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Design rules for REpresentational State Transfer (REST)
Solution Sets (SS)
(3GPP TS 32.158 version 17.9.0 Release 17)**

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1 Scope

The present document defines design rules for REpresentational State Transfer (REST) Solution Sets (SS). These rules are applied when specifying REST Solution Sets.

2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies. In the case of a reference to a 3GPP document (including a GSM document), a non-specific reference implicitly refers to the latest version of that document *in the same Release as the present document*.

- [1] 3GPP TR 21.905: "Vocabulary for 3GPP Specifications".
- [2] IETF RFC 7231: "Hypertext Transfer Protocol (HTTP/1.1): Semantics and Content".
- [3] 3GPP TS 32.300: "Telecommunication management; Configuration Management (CM); Name convention for Managed Objects".
- [4] IETF RFC 3986: "Uniform Resource Identifier (URI): Generic Syntax".
- [5] IETF RFC 7230: "Hypertext Transfer Protocol (HTTP/1.1): Message Syntax and Routing".
- [6] IETF RFC 7159: "The JavaScript Object Notation (JSON) Data Interchange Format".
- [7] draft-bhutton-json-schema-01 (June 2022): "JSON Schema: A Media Type for Describing JSON Documents".

Note: The above document is an individual draft from IETF. It cannot be formally referenced until it is published as an RFC. It is available from the following link:

<https://datatracker.ietf.org/doc/html/draft-bhutton-json-schema-01>.

- [8] draft-bhutton-json-schema-validation-01 (June 2022): "JSON Schema Validation: A Vocabulary for Structural Validation of JSON".

Note: The above document is an individual draft from IETF. It cannot be formally referenced until it is published as an RFC. It is available from the following link:

<https://datatracker.ietf.org/doc/html/draft-bhutton-json-schema-validation-01>.

- [9] draft-handrews-json-schema-hyperschema-02 (September 2019): "JSON Hyper-Schema: A Vocabulary for Hypermedia Annotation of JSON".

Note: The above document is an individual draft from IETF. It cannot be formally referenced until it is published as an RFC. It is available from the following link:

<https://datatracker.ietf.org/doc/html/draft-handrews-json-schema-hyperschema-02>.

- [10] OpenAPI Specification (<https://github.com/OAI/OpenAPI-Specification>)
- [11] IETF RFC 5789: "PATCH Method for HTTP".
- [12] IETF RFC 7396: "JSON Merge Patch".
- [13] IETF RFC 6902: "JavaScript Object Notation (JSON) Patch".
- [14] IETF RFC 6901: "JavaScript Object Notation (JSON) Pointer".
- [15] XML Path Language (XPath) Version 1.0, W3C Recommendation 16 November 1999 (<https://www.w3.org/TR/xpath-10/>)

[16] 3GPP TR 32.160: "Management and orchestration; Management service template".

3 Definitions and abbreviations

3.1 Definitions

For the purposes of the present document, the terms and definitions given in TR 21.905 [1] and the following apply. A term defined in the present document takes precedence over the definition of the same term, if any, in TR 21.905 [1].

3.2 Abbreviations

For the purposes of the present document, the abbreviations given in TR 21.905 [1] and the following apply. An abbreviation defined in the present document takes precedence over the definition of the same abbreviation, if any, in TR 21.905 [1].

| | |
|------|----------------------------------|
| CRUD | Create, Retrieve, Update, Delete |
| DC | Domain Component |
| DN | Distinguished Name |
| DNS | Domain Name Service |
| FQDN | Fully Qualified Domain Name |
| HTTP | Hypertext Transfer Protocol |
| JSON | JavaScript Object Notation |
| LDN | Local Distinguished Name |
| MnS | Management Service |
| REST | REpresentational State Transfer |
| RPC | Remote Procedure Call |
| TCP | Transmission Control Protocol |
| URI | Uniform Resource Identifier |

4 General rules

4.1 Information models and resources

4.1.1 Information models

An information model is a representation of a system. Typical models do not reflect all facets of the system, but only certain aspects required to solve the management problem the model is designed for. 3GPP follows an object-oriented modelling approach. Models are built from managed object classes. Each object class contains information elements called attributes. Relationships between classes represent the logical connections. Models are specified formally with class diagrams produced using the Unified Modelling Language (UML).

The instantiation of a managed object class is called managed object instance, or concisely just managed object or object. All managed object instances together with the relationships between them constitute an object tree. An object tree is also called containment tree.

4.1.2 Resources

HTTP uses a different terminology based on the notion of resources, as defined in clause 2 of RFC 7231 [2]. Each resource is represented by one or more resource representations as defined in clause 3 of RFC 7231 [2]. Valid resource representations are e.g. XML instance documents or JSON instance documents.

Besides this primary resource, RFC 3986 [4], clause 3.5 introduces the concept of secondary resources. Secondary resources are specific portions or subsets of primary resources, that are identifiable.

4.1.3 Resource archetypes

Resources can be classified according to their structure and behaviour into resource archetypes. This helps specifying clear and understandable interfaces. The following three archetypes are defined:

- **Document resource:** This is the standard resource containing data in form of name value pairs and links to related resources. This kind of resource typically represents a real-world object or a logical concept.
- **Collection resource:** A collection resource is grouping resources of the same kind. The resources below the collection resource are called items of the collection. An item of a collection is normally a document resource. Collection resources typically contain links to the items of the collection and information about the collection like the total number of items in the collection. Collection resources can be further distinguished into server-managed and client-managed resources. Collection resources are also known as container resources.
- **Operation resource:** Operation resources represent executable functions. They may have input and output parameters. Operation resources allow some sort of fall back to an RPC style design in case application specific actions cannot be mapped easily to CRUD style operations.

4.1.4 Mapping of information models to resources

RESTful SS shall be specified in a way that managed object instances are described by (primary) document resources. Collection resources have no equivalent in an information model unless some dedicated collection class is introduced.

Attributes are mapped to secondary resources.

4.1.5 Usage of information models

Information models are used for two purposes when specifying interfaces to observe and act upon information models:

- They provide a means to identify information in request messages.
- They provide a format to transfer information in request and response messages.
- They provide constraints on the structure of information on the MnS Producer.
- They provide constraints on the possibilities to update information on the MnS Producer.

Identification of information is necessary when retrieving information from a MnS Producer; the MnS Consumer needs to be able to specify in his retrieval request the information the MnS Producer shall return. But also when information needs to be updated or deleted the MnS Consumer needs to identify the information to be updated or deleted in his request. When information is added, the location of the new information is specified relative to the location of existing information.

Request and response message bodies carrying (some parts of) the information model are also constructed based on the information model supported by the MnS Producer. The message format is either identical to the information model format or identical to some transformation of the information model format.

4.2 Managed object naming and resource identification

4.2.1 Managed object naming

4.2.1.0 Distinguished Name (DN)

The Distinguished Name (DN) is used in 3GPP to uniquely identify a managed object instance within a specific name space. The DN is a comma (",") separated list of Relative Distinguished Names (RDNs). Each managed object instance has an associated RDN. The sequence of RDNs is governed by name containment relationships in the UML class diagram describing the modelled network. The RDN consists of a naming attribute name separated by an equal sign ("=") from the naming attribute value. The naming attribute name is equal to the class name of the MOI.

In addition to the RDNs associated to a managed object instance the DN may have as leftmost RDN whose naming attribute name is "DC" (Domain Component) and whose value is a domain name. A DN with DC is globally unique.

The DN concept is described in detail in TS 32.300 [3]. The following example DN has a DC.

```
DN = "DC=operatorA.com,SubNetwork=south,ManagedElement=a,ENBFunction=1,Cell=1"
```

4.2.1.1 Global and local namespaces

A DN in the global name space is globally unique and starts with the RDN of the global root. A DN in a local name space starts with the RDN of the local root and is unique only within this name space. A DN in a local namespace is also referred to as Local Distinguished Name (LDN). The DN of the local root relative to the global root is called DN prefix. The concatenation of DN prefix and LDN is equal to the globally unique DN of a managed object.

The local root is typically the root of the network resource model representing the managed network.

4.2.2 Resource identification

HTTP uses a subset of the generic Uniform Resource Identifier (URI) scheme (RFC 3986 [4]) defined in RFC 7230 [5] for target resource identification.

```
http-URI = "http:" "://" authority path-abempty [ "?" query ] [ "#" fragment ]
```

The path component is an absolute path (one that starts with a single slash character) or empty.

The origin server is identified by the authority component, which includes a host identifier and an optional TCP port. The hierarchical path component and optional query component serve as an identifier for a potential target resource within that origin server's name space. The optional fragment component allows for indirect identification of a secondary resource. The host identifier is either an IP address or an indirect identifier such as a FQDN to be resolved with DNS.

URIs are used by HTTP for routing and addressing of target resources.

4.2.3 Mapping of DNs to URIs

URIs are globally unique. For this reason only a globally unique DN with DC is mappable into a URI. The mapping rules are as follow:

- The DN prefix is mapped semantically to the authority component of the URI. The syntax of the DN prefix is modified to match the syntax of the authority component.
- The LDN is mapped semantically to the path component of the URI. The syntax of the LDN is modified to match the syntax of the path component.

When mapping a LDN the equal sign "=" shall be used as delineator between the naming attribute name and naming attribute value when constructing a RDN.

```
URI-RDN = {namingAttributeName} "=" {namingAttributeValue}
```

The URI-LDN is the concatenation of URI-RDNs separated by a slash "/".

```
URI-LDN = *( "/" RDN )
```

For example, the LDN

```
LDN = "SubNetwork=south,ManagedElement=a,ENBFunction=1,Cell=1"
maps to
```

```
URI-LDN = "/SubNetwork=south/ManagedElement=a/ENBFunction=1/Cell=1"
```

and the LDN

```
LDN = "ManagedElement=a,ENBFunction=1,Cell=1"
to
```

```
URI-LDN = "/ManagedElement=a/ENBFunction=1/Cell=1"
```

When constructing the authority part from the DN prefix, it shall be reformatted according to the name conventions applying to FQDNs. For example, the DN prefix

DN-prefix = "DC=operatorA.com"

maps to

URI-DN-prefix = "operatorA.com"

and the DN prefix

DN-prefix = "DC=operatorA.com,SubNetwork=south"

to

URI-DN-prefix = "south.subNetwork.operatorA.com"

The complete URIs for the examples are

`http://operatorA.com/SubNetwork=south/ManagedElement=a/ENBFunction=1/Cell=1`

`http://south.subNetwork.operatorA.com/ManagedElement=a/ENBFunction=1/cell=1`

The constructed URI-DN-prefix is a FQDN that can be registered into a name resolution service such as DNS. The sole presence of a constructed FQDN does not mean it can be resolved to an IP address and there is a server listening at that address.

Using the mapping rule, a DN is mapped predictably into the URI authority component and path component.

The character set allowed in DNs is much bigger than the character set allowed in the path component and authority component of a URI. Care needs to be taken when selecting the naming attribute names and values that the mapping from a DN to a URI does not become impossible as a consequence of not mappable characters.

When no registered name can be used, the IP address shall be specified directly in the host component, for example:

`http://168.212.226.204/SubNetwork=south/.../Cell=1`

This might be required in multiple situations. For example, when a DN prefix is used but the corresponding URI-DN-prefix cannot be resolved, the MnS Consumer needs to specify an IP address in the target URI of HTTP request messages. The same is true when no DN prefix is used at all. Another example is when no DN prefix is configured into MnS Producers and the MnS Producer wants to report events, that occurred related to resources, using notifications sent to MnS Consumers. The MnS Producer has no other option than to put its own IP address into the host component of the URI identifying the resource where the event occurred.

4.2.4 Canonical URI

The URI defined in clause 4.2.3 is called canonical URI. It is the main or official URI of a resource. It shall be used whenever the resource as such shall be identified. The URI for sending HTTP requests to a resource may be different as described in clause 4.4. Special kinds of requests may have all their own URI. Therefore, a resource has typically one canonical URI and one or more other URIs. The canonical URI may be looked at as a protocol specific version of the protocol neutral DN.

A canonical URI may or may not yield further information if dereferenced.

An example usage of a canonical URI is in event notifications such as alarm notifications for identifying the resource where the event occurred.

4.3 Message content formats

4.3.1 Media types

The format of HTTP request and response message content is indicated with media types consisting of a type, a subtype and optional parameters, as defined in clause 3.1.1.1 of RFC 7231 [2]. The "Content-Type" header field of a message contains the media type of the message content (clause 3.1.1.5 of RFC 7231 [2]).

If not otherwise stated, the media type of request and response message bodies in the REST SS is

- application/json (RFC 7159 [6]).

Exceptions are when JSON patch documents are contained in request bodies. They are identified with the media types

- application/merge-patch+json (RFC 7396 [12], and clause 6.3.2 of the present document),
- application/json-patch+json (RFC 6902 [13], and clause 6.3.3 of the present document).

Furthermore, this specification defines four new formats. Their media types are

- application/vnd.3gpp.merge-patch+json (clause 6.4.2 of the present document),
- application/vnd.3gpp.json-patch+json (clause 6.4.3 of the present document),
- application/vnd.3gpp.object-tree-hierarchical+json (clause 6.1.4 of the present document),
- application/vnd.3gpp.object-tree-flat+json (clause 6.1.4 of the present document).

JSON documents shall conform to JSON Schema ([7], [8], [9]).

4.3.2 Response content format negotiation

The MnS Consumer shall engage in proactive content negotiation as defined in clause 3.4.1 of RFC 7231 [2] by including the "Accept" request header field in HTTP requests that expect a message body in the response. The "Accept" header field indicates to the MnS Producer the media types acceptable to the MnS Consumer.

If the MnS Producer cannot provide any of the acceptable resource representations, it shall respond either with a "406 Not Acceptable" error code or provide a representation for the resource that is not specified in the "Accept" header field.

4.4 URI structure

4.4.1 Introduction

MnS producers can be divided into two categories. The first category exposes MnS(s) to manipulate resources representing managed object instances. In this case the URI structure is governed by the mapping rules defined in clause 4.2.3. The second category exposes MnS(s) to manipulate resources not representing managed object instances. In this case the DN concept is not relevant. The URI structure for both categories is different.

4.4.2 URI structure for resources representing managed object instances

URIs identifying resources representing managed object instances shall follow, when being used as a target URI in HTTP requests, the structure given by

```
{scheme}:///{URI-DN-prefix}/{root}/{MnSName}/{MnSVersion}/{URI-LDN}
```

with:

| | |
|-----------------|---|
| {scheme} | Scheme component "http" or "https" |
| {URI-DN-prefix} | Authority component (host identifier and optional TCP port), the host name is constructed from the DN prefix as defined in clause 4.2.3. |
| {root} | Part of the path component, allows specifying one or more optional path segments for structuring the resource hierarchy on a HTTP server. The DN or parts thereof shall not be mapped to this path component. |
| {MnSName} | Part of the path component, allows specifying an optional MnS name in a single path segment. |
| {MnSVersion} | Part of the path component, allows specifying an optional MnS version in a single path segment. |

{URI-LDN} Part of the path component, constructed from the LDN as defined in clause 4.2.3, containing zero, one or more path segments.

As seen above, to construct the URI from a DN, it is necessary to map the "DNPrefixPlusRDNSeparator" as defined in clause 7.3 of TS 32.300 [3], the "LocalDN" as defined in clause 7.3 of TS 32.300 [3], and to add the additional optional path segments "{root}/{MnSName}/{MnSVersion}".

To allow for a predictive mapping from an URI to the original DN it is necessary to specify "{MnSName}/{MnSVersion}" in such a way that the beginning of the "LocalDN" can be unambiguously identified.

Note it may be required when specifying a MnS to clearly identify the last RDN of "{URI-LDN}" and to use the following instead of "{URI-LDN}"

```
{URI-LDN-first-part}/{RDN}
```

or

```
{URI-LDN-first-part}/{className}={id}.
```

For the sake of brevity, "MnSRoot" is introduced that includes the "{scheme}" part, the colon (":"), the two slash characters ("/"), the "{authority}" part, a single slash character ("/") and the "{root}" part.

```
{MnSRoot} := {scheme}://{URI-DN-prefix}/{root}
```

When using "{MnSRoot}" the abbreviated URI structure is given by

```
{MnSRoot}/{MnSName}/{MnSVersion}/{URI-LDN}
```

or

```
{MnSRoot}/{MnSName}/{MnSVersion}/{URI-LDN-first-part}/{className}={id}
```

It is recommended to use this abbreviated form of the URI structure when defining Management Services.

The path segment "MnSVersion" allows access to resources with different MnS versions, for example:

```
http://operatorA.com/ProvMnS/v1500/SubNetwork=south/.../Cell=1
http://operatorA.com/ProvMnS/v1600/SubNetwork=south/.../Cell=1
```

Note that both URIs, though different as to the path segment indicating the version number of the ProvMnS, identify the same resource that is identified by the canonical URI:

```
http://operatorA.com/SubNetwork=south/.../Cell=1
```

and whose DN is:

```
DC=operatorA.com,SubNetwork=south,...,Cell=1
```

The optional path component "{root}" may be used to separate the name space for 3GPP management from the name space for other domains:

```
http://operatorA.com/3gppManagement/ProvMnS/v1600/SubNetwork=south/.../Cell=1
```

or to provide dedicated URIs on the same host for different tasks:

```
http://operatorA.com/3gppManagement/cm/ProvMnS/v1600/SubNetwork=south/.../Cell=1
http://operatorA.com/3gppManagement/fm/ProvMnS/v1600/SubNetwork=south/.../Cell=1
```

Note that when different hosts are used for different management tasks, like in

```
http://cm.operatorA.com/3gppManagement/ProvMnS/v1600/SubNetwork=south/.../Cell=1
http://fm.operatorA.com/3gppManagement/ProvMnS/v1600/SubNetwork=south/.../Cell=1
```

then also the resources are different and identified by the canonical URIs

```
http://cm.operatorA.com/SubNetwork=south/.../Cell=1
http://fm.operatorA.com/SubNetwork=south/.../Cell=1
```

or the DNs

DC=cm.operatorA.com,SubNetwork=south,...,Cell=1
 DC=fm.operatorA.com,SubNetwork=south,...,Cell=1

In the example above, it is assumed that both resources represent the same cell in the network. This information cannot be derived from the DN or canonical URI, though.

4.4.3 URI structure for resources not representing managed object instances

URIs identifying other resources shall follow, when being used as a target URI in HTTP requests, the structure given by

`{scheme}://{authority}/{root}/{MnSName}/{MnSVersion}/{MnSResourcePath}`

with:

| | |
|--------------------------------|---|
| <code>{scheme}</code> | Scheme component "http" or "https" |
| <code>{authority}</code> | Authority component (host identifier and optional TCP port) |
| <code>{root}</code> | Part of the path component, allows specifying optional path segments for structuring the resource hierarchy on a HTTP server. |
| <code>{MnSName}</code> | Part of the path component, specifies the mandatory MnS name in a single path segment. |
| <code>{MnSVersion}</code> | Part of the path component, specifies the mandatory MnS version in a single path segment. |
| <code>{MnSResourcePath}</code> | Part of the path component, one or more path segments, specifies a resource of the MnS |

For the sake of brevity, `{MnSRoot}` is introduced that includes the "`{scheme}`" part, the two slash characters ("`//`"), the "`{authority}`" part, a single slash character ("`/`") and the "`{root}`" part. When using "`{MnSRoot}`" the abbreviated URI structure is given by

`{MnSRoot}/{MnSName}/{MnSVersion}/{MnSResourcePath}`

It is recommended to use this abbreviated form of the URI structure when defining Management Services.

4.4.4 Resource "`../{MnSName}/{MnSVersion}`"

The resource identified by "`../{MnSName}/{MnSVersion}`" is called NRM root. It represents the conceptual parent of the top-level managed object instances. It is created by the MnS Producer. A MnS Consumer cannot create or delete this resource.

The resource is the target resource for many HTTP requests, such as requests to retrieve all top-level managed object instances in case there are multiple top-level managed object instances, or for requests to create objects in case there are no managed object instances yet and the creation request needs to be directed to the parent of the resource to be created.

Attempts to read the NRM root only shall return "204 No Content".

4.5 Response status codes

The response status codes as defined in section 6 of RFC 7231 [2] shall be supported.