TM Forum Specification

REST API Design Guidelines Part 3

Guidelines for extending TMF Open API’s with hypermedia support

TMF630
Team Approved Date: 08-May-2020

<table>
<thead>
<tr>
<th>Release Status: Production</th>
<th>Status: TM Forum Approved</th>
</tr>
</thead>
<tbody>
<tr>
<td>Version 4.0.1</td>
<td>IPR Mode: RAND</td>
</tr>
</tbody>
</table>
Notice

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Executive Summary

This document, “REST API Design Guidelines Part 3” provides information for the development of hypermedia extensions to TM Forum APIs without payload modification. It also includes guidelines on how JSON-LD support may also be added to the existing TMF Open API without payload modifications.

JSON-LD support in TMF Open API’s is optional.

An API can support hypermedia extension and can also be JSON-LD enabled.
1. **Hypermedia API and API State machine**

The term Hypermedia API explicitly states that an API follows the principle of Hypermedia As The Engine of Application State (HATEOS) which is a required criteria of being RESTful.

A hypermedia aka web API shall express that an API is naturally following the REST architectural style and hence the web architecture in all aspects. A good summary reflecting on the important role HATEOS is playing for RESTful APIs and an explanation of a RESTful API maturity model, can be found [here](#).

Hypermedia is a way for the server to tell the client what HTTP requests the client might want to make in the future. It is a menu, provided by the server, from which the client is free to choose. The server knows what happens, but the client decides what actually happens. The World Wide Web works like this.

Due to the nature of HATEOAS, a web API (and also every web application) can be modelled as a state machine or a workflow.

It describes all states by nodes and the state transitions by vertices from one node to another.

The states usually correspond to a resource, the transitions usually correspond to hypermedia controls, i.e. links that are provided by a resource representation in order to reach another state.

An example is given below:

![Figure 1. Trouble Ticket API - State Machine](#)
2. Hypermedia Representation Design

Much like web’s HTML-based hyperlinks, Web API’s response message’s body includes links and actions that are available for a given resource, in a given state.

Included along with other fields of a resource representation, links convey the relationships between resources and offer clients a menu of resource-related actions, which are context-sensitive.

A Web API MUST offer clients a consistent way to easily discover the available links within a representation.

2.1 Media Type

The TMF Open API design currently makes use of JSON representations only. The media type is plain JSON ("application/json").

TMF Open API’s offers support for hypermedia links as an extension so without breaking existing clients that rely on the application/json media type.

At the moment the presence of hypermedia extension in the API is not negotiated between client and server based on media type.

The TMF does not use a special media type for hypermedia.

It is assumed that an application supporting hypermedia extension will use the extended representation when the application context is application/json.

2.2 Home Document

Serves links to relevant top-level resources of the API.

Can provide some relevant properties on top.

A home document can

• Evolve like all the other parts of a hypermedia API. The API provider can introduce new link-relation types “on – the fly”. Clients need to be able to cope with getting new link relation types in the home-document. By that we mean that they should keep providing the established functionality and they must not crash – obviously they don’t need to make use of the additional functionality

• Vary depending in which context it is retrieved. Typically, the available functionality is depending on:
  • Which API Consumer has been requesting the home document
  • On which user’s behalf is the home document retrieved

In order to be able to do so, the authentication/authorization scheme needs to be aware of all two.

The Home URI can be thought of in the same light as a web site home page.

If the API supports hypermedia extension then the HOME URI MUST be supported by the implementation.
A HOME URI only supports an HTTP GET verb.
A HOME URI MUST return a JSON list of linked resource collections as a minimum.
Every TMF Hypermedia Open API MUST have a home document.

An example of **Home resource** for Trouble Ticket API can be seen below:

```json
{
  "_links": {
    "self": {
      "href": "/troubleTicketManagement/v2/home"
    },
    "list-ticket": {
      "href": "/troubleTicketManagement/v2/troubleTicket"
    },
    "retrieve-ticket": {
      "hrefTemplate": "/troubleTicketManagement/v2/troubleTicket/{id}"
    },
    "create-ticket": {
      "title": "Create Ticket",
      "href": "/troubleTicketManagement/v2/troubleTicket"
    }
  }
}
```

```json
"hrefVars": {
  "id": "/troubleTicketManagement/v2/schema/troubleTicket.json"
}
```

```json
"method": "POST",
"accepts": "application/json",
"schemaType": "json-schema",
```
"schemaUrl": "
/troubleTicketManagement/v2/schema/troubleTicket.json"
}

"create-hub": {
  "href": "/troubleTicketManagement/v2/hub",
  "method": "POST"
}

"get-hub": {
  "hrefTemplate": "/troubleTicketManagement/v2/hub{id}",
  "hrefVars": {
    "href": "/troubleTicketManagement/v2/schema/troubleTicket.json"
  },
  "method": "GET"
}

"delete-hub": {
  "hrefTemplate": "/troubleTicketManagement/v2/hub{id}",
  "hrefVars": {
    "href": "/troubleTicketManagement/v2/schema/param/id"
  },
  "method": "DELETE"
}

"publish-event": {
  "href": "/troubleTicketManagement/v2/listener",
  "method": "POST"
}
}
### 2.3 Linking

A Web API response message body MUST includes links and information about the meaning of the links to allow REST clients to traverse the links to access resources related to the actual resource and perform actions on them.

Links MUST be included, along with fields, within resource state representation.

The link is a JSON object with the name of the object indicating the relationship type, "rel" attribute.

The links MUST be URI's.

Links are represented in TMF Open APIs as JSON objects contained within a _links hash that MUST be a direct property of a resource object and have the following structure:

<table>
<thead>
<tr>
<th>Name</th>
<th>Attribute name</th>
<th>Mandatory?</th>
<th>Description</th>
<th>Type</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Title</td>
<td>title</td>
<td>No</td>
<td>Its value is a string and is intended for labelling the link with a human-readable identifier</td>
<td>String</td>
<td></td>
</tr>
<tr>
<td>Name</td>
<td>name</td>
<td>No</td>
<td>Its value MAY be used as a secondary key for selecting Link Object which share the same relation type.</td>
<td>String</td>
<td></td>
</tr>
<tr>
<td>URI</td>
<td>href</td>
<td>Conditional</td>
<td>URI</td>
<td>String</td>
<td>Either &quot;href&quot; or &quot;hrefTemplate&quot; to be present</td>
</tr>
<tr>
<td>URI Template</td>
<td>hrefTemplate</td>
<td>Conditional</td>
<td>Template URI. Parameters are to be present in flower brackets {}</td>
<td>String</td>
<td>Either &quot;href&quot; or &quot;hrefTemplate&quot; to be present: &quot;hrefTemplate&quot;: &quot;/widgets/(widget_id)&quot;</td>
</tr>
<tr>
<td>Name</td>
<td>Attribute name</td>
<td>Mandatory?</td>
<td>Description</td>
<td>Type</td>
<td>Remarks</td>
</tr>
<tr>
<td>---------------</td>
<td>----------------</td>
<td>------------</td>
<td>-----------------------------------------------------------------------------</td>
<td>---------</td>
<td>---------</td>
</tr>
<tr>
<td>URI Variables</td>
<td>hrefVar</td>
<td>Conditional</td>
<td>Variables to be populated in the hrefTemplate</td>
<td>Object</td>
<td>If &quot;hrefTemplate&quot; is present, &quot;hrefVar&quot; should also be present.</td>
</tr>
<tr>
<td>URL Variable</td>
<td>&lt;Parameter Name&gt; used in the hrefTemplate</td>
<td>Conditional</td>
<td>Reference to the definition of the variable / parameter</td>
<td>String</td>
<td>Example</td>
</tr>
</tbody>
</table>
|               |                |            | "hrefTemplate": "/widgets/{widget_id}",
|               |                |            | "hrefVars": {
|               |                |            | "widget_id": "https://example.org/param/widget"
<p>|               |                |            | }                                   |         |         |
| HTTP Method   | method         | No         | HTTP method. Enumerated values GET, POST, PATCH, PUT, DELETE                | Enum    | Default: GET |
| Format accepted | accepts     | No         | Content type format accepted by the URL                                    | String  |         |
| Fields        |                | No         |                                                                               | Array   |         |
| Field name    | name           | Yes        |                                                                               | String  |         |
| Field value   | value          | No         |                                                                               |         |         |
| Field type    | type           | No         |                                                                               |         |         |</p>
<table>
<thead>
<tr>
<th>Name</th>
<th>Attribute name</th>
<th>Mandatory?</th>
<th>Description</th>
<th>Type</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Request Schema type</td>
<td>schemaType</td>
<td>No</td>
<td>Enumerated values &quot;json-schema&quot;, &quot;xsd&quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Request schema URL</td>
<td>schemaUrl</td>
<td>No</td>
<td>URL of a schema describing the expected payload for e.g. POST links. Can be used instead of the fields for a more complex structure.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

A *self* link MUST be included in response message body representation.

A *home* link MAY be included in response message body representation.

An example is given below GET /troubleTicket/42:

```json
{
    "_links": { 
        "self": { 
            "href": "/troubleTicketManagement/v2/troubleTicket/42"
        },
        "home": { 
            "href": "/troubleTicketManagement/v2/home"
        }
    }
}
```
The `self` link for the collection resource SHOULD be exposed as Web Linking HTTP header. Other special links MAY be included such as pagination links. An example is given below:

```json
[Response]

Content-Type: application/json

X-Total-Count :50

Link: <https://host:port/troubleTicketManagement/v2/troubleTicket?count=20&limit=10>; rel="self",
<https://host:port/troubleTicketManagement/v2/troubleTicket>; rel="home",
<https://host:port/troubleTicketManagement/v2/troubleTicket?count=0&count=10>; rel="first",
<https://host:port/troubleTicketManagement/v2/troubleTicket?count=30&limit=10>; rel="next",
<https://host:port/troubleTicketManagement/v2/troubleTicket?count=10&limit=10>; rel="prev",
<https://host:port/troubleTicketManagement/v2/troubleTicket?count=40&limit=10>; rel="last"

[

"_links": {

"self": {

"href": "/troubleTicketManagement/v2/troubleTicket/6275"

}

"home": {

"href": "/troubleTicketManagement/v2/home"

}

}

]
When retrieving the items within a collection resource, `self` link MUST be included for each item. Other special links MAY be included but it is recommended that other links to be retrieved by the client by going to the `self` link for each item within a collection.

A resource MAY have multiple links that share the same link relation. This can be represented using an array of links. In this case the attribute name can be used as a secondary key.

An example is given below:

```
{
    "_links": {
        "self": {
            "href": "/troubleTicketManagement/v2/troubleTicket/6275"
        },
        "home": {
            "href": "/troubleTicketManagement/v2/home"
        },
        "related-party": [{
```
Here is a full example for Trouble Ticket with all possible links as per the API state machine defined in chapter 1:

```json
{
    "id": "2",
    "type": "Invoice dispute",
    "severity": "low",
    "description": "Invoice number 42 is wrong",
    "status": "Submitted",
    "statusChangeReason": "Initial submission",
    "note": [
        {
            "author": "Dirk Rejahl",
            "text": "Customer called CC"
        }
    ]
}
```
"_links": {
  "self": {
    "href": "/troubleTicketManagement/v1/troubleTicket/2"
  },
  "acknowledge": {
    "title": "Acknowledge Ticket",
    "href": "/troubleTicketManagement/v1/troubleTicket/2",
    "method": "PATCH",
    "accepts": "application/json",
    "fields": [
      {
        "name": "status",
        "value": "Acknowledged"
      },
      {
        "name": "statusChangeReason",
        "type": "string"
      }
    ]
  },
  "reject": {
    "title": "Reject Ticket",
    "href": "/troubleTicketManagement/v1/troubleTicket/2",
  }
}
2.4 Link Relation Types

Links relations tell clients the meaning of the link allowing REST clients to interact with links.

The IANA provides a registry (http://www.iana.org/assignments/link-relations/link-relations.xhtml) for common link relations.

The table below holds the list of special relationship types supported by the links "rel" property. These are also registered as per the Web Linking standard [RFC5988].

<p>| &quot;self&quot;   | A link referencing the resource itself. |</p>
<table>
<thead>
<tr>
<th>“related”</th>
<th>A link referencing another resource.</th>
</tr>
</thead>
</table>
| “up”               | A link referencing the parent of this resource.  
Note, there is no “down” relation defined in the Registry Contents. |
| “first”            | A link to the farthest preceding resource in a series of resources. In the context of the pagination this refers to the first page. |
| “last”             | A link to the remotest following resource in a series of resources. In the context of the pagination this refers to the last page. |
| “next”             | A link to the next resource in an ordered series of resources. In the context of the pagination this is the next page. |
| “previous”         | A link to the previous resource in an ordered series of resources. In the context of the pagination this is the previous page. |

In addition the TMF Open API defines the following extensions:

| Role Specific | An undefined list of relationships, to be taken from the TMF Open API, that represents the relationship type between the target resource and the source resource.  
e.g For TroubleTicket API we have relationships between a ticket and relatedObject and relatedParty.  
These relationships can be exposed as specific link relation types: related -party, related- object |
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>home</td>
<td>A link to the API home document</td>
</tr>
<tr>
<td>list- {ApiResource}</td>
<td>A link to retrieve all items for API resource collection</td>
</tr>
<tr>
<td>retrieve- {ApiResource}</td>
<td>A link to retrieve a single API resource representation</td>
</tr>
<tr>
<td>create- {ApiResource}</td>
<td>A link pointing to where an existing API resource representation can be created.</td>
</tr>
<tr>
<td>URL Pattern</td>
<td>Description</td>
</tr>
<tr>
<td>---------------------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>update-{APIResource}</td>
<td>A link pointing to how an existing API resource representation can be updated.</td>
</tr>
<tr>
<td>delete {APIResource}</td>
<td>A link pointing to how an existing API resource representation can be deleted.</td>
</tr>
</tbody>
</table>

### 2.5 Resource Addressing

All the resources MUST be identified by URIs, thus the URL that was used to request the resource is considered its identifier.

In addition to that the identifier can be represented as a Web Linking HTTP header or as a link object – both with the relation type self.

All the resources MUST contain the self link.
3. Linked Data

To make the API machine readable, the context of the data passed in the API needs to be communicated to the API client.

This can be done by passing the JSON-LD context to the consumer of the API. The JSON-LD context SHOULD be passed in the Link HTTP Response header.

An example is given below:

HTTP Response Header

<table>
<thead>
<tr>
<th>JSON-LD Context Header</th>
</tr>
</thead>
<tbody>
<tr>
<td>Link: <a href="https://host:port/troubleTicketManagement/v2/tt_context">https://host:port/troubleTicketManagement/v2/tt_context</a>; rel=&quot;<a href="http://www.w3.org/ns/json-ld#context">http://www.w3.org/ns/json-ld#context</a>&quot;;</td>
</tr>
</tbody>
</table>

HTTP Response Body

<table>
<thead>
<tr>
<th>JSON-LD Context – Response Body</th>
</tr>
</thead>
<tbody>
<tr>
<td>{</td>
</tr>
<tr>
<td>&quot;id&quot;: &quot;1&quot;,</td>
</tr>
</tbody>
</table>
|   "href": "/troubleTicketManagement/v2/troubleTicket/1",
|   "correlationId": "TT53482",
|   "description": "Customer complaint over last invoice.",
|   "severity": "Urgent",
|   "@type": "troubleTicket",
|   "_links": {                   |
|     "self": {                  |
|       "href": "/troubleTicketManagement/v2/troubleTicket/1" |
|   }                           |
|}                               |
A sample context for Trouble Ticket API is defined below:

**JSON-LD Trouble Ticket Context**

```json
{
    "@context": {
        "troubleTicket": "http://tmf.schema.org/TroubleTicket",
        "id": "http://tmf.schema.org/id",
        "correlationId": "http://tmf.schema.org/correlationId",
        "description": "http://tmf.schema.org/description",
        "severity": "http://tmf.schema.org/severity",
        "creationDate": "http://tmf.schema.org/creationDate"
    }
}
```
"targetResolutionDate": "http://tmf.schema.org/targetResolutionDate",
"status": "http://tmf.schema.org/status",
"substatus": "http://tmf.schema.org/substatus",
"statusChangeReason": "http://tmf.schema.org/statusChangeReason",
"statusChangeDate": "http://tmf.schema.org/statusChangeDate",
"resolutionDate": "http://tmf.schema.org/resolutionDate",
"relatedParty": "http://tmf.schema.org/RelatedParty",
"href": {
    "@id": "http://tmf.schema.org/RelatedParty#href",
    "@type": "@id"
  },
"role": "http://tmf.schema.org/RelatedParty#role",
"relatedObject": "http://tmf.schema.org/RelatedObject",
"involvement": "http://tmf.schema.org/RelatedObject#involvement",
"reference": {
    "@id": "http://tmf.schema.org/RelatedObject#reference",
    "@type": "@id"
  },
"note": "http://tmf.schema.org/Note",
"date": "http://tmf.schema.org/Note#date",
"author": "http://tmf.schema.org/Note#author",
"text": "http://tmf.schema.org/Note#text",
"_links": "http://tmf.schema.org/links",
"self": "http://tmf.schema.org/self",
__ "@schemaLocation": "http://tmf.schema.org/schemaLocation",
"@baseType": "http://tmf.schema.org/baseType"
}
Note that the context for core TroubleTicket attributes like id, correlationid, description, severity etc. as well as that of keywords like _links, @schemaLocation, @type, @baseType etc. is also defined above. Any extensions to the Trouble Ticket API SHOULD be present in the JSON-LD context.

Also vocabulary for the above context needs to be also defined as a tmf.schema.org definition so that the semantics of the attributes are understood.

TMF.schema.org vocabulary provides a specialized vocabulary for the TMF Open API’s and it is built upon the core Schema.org using the extension mechanism provided.

The following provides an example defining the vocabulary of Trouble Ticket entity:

<table>
<thead>
<tr>
<th>Schema.org Trouble Ticket Vocabulary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample content of the vocabulary is provided below.</td>
</tr>
<tr>
<td>{</td>
</tr>
<tr>
<td>&quot;@context&quot;: {</td>
</tr>
<tr>
<td>&quot;rdf&quot;: &quot;<a href="http://www.w3.org/1999/02/22-rdf-syntax-ns#">http://www.w3.org/1999/02/22-rdf-syntax-ns#</a>&quot;,</td>
</tr>
<tr>
<td>&quot;rdfs&quot;: &quot;<a href="http://www.w3.org/2000/01/rdf-schema#">http://www.w3.org/2000/01/rdf-schema#</a>&quot;,</td>
</tr>
<tr>
<td>&quot;xsd&quot;: &quot;<a href="http://www.w3.org/2001/XMLSchema#">http://www.w3.org/2001/XMLSchema#</a>&quot;</td>
</tr>
<tr>
<td>}</td>
</tr>
<tr>
<td>&quot;@graph&quot;: [</td>
</tr>
<tr>
<td>{</td>
</tr>
<tr>
<td>&quot;@id&quot;: &quot;<a href="http://schema.org/TroubleTicket">http://schema.org/TroubleTicket</a>&quot;</td>
</tr>
<tr>
<td>&quot;@type&quot;: &quot;rdfs:Class&quot;</td>
</tr>
<tr>
<td>&quot;<a href="http://schema.org/isPartOf">http://schema.org/isPartOf</a>&quot;: {</td>
</tr>
<tr>
<td>&quot;@id&quot;: &quot;<a href="http://tmf.schema.org">http://tmf.schema.org</a>&quot;</td>
</tr>
<tr>
<td>}</td>
</tr>
<tr>
<td>&quot;rdfs:comment&quot;: &quot;Trouble Ticket&quot;</td>
</tr>
<tr>
<td>&quot;rdfs:label&quot;: &quot;TroubleTicket&quot;</td>
</tr>
<tr>
<td>&quot;rdfs:subClassOf&quot;: {</td>
</tr>
<tr>
<td>&quot;@id&quot;: &quot;<a href="http://schema.org/Thing">http://schema.org/Thing</a>&quot;</td>
</tr>
<tr>
<td>}</td>
</tr>
</tbody>
</table>
{
  "@id": "http://schema.org/id",
  "@type": "rdf:Property",
  "http://schema.org/domainIncludes": [
    {
      "@id": "http://schema.org/TroubleTicket"
    }
  ],
  "http://schema.org/rangeIncludes": {
    "@id": "http://schema.org/Text"
  },
  "http://schema.org/isPartOf": {
    "@id": "http://tmf.schema.org"
  },
  "rdfs:comment": "Ticket ID for a Trouble Ticket entity",
  "rdfs:label": "id"
},
...
}
Class Trouble Ticket (http://schema.org/TroubleTicket) is defined as a sub class of http://schema.org/Thing and is part of the schema http://tmf.schema.org/.

```json
Class Trouble Ticket

{
   "@id": "http://schema.org/TroubleTicket",
   "@type": "rdfs:Class",
   "http://schema.org/isPartOf": {
      "@id": "http://tmf.schema.org"
   },
   "rdfs:comment": "Trouble Ticket",
   "rdfs:label": "TroubleTicket",
   "rdfs:subClassOf": {
      "@id": "http://schema.org/Thing"
   }
}
```

Also attribute correlation id (http://schema.org/correlationId) is defined as a Property in the class Trouble Ticket.

```json
Attribute Correlation Id

{
   "@id": "http://schema.org/correlationId",
   "@type": "rdf:Property",
   "http://schema.org/domainIncludes": ["http://schema.org/Thing"
```
Similarly enumerated values are also can be defined – Example: Severity - http://schema.org/Severity.

**Enumerated -Severity**

```
{
  "@id": "http://schema.org/Severity",
  "@type": "rdfs:Class",
  "http://schema.org/isPartOf": {
    "@id": "http://tmf.schema.org"
  },
  "rdfs:comment": "Enumerated Severity values.",
  "rdfs:label": "Severity",
  "rdfs:subClassOf": {
    "@id": "http://schema.org/Enumeration"
  }
}
```
Other enum values of Severity
4. Appendix A: Terms and Abbreviations Used within this Document

4.1 Terminology

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
<th>TMF or Outside Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>hypermedia</td>
<td>Hypermedia is data, sent from the server to the client, which explains what client can do next.</td>
<td></td>
</tr>
<tr>
<td>Hypermedia control</td>
<td>A hypermedia controls describes a state transition</td>
<td></td>
</tr>
<tr>
<td>Media type</td>
<td>A media type (also called a content type or MIME type) is a short string identifying the format of the document. Once you know a document’s media type you can parse it. You may also be able to understand of its application semantics</td>
<td></td>
</tr>
</tbody>
</table>
### 5. References

#### 5.1 References

<table>
<thead>
<tr>
<th>Reference</th>
<th>Description</th>
<th>Source</th>
<th>Brief Use Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td>JSON-LD</td>
<td>JSON For Linking Data</td>
<td><a href="http://json-ld.org/">http://json-ld.org/</a></td>
<td>Enrich TMF Open API with application semantics in order to enable machine-readable API's.</td>
</tr>
<tr>
<td></td>
<td>Define context to provide clients with additional application semantics of the data</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SCHEMA.ORG</td>
<td>Provides core, basic vocabulary for describing the kind of entities the most common applications need</td>
<td><a href="http://schema.org/">http://schema.org/</a></td>
<td>Define vocabulary for TMF Open API Data Model built upon core schema.org vocabulary</td>
</tr>
<tr>
<td>Home Documents for HTTP APIs</td>
<td>This document proposes a &quot;home document&quot; format for non-browser HTTP clients.</td>
<td><a href="https://tools.ietf.org/html/draft-nottingham-json-home-02">https://tools.ietf.org/html/draft-nottingham-json-home-02</a></td>
<td>hrefTemplate and hrefVars are aligned with the draft internet standard.</td>
</tr>
<tr>
<td>Richardson Maturity Model</td>
<td></td>
<td><a href="https://martinfowler.com/articles/richardsonMaturityModel.html">https://martinfowler.com/articles/richardsonMaturityModel.html</a></td>
<td></td>
</tr>
</tbody>
</table>
6. Administrative Appendix

This Appendix provides additional background material about the TM Forum and this document. In general, sections may be included or omitted as desired; however, a Document History must always be included.

6.1 Document History

6.1.1 Version History

This section records the changes between this and the previous document version as it is edited by the team concerned. Note: this is an incremental number which does not have to match the release number and used for change control purposes only.

<table>
<thead>
<tr>
<th>Version Number</th>
<th>Date Modified</th>
<th>Modified by:</th>
<th>Description of changes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>25-Aug-2017</td>
<td>Pierre Gauthier</td>
<td>Description e.g. first issue of document</td>
</tr>
<tr>
<td></td>
<td></td>
<td>TM Forum</td>
<td></td>
</tr>
<tr>
<td>2.0.0</td>
<td>08-Nov-2017</td>
<td>Peter Norbury</td>
<td>Update Notice and change document number</td>
</tr>
<tr>
<td>2.0.1</td>
<td>12-Dec-2017</td>
<td>Adrienne Walcott</td>
<td>Formatting/style edits prior to publishing</td>
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<tr>
<td>2.0.2</td>
<td>20-Mar-2018</td>
<td>Adrienne Walcott</td>
<td>Updated to reflect TM Forum Approved Status</td>
</tr>
<tr>
<td>4.0.0</td>
<td>14-May-2020</td>
<td>Alan Pope</td>
<td>Minor edits prior to publication</td>
</tr>
<tr>
<td>4.0.1</td>
<td>20-Jul-2020</td>
<td>Adrienne Walcott</td>
<td>Updated to reflect TM Forum Approved Status</td>
</tr>
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</table>

6.1.2 Release History

This section records the changes between this and the previous Official document release. The release number is the ‘Marketing’ number which this version of the document is first being assigned to.

<table>
<thead>
<tr>
<th>Release Number</th>
<th>Date Modified</th>
<th>Modified by:</th>
<th>Description of changes</th>
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</thead>
<tbody>
<tr>
<td>17.5.0</td>
<td>08-Nov-2017</td>
<td>Peter Norbury</td>
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<td>Adrienne Walcott</td>
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</tr>
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<td>Pre-production</td>
<td>14-May-2020</td>
<td>Alan Pope</td>
<td>Updated to v4.0</td>
</tr>
<tr>
<td>Production</td>
<td>20-Jul-2020</td>
<td>Adrienne Walcott</td>
<td>Updated to reflect TM Forum Approved Status</td>
</tr>
</tbody>
</table>

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6.2 Acknowledgments

This document was prepared by the members of the TM Forum <<team name>> team:

- Pierre Gauthier, TM Forum, Editor and Team Leader
- Nicoleta Stoica, Vodafone, Author
- Dirk Rejahl, Infonova, Contributor
- Sundar Ramakrishnan, Infosys, Contributor
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