



Repeatable Requests Version 1.0

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Related work:

This specification is related to:

- Org.OData.Repeatability.V1.xml. <https://oasis-tcs.github.io/odata-vocabularies/vocabularies/Org.OData.Repeatability.V1.xml>.

Abstract:

This document describes a method to provide the ability to retry unsafe (i.e. POST, PUT, PATCH, DELETE) requests without incurring unintended side-effects. This specification can be applied to any HTTP based protocol.

Status:

This document was last revised or approved by the OASIS Open Data Protocol (OData) TC on the above date. The level of approval is also listed above. Check the "Latest stage" location noted above for possible later revisions of this document. Any other numbered Versions and other technical work

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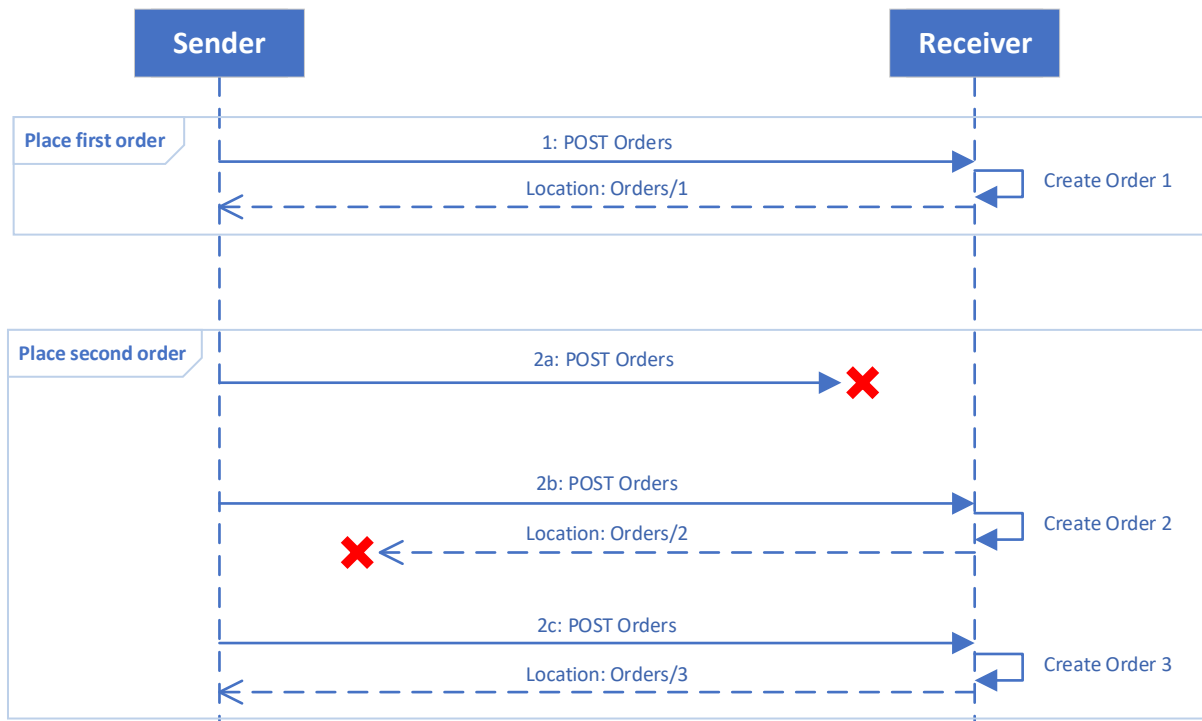
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1 Introduction

HTTP is an inherently unreliable protocol. If connection or other issues prevent the client from receiving a response, the client is left in doubt as to whether the request was processed by the server. For safe HTTP requests as defined in [RFC7231] section 4.2 (for example, GET) the client can simply re-try the request, but for operations that change state (for example, inserting a new resource or invoking a side-effecting service operation such as `PlaceOrder` or `TransferFunds`) re-issuing the request may result in an undesired state (for example, two orders placed, or double the amount of funds transferred).

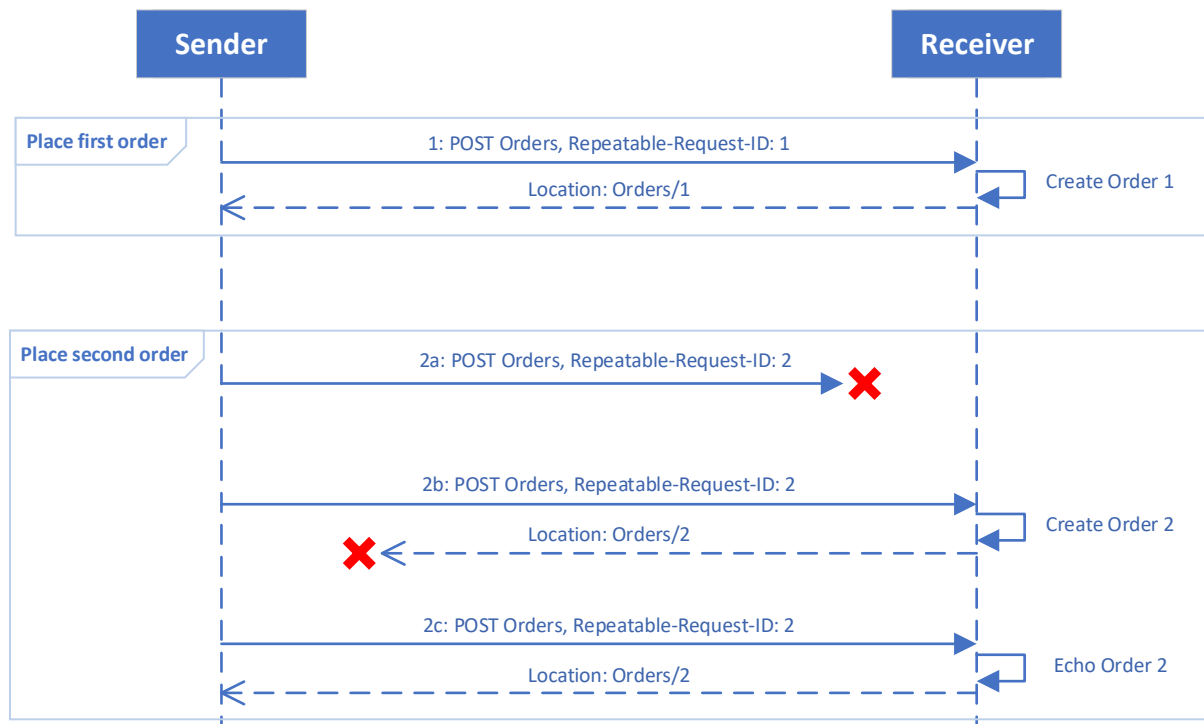
Figure 1: Lost requests and responses without Repeatability



As the sender does not receive responses to requests 2a and 2b, it creates three orders instead of the intended two orders.

This document proposes a simple approach that lets the receiver recognize repeated requests, so it can echo a stored response for an already received and processed request without processing the request a second time:

Figure 2: Lost requests and responses with Repeatability



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1.2 Terminology

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 [\[RFC2119\]](#) and [\[RFC8174\]](#) when, and only when, they appear in all capitals, as shown here.

1.3 Non-Normative References

- [OData-Protocol]** OData Version 4.01 Part 1: Protocol. See link in "Related work" section on cover page.
- [OData-JSON]** OData JSON Format Version 4.01. See link in "Related work" section on cover page.
- [OData-VocRep]** OData Vocabularies Version 4.0: Repeatability Vocabulary. See link in "Related work" section on cover page.
- [RFC4122]** Leach, P., Mealling, M., and R. Salz, "A Universally Unique Identifier (UUID) URN Namespace", RFC 4122, DOI 10.17487/RFC4122, July 2005.
<https://www.rfc-editor.org/info/rfc4122>.
- [RFC5789]** Dusseault, L., and J. Snell, "Patch Method for HTTP", RFC 5789, March 2010.
<http://tools.ietf.org/html/rfc5789>.

[RFC7231]

Fielding, R., Ed., and J. Reschke, Ed., "Hypertext Transfer Protocol (HTTP/1.1): Semantics and Content", RFC 7231, DOI 10.17487/RFC7231, June 2014.
<https://www.rfc-editor.org/info/rfc7231>.

1.4 Typographical Conventions

Keywords defined by this specification use this `monospaced font`.

Normative source code uses this paragraph style.

Some sections of this specification are illustrated with non-normative examples.

Example 1: text describing an example uses this paragraph style

```
Non-normative examples use this paragraph style.
```

All examples in this document are non-normative and informative only.

All other text is normative unless otherwise labeled.

A *repeatable request* is one in which the client sends the request with the `Repeatability-Request-ID` and `Repeatability-First-Sent` headers.

2 Repeatable Request

A *repeatable request* is one in which the client sends the request with the `Repeatability-Request-ID` and `Repeatability-First-Sent` headers.

An *unsafe request* is a non-idempotent request; that is, a request which has the potential to change the service each time it is executed. For example, a request to create a resource is an unsafe request because executing the request multiple times could result in the same resource being created multiple times.

3 Header Fields

Repeatable Requests defines semantics around the following request and response headers.

3.1 Request Headers

Two request headers are required to facilitate the ability to retry requests without incurring unintended side effects. Clients **MUST** send the `Repeatability-Request-ID` and `Repeatability-First-Sent` header to specify that a request is repeatable; that is, that the client can make the request multiple times with the same `Repeatability-Request-ID` and `Repeatability-First-Sent` header values and get back an appropriate response without the server executing the request multiple times.

Another optional header, `Repeatability-Client-ID`, can be provided to facilitate the ability for a server to eagerly cleanup tracking information that it may use for the implementation of repeatable requests (rather than keeping such information for a possibly extended retention period).

3.1.1 Repeatability-Request-ID

`Repeatability-Request-ID` **MUST** be sent by clients to specify that a request is repeatable. The value of the `Repeatability-Request-ID` is an opaque string representing a client-generated, globally unique for all time, identifier for the request. Servers **MUST** accommodate the 36-character hexadecimal case-insensitive encoding of a UUID (GUID), as defined in [RFC4122]. It is recommended for security purposes to use version 4 (random) UUIDs as defined in [RFC4122] section 4.1.3. Support for other forms of unique identifiers is optional.

If specified, the client directs that the request **MUST** be repeatable. Servers aware of repeatability but unable to fulfill this direction for this request type **MUST** not execute the request and instead return 501 Not Implemented.

3.1.2 Repeatability-First-Sent

`Repeatability-First-Sent` **MUST** be sent by clients to specify that a request is repeatable. `Repeatability-First-Sent` is used to specify the date and time at which the request was first created. `Repeatability-First-Sent` value **MUST** be expressed using the IMF-fixdate form of HTTP-date as defined in [RFC7231].

`Repeatability-First-Sent` allows the server to determine if the request is within its currently tracked window of time for repeatability. If `Repeatability-First-Sent` is within the server's window and the request has not been seen previously, the server can safely execute it. If it is not in the window of currently tracked requests, the server cannot guarantee the request was not already executed and so **MUST** return an error. Without using `Repeatability-First-Sent`, if/when the server cleans up tracking information, the server could receive a `Repeatability-Request-ID` that it has already executed but no longer has any tracking data for and so the server would incorrectly execute the request again.

3.1.3 Repeatability-Client-ID

`Repeatability-Client-ID` is an optional header that **MAY** be provided by the client.

`Repeatability-Client-ID` is an opaque string representing a client-generated, globally unique for all time, identifier for the instance of the client application that issued the request. Servers, if they do not ignore this header, **MUST** accommodate the 36-character hexadecimal case-insensitive encoding of a UUID (GUID), as defined in [RFC4122]. It is recommended for security purposes to use version 4 (random) UUIDs as defined in [RFC4122] section 4.1.3. Support for other forms of unique identifiers is optional.

`Repeatability-Client-ID`, if provided by the client, **MAY** be used by the server to support bulk Repeatability Deletion.

3.2 Response Headers

3.2.1 Repeatability-Result

Servers aware of repeatability MUST return the `Repeatability-Result` response header in the result of a repeatable request with one of the case-insensitive values `accepted` or `rejected`.

3.2.1.1 Accepted

The server MUST return the value `accepted` for the `Repeatability-Result` response header if the request was accepted and the server guarantees that the server state reflects a single execution of the operation.

The response returned by the server MUST be the success or failure state of the operation as first executed by the server and reflects either the current state of the system or the state as it existed when the request was first received.

3.2.1.2 Rejected

The server MUST return the value `rejected` for the `Repeatability-Result` response header if the request was rejected because the combination of `Repeatability-First-Sent` and `Repeatability-Request-ID` were invalid or because the `Repeatability-First-Sent` value was outside the range of values held by the server.

The server MUST also return a `4xx` or `5xx` response code without attempting to execute the request when `rejected` is returned.

The server state MUST be the same as if the request was never received.

4 Client Behavior

In order to issue a repeatable request, the client first creates a UUID (GUID) and encodes that as a string. It **MUST** set that as the string value of the `Repeatability-Request-ID` header and **MUST** also set the `Repeatability-First-Sent` header to the current date-time value.

The client **MAY** also include a `Repeatability-Client-ID` header allowing the server to associate with the client any tracking information that it may use in support of repeatable requests.

If the request fails to return, for example, due to connection issues, what the client can do will depend on what it already knows about the server.

If the client has out-of-band knowledge that the server supports repeatability, then the client can safely re-execute the request.

If the client had previously executed a repeatable request for which it got a response, it can also determine whether the server supports repeatability based on whether or not the server responded with a `Repeatability-Result` header. If the server responded with a `Repeatability-Result` header the client knows that the server supports repeatability; re-executing the request in this case is safe. However, if the response did not return a `Repeatability-Result` header, then the client **MUST** assume that the request did not reach a server that knows about repeatable requests.

If the client does not have out-of-band knowledge that that the server supports repeatability and the client has not previously sent a repeatable request for which it received a `Repeatability-Result` header, it **MUST NOT** assume the server supports repeatability and therefore cannot safely re-execute the request. In this case, re-issuing the request **MAY** result in multiple executions.

If the client has determined that the server supports repeatability, it can re-execute a request for which it did not receive a response by sending the request again with the same `Repeatability-Request-ID` and `Repeatability-First-Sent` headers (and `Repeatability-Client-ID`, if it was specified previously).

If the request returns with a `Repeatability-Result` header with a value of `accepted` then the client knows that the request has been executed in a repeatable manner and consumes the results.

If the request returns with a `Repeatability-Result` header with a value of `rejected` then the client knows that the creation time is beyond the window of requests that the server has stored and it cannot safely retry the operation, or some other error has occurred (for example, the `Repeatability-Request-ID` and `Repeatability-First-Sent` values were inconsistent with each other or with a previous request).

If the request returns with HTTP response code 501 `Not Implemented` with a `Repeatability-Result` value of `accepted`, it implies the service knows about repeatability but there is something wrong with the request.

If the request returns with HTTP response code 501 `Not Implemented` with a `Repeatability-Result` value of `rejected`, it implies that the service does know about repeatability but the server does not support repeatability of the request.

5 Server Behavior

This section applies to servers that are aware of this specification.

If the server receives the `Repeatability-Request-ID` header but the `Repeatability-First-Sent` value is missing, it **MUST** return 400 Bad Request with a `Repeatability-Result` of rejected.

If the server receives the `Repeatability-First-Sent` header but the `Repeatability-Request-ID` value is missing, it **MUST** return 400 Bad Request with a `Repeatability-Result` of rejected.

If the server receives the `Repeatability-First-Sent` header but the value is not a valid IMF-fixdate form of HTTP-date as defined in [\[RFC7231\]](#), it **MUST** return 400 Bad Request with a `Repeatability-Result` of rejected.

If the server receives a request with valid, non-null, `Repeatability-Request-ID` and `Repeatability-First-Sent` values and

- does not support repeatable execution of the request it **MUST** return 501 Not Implemented with a `Repeatability-Result` of rejected, or
- the `Repeatability-First-Sent` value is before the earliest remembered `Repeatability-Request-ID`, or this request cannot be reliably executed for some other implementation-specific reason, the server **MUST** return 412 Precondition Failed with a `Repeatability-Result` value of rejected, or
- has not seen the `Repeatability-Request-ID` since its earliest remembered `Repeatability-Request-ID` (if any), and the `Repeatability-First-Sent` value is within its window of remembered `Repeatability-Request-ID` values, then it **MUST** execute the request and return the result with `Repeatability-Result` header value of accepted and record the `Repeatability-Request-ID` and any additional information to ensure the request is not executed more than once, and any additional information to respond should the client send the request again.

The server **SHOULD** return an error 400 Bad Request along with a `Repeatability-Result` value of rejected if `Repeatability-Request-ID` is non-null and the request verb, URI, or header fields other than `Date` are different from that of the original request.

If the server has seen the `Repeatability-Request-ID`, it **MAY** return an error 400 Bad Request along with a `Repeatability-Result` header value of rejected if the request body was different from that of the original `Repeatability-Request-ID`.

If the server has seen the `Repeatability-Request-ID` and the request matches the previous request to the extent validated by the server, the server **MUST** return a response with a `Repeatability-Result` value of accepted that is either:

- the same response code and body as was generated (if any) when the original request with that `Repeatability-Request-ID` was processed, or
- the response code and response body resulting from re-executing the request if the original response code was 4xx or 5xx, i.e. a client error or an internal server error.

In order to permit the server to optimize the storage of response bodies, the client and server may wish to negotiate the amount of content that will be returned in an initial response and any subsequent repeated response. The mechanism for such response content negotiation may depend on the protocol used.

Whether a server is considered to have *seen* a previous request should be transactionally consistent with the mutating effects of the request. For example, a server is not required to remember a previous request whose effects were rolled back due to a failure, since the client could reissue such a request without any possibility for duplication of the effects.

Servers **MAY** support repeatability on POST, PUT, PATCH and DELETE:

- Repeatability on `POST` ensures that the operation is executed, or the insert is performed no more than once.
- Repeatability on `PUT` or `PATCH` is different from the use of an ETag in that repeated `PUT` or `PATCH` operations to the same resource will return success (or fail), possibly including a payload, versus a concurrency violation. It is important for a repeated request to return with success if the original request actually succeeded, rather than a failure due to a conflict detected on the repeated execution.
- Repeatability on `DELETE` is different from use of an ETag in that repeated `DELETE` operations to the same resource will return success (or fail) rather than `404 Not Found`.

Servers **MUST** ignore `Repeatability-Request-ID` and `Repeatability-First-Sent` for `GET` and `HEAD` requests.

If the server knows about repeatability and it does not support it for a particular repeatable request, it **MUST NOT** execute the request and **MUST** return a `4xx` or `5xx` response with a `Repeatability-Result` header with a value of `rejected`.

6 Example Scenarios

Example 2: Create a new Order. Adding a new item to a collection is a POST request to the collection. To safeguard against a lost response the client adds repeatability headers:

```
POST /service/Orders
Content-Type: application/json
Repeatability-Request-ID: 112a3a3e-f94c-4f56-b49b-5aab3d97e5b7
Repeatability-First-Sent: Tue, 26 Mar 2019 16:06:51 GMT

{
  "CustomerID": "ALFKI",
  "OrderLines": [
    {
      "ProductID": "tomatoes-red-cherry",
      "Quantity": 5,
      "Unit": "kg",
    },
    {
      "ProductID": "grapejuice-merlot",
      "Quantity": 2,
      "Unit": "l",
    }
  ]
}
```

The client does not receive a response, so it simply sends the request again:

```
POST /service/Orders
Content-Type: application/json
Repeatability-Request-ID: 112a3a3e-f94c-4f56-b49b-5aab3d97e5b7
Repeatability-First-Sent: Tue, 26 Mar 2019 16:06:51 GMT

{
  "CustomerID": "ALFKI",
  "OrderLines": [
    {
      "ProductID": "tomatoes-red-cherry",
      "Quantity": 5,
      "Unit": "kg",
    },
    {
      "ProductID": "grapejuice-merlot",
      "Quantity": 2,
      "Unit": "l",
    }
  ]
}
```

This time the client receives a response:

```
HTTP/1.1 201 Created
Content-Type: application/json
Location: http://host/service/Orders/4711
Repeatability-Result: accepted

{
  "OrderID": 4711,
  "CustomerID": "ALFKI",
  "OrderLines": [
    {
      "ProductID": "tomatoes-red-cherry",
      "Quantity": 5,
    }
  ]
}
```

```
    "Unit": "kg",
  },
  {
    "ProductID": "grapejuice-merlot",
    "Quantity": 2,
    "Unit": "l",
  }
]
}
```

The *Repeatability-Result* response header tells the client that it need not worry: the new order was created exactly once.

Example 2: Invoke an Action. The client wants to place an exact clone of a recent order using the *Clone* action:

```
POST /service/Orders/4711/Clone
Content-Type: application/json
Repeatability-Request-ID: a47a83d9-be50-46aa-ab2a-55f18f4fbc64
Repeatability-First-Sent: Mon, 01 Apr 2019 06:22:03 GMT

{ }
```

The client does not receive a response, so it simply sends the request again. This time the client receives a response:

```
HTTP/1.1 204 No Content
Location: http://host/service/Orders/4712
Repeatability-Result: accepted
```

The *Repeatability-Result* response header tells the client that it need not worry: the new order was cloned exactly once.

7 Repeatable Request Cleanup

In some situations, such as when using occasionally-connected mobile devices, clients may expect the server to offer a significant retention period (e.g. 50 days) for remembered repeatable requests. In such situations, the server's storage system may be burdened by the retention requirements, so it is valuable to offer clients a way to signal that certain remembered repeatable requests may be forgotten (deleted) by the server even before the retention period has expired. Some clients may be able to acknowledge that they have received all responses to all outstanding requests. Bulk deletion of all the tracking information for repeatable requests from a particular `Repeatability-Client-ID` may enable a significant performance boost for the server.

A server MAY support the deletion of remembered requests by `Repeatability-Request-ID`. If supported, the server SHOULD use the `DELETE` method with the URL pattern "`$RepeatableRequestWithRequestID/<Repeatability-Request-ID>`" for this purpose. The HTTP response status SHOULD be `204 No Content`, even if no such request was found.

A server MAY support the deletion of remembered requests by `Repeatability-Client-ID`. If supported, the server SHOULD use the `DELETE` method with the URL pattern "`$RepeatableRequestsWithClientID/<Repeatability-Client-ID>`" for this purpose. The HTTP response status SHOULD be `204 No Content`, even if no such requests were found.

Note that supporting cleanup by `Repeatability-Client-ID` does not mean that the server needs to record information about client instances separately from its set of remembered repeatable requests. For example, it might be achieved simply with an extra (indexed) storage column in the storage table used to track repeatable requests.

8 Incorporation into OData

This specification is valid outside the context of OData but this section details the specifics of using it with OData, see [\[OData-Protocol\]](#).

8.1 Support

OData services are not required to support Repeatability. Clients MUST rely on external means (e.g. capabilities) in order to know whether the server supports repeatability.

8.2 Discovery

Services supporting repeatability SHOULD annotate the entity container, entity sets, singletons, action imports, or actions in the service metadata with the term `Repeatability.Supported` defined in the `Repeatability` vocabulary, see [\[OData-VocRep\]](#).

Services supporting repeatable requests cleanup by `Repeatability-Request-ID` and/or `Repeatability-Client-ID` SHOULD annotate the entity container with the terms `Repeatability.DeleteWithRequestIDSupported` and/or `Repeatability.DeleteWithClientIDSupported`.

If lower-level elements such as individual entity sets do not support repeatability, then they can opt out of repeatability using a lower-level override of the `Repeatability.Supported` term.

Services MAY support repeatability without the use of annotations in the service metadata.

8.3 Response Payload

The client can optionally use system query options `$select` and/or `$expand` in the request URL to force the service to return a payload containing the minimal information required by the client, as compared to what it would ordinarily return without the use of system query options. Note that `@Core.ContentID` is always returned in the response payload if it was specified in the request body.

If the client sends a repeatable request containing a data modification operation for an entity, and the client does not include `$select` or `$expand` in the request URL, the server MAY choose to return `204 No Content` even if it would ordinarily return status code `200` or `201` for a non-repeatable request.

The above paragraphs allow the service to minimize the tracking information that it stores in support of repeatable requests.

8.4 Batch Requests

Services MAY support repeatability for individual requests within a batch request, as well as for individual requests within a change set or atomicity group within a batch request.

Individual requests within a batch MAY have a mix of `Repeatability-Request-ID` and `Repeatability-First-Sent` values. In this case, each individual response within the batch response has the appropriate `Repeatability-Result` (or not) according to the corresponding request.

Repeatable request headers MUST NOT be applied to change sets or atomicity groups directly because there is no way to specify headers for an atomicity group in JSON batch requests, see [\[OData-JSON\]](#). To make a change set or atomicity group repeatable, a client MUST specify the same `Repeatability-Request-ID` and `Repeatability-First-Sent` values for all requests in the change set or atomicity group. The client MUST retry the entire change set or atomicity group as a unit if it is repeatable; individual operations within the change set or atomicity group MUST NOT be retried.

There is no correlation between the repeatability of a request and the repeatability of any of its dependent requests. That is, a repeatable request may be retried without retrying any of its dependent requests.

Repeatability cannot be applied to batch requests themselves because a single `Repeatability-Request-ID` on the batch request is not sufficient for uniquely identifying the individual requests within

the batch request, and because repeatability implies transactional atomicity which cannot be guaranteed for a batch request containing multiple change sets, some of which may succeed (commit) and some of which may fail (rollback). Therefore, if a server receives a batch request with either a `Repeatability-Request-ID` or a `Repeatability-First-Sent` value, it **MUST NOT** execute any requests within the batch and **MUST** respond with `4xx` or `5xx` response and with a `Repeatability-Result` value of `rejected`.

9 Security Considerations

For HTTP relevant security implications please cf. the relevant sections of [\[RFC7231\]](#) (9. Security Considerations) and for the HTTP `PATCH` method [\[RFC5789\]](#) (5. Security Considerations) as starting points.

Servers SHOULD authenticate the client before further evaluating the repeatability of any requests.

As mentioned in [section 3.1.1](#), it is recommended for security purposes that clients use randomly generated `Repeatability-Request-ID` values such as version 4 UUIDs as defined in [\[RFC4122\]](#) section 4.1.3.

10 Conformance

10.1 Service Conformance

In order to conform to this specification, a service:

1. MUST conform to the semantics of the following headers, or fail the request:
 - 1.1. `Repeatability-Request-ID` (section 3.1.1)
 - 1.2. `Repeatability-First-Sent` (section 3.1.2)
2. MUST return the `Repeatability-Result` response header in response to repeatable requests (section 2) with one of the values `accepted` (section 3.2.1.1) or `rejected` (section 3.2.1.2)
3. MUST follow the guidelines in Server Behavior (section 5)

10.2 Client Conformance

If a client wants to safely repeat a request, a client:

1. MUST specify the `Repeatability-Request-ID` header in an unsafe request (section 3.1.1)
2. MUST specify the `Repeatability-First-Sent` header in a unsafe request (section 3.1.2)
3. MUST only repeat a request if it has previously determined (through whatever means) that the server supports repeatability and MUST specify the repeatability headers (section 4).

Appendix A. Acknowledgments

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Appendix B. Revision History

Revision	Date	Editor	Changes Made
Initial Draft 01	2013-06-25	Mike Pizzo, Ralf Handl	Initial version
Committee Note Draft 01	2019-10-17	Matt Borges, Evan Ireland	Aligned header names Added Repeatability Deletion Clarified client and server behavior with regard to errors Clarified what servers are required to store and return for repeated requests and how the client and server can negotiate this for OData
Committee Specification Draft 01	2020-04-07	Matt Borges, Evan Ireland	Changed the committee note draft into a committee specification draft