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Session Initiation Protocol Extension Header Field for Service Route Discovery in Private Networks
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Status of this Memo

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Abstract

This document proposes a private SIP extension header field used in conjunction with responses to REGISTER requests to provide a mechanism by which a registrar may inform a registering UA of a service route that the UA may use to request outbound services from the registrar's domain.

Table of Contents

1. Terminology 3

2. Background 3

3. Discussion of Mechanism 4

4. Applicability Statement 5

5. Syntax 5

6. Usage 6
6.1 Procedures at the UA 6
6.2 Procedures at the Proxy 7
6.3 Procedures at the Registrar 7
6.4 Examples of Usage 8
6.4.1 Example of Mechanism in REGISTER Transaction 8
6.4.2 Example of Mechanism in INVITE Transaction 11

7. Security Considerations 13

8. IANA Considerations 13

Normative References 14

Non-Normative References 14

Authors' Addresses 14

Full Copyright Statement 16

1. Terminology

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in RFC 2119 [3].

2. Background

3GPP established a requirement for discovering home proxies during SIP registration and published this requirement in draft-garcia-sipping-3gpp-reqs [6]. Unlike many other network environments, the 3GPP network dynamically assigns a home service proxy to each address-of-record. This assignment may occur in conjunction with a REGISTER operation, or out-of-band as needed to support call services when the address-of-record has no registrations. This home service proxy may provide both inbound (UA terminated) and outbound (UA originated) services.

For inbound (UA terminated) session cases, the home proxy network routes requests having a request-URI targeting the address-of-record associated with the UA to the assigned home service proxy by using some sort of look-up-mechanism outside the scope of this document.

Outbound (UA originated) session cases raise another issue. Specifically, "How does the UA know which service proxy to use and how to get there?"

Several mechanisms have been proposed in list discussions, including:

1. Configuration data in the UA. This raises questions of UA configuration management and updating, especially if proxy assignment is very dynamic, such as in load-balancing scenarios.
2. Use of some other protocol, such as HTTP, to get configuration data from a configuration server in the home network. While functional, this solution requires additional protocol engines, firewall complexity, operations overhead, and a significant additional "over the air" traffic.
3. Use of lookup tables in the home network, as is done for inbound requests. This has a relatively high overhead in terms of database operations.
4. Returning a 302 response indicating the service proxy as a new contact, causing the upstream node processing the 302 (ostensibly the UA) to retransmit the request toward the service proxy. While this shares the database operation of the previous alternative, it does explicitly allow for caching the 302 response thereby potentially reducing the frequency and number of database operations.

5. Performing an operation equivalent to record-routing in a

REGISTER transaction between the UA and the associated registrar, then storing that route in the UA and reusing it as a service route on future requests originating from the UA. While efficient, this constrains the service route for proxy operations to be congruent with the route taken by the REGISTER message.

6. Returning service route information as the value of a header field in the REGISTER response. While similar to the previous alternative, this approach grants the ability for the registrar to selectively apply knowledge about the topology of the home network in constructing the service route.

This document discusses this final alternative: using a header field in the REGISTER response to indicate a service route that the UA may wish to use if requesting services from the proxy network associated with the registrar generating the response.

Scenario

```
UA1----P1-----|    |--R-------|
              |    |          |
              P2---|         DBMS
              |    |          |
UA2-----------|    |--HSP-----|
```

In this scenario, we have a "home network" containing routing proxy P2, registrar R, home service proxy HSP, and database DBMS used by both R and HSP. P2 represents the "edge" of the home network from a SIP perspective, and might be called an "edge proxy". UA1 is an external UA behind proxy P1. UA1 discovers P1 via DHCP. UA2 is another UA on the Internet, and does not use a default outbound proxy. We do not show DNS elements in this diagram, but will assume their reasonable availability in the discussion. The mission is for UA1 to discover HSP so that outbound requests from UA1 may be routed (at the discretion of UA1) through HSP, thereby receiving outbound services from HSP.

3. Discussion of Mechanism

The proposed mechanism uses a private header field "P-Service-Route" in the REGISTER response to indicate a service route that the UA may wish to use if requesting services from the proxy network associated with the registrar generating the response. The routing established by the P-Service-Route mechanism applies only to requests originating in the user agent.

Simply put, the registrar generates a service route for the registering UA and returns it in the response to each successful REGISTER request. This service route has the form of a Route header field that the registering UA may use to send requests through the service proxy selected by the registrar. The UA would use this route by inserting it as a preloaded Route header field in requests originated by the UA intended for routing through the service proxy.

The mechanism by which the registrar constructs the header field value is specific to the local implementation and outside the scope of this document.

4. Applicability Statement

The P-Service-Route mechanism is applicable when:

1. The UA registers with a REGISTRAR in a given domain.
2. The domain dynamically assigns a service proxy for the UA.
3. The registrar(s) in the domain has/have sufficient knowledge of the network topology, policy, and situation such that a reasonable service route can be constructed.
4. Other mechanisms for proposing a service route to the UA are not available or are inappropriate for use within the administrative domain.

5. Syntax

The syntax for the P-Service-Route header field is:

```
P-Service-Route = "P-Service-Route" HCOLON p-sr-value *( COMMA p-sr-
value)

p-sr-value = name-addr *( SEMI rr-param )

rr-param = generic-param
```

The allowable usage of header fields is described in Tables 2 and 3 of SIPbis [1]. The following additions to this table are needed for P-Service-Route.

Addition of P-Service-Route to SIP Table 3:

Header field	where	proxy	ACK	BYE	CAN	INV	OPT	REG	PRA
P-Service-Route	2xx	ar	-	-	-	-	-	o	-

6. Usage

6.1 Procedures at the UA

The UA performs a registration as usual. The REGISTER response may contain a P-Service-Route header field. If so, the UA MAY store the value of the P-Service-Route header field in an association with the address-of-record for which the REGISTER transaction had registered a contact. If the UA supports multiple address of records, it may be able to store multiple service routes, one per address-of-record. If the UA refreshes the registration, the stored value of the P-Service-Route is updated according to the P-Service-Route header field of the latest 200 OK response. If there is no P-Service-Route header field in the response, the UA clears any service route for that registrar previously stored by the UA. If the re-registration request is refused or if an existing registration expires and the UA chooses not to re-register, the UA SHOULD discard any stored service route for that address-of-record.

The UA MAY choose to exercise a service route for future requests associated with a given address-of-record for which a service route is known. If so, it uses the content of the P-Service-Route header field as a preloaded Route header field in outgoing requests [1]. The UA MUST preserve the order, in case there is more than one P-Service-Route header field or header field value.

Loose routes may interact with routing policy in interesting ways. The specifics of how the service route set integrates with any locally required default route and local policy are implementation dependent. For example, some devices will use locally-configured explicit loose routing to reach a next-hop proxy, and others will use a default outbound-proxy routing rule. However, for the result to function, the combination MUST provide valid routing in the local environment. In general, the service route set is appended to any locally configured route needed to egress the access proxy chain. Systems designers must match the service routing policy of their nodes with the basic SIP routing policy in order to get a workable system.

6.2 Procedures at the Proxy

The P-Service-Route header field is generally treated like any other unknown header field by intermediate proxies. They simply forward it on towards the destination.

There is a question of whether proxies processing a REGISTER response may add themselves to the route set in the P-Service-Route header field. While this would enable dynamic construction of service routes, it has two significant problems. The first is one of transparency, as seen by the registrar: Intermediate proxies could add themselves without the knowledge or consent of the registrar. The second problem is interaction with end-to-end security. If the registrar uses S/MIME techniques to protect the REGISTER response, such additions would be visible to the UA as "man in the middle" alterations in the response. Consequently, intermediate proxies SHOULD NOT alter the value of P-Service-Route in REGISTER responses, and if they do, acceptance of the alteration by the UA MUST NOT be required.

6.3 Procedures at the Registrar

When a registrar receives a successful REGISTER request, it MAY choose to return one or more P-Service-Route header field(s) in the 200 OK response. The determinations of whether to include these header fields(s) into the 200 OK response and what value(s) to insert are a matter of local policy and outside the scope of this document.

Having inserted a P-Service-Route header field or fields, the registrar returns the 200 OK response to the UA in accordance with standard procedures.

A REGISTER operation performing a Fetching Bindings (i.e. no Contact header field is present in the request) SHOULD return the same value of P-Service-Route as returned in the corresponding previous REGISTER response for the address-of-record in question. In some cases, the P-Service-Route may be dynamically calculated by the registrar rather than stored, and the decision as to whether this route should be recalculated in the event of a Fetching Bindings operation is left to the implementation.

Note: A Fetching Bindings operation could be used by the UA to recover a lost value of P-Service-Route.

Certain network topologies MAY require a specific proxy (e.g. firewall proxy) to be traversed before the home service proxy. Thus, a registrar with specific knowledge of the network topology MAY return more than one P-Service-Route header field or element in the

200 OK response; the order is specified as top-down, meaning the topmost P-Service-Route entry will be visited first. Such constructions are implementation specific and outside the scope of this document.

In general, the P-Service-Route header field contains references to elements strictly within the administrative domain of the registrar and home service proxy. For example, consider a case where a user leaves the "home" network and roams into a "visited" network. The registrar cannot be assumed to have knowledge of the topology of the visited network, so the P-Service-Route it returns contains elements only within the home network.

Note that the inserted P-Service-Route element(s) MUST conform to the syntax of a Route element as defined in [1]. As suggested therein, such route elements MUST include the loose-routing indicator parameter ";lr" for full compliance with [1]

6.4 Examples of Usage

We present an example in the context of the scenario presented in the Background section earlier in this document. The network diagram is replicated below:

Scenario

```
UA1----P1-----|    |--R-------|
              |    |          |
              P2---|         DBMS
              |    |          |
UA2-----------|    |--HSP-----|
```

6.4.1 Example of Mechanism in REGISTER Transaction

This example shows the message sequence for user agent UA1 registering to HOMEDOMAIN using registrar R. R returns a P-Service-Route indicating that UA1 may use home service proxy HSP to receive outbound services from HOMEDOMAIN.

Please note that the name UA1, HOMEDOMAIN, etc. are placeholders for appropriate user and host names or addresses.

Message sequence for REGISTER returning P-Service-Route:

F1 Register UA1 -> P1

```
REGISTER sip:HOMEDOMAIN SIP/2.0
Via: SIP/2.0/UDP 192.0.2.4:5060;branch=z9hG4bKnashds7
To: Lawyer <sip:UA1@HOMEDOMAIN>
From: Lawyer <sip:UA1@HOMEDOMAIN>;tag=456248
Call-ID: 843817637684230@998sdasdh09
CSeq: 1826 REGISTER
Contact: <sip:UA1@192.0.2.4>
 . . .
```

F2 Register P1 -> P2

```
REGISTER sip:HOMEDOMAIN SIP/2.0
Via: SIP/2.0/UDP P1:5060;branch=z9hG4bK34ghi7ab04
Via: SIP/2.0/UDP 192.0.2.4:5060;branch=z9hG4bKnashds7
To: Lawyer <sip:UA1@HOMEDOMAIN>
From: Lawyer <sip:UA1@HOMEDOMAIN>;tag=456248
Call-ID: 843817637684230@998sdasdh09
CSeq: 1826 REGISTER
Contact: <sip:UA1@192.0.2.4>
 . . .
```

F3 Register P2 -> R

```
REGISTER sip:HOMEDOMAIN SIP/2.0
Via: SIP/2.0/UDP P2:5060;branch=z9hG4bKiokioukju908
Via: SIP/2.0/UDP P1:5060;branch=z9hG4bK34ghi7ab04
Via: SIP/2.0/UDP 192.0.2.4:5060;branch=z9hG4bKnashds7
To: Lawyer <sip:UA1@HOMEDOMAIN>
From: Lawyer <sip:UA1@HOMEDOMAIN>;tag=456248
Call-ID: 843817637684230@998sdasdh09
CSeq: 1826 REGISTER
Contact: <sip:UA1@192.0.2.4>
 . . .
```

F4 R executes Register

```
R Stores:
For <sip:UA1@HOMEDOMAIN>
Contact = <sip:UA1@192.0.2.4>
```

F5 R calculates Service Route

In this example, R is statically configured to reference HSP as a service route, so P-Service-Route = <sip:HSP;lr>

F6 Register Response r -> P2

```
SIP/2.0 200 OK
Via: SIP/2.0/UDP P2:5060;branch=z9hG4bKiokioukju908
Via: SIP/2.0/UDP P1:5060;branch=z9hG4bK34ghi7ab04
Via: SIP/2.0/UDP 192.0.2.4:5060;branch=z9hG4bKnashds7
To: Lawyer <sip:UA1@HOMEDOMAIN>;tag=87654
From: Lawyer <sip:UA1@HOMEDOMAIN>;tag=456248
Call-ID: 843817637684230@998sdasdh09
CSeq: 1826 REGISTER
Contact: <sip:UA1@192.0.2.4>
P-Service-Route: <sip:HSP;lr>
 . . .
```

F7 Register Response P2 -> P1

```
SIP/2.0 200 OK
Via: SIP/2.0/UDP P1:5060;branch=z9hG4bK34ghi7ab04
Via: SIP/2.0/UDP 192.0.2.4:5060;branch=z9hG4bKnashds7
To: Lawyer <sip:UA1@HOMEDOMAIN>;tag=87654
From: Lawyer <sip:UA1@HOMEDOMAIN>;tag=456248
Call-ID: 843817637684230@998sdasdh09
CSeq: 1826 REGISTER
Contact: <sip:UA1@192.0.2.4>
P-Service-Route: <sip:HSP;lr>
 . . .
```

F8 Register Response P1 -> UA1

```
SIP/2.0 200 OK
Via: SIP/2.0/UDP 192.0.2.4:5060;branch=z9hG4bKnashds7
To: Lawyer <sip:UA1@HOMEDOMAIN>;tag=87654
From: Lawyer <sip:UA1@HOMEDOMAIN>;tag=456248
Call-ID: 843817637684230@998sdasdh09
CSeq: 1826 REGISTER
Contact: <sip:UA1@192.0.2.4>
P-Service-Route: <sip:HSP;lr>
 . . .
```

F9 UA1 stores service route for HOMEDOMAIN

6.4.2 Example of Mechanism in INVITE Transaction

This example shows the message sequence for an INVITE transaction originating from UA1 eventually arriving at UA2 using outbound services from HOMEDOMAIN, where UA1 has previously registered with HOMEDOMAIN and been informed of a service route through HSP. The service being provided by HOMEDOMAIN is a "logging" service, which provides a record of the call for UA1's use (perhaps the user of UA1 is an attorney who bills for calls to customers).

Message sequence for INVITE using P-Service-Route:

F1 INVITE UA1 -> P1

```
INVITE sip:UA2@HOMEDOMAIN  SIP/2.0
Via: SIP/2.0/UDP 192.0.2.4:5060;branch=z9hG4bKnashds7
To: Customer <sip:UA2@HOMEDOMAIN>
From: Lawyer <sip:UA1@HOMEDOMAIN>;tag=456248
Call-ID: 843817637684230@998sdasdh09
CSeq: 18 INVITE
Contact: <sip:UA1@192.0.2.4>
Route: <sip:HSP;lr>
 . . .
```

Note: P1 is selected using the "outbound proxy" rule in UA1.

F2 INVITE P1 -> P2

```
INVITE sip:UA2@HOMEDOMAIN  SIP/2.0
Via: SIP/2.0/UDP P1:5060;branch=z9hG4bK34ghi7ab04
Via: SIP/2.0/UDP 192.0.2.4:5060;branch=z9hG4bKnashds7
To: Customer <sip:UA2@HOMEDOMAIN>
From: Lawyer <sip:UA1@HOMEDOMAIN>;tag=456248
Call-ID: 843817637684230@998sdasdh09
CSeq: 18 INVITE
Contact: <sip:UA1@192.0.2.4>
Record-Route: <sip:P1;lr>
Route: <sip:HSP;lr>
 . . .
```

Note: P2 is selected using a DNS lookup on the domain of HSP.
P1 has added itself to the Record Route.

F3 INVITE P2 -> HSP

```
INVITE sip:UA2@HOMEDOMAIN  SIP/2.0
Via: SIP/2.0/UDP P2:5060;branch=z9hG4bKiokioukju908
Via: SIP/2.0/UDP P1:5060;branch=z9hG4bK34ghi7ab04
Via: SIP/2.0/UDP 192.0.2.4:5060;branch=z9hG4bKnashds7
To: Customer <sip:UA2@HOMEDMAIN>
From: Lawyer <sip:UA1@HOMEDOMAIN>;tag=456248
Call-ID: 843817637684230@998sdasdh09
CSeq: 18 INVITE
Contact: <sip:UA1@192.0.2.4>
Record-Route: <sip:P2;lr>
Record-Route: <sip:P1;lr>
Route: <sip:HSP;lr>
 . . .
```

Note: HSP is selected using a DNS lookup for HSP within HOMEDOMAIN. P2 has addded itself to the Record Route.

F4 HSP executes service

HSP identifies the service to be executed from UA1's stored profile. The specifics of this are outside the scope of this document. For this example HSP writes a record to "Lawyer"s log book, then looks up name "sip:UA2@HOMEDOMAIN" and discovers that the current contact for UA2 is address 18.19.20.21. This will be the request-URI of the next-hop INVITE

F5 INVITE HSP->P2

```
INVITE sip:UA2@18.19.20.21
Via: SIP/2.0/USP HSP:5060;branch=z9hG4bKHSP10120323
Via: SIP/2.0/UDP P2:5060;branch=z9hG4bKiokioukju908
Via: SIP/2.0/UDP P1:5060;branch=z9hG4bK34ghi7ab04
Via: SIP/2.0/UDP 192.0.2.4:5060;branch=z9hG4bKnashds7
To: Customer <sip:UA2@HOMEDOMAIN>
From: Lawyer <sip:UA1@HOMEDOMAIN>;tag=456248
Call-ID: 843817637684230@998sdasdh09
CSeq: 18 INVITE
Contact: <sip:UA1@192.0.2.4>
Record-Route: <sip:HSP;lr>
Record-Route: <sip:P2;lr>
Record-Route: <sip:P1;lr>
 . . .
```

Note: P2 selected by outbound proxy rule on HSP.

INVITE propagates toward UA2 as usual.

7. Security Considerations

It is possible for proxies between the UA and the registrar during the REGISTER transaction to modify the value of P-Service-Route returned by the registrar, or to insert a P-Service-Route even when one was not returned by the registrar. It is also possible for proxies on the INVITE path to execute many different attacks. It is therefore desirable to apply transitive mutual authentication using sips: or other available mechanisms in order to prevent such attacks.

The "sips:" URI as defined in [1] defines a mechanism by which a UA may request transport-level message integrity and mutual authentication. Since there is no requirement for proxies to modify message, S/MIME signed bodies may be used to provide end-to-end protection for the returned value.

Systems using P-Service-Route SHOULD provide hop-by-hop message integrity and mutual authentication. UAs SHOULD request this support by using a "sips:" URI. Registrars returning a P-Service-Route SHOULD provide end-to-end protection on the return using S/MIME. UAs receiving P-Service-Route SHOULD authenticate attached S/MIME bodies.

8. IANA Considerations

This document defines the SIP extension header field "P-Service-Route" which should be included in the registry of SIP header fields defined in SIP bis [1]. As required by the SIP change process draft-tsvarea-sipchange [7] the SIP extension header field name "Service-Route" should also be registered in association with this extension. However, "Service-Route" MUST not be used until documented by a standards-track RFC. Expert review as required for this process is to be provided by the SIP Working Group.

The following is the registration for the P-Service-Route header field:

RFC Number: RFCXXXX [Note to IANA: Fill in with the RFC number of this specification.]

Header Field Name: P-Service-Route

Compact Form: none

The following is the registration for the Service-Route header field:

RFC Number: RFCXXXX [Note to IANA: Fill in with the RFC number of this specification.] (not yet specified, only reserved)

Header Field Name: Service-Route

Compact Form: none

Normative References

[1] Rosenberg, J., "SIP: Session Initiation Protocol", draft-ietf-sip-rfc2543bis-09 (work in progress), March 2002.

[2] Bradner, S., "The Internet Standards Process -- Revision 3", BCP 9, RFC 2026, October 1996.

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

[4] Postel, J. and J. Reynolds, "Instructions to RFC Authors", RFC 2223, October 1997.

[5] Handley, M., Schulzrinne, H., Schooler, E. and J. Rosenberg, "SIP: Session Initiation Protocol", RFC 2543, March 1999.

Non-Normative References

[6] Garcia-Martin, MA., "3GPP Requirements On SIP", draft-garcia-sipping-3gpp-reqs-03 (work in progress), March 2002.

[7] Mankin, A., "SIP Change Process", draft-tsvarea-sipchange-01 (work in progress), March 2002.

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