Third Party Authorization in the Session Initiation Protocol

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Abstract

This draft describes some circumstances that are common in SIP deployments which lack a rigorous authorization model, and points out some ways in which this has resulted in poor security.
characteristics.

The purpose of this document is to stimulate discussion of the identified problem and proposed requirements for any solution.

Comments are solicited, and should be directed to the DISPATCH working group list at ‘dispatch@ietf.org’.

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1. Introduction

This draft attempts to make the case that SIP lacks a mechanism needed to provide for the implementation and enforcement of security policy in typical deployments. It’s purpose is to present the problem, outline some requirements for a solution, and to pose the question of whether or not is is an area the IETF community considers worth designing solutions for.

This draft does not propose any mechanisms to address the problem it describes; it also does not comprehensively evaluate the relevance of existing SIP security mechanisms (either standardize or proposed) in addressing this problem. Both are possible areas for future work.

2. Problem Description

The Session Initiation Protocol (SIP) [RFC3261], by design, distributes functionality broadly throughout the network – it is often characterised as "pushing intelligence out to the edge". This sometimes means that important security policy enforcement must also be distributed. SIP currently lacks some features that facilitate this distribution of security enforcement.

2.1. Authentication vs Authorization

It is important when considering the problems described in this memo to keep in mind the difference between Authentication and Authorization:

Authentication
  is the process of confirming some identity.

Authorization
  is the process of deciding whether or not something is permitted by a security policy.

Usually an Authorization decision depends upon an Authentication. For example, if Alice tries to call Bob and a proxy between them is deciding whether or not to allow the call, it must first Authenticate that the request is from Alice, and then consult the policy to see whether or not Alice is Authorized to make calls to Bob.

It is an unfortunate historical error that the header name used to carry Authentication information in a SIP (or HTTP) request is named "Authorization", which only increases the confusion between these two concepts.
In the remainder of this document, the modifier "Authorizing" is applied to various entities to designate the party that is making an Authorization decision - consulting a security policy and any relevant information - to determine whether or not a SIP request is permitted by the policy.

### 2.2. The Locality of Authority and Enforcement

In a distributed system, the ultimate enforcement of a security policy is best implemented as closely as possible to the object of that policy. In less abstract terms: if the goal of a policy is to control access to a resource, then the ultimate enforcement of whether or not to grant access to the resource is best made by an entity local to that resource. Any separation between the resource that is the object of the policy and the entity implementing the enforcement of that policy introduces a gap which an attacker may be able to exploit. Because it is not always possible to colocate the policy decision at the point of enforcement, it is sometimes necessary to have an Authorizing entity in one part of a distributed system that then conveys the appropriate decision to another at which the enforcement action takes place.

In SIP, the optimal enforcement point is often at either the ultimate UAS that is the target of a request, or at an Intermediate Entity whose role includes the enforcement of policy at the edge of an administrative domain. In this document, the term: Intermediate Entity

is used to mean any SIP entity that receives SIP requests and sends requests somehow related to those received requests to other targets. The term includes Proxies, Application Servers, Back To Back User Agents, and any other entity that acts as forwarding or translating entity with SIP on both "sides".

However, these systems, and especially User Agents, are often not the appropriate place to actually make the Authorization decision. For various reasons it is sometimes appropriate to make the Authorization decision somewhere other than the point of enforcement, and in these cases at present SIP lacks a standard means to convey the results of that decision.

Most specifications of SIP mechanisms expect that a request will be subjected to an authorization decision by the receiving User Agent Server. If the Alice’s UA sends a request to Bob’s UA, it is Bob’s UA that decides (presumably after authenticating that the request is really from Alice) whether or not Alice should be allowed whatever access the request requires. This model is the correct one in many cases, especially those in which the actual authorization decision
can be made by the human user: if the request is for Bob’s presence information, the UA can let Bob decide whether Alice should be allowed to see his presence and respond appropriately.

Using the user to make the authorization decision is not always appropriate, however - it fits poorly or not at all when:

There is no way to consult a user

Many kinds of UAs either don’t have a "user" to consult (such as a PSTN gateway or a ceiling-mounted paging system speaker), or don’t have a user interface adequate to construct a query (an ATA).

Consulting the user is the wrong thing to do

The nature of the request may be such that consulting the user would be counter to the nature of the request. If the request is that Alice, a call center manager, be silently conferenced in order to monitor a call between a customer and Bob, a service representative under her supervision, then alerting Bob that Alice wishes to listen to the call would defeat the purpose.

Asking the user would be ambiguous

The request might be such that the user either could not understand the question or be such that the user cannot reasonably be expected to understand why permission should be granted. If Bob were asked whether or not Alice should be allowed to receive dialog event notices regarding the call he is on now, he would probably not understand the question and be annoyed at the interruption of his call; he could not tell whether this was in support of a future request to Join the call, a future request that Alice be able to call him when he becomes available, or just in support of lighting the Busy Lamp for his line on Alice’s phone.

2.2.1. User Agent Based Authorization Scales Poorly

Placing the authorization decision in the ultimate User Agent Server suffers from a scaling problem: the size and complexity of the authorization decision scales with the number of possible interactions. While Bob’s UA may be able to authenticate that a particular request came from Alcine’s UA, if Alice and Bob are in a large administrative domain, the problem of deciding which users in that domain are authorized to make which requests grows too large to reasonably implement inside many UAs. Even if the problem is just one of storing the appropriate access control lists, it is not reasonable to replicate the lists into all UAs (and perhaps not
desirable from a security perspective, since this decreases the
security of the lists themselves).

Even aside from the problem of database sizes that may be required
for authorization decisions in the ultimate UAS, the non-uniformity
of facilities in UAS makes central control of security policy
impractical. If an organization wishes to create a security policy
for a particular kind of request, the capabilities offered by UAs are
too limited for any but the most primitive of possibilities (and often
not even that). For example, one might want to make different rules
for whether a particular request be allowed at one time of day but
not at another. Since few UAs will have that capability (and since
the means of expressing it probably vary even among those that did),
an organization that needed such a policy would have to make the
authorization decision elsewhere, but other than preventing delivery
of the request, there is no standard way to communicate the result of
that authorization decision to the UAS.

2.2.2. Request Delivery as an Authorization Indication

Today, authorization control that is not local to the target UAS
usually takes the form of delivery control: an Intermediate entity
makes an authorization decision and either delivers the request
onwards toward the target UAS or rejects it. The fact that the
target UAS recieves the request from the authorizing entity is the
indication that the request has been authorized. There are a number
of problems with this as a security policy enforcement architecture:

Passive participation by the recipient

In many cases, the agent that is the recipient of the "authorized"
request is not enforcing the requirement that the request be
processed by the authorizing entity. It will act on any request
it receives, and only the fact that the rest of the well behaved
requestors will route through the Authorizing Intermediate allows
the security policy to be enforced at all. An attacker who can
find a way to route requests such that they do not pass through
the Authorizing entity will find the target UAS happy to accept
them.

Use of IP addresses as authenticators

The most common form that "delivery as authorization" takes is
that the IP address(es) of one or more Authorizing Intermediates
is configured into the UAS such that only requests from those
Intermediates are to be considered to have been authorized. Most
often, the UAS uses the peer address from the UDP or TCP level as
the authentication indication. Since techniques for spoofing IP
addresses are well known, this is a very weak basis upon which to build any security. In some particularly weak implementations, the presence of an IP address value in the Via headers has been seen to be used as an authenticator; this does not even merit further discussion.

TLS peer authentication

A much stronger but unfortunately less common version of "delivery as authorization" is the use of a mutually authenticated TLS transport between an Intermediate and the point of enforcement. This has the advantage that it is based on the identities in the certificates, so given a usable certificate infrastructure and good implementations, at least the authentication component of the decision is a strong one. This solution is especially well suited to authorizing requests as they cross a boundary between one administrative domain and another (such as between an enterprise and a telephony service provider). It is, however, limited by the fact that it only allows one degree of separation between the Authorizing entity and the Enforcing entity - they may not be more than a single SIP hop apart for this to be a usable authorization indication. It is also worth noting that even in this limited deployment mode, there is no well-defined indication included in the SIP signalling that explicitly communicates that a particular message has been authorized by the sender; the indication is always implicit.

This last problem - the fact that for delivery to work as an authorization indication, the authorizing and enforcing entities must be adjacent - creates another more subtle architectural problem. The requirement for adjacency interferes with a property of SIP that is otherwise one of its great strengths: that a proxy (or other well-behaved Intermediate) need not understand every aspect of the requests and responses it forwards. It is this property that allows User Agents to evolve new capabilities, and, so long as they are able to find other UAs with complementary features, to use those capabilities without the SIP routing fabric between them needing to be upgraded. If there is a security property of some new capability, and authorization decisions appropriate to that new capability are not easily implementable in the originating and terminating UAs themselves, then there is only one place in the SIP routing fabric where the authorization decision can be placed: adjacent to the target UAS.

2.3. Examples of Distributed Authorization and Enforcement in SIP

The following are examples of SIP operations that currently suffer from poor security properties in many deployments and/or are not well
supported by User Agents in part because providing appropriate
security is problematic. It is by no means an exhaustive list.

2.3.1. Dialog Event Subscriptions

The dialog event package [RFC4235]:

allows users to subscribe to another user and to receive
notification of the changes in state of INVITE- initiated dialog
usages in which the subscribed-to user is involved.

A SUBSCRIBE request [RFC3265] for the "dialog" package allows the
requesting UA to ask for NOTIFY messages that include the dialog
state and identifiers (call-id and tag values) for, potentially, all
dialogs at the receiving UA. There are many legitimate purposes for
such a request, since they are needed to implement a number of
desirable features in a distributed communications system. However,
the SUBSCRIBE request does not communicate what feature the request
is being made to support, nor can the NOTIFY communicating the dialog
information restrict the purposes for which it is used. The dialog
package specification includes some recommendations on how to
construct security policies in a UAS so as to restrict access to
dialog identifiers and other sensitive information, but because
leaving out parts of the information would often disable desired
features in a distributed system, it is common for implementations to
include all the dialog information, and to accept any requests they
receive (in effect passively implementing a request delivery
authorization policy as described in Section 2.2.2).

[RFC4538] defines the SIP Target-Dialog header field

This header field is used in requests that create SIP dialogs. It
indicates to the recipient that the sender is aware of an existing
dialog with the recipient, either because the sender is on the
other side of that dialog, or because it has access to the dialog
identifiers. The recipient can then authorize the request based
on this awareness.

This authorization by awareness of dialog identifiers is used in many
SIP services, so having weak authorization mechanisms in the UASes
responsible for those identifiers creates vulnerabilities elsewhere.

2.3.2. INVITE at a PSTN Gateway

One of the most common operations in SIP telephony is the gateway
function - receiving a SIP INVITE request and using the information
in it to initiate a PSTN call setup request. Because a PSTN call is
often a potentially expensive billable event, enforcement of access
control is important. In many (perhaps most) SIP telephony deployments, the actual authorization decision is not implemented in the gateway itself, but in some intermediate system between the requesting UAC and the gateway; gateways typically implement at most a request delivery authorization policy as described in Section 2.2.2.

2.3.3. INVITE with Join

[RFC3911] defines the Join header field "to logically join an existing SIP dialog with a new SIP dialog"; the specification notes that:

This primitive can be used to enable a variety of features, for example: "Barge-In", answering-machine-style "Message Screening" and "Call Center Monitoring".

The Join mechanism is a good example of a primitive that, depending on the service it is being used to implement, can have very different authorization requirements - but the UAS may not be able to easily distinguish what the service is and therefore know which to requirements to apply. A simple example is an INVITE-with-Join request received by a phone, containing SDP that requests that the joining phone receive media but not provide any to be mixed into the call: this request may have resulted from

- The human User using the receiving UAS may have (through out-of-band means) asked a colleague to listen to the call so as to provide advice or to be available as a witness to what transpired on a sensitive call.

- The request may come from that User's supervisor in order to determine (as allowed by the management policies that govern their relationship) whether or not the User is conducting the call appropriately.

At the protocol level, these two requests may be indistinguishable, but in the former case it would be appropriate for the UAS to query the user to authorize the Join request (and useful to that User to receive an indication that the monitoring has begun), while in the latter case it would defeat the purpose of the request to do so. In any case, it would clearly be inappropriate for a phone to unconditionally and without notice accept any such request.

3. Candidate Solution Requirements

This draft argues that SIP would be improved by a mechanism that
allowed for a small number of entities in a given deployment to make
Authorization decisions with respect to SIP requests according to a
locally defined policy, and have a secure means of communicating that
a given has been authorized. This would allow other SIP entities
(whether Intermediate Systems or User Agent Servers) to make very
simple enforcement decisions based on whether or not a request had
been authorized by an authority they recognize. The complexity of
the security configuration for most SIP entities would be reduced to
recognition and validation of a small number of valid authorizors.

This section proposes some requirements that any solution would need
to meet in order to address the problem described in Section 2 and be
usable and incrementally deployable in existing SIP usage.

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL
NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL"
in this document are to be interpreted as described in RFC-2119
[RFC2119].

These proposed requirements use the following terms (the definitions
of which are admittedly somewhat vague):

Authorization Indication
The information incorporated into a SIP message that indicates
that a request is authorized within some security policy. No
specific forms are suggested for Authorization Indications in this
draft.

Authorizing Third Party
Any implementation that can receive a SIP message generated by
some originating UAC, evaluate that request with respect to some
security policy, and generate an Authorization Indication to be
incorporated into some other SIP message such that a later
recipient of that SIP message or one derived from it can be
assured that the request is allowed under the security policy.

3.1. Authorizing Third Party Requirements

SIP deployments often contain many different ‘types’ of
implementations: some, like User Agents and Proxies, that are well
defined by the existing formal specifications, and others that are
less rigorously defined but meet practical needs and are essential to
functionality required by end users. This reality must be recognized
in order for any solution to be deployable in real (rather than just
hypothetical architecturally "pure") SIP networks. This implies that
the definition of an Authorizing Third Party is very flexible: The
following are suggested requirements relating to which implementation
roles can act as an Authorizing Third Party:
It MUST be possible for a UAS to act as an Authorizing Third Party, incorporating an Authorization Indication in a response (see Figure 2 and Figure 3).

It MUST be possible for a Proxy to act as an Authorizing Third Party, incorporating an Authorization Indication in requests it forwards (see Figure 1 and Figure 3).

It MUST be possible for other non-Proxy intermediate systems, such as Back-To-Back User Agents to act as an Authorizing Third Party, incorporating an Authorization Indication in requests they forward.

The following are suggested requirements relating to the kinds of SIP messages a Third Party Authentication could be used with:

It MUST be possible to include an Authorization Indication in a REFER request such that when the UA that is the target of the REFER makes a request as directed by the REFER, that new request can include an Authorization Indication (see Figure 4).

It MUST be possible to include an Authorization Indication in both dialog-forming and in-dialog requests.

3.1.1. Third Party Topologies

In real SIP networks, Intermediate entites can appear in unexpected places - a solution that does not recognize that fact will not be useful.

It MUST be possible for an Authorization Indication to be usefully forwarded by an Intermediate system that does not implement the Third Party Authorization mechanisms.

The requirement above does NOT mean that it must be possible to forward any Authorization Indication through any intermediate system at all and always be useful - such a requirement would not be possible to meet. The objective is that at least "well behaved" intermediates have some chance of forwarding; defining "well behaved" in this context will be an important part of evaluating any proposed mechanism.

Figure 1 illustrates a topology in which an Intermediate system adds the authorizing information, changing the original request (r1) into the authorized request (ar):
Figure 1: Authorizing Intermediate

Figure 2 illustrates a topology in which a Redirecting system includes the authorizing information in a redirect (3xx) response (r1r) to the original request (r1), causing the UAC to generate the authorized request (ar):

Figure 2: Authorizing Redirector

Figure 3 combines elements of the previous two topologies; the Originating UAC sends the original request (r1) to an Intermediate system, which then sends a request (r2) to a Redirecting system (r2), which then adds the authorizing information to its redirect (3xx) response (r2r), causing the Intermediate system to generate the authorized request (ar). Either the r1 path or the ar path might contain other intermediates.
Figure 3: Authorizing Redirection At Intermediate

Figure 4 illustrates a topology in which the Originating UAC incorporates an Authorization Indication into a REFER request sent to some other UAC. The Referred UAC incorporates the Authorization Indication into the resulting request (ar), communicating to the Enforcing UAS that the Originating UAC authorized the request.

Figure 4: Authorizing Referror

3.2. Authorization and Integrity Protection

It is tempting to suggest the requirement that it be impossible for an attacker to modify a SIP message containing an Authorization Indication, or to copy an Authorization Indication from one SIP message to another without detection. Unfortunately, it is an integral part of the SIP architecture that SIP messages are modified as they move from one system to another; these modifications are not only unavoidable but essential to the correct operation of the SIP
protocol as currently defined. There are also important use cases (see Figure 4) in which an Authorization Indication is explicitly meant to be copied from one request to another. The following requirements for message integrity protection are suggested:

R7 It MUST be possible for an Authorization Indication to include integrity protection of the parts of a request that it authorizes.

R8 It MUST be possible for an Intermediate system to detect what parts of a request are integrity protected so that the Intermediate system can either avoid changing the protected parts or return an error that indicates that the request cannot be satisfied because of the protection.

R9 It MUST be possible for an Enforcing system to determine what parts of a request are integrity protected by the Authorization Indication and what parts are not.

R10 It MUST be possible for an Enforcing system to determine the identity of the party that provided the Authorization Indication as distinct from the Originating UAC.

4. IANA Considerations

None until a solution is described.

5. Security Considerations

This memo attempts to make the case that the current definition and deployment of the Session Initiation Protocol is missing a mechanism important to appropriately secured operation in at least many of the environments in which it is used. Section 3 attempts to bound a solution space, and as such should be read carefully to determine whether or not appropriate goals have been described.

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7. Informative References


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