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WebRTC-HTTP ingestion protocol (WHIP)

Abstract

This document describes a simple HTTP-based protocol that will allow WebRTC-based ingestion of content into streaming services and/or CDNs.

Status of This Memo

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1. Introduction

The IETF RTCWEB working group standardized JSEP ([RFC8829]), a mechanism used to control the setup, management, and teardown of a multimedia session. It also describes how to negotiate media flows using the Offer/Answer Model with the Session Description Protocol (SDP) [RFC3264] as well as the formats for data sent over the wire (e.g., media types, codec parameters, and encryption). WebRTC intentionally does not specify a signaling transport protocol at application level.

Unfortunately, the lack of a standardized signaling mechanism in WebRTC has been an obstacle to adoption as an ingestion protocol within the broadcast/streaming industry, where a streamlined production pipeline is taken for granted: plug in cables carrying raw media to hardware encoders, then push the encoded media to any streaming service or Content Delivery Network (CDN) ingest using an ingestion protocol.

While WebRTC can be integrated with standard signaling protocols like SIP [RFC3261] or XMPP [RFC6120], they are not designed to be used in broadcasting/streaming services, and there also is no sign of adoption in that industry. RTSP [RFC7826], which is based on RTP, is not compatible with the SDP offer/answer model [RFC3264].

This document proposes a simple protocol for supporting WebRTC as media ingestion method which:

* Is easy to implement,

* Is as easy to use as popular IP-based broadcast protocols

* Is fully compliant with WebRTC and RTCWEB specs

* Allows for ingest both in traditional media platforms and in WebRTC end-to-end platforms with the lowest possible latency.

* Lowers the requirements on both hardware encoders and broadcasting services to support WebRTC.

* Is usable both in web browsers and in native encoders.

2. Terminology

The key words "**MUST**", "**MUST NOT**", "**REQUIRED**", "**SHALL**", "**SHALL NOT**", "**SHOULD**", "**SHOULD NOT**", "**RECOMMENDED**", "**NOT RECOMMENDED**", "**MAY**", and "**OPTIONAL**" in this document are to be interpreted as described in BCP 14 [RFC2119] [RFC8174] when, and only when, they appear in all capitals, as shown here.

* WHIP client: WebRTC media encoder or producer that acts as a client of the WHIP protocol by encoding and delivering the media to a remote Media Server.

* WHIP endpoint: Ingest server receiving the initial WHIP request.

* WHIP endpoint URL: URL of the WHIP endpoint that will create the WHIP resource.

* Media Server: WebRTC Media Server or consumer that establishes the media session with the WHIP client and receives the media produced by it.

* WHIP resource: Allocated resource by the WHIP endpoint for an ongoing ingest session that the WHIP client can send requests for altering the session (ICE operations or termination, for example).

* WHIP resource URL: URL allocated to a specific media session by the WHIP endpoint which can be used to perform operations such as terminating the session or ICE restarts.

3. Overview

The WebRTC-HTTP Ingest Protocol (WHIP) uses an HTTP POST request to perform a single-shot SDP offer/answer so an ICE/DTLS session can be established between the encoder/media producer (WHIP client) and the broadcasting ingestion endpoint (Media Server).

Once the ICE/DTLS session is set up, the media will flow unidirectionally from the encoder/media producer (WHIP client) to the broadcasting ingestion endpoint (Media Server). In order to reduce complexity, no SDP renegotiation is supported, so no "m=" sections can be added once the initial SDP offer/answer over HTTP is completed.

```
 +-------------+    +---------------+ +--------------+ +---------------+
 | WHIP client |    | WHIP endpoint | | Media Server | | WHIP resource |
 +--+----------+    +---------+-----+ +------+-------+ +--------|------+
    |                         |              |                  |
    |                         |              |                  |
    |HTTP POST (SDP Offer)    |              |                  |
    +------------------------>+              |                  |
    |201 Created (SDP answer) |              |                  |
    +<------------------------+              |                  |
    |          ICE REQUEST                   |                  |
    +--------------------------------------->+                  |
    |          ICE RESPONSE                  |                  |
    |<---------------------------------------+                  |
    |          DTLS SETUP                    |                  |
    |<======================================>|                  |
    |          RTP/RTCP FLOW                 |                  |
    +<-------------------------------------->+                  |
    | HTTP DELETE                                               |
    +---------------------------------------------------------->+
    | 200 OK                                                    |
    <-----------------------------------------------------------x
```

Figure 1: WHIP session setup and teardown

4. Protocol Operation

In order to set up an ingestion session, the WHIP client will generate an SDP offer according to the JSEP rules and perform an HTTP POST request to the configured WHIP endpoint URL.

The HTTP POST request will have a content type of "application/sdp" and contain the SDP offer as the body. The WHIP endpoint will generate an SDP answer and return a "201 Created" response with a content type of "application/sdp", the SDP answer as the body, and a Location header field pointing to the newly created resource.

The SDP offer **SHOULD** use the "sendonly" attribute and the SDP answer **MUST** use the "recvonly" attribute.

```
POST /whip/endpoint HTTP/1.1
Host: whip.example.com
Content-Type: application/sdp
Content-Length: 1326

v=0
o=- 5228595038118931041 2 IN IP4 127.0.0.1
s=-
t=0 0
a=group:BUNDLE 0 1
a=extmap-allow-mixed
a=msid-semantic: WMS
m=audio 9 UDP/TLS/RTP/SAVPF 111
c=IN IP4 0.0.0.0
a=rtcp:9 IN IP4 0.0.0.0
a=ice-ufrag:EsAw
a=ice-pwd:bP+XJMM09aR8AiX1jdukzR6Y
a=ice-options:trickle
a=fingerprint:sha-256 DA:7B:57:DC:28:CE:04:4F:31:79:85:C4:31:67:EB:27:58
a=setup:actpass
a=mid:0
a=bundle-only
a=extmap:4 urn:ietf:params:rtp-hdrext:sdes:mid
a=sendonly
a=msid:- d46fb922-d52a-4e9c-aa87-444eadc1521b
a=rtcp-mux
a=rtpmap:111 opus/48000/2
a=fmtp:111 minptime=10;useinbandfec=1
m=video 9 UDP/TLS/RTP/SAVPF 96 97
c=IN IP4 0.0.0.0
a=rtcp:9 IN IP4 0.0.0.0
a=ice-ufrag:EsAw
a=ice-pwd:bP+XJMM09aR8AiX1jdukzR6Y
a=ice-options:trickle
a=fingerprint:sha-256 DA:7B:57:DC:28:CE:04:4F:31:79:85:C4:31:67:EB:27:58
a=setup:actpass
a=mid:1
a=bundle-only
a=extmap:4 urn:ietf:params:rtp-hdrext:sdes:mid
a=extmap:10 urn:ietf:params:rtp-hdrext:sdes:rtp-stream-id
a=extmap:11 urn:ietf:params:rtp-hdrext:sdes:repaired-rtp-stream-id
a=sendonly
a=msid:- d46fb922-d52a-4e9c-aa87-444eadc1521b
a=rtcp-mux
a=rtcp-rsize
a=rtpmap:96 VP8/90000
a=rtcp-fb:96 ccm fir
a=rtcp-fb:96 nack
a=rtcp-fb:96 nack pli
```

```
a=rtpmap:97 rtx/90000
a=fmtp:97 apt=96

HTTP/1.1 201 Created
ETag: "xyzzy"
Content-Type: application/sdp
Content-Length: 1400
Location: https://whip.example.com/resource/id

v=0
o=- 1657793490019 1 IN IP4 127.0.0.1
s=-
t=0 0
a=group:BUNDLE 0 1
a=extmap-allow-mixed
a=ice-lite
a=msid-semantic: WMS *
m=audio 9 UDP/TLS/RTP/SAVPF 111
c=IN IP4 0.0.0.0
a=rtcp:9 IN IP4 0.0.0.0
a=ice-ufrag:38sdf4fdsf54
a=ice-pwd:2e13dde17c1cb009202f627fab90cbec358d766d049c9697
a=fingerprint:sha-256 F7:EB:F3:3E:AC:D2:EA:A7:C1:EC:79:D9:B3:8A:35:DA:70
a=candidate:1 1 UDP 2130706431 198.51.100.1 39132 typ host
a=setup:passive
a=mid:0
a=bundle-only
a=extmap:4 urn:ietf:params:rtp-hdrext:sdes:mid
a=recvonly
a=rtcp-mux
a=rtcp-rsize
a=rtpmap:111 opus/48000/2
a=fmtp:111 minptime=10;useinbandfec=1
m=video 9 UDP/TLS/RTP/SAVPF 96 97
c=IN IP4 0.0.0.0
a=rtcp:9 IN IP4 0.0.0.0
a=ice-ufrag:38sdf4fdsf54
a=ice-pwd:2e13dde17c1cb009202f627fab90cbec358d766d049c9697
a=fingerprint:sha-256 F7:EB:F3:3E:AC:D2:EA:A7:C1:EC:79:D9:B3:8A:35:DA:70
a=candidate:1 1 UDP 2130706431 198.51.100.1 39132 typ host
a=setup:passive
a=mid:1
a=bundle-only
a=extmap:4 urn:ietf:params:rtp-hdrext:sdes:mid
a=extmap:10 urn:ietf:params:rtp-hdrext:sdes:rtp-stream-id
a=extmap:11 urn:ietf:params:rtp-hdrext:sdes:repaired-rtp-stream-id
a=recvonly
a=rtcp-mux
a=rtcp-rsize
```

```
a=rtpmap:96 VP8/90000
a=rtcp-fb:96 ccm fir
a=rtcp-fb:96 nack
a=rtcp-fb:96 nack pli
a=rtpmap:97 rtx/90000
a=fmtp:97 apt=96
```

Figure 2: HTTP POST doing SDP O/A example

Once a session is setup, ICE consent freshness [RFC7675] **SHALL** be used to detect non graceful disconnection and DTLS teardown for session termination by either side.

To explicitly terminate a session, the WHIP client **MUST** perform an HTTP DELETE request to the resource URL returned in the Location header field of the initial HTTP POST. Upon receiving the HTTP DELETE request, the WHIP resource will be removed and the resources freed on the Media Server, terminating the ICE and DTLS sessions.

A Media Server terminating a session **MUST** follow the procedures in [RFC7675] section 5.2 for immediate revocation of consent.

The WHIP endpoints **MUST** return an "405 Method Not Allowed" response for any HTTP GET, HEAD or PUT requests on the endpoint URL in order to reserve its usage for future versions of this protocol specification.

The WHIP endpoints **MUST** support OPTIONS requests for Cross-Origin Resource Sharing (CORS) as defined in [FETCH] and it **SHOULD** include an "Accept-Post" header with a mime type value of "application/sdp" on the "200 OK" response to any OPTIONS request received as per [W3C.REC-ldp-20150226].

The WHIP resources **MUST** return an "405 Method Not Allowed" response for any HTTP GET, HEAD, POST or PUT requests on the resource URL in order to reserve its usage for future versions of this protocol specification.

4.1. ICE and NAT support

The initial offer by the WHIP client **MAY** be sent after the full ICE gathering is complete with the full list of ICE candidates, or it **MAY** only contain local candidates (or even an empty list of candidates) as per [RFC8863].

In order to simplify the protocol, there is no support for exchanging gathered trickle candidates from Media Server ICE candidates once the SDP answer is sent. The WHIP Endpoint **SHALL** gather all the ICE candidates for the Media Server before responding to the client request and the SDP answer **SHALL** contain the full list of ICE candidates of the Media Server. The Media Server **MAY** use ICE lite, while the WHIP client **MUST** implement full ICE.

The WHIP client **MAY** perform trickle ICE or ICE restarts as per [RFC8838] by sending an HTTP PATCH request to the WHIP resource URL with a body containing a SDP fragment with MIME type "application/trickle-ice-sdpfrag" as specified in [RFC8840]. When used for trickle ICE, the body of this PATCH message will contain the new ICE candidate; when used for ICE restarts, it will contain a new ICE ufrag/pwd pair.

Trickle ICE and ICE restart support is **RECOMMENDED** for a WHIP resource.

If the WHIP resource supports either Trickle ICE or ICE restarts, but not both, it **MUST** return a "405 Not Implemented" response for the HTTP PATCH requests that are not supported.

If the WHIP resource does not support the PATCH method for any purpose, it **MUST** return a "501 Not Implemented" response, as described in [RFC9110] section 6.6.2.

As the HTTP PATCH request sent by a WHIP client may be received out-of-order by the WHIP resource, the WHIP resource **MUST** generate a unique strong entity-tag identifying the ICE session as per [RFC9110] section 2.3. The initial value of the entity-tag identifying the initial ICE session **MUST** be returned in an ETag header field in the "201 Created" response to the initial POST request to the WHIP endpoint. It **MUST** also be returned in the "200 OK" of any PATCH request that triggers an ICE restart. Note that including the ETag in the original "201 Created" response is only **REQUIRED** if the WHIP resource supports ICE restarts and **OPTIONAL** otherwise.

A WHIP client sending a PATCH request for performing trickle ICE **MUST** include an "If-Match" header field with the latest known entity-tag as per [RFC9110] section 3.1. When the PATCH request is received by the WHIP resource, it **MUST** compare the indicated entity-tag value with the current entity-tag of the resource as per [RFC9110] section 3.1 and return a "412 Precondition Failed" response if they do not match.

WHIP clients **SHOULD NOT** use entity-tag validation when matching a specific ICE session is not required, such as for example when initiating a DELETE request to terminate a session.

A WHIP resource receiving a PATCH request with new ICE candidates, but which does not perform an ICE restart, **MUST** return a "204 No Content" response without body. If the Media Server does not support a candidate transport or is not able to resolve the connection address, it **MUST** accept the HTTP request with the "204 No Content" response and silently discard the candidate.

```
PATCH /resource/id HTTP/1.1
Host: whip.example.com
If-Match: "xyzzy"
Content-Type: application/trickle-ice-sdpfrag
Content-Length: 548

a=ice-ufrag:EsAw
a=ice-pwd:P2uYro0UCOQ4zxjKXaWCBui1
m=audio 9 RTP/AVP 0
a=mid:0
a=candidate:1387637174 1 udp 2122260223 192.0.2.1 61764 typ host generat
a=candidate:3471623853 1 udp 2122194687 198.51.100.1 61765 typ host gene
a=candidate:473322822 1 tcp 1518280447 192.0.2.1 9 typ host tcptype acti
a=candidate:2154773085 1 tcp 1518214911 198.51.100.2 9 typ host tcptype
a=end-of-candidates

HTTP/1.1 204 No Content
```

Figure 3: Trickle ICE request

A WHIP client sending a PATCH request for performing ICE restart **MUST** contain an "If-Match" header field with a field-value "*" as per [RFC9110] section 3.1.

If the HTTP PATCH request results in an ICE restart, the WHIP resource **SHALL** return a "200 OK" with an "application/trickle-ice-sdpfrag" body containing the new ICE username fragment and password and OPTIONALLY a new set of ICE candidates for the WHIP client . Also, the "200 OK" response for a successful ICE restart **MUST** contain the new entity-tag corresponding to the new ICE session in an ETag response header field and **MAY** contain a new set of ICE candidates for the Media Server.

If the ICE request cannot be satisfied by the WHIP resource, the resource **MUST** return an appropriate HTTP error code and **MUST NOT** terminate the session immediately. The WHIP client **MAY** retry performing a new ICE restart or terminate the session by issuing an HTTP DELETE request instead. In either case, the session **MUST** be terminated if the ICE consent expires as a consequence of the failed ICE restart as per [RFC7675] section 5.1.

```
PATCH /resource/id HTTP/1.1
Host: whip.example.com
If-Match: "*"
Content-Type: application/trickle-ice-sdpfrag
Content-Length: 54

a=ice-ufrag:ysXw
a=ice-pwd:vw5LmwG4y/e6dPP/zAP9Gp5k

HTTP/1.1 200 OK
ETag: "abccd"
Content-Type: application/trickle-ice-sdpfrag
Content-Length: 102

a=ice-lite
a=ice-ufrag:289b31b754eaa438
a=ice-pwd:0b66f472495ef0ccac7bda653ab6be49ea13114472a5d10a
```

Figure 4: ICE restart request

Because the WHIP client needs to know the entity-tag associated with the ICE session in order to send new ICE candidates, it **MUST** buffer any gathered candidates before it receives the HTTP response to the initial POST request or the PATCH request with the new entity-tag value. Once it knows the entity-tag value, the WHIP client **SHOULD** send a single aggregated HTTP PATCH request with all the ICE candidates it has buffered so far.

In case of unstable network conditions, the ICE restart HTTP PATCH requests and responses might be received out of order. In order to mitigate this scenario, when the client performs an ICE restart, it **MUST** discard any previous ice username and passwords fragments and ignore any further HTTP PATCH response received from a pending HTTP PATCH request. WHIP clients **MUST** apply only the ICE information received in the response to the last sent request. If there is a mismatch between the ICE information at the client and at the server (because of an out-of-order request), the STUN requests will contain invalid ICE information and will be rejected by the server. When this situation is detected by the WHIP Client, it **SHOULD** send a new ICE restart request to the server.

4.2. WebRTC constraints

In the specific case of media ingestion into a streaming service, some assumptions can be made about the server-side which simplifies the WebRTC compliance burden, as detailed in WebRTC-gateway document [I-D.draft-ietf-rtcweb-gateways].

In order to reduce the complexity of implementing WHIP in both clients and Media Servers, WHIP imposes the following restrictions regarding WebRTC usage:

Both the WHIP client and the WHIP endpoint **SHALL** use SDP bundle [RFC9143]. Each "m=" section **MUST** be part of a single BUNDLE group. Hence, when a WHIP client sends an SDP offer, it **MUST** include a "bundle-only" attribute in each bundled "m=" section. The WHIP client and the Media Server **MUST** support multiplexed media associated with the BUNDLE group as per [RFC9143] section 9. In addition, per [RFC9143] the WHIP client and Media Server will use RTP/RTCP multiplexing for all bundled media. The WHIP client and Media Server **SHOULD** include the "rtcp-mux-only" attribute in each bundled "m=" sections as per [RFC8858].

This version of the specification only supports, at most, a single audio and video MediaStreamTrack in a single MediaStream as defined in [[!RFC8830]] and therefore, all "m=" sections **MUST** contain an "msid" attribute with the same value. However, it would be possible for future revisions of this spec to allow more than a single MediaStream or MediaStreamTrack of each media kind, so in order to ensure forward compatibility, if the number of audio and or video tracks or number streams is not supported by the WHIP Endpoint, it **MUST** reject the HTTP POST request with a "406 Not Acceptable" error response.

Furthermore, the WHIP Endpoint **SHOULD NOT** reject individual "m=" sections as per [RFC8829] section 5.3.1 in case there is any error processing the "m=" section, but reject the HTTP POST request with a "406 Not Acceptable" error response to prevent having partially successful WHIP sessions.

When a WHIP client sends an SDP offer, it **SHOULD** insert an SDP "setup" attribute with an "actpass" attribute value, as defined in [RFC8842]. However, if the WHIP client only implements the DTLS client role, it **MAY** use an SDP "setup" attribute with an "active" attribute value. If the WHIP endpoint does not support an SDP offer with an SDP "setup" attribute with an "active" attribute value, it **SHOULD** reject the request with a "422 Unprocessable Entity" response.

NOTE: [RFC8842] defines that the offerer must insert an SDP "setup" attribute with an "actpass" attribute value. However, the WHIP client will always communicate with a Media Server that is expected to support the DTLS server role, in which case the client might choose to only implement support for the DTLS client role.

Trickle ICE and ICE restarts support is **OPTIONAL** for both the WHIP clients and Media Servers as explained in section 4.1.

4.3. Load balancing and redirections

WHIP endpoints and Media Servers might not be colocated on the same server, so it is possible to load balance incoming requests to different Media Servers. WHIP clients **SHALL** support HTTP redirection via the "307 Temporary Redirect" response as described in [RFC9110] section 6.4.7. The WHIP resource URL **MUST** be a final one, and redirections are not required to be supported for the PATCH and DELETE requests sent to it.

In case of high load, the WHIP endpoints **MAY** return a "503 Service Unavailable" response indicating that the server is currently unable to handle the request due to a temporary overload or scheduled maintenance, which will likely be alleviated after some delay. The WHIP endpoint might send a Retry-After header field indicating the minimum time that the user agent ought to wait before making a follow-up request.

4.4. STUN/TURN server configuration

The WHIP endpoint **MAY** return STUN/TURN server configuration URLs and credentials usable by the client in the "201 Created" response to the HTTP POST request to the WHIP endpoint URL.

Each STUN/TURN server will be returned using the "Link" header field [RFC8288] with a "rel"" attribute value of "ice-server". The Link target URI is the server URL as defined in [RFC7064] and [RFC7065]. The credentials are encoded in the Link target attributes as follows:

* username: If the Link header field represents a TURN server, and credential-type is "password", then this attribute specifies the username to use with that TURN server.

* credential: If the "credential-type" attribute is missing or has a "password" value, the credential attribute represents a long-term authentication password, as described in [RFC8489], Section 10.2.

* credential-type: If the Link header field represents a TURN server, then this attribute specifies how the credential attribute value should be used when that TURN server requests authorization. The default value if the attribute is not present is "password".

```
  Link: <stun:stun.example.net>; rel="ice-server"
  Link: <turn:turn.example.net?transport=udp>; rel="ice-server";
        username="user"; credential="myPassword"; credential-type="pa
  Link: <turn:turn.example.net?transport=tcp>; rel="ice-server";
        username="user"; credential="myPassword"; credential-type="pa
  Link: <turns:turn.example.net?transport=tcp>; rel="ice-server";
        username="user"; credential="myPassword"; credential-type="pa
```

Figure 5: Example ICE server configuration

NOTE: The naming of both the "rel" attribute value of "ice-server" and the target attributes follows the one used on the W3C WebRTC recommendation [W3C.REC-webrtc-20210126] RTCConfiguration dictionary in section 4.2.1. "rel" attribute value of "ice-server" is not prepended with the "urn:ietf:params:whip:" so it can be reused by other specifications which may use this mechanism to configure the usage of STUN/TURN servers.

NOTE: Depending on the ICE Agent implementation, the WHIP client may need to call the setConfiguration method before calling the setLocalDescription method with the local SDP offer in order to avoid having to perform an ICE restart for applying the updated STUN/TURN server configuration on the next ICE gathering phase.

There are some WebRTC implementations that do not support updating the STUN/TURN server configuration after the local offer has been created as specified in [RFC8829] section 4.1.18. In order to support these clients, the WHIP endpoint **MAY** also include the STUN/TURN server configuration on the responses to OPTIONS request sent to the WHIP endpoint URL before the POST request is sent. However, this method is not **NOT RECOMMENDED** and if supported by the underlying WHIP Client's webrtc implementation, the WHIP Client **SHOULD** wait for the information to be returned by the WHIP Endpoint on the response of the HTTP POST request instead.

The generation of the TURN server credentials may require performing a request to an external provider, which can both add latency to the OPTIONS request processing and increase the processing required to handle that request. In order to prevent this, the WHIP Endpoint **SHOULD NOT** return the STUN/TURN server configuration if the OPTIONS request is a preflight request for CORS, that is, if The OPTIONS request does not contain an Access-Control-Request-Method with "POST" value and the the Access-Control-Request-Headers HTTP header does not contain the "Link" value.

It might be also possible to configure the STUN/TURN server URLs with long term credentials provided by either the broadcasting service or an external TURN provider on the WHIP client, overriding the values provided by the WHIP endpoint.

4.5. Authentication and authorization

WHIP endpoints and resources **MAY** require the HTTP request to be authenticated using an HTTP Authorization header field with a Bearer token as specified in [RFC6750] section 2.1. WHIP clients **MUST** implement this authentication and authorization mechanism and send the HTTP Authorization header field in all HTTP requests sent to either the WHIP endpoint or resource except the preflight OPTIONS requests for CORS.

The nature, syntax, and semantics of the bearer token, as well as how to distribute it to the client, is outside the scope of this document. Some examples of the kind of tokens that could be used are, but are not limited to, JWT tokens as per [RFC6750] and [RFC8725] or a shared secret stored on a database. The tokens are typically made available to the end user alongside the WHIP endpoint URL and configured on the WHIP clients (similar to the way RTMP URLs and Stream Keys are distributed).

WHIP endpoints and resources could perform the authentication and authorization by encoding an authentication token within the URLs for the WHIP endpoints or resources instead. In case the WHIP client is not configured to use a bearer token, the HTTP Authorization header field must not be sent in any request.

4.6. Simulcast and scalable video coding

Simulcast as per [RFC8853] **MAY** be supported by both the Media Servers and WHIP clients through negotiation in the SDP offer/answer.

If the client supports simulcast and wants to enable it for publishing, it **MUST** negotiate the support in the SDP offer according to the procedures in [RFC8853] section 5.3. A server accepting a simulcast offer **MUST** create an answer according to the procedures [RFC8853] section 5.3.2.

It is possible for both Media Servers and WHIP clients to support Scalable Video Coding (SVC). However, as there is no universal negotiation mechanism in SDP for SVC, the encoder must consider the negotiated codec(s), intended usage, and SVC support in available decoders when configuring SVC.

4.7. Protocol extensions

In order to support future extensions to be defined for the WHIP protocol, a common procedure for registering and announcing the new extensions is defined.

Protocol extensions supported by the WHIP server **MUST** be advertised to the WHIP client in the "201 Created" response to the initial HTTP POST request sent to the WHIP endpoint. The WHIP endpoint **MUST** return one "Link" header field for each extension, with the extension "rel" type attribute and the URI for the HTTP resource that will be available for receiving requests related to that extension.

Protocol extensions are optional for both WHIP clients and servers. WHIP clients **MUST** ignore any Link attribute with an unknown "rel" attribute value and WHIP servers **MUST NOT** require the usage of any of the extensions.

Each protocol extension **MUST** register a unique "rel" attribute value at IANA starting with the prefix: "urn:ietf:params:whip:ext" as defined in Section 6.3.

For example, considering a potential extension of server-to-client communication using server-sent events as specified in https://html.spec.whatwg.org/multipage/server-sent-events.html#server-sent-events, the URL for connecting to the server side event resource for the published stream could be returned in the initial HTTP "201 Created" response with a "Link" header field and a "rel" attribute of "urn:ietf:params:whip:ext:example:server-sent-events". (This document does not specify such an extension, and uses it only as an example.)

In this theoretical case, the "201 Created" response to the HTTP POST request would look like:

```
HTTP/1.1 201 Created
Content-Type: application/sdp
Location: https://whip.example.com/resource/id
Link: <https://whip.ietf.org/publications/213786HF/sse>;
      rel="urn:ietf:params:whip:ext:example:server-side-events"
```

5. Security Considerations

HTTPS **SHALL** be used in order to preserve the WebRTC security model.

6. IANA Considerations

This specification adds a new link relation type and a registry for URN sub-namespaces for WHIP protocol extensions.

6.1. Link Relation Type: ice-server

The link relation type below has been registered by IANA per Section 4.2 of [RFC8288].

Relation Name: ice-server

Description: For the WHIP protocol, conveys the STUN and TURN servers that can be used by an ICE Agent to establish a connection with a peer.

Reference: TBD

6.2. Registration of WHIP URN Sub-namespace and WHIP Registry

IANA has added an entry to the "IETF URN Sub-namespace for Registered Protocol Parameter Identifiers" registry and created a sub-namespace for the Registered Parameter Identifier as per [RFC3553]: "urn:ietf:params:whip".

To manage this sub-namespace, IANA has created the "WebRTC-HTTP ingestion protocol (WHIP) URIs" registry, which is used to manage entries within the "urn:ietf:params:whip" namespace. The registry description is as follows:

* Registry name: WHIP

* Specification: this document (RFC TBD)

* Repository: See Section Section 6.3

* Index value: See Section Section 6.3

6.3. URN Sub-namespace for WHIP

WHIP Endpoint utilizes URIs to identify the supported WHIP protocol extensions on the "rel" attribute of the Link header as defined in Section 4.7.

This section creates and registers an IETF URN Sub-namespace for use in the WHIP specifications and future extensions.

6.3.1. Specification Template

Namespace ID:

* The Namespace ID "whip" has been assigned.

Registration Information:

* Version: 1

* Date: TBD

Declared registrant of the namespace:

* Registering organization: The Internet Engineering Task Force.

* Designated contact: A designated expert will monitor the WHIP public mailing list, "wish@ietf.org".

Declaration of Syntactic Structure:

* The Namespace Specific String (NSS) of all URNs that use the "whip" Namespace ID shall have the following structure: urn:ietf:params:whip:{type}:{name}:{other}.

* The keywords have the following meaning:

  - type: The entity type. This specification only defines the "ext" type.

  - name: A required US-ASCII string that conforms to the URN syntax requirements (see [RFC8141]) and defines a major namespace of a WHIP protocol extension. The value **MAY** also be an industry name or organization name.

  - other: Any US-ASCII string that conforms to the URN syntax requirements (see [RFC8141]) and defines the sub-namespace (which **MAY** be further broken down in namespaces delimited by colons) as needed to uniquely identify an WHIP protocol extension.

Relevant Ancillary Documentation:

* None

Identifier Uniqueness Considerations:

* The designated contact shall be responsible for reviewing and enforcing uniqueness.

Identifier Persistence Considerations:

* Once a name has been allocated, it **MUST NOT** be reallocated for a different purpose.

* The rules provided for assignments of values within a sub-namespace **MUST** be constructed so that the meanings of values cannot change.

* This registration mechanism is not appropriate for naming values whose meanings may change over time.

Process of Identifier Assignment:

* Namespace with type "ext" (e.g., "urn:ietf:params:whip:ext") is reserved for IETF-approved WHIP specifications.

Process of Identifier Resolution:

* None specified.

Rules for Lexical Equivalence:

* No special considerations; the rules for lexical equivalence specified in [RFC8141] apply.

Conformance with URN Syntax:

* No special considerations.

Validation Mechanism:

* None specified.

Scope:

* Global.

6.4. Registering WHIP Protocol Extensions URIs

This section defines the process for registering new WHIP protocol extensions URIs with IANA in the "WebRTC-HTTP ingestion protocol (WHIP) URIs" registry (see Section 6.3).

A WHIP Protocol Extension URI is used as a value in the "rel" attribute of the Link header as defined in Section 4.7 for the purpose of signaling the WHIP protocol extensions supported by the WHIP Endpoints.

WHIP Protocol Extensions URIs have a "ext" type as defined in Section 6.3.

6.4.1. Registration Procedure

The IETF has created a mailing list, "wish@ietf.org", which can be used for public discussion of WHIP protocol extensions proposals prior to registration. Use of the mailing list is strongly encouraged. The IESG has appointed a designated expert [RFC8126] who will monitor the wish@ietf.org mailing list and review registrations.

Registration of new "ext" type URI (in the namespace "urn:ietf:params:whip:ext") belonging to a WHIP Protocol Extension **MUST** be reviewed by the designated expert and published in an RFC. An RFC is **REQUIRED** for the registration of new value data types that modify existing properties. An RFC is also **REQUIRED** for registration of WHIP Protocol Extensions URIs that modify WHIP Protocol Extensions previously documented in an existing RFC.

The registration procedure begins when a completed registration template, defined in the sections below, is sent to wish@ietf.org and iana@iana.org. Within two weeks, the designated expert is expected to tell IANA and the submitter of the registration whether the registration is approved, approved with minor changes, or rejected with cause. When a registration is rejected with cause, it can be resubmitted if the concerns listed in the cause are addressed.

Decisions made by the designated expert can be appealed to the IESG Applications Area Director, then to the IESG. They follow the normal appeals procedure for IESG decisions.

Once the registration procedure concludes successfully, IANA creates or modifies the corresponding record in the WHIP Protocol Extension registry. The completed registration template is discarded.

An RFC specifying one or more new WHIP Protocol Extension URIs **MUST** include the completed registration templates, which **MAY** be expanded with additional information. These completed templates are intended to go in the body of the document, not in the IANA Considerations section. The RFC **SHOULD** include any attributes defined.

6.4.2. WHIP Protocol Extension Registration Template

A WHIP Protocol Extension URI is defined by completing the following template:

* URI: A unique URI for the WHIP Protocol Extension (e.g., "urn:ietf:params:whip:ext:example:server-sent-events").

* Reference: A formal reference to the publicly available specification

* Name: A descriptive name of the WHIP Protocol Extension extension (e.g., "Sender Side events").

* Description: A short phrase describing the function of the extension

* Contact information: Contact information for the organization or person making the registration

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