content-Length: 0
```

The registrar notices that a different contact, sip:callee@192.0.2.1, is already associated with the same instance ID. It registers the new one too and returns both in the REGISTER response. Both have the same GRUU. However, only this new contact (the most recently registered one) will be used by the proxy for population in the target set. It then generates the following response:

```
SIP/2.0 200 OK
Via: SIP/2.0/UDP 192.0.2.2;branch=z9hG4bKnasbba
From: Callee <sip:callee@example.com>;tag=ha8d777f0
To: Callee <sip:callee@example.com>;tag=99f8f7
Require: gruu
Call-ID: hf8asxzff8s7f@192.0.2.2
CSeq: 1 REGISTER
<allOneLine>
Contact: <sip:callee@192.0.2.2>
;gruu="sip:callee@example.com;opaque=urn:
uuid:f81d4fae-7dec-11d0-a765-00a0c91e6bf6"
;+sip.instance="<urn:uuid:f81d4fae-7dec-11d0-a765-00a0c91e6bf6>"
;expires=3600
</allOneLine>
Contact: <sip:callee@192.0.2.1>
;gruu="sip:callee@example.com;opaque=urn:
uuid:f81d4fae-7dec-11d0-a765-00a0c91e6bf6"
;+sip.instance="<urn:uuid:f81d4fae-7dec-11d0-a765-00a0c91e6bf6>"
;expires=400
</allOneLine>
Content-Length: 0
```

13. Security Considerations

GRUUs do not provide a solution for privacy. In particular, since the GRUU does not change during the lifetime of a registration, an attacker could correlate two calls as coming from the same source, which in and of itself reveals information about the caller. Furthermore, GRUUs do not address other aspects of privacy, such as the addresses used for media transport. For a discussion of how privacy services are provided in SIP, see RFC 3323 [14].

It is important for a UA to be assured of the integrity of a GRUU when it is given one in a REGISTER response. If the GRUU is tampered with by an attacker, the result could be denial of service to the UA. As a result, it is RECOMMENDED that a UA use the SIPS URI scheme in the Request-URI when registering.

The example GRUU construction algorithm in Appendix A.1 makes no attempt to create a GRUU that hides the AOR and instance ID associated with the GRUU. In general, determination of the AOR associated with a GRUU is considered a good property, since it allows for easy tracking of the target of a particular call. Learning the instance ID provides little benefit to an attacker. To register or otherwise impact registrations for the user, an attacker would need to obtain the credentials for the user. Knowing the instance ID is insufficient.

The example GRUU construction algorithm in Appendix A.1 makes no attempt to create a GRUU that prevents users from guessing a GRUU based on knowledge of the AOR and instance ID. A user that is able to do that will be able to direct a new request at a particular instance. However, this specification recommends that service treatment be given to requests that are sent to a GRUU, including screening features in particular. That treatment will make sure that the GRUU does not provide a back door for attackers to contact a user that has tried to block the attacker.

14. IANA Considerations

This specification defines a new Contact header field parameter, two SIP URI parameters, a media feature tag and a SIP option tag.

14.1 Header Field Parameter

This specification defines a new header field parameter, as per the registry created by [12]. The required information is as follows:

Header field in which the parameter can appear: Contact

Name of the Parameter gruu

RFC Reference RFC XXXX [[NOTE TO IANA: Please replace XXXX with the RFC number of this specification.]]

14.2 URI Parameters

This specification defines two new SIP URI parameters, as per the registry created by [13].

Name of the Parameter grid

RFC Reference RFC XXXX [[NOTE TO IANA: Please replace XXXX with the RFC number of this specification.]]

Name of the Parameter opaque

RFC Reference RFC XXXX [[NOTE TO IANA: Please replace XXXX with the RFC number of this specification.]]

14.3 Media Feature Tag

This section registers a new media feature tag, per the procedures defined in RFC 2506 [8]. The tag is placed into the sip tree, which

is defined in [11].

Media feature tag name: sip.instance

ASN.1 Identifier: New assignment by IANA.

Summary of the media feature indicated by this tag: This feature tag contains a string containing a URI, and ideally a URN, that indicates a unique identifier associated with the UA instance registering the Contact.

Values appropriate for use with this feature tag: String.

The feature tag is intended primarily for use in the following applications, protocols, services, or negotiation mechanisms: This feature tag is most useful in a communications application, for describing the capabilities of a device, such as a phone or PDA.

Examples of typical use: Routing a call to a specific device.

Related standards or documents: RFC XXXX [[Note to IANA: Please replace XXXX with the RFC number of this specification.]]

Security Considerations: This media feature tag can be used in ways which affect application behaviors. For example, the SIP caller preferences extension [22] allows for call routing decisions to be based on the values of these parameters. Therefore, if an attacker can modify the values of this tag, they may be able to affect the behavior of applications. As a result of this, applications which utilize this media feature tag SHOULD provide a means for ensuring its integrity. Similarly, this feature tag should only be trusted as valid when it comes from the user or user agent described by the tag. As a result, protocols for conveying this feature tag SHOULD provide a mechanism for guaranteeing authenticity.

14.4 SIP Option Tag

This specification registers a new SIP option tag, as per the guidelines in Section 27.1 of RFC 3261.

Name: gruu

Description: This option tag is used to identify the Globally Routable User Agent URI (GRUU) extension. When used in a Supported header, it indicates that a User Agent understands the extension, and has included a GRUU in the Contact header field of

its dialog initiating requests and responses. When used in a Require header field of a REGISTER request, it indicates that the registrar should assign a GRUU to the Contact URI.

15. Acknowledgements

The author would like to thank Rohan Mahy, Paul Kyzivat, Alan Johnston, and Cullen Jennings for their contributions to this work.

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Author's Address

Jonathan Rosenberg
Cisco Systems
600 Lanidex Plaza
Parsippany, NJ 07054
US

Phone: +1 973 952-5000
Email: jdrosen@cisco.com
URI: http://www.jdrosen.net

Appendix A. Example GRUU Construction Algorithms

The mechanism for constructing a GRUU is not subject to specification. This appendix provides two examples that can be used by a registar. Others are, of course, permitted, as long as they meet the constraints defined for a GRUU.

A.1 Instance ID in opaque URI Parameter

The most basic approach for constructing a GRUU is to utilize the "opaque" URI parameter. The user and domain portions of the URI are equal to the AOR, and the "opaque" parameter is populated with the instance ID.

A.2 Encrypted Instance ID and AOR

In many cases, it will be desirable to construct the GRUU in such a way that it will not be possible, based on inspection of the URI, to

determine the Contact URI that the GRUU translates to. It may also be desirable to construct it so that it will not be possible to determine the instance ID/AOR pair associated with the GRUU. Whether or not a GRUU should be constructed with this property is a local policy decision.

With these rules, it is possible to construct a GRUU without requiring the maintenance of any additional state. To do that, the URI would be constructed in the following fashion:

```
user-part = "GRUU" | BASE64(E(K, (salt | " " | AOR | " " |
instance ID)))
```

Where E(K,X) represents a suitable encryption function (such as AES with 128 bit keys) with key K applied to data block X, and the "|" operator implies concatenation. The single space (" ") between components is used as a delimeter, so that the components can easily be extracted after decryption. Salt represents a random string that prevents a client from obtaining pairs of known plaintext and ciphertext. A good choice would be at least 128 bits of randomness in the salt.

This mechanism uses the user-part of the SIP URI to convey the encrypted AOR and instance ID. The user-part is used instead of the "opaque" URI parameter because of the desired anonymity properties.

The benefit of this mechanism is that a server need not store additional information on mapping a GRUU to its corresponding contact. The user part of the GRUU contains the instance ID and AOR. Assuming that the domain stores registrations in a database indexed by the AOR, the proxy processing the GRUU would look up the AOR, extract the currently registered contacts, and find the one matching the instance ID encoded in the request URI. The contact whose instance ID is that instance ID is then used as the translated version of the GRUU. Encryption is needed to prevent attacks whereby the server is sent requests with faked GRUU, causing the server to direct requests to any named URI. Even with encryption, the proxy should validate the user part after decryption. In particular, the AOR should be managed by the proxy in that domain. Should a UA send a request with a fake GRUU, the proxy would decrypt and then discard it because there would be no URI or an invalid URI inside.

While this approach has many benefits, it has the drawback of producing fairly long GRUUs.

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Acknowledgment

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