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The WebSocket Protocol as a Transport for the Message Session Relay Protocol (MSRP)
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Abstract

The WebSocket protocol enables two-way real-time communication between clients and servers. This document specifies a new WebSocket sub-protocol as a reliable transport mechanism between MSRP (Message Session Relay Protocol) clients and relays to enable usage of MSRP in new scenarios. This document normatively updates RFC 4975 and RFC 4976.

Status of this Memo

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1. Introduction

The WebSocket [RFC6455] protocol enables message exchange between clients and servers on top of a persistent TCP connection (optionally secured with TLS [RFC5246]). The initial protocol handshake makes use of HTTP [RFC2616] semantics, allowing the WebSocket protocol to reuse existing HTTP infrastructure.

Modern web browsers include a WebSocket client stack complying with the WebSocket API [WS-API] as specified by the W3C. It is expected that other client applications (those running in personal computers and devices such as smart-phones) will also make a WebSocket client stack available. The specification in this document enables usage of MSRP in these scenarios.

This specification defines a new WebSocket sub-protocol (as defined in section 1.9 in [RFC6455]) for transporting MSRP messages between a WebSocket client and MSRP relay [RFC4976] containing a WebSocket server, a new transport for MSRP, and procedures for MSRP clients and relays implementing the WebSocket transport.

2. Terminology

All diagrams, examples, and notes in this specification are non-normative, as are all sections explicitly marked non-normative. Everything else in this specification is normative.

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 [RFC2119].

2.1. Definitions

MSRP WebSocket Client: An MSRP entity capable of opening outbound connections to MSRP relays which are WebSocket servers and communicating using the WebSocket MSRP sub-protocol as defined by this document.

MSRP WebSocket Server: An MSRP entity (specifically an MSRP relay [RFC4976]) capable of listening for inbound connections from WebSocket clients and communicating using the WebSocket MSRP sub-protocol as defined by this document.

3. The WebSocket Protocol

This section is non-normative.

The WebSocket protocol [RFC6455] is a transport layer on top of TCP (optionally secured with TLS [RFC5246]) in which both client and server exchange message units in both directions. The protocol defines a connection handshake, WebSocket sub-protocol and extensions negotiation, a frame format for sending application and control data, a masking mechanism, and status codes for indicating disconnection causes.

The WebSocket connection handshake is based on HTTP [RFC2616] and utilizes the HTTP GET method with an "Upgrade" request. This is sent by the client and then answered by the server (if the negotiation succeeded) with an HTTP 101 status code. Once the handshake is completed the connection upgrades from HTTP to the WebSocket protocol. This handshake procedure is designed to reuse the existing HTTP infrastructure. During the connection handshake, client and server agree on the application protocol to use on top of the WebSocket transport. Such application protocol (also known as a "WebSocket sub-protocol") defines the format and semantics of the messages exchanged by the endpoints. This could be a custom protocol or a standardized one (such as the WebSocket MSRP sub-protocol defined in this document). Once the HTTP 101 response is processed both client and server reuse the underlying TCP connection for sending WebSocket messages and control frames to each other. Unlike plain HTTP, this connection is persistent and can be used for multiple message exchanges.

WebSocket defines message units to be used by applications for the exchange of data, so it provides a message boundary-preserving transport layer. These message units can contain either UTF-8 text or binary data, and can be split into multiple WebSocket text/binary transport frames as needed by the WebSocket stack.

> The WebSocket API [WS-API] for web browsers only defines callbacks to be invoked upon receipt of an entire message unit, regardless of whether it was received in a single WebSocket frame or split across multiple frames.

4. The WebSocket MSRP Sub-Protocol

The term WebSocket sub-protocol refers to an application-level protocol layered on top of a WebSocket connection. This document specifies the WebSocket MSRP sub-protocol for carrying MSRP requests and responses through a WebSocket connection.

4.1. Handshake

The MSRP WebSocket Client and MSRP WebSocket Server negotiate usage of the WebSocket MSRP sub-protocol during the WebSocket handshake procedure as defined in section 1.3 of [RFC6455]. The Client MUST include the value "msrp" in the Sec-WebSocket-Protocol header in its handshake request. The 101 reply from the Server MUST contain "msrp" in its corresponding Sec-WebSocket-Protocol header.

Below is an example of a WebSocket handshake in which the Client requests the WebSocket MSRP sub-protocol support from the Server:

```
GET / HTTP/1.1
Host: a.example.com
Upgrade: websocket
Connection: Upgrade
Sec-WebSocket-Key: dGhlIHNhbXBsZSBub25jZQ==
Origin: http://www.example.com
Sec-WebSocket-Protocol: msrp
Sec-WebSocket-Version: 13
```

The handshake response from the Server accepting the WebSocket MSRP sub-protocol would look as follows:

```
HTTP/1.1 101 Switching Protocols
Upgrade: websocket
Connection: Upgrade
Sec-WebSocket-Accept: s3pPLMBiTxaQ9kYGzzhZRbK+xOo=
Sec-WebSocket-Protocol: msrp
```

Once the negotiation has been completed, the WebSocket connection is established and can be used for the transport of MSRP requests and responses. The WebSocket messages transmitted over this connection MUST conform to the negotiated WebSocket sub-protocol.

4.2. MSRP encoding

WebSocket messages can be transported in either UTF-8 text frames or binary frames. MSRP [RFC4975] allows both text and binary bodies in MSRP requests. Therefore MSRP WebSocket Clients and Servers MUST accept both text and binary frames.

5. MSRP WebSocket Transport

5.1. General

WebSocket clients cannot receive WebSocket connections initiated by other WebSocket clients or WebSocket servers. This means that it is impossible for an MSRP client to communicate directly with other MSRP clients. Therefore, all MSRP over WebSocket messages MUST be routed via an MSRP WebSocket Server.

MSRP WebSocket Servers can be used to route MSRP messages between MSRP WebSocket Clients, and between MSRP WebSocket Clients and "normal" MSRP clients and relays.

Each MSRP message MUST be carried within a single WebSocket message, and a WebSocket message MUST NOT contain more than one MSRP message.

> This simplifies parsing of MSRP messages for both clients and servers. When large messages are sent MSRP chunking (as defined in section 5.1 of [RFC4975]) MUST be used to split the message into several smaller MSRP messages.

5.2. Updates to RFC 4975

5.2.1. MSRP URI Transport Parameter

This document defines the value "ws" as the transport parameter value for an MSRP URI [RFC3986] to be contacted using the MSRP WebSocket sub-protocol as transport.

The updated augmented BNF (Backus-Naur Form) [RFC5234]for this parameter is the following (the original BNF for this parameter can be found in [RFC4975]):

```
transport  =  "tcp" / "ws" / 1*ALPHANUM
```

5.2.2. SDP Transport Protocol

This document does not define a new SDP transport protocol for MSRP over WebSockets. Adding a new SDP transport protocol may cause problems with parsers in existing, non-WebSocket, MSRP clients. Further, as all MSRP over WebSocket messages MUST be routed via an MSRP WebSocket Server it is acceptable for an MSRP WebSocket Client to specify the "TCP/MSRP" or "TCP/TLS/MSRP" protocols in SDP - that being the protocol used by non-WebSocket clients and between MSRP relays.

5.3. Updates to RFC 4976

5.3.1. AUTH Request Authentication

The MSRP relay specification [RFC4976] states that AUTH requests MUST be authenticated. This document modifies this requirement to state that all connections between MSRP clients and relays MUST be authenticated. In the case of the MSRP WebSocket Clients there are two possible authentication mechanisms:

1. HTTP Digest authentication in AUTH (as per [RFC4976]).

2. Cookie-based or HTTP Digest authentication in the WebSocket Handshake (see Section 7).

5.3.2. Use of TLS

The MSRP relay specification [RFC4976] mandates the use of TLS between MSRP clients and MSRP relays, and specifies the mechanisms that must be used for TLS authentication. This document downgrades the MUSTs with respect to TLS to SHOULDs when using the MSRP WebSocket sub-protocol as transport. Connections between MSRP WebSocket Clients and Servers SHOULD use secure WebSocket connections, but MAY use insecure WebSocket connections. As the secure WebSocket connections are negotiated between the client's WebSocket stack and the WebSocket server, an MSRP WebSocket Client may have no knowledge of, or control over, the mechanisms used for TLS authentication.

6. Connection Keep Alive

This section is non-normative.

It is RECOMMENDED that MSRP WebSocket Clients and Servers keep their WebSocket connections open by sending periodic WebSocket "Ping" frames as described in [RFC6455] section 5.5.2.

> The WebSocket API [WS-API] does not provide a mechanism for applications running in a web browser to control whether or not periodic WebSocket "Ping" frames are sent to the server. The implementation of such a keep alive feature is the decision of each web browser manufacturer and may also depend on the configuration of the web browser.

A future WebSocket protocol extension providing a similar keep alive mechanism could also be used.

7. Authentication

This section is non-normative.

Prior to sending MSRP requests, an MSRP WebSocket Client connects to an MSRP WebSocket Server and performs the connection handshake. As described in Section 3 the handshake procedure involves a HTTP GET method request from the Client and a response from the Server including an HTTP 101 status code.

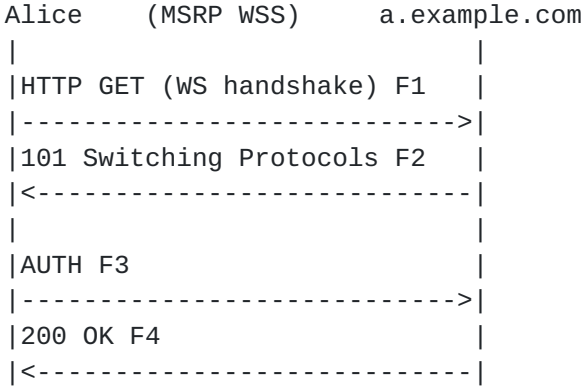
In order to authorize the WebSocket connection, the MSRP WebSocket Server MAY inspect any Cookie [RFC6265] headers present in the HTTP GET request. For many web applications the value of such a Cookie is provided by the web server once the user has authenticated themselves to the web server, which could be done by many existing mechanisms. As an alternative method, the MSRP WebSocket Server could request HTTP authentication by replying to the Client's GET method request with a HTTP 401 status code. The WebSocket protocol [RFC6455] covers this usage in section 4.1:

> If the status code received from the server is not 101, the WebSocket client stack handles the response per HTTP [RFC2616] procedures, in particular the client might perform authentication if it receives 401 status code.

Regardless of whether the MSRP WebSocket Server requires authentication during the WebSocket handshake, authentication MAY be requested at MSRP protocol level. Therefore it is RECOMMENDED that an MSRP WebSocket Client implements HTTP Digest [RFC2617] authentication as stated in [RFC4976].

8. Examples

8.1. AUTH

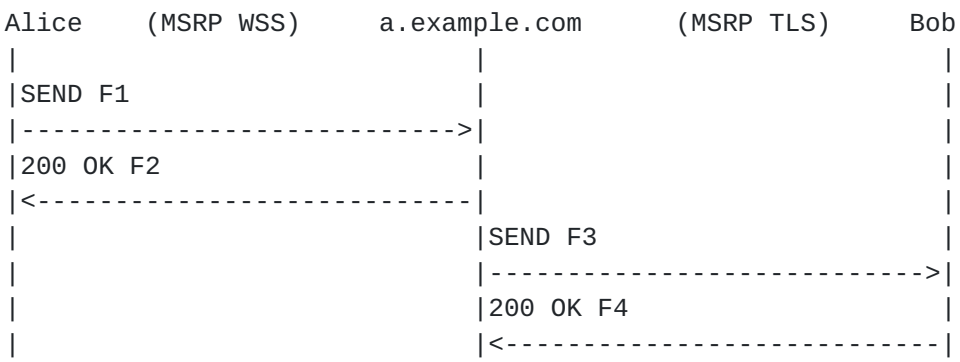


Alice loads a web page using her web browser and retrieves JavaScript code implementing the WebSocket MSRP sub-protocol defined in this document. The JavaScript code (an MSRP WebSocket Client) establishes a secure WebSocket connection with an MSRP relay (an MSRP WebSocket Server) at a.example.com. Upon WebSocket connection, Alice constructs and sends an MSRP AUTH request. Since the JavaScript stack in a browser has no way to determine the local address from which the WebSocket connection was made, this implementation uses a random ".invalid" domain name for the hostpart of the From-Path URI (see Appendix A.1).

Message details (authentication is omitted for simplicity):

```
   F1 HTTP GET (WS handshake)  Alice -> a.example.com (TLS)

   GET / HTTP/1.1
   Host: a.example.com
   Upgrade: websocket
   Connection: Upgrade
   Sec-WebSocket-Key: dGhlIHNhbXBsZSBub25jZQ==
   Origin: https://www.example.com
   Sec-WebSocket-Protocol: msrp
   Sec-WebSocket-Version: 13


   F2 101 Switching Protocols  a.example.com -> Alice (TLS)

   HTTP/1.1 101 Switching Protocols
   Upgrade: websocket
   Connection: Upgrade
   Sec-WebSocket-Accept: s3pPLMBiTxaQ9kYGzzhZRbK+xOo=
   Sec-WebSocket-Protocol: msrp


   F3 AUTH  Alice -> a.example.com (transport WSS)

   MSRP 49fi AUTH
   To-Path: msrps://alice@a.example.com:443;ws
   From-Path: msrps://df7jal23ls0d.invalid:2855/98cjs;ws
   -------49fi$


   F4 200 OK  a.example.com -> Alice (transport WSS)

   MSRP 49fi 200 OK
   To-Path: msrps://df7jal23ls0d.invalid:2855/98cjs;ws
   From-Path: msrps://alice@a.example.com:443;ws
   Use-Path: msrps://a.example.com:2855/jui787s2f;tcp
   Expires: 900
   -------49fi$
```

8.2. SEND (MSRP WebSocket Client to MSRP Client)



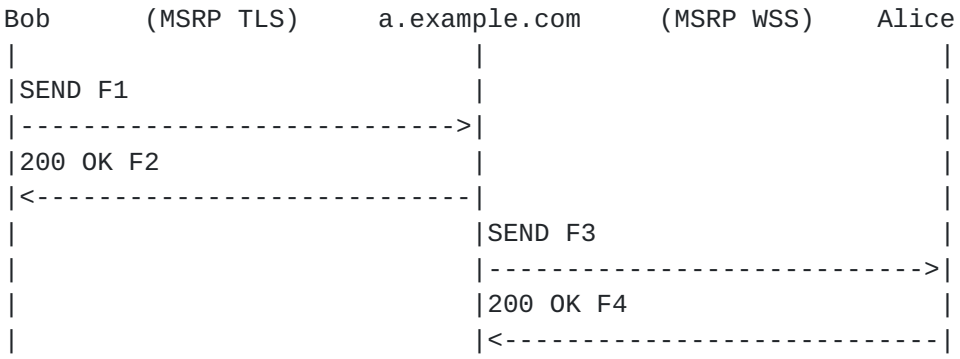
In the same scenario Alice sends an instant message to Bob (session details having been previously negotiated by some other mechanism - such as SDP [RFC4976]). The MSRP WebSocket Server at a.example.com acts as an MSRP relay, routing the message to Bob over TLS.

In this example Bob himself does not require an MSRP relay and has not authenticated with a.example.com but Alice does and has.

Message details (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):

```
F1 SEND  Alice -> a.example.com (transport WSS)

MSRP 6aef SEND
To-Path: msrps://a.example.com:2855/jui787s2f;tcp \
         msrps://bob.example.com:8145/foo;tcp
From-Path: msrps://df7jal23ls0d.invalid:2855/98cjs;ws
Success-Report: no
Byte-Range: 1-*/*
Message-ID: 87652
Content-Type: text/plain

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


F2 200 OK  a.example.com -> Alice (transport WSS)

MSRP 6aef 200 OK
To-Path: msrps://df7jal23ls0d.invalid:2855/98cjs;ws
From-Path: msrps://a.example.com:2855/jui787s2f;tcp
-------6aef$


F3 SEND  a.example.com -> Bob (transport TLS)

MSRP juh76 SEND
To-Path: msrps://bob.example.com:8145/foo;tcp
From-Path:  msrps://a.example.com:2855/jui787s2f;tcp \
            msrps://df7jal23ls0d.invalid:2855/98cjs;ws
Success-Report: no
Byte-Range: 1-*/*
Message-ID: 87652
Content-Type: text/plain

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


F4 200 OK  Bob -> a.example.com (transport TLS)

MSRP juh76 200 OK
To-Path: msrps://a.example.com:2855/jui787s2f;tcp
From-Path: msrps://bob.example.com:8145/foo;tcp
-------juh76$
```

8.3. SEND (MSRP Client to MSRP WebSocket Client)



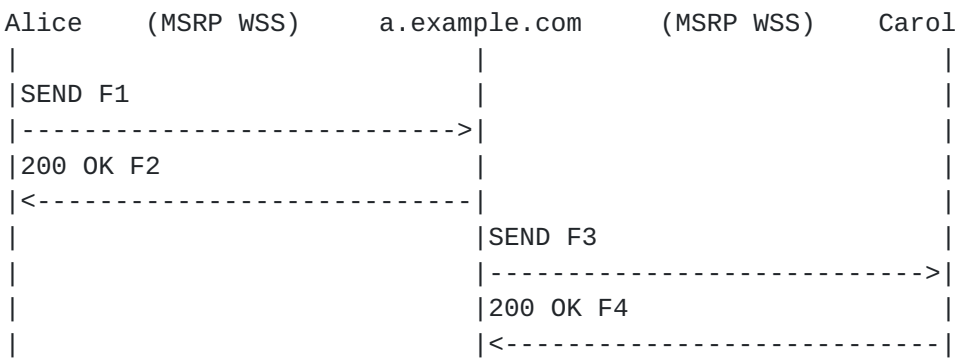
In the same scenario Bob sends an instant message to Alice (session details having been previously negotiated by some other mechanism - such as SDP [RFC4976]). The MSRP WebSocket Server at a.example.com acts as an MSRP relay, routing the message to Alice over secure WebSocket.

In this example Bob himself does not require an MSRP relay and has not authenticated with a.example.com but Alice does and has.

Message details (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):

```
   F1 SEND  Bob -> a.example.com (transport TLS)

   MSRP xght6 SEND
   To-Path: msrps://a.example.com:2855/jui787s2f;tcp \
            msrps://df7jal23ls0d.invalid:2855/98cjs;ws
   From-Path: msrps://bob.example.com:8145/foo;tcp
   Success-Report: no
   Byte-Range: 1-*/*
   Message-ID: 87652
   Content-Type: text/plain

   Thanks for the file.
   -------xght6$


   F2 200 OK  a.example.com -> Bob (transport TLS)

   MSRP xght6 200 OK
   To-Path: msrps://bob.example.com:8145/foo;tcp
   From-Path: msrps://a.example.com:2855/jui787s2f;tcp
   -------xght6$


   F3 SEND  a.example.com -> Alice (transport WSS)

   MSRP yh67 SEND
   To-Path:  msrps://df7jal23ls0d.invalid:2855/98cjs;ws
   From-Path:  msrps://a.example.com:2855/jui787s2f;tcp \
               msrps://bob.example.com:8145/foo;tcp
   Success-Report: no
   Byte-Range: 1-*/*
   Message-ID: 87652
   Content-Type: text/plain

   Hi Bob, I'm about to send you file.mpeg
   -------yh67$


   F4 200 OK  Bob -> a.example.com (transport TLS)

   MSRP yh67 200 OK
   To-Path:  msrps://a.example.com:2855/jui787s2f;tcp
   From-Path:  msrps://df7jal23ls0d.invalid:2855/98cjs;ws
   -------yh67$
```

8.4. SEND (MSRP WebSocket Client to MSRP WebSocket Client)



In the same scenario Alice sends an instant message to Carol (session details having been previously negotiated by some other mechanism - such as SDP [RFC4976]). The MSRP WebSocket Server at a.example.com acts as an MSRP relay, routing the message to Carol over secure WebSocket.

In this example both Alice and Carol are using MSRP WebSocket Clients and an MSRP WebSocket Server. This means that a.example.com will appear twice in the To-Path in F1. a.example.com can either handle this internally or loop the MSRP SEND request back to itself as if it were two, separate, MSRP relays.

Message details (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):

```
   F1 SEND  Alice -> a.example.com (transport WSS)

   MSRP kjh6 SEND
   To-Path: msrps://a.example.com:2855/jui787s2f;tcp \
            msrps://a.example.com:2855/iwnslt;tcp \
            msrps://jk9awp14vj8x.invalid:2855/76qwe;ws
   From-Path: msrps://df7jal23ls0d.invalid:2855/98cjs;ws
   Success-Report: no
   Byte-Range: 1-*/*
   Message-ID: 87652
   Content-Type: text/plain

   Carol, here is the file Bob sent me.
   -------kjh6$


   F2 200 OK  a.example.com -> Alice (transport WSS)

   MSRP kjh6 200 OK
   To-Path: msrps://df7jal23ls0d.invalid:2855/98cjs;ws
   From-Path: msrps://a.example.com:2855/jui787s2f;tcp
   -------kjh6$


   F3 SEND  a.example.com -> Carol (transport WSS)

   MSRP re58 SEND
   To-Path: msrps://jk9awp14vj8x.invalid:2855/76qwe;ws
   From-Path: msrps://a.example.com:2855/iwnslt;tcp \
              msrps://a.example.com:2855/jui787s2f;tcp \
              msrps://df7jal23ls0d.invalid/98cjs;ws
   Success-Report: no
   Byte-Range: 1-*/*
   Content-Type: text/plain

   Carol, here is the file Bob sent me.
   -------re58$


   F4 200 OK  Carol -> a.example.com (transport WSS)

   MSRP re58 200 OK
   To-Path: msrps://a.example.com:2855/iwnslt;tcp
   From-Path: msrps://jk9awp14vj8x.invalid:2855/76qwe;ws
   -------re58$
```

9. Security Considerations

9.1. Secure WebSocket Connection

It is RECOMMENDED that the MSRP traffic transported over a WebSocket communication be protected by using a secure WebSocket connection (using TLS [RFC5246] over TCP).

10. IANA Considerations

10.1. Registration of the WebSocket MSRP Sub-Protocol

This specification requests IANA to register the WebSocket MSRP sub-protocol in the registry of WebSocket sub-protocols with the following data:

Subprotocol Identifier: msrp

Subprotocol Common Name: WebSocket Transport for MSRP (Message Session Relay Protocol)

Subprotocol Definition: TBD, it should point to this document

11. Acknowledgements

Special thanks to Inaki Baz Castillo, Jose Luis Millan Villegas, and Victor Pascual, the authors of [I-D.ietf-sipcore-sip-websocket] which has inspired this draft.

Additional thanks to Inaki Baz Castillo who pointed out that "web-browser" shouldn't be used all the time as this specification should be valid for smartphones and apps other than browsers.

Special thanks to James Wyatt from Crocodile RCS Ltd for helping with the JavaScript MSRP over WebSockets prototyping.

12. References

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Appendix A. Implementation Guidelines

This section is non-normative.

A.1. MSRP WebSocket Client Considerations

The JavaScript stack in web browsers does not have the ability to discover the local transport address used for originating WebSocket connections. Therefore the MSRP WebSocket Client constructs a domain name consisting of a random token followed by the ".invalid" top-level domain name, as stated in [RFC2606], and uses it within its From-Path headers.

> The From-Path URI provided by MSRP clients which use an MSRP relay is not used for routing MSRP messages, thus it is safe to set a random domain in the hostpart of the From-Path URI.

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