



Open Retailing Design Rules for APIs OAS 3.0

July 30, 2021

Version 1.9

Document Summary

This document describes the Open Retailing (fuel retailing and convenience store) style guidelines for the use of RESTful Web Service APIs, specifically the use of the OAS3.0 file format and referencing of relevant JSON Schemas (written as OAS3.0 documents) from that file. These guidelines are based on best practice gleaned from OMG (IXRetail), W3C, Amazon, Open API Standard and other industry bodies.

These guidelines are not to be considered a primer for how to create APIs. There are thousands of documents and blog posts about APIs and best-practices for creating them. This guide is rather a set of practices to serve as “guardrails” to ensure that Open Retailing APIs have a consistent design.

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This document was reviewed and approved by the Joint IFSF and Conexus Application Programming Interface Work Group and the Technical Advisory Committee within Conexus.

Revision History

Revision Date	Revision Number	Revision Editor(s)	Revision Changes
July 30, 2021	V1.9	David Ezell, Conexus	<ul style="list-style-type: none">• Added section on consistent naming of examples in projects.• Adjusted for comments from the meeting 2021-08-03.
June 28, 2021	V1.8	David Ezell, Conexus	<ul style="list-style-type: none">• Deprecate use of HTTP PUT.• Define use of scalars.• Provide guidelines for use of “security” and “server” properties.
December 8, 2020	V1.7	David Ezell, Conexus	<ul style="list-style-type: none">• Change section 4.1.1.6 (use of headers) to explain mapping of “kebab-case” (no upper case) from “lower camel case”.• Adjust section 4.1.1.7 (“servers:” property) to align with use in scripting.

September 8, 2020	V1.6	David Ezell, Conexus Linda Toth, Conexus	<ul style="list-style-type: none"> Added section 4.4 on dependencies.txt Adjusted section 4.1.1.6 on use of headers. Added section 4.1.1.14.1 on SSE data, and an example of a data definition in the Appendix H. Added section 4.1.1.9.1 to clarify return codes 2xx vs 4xx or 5xx. Accepted tracked changes after joining API working group review and adjusted formatting as required.
August 10, 2020	V1.5.1	Linda Toth, Conexus	Accepted tracked changes Modified formatting for consistency
July, 07, 2020	V 1.5	Clerley Silveira	Adding clarification to section 4.1.1.1 – Better defining how PUT and POST are used.
June, 29, 2020	V1.4	Clerley Silveira	Adding more information to section 4.1.1.2. There is some confusion understanding the concepts of Element, Objects vs. Data Types. Added an Appendix with a Walk-through example to help with intuition.
May, 10, 2020	V1.3	John Carrier, IFSF Linda Toth, Conexus	Section 4.1.1.7 OAS “servers:” Specification added. Minor text corrections to 4.1.1.5 and 4.1.2.3. Note current sections 4.1.17 and onwards are renumbered. Cleaned up formatting and references to fuel retailing.
April 1, 2020	V1.2	David Ezell, Conexus	Clarified the file naming conventions associated with Elements, Objects, and Types.
March 29, 2020	V1.1	David Ezell, Conexus	Added a section to Design Rules defining the standard directory layout for APIs.

March 25, 2020	V1.1	David Ezell, Conexxus	Changed so that referenced schema documents are written in YAML in OAS3.0, using the JSON-Schema 0.7 specification. Added references and warning about use of headers.
February 3, 2020	V1.0	Linda Toth, Conexxus	Changed fuel retailing to open retailing. Cleaned up formatting.
December 24, 2019	v.13	David Ezell, Conexxus	Revised Appendix F (removed example) and added a note about error message functionality in the section on "Return Codes."
September 9, 2019	Vo.12	David Ezell, Conexxus	Added example ADF (fdc.yaml), added need for /softwareConfiguration
July 30, 2019	Vo.11	David Ezell, Conexxus	Clarify SSE use based on new learnings.
July 23, 2019	Vo.10	David Ezell, Conexxus	Changed fragment identifiers to a simple hash, included in open issues.
July 14, 2019	Vo.9	Linda Toth, Conexxus	Accepted all changes. Cleaned up formatting. Added open issues section. Revised the section on "servers:" property to align with scripting practices.
July 9, 2019	Vo.8.1	David Ezell, Conexxus	Added changes per Joint API WG meeting on 2019-July-09
July 8, 2019	Vo.8	Linda Toth, Conexxus	Reformatted for joint document.
July 2, 2019	Vo.7	David Ezell	Removed Security and Transport sections (they're in other documents) and accept all committee decisions. Review and modify the glossary and references as needed.
June 3, 2019	Vo.6	David Ezell	Filled in references to representation definitions (JSON Schema).
May 28, 2019	Vo.5	David Ezell	Filled in empty sections.
May 14, 2019	vo.4	John Carrier, IFSF	Updates from API WG Meeting of 14 May

May 11, 2019	v0.3	David Ezell, Conexus	Merge content from “Part-2-03-communications_over_http_rest_draft_v1.1.” Merge content from the IFSF Wiki homepage. Include changes from the f2f meeting on 2019-04-29.
April 19, 2019	v0.2	David Ezell, Conexus	Add links to industry practices, update TOC, insert examples
March 2019	Draft V0.1	David Ezell, Conexus	Initial Draft for Joint API WG Review

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1 Introduction

This document provides guidelines for defining RESTful Web Service APIs using OAS 3.0 and JSON Schema 0.7. These guidelines help to ensure that APIs created by IFSF and Conexus will be compatible and work well together, and that the resulting standards adhere to common design principles and design methodologies, making them much easier to understand and to maintain.

Representational State Transfer (REST) is a software architecture style for building scalable web services. REST gives a coordinated set of constraints to the design of components in a distributed hypermedia system that can lead to a higher performing and more maintainable architecture. While there are other tools and specifications for creating APIs, the requirements in this document follow the style of API most widely accepted and standardized.

This document is NOT a primer on API design: there are thousands of web sites and blog posts devoted to best-practices in API design.

The guideline applies to all API definitions developed by IFSF, Conexus and their work groups. This document relies to some extent on the IFSF / Conexus "Open Retailing Design Rules for JSON" document to define specific rules that apply to JSON object definitions used by APIs, as well as versioning logic rules.

Please see “Best Practices in API Design” by Keshav Vasudevan, as well as “Writing OpenAPI (Swagger) Specification Tutorial” by Arnaud Lauret, for more complete descriptions.

1.1 Audience

The intended audiences of this document include, non-exhaustively:

- Architects and developers designing, developing, or documenting RESTful Web Services; and
- Standards architects and analysts developing specifications that make use of Open Retailing REST based APIs.

1.2 Background

As described in the IFSF/Conexus “Open Retailing Design Rules for JSON,” APIs today are commonly defined as RESTful Web Services. Successful definitions of RESTful Web Services require standards for JSON Design be followed, as well as topics specific to APIs, for instance loose coupling and high cohesion, use of YAML as a design language, message relationships, callbacks, API extensions, documentation, and security. This document addresses these API topics.

2 Design Objectives

By following the guidelines in this document, it should be straightforward to create well designed APIs that are compatible with other API work from Conexus and IFSF.

2.1 Overall API Design

The use of Open API Specification 3.0 as an Interface Definition Language (IDL) provides access to the most up-to-date industry tool implementations, as well as making use of current industry “best-practices” in API design simple to achieve.

2.2 Commercial Messages in Edited Documents

All commercial messages in OAS 3.0 documents SHALL be removed. For example, remove any messages similar to:

```
"Edited by <owner> with <Swagger editor> V2.0".
```

3 Versioning

In general, API versioning should follow the tenets in “Semantic Versioning 2.0.0.” This practical guide says that a version number is divided into three parts: Major number, minor number, and revision (or patch). These numbers are separated by a dot (‘.’) character. The following rules apply:

- Major number – must increment on any breaking change, i.e., any change that would cause an existing client of the API to malfunction.
- Minor number – must be incremented if the interface is extended in such a way that existing clients continue to function normally, but new functionality becomes available through the interface.
- Revision (in semantic versioning called a patch) – must be incremented to indicate other kinds of changes, such as documentation or minor extensions or clarifications (bug fixes).

4 Design Guidelines

These API Design Guidelines cover the definition of data components and the API definition in OAS 3.0 files. Additional constraints on API Implementations – not covered in this document - include security definitions as well as exactly which transport mechanisms may be used.

See the documents API Implementation Guide: Security and API Implementation Guide: Transport Alternatives for details.

4.1 Design Basics

4.1.1 RESTful Design Guidelines

RESTful APIs consist of resources, URIs that identify those resources, HTTP methods for operating on resources, HTTP message headers (meta data), and representations of domain objects sent and received in HTTP message bodies. This section tries to reduce the choices in constructing APIs in order to produce APIs that are easier to review for consistency and quality.

4.1.1.1 Resources

There are several definitions for a RESTful API resource. The definition we are going to use in this document is: "A resource is any data, thing or information that can be named." That definition restricts resources to nouns.

Verbs are very important when defining APIs, specifically the HTTP verbs (GET, POST, and DELETE). Those verbs are transmitted in the HTTP field "method." For that reason, they are also known as "HTTP methods."

HTTP verbs and HTTP methods can be used interchangeably.

Resources are operated upon by HTTP methods. For instance, a GET method used against a resource should return the contents of the resource as a "domain object" graph represented in JSON. Similarly, a "domain object" graph, (also represented in JSON), can be applied to a resource using POST, which will normally change the state of the resource. Resources can be either individual resources, or a resource can be a collection of resources. Collections should normally be indicated by a plural noun (see Section 4.1.1.5 URI Construction).

For instance, an individual resource might be:

```
https://openretailing.org/apis/employee/441125
```

and an associated collection might be:

```
https://openretailing.org/apis/employees
```

4.1.1.2 Resource Domain Objects (Representations)

Most Message representations will require a Domain Object Graph. Object Graphs represent instances of objects and their relationships. For example, a customer object may contain an address object which also defines an object graph on its own with street number, city, state, and postal code:

```
Customer
|--Address
  |--Street Number
  |-- City
  |-- State
  |-- Postal Code
```

When applied to a domain (Billing system, Payment System, or any other system), the object becomes a Domain Object Graph representation because it applies to that domain.

All "Domain Object Graphs" must be coded as JSON. There are two supported mechanisms to define JSON objects:

- Described in an OAS3.0 file (in YAML, and conforming to JSON-Schema 0.7) referenced from the OAS 3.0 API definition file; and
- Described in the API definition file itself. Short representations and those that are used repeatedly in responses (e.g., error responses) are good candidates for this kind of definition.

Domain objects must be defined as one of the following types:

- Element – a "property" naming either a defined object or an array;
- Object – a set of properties that define reusable content, i.e. the contents of an element, but with the name not yet assigned; or
- Data type – A primitive JSON type constrained in some way. E.g., a numeric type can be constrained by value, and a string type can be restricted by length or by "regular expression."

To illustrate Elements, Objects, and Data Types, and apply those to concepts defined in OAS3.0 YAML, please refer to Appendix G.

4.1.1.3 Data Dictionary and Data Dictionary Candidate Entries

In the course of development, Resource Domain Objects may be indicated to be candidates for the Data Dictionary, and should use the same naming conventions as the Dictionary. The file naming conventions for either Data Dictionary entries or for candidate entries is described below.

The Data Dictionary will be composed of the following:

1. Element – a YAML file as described above, starting with the element name and ending in “Element.yaml”.
2. Object – a YAML file as described above, starting with the object name, and ending in “Object.yaml”.
3. Type – a YAML file as described above, starting with the type name, and ending in “Type.yaml”.

A special variety of “Type” is “BaseType.” “BaseTypes” are useful for reuse in a variety of situations, and example being id4NBaseType.yaml, which defines 4 numeric characters serialized as a string in JSON, and used as an identifier.

4.1.1.4 HTTP Methods

Obey the following general guidelines for using HTTP methods:

GET - Used to retrieve information related to a resource. The GET verb does not allow for data to be transferred in the body of the HTTPS request. Web Servers will drop any information in the "body" of the HTTPS message. Thus, the only mechanism available to transfer parameters is query strings or the URI path. GET verbs must not trigger a state change. If a GET request is issued multiple times using the same set of parameters, the response should always be the same. The only exception to that rule would be for cases where some POST or DELETE operation was issued against a resource in between GET calls. For those cases, a state change caused by one of those calls may change the response to a follow-up GET request, but the GET request must not cause the state change.

POST - Used to create a new instance of a resource or, to modify an existing instance. POST verbs allow for data to be transmitted in the body of the HTTP request. In addition, POST supports query strings and URI based parameters. POST can also cause state change, sending a POST request with the same set of parameters can cause multiple state changes. POST is the most common verb used on Conexus APIs.

DELETE - The DELETE Verb is used to cancel, remove or rollback state related to a resource. It has some of the same constraints as GET. Since DELETE has no semantics

defined for information passed in the body of the HTTP request, avoid doing so. Web Servers may drop requests if the DELETE verb contains data in the "body" of the message. Use query strings or URI paths for that purpose.

The following general usage guidelines apply:

1. Individual resources may use any of HTTP methods (GET, POST, PUT, DELETE). See Section 4.1.1.4 HTTP Methods.
2. Collections
 - GET may be used with a collection and would return an array of domain objects. It can be constrained with information defined in the URI's "query string". For example: `accounts?start=1&end=1000`
 - POST may be used with a collection provided the representation (body) contains the necessary information to create or modify a resource or resources in the collection.
 - DELETE may be used with a collection to remove all resources in the collection. If the requirement is to delete one resource, use the specific resource, not the collection. In general, the body of a DELETE request will not further identify the resource to be removed.

4.1.1.5 URI Construction

An API is a set of resources, each resource being indicated by a Uniform Resource Identifier (URI), and each URI being operated on by HTTP methods. Using the following guidelines for URI construction will help make the resulting APIs more consistent:

- Use nouns as path components;
- Use LCC or all lower case for path components;
- Path components should be alphanumeric only; and
- Use path components to indicate the version number; do not use the HTTP Content-Type header. For example, using `Content-Type: application/vnd.api+json; version=2.0` should be avoided.

URIs are described in detail in RFC 3986, and updated in RFC 6874 and RFC 7320. RFC 3986 explains the "scheme," "host," "port," "path," "query" (starts with '?'), and "fragment" (starts with '#') components in detail. For the purposes of API construction, the "path," "query," and "fragment" components are of primary interest.

The following is the proposed API path component format:

```
{APIName}/v{APIVersionNumber} [/{resource}] [?{parameters}] [{#fragment-identifier}]
```

{APIName} is the application name, such as “fdc”. Below are possible examples:

- fdc, for forecourt device controller;
- wsm, for wet stock management server;
- fm, for fuel management server;
- eps, for electronic payment server;
- pp, for price pole server;
- cw, for car wash server;
- tlg, for tank level gauge server; and
- emc, for remote equipment monitoring and control.

{APIVersionNumber} consists of “major” where:

- major corresponds to the major version number of the API; and
- any minor number should not appear in the path component. If the minor number is relevant, evidence of minor version (implicit or explicit) should appear in the associated representation.

{resource} specific identification of the target resource. The resource string may contain parameter components.

{parameters} is a set of name/value pairs separated with ‘&’ (ampersand) characters. Name values should not be verbs.

Examples:

```
https://api.openretailing.org/pp/v2/sites  
https://api.openretailing.org/fdc/v1/products
```

Overloading of methods on resources, on methods other than POST, MUST be avoided.

4.1.1.6 Use of HTTP Headers

The API should use the standard HTTP headers where relevant:

- **Accept:** to negotiate the representations of a resource, and the version of the referenced resource.
- **Accept-language:** to negotiate the language of the representation of a resource (for internationalization). If this header is not specified, the application will respond in its default implementation language.

- `Authorization`: to manage the authentication and authorization of a user and application to a given resource.
- `Accept-encoding`: Used to compress server response.
- `Cache-Control`: Used to direct proxy servers not to cache responses
- `Content-type`: to inform the representation of a query or a response.

Note: Custom HTTP headers may be used in accordance with RFC6648. All such headers must have a JSON type definition in the “API Data Dictionary” or defined locally in the project.

- 1) Custom HTTP header names should be coded in “kebab-case” (case ignored, words separated with ‘-’) instead of lower camel case.
- 2) Custom header names should not use upper case.
- 3) It is good practice to prefix custom headers with “openretailing-“ to avoid name collisions.

Note: New APIs must conform with #1, #2, and #3 above if submitted for approval after December 9, 2020.

Note: Use of HTTP headers should be considered carefully, since using them may cause use of protocols other than HTTP more difficult.

4.1.1.7 API Crafting (highly cohesive but loosely coupled)

The scope of a given API should be “as small as possible, but no smaller.” Although some style guides suggest between four and eight resources are roughly a right-sized API, these guidelines don’t make specific recommendations.

Care in defining the resources in an API help assure **highly cohesive** designs, where the resources and methods in an API work together to create a unified component addressing well defined functionality with a limited (the “micro” in “microservices”) scope.

Loose coupling means that the API can easily be used alone or with other APIs, giving great flexibility in designing systems.

Following these tenets helps assure systems that can be maintained using continuous integration, where individual components can be updated separately and with minimal service disruption.

4.1.1.8 Return Codes

API definitions SHOULD limit response codes to the following subset:

- **2XX** - Success
 - 200 OK
Normal successful return
 - 201 Created
Resource created
 - 202 Accepted (not complete)
Successful request initiation. Returned for asynchronous commands to avoid waiting.
 - 204 No Content
No representation (body document) in the return message.
- **4XX** – Client Error
 - 400 Bad Request
Problem with either the representation or meta data
(Note: additional client error codes MAY be disallowed in production for security reasons in cloud-based systems.)
 - 401 Unauthorized
Credential doesn't allow operation
 - 403 Forbidden
Request on resource (resource is valid) not allowed for some reason
 - 404 Not Found
URI doesn't point to any known resource
 - 405 Method Not Allowed
HTTP method not allowed for resource
 - 408 Request Timeout (server state expired)
 - 426 Upgrade Required
- **5XX** – Server Error
 - 500 Internal Server Error

Note: some API implementations may have a development mode that allows more error codes or more information. If present, this feature must have a setting to turn it on or off, with the default setting being “off,” even if the supporting property data is copied from another machine (so that it can't be turned “on” by accident.)

4.1.1.8.1 Return Code 2XX (Success) vs. 4xx or 5xx

In general, 400 and 500 series return codes indicate document/addressing or system failures. For instance, an invalid message body or invalid URLs will give rise to a 400 series error. An internal server error will give rise to a 500 series error.

If the message is received by the server in good order, the server should return a 200 series message. However, the dispensation can be indicated using the return status as defined in the API Data Dictionary utilities directory. See

`errorCodeEENumType.yaml`:

```
"statusReturn": {
```

```
    "timestamp": "2009-11-20T17:30:50",
    "result": "success",
    "error": "ERRCD_OK",
    "message": "Operation completed successfully"
}
```

For any “200” response, the `statusReturn` property should normally be the first property in the `responseBody` of the API call. `ERRCD_OK` indicates complete success. But if the message is a success, but the service can’t complete its mission (through no fault of the client calling it), it might return `ERRCD_DEVICEUNAVAILABLE`.

Please see the API Data Dictionary for details.

4.1.1.9 Content Type (Representation)

For Connexus/IFSF APIs, the content should use the MIME-type `application/json`. If using the `Accept` header, the header should always indicate this type.

4.1.1.10 Space-Saving Encoding

A conforming API client MAY indicate “gzip” as an acceptable format. The use of “gzip” is the client’s choice. Server support is optional.

Example:

```
GET https://api.openretailing.org/remc/v1/sites
Accept-Encoding: gzip
```

4.1.1.11 Caching

Conforming APIs, in general, will choose `Cache-Control: no-cache`, and conforming servers should assume `no-cache` as the default.

Use cases may occur where caching might be of great benefit, though care is required to make sure that the client receives valid information.

4.1.1.12 Use of HATEOAS and Links

Use of “Hypertext as the Engine of Application State” (HATEOAS) is recommended in situations where the server state changes when resources are accessed with HTTP methods.

4.1.1.12.1 Link Header

The server MAY return HATEOS links in the response header as defined in RFC 5988, so as not to have any impact on the representation data.

4.1.1.12.2 Pagination of Results (Message Body)

If results must be paginated, it may be achieved by using links. For example:

```
GET http://api.openretailing.org/fdc/v1/sites?
zone=Boston&start=20&limit=5
```

The response should include pagination information in the `Link` header field:

```
{
  "start": 1,
  "count": 5,
  "totalCount": 100,
  "totalPages": 20,
  "links": [{
    "href":
"http://api.openretailing.org/fdc/v1/sites?zone=Boston&start=26&limit=5",
    "rel": "next"
  },
  {
    "href":
"http://api.openretailing.org/fdc/v1/sites?zone=Boston&start=16&limit=5",
    "rel": "previous"
  }
]
```

4.1.1.13 Server Sent Events (SSE)

Server Sent Events can provide a subscribing client application with events related to a given resource. Events should always be tied to a resource in the API.

For instance here is a request for information on fueling point (or position) 12:

```
GET https://openretailing.org/fdc/FPs/12
```

And here is a request for an event stream that could send events when any resource in the collection changes:

```
GET https://openretailing.org/fdc/FPs-events
```

Note: a QueryString MAY be defined in the standard to filter on a specific event type or a range of endpoints, if desired. A server based on such a definition SHOULD attempt to honor the QueryString, but if it's impossible MUST return a 4xx error.

The response message body from the call to #events MUST return a URL to use as an “EventSource,” e.g.,:

```
{  "eventURL": "https://openretailing.org/event-streams/employees"
}
```

The URL returned MUST indicate HTTPS, and it would subsequently be used in a call to an Event Source constructor, e.g.,:

```
<script>
  var sse = new EventSource(
    "https://openretailing.org/event-streams/employees"
  );
</script>
```

The event source may be closed using the `close()` method on the object. There is no API call to close an event source.

There is no requirement on the actual URL returned, but it SHOULD be in the same domain as the resource with which it is affiliated.

Because events can be lost for a number of reasons, a companion URL SHOULD provide event history up to some maximum number of events (using GET), and allowing limitation using Query String with “maximum=<number of events>”. For example:

```
GET https://openretailing.org/fdc/FPs/events
```

4.1.1.13.1 Server Sent Events Data Formats

Server sent events define the following fields for each event, each ending with a newline character:

- `id`: a unique id in the event stream, useful for reconnecting.
- `event`: a string defining the kind of event. Standard libraries allow assigning processing code (functions) to be triggered when an event of a specific type arrives.
- `data`: associated data for the event. Multiple “data:” elements can appear.
- `blank line`: essentially an extra newline character, marks the end of the event.

The data in the `data` area(s) of events must be defined in the API definition, using types ending in `EventObject`. These objects have intentionally duplicated the `id` and `event` fields, so the definition could potentially be used in other ways (such as Web Sockets).

Note: In the Server Sent Events definition, both `id` and `event` are optional fields. These fields are mandatory for IFSF/Conexus Openretailing specifications, and they are intentionally duplicated in the data.

4.1.1.14 Web Sockets

Web Sockets can provide a subscribing client application with full duplex data streams related to a given resource. Web Sockets should always be tied to a resource in the API.

For instance, here is a request for information on employee “1234”:

```
GET https://openretailing.org/apis/employees/1234
```

And here is a request for an event stream that could show a movie related to that employee:

```
GET https://openretailing.org/apis/employee/1234/  
movie-websocket
```

The response message body from the call to `#websocket` MUST return a URL to use as a web socket reference, e.g.,:

```
{  
  "socketURL": "wss://openretailing.org/web-  
sockets/employees/1234/movie"  
}
```

The URL returned MUST indicate WSS, and it would subsequently be used in a call to a `WebSocket` constructor, e.g.,:

```
<script>  
  var sse = new WebSocket(  
    "wss://openretailing.org/ web-sockets/employees/1234/movie"  
  );  
</script>
```

The `WebSocket` may be closed using the `close()` method on the object. There is no API call to close a `WebSocket`.

There is no requirement on the actual URL returned, but it SHOULD be in the same domain as the resource with which it is affiliated.

4.1.2 OAS 3.0 Design Specifications

The guidelines here are essentially limitations on definitions possible with the OAS 3.0 specification.

4.1.2.1 API Definitions in YAML

OAS 3.0 supports definitions written either in JSON or YAML. APIs should be defined using YAML. YAML supports the same data structures but is easier to read and edit.

4.1.2.1.1 “servers” OAS Property

The servers: body of the ADF MUST be standardized to enable development tools to process it consistently. The standard url: path is defined as:

url: `https://{domain}/{basePath}/{subPath}/{version}`

The parameters {domain}, {globalsiteID}, {basePath} and {version} have standard content.

{domain} :	the default value is “factory.openretailing.org”
{basePath}:	this value is specific to the API-Collection.
{subPath}:	this value is specific to a given Application Definition File (ADF), normally describing a “micro-service” sized interface. This component is optional.
{version}:	this indicates the current version number. The first draft version is “vo”. These increment according to the version numbering rules specified in the JSON Design Rules document.

A working example; taken from POSActivityPOSJournal.yaml ADF is given below. In this example the {basePath} has content ‘para’, {subPath}is ‘pos-journal’, and the {version} is v1.

```
servers:  
- url: https://{domain}/{basePath}/{subPath}/{version}  
  description: The production API server  
  variables:  
    domain:  
      # note! no enum here means it is an open value  
      default: factory.openretailing.org  
      description: this value is assigned by the service provider, in this example `openretailing.org`  
    basePath:  
      default: para  
    subPath:  
      default: pos-journal
```

```
version:  
default: v1
```

Note: These values should align with variables used to describe API test scripts (for example, “Postman” scripts). In cases where more than one ADF, the {subPath} variable may have a suffixed integer, e.g., {subPath1}, {subPath2}.

4.1.2.1.2 Security Related OAS Properties

For OAS 3.x, security should be defined both as a “securitySchemes” property under the “components” property, and also as one or more array entries under the top-level “security” property. The following example references pre-defined entries for the schemes. Note that any implementor, with appropriate justification, may adjust these entries if needed for their specific implementation.

```
components:  
  
  securitySchemes:  
  
    apikey:  
  
      $ref: '../api-data-dictionary/utilities/security.yaml#/components/securitySchemes/apikey'  
  
    basic:  
  
      $ref: '../api-data-dictionary/utilities/security.yaml#/components/securitySchemes/basic'  
  
    oauth2:  
  
      $ref: '../api-data-dictionary/utilities/security.yaml#/components/securitySchemes/oauth2'  
  
# At least one of apikey, basic, or oauth2 should be defined here.  
  
security:  
  
  - apikey: []  
  
  - basic: []  
  
  - oauth2: []
```

4.1.2.2 Use of Scalar Values in YAML “description” elements

“Scalar” values in YAML are strings. YAML provides several ways to handle strings, and these are important in the OAS file for documentation (“description:” properties). For instance, in some cases strings may allow including literal newline characters and tabs, and in other cases they may allow including “escaped” newline characters and tabs. In addition, YAML allows scalar values to be defined either as “block scalar values” or “flow scalar values.”

4.1.2.2.1 Block Scalars

The block style mode is indicated in the first few characters of a property value. Following is a description example:

```
description: >
  Lorem ipsum dolor sit amet, consectetur adipiscing
  elit, sed do eiusmod tempor...
```

In this case, the style mode is indicated by a single character: ‘>’. The text must be indented one level deeper than the enclosing property name (“description” in this case).

```
description: XYZ
  ||+---- number of spaces to indent the result, or zero if absent.
  |+----- "block chomping", one of '-', '+', or nothing.
  +----- literal style ('|') or folded style ('>')
```

- Block scalar style – fold or preserver format.
 - Literal style '|' – preserve all embedded newline characters.
 - Folded style '>' – fold long lines as page formatting may dictate, but preserving newline characters if they occur alone on a line.
- Block chomping – affects newline characters at the end of the block.
 - Indication not present – leave a single newline at the end of the block.
 - Indication '-' – don't leave a newline at the end of the block.
 - Indication '+' – leave newlines alone (any number at the end of the block).
- Indentation – if present, number of characters to indent the formatted block on output.

4.1.2.2.2 Flow Scalars

Flow scalar modes are more familiar from programming languages. These are strings either inclosed in single quotes (' ') or double quotes (" "). The main difference between the two is that single-quoted scalars don't process any special escaping. E.g., '\n' will appear in output as '\n'. Double-quoted scalars process escape characters for output. E.g., '\t' will produce a tab character on output.

Note: In YAML, if a string appears on the same line as a property but without newlines or quotes it is treated as a single-quote flow scalar.

4.1.2.2.3 Design Guidelines for Scalars

The following design rules should be observed unless there is some special reason not to do so. For instance, the guidelines suggest “folded with single newline.” However, if tabular data were present, “literal with single newline” might be a better choice.

- 1) Description properties – use “folded with single newline scalars.” e.g.,

```
description: >
  Lorem ipsum dolor sit amet, consectetur adipiscing
  elit, sed do eiusmod tempor...
```
- 2) For JSON Pointer entries – use “single-quoted flow scalars.” These pointer entries occur most often after a “\$ref” property, and embedded characters should not be escaped.
- 3) For REGEX entries – use “single-quoted flow scalars.” These entries are normally the content of a “pattern” property.

4.1.2.3 References to Representation Definitions (JSON Schema)

Representations of domain objects should be in external OAS3.0 files, using the ‘#/components/schemas/’ section of the document. The definitions are to be in JSON Schema 0.7 and encoded in YAML. Message parts that are not domain objects per se MAY be defined in the OAS3.0 file itself.

4.1.2.4 Security Considerations

Please see “Open Retailing API Implementation Guide: Security” for details.

4.1.2.5 Extending an API

Extensions to existing APIs should, in general, be done by the committee (applying the rules for Semantic Versioning 2.0.0) and not by individual implementers. Microservices are small. Extensions to a microservice should be accomplished by:

- 1) Creating a second microservice with a related base URL.
- 2) Submitting all changes to the committee.
- 3) Wrapping resulting committee changes in the extended API (so existing client implementations remain useable).

4.2 Documentation Requirements

4.2.1 OAS 3.0 Definition File

The “base” file of the API is an OAS 3.0 definition file, hereafter referred to as the ADF (API definition file). The ADF lists resources, methods allowed on those resources, and responses to be expected on executing those methods.

Note that a “response” may have an enclosing “wrapper” JSON object(s), but domain specific objects should be defined externally.

Not all fields in the OAS file required for a real standard can be filled in. For instance, the `servers: []` array will contain URLs unknown to the committee creating the standard.

4.2.2 Naming of Example Files

A given project may have numerous example files. Some of these files will be referenced from the OAS 3.0 Definition File(s), but many others may be useful in the project. It is important to name these files consistently. All of the following examples are assumed to appear in the “examples” subdirectory of the project.

1. With some exceptions as indicated below, all examples MUST be named for the resource (including variables), the method, and either "Request" or "Response."
Note: examples not referenced by the definition file(s) should be “Request” documents.

Example: `journal-post-Request.json`

2. Responses must also have a return code (200, 400, etc.).

Example: `journal-get-Response-200.json`

3. If the example is a “Response”, ERRCD codes (for 2xx or 4xx) included in the “status:” property must be part of the name, with an exception for "ERRCD_OK" which is not an error.

Example: `journal-get-Response-200-ERRCD_NOTALLOWED.json`

4. 4xx returns may use the same filename format as the 2xx codes, but they may also use a common, single file to handle the response body for a given 4xx error.

Example: `error_400_Response_ERRCD_NOTALLOWED.json`.

5. Examples that are NOT referenced from the API must follow the file naming rules above, but begin with "alt-".

Example: `alt-journal-post-Request.json`

6. Example files MUST appear in the “examples” subdirectory of the project, but they may appear in subdirectories of the “examples” subdirectory.

Example: `journals/journal-post-Request.json`

4.2.3 JSON Schema Documents

Domain objects should be defined in external documents referenced from the ADF. Such external definitions allow reuse of those definitions. External definitions should be OAS3.0 files, encoded in YAML, with the external definitions being in the ‘#/components/schemas’ section.

Please see the OAS 3.0 example documents.

4.2.4 Threat Model

See the “OpenRetailing API Implementation Guide: Security” document for details on the threat model.

4.2.5 Implementation Guide

Each API should have an implementation guide to help those who want to create a service using the API.

4.2.6 Client Guide

Often, a developer will need to access an API without needing to know all about the implementation. The Client Guide should provide details on how to stand up a consuming application quickly, calling out common error conditions and how to handle them.

4.3 Standard Directory Layout for APIs

API projects should conform to the following directory layout. Each entry with “<api collection name>” should be in its own GitLab project. “api-data-dictionary” will also be in its own GitLab project.

Home GitLab Directory

```
|
| -+ api-data-dictionary (repository clone)
| +- schemas (for all *DataType.yaml, *Object.yaml,
*Element.yaml)
| +- traits (paging and order parameters .yaml)
| +- utilities
|
| -+ <api group name> (repository clone)
| +- README.md file
| +-+ api
| | +- <api definition file> (may be more than one)
| | +- dependencies.txt
| |
| | +-+ schemas
| | | +- *.yaml
| | | +- dataTypes.yaml
| | | +- objects.yaml
| | | +- elements.yaml
| | | +- events.yaml
| | | +- requests.yaml
| | | +- responses.yaml
| |
| | +-+ examples
| | | +- <example files>
| |
| | +-+ unit-tests
| | | +- common-schemas
| | | +- common-scripts
| | | +-+ tests
| | | | +- testcase-1
| | | | +- testcase-2
| | | | ...
| +- bundles
| +- docs
|
| -+ <api group name> (repository clone)
| ...
|
...

```

4.4 Use of the “dependencies.txt” file

Each API project will have a “dependencies.txt” file. Each line of the file should be of the form “<project-name>/<label>/<branch>”, where one of “label” or “branch” must be populated, e.g.:

- `api-data-dictionary/v1.0`
- `api-data-dictionary/v33/21-dev`
- `api-data-dictionary//2-dev`

Any of these examples is valid. No project name would ever be used more than once.

5 Open Issues

None

6 Appendices

A. References

A.1 Normative References

Open Retailing API Implementation Guide - Transport Alternatives:

<https://www.conexus.org> OR <https://www.ifsf.org>

Open Retailing API Implementation Guide - Security:

<https://www.conexus.org> OR <https://www.ifsf.org>

Open Retailing Design Rules for JSON:

<https://www.conexus.org> OR <https://www.ifsf.org>

IETF RFC 3986 URI: Generic Syntax:

<https://www.ietf.org/rfc/rfc3986.txt>

IETF RFC 5988 Web Linking:

<https://www.ietf.org/rfc/rfc5988.txt>

IETF RFC 6648 Deprecating the "X-" Prefix and Similar Constructs in Application Protocols

<https://tools.ietf.org/rfc/rfc6648.txt>

IETF RFC 6874 Representing IPv6 Zone Identifiers in Address Literals and URIs:

<https://www.ietf.org/rfc/rfc6874.txt>

IETF RFC 7320 URI Design and Ownership:

<https://www.ietf.org/rfc/rfc7230.txt>

JSON-Schema Version 0.7

<https://json-schema.org/specification-links.html#draft-7>

Open API Specification Version 3.0.1

<https://github.com/OAI/OpenAPI-Specification/blob/master/versions/3.0.1.md>

Semantic Versioning 2.0.0: <https://semver.org>

A.2 Non-Normative References

- Best Practices in API Design Blog Site, Keshav Vasudevan
<https://swagger.io/blog/api-design/api-design-best-practices/>

- OpenAPI (Swagger) Tutorial, Arnaud Lauret
<https://apihandyman.io/writing-openapi-swagger-specification-tutorial-part-1-introduction/>
- API Stylebook
<http://apistylebook.com/design/topics/api-counts>
- YAML Resources
<https://yaml.org/>
- JSON Resources
<http://www.json.org/>
<http://www.json-schema.org/>
<http://www.jsonapi.org/>
- Google JSON Style Guide
<https://google.github.io/styleguide/jsoncstyleguide.xml>
- Design Beautiful REST + JSON APIs
<https://www.youtube.com/watch?v=hdSrT4yjS1g>
<http://www.slideshare.net/stormpath/rest-jsonapis>

B. Glossary

Term	Definition
API	Application Programming Interface. An API is a set of routines, protocols, and tools for building software applications
Domain Objects	Structures exchanged in the messaging format when performing operations on a resource. For current APIs, these structures will be exchanged in JSON format.
HTTP Method	The basic HTTP methods: GET, POST, PUT, PATCH, and DELETE. These methods operate on a resource, and result in a response message.
HTTP Response Codes	Part of the HTTP response that indicates how well the method worked. Success is indicated by codes in the 200 range, errors in the 400 or 500 range. Other response codes are possible but are out of scope for this guide.
IFSF	International Forecourt Standards Forum
Internet	The name given to the interconnection of many isolated networks into a virtual single network.

Term	Definition
IETF	The Internet Engineering Task Force
JSON	JavaScript Object Notation ; is an open standard format that uses human-readable text to transmit data objects consisting of properties (name-value pairs), objects (sets of properties, other objects, and arrays), and arrays (ordered collections of data, or objects). JSON is in a format which is both human-readable and machine-readable.
OAS	OAS (OpenAPI Specification) is a specification for machine-readable interface files for describing, producing, consuming, and visualizing RESTful web services. The current version of OAS (as of the date of this document) is 3.0.
OpenRetailing	Open Retailing means both Service (Gas) Station and Convenience Store.
Port	A logical address of a service/protocol that is available on a particular device.
Resource	An entity, either physical or digitally represented, normally referenced by a Uniform Resource Identifier (URI), or its more common subset, Uniform Resource Locator (URL)
REST	REpresentational State Transfer) is an architectural style, and an approach to communications that is often used in the development of Web Services.
Service	A process that accepts connections from other processes, typically called client processes, either on the same device or a remote device.
URI	Uniform Resource Identifier
URL	Uniform Resource Locator

C. Advantages and Disadvantages of using RESTful APIs

Some of the advantages of using REST include:

- Every resource and interconnection of resources is uniquely identified and addressable with a URI [consistency advantage]
- Only three HTTP commands are used by Conexus/IFSF standards (HTTP GET, POST, DELETE) [standards compliance advantage]
- Data is not passed, but rather a link to the data (as well as metadata about the referenced data) is sent, which minimizes the load on the network and allows the

data repository to enforce and maintain access control [capacity/efficiency advantage]

- Can be implemented quickly [time to market advantage]
- Short learning curve to implement; already understood as it is the way the World Wide Web works now [time to market advantage]
- Intermediaries (e.g., proxy servers, firewalls) can be inserted between clients and resources [capacity advantage]
- Statelessness simplifies implementation – no need to synchronize state [time to market advantage]
- Facilitates integration (mashups) of RESTful services [time to market advantage]
- Can utilize the client to do more work (the client being an untapped resource)

Some of the disadvantages of REST include:

- Servers and clients implementing/using REST are vulnerable to the same threats as any HTTP/Web application
- If the HTTP commands are used improperly or the problem is not well broken out into a RESTful implementation, things can quickly resort to the use of Remote Procedure Call (RPC) methods and thus have a nonRESTful solution
- REST servers are designed for scalability and will quickly disconnect idle clients. Long running requests must be handled via callbacks or job queues.
- Porting an Unsolicited Messages mechanism to REST is not trivial. The client must have a reachable HTTP(S) server and a subscription mechanism is necessary.

D. Criteria for RESTful APIs

In order to design the IFSF/Conexus RESTful API, the following principles are applied:

- Short (as possible). This makes them easy to write down, spell, or remember.
- Hackable ‘up the tree’. The consumer should be able to remove the leaf path and get an expected page back. e.g. <http://mycentralremc.com/sites/12345> you could remove the 12345 site ID identifier and expect to get back all the site list.
- Meaningful. Describes the resource.
- Predictable. Human-guessable. If your URLs are meaningful, they may also be predictable. If your users understand them and can predict what a URL for a given resource is then may be able to go ‘straight there’ without having to find a hyperlink on a page. If your URIs are predictable, then your developers will argue less over what should be used for new resource types.
- Readable.
- Nouns, not verbs. A resource is a noun, modified using the HTTP verbs
- Query args (everything after the ?) are used on querying/searching resources (exclusively). They contain data that affects the query.
- Consistent. If you use extensions, do not use .html in one location and .htm in another. Consistent patterns make URIs more predictable.

- Stateless. Refers to the state of the protocol, not necessarily of the server.
- Return a representation (e.g. XML or JSON) based on the request headers. For the scope of IFSF/Conexus REST implementation, only JSON representations will be supported.
- Tied to a resource. Permanent. The URI will continue to work while the resource exists, and despite the resource potentially changing over time.
- Report canonical URIs. If you have two different URIs for the same resource, ensure you put the canonical URL in the response.
- Follows the digging-deeper-path-and-backspace convention. URI path can be used like a backspace.
- Uses name1=value1;name2=value2 (aka matrix parameters) when filtering collections of resources.
- Use a plural path for collections. e.g. /sites.
- Put individual resources under the plural collection path. e.g. /sites/123456. Although some may disagree and argue it be something like /123456, the individual resource fits nicely under the collection. It also allows to ‘hack the url’ up a level and remove the siteID part and be left on the /sites page listing all (or some) of the sites.
- The definitions of the URIs will follow the IETF RFC 3986 that define an URI as a hierarchical form.

E. Safety and Idempotence

A few key concepts to understand before implementing HTTP methods include the concepts of safety and idempotence.

A safe method is one that is not expected to cause side effects. An example of a side effect would be a user conducting a search and altering the data by the mere fact that they conducted a search (e.g., if a user searches on “blue car” the data does not increment the number of blue cars or update the user’s data to indicate his favorite colour is blue). The search should have no ‘effect’ on the underlying data. Side effects are still possible, but they are not done at the request of the client and they should not cause harm. A method that follows these guidelines is considered ‘safe.’

Idempotence is a more complex concept. An operation on a resource is idempotent if making one request is the same as making a series of identical requests. The second and subsequent requests leave the resource state in exactly the same state as the first request did. GET, PUT, DELETE and HEAD are methods that are naturally idempotent (e.g. when you delete a file, if you delete it again it is still deleted).

HTTP Method	Idempotent	Safe
OPTIONS*	Yes	Yes

GET	Yes	Yes
HEAD*	Yes	Yes
PUT*	Yes	No
POST	No	No
DELETE	Yes	No
PATCH*	No	No

* Not recommended for use in IFSF/Conexxus APIs.

F. OAS 3.0 Notes

The Application Definition File should conform to the tenets described in this Design Guidelines document. Properties in that file are referenced using JSON Pointer notation (RFC6901). For example, “#/info/termsOfService” refers to the “termsOfService” property under the global property “info”.

1. #/info/title, #/info/version, and #/info/description should all be filled out by the committee.
2. #/info/termsOfService, #/info/contact/ and #/info/license will all be filled out with “boilerplate” from Conexxus.
3. #/servers/[0] – the first entry for a server should be the one the committee would like to show up in generic Swagger UI. Tools are variable in their ability to show subsequent server entries. Please refer to details in section 4.1.1.7 OAS “servers:” Specification for how this is specified.
4. #/tags – these should name the basic functional areas of the API. Various methods on a single “path” may, for instance, have differing tags for GET and POST, depending on what they do.
5. #/paths/softwareComponents – an entry conforming to the FDC submission should be present in every API for consistency. Please see “FDC.yaml”.
6. #/paths/connection – an entry conforming to the FDC submission should be present in every API for consistency. Please see “FDC.yaml”.
7. Return codes should be indicated without quotes around the number, e.g., #/paths/connection/post/responses/200.

G. Object, Data Types and Elements (Walk-Through)

To illustrate Elements, Objects, and Data Types, and apply those to concepts defined in OAS3.0 YAML, we will walk through a hypothetical example.

YAML allows for the concept of a reference. A reference is much like a "C" include or "Python" import. It allows for object definitions to be created in one file and reused in other files containing other objects (Composition). One crucial difference when YAML is compared to other programming languages is that "\$ref:" (Reference), will import the data elements of the object but not the object itself. For example:

```
components:
  schemas:
    myObject:
      type: object
      properties:
        myField1:
          type: string
        myField2:
          type: string
```

Represents a JSON object:

```
"myObject": {
  "myField1": "Data1",
  "myField2": "Data2"
}
```

However, when that object is referenced, such as the example below, the top name myObject is dropped.

```
components:
  schemas:
    SecondObject:
      "$ref":#/components/schemas/myObject
```

Represents the JSON object below with fields myField1 and myField2. The name "myObject" is dropped because, YAML "\$ref" works like programming languages "Mixin":

```
"SecondObject": {
  "myField1": "Data1",
  "myField2": "Data2"
}
```

Now, for the concept of Elements, Objects, and Data Types.

DataTypes are basic types, much like the XML SimpleType. It defines restrictions to a string or numeric value. An excellent example of a candidate for a Data Type is a date and time format. JSON does not have support for date and time fields natively; we accomplish that by applying a "regular expression" pattern to it, below is an example from the data-dictionary.

```
components:
  schemas:
    dateTimeType:
      type: string
      minLength: 10
      maxLength: 25
      pattern: >-
        ^[0-9]{4,4}\-[0-9]{2,2}\-[0-9]{2,2}T[0-9]{2,2}:[0-9]{2,2}:[0-9]{2,2}(Z|[0-9]{2,2}:[0-9]{2,2}){0,1}$
```

As you can see above, the JSON type is a string but, we have restricted that string to a specific format, notably YYYY-MM-DDHH:MM:SSZ.

Objects are like XML ComplexTypes. They define a basic structure with multiple elements. They can also define repetition in the form of arrays. Once again, we will refer to the data dictionary and "borrow" the object quantity:

```
components:
  schemas:
    quantityObject:
      type: object
      properties:
        value:
          $ref:
            'decimal12BaseType.yaml#/components/schemas/decimal12BaseType'
          description: Quantity in units with an optional UOM
          designation.
          uom:
            $ref:
              'quantityUOMEENUMType.yaml#/components/schemas/quantityUOMEENUMType'
          description: Quantity in units with an optional UOM
          designation.
          required:
            - value
```

The quantity object contains a unit of measure field "uom" and a "value" field. Both combined define a quantity.

The Data Types and the Objects so far are equivalent to XML simple types and complex types. Elements require a little more explanation. To demonstrate the Element concept, let's say that a standard needs an expiration date field. We would like every standard using an "expiration date" to name it "expirationDate". How can one guarantee that "expiration date" is not named "expDate" or "expireDate" and still make sure the proper dateTimeType data type "regular expression" is used? That is when Elements can be used. You could create an element as defined below:

```
components:
```

```
  schemas:
    expirationDateElement:
      type: object
      properties:
        expirationDate:
          $ref: "dateTimeType.yaml#/components/schemas/dateTimeType"
```

When the element expirationDateElement is "imported/referenced", users would have expirationDate defined. The same would be true if a "startingDate" field is required.

The concepts can be applied to the quantityObject as well. Some standards will require a minQuantity, maxQuantity. Elements address that need and can help keeping the standards consistent.

H. Server Sent Events: example data

```
components:
  schemas:
    # this field is intentionally duplicated in the "data:" of
    # the event itself, replicating the "id:" field.
    eventIDType:
      type: string
      maxLength: 20

    # the strings in this enumeration are what will appear in
    # the SSE "event:" field.
    # they are intentionally duplicated in the "data:" of the
    # event itself to provide "discriminator" functionality
    # (put example)
    carwashEventENUMType:
      type: string
      maxLength: 40
      enum:
        - carwashStateChange
        - carwashAlarm

    # "EventObject" indicates an object designed specifically
    # for SSE.
    # the EventObject defined here is a combination of the two
    # allowed events.
    # the discriminatory property name allows the receiving
    # application to choose how to process the event.
    carwashEventObject:
      description: |
        This is the schema for the `Server Sent Events`
        that will be pushed when connecting to the URL indicated
        by the corresponding event `GET` request
      oneOf:
        - $ref: '#/components/schemas/carwashStateChangeEventObject'
        - $ref: '#/components/schemas/carwashAlarmEventObject'
      discriminator:
        propertyName: event

    carwashStateChangeEventObject:
      description: |
        Message sent when the carwash changes its state
      type: object
      properties:
        # these three fields are intentionally duplicated
        # definitions of the SSE definition
        eventID:
          $ref: '#/components/schemas/eventIDType'
          description: id of the event
        event:
          $ref: '#/components/schemas/carwashEventENUMType'
```



```

        description: carwashStateChange
        # the following definitions are specific to this
        # particular kind of event
        timestamp:
            $ref: '../..//api-data-
dictionary/schemas/dateTimeType.yaml#/components/schemas/dateTimeType'
        deviceID:
            $ref: '../..//api-data-
dictionary/schemas/id16BaseType.yaml#/components/schemas/id16BaseType'
        state:
            $ref:
'../schemas/carwashStateEENUMType.yaml#/components/schemas/carwashStat
eEENUMType'
        required:
            - event

carwashAlarmEventObject:
    description: |
        Message sent when the carwash has an alarm
    type: object
    properties:
        # these three fields are intentionally duplicated
        # definitions of the SSE definition
        eventID:
            $ref: '#/components/schemas/eventIDType'
            description: id of the event
        event:
            $ref: '#/components/schemas/carwashEventENUMType'
            description: carwashAlarm
        # the following definitions are specific to this
        # particular kind of event
        timestamp:
            $ref: '../..//api-data-
dictionary/schemas/dateTimeType.yaml#/components/schemas/dateTimeType'
        deviceID:
            $ref: '../..//api-data-
dictionary/schemas/id16BaseType.yaml#/components/schemas/id16BaseType'
        alarmMsg:
            $ref: '../..//api-data-
dictionary/schemas/alarmMsgObject.yaml#/components/schemas/alarmMsgObj
ect'
        required:
            - event

```