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Relay Extensions for the Message Session Relay Protocol (MSRP)

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Abstract

Two separate models for conveying instant messages have been defined. Page-mode messages stand alone and are not part of a Session Initiation Protocol (SIP) session, whereas session-mode messages are set up as part of a session using SIP. The Message Session Relay Protocol (MSRP) is a protocol for near real-time, peer-to-peer exchanges of binary content without intermediaries, which is designed to be signaled using a separate rendezvous protocol such as SIP. This document introduces the notion of message relay intermediaries to MSRP and describes the extensions necessary to use them.

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1. Introduction and Requirements

There are a number of scenarios in which using a separate protocol for bulk messaging is desirable. In particular, there is a need to handle a sequence of messages as a session of media initiated using SIP [8], just like any other media type. The Message Session Relay Protocol (MSRP) [11] is used to convey a session of messages directly between two end systems with no intermediaries. With MSRP, messages can be arbitrarily large and all traffic is sent over reliable, congestion-safe transports.

This document describes extensions to the core MSRP protocol to introduce intermediaries called relays. With these extensions, MSRP clients can communicate directly, or through an arbitrary number of relays. Each client is responsible for identifying any relays acting on its behalf and providing appropriate credentials. Clients that can receive new TCP connections directly do not have to implement any new functionality to work with these relays.

The goals of the MSRP relay extensions are listed below:

- convey arbitrary binary MIME data without modification or transfer encoding
- continue to support client-to-client operation (no relay servers required)
- operate through an arbitrary number of relays for policy enforcement
- operate through relays under differing administrative control
- allow each client to control which relays are traversed on its behalf
- prevent unsolicited messages (spam), "open relays", and Denial of Service (DoS) amplification
- allow relays to use one or a small number of TCP or TLS [2] connections to carry messages for multiple sessions, recipients, and senders
- allow large messages to be sent over slow connections without causing head-of-line blocking problems
- allow transmissions of large messages to be interrupted and resumed in places where network connectivity is lost and later reestablished

- offer notification of message failure at any intermediary
- allow relays to delete state after a short amount of time

2. Conventions and Definitions

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 [9].

Below we list several definitions important to MSRP:

MSRP node: a host that implements the MSRP protocols as a client or a relay.

MSRP client: an MSRP node that is the initial sender or final target of messages and delivery status.

MSRP relay: an MSRP node that forwards messages and delivery status and may provide policy enforcement. Relays can fragment and reassemble portions of messages.

Message: arbitrary MIME [13][14] content that one client wishes to send to another. For the purposes of this specification, a complete MIME body as opposed to a portion of a complete message.

chunk: a portion of a complete message delivered in a SEND request.

end-to-end: delivery of data from the initiating client to the final target client.

hop: delivery of data between one MSRP node and an adjacent node.

3. Protocol Overview

With the introduction of this extension, MSRP has the concept of both clients and relays. Clients send messages to relays and/or other clients. Relays forward messages and message delivery status to clients and other relays. Clients that can open TCP connections to each other without intervening policy restrictions can communicate directly with each other. Clients who are behind firewalls or who need to use intermediaries for policy reasons can use the services of a relay. Each client is responsible for enlisting the assistance of one or more relays for its side of the communication.

Clients that use a relay operate by first opening a TLS connection with a relay, authenticating, and retrieving an msrps: URI (from the relay) that the client can provide to its peers to receive messages

later. There are several steps for doing this. First, the client opens a TLS connection to its first relay, and verifies that the name in the certificate matches the name of the relay to which it is trying to connect. Such verification is performed according to the procedures defined in Section 9.2. After verifying that it has connected to the proper host, the client authenticates itself to the relay using an AUTH request containing appropriate authentication credentials. In a successful AUTH response, the relay provides an msrps: URI associated with the path back to the client. The client can then give this URI to other clients for end-to-end message delivery.

When clients wish to send a short message, they issue a SEND request with the entire contents of the message. If any relays are required, they are included in the To-Path header. The leftmost URI in the To-Path header is the next hop to deliver a request or response. The rightmost URI in the To-Path header is the final target.

SEND requests contain headers that indicate how they are acknowledged in a hop-by-hop form and in an end-to-end form. The default is that SEND messages are acknowledged hop-by-hop. (Each relay that receives a SEND request acknowledges receipt of the request before forwarding the content to the next relay or the final target.) All other requests are acknowledged end-to-end.

With the introduction of relays, the subtle semantics of the To-Path header and the From-Path header become more relevant. The To-Path in both requests and responses is the list of URIs that need to be visited in order to reach the final target of the request or response. The From-Path is the list of URIs that indicate how to get back to the original sender of the request or response. These headers differ from the To and From headers in SIP, which do not "swap" from request to response. (Note that sometimes a request is sent to or from an intermediary directly.)

When a relay forwards a request, it removes its address from the To-Path header and inserts it as the first URI in the From-Path header. For example, if the path from Alice to Bob is through relays A and B, when B receives the request it contains path headers that look like the following. (Note that MSRP does not permit line folding. A "\" in the examples shows a line continuation due to limitations in line length of this document. Neither the backslash nor the extra CRLF is included in the actual request or response.)

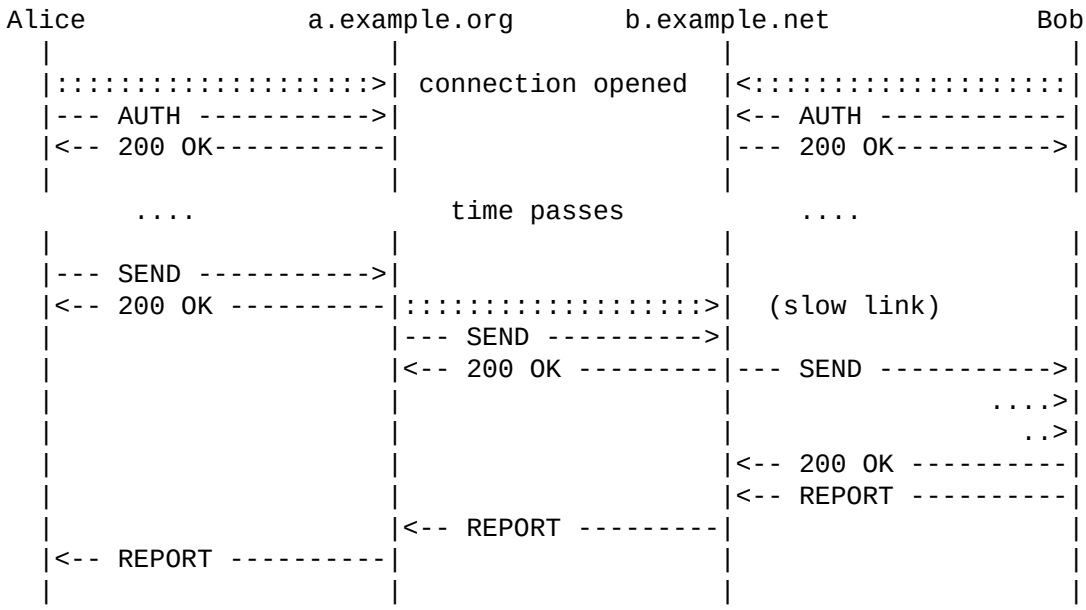
```
To-Path:   msrps://B.example.com/bbb;tcp \
           msrps://Bob.example.com/bob;tcp
From-Path: msrps://A.example.com/aaa;tcp \
           msrps://Alice.example.com/alice;tcp
```

After forwarding the request, the path headers look like this:

```
To-Path: msrps://Bob.example.com/bob;tcp
From-Path: msrps://B.example.com/bbb;tcp \
           msrps://A.example.com/aaa;tcp \
           msrps://Alice.example.com/alice;tcp
```

The sending of an acknowledgment for SEND requests is controlled by the Success-Report and Failure-Report headers and works the same way as in the base MSRP protocol. When a relay receives a SEND request, if the Failure-Report is set to "yes", it means that the previous hop is running a timer and the relay needs to send a response to the request. If the final response conveys an error, the previous hop is responsible for constructing the error report and sending it back to the original sender of the message. The 200 response acknowledges receipt of the request so that the previous hop knows that it is no longer responsible for the request. If the relay knows that it will not be able to deliver the request and the Failure-Report is set to any value other than "no", then it sends a REPORT to tell the sender about the error. If the Failure-Report is set to "yes", then after the relay is done sending the request to the next hop it starts running a timer; if the timer expires before a response is received from the next hop, the relay assumes that an error has happened and sends a REPORT to the sender. If the Failure-Report is not set to "yes", there is no need for the relay to run this timer.

The following example shows a typical MSRP session. The AUTH requests are explained in a later section but left in the example for call flow completeness.



The SEND and REPORT messages are shown below to illustrate the To-Path and From-Path headers. (Note that MSRP does not permit line folding. A "\" in the examples shows a line continuation due to limitations in line length of this document. Neither the backslash, nor the extra CRLF is included in the actual request or response.)

```
MSRP 6aef SEND
To-Path: msrps://a.example.org:9000/kjfjan;tcp \
         msrps://b.example.net:9000/aeiug;tcp \
         msrps://bob.example.net:8145/foo;tcp
From-Path: msrps://alice.example.org:7965/bar;tcp
Success-Report: yes
Byte-Range: 1-*/*
Message-ID: 87652
Content-Type: text/plain

Hi Bob, I'm about to send you file.mpeg
-------6aef$


MSRP 6aef 200 OK
To-Path: msrps://alice.example.org:7965/bar;tcp
From-Path: msrps://a.example.org:9000/kjfjan;tcp
Message-ID: 87652
-------6aef$
```

```
MSRP juh76 SEND
To-Path: msrps://b.example.net:9000/aeiug;tcp \
         msrps://bob.example.net:8145/foo;tcp
From-Path: msrps://a.example.org:9000/kjfjan;tcp \
           msrps://alice.example.org:7965/bar;tcp
Success-Report: yes
Message-ID: 87652
Byte-Range: 1-*/*
Content-Type: text/plain

Hi Bob, I'm about to send you file.mpeg
-------juh76$


MSRP juh76 200 OK
To-Path: msrps://a.example.org:9000/kjfjan;tcp
From-Path: msrps://b.example.net:9000/aeiug;tcp
Message-ID: 87652
-------juh76$

MSRP xght6 SEND
To-Path: msrps://bob.example.net:8145/foo;tcp
From-Path: msrps://b.example.net:9000/aeiug;tcp \
           msrps://a.example.org:9000/kjfjan;tcp \
           msrps://alice.example.org:7965/bar;tcp
Success-Report: yes
Message-ID: 87652
Byte-Range: 1-*/*
Content-Type: text/plain

Hi Bob, I'm about to send you file.mpeg
-------xght6$


MSRP xght6 200 OK
To-Path: msrps://b.example.net:9000/aeiug;tcp
From-Path: msrps://bob.example.net:8145/foo;tcp
Message-ID: 87652
```

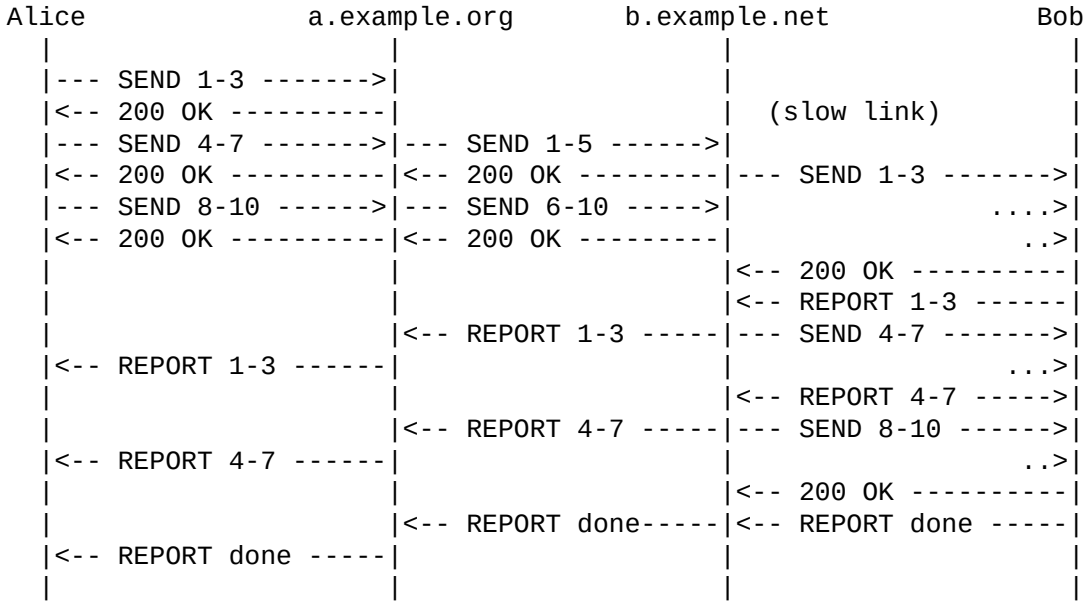
```
MSRP yh67 REPORT
To-Path: msrps://b.example.net:9000/aeiug;tcp \
         msrps://a.example.org:9000/kjfjan;tcp \
         msrps://alice.example.org:7965/bar;tcp
From-Path: msrps://bob.example.net:8145/foo;tcp
Message-ID: 87652
Byte-Range: 1-39/39
Status: 000 200 OK
-------yh67$


MSRP yh67 REPORT
To-Path: msrps://a.example.org:9000/kjfjan;tcp \
         msrps://alice.example.org:7965/bar;tcp
From-Path: msrps://b.example.net:9000/aeiug;tcp \
           msrps://bob.example.net:8145/foo;tcp
Message-ID: 87652
Byte-Range: 1-39/39
Status: 000 200 OK
-------yh67$


MSRP yh67 REPORT
To-Path: msrps://alice.example.org:7965/bar;tcp
From-Path: msrps://a.example.org:9000/kjfjan;tcp \
           msrps://b.example.net:9000/aeiug;tcp \
           msrps://bob.example.net:8145/foo;tcp
Message-ID: 87652
Byte-Range: 1-39/39
Status: 000 200 OK
-------yh67$
```

When sending large content, the client may split up a message into smaller pieces; each SEND request might contain only a portion of the complete message. For example, when Alice sends Bob a 4-GB file called "file.mpeg", she sends several SEND requests each with a portion of the complete message. Relays can repack message fragments en route. As individual parts of the complete message arrive at the final destination client, the receiving client can optionally send REPORT requests indicating delivery status.

MSRP nodes can send individual portions of a complete message in multiple SEND requests. As relays receive chunks, they can reassemble or re-fragment them as long as they resend the resulting chunks in order. (Receivers still need to be prepared to receive out-of-order chunks, however.) If the sender has set the Success-Report header to "yes", once a chunk or complete message arrives at the destination client, the destination will send a REPORT request

indicating that a chunk arrived end-to-end. This request travels back along the reverse path of the SEND request. Unlike the SEND request, which can be acknowledged along every hop, REPORT requests are never acknowledged.

The following example shows a message being re-chunked through two relays:



Relays only keep transaction states for a short time for each chunk. Delivery over each hop should take no more than 30 seconds after the last byte of data is sent. Client applications define their own implementation-dependent timers for end-to-end message delivery.

For client-to-client communication, the sender of a message typically opens a new TCP connection (with or without TLS) if one is needed. Relays reuse existing connections first, but can open new connections (typically to other relays) to deliver requests such as SEND or REPORT. Responses can only be sent over existing connections.

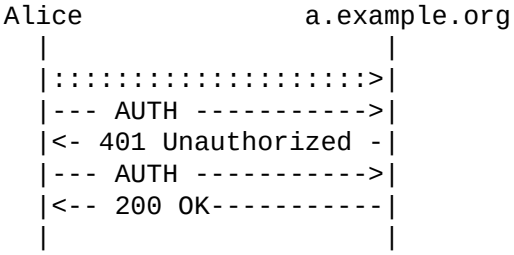
The relationship between MSRP and signaling protocols (such as SIP) is unchanged by this document, and is as described in [11]. An example of an SDP exchange for an MSRP session involving relays is shown in Section 11.

3.1. Authorization Overview

A key element of this protocol is that it cannot introduce open relays, with all the associated problems they create, including DoS attacks. A message is only forwarded by a relay if it is either going to or coming from a client that has authenticated to the relay and been authorized for relaying messages on that particular session. Because of this, clients use an AUTH message to authenticate to a relay and get a URI that can be used for forwarding messages.

If a client wishes to use a relay, it sends an AUTH request to the relay. The client authenticates the relay using the relay's TLS certificate. The client uses HTTP Digest authentication [1] to authenticate to the relay. When the authentication succeeds, the relay returns a 200 response that contains the URI that the client can use in the MSRP path for the relay.

A typical challenge response flow is shown below:



The URI that the client should use is returned in the Use-Path header of the 200.

Note that URIs returned to the client are effectively secret tokens that should be shared only with the other MSRP client in a session. For that reason, the client MUST NOT reuse the same URI for multiple sessions, and needs to protect these URIs from eavesdropping.

4. New Protocol Elements

4.1. The AUTH Method

AUTH requests are used by clients to create a handle they can use to receive incoming requests. AUTH requests also contain credentials used to authenticate a client and authorization policy used to block Denial of Service attacks.

In response to an AUTH request, a successful response contains a Use-Path header with a list of URIs that the client can give to its peers to route responses back to the client.

4.2. The Use-Path Header

The Use-Path header is a list of URIs provided by an MSRP relay in response to a successful AUTH request. This list of URIs can be used by the MSRP client that sent the AUTH request to receive MSRP requests and to advertise this list of URIs, for example, in a session description. URIs in the Use-Path header MUST include a fully qualified domain name (as opposed to a numeric IP address) and an explicit port number.

The URIs in the Use-Path header are in the same order that the authenticating client uses them in a To-Path header. Instructions on forming To-Path headers and SDP [7] path attributes from information in the Use-Path header are provided in Section 5.1.

4.3. The HTTP Authentication "WWW-Authenticate" Header

The "WWW-Authenticate" header contains a challenge token used in the HTTP Digest authentication procedure (from RFC 2617 [1]). The usage of HTTP Digest authentication in MSRP is described in detail in Section 5.1.

4.4. The HTTP Authentication "Authorization" Header

The "Authorization" header contains authentication credentials for HTTP Digest authentication (from RFC 2617 [1]). The usage of HTTP Digest authentication in MSRP is described in detail in Section 5.1.

4.5. The HTTP Authentication "Authentication-Info" Header

The "Authentication-Info" header contains future challenges to be used for HTTP Digest authentication (from RFC 2617 [1]). The usage of HTTP Digest authentication in MSRP is described in detail in Section 5.1.

4.6. Time-Related Headers

The Expires header in a request provides a relative time after which the action implied by the method of the request is no longer of interest. In a request, the Expires header indicates how long the sender would like the request to remain valid. In a response, the Expires header indicates how long the responder considers this information relevant. Specifically, an Expires header in an AUTH request indicates how long the provided URIs will be valid.

The Min-Expires header contains the minimum duration a server will permit in an Expires header. It is sent only in 423 "Interval Out-of-Bounds" responses. Likewise, the Max-Expires header contains the maximum duration a server will permit in an Expires header.

5. Client Behavior

5.1. Connecting to Relays Acting on Your Behalf

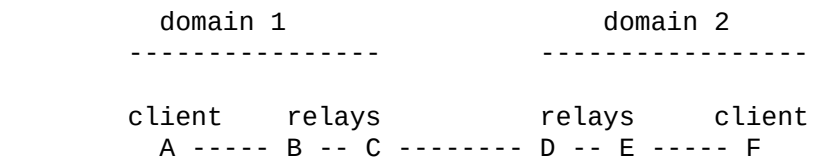
Clients that want to use the services of a relay or list of relays need to send an AUTH request to each relay that will act on their behalf. (For example, some organizations could deploy an "intra-org" relay and an "extra-org" relay.) The inner relay is used to tunnel the AUTH requests to the outer relay. For example, the client will send an AUTH to intra-org and get back a path that can be used for forwarding through intra-org. The client would then send a second AUTH destined to extra-org but sent through intra-org. The intra-org relay forwards this to extra-org and extra-org returns a path that can be used to forward messages from another destination to extra-org to intra-org and then on to this client. Each relay authenticates the client. The client authenticates the first relay and each relay authenticates the next relay.

Clients can be configured (typically, through discovery or manual provisioning) with a list of relays they need to use. They MUST be able to form a connection to the first relay and send an AUTH command to get a URI that can be used in a To-Path header. The client can authenticate its first relay by looking at the relay's TLS certificate. The client MUST authenticate itself to each of its relays using HTTP Digest authentication [1] (see Section 9.1 for details).

The relay returns a URI, or list of URIs, in the "Use-Path" header of a success response. Each URI SHOULD be used for only one unique session. These URIs are used by the client in the path attribute that is sent in the SDP to set up the session, and in the To-Path header of outgoing requests. To form the To-Path header for outgoing requests, the client takes the list of URIs in the Use-Path header after the outermost authentication and appends the list of URIs provided in the path attribute in the peer's session description. To form the SDP path attribute to provide to the peer, the client reverses the list of URIs in the Use-Path header (after the outermost authentication), and appends the client's own URI.

> For example, "A" has to traverse its own relays "B" and "C", and then relays "D" and "E" in domain2 to reach "F". Client "A" will authenticate with its relays "B" and "C" and eventually receive a Use-Path header containing "B C". Client "A" reverses the list

(now "C B") and appends its own URI (now "C B A"), and provides this list to "F" in a path SDP attribute. Client "F" sends its SDP path list "D E F", which client "A" appends to the Use-Path list it received "B C". The resulting To-Path header is "B C D E F".



Use-Path returned by C:	B C
path: attribute generated by A:	C B A
path: attribute received from F:	D E F
To-Path header generated by A:	B C D E F

The initial AUTH request sent to a relay by a client will generally not contain an Authorization header, since the client has no challenge to which it can respond. In response to an AUTH request that does not contain an Authorization header, a relay MUST respond with a "401 Unauthorized" response containing a WWW-Authenticate header. The WWW-Authenticate header is formed as described in RFC 2617 [1], with the restrictions and modifications described in Section 9.1. The realm chosen by the MSRP relay in such a challenge is a matter of administrative policy. Because a single relay does not have multiple protection spaces in MSRP, it is not unreasonable to always use the relay's hostname as the realm.

Upon receiving a 401 response to a request, the client SHOULD fetch the realm from the WWW-Authenticate header in the response and retry the request, including an Authorization header with the correct credentials for the realm. The Authorization header is formed as described in RFC 2617 [1], with the restrictions and modifications described in Section 9.1.

When a client wishes to use more than one relay, it MUST send an AUTH request to each relay it wishes to use. Consider a client A, that wishes messages to flow from A to the first relay, R1, then on to a second relay, R2. This client will do a normal AUTH with R1. It will then do an AUTH transaction with R2 that is routed through R1. The client will form this AUTH message by setting the To-Path to msrps://R1;tcp msrps://R2;tcp. R1 will forward this request onward to R2.

When sending an AUTH request, the client MAY add an Expires header to request a MSRP URI that is valid for no longer than the provided interval (a whole number of seconds). The server will include an

Expires header in a successful response indicating how long its URI from the Use-Path will be valid. Note that each server can return an independent expiration time.

Note that MSRP does not permit line folding. A "\" in the examples shows a line continuation due to limitations in line length of this document. Neither the backslash nor the extra CRLF is included in the actual request or response.

(Alice opens a TLS connection to intra.example.com and sends an AUTH request to initiate the authentication process.)

```
MSRP 49fh AUTH
To-Path: msrps://alice@intra.example.com;tcp
From-Path: msrps://alice.example.com:9892/98cjs;tcp
-------49fh$
```

(Alice's relay challenges the AUTH request.)

```
MSRP 49fh 401 Unauthorized
To-Path: msrps://alice.example.com:9892/98cjs;tcp
From-Path: msrps://alice@intra.example.com;tcp
WWW-Authenticate: Digest realm="intra.example.com", qop="auth", \
                  nonce="dcd98b7102dd2f0e8b11d0f600bfb0c093"
-------49fh$
```

(Alice responds to the challenge.)

```
MSRP 49fi AUTH
To-Path: msrps://alice@intra.example.com;tcp
From-Path: msrps://alice.example.com:9892/98cjs;tcp
Authorization: Digest username="Alice",
               realm="intra.example.com", \
               nonce="dcd98b7102dd2f0e8b11d0f600bfb0c093", \
               qop=auth, nc=00000001, cnonce="0a4f113b", \
               response="6629fae49393a05397450978507c4ef1"
-------49fi$
```

(Alice's relay confirms that Alice is an authorized user. As a matter of local policy, it includes an "Authentication-Info" header with a new nonce value to expedite future AUTH requests.)

```
    MSRP 49fi 200 OK
    To-Path: msrps://alice.example.com:9892/98cjs;tcp
    From-Path: msrps://alice@intra.example.com;tcp
    Use-Path: msrps://intra.example.com:9000/jui787s2f;tcp
    Authentication-Info: nextnonce="40f2e879449675f288476d772627370a",\
                         rspauth="7327570c586207eca2afae94fc20903d", \
                         cnonce="0a4f113b", nc=00000001, qop=auth
    Expires: 900
    -------49fi$
```

(Alice now sends an AUTH request to her "external" relay through her "internal" relay, using the URI she just obtained; the AUTH request is challenged.)

```
    MSRP mnbvw AUTH
    To-Path: msrps://intra.example.com:9000/jui787s2f;tcp \
             msrps://extra.example.com;tcp
    From-Path: msrps://alice.example.com:9892/98cjs;tcp
    -------mnbvw$

    MSRP m2nbvw AUTH
    To-Path: msrps://extra.example.com;tcp
    From-Path: msrps://intra.example.com:9000/jui787s2f;tcp \
               msrps://alice.example.com:9892/98cjs;tcp
    -------m2nbvw$

    MSRP m2nbvw 401 Unauthorized
    To-Path: msrps://intra.example.com:9000/jui787s2f;tcp \
             msrps://alice.example.com:9892/98cjs;tcp
    From-Path: msrps://extra.example.com;tcp
    WWW-Authenticate: Digest realm="extra.example.com", qop="auth", \
                      nonce="Uumu8cAV38FGsEF31VLevIbNXj9HWO"
    -------m2nbvw$

    MSRP mnbvw 401 Unauthorized
    To-Path: msrps://alice.example.com:9892/98cjs;tcp
    From-Path: msrps://intra.example.com:9000/jui787s2f;tcp \
               msrps://extra.example.com;tcp
    WWW-Authenticate: Digest realm="extra.example.com", qop="auth", \
                      nonce="Uumu8cAV38FGsEF31VLevIbNXj9HWO"
    -------mnbvw$
```

(Alice replies to the challenge with her credentials and is then authorized to use the "external" relay).

```
    MSRP m3nbvx AUTH
    To-Path: msrps://intra.example.com:9000/jui787s2f;tcp \
             msrps://extra.example.com;tcp
    From-Path: msrps://alice.example.com:9892/98cjs;tcp
    Authorization: Digest username="Alice",
                   realm="extra.example.com", \
                   nonce="Uumu8cAV38FGsEF31VLevIbNXj9HWO", \
                   qop=auth, nc=00000001, cnonce="85a0dca8", \
                   response="cb06c4a77cd90918cd7914432032e0e6"
    -------m3nbvx$

    MSRP m4nbvx AUTH
    To-Path: msrps://extra.example.com;tcp
    From-Path: msrps://intra.example.com:9000/jui787s2f;tcp \
               msrps://alice.example.com:9892/98cjs;tcp
    Authorization: Digest username="Alice",
                   realm="extra.example.com", \
                   nonce="Uumu8cAV38FGsEF31VLevIbNXj9HWO", \
                   qop=auth, nc=00000001, cnonce="85a0dca8", \
                   response="cb06c4a77cd90918cd7914432032e0e6"
    -------m4nbvx$

    MSRP m4nbvx 200 OK
    To-Path: msrps://intra.example.com:9000/jui787s2f;tcp \
             msrps://alice.example.com:9892/98cjs;tcp
    From-Path: msrps://extra.example.com;tcp
    Use-Path: msrps://intra.example.com:9000/jui787s2f;tcp \
              msrps://extra.example.com:9000/mywdEe1233;tcp
    Authentication-Info: nextnonce="bz8V080GEA2sLyEDpITF2AZCq7gIkc", \
                         rspauth="72f109ed2755d7ed0d0a213ec653b3f2", \
                         cnonce="85a0dca8", nc=00000001, qop=auth
    Expires: 1800
    -------m4nbvx$

    MSRP m3nbvx 200 OK
    To-Path: msrps://alice.example.com:9892/98cjs;tcp
    From-Path: msrps://intra.example.com:9000/jui787s2f;tcp \
               msrps://extra.example.com;tcp
    Use-Path: msrps://extra.example.com:9000/mywdEe1233;tcp \
              msrps://extra.example.com:9000/mywdEe1233;tcp
    Authentication-Info: nextnonce="bz8V080GEA2sLyEDpITF2AZCq7gIkc", \
                         rspauth="72f109ed2755d7ed0d0a213ec653b3f2", \
                         cnonce="85a0dca8", nc=00000001, qop=auth
    Expires: 1800
    -------m3nbvx$
```

5.2. Sending Requests

The procedure for forming SEND and REPORT requests is identical for clients whether or not relays are involved. The specific procedures are described in Section 7 of the core MSRP protocol.

As usual, once the next-hop URI is determined, the client MUST find the appropriate address, port, and transport to use and then check if there is already a suitable existing connection to the next-hop target. If so, the client MUST send the request over the most suitable connection. Suitability MAY be determined by a variety of factors such as measured load and local policy, but in most simple implementations a connection will be suitable if it exists and is active.

5.3. Receiving Requests

The procedure for receiving requests is identical for clients whether or not relays are involved.

5.4. Managing Connections

Clients should open a connection whenever they wish to deliver a request and no suitable connection exists. For connections to relays, the client should leave a connection up until no sessions have used it for a locally defined period of time, which defaults to 5 minutes for foreign relays and one hour for the client's relays.

6. Relay Behavior

6.1. Handling Incoming Connections

When a relay receives an incoming connection on a port configured for TLS, it includes a client CertificateRequest in the same record in which it sends its ServerHello. If the TLS client provides a certificate, the server verifies it and continues if the certificate is valid and rooted in a trusted authority. If the TLS client does not provide a certificate, the server assumes that the client is an MSRP endpoint and invokes Digest authentication. Once a TCP or TLS channel is negotiated, the server waits for up to 30 seconds to receive an MSRP request over the channel. If no request is received in that time, the server closes the connection. If no successful requests are sent during this probationary period, the server closes the connection. Likewise, if several unsuccessful requests are sent during the probation period and no requests are sent successfully, the server SHOULD close the connection.

6.2. Generic Request Behavior

Upon receiving a new request, relays first verify the validity of the request. Relays then examine the first URI in the To-Path header and remove this URI if it matches a URI corresponding to the relay. If the request is not addressed to the relay, the relay immediately drops the corresponding connection over which the request was received.

6.3. Receiving AUTH Requests

When a relay receives an AUTH request, the first thing it does is to authenticate and authorize the previous hop and the client at the far end. If there are no other relays between this relay and the client, then these are the same thing.

When the previous hop is a relay, authentication is done with TLS using mutual authentication. If the TLS client presented a host certificate, the relay checks that the subjectAltName in the certificate of the TLS client matches the hostname in the first From-Path URI. If the TLS client doesn't provide a host certificate, the relay assumes the TLS client is an MSRP client and sends it a challenge.

Authorization is a matter of local policy at the relay. Many relays will choose to authorize all relays that can be authenticated, possibly in conjunction with a blacklisting mechanism. Relays intended to operate only within a limited federation may choose to authorize only those relays whose identity appears in a provisioned list. Other authorization policies may also be applied.

When the previous hop is a client, the previous hop is the same as the identity of the client. The relay checks the credentials (username and password) provided by the client in the Authorization header and checks if this client is allowed to use the relay. If the client is not authorized, the relay returns a 403 response. If the client has requested a particular expiration time in an Expires header, the relay needs to check that the time is acceptable to it and, if not, return an error containing a Min-Expires or Max-Expires header, as appropriate.

Next the relay will generate an MSRP URI that allows messages to be forwarded to or from this previous hop. If the previous hop was a relay authenticated by mutual TLS, then the URI MUST be valid to route across any connection the relay has to the previous hop relay. If the previous hop is a client, then the URI MUST only be valid to

route across the same connection over which the AUTH request was received. If the client's connection is closed and then reopened, the URI MUST be invalidated.

If the AUTH request contains an Expires header, the relay MUST ensure that the URI is invalidated after the expiry time. The URI MUST contain at least 64 bits of cryptographically random material so that it is not guessable by attackers. If a relay is requested to forward a message for which the URI is not valid, the relay MUST discard the message and MAY send a REPORT indicating that the AUTH URI was bad.

A successful AUTH response returns a Use-Path header that contains an MSRP URI that the client can use. It also returns an Expires header that indicates how long the URI will be valid (expressed as a whole number of seconds).

If a relay receives several unsuccessful AUTH requests from a client that is directly connected to it via TLS, the relay SHOULD terminate the corresponding connection. Similarly, if a relay forwards several failed AUTH requests to the same destination that originate from a client that is directly connected to it via TLS, the relay SHOULD terminate the corresponding connection. Determination of a remote AUTH failure can be made by observing an AUTH request containing an Authorization header that triggers a 401 response without a "stale=TRUE" indication. These preventive measures apply only to a connection between a relay and a client; a relay SHOULD NOT use excessive AUTH request failures as a reason to terminate a connection with another relay.

6.4. Forwarding

Before any request is forwarded, the relay MUST check that the first URI in the To-Path header corresponds to a URI that this relay has created and handed out in the Use-Path header of an AUTH request. Next it verifies that either 1) the next hop is the next hop back toward the client that obtained this URI, or 2) the previous hop was the correct previous hop coming from the client that obtained this URI.

Since transact-id values are not allowed to conflict on a given connection, a relay will generally need to construct a new transact-id value for any request that it forwards.

6.4.1. Forwarding SEND Requests

If an incoming SEND request contains a Failure-Report header with a value of "yes", an MSRP relay that receives that SEND request MUST respond with a final response immediately. A 200-class response indicates the successful receipt of a message fragment but does not mean that the message has been forwarded on to the next hop. The final response to the SEND MUST be sent only to the previous hop, which could be an MSRP relay or the original sender of the SEND request.

If the Failure-Report header is "yes", then the relay MUST run a timer to detect if transmission to the next hop fails. The timer starts when the last byte of the message has been sent to the next hop. If after 30 seconds the next hop has not sent any response, then the relay MUST construct a REPORT with a status code of 408 to indicate a timeout error happened sending the message, and send the REPORT to the original sender of the message.

If the Failure-Report header is "yes" or "partial", and if there is a problem processing the SEND request or if an error response is received for that SEND request, then the relay MUST respond with an appropriate error response in a REPORT back to the original source of the message.

The MSRP relay MAY further break up the message fragment received in the SEND request into smaller fragments and forward them to the next hop in separate SEND requests. It MAY also combine message fragments received before or after this SEND request, and forward them out in a single SEND request to the next hop identified in the To-Path header. The MSRP relay MUST NOT combine message fragments from SEND requests with different values in the Message-ID header.

The MSRP relay MAY choose whether to further fragment the message, or combine message fragments, or send the message as is, based on some policy that is administered, or based on the network speed to the next hop, or any other mechanism.

If the MSRP relay has knowledge of the byte range that it will transmit to the next hop, it SHOULD update the Byte-Range header in the SEND request appropriately.

Before forwarding the SEND request to the next hop, the MSRP relay MUST inspect the first URI in the To-Path header. If it indicates this relay, the relay removes this URI from the To-Path header and inserts this URI in the From-Path header before any other URIs. If it does not indicate this relay, there has been an error in

forwarding at a previous hop. In this case, the relay SHOULD discard the message, and if the Failure-Report header is set to "yes", the relay SHOULD generate a failure report.

6.4.2. Forwarding Non-SEND Requests

An MSRP relay that receives any request other than a SEND request (including new methods unknown to the relay) first follows the validation and authorization rules for all requests. Then the relay moves its URI from the beginning of the To-Path headers to the beginning of the From-Path header and forwards the request on to the next hop. If it already has a connection to the next hop, it SHOULD use this connection and not form a new connection. If no suitable connection exists, the relay opens a new connection.

Requests with an unknown method are forwarded as if they were REPORT requests. An MSRP node MAY be configured to block unknown methods for security reasons.

6.4.3. Handling Responses

Relays receiving a response first verify that the first URI in the To-Path corresponds to itself; if not, the response SHOULD be dropped. Likewise, if the message cannot be parsed, the relay MUST drop the response. Next the relay determines if there are additional URIs in the To-Path. (For responses to SEND requests there will be no additional URIs, whereas responses to AUTH requests have additional URIs directing the response back to the client.)

If the response matches an existing transaction, then that transaction is completed and any timers running on it can be removed. If the response is a non 200 response, and the original request was a SEND request that had a Failure-Report header with a value other than "no", then the relay MUST send a REPORT indicating the nature of the failure. The response code received by the relay is used to form the status line in the REPORT that the relay sends.

If there are additional URIs in the To-Path header, the relay MUST then move its URI from the To-Path header, insert its URI in front of any other URIs in the From-Path header, and forward the response to the next URI in the To-Path header. The relay sends the request over the best connection that corresponds to the next URI in the To-Path header. If this connection has closed, then the response is silently discarded.

6.5. Managing Connections

Relays should keep connections open as long as possible. If a connection has not been used in a significant time (more than one hour), it MAY be closed. If the relay runs out of resources and can no longer establish new connections, it SHOULD start closing existing connections. It MAY choose to close the connections based on a least recently used basis.

7. Formal Syntax

The following syntax specification uses the Augmented Backus-Naur Form (ABNF) as described in RFC 4234 [10].

```
; This ABNF imports all the definitions in the ABNF of RFC 4975.

header =/  Expires / Min-Expires / Max-Expires / Use-Path /
           WWW-Authenticate / Authorization / Authentication-Info
           ; this adds to the rule in RFC 4975

mAUTH               = %x41.55.54.48          ; AUTH in caps
method              =/ mAUTH
                      ; this adds to the rule in RFC 4975

WWW-Authenticate    = "WWW-Authenticate:" SP "Digest" SP digest-param
                      *("," SP digest-param)

digest-param        = ( realm / nonce / [ opaque ] / [ stale ] / [
                      algorithm ] / qop-options  / [auth-param] )

realm               = "realm=" realm-value
realm-value         = quoted-string

auth-param          = token "=" ( token / quoted-string )

nonce               = "nonce=" nonce-value
nonce-value         = quoted-string
opaque              = "opaque=" quoted-string
stale               = "stale=" ( "true" / "false" )
algorithm           = "algorithm=" ( "MD5" / token )
qop-options         = "qop=" DQUOTE qop-list DQUOTE
qop-list            = qop-value *( "," qop-value )
qop-value           = "auth" / token

Authorization       = "Authorization:" SP credentials

credentials         = "Digest" SP digest-response
                      *( "," SP digest-response)
```

```
digest-response     = ( username / realm / nonce / response / [
                      algorithm ] / cnonce / [opaque] / message-qop /
                      [nonce-count]  / [auth-param] )

username            = "username=" username-value
username-value      = quoted-string
message-qop         = "qop=" qop-value
cnonce              = "cnonce=" cnonce-value
cnonce-value        = nonce-value
nonce-count         = "nc=" nc-value
nc-value            = 8LHEX
response            = "response=" request-digest
request-digest      = DQUOTE 32LHEX DQUOTE
LHEX                = DIGIT / %x61-66 ;lowercase a-f

Authentication-Info =  "Authentication-Info:" SP ainfo
                       *("," ainfo)
ainfo               =  nextnonce / message-qop
                        / response-auth / cnonce
                        / nonce-count
nextnonce           =  "nextnonce=" nonce-value
response-auth       =  "rspauth=" response-digest
response-digest     =  DQUOTE *LHEX DQUOTE

Expires     = "Expires:" SP 1*DIGIT
Min-Expires = "Min-Expires:" SP 1*DIGIT
Max-Expires = "Max-Expires:" SP 1*DIGIT

Use-Path = "Use-Path:" SP MSRP-URI *(SP MSRP-URI)
```

8. Finding MSRP Relays

When resolving an MSRP URI that contains an explicit port number, an MSRP node follows the rules in Section 6 of the MSRP base specification. MSRP URIs exchanged in SDP and in To-Path and From-Path headers in non-AUTH requests MUST have an explicit port number. (The only message in this specification that can have an MSRP URI without an explicit port number is in the To-Path header in an AUTH request.) Similarly, if the authority component of an msrps: URI contains an IPv4 address or an IPv6 reference, a port number MUST be present.

The following rules allow MSRP clients to discover MSRP relays more easily in AUTH requests. If the authority component contains a domain name and an explicit port number is provided, attempt to look up a valid address record (A or AAAA) for the domain name. Connect using TLS over the default transport (TCP) with the provided port number.

If a domain name is provided but no port number, perform a DNS SRV [4] lookup for the '_msrps' service and '_tcp' transport at the domain name, and follow the Service Record (SRV) selection algorithm defined in that specification to select the entry. (An '_msrp' service is not defined, since AUTH requests are only sent over TLS.) If no SRVs are found, try an address lookup (A or AAAA) for the domain name. Connect using TLS over the default transport (TCP) with the default port number (2855). Note that AUTH requests MUST only be sent over a TLS-protected channel. An SRV lookup in the example.com domain might return:

```
;; in example.com.      Pri Wght Port Target
_msrps._tcp   IN SRV    0   1    9000 server1.example.com.
_msrps._tcp   IN SRV    0   2    9000 server2.example.com.
```

If implementing a relay farm, it is RECOMMENDED that each member of the relay farm have an SRV entry. If any members of the farm have multiple IP addresses (for example, an IPv4 and an IPv6 address), each of these addresses SHOULD be registered in DNS as separate A or AAAA records corresponding to a single target.

9. Security Considerations

This section first describes the security mechanisms available for use in MSRP. Then the threat model is presented. Finally, we list implementation requirements related to security.

9.1. Using HTTP Authentication

AUTH requests MUST be authenticated. The authentication mechanism described in this specification uses HTTP Digest authentication. HTTP Digest authentication is performed as described in RFC 2617 [1], with the following restrictions and modifications:

- Clients MUST NOT attempt to use Basic authentication, and relays MUST NOT request or accept Basic authentication.

- The use of a qop value of auth-int makes no sense for MSRP. Integrity protection is provided by the use of TLS. Consequently, MSRP relays MUST NOT indicate a qop of auth-int in a challenge.

- The interaction between the MD5-sess algorithm and the nextnonce mechanism is underspecified in RFC 2617 [1]; consequently, MSRP relays MUST NOT send challenges indicating the MD5-sess algorithm.

- Clients SHOULD consider the protection space within a realm to be scoped to the authority portion of the URI, without regard to the contents of the path portion of the URI. Accordingly, relays

SHOULD NOT send the "domain" parameter on the "WWW-Authenticate" header, and clients MUST ignore it if present.

- Clients and relays MUST include a qop parameter in all "WWW-Authenticate" and "Authorization" headers. Note that the value of the qop parameter in a "WWW-Authenticate" header is quoted, but the value of the qop parameter in an "Authorization" header or "Authentication-Info" header is not quoted.

- Clients MUST send cnonce and nonce-count parameters in all "Authorization" headers.

- The request-URI to be used in calculating H(A2) is the rightmost URI in the To-Path header.

- Relays MUST include rspauth, cnonce, nc, and qop parameters in a "Authentication-Info" header for all "200 OK" responses to an AUTH request.

Note that the BNF in RFC 2617 has a number of errors. In particular, the value of the uri parameter MUST be in quotes; further, the parameters in the Authentication-Info header MUST be separated by commas. The BNF in this document is correct, as are the examples in RFC 2617 [1].

The use of the nextnonce and nc parameters is supported as described in RFC 2617 [1], which provides guidance on how and when they should be used. As a slight modification to the guidance provided in RFC 2617, implementors of relays should note that AUTH requests cannot be pipelined; consequently, there is no detrimental impact on throughput when relays use the nextnonce mechanism.

See Section 5.1 for further information on the procedures for client authentication.

9.2. Using TLS

TLS is used to authenticate relays to senders and to provide integrity and confidentiality for the headers being transported. MSRP clients and relays MUST implement TLS. Clients MUST send the TLS ClientExtendedHello extended hello information for server name indication as described in RFC 4366 [5]. A TLS cipher-suite of TLS_RSA_WITH_AES_128_CBC_SHA [6] MUST be supported (other cipher-suites MAY also be supported). A relay MUST act as a TLS server and present a certificate with its identity in the SubjectAltName using the choice type of dnsName. Relay-to-relay connections MUST use TLS with mutual authentication. Client-to-relay communications MUST use TLS for AUTH requests and responses.

The SubjectAltName in the certificate received from a relay MUST match the hostname part of the URI, and the certificate MUST be valid according to RFC 3280 [12], including having a date that is valid and being signed by an acceptable certification authority. After validating that such is the case, the device that initiated the TLS connection can assume that it has connected to the correct relay.

This document does not define procedures for using mutual authentication between an MSRP client and an MSRP relay. Authentication of clients is handled using the AUTH method via the procedures described in Section 5.1 and Section 6.3. Other specifications may define the use of TLS mutual authentication for the purpose of authenticating users associated with MSRP clients. Unless operating under such other specifications, MSRP clients SHOULD present an empty certificate list (if one is requested by the MSRP relay), and MSRP relays SHOULD ignore any certificates presented by the client.

> This behavior is defined specifically to allow forward-compatibility with specifications that define the use of TLS for client authentication.

Note: When relays are involved in a session, TCP without TLS is only used when a user that does not use relays connects directly to the relay of a user that is using relays. In this case, the client has no way to authenticate the relay other than to use the URIs that form a shared secret in the same way those URIs are used when no relays are involved.

9.3. Threat Model

This section discusses the threat model and the broad mechanism that needs to be in place to secure the protocol. The next section describes the details of how the protocol mechanism meets the broad requirements.

MSRP allows two peer-to-peer clients to exchange messages. Each peer can select a set of relays to perform certain policy operations for them. This combined set of relays is referred to as the route set. A channel outside of MSRP always needs to exist, such as out-of-band provisioning or an explicit rendezvous protocol such as SIP, that can securely negotiate setting up the MSRP session and communicate the route set to both clients. A client may trust a relay with certain types of routing and policy decisions, but it might or might not trust the relay with all the contents of the session. For example, a relay being trusted to look for viruses would probably need to be allowed to see all the contents of the session. A relay that helped deal with traversal of the ISP's Network Address Translator (NAT)

would likely not be trusted with the contents of the session but would be trusted to correctly forward messages.

Clients implicitly trust the relays through which they send and receive messages to honor the routing indicated in those messages, within the constraints of the MSRP protocol. Clients also need to trust that the relays they use do not insert new messages on their behalf or modify messages sent to or by the clients. It is worth noting that some relays are in a position to cause a client to misroute a message by maliciously modifying a Use-Path returned by a relay further down the chain. However, this is not an additional security threat because these same relays can also decide to misroute a message in the first place. If the relay is trusted to route messages, it is reasonable to trust it not to tamper with the Use-Path header. If the relay cannot be trusted to route messages, then it cannot be used.

Under certain circumstances, relays need to trust other relays not to modify information between them and the client they represent. For example, if a client is operating through Relay A to get to Relay B, and Relay B is logging messages sent by the client, Relay B may be required to authenticate that the messages they logged originate with the client, and have not been modified or forged by Relay A. This can be done by having the client sign the message.

Clients need to be able to authenticate that the relay they are communicating with is the one they trust. Likewise, relays need to be able to authenticate that the client is the one they are authorized to forward information to. Clients need the option of ensuring that information between the relay and the client is integrity protected and confidential to elements other than the relays and clients. To simplify the number of options, traffic between relays is always integrity protected and encrypted regardless of whether or not the client requests it. There is no way for the clients to tell the relays what strength of cryptographic mechanisms to use between relays other than to have the clients choose relays that are administered to require an adequate level of security.

The system also needs to stop messages from being directed to relays that are not supposed to see them. To keep the relays from being used in Denial of Service (DoS) attacks, the relays never forward messages unless they have a trust relationship with either the client sending or the client receiving the message; further, they only forward a message if it is coming from or going to the client with which they have the trust relationship. If a relay has a trust relationship with the client that is the destination of the message, it should not send the message anywhere except to the client that is the destination.

Some terminology used in this discussion: SClient is the client sending a message and RClient is the client receiving a message. SRelay is a relay the sender trusts and RRelay is a relay the receiver trusts. The message will go from SClient to SRelay1 to SRelay2 to RRelay2 to RRelay1 to RClient.

9.4. Security Mechanism

Confidentiality and privacy from elements not in the route set is provided by using TLS on all the transports. Relays always use TLS. A client can use unprotected TCP for peer-to-peer MSRP, but any time a client communicates with its relay, it MUST use TLS.

The relays authenticate to the clients using TLS (but don't have to do mutual TLS). Further, the use of the rspauth parameter in the Authentication-Info header provides limited authentication of relays to which the client is not directly connected. The clients authenticate to the relays using HTTP Digest authentication. Relays authenticate to each other using TLS mutual authentication.

By using Secure/Multipurpose Internet Mail Extensions (S/MIME) [3] encryption, the clients can protect their actual message contents so that the relays cannot see the contents. End-to-end signing is also possible with S/MIME.

The complex part is making sure that relays cannot successfully be instructed to send messages to a place where they should not. This is done by having the client authenticate to the relay and having the relay return a token. Messages that contain this token can be relayed if they come from the client that got the token or if they are being forwarded towards the client that got the token. The tokens are the URIs that the relay places in the Use-Path header. The tokens contain random material (defined in Section 6.3) so that they are not guessable by attackers. The tokens need to be protected so they are only ever seen by elements in the route set or other elements that at least one of the parties trusts. If some third party discovers the token that RRelay2 uses to forward messages to RClient, then that third party can send as many messages as they want to RRelay2 and it will forward them to RClient. The third party cannot cause them to be forwarded anywhere except to RClient, eliminating the open relay problems. SRelay1 will not forward the message unless it contains a valid token.

When SClient goes to get a token from SRelay2, this request is relayed through SRelay1. SRelay2 authenticates that it really is SClient requesting the token, but it generates a token that is only valid for forwarding messages to or from SRelay1. SRelay2 knows it is connected to SRelay1 because of the mutual TLS.

The tokens are carried in the resource portion of the MSRP URIs. The length of time the tokens are valid for is negotiated using the Expire header in the AUTH request. Clients need to re-negotiate the tokens using a new offer/answer [15] exchange (e.g., a SIP re-invite) before the tokens expire.

Note that this scheme relies on relays as trusted nodes, acting on behalf of the users authenticated to them. There is no security mechanism to prevent relays on the path from inserting forged messages, manipulating the contents of messages, sending messages in a session to a party other than that specified by the sender, or from copying them to a third party. However, the one-to-one binding between session identifiers and sessions helps mitigate any damage that can be caused by rogue relays by limiting the destinations to which forged or modified messages can be sent to the two parties involved in the session, and only for the duration of the session. Additionally, the use of S/MIME encryption can be employed to limit the utility of redirecting messages. Finally, clients can employ S/MIME signatures to guarantee the authenticity of messages they send, making it possible under some circumstances to detect relay manipulation or the forging of messages.

Clients are not the only actors in the network who need to trust relays to act in non-malicious ways. If a relay does not have a direct TLS connection with the client on whose behalf it is acting (i.e. There are one or more intervening relays), it is at the mercy of any such intervening relays to accurately transmit the messages sent to and from the client. If a stronger guarantee of the authentic origin of a message is necessary (e.g. The relay is performing logging of messages as part of a legal requirement), then users of that relay can be instructed by their administrators to use detached S/MIME signatures on all messages sent by their client. The relay can enforce such a policy by returning a 415 response to any SEND requests using a top-level MIME type other than "multipart/signed". Such relays may choose to make policy decisions (such as terminating sessions and/or suspending user authorization) if such signatures fail to match the contents of the message.

10. IANA Considerations

10.1. New MSRP Method

This specification defines a new MSRP method, to be added to the Methods sub-registry under the MSRP Parameters registry: AUTH. See Section 5.1 for details on the AUTH method.

10.2. New MSRP Headers

This specification defines several new MSRP header fields, to be added to the header-field sub-registry under the MSRP Parameters registry:

- Expires
- Min-Expires
- Max-Expires
- Use-Path
- WWW-Authenticate
- Authorization
- Authentication-Info

10.3. New MSRP Response Codes

This specification defines one new MSRP status code, to be added to the Status-Code sub-registry under the MSRP Parameters registry:

The 401 response indicates that an AUTH request contained no credentials, an expired nonce value, or invalid credentials. The response includes a "WWW-Authenticate" header containing a challenge (among other fields); see Section 9.1 for further details. The default response phrase for this response is "Unauthorized".

11. Example SDP with Multiple Hops

The following section shows an example SDP that could occur in a SIP message to set up an MSRP session between Alice and Bob where Bob uses a relay. Alice makes an offer with a path to Alice.

```
c=IN IP4 a.example.com
m=message 1234 TCP/MSRP *
a=accept-types: message/cpim text/plain text/html
a=path:msrp://a.example.com:1234/agic456;tcp
```

In this offer, Alice wishes to receive MSRP messages at a.example.com. She wants to use TCP as the transport for the MSRP session. She can accept message/cpim, text/plain, and text/html message bodies in SEND requests. She does not need a relay to set up the MSRP session.

To this offer, Bob's answer could look like:

```
c=IN IP4 bob.example.com
m=message 1234 TCP/TLS/MSRP *
a=accept-types: message/cpim text/plain
a=path:msrps://relay.example.com:9000/hjdhfha;tcp  \
       msrps://bob.example.com:1234/fuige;tcp
```

Here Bob wishes to receive the MSRP messages at bob.example.com. He can accept only message/cpim and text/plain message bodies in SEND requests and has rejected the text/html content offered by Alice. He wishes to use a relay called relay.example.com for the MSRP session.

12. Acknowledgments

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13. References

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13.2. Informative References

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Appendix A. Implementation Considerations

This text is not necessary in order to implement MSRP in an interoperable way, but is still useful as an implementation discussion for the community. It is purely an implementation detail.

Note: The idea has been proposed of having a relay return a base URI that the client can use to construct more URIs, but this allows third parties that have had a session with the client to know URIs that the relay will use for forwarding after the session with the third party has ended. Effectively, this reveals the secret URIs to third parties, which compromises the security of the solution, so this approach is not used.

An alternative to this approach causes the relays to return a URI that is divided into an index portion and a secret portion. The client can encrypt its identifier and its own opaque data with the secret portion, and concatenate this with the index portion to create a plurality of valid URIs. When the relay receives one of these URIs, it could use the index to look up the appropriate secret, decrypt the client portion, and verify that it contains the client identifier. The relay can then forward the request. The client does not need to send an AUTH request for each URI it uses. This is an implementation detail that is out of the scope of this document.

It is possible to implement forwarding requirements in a farm without the relay saving any state. One possible implementation that a relay might use is described in the rest of this section. When a relay starts up, it could pick a cryptographically random 128-bit password (K) and 128-bit initialization vector (IV). If the relay was actually a farm of servers with the same DNS name, all the machines in the farm would need to share the same K. When an AUTH request is received, the relay forms a string that contains the expiry time of the URI, an indication if the previous hop was mutual TLS authenticated or not, and if it was, the name of the previous hop, and if it was not, the identifier for the connection that received the AUTH request. This string would be padded by appending a byte with the value 0x80 then adding zero or more bytes with the value of 0x00 until the string length is a multiple of 16 bytes long. A new random IV would be selected (it needs to change because it forms the salt) and the padded string would be encrypted using AES-CBC with a key of K. The IV and encrypted data and an SPI (security parameter index) that changes each time K changes would be base 64 encoded and form the resource portion of the request URI. The SPI allows the key to be changed and for the system to know which K should be used. Later when the relay receives this URI, it could decrypt it and check that the current time was before the expiry time and check that the message was coming from or going to the connection or location

specified in the URI. Integrity protection is not required because it is extremely unlikely that random data that was decrypted would result in a valid location that was the same as the one the message was routing to or from. When implementing something like this, implementors should be careful not to use a scheme like EBE that would allows portions of encrypted tokens to be cut and pasted into other URIs.

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