Byte Range PATCH

A media type for writing at offsets

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Motivation

- Problem: I only want to change the first four bytes of a file over HTTP
- Current solutions:
  - Endpoint-specific POST URI <http://example.com/logs.update>
  - Endpoint-specific URI format to identify only the selected bytes, e.g. <http://example.com/logs?bytes=200-299>
  - RFC 9110 Content-Range PUT request
- None of these can be worked into generic HTTP toolchains

Workaround

Endpoint-specific POST request

```
POST /log HTTP/1.1
Content-Type: application/x-www-urlencoded

range=4-7&bytes=EFGH
```

Workaround

Endpoint-specific URI format

```
GET /log?bytes=4-7 HTTP/1.1
Content-Type: application/octet-stream

EFGH
```

```
PUT /log?bytes=4-7 HTTP/1.1
Content-Type: application/octet-stream

WXYZ
```

RFC 9110 Content-Range PUT

①

```
GET / HTTP/1.1
Range: bytes=4275-4302
```

```
HTTP/1.1 206 Partial Content
Content-Range: 4275-4302/7550

was ALICE’S SPOON! And nobod
```

---

②

```
PUT / HTTP/1.1
Content-Range: 4275-4302/7550

was CAROL’S SPOON! And nobod
```

```
HTTP/1.1 200 OK
```

---

③

```
GET / HTTP/1.1
Range: bytes=4275-4302
```

```
HTTP/1.1 206 Partial Content
Content-Range: 4275-4302/7550

was CAROL’S SPOON! And nobod
```

Content-Range PUT Shortcomings

RFC 9110 is insufficient for many applications

- Requires prior agreement, otherwise it will overwrite the entire resource
    - There’s no benefit over using POST endpoint
    - No way to safely opt back out: Once implemented in clients, removing support will cause breakage.
- `Content-Range` does not permit indeterminate length responses
    - e.g. live streams that may continue indefinitely
- A media type is useful for describing changes outside the context of an HTTP request

Barriers

Why this hasn’t been standardized yet?

- HTTP resources aren't *exactly* files on a filesystem
- … But they still both represent a string of bytes
- PATCH is relatively new
- And actually, RFC 9110 standardized a partial solution

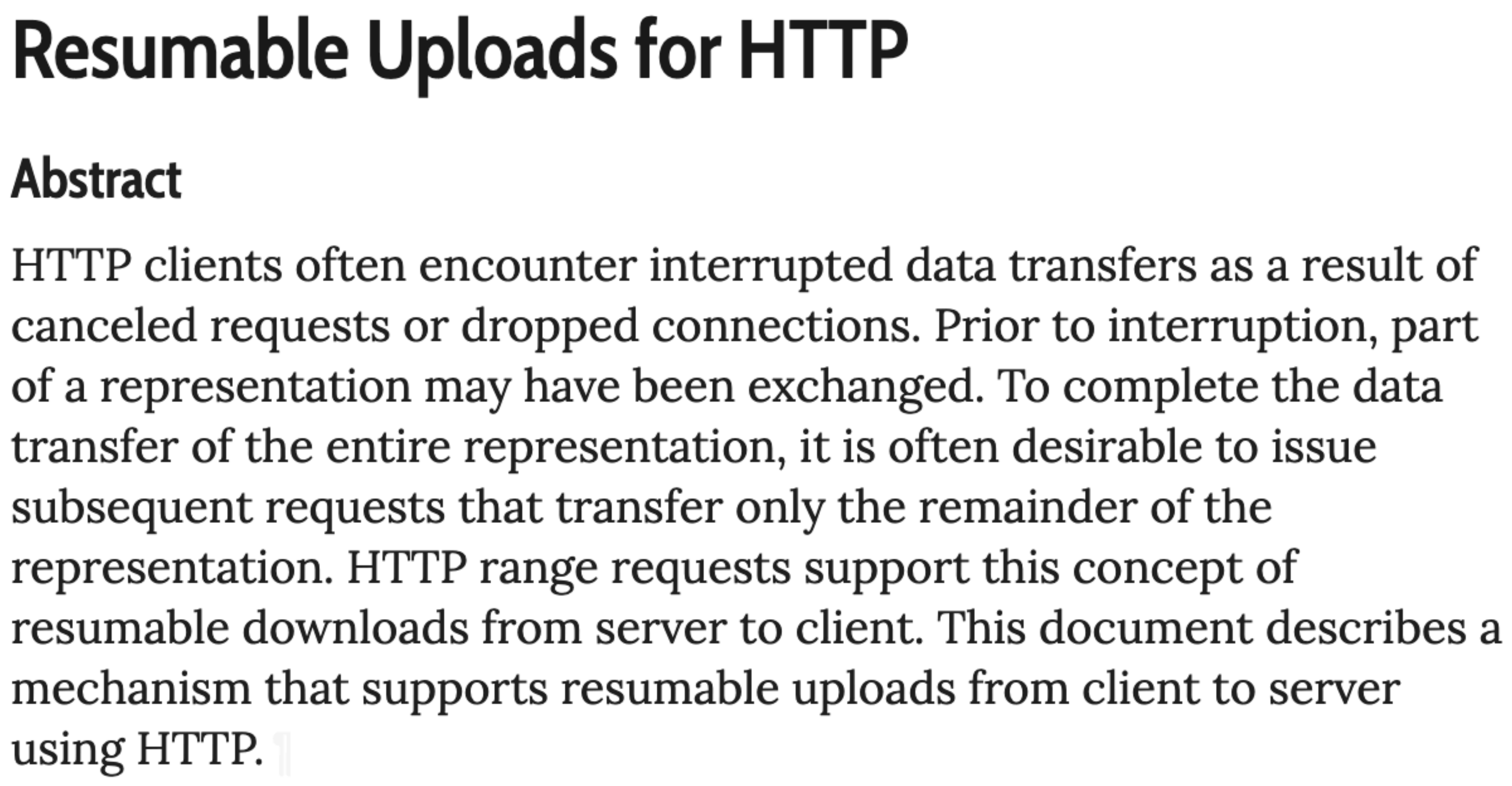
Use Cases

- Segmented/chunked uploads
- Resuming broken uploads
- Writes to block devices
- Optimizes many file formats, e.g. embedded databases, append-only files, media files with indexes at the start of the file.

Use Cases: Segmented/chunked uploads

- PUT /file/data.json.000 HTTP/1.1
  PUT /file/0001.json.001 HTTP/1.1
  PUT /file/0002.json.002 HTTP/1.1
  - Problem: Each resource will be malformed, client must perform endpoint-specific steps to recreate the correct resource

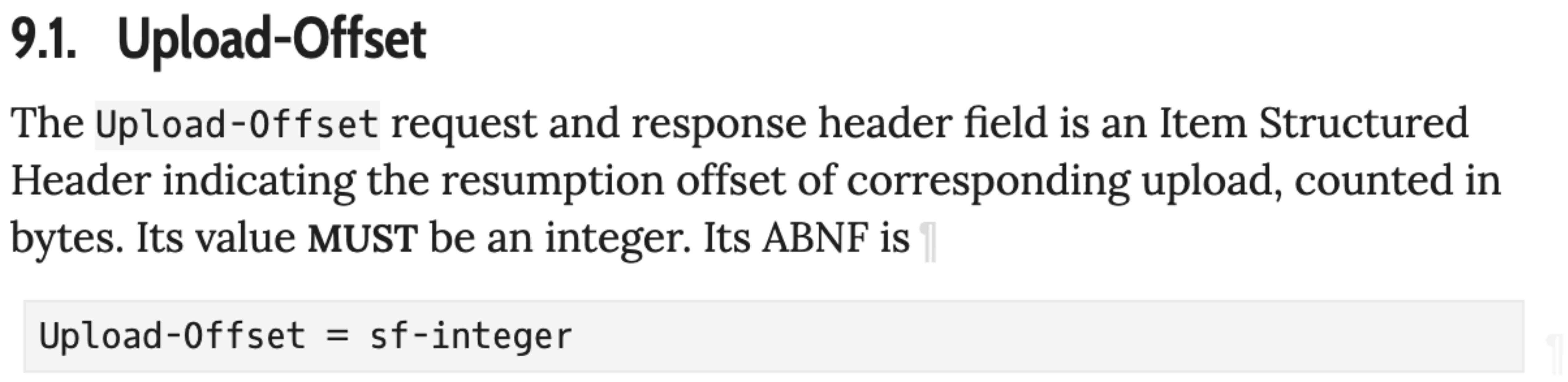
Use Cases: Resuming broken uploads



Resumable Uploads for HTTP

Abstract

HTTP clients often encounter interrupted data transfers as a result of canceled requests or dropped connections. Prior to interruption, part of a representation may have been exchanged. To complete the data transfer of the entire representation, it is often desirable to issue subsequent requests that transfer only the remainder of the representation. HTTP range requests support this concept of resumable downloads from server to client. This document describes a mechanism that supports resumable uploads from client to server using HTTP. ¶



9.1. Upload-Offset

The `Upload-Offset` request and response header field is an Item Structured Header indicating the resumption offset of corresponding upload, counted in bytes. Its value **MUST** be an integer. Its ABNF is ¶

```
Upload-Offset = sf-integer
```

¶

Use Cases: Appending to a log file

```
POST / HTTP/1.1
Host: logs.monitoring.us-west-1.amazonaws.com
X-Amz-Date: 20130315T092054Z
Authorization: AWS4-HMAC-SHA256 …
User-Agent: FooBar/2.0
Accept: application/json
Content-Type: application/x-amz-json-1.1
Content-Length: 332
X-Amz-Target: Logs_20140328.PutLogEvents

{
  "logGroupName": "my-log-group",
  "logStreamName": "my-log-stream",
  "logEvents": [
    { "timestamp": 1396035378988, "message": "Example event 1" },
    { "timestamp": 1396035378988,  "message": "Example event 2" }
  ]
}
```

Use Cases: Optimized file formats

Appending to a WAV file

32-bit little-endian file length ≈ 40M

```
00000000  52 49 46 46 e0 64 81 02  57 41 56 45 66 6d 74 20  |RIFF.d..WAVEfmt |
00000010  10 00 00 00 01 00 02 00  44 ac 00 00 10 b1 02 00  |........D.......|
00000020  04 00 10 00 4c 49 53 54  b4 00 00 00 49 4e 46 4f  |....LIST....INFO|
00000030  49 41 52 54 18 00 00 00  54 68 65 20 4c 61 7a 69  |IART....The Lazi|
00000040  65 73 74 20 4d 65 6e 20  6f 6e 20 4d 61 72 73 00  |est Men on Mars.|
00000050  49 43 4d 54 2f 00 00 00  68 74 74 70 3a 2f 2f 77  |ICMT/...http://w|
00000060  77 77 2e 61 6c 62 69 6e  6f 62 6c 61 63 6b 73 68  |ww.albinoblacksh|
00000070  65 65 70 2e 63 6f 6d 2f  66 6c 61 73 68 2f 62 61  |eep.com/flash/ba|
00000080  73 65 2e 70 68 70 00 00  49 43 52 44 05 00 00 00  |se.php..ICRD....|
00000090  32 30 30 30 00 00 49 47  4e 52 05 00 00 00 47 61  |2000..IGNR....Ga|
000000a0  6d 65 00 00 49 4e 41 4d  1e 00 00 00 49 6e 76 61  |me..INAM....Inva|
000000b0  73 69 6f 6e 20 6f 66 20  74 68 65 20 47 61 62 62  |sion of the Gabb|
000000c0  65 72 20 52 6f 62 6f 74  73 00 49 53 46 54 0e 00  |er Robots.ISFT..|
000000d0  00 00 4c 61 76 66 35 39  2e 32 37 2e 31 30 30 00  |..Lavf59.27.100.|
000000e0  64 61 74 61 00 64 81 02  00 00 00 00 00 00 00 00  |data.d..........|
000000f0  00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00  |................|
```

Byte range patch
Functional requirements

- Opportunistic — the server will return 412 Unknown Media Type if unsupported
    - More useful than 400 Client Error for rejecting Content-Range PUT
- Maps directly to filesystem operations, including **append** and **overwrite** that many file formats are optimized for.
- Support for determinate length and indeterminate length resources
    - Writing log files (determinate length), or live streaming an audio feed (indeterminate length)

HTTP extension mechanisms

- Use HTTP existing extension mechanisms
  - **Header/Field** — used for opportunistically signaling something to the server, but ignoring is OK.
  - **Method** or **media type** — used if some part of the request *must* be understood.
    - The PATCH method satisfies all the necessary semantics (create or update the target resource according to some enclosed instructions), so a new media type to encode these instructions is most suitable.

Scope

- For simplicity, **limit to standard filesystem operations**. A small patch should cause a small write. More complicated operations may be implemented with a different patch media type, e.g.
    - support for prepending and splicing in the middle of a file, would be a new media type (`application/splice`?)
    - Sophisticated delta algorithms, e.g. VCDIFF, could be registered as a media type.
- Splices/insertions can cause the whole file to be rewritten. Servers shouldn't be required to implement this just to support simpler operations.

Forward compatibility

What about future extensions?

- By requiring that at least one Content-Range field to be present in the patch, use of a field different than Content-Range field can be used as an extension mechanism.

Existing Formats

- Idea: 206 Partial Content with `multipart/byteranges` indicates the response is a wrapper, not the literal resource
- Likewise, the PATCH method indicates the request is not the literal resource, but instructions for processing.

```
--THIS_STRING_SEPARATES
Content-Range: bytes 2-6/25
Content-Type: text/plain

23456
--THIS_STRING_SEPARATES
Content-Range: bytes 17-21/25
Content-Type: text/plain

78901
--THIS_STRING_SEPARATES--
```

Possible Syntaxes

- Existing `multipart/byterange` format
- Adapt existing `message/http` format for requests targeting only one range
- Create binary format — should be suitable for multipart responses too

Example: Log files

- Provide a byte offset to ensure that the remote copy matches the local copy

```
PATCH /log/prod-prndl-mysql3/mysqld-2023-03-05.log HTTP/1.1
Content-Type: message/byterange

Content-Range: 4275-5130/*

2022-10-26 23:47:59.500681Z Manifest version: 1
2022-10-26 23:47:59.511891Z Loaded Persona Generation ID from manifest:1
2022-10-26 23:47:59.512362Z PersonaType:3 is in the manifest
2022-10-26 23:47:59.515182Z PersonaType:5 is in the manifest
2022-10-26 23:47:59.515222Z PersonaType:4 is in the manifest
2022-10-26 23:47:59.515263Z All default System/System Proxy present
2022-10-26 23:47:59.535016Z Loaded persona manifest
```

Example: Log files

- Or omit the offset, and append to the end of the resource

```
PATCH /log/prod-prndl-mysql3/mysqld-2023-03-05.log HTTP/1.1
Content-Type: message/byterange

Content-Range: */*

2022-10-26 23:47:59.500681Z Manifest version: 1
2022-10-26 23:47:59.511891Z Loaded Persona Generation ID from manifest:1
2022-10-26 23:47:59.512362Z PersonaType:3 is in the manifest
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2022-10-26 23:47:59.515263Z All default System/System Proxy present
2022-10-26 23:47:59.535016Z Loaded persona manifest
```

Example: Segmented Uploads

- Upload a file in parts, or complete uploading an interrupted upload.
  - Nit: Resuming an interrupted upload requires that the server preserves state from an unfinished request.

```
PATCH /data/bulk.json HTTP/1.1
Content-Type: message/byterange
If-None-Match: *

Content-Range: 0-99/200
Content-Type: application/json

First 100 bytes of content…
```

```
PATCH /data/bulk.json HTTP/1.1
Content-Type: message/byterange
If-Match: “e4912”

Content-Range: 100-199/200
Content-Type: application/json

Last 100 bytes of content…
```

Questions?