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'Out-Of-Band' Content Coding for HTTP
draft-reschke-http-oob-encoding-05

Abstract

This document describes an Hypertext Transfer Protocol (HTTP) content coding that can be used to describe the location of a secondary resource that contains the payload.

Editorial Note (To be removed by RFC Editor before publication)

Distribution of this document is unlimited. Although this is not a work item of the HTTPbis Working Group, comments should be sent to the Hypertext Transfer Protocol (HTTP) mailing list at ietf-http-wg@w3.org [1], which may be joined by sending a message with subject "subscribe" to ietf-http-wg-request@w3.org [2].

Discussions of the HTTPbis Working Group are archived at <http://lists.w3.org/Archives/Public/ietf-http-wg/>.

XML versions, latest edits, and issue tracking for this document are available from <https://github.com/reschke/oobencoding> and <http://greenbytes.de/tech/webdav/#draft-reschke-http-oob-encoding>.

The changes in this draft are summarized in Appendix C.5.

Status of This Memo

This Internet-Draft will expire on October 17, 2016.

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1. Introduction

This document describes an Hypertext Transfer Protocol (HTTP) content coding (Section 3.1.2.1 of [RFC7231]) that can be used to describe the location of a secondary resource that contains the payload.

The primary use case for this content coding is to enable origin servers to securely delegate the delivery of content to a secondary server that might be "closer" to the client (with respect to network topology) and/or able to cache content ([SCD]), leveraging content encryption ([ENCRYPTENC]).

2. Notational Conventions

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].

This document reuses terminology used in the base HTTP specifications, namely Section 2 of [RFC7230] and Section 3 of [RFC7231].

3. 'Out-Of-Band' Content Coding

3.1. Overview

The 'Out-Of-Band' content coding is used to direct the recipient to retrieve the actual message representation (Section 3 of [RFC7231]) from a secondary resource, such as a public cache:

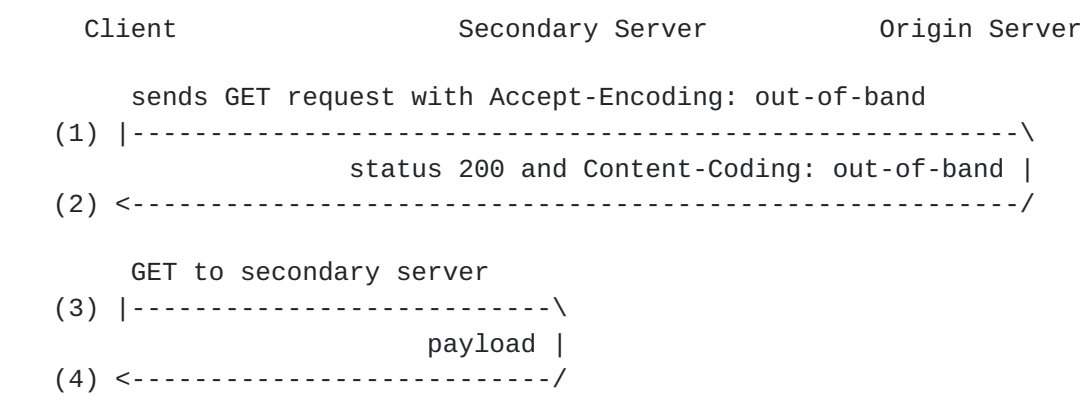
1. Client performs a request

2. Received response specifies the 'out-of-band' content coding; the payload of the response contains additional meta data, plus the location of the secondary resource

3. Client performs GET request on secondary resource (usually again via HTTP(s))

4. Secondary server provides payload

5. Client combines above representation with additional representation metadata obtained from the primary resource



3.2. Definitions

The name of the content coding is "out-of-band".

The payload format uses JavaScript Object Notation (JSON, [RFC7159]), describing an object describing secondary resources plus OPTIONAL additional metadata:

'URIs' A REQUIRED string array containing at least one URI reference (Section 4.1 of [RFC3986]) of a secondary resource.

'fallback' An OPTIONAL string containing a URI reference of a fallback resource (see Appendix B.1). This URI reference, after resolution against the URI of the primary resource, MUST identify a resource on the same server as the primary resource.

'metadata' An OPTIONAL object containing additional members, representing header field values which can not appear as header fields in the response message itself (header fields that occur multiple times need to be combined into a single field value as per Section 3.2.2 of [RFC7230]; header field names are lower-cased).

The payload format uses a JSON array so that the origin server can specify multiple secondary resources. When a client receives a response containing multiple URIs, it is free to choose which of these to use.

New specifications can define new OPTIONAL header fields, thus clients MUST ignore unknown fields. Extension specifications will have to update this specification. [[anchor3: or we define a registry]]

3.3. Processing Steps

Upon receipt of an out-of-band encoded response, a client first needs to obtain the secondary resource's presentation. This is done using an HTTP GET request (independantly of the original request method).

In order to prevent any leakage of information, the GET request for the secondary resource MUST NOT contain any information provided by origins other than the secondary server itself, namely HTTP authentication credentials ([RFC7235]) and cookies ([RFC6265]).

Furthermore, the request MUST include an "Origin" header field indicating the origin of the original resource ([RFC6454], Section 7). The secondary server MUST verify that the specified origin is authorized to retrieve the given payload (or otherwise return an appropriate 4xx status code).

After receipt of the secondary resource's payload, the client then reconstructs the original message by:

1. Unwrapping the encapsulated HTTP message by removing any transfer and content codings.

2. Replacing/setting any response header fields from the primary response except for framing-related information such as Content-Length, Transfer-Encoding and Content-Encoding.

3. Replacing/setting any header fields with those present as members in the "metadata" object. [[anchor4: Do we have a use case for this?]]

If the client is unable to retrieve the secondary resource's representation (host can't be reached, non 2xx response status code, payload failing integrity check, etc.), it can choose an alternate secondary resource (if specified), try the fallback URI (if given), or simply retry the request to the origin server without including "out-of-band" in the Accept-Encoding request header field. In the latter case, it can be useful to inform the origin server about what problems were encountered when trying to access the secondary resource; see Section 3.4 for details.

Note that although this mechanism causes the inclusion of external content, it will not affect the application-level security properties of the reconstructed message, such as its web origin ([RFC6454]).

The cacheability of the response for the secondary resource does not affect the cacheability of the reconstructed response message, which is the same as for the origin server's response.

Note that because the server's response depends on the request's Accept-Encoding header field, the response usually will need to be declared to vary on that. See Section 7.1.4 of [RFC7231] and Section 2.3 of [RFC7232] for details.

3.4. Problem Reporting

When the client fails to obtain the secondary resource, it can be useful to inform the origin server about the condition. This can be accomplished by adding a "Link" header field ([RFC5988]) to a subsequent request to the origin server, detailing the URI of the secondary resource and the failure reason.

The following link extension relations are defined:

3.4.1. Server Not Reachable

Used in case the server was not reachable.

Link relation:

http://purl.org/NET/linkrel/not-reachable

3.4.2. Resource Not Found

Used in case the server responded, but the object could not be obtained.

Link relation:

http://purl.org/NET/linkrel/resource-not-found

3.4.3. Payload Unusable

Used in case the the payload could be obtained, but wasn't usable (for instance, because integrity checks failed).

Link relation:

http://purl.org/NET/linkrel/payload-unusable

3.5. Examples

3.5.1. Basic Example

Client request of primary resource at https://www.example.com/test:

```
GET /test HTTP/1.1
Host: www.example.com
Accept-Encoding: gzip, out-of-band
```

Response:

```
HTTP/1.1 200 OK
Date: Thu, 14 May 2015 18:52:00 GMT
Content-Type: text/plain
Cache-Control: max-age=10, public
Content-Encoding: out-of-band
Content-Length: 145
Vary: Accept-Encoding

{
  "URIs": [
    "http://example.net/bae27c36-fa6a-11e4-ae5d-00059a3c7a00"
  ],
  "fallback": "/c/bae27c36-fa6a-11e4-ae5d-00059a3c7a00"
}
```

(note that the Content-Type header field describes the media type of the secondary's resource representation, and the origin server supplied a fallback URI)

Client request for secondary resource:

```
GET /bae27c36-fa6a-11e4-ae5d-00059a3c7a00 HTTP/1.1
Host: example.net
Origin: https://www.example.com
```

Response:

```
HTTP/1.1 200 OK
Date: Thu, 14 May 2015 18:52:10 GMT
Cache-Control: private
Content-Length: 15

Hello, world.
```

(Note no Content-Type header field is present here because the secondary server truly does not know the media type of the payload)

Final message after recombining header fields:

```
HTTP/1.1 200 OK
Date: Thu, 14 May 2015 18:52:00 GMT
Content-Length: 15
Cache-Control: max-age=10, public
Content-Type: text/plain

Hello, world.
```

3.5.2. Example for an attempt to use out-of-band cross-origin

Section 3.3 requires the client to include an "Origin" header field in the request to a secondary server. The example below shows how the server for the secondary resource would respond to a request which contains an "Origin" header field identifying an unauthorized origin.

Continuing with the example from Section 3.5.1, and a secondary server that is configured to allow only access for requests initiated by "https://www.example.org":

Client request for secondary resource:

```
GET /bae27c36-fa6a-11e4-ae5d-00059a3c7a00 HTTP/1.1
Host: example.net
Origin: https://www.example.com
```

Response:

```
HTTP/1.1 403 Forbidden
Date: Thu, 14 May 2015 18:52:10 GMT
```

Note that a request missing the "Origin" header field would be treated the same way.

[[anchor7: Any reason why to *mandate* a specific 4xx code?]]

3.5.3. Example involving an encrypted resource

Given the example HTTP message from Section 5.4 of [ENCRYPTENC], a primary resource could use the "out-of-band" encoding to specify just the location of the secondary resource plus the contents of the "Crypto-Key" header field needed to decrypt the payload:

Response:

```
HTTP/1.1 200 OK
Date: Thu, 14 May 2015 18:52:00 GMT
Content-Encoding: aesgcm128, out-of-band
Content-Type: text/plain
Encryption: keyid="a1"; salt="vr0o6Uq3w_KDWeatc27mUg"
Crypto-Key: keyid="a1"; aesgcm128="csPJEXBYA5U-Tal9EdJi-w"
Content-Length: 87
Vary: Accept-Encoding

{
  "URIs": [
    "http://example.net/bae27c36-fa6a-11e4-ae5d-00059a3c7a00"
  ]
}
```

(note that the Content-Type header field describes the media type of the secondary's resource representation)

Response for secondary resource:

```
HTTP/1.1 200 OK
Date: Thu, 14 May 2015 18:52:10 GMT
Content-Length: ...
Cache-Control: private

fuag8ThIRIazSHKUqJ5OduR75UgEUuM76J8UFwadEvg
```

(payload body shown in base64 here)

Final message undoing all content codings:

```
HTTP/1.1 200 OK
Date: Thu, 14 May 2015 18:52:00 GMT
Content-Length: 15
Content-Type: text/plain

I am the walrus
```

Note: in this case, the ability to undo the "aescgm128" is needed to process the response. If "aescgm128" wasn't listed as acceptable content encoding in the request, the origin server wouldn't be able to use the "out-of-band" mechanism.

3.5.4. Example For Problem Reporting

Client requests primary resource as in Section 3.5.1, but the attempt to access the secondary resource fails.

Response:

```
HTTP/1.1 404 Not Found
Date: Thu, 08 September 2015 16:49:00 GMT
Content-Type: text/plain
Content-Length: 20

Resource Not Found
```

Client retries with the origin server and includes Link header field reporting the problem:

```
GET /test HTTP/1.1
Host: www.example.com
Accept-Encoding: gzip, out-of-band
Link: <http://example.net/bae27c36-fa6a-11e4-ae5d-00059a3c7a00>;
      rel="http://purl.org/NET/linkrel/resource-not-found"
```

4. Content Codings and Range Requests

The combination of content codings ([RFC7231], Section 3.1.2 with range requests ([RFC7233]) can lead to surprising results, as applying the range request happens after applying content codings.

Thus, for a request for the bytes starting at position 100000 of a video:

```
GET /test.mp4 HTTP/1.1
Host: www.example.com
Range: bytes=100000-
Accept-Encoding: identity
```

...a successful response would use status code 206 (Partial Content) and have a payload containing the octets starting at position 100000.

```
HTTP/1.1 206 Partial Content
Date: Thu, 08 September 2015 16:49:00 GMT
Content-Type: video/mp4
Content-Length: 134567
Content-Range: bytes 100000-234566/234567

(binary data)
```

However, if the request would have allowed the use of out-of-band encoding:

```
GET /test.mp4 HTTP/1.1
Host: www.example.com
Range: bytes=100000-
Accept-Encoding: out-of-band
```

...a server might return an empty payload (if the out-of-band encoded response body would be shorter than 100000 bytes, as would be usually the case).

Thus, in order to avoid unnecessary network traffic, servers SHOULD NOT apply range request processing to responses using ouf-of-band content coding (or, in other words: ignore "Range" request header fields in this case).

5. Feature Discovery

New content codings can be deployed easily, as the client can use the "Accept-Encoding" header field (Section 5.3.4 of [RFC7231]) to signal which content codings are supported.

6. Security Considerations

6.1. Content Modifications

This specification does not define means to verify that the payload obtained from the secondary resource really is what the origin server expects it to be. Content signatures can address this concern (see [CONTENTSIG] and [MICE]).

6.2. Content Stealing

The Out-Of-Band content coding could be used to circumvent the same-origin policy ([RFC6454], Section 3) of user agents: an attacking

site which knows the URI of a secondary resource would use the out-of-band coding to trick the user agent to read the contents of the secondary resource, which then, due to the security properties of out-of-band codings, would be handled as if it originated from the origin's resource.

This scenario is addressed by the client requirement to include the "Origin" request header field and the server requirement to verify that the request was initiated by an authorized origin.

> Note: similarities with the "Cross-Origin Resource Sharing" protocol ([CORS]) are intentional.

Requiring the secondary resource's payload to be encrypted ([ENCRYPTENC]) is an additional mitigation.

6.3. Use in Requests

In general, content codings can be used in both requests and responses. This particular content coding has been designed for responses. When supported in requests, it creates a new attack vector where the receiving server can be tricked into including content that the client might not have access to otherwise (such as HTTP resources behind a firewall).

7. IANA Considerations

The IANA "HTTP Content Coding Registry", located at <http://www.iana.org/assignments/http-parameters>, needs to be updated with the registration below:

Name: out-of-band

Description: Payload needs to be retrieved from a secondary resource

Reference: Section 3 of this document

8. References

8.1. Normative References

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8.2. Informative References

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Latest version available at <http://www.w3.org/TR/cors/>.

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[RFC7233] Fielding, R., Ed., Lafon, Y., Ed., and J. Reschke, Ed., "Hypertext Transfer Protocol (HTTP/1.1): Range Requests", RFC 7233, DOI 10.17487/RFC7233, June 2014, <http://www.rfc-editor.org/info/rfc7233>.

[SCD] Thomson, M., Eriksson, G., and C. Holmberg, "An Architecture for Secure Content Delegation using HTTP", draft-thomson-http-scd-00 (work in progress), March 2016.

URIs

[1] <mailto:ietf-http-wg@w3.org>

[2] <mailto:ietf-http-wg-request@w3.org?subject=subscribe>

Appendix A. Alternatives, or: why not a new Status Code?

A plausible alternative approach would be to implement this functionality one level up, using a new redirect status code (Section 6.4 of [RFC7231]). However, this would have several drawbacks:

- Servers will need to know whether a client understands the new status code; thus some additional signal to opt into this protocol would always be needed.

- In redirect messages, representation metadata (Section 3.1 of [RFC7231]), namely "Content-Type", applies to the response message, not the redirected-to resource.

- The origin-preserving nature of using a content coding woudld be lost.

Another alternative would be to implement the indirection on the level of the media type using something similar to the type "message/external-body", defined in [RFC2017] and refined for use in the Session Initiation Protocol (SIP) in [RFC4483]. This approach though would share most of the drawbacks of the status code approach mentioned above.

Appendix B. Open Issues

B.1. Accessing the Secondary Resource Too Early

One use-case for this protocol is to enable a system of "blind caches", which would serve the secondary resources. These caches might only be populated on demand, thus it could happen that whatever mechanism is used to populate the cache hasn't finished when the client hits it (maybe due to race conditions, or because the cache is behind a middlebox which doesn't allow the origin server to push content to it).

In this particular case, it can be useful if the client was able to "piggyback" the URI of the fallback for the primary resource, giving the secondary server a means by which it could obtain the payload itself. This information could be provided in yet another Link header field:

```
GET bae27c36-fa6a-11e4-ae5d-00059a3c7a00 HTTP/1.1
Host: example.net
Link: <http://example.com/c/bae27c36-fa6a-11e4-ae5d-00059a3c7a00>;
      rel="http://purl.org/NET/linkrel/primary-resource"
```

(continuing the example from Section 3.5.1)

B.2. Resource maps

When out-of-band encoding is used as part of a caching solution, the additional round trips to the origin server can be a significant performance problem; in particular, when many small resources need to be loaded (such as scripts, images, or video fragments). In cases like these, it could be useful for the origin server to provide a "resource map", allowing to skip the round trips to the origin server

for these mapped resources. Plausible ways to transmit the resource map could be:

- as extension in the out-of-band encoding JSON payload, or
- as separate resource identified by a "Link" response header field.

This specification does not define a format, nor a mechanism to transport the map, but it's a given that some specification using "out-of-band" encoding will do.

B.3. Padding

It might be a good idea to allow padding in the secondary resource's payload, in order to even hide the precise content length. This could be accomplished by adding range information to the out-of-band metadata, allowing the client to throw away parts of the payload when reconstructing the response body.

B.4. Fragmenting

It might be interesting to divide the original resource's payload into fragments, each of which being mapped to a distinct secondary resource. This would allow to not store the full payload of a resource in a single cache, thus

- distribute load,
- caching different parts of the resource with different characteristics (such as only distribute the first minutes of a long video), or
- hide information from the secondary server.

Another benefit might be that it would allow the origin server to only serve the first part of a resource itself (reducing time to play of a media resource), while delegating the remainder to a cache (however, this might require further adjustments of the out-of-band payload format).

Appendix C. Change Log (to be removed by RFC Editor before publication)

C.1. Changes since draft-reschke-http-oob-encoding-00

Mention media type approach.

Explain that clients can always fall back not to use oob when the secondary resource isn't available.

Add Vary response header field to examples and mention that it'll usually be needed (<https://github.com/reschke/oobencoding/issues/6>).

Experimentally add problem reporting using piggy-backed Link header fields (<https://github.com/reschke/oobencoding/issues/7>).

C.2. Changes since draft-reschke-http-oob-encoding-01

Updated ENCRYPTENC reference.

C.3. Changes since draft-reschke-http-oob-encoding-02

Add MICE reference.

Remove the ability of the secondary resource to contain anything but the payload (<https://github.com/reschke/oobencoding/issues/11>).

Changed JSON payload to be an object containing an array of URIs plus additional members. Specify "fallback" as one of these additional members, and update Appendix B.1 accordingly).

Discuss extensibility a bit.

C.4. Changes since draft-reschke-http-oob-encoding-03

Mention "Content Stealing" thread.

Mention padding.

C.5. Changes since draft-reschke-http-oob-encoding-04

Reduce information leakage by disallowing ambient authority information being sent to the secondary resource. Require "Origin" to be included in request to secondary resource, and require seconday server to check it.

Mention "Origin" + server check on secondary resource as defense to content stealing.

Update ENCRYPTENC reference, add SCD reference.

Mention fragmentation feature.

Discuss relation with range requests.

Appendix D. Acknowledgements

Thanks to Christer Holmberg, Daniel Lindstrom, Erik Nygren, Goran Eriksson, John Mattsson, Kevin Smith, Magnus Westerlund, Mark Nottingham, Martin Thomson, and Roland Zink for feedback on this document.

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