

ETSI TS 128 623 V18.8.0 (2024-10)



**Universal Mobile Telecommunications System (UMTS);
LTE;
5G;
Telecommunication management;
Generic Network Resource Model (NRM)
Integration Reference Point (IRP);
Solution Set (SS) definitions
(3GPP TS 28.623 version 18.8.0 Release 18)**



Reference

RTS/TSGS-0528623v180

Keywords

5G,LTE,UMTS

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Sous-Préfecture de Grasse (06) N° w061004871

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Foreword

This Technical Specification has been produced by the 3rd Generation Partnership Project (3GPP).

The contents of the present document are subject to continuing work within the TSG and may change following formal TSG approval. Should the TSG modify the contents of the present document, it will be re-released by the TSG with an identifying change of release date and an increase in version number as follows:

Version x.y.z

where:

- x the first digit:
 - 1 presented to TSG for information;
 - 2 presented to TSG for approval;
 - 3 or greater indicates TSG approved document under change control.
- y the second digit is incremented for all changes of substance, i.e. technical enhancements, corrections, updates, etc.
- z the third digit is incremented when editorial only changes have been incorporated in the document.

Introduction

The present document is part of a TS-family covering the 3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; Telecommunication management; as identified below:

28.621 Generic Network Resource Model (NRM) Integration Reference Point (IRP); Requirements.

28.622 Generic Network Resource Model (NRM) Integration Reference Point (IRP); Information Service (IS).

28.623 Generic Network Resource Model (NRM) Integration Reference Point (IRP); Solution Set (SS) definitions.

1 Scope

This TS-family specifies a generic Network Resource Model, NRM (also referred to as a Management Information Model - MIM) with definitions of Information Object Classes (IOCs) and Managed Object Classes (MOCs).

The present document specifies the Solution Set definition for the Generic NRM IRP.

The Solution Set definition is related to 3GPP TS 28.622.

Note that the present document is applicable to deployment scenarios using the Service Based Management Architecture (SBMA) as defined in TS 28.533 [20].

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 TS 32.101: "Telecommunication management; Principles and high level requirements".
- [2] 3GPP TS 32.102: "Telecommunication management; Architecture".
- [3] 3GPP TS 32.600: "Telecommunication management; Configuration Management (CM); Concept and high-level requirements".
- [4] 3GPP TS 28.622: "Generic Network Resource Model (NRM) Integration Reference Point (IRP); Information Service (IS)".
- [5] Void
- [6] Void
- [7] Void
- [8] Void
- [9] Void.
- [10] Void
- [11] Void
- [12] Void
- [13] Void
- [14] 3GPP TS 32.160: "Management and orchestration; Management Service Template".
- [15] 3GPP TR 21.905: "Vocabulary for 3GPP Specifications".
- [16] IETF RFC 8528: "YANG Schema Mount".
- [17] Management and Orchestration APIs Stage 3 Repository https://forge.3gpp.org/rep/sa5/MnS/-/tree/Tag_Rel18_SA105/
- [18] RFC 8525: "YANG Library"

- [19] RFC 6022: "YANG Module for NETCONF Monitoring"
- [20] 3GPP TS 28.533: "Management and orchestration; Architecture framework".

3 Definitions and abbreviations

3.1 Definitions

For the purposes of the present document, the terms and definitions given in 3GPP TR 21.905 [15], 3GPP TS 32.101 [1], 3GPP TS 32.102 [2], 3GPP TS 32.600 [3], 3GPP TS 28.622 [4] and the following apply. A term defined in the present document takes precedence over the definition of the same term, if any, in 3GPP TR 21.905 [15] and 3GPP TS 32.101 [1], 3GPP TS 32.102 [2] and 3GPP TS 32.600 [3] and 3GPP TS 28.622 [4].

3.2 Abbreviations

For the purposes of the present document, the abbreviations given in 3GPP TR 21.905 [15], 3GPP TS 32.600 [3] and the following apply. An abbreviation defined in the present document takes precedence over the definition of the same abbreviation, if any, in 3GPP TR 21.905 [15] and 3GPP TS 32.600 [3].

JSON	JavaScript Object Notation
SS	Solution Set

4 Solution Set (SS) definitions

4.1 Void

4.2 Void

4.3 OpenAPI Definitions

The present clause contains the OpenAPI definitions of the Generic NRM in YAML format.

The Information Service (IS) of the Generic NRM is defined in 3GPP TS 28.622 [4].

Mapping rules to produce the OpenAPI definition based on the IS are defined in 3GPP TS 32.160 [14].

OpenAPI/YAML definitions are specified in 3GPP Forge [17].

Directory: OpenAPI

Files:

TS28623_ComDefs.yaml

TS28623_GenericNrm.yaml

TS28623_PmControlNrm.yaml

TS28623_ThresholdMonitorNrm.yaml

TS28623_SubscriptionControlNrm.yaml

TS28623_MnSRegistryNrm.yaml

TS28623_FileManagementNrm.yaml

TS28623_ManagementDataCollectionNrm.yaml

TS28623_QoEMeasurementCollectionNrm.yaml

TS28623_TraceControlNrm.yaml

4.4 YANG Definitions

The present clause contains the YANG definitions for the Generic NRM.

The Information Service (IS) of the Generic NRM is defined in 3GPP TS 28.622 [4].

Mapping rules to produce the YANG definition based on the IS are defined in 3GPP TS 32.160 [14].

YANG definitions are specified in 3GPP Forge [17].

Directory: yang-models

Files:

_3gpp-common-ep-rp.yang

_3gpp-common-filemanagement.yang

_3gpp-common-files.yang

_3gpp-common-managed-element.yang

_3gpp-common-managed-function.yang

_3gpp-common-managementdatacollection.yang

_3gpp-common-management-node.yang

_3gpp-common-measurements.yang

_3gpp-common-mecontext.yang

_3gpp-common-mnsagent.yang

_3gpp-common-mnsregistry.yang

_3gpp-common-qmcjob.yang

_3gpp-common-subnetwork.yang

_3gpp-common-subscription-control.yang

_3gpp-common-top.yang

_3gpp-common-trace.yang

_3gpp-common-util.yang

_3gpp-common-yang-extensions.yang

_3gpp-common-yang-types.yang

Mount information

If the class ManagedElement and the underlying hierarchy is contained under a SubNetwork, the YANG module for ManagedElement shall be mounted at the mountpoint "children-of- SubNetwork" in the YANG module _3gpp-common-subnetwork, together with the YANG modules containing IOCs that can be contained under the ManagedElement directly or under other IOCs contained by the ManagedElement.

If the class ManagedElement and the underlying hierarchy is contained under a MeContext, the YANG module for ManagedElement shall be mounted at the mountpoint "children-of-MeContext" in the YANG module _3gpp-common-mecontext, together with the YANG modules containing IOCs that can be contained under the ManagedElement directly or under other IOCs contained by the ManagedElement. See IETF RFC 8528 [16] that describes the mechanism that adds the schema trees defined by a set of YANG modules onto a mount point defined in the schema tree in another YANG module.

Annex A (normative):Void

Annex B (normative):Void

Annex C (normative):Void

Annex D (normative):Void

Annex E (normative): Solution set specific provisions and examples

E.1 RESTful HTTP-based solution set

MnS producer specific schema definitions

The NRM properties supported by a specific MnS producer are specified by MnS producer specific versions of the standardized OpenAPI definition files. These definitions reflect exactly what is supported. The OpenAPI definitions for unsupported properties are removed.

For example, the schema of the Generic NRM as published by 3GPP allows both a "SubNetwork" of type "SubNetwork-Multiple" and a "ManagedElement" of type "ManagedElement-Multiple" as roots. A concrete MnS producer has only one root class. Therefore, the schema definitions need to be modified accordingly in the file describing the NRM properties of a concrete MnS producer.

Furthermore, the standardized definition of "SubNetwork-Single" and "ManagedElement-Single" includes all possible name-contained objects. A concrete MnS producer supports in most cases only a subset of those. Unsupported name-containments need to be removed. For example, if "SubNetwork-Single" does not support the Intent NRM, then the following line "\$ref: 'TS28312_IntentNrm.yaml#/components/schemas/SubNetwork-ncO-IntentNrm'" needs to be deleted.

When objects, attributes or attribute fields are unsupported, its schema definitions need to be removed.

The MnS producer specific schema of the Generic NRM is always the root schema, that includes references to child schemas in other files, that in turn may reference other schemas, and so forth. It is recommended to locate the root schema at a URI that is composed by appending the path component "/schemas" to the URI specified in "mnsAddress":

```
<mnsAddress>/schemas
```

To obtain all NRM properties supported by a MnS producer it is necessary to inspect the root schema and all its descendant schemas.

References in a file may contain a relative path or an absolute path. When a reference has a relative path, the processor shall assume that the referenced file is located at the same address as the file referencing it.

Examples:

The following example shows an excerpt of a file specifying a NRM, that supports the complete Generic NRM and the complete NR NRM. The root class is "SubNetwork".

The schema definition published by 3GPP specifies the allowed root classes.

```
NrmRoot:
  oneOf:
    - type: object
      properties:
        SubNetwork:
          $ref: '#/components/schemas/SubNetwork-Multiple'
    - type: object
      properties:
        ManagedElement:
          $ref: '#/components/schemas/ManagedElement-Multiple'
```

This definition needs to be modified to produce the following schema definition that allows only "SubNetwork" as root class.

```
NrmRoot:
  type: object
  properties:
    SubNetwork:
      $ref: '#/components/schemas/SubNetwork-Multiple'
```

Furthermore, all objects name-contained by "SubNetwork" and "ManagedElement" that are not defined by the NR NRM need to be removed. The excerpt of the schema published by 3GPP may look as follows.

```

SubNetwork-Single:
  allOf:
    - $ref: '#/components/schemas/Top'
    - $ref: '#/components/schemas/SubNetwork-Attr'
    - $ref: '#/components/schemas/SubNetwork-ncO'
    - $ref: 'TS28104_MdaNrm.yaml#/components/schemas/SubNetwork-ncO-MdaNrm'
    - $ref: 'TS28105_AiMlNrm.yaml#/components/schemas/SubNetwork-ncO-AiMlNrm'
    - $ref: 'TS28312_IntentNrm.yaml#/components/schemas/SubNetwork-ncO-IntentNrm'
    - $ref: 'TS28317_RanScNrm.yaml#/components/schemas/SubNetwork-ncO-RanScNrm'
    - $ref: 'TS28536_CoslaNrm.yaml#/components/schemas/SubNetwork-ncO-CoslaNrm'
    - $ref: 'TS28538_EdgeNrm.yaml#/components/schemas/SubNetwork-ncO-EdgeNrm'
    - $ref: 'TS28541_SliceNrm.yaml#/components/schemas/SubNetwork-ncO-SliceNrm'
    - $ref: 'TS28541_NrNrm.yaml#/components/schemas/SubNetwork-ncO-NrNrm'
    - $ref: 'TS28541_5GcNrm.yaml#/components/schemas/SubNetwork-ncO-5GcNrm'

ManagedElement-Single:
  allOf:
    - $ref: '#/components/schemas/Top'
    - $ref: '#/components/schemas/ManagedElement-Attr'
    - $ref: '#/components/schemas/ManagedElement-ncO'
    - $ref: 'TS28104_MdaNrm.yaml#/components/schemas/ManagedElement-ncO-MdaNrm'
    - $ref: 'TS28105_AiMlNrm.yaml#/components/schemas/ManagedElement-ncO-AiMlNrm'
    - $ref: 'TS28536_CoslaNrm.yaml#/components/schemas/ManagedElement-ncO-CoslaNrm'
    - $ref: 'TS28541_NrNrm.yaml#/components/schemas/ManagedElement-ncO-NrNrm'
    - $ref: 'TS28541_5GcNrm.yaml#/components/schemas/ManagedElement-ncO-5GcNrm'

```

The schema describing the example NRM includes only name-containments from the NR NRM.

```

SubNetwork-Single:
  allOf:
    - $ref: '#/components/schemas/Top'
    - $ref: '#/components/schemas/SubNetwork-Attr'
    - $ref: '#/components/schemas/SubNetwork-ncO'
    - $ref: 'TS28541_NrNrm.yaml#/components/schemas/SubNetwork-ncO-NrNrm'

ManagedElement-Single:
  allOf:
    - $ref: '#/components/schemas/Top'
    - $ref: '#/components/schemas/ManagedElement-Attr'
    - $ref: '#/components/schemas/ManagedElement-ncO'
    - $ref: 'TS28541_NrNrm.yaml#/components/schemas/ManagedElement-ncO-NrNrm'

```

The next example demonstrates how to deal with attributes whose support qualifier is optional and that are not supported by a MnS producer. The "FileDownloadJob" is a case that has as one optional attribute, the "notificationRecipientAddress". The schema published by 3GPP includes its attribute definition.

```

FileDownloadJob-Single:
  allOf:
    - $ref: 'TS28623_GenericNrm.yaml#/components/schemas/Top'
    - type: object
      properties:
        attributes:
          type: object
          properties:
            fileLocation:
              type: string
            notificationRecipientAddress:
              $ref: 'TS28623_ComDefs.yaml#/components/schemas/Uri'
            cancelJob:
              type: string
              enum:
                - TRUE
                - FALSE
            jobMonitor:
              $ref: '#/components/schemas/FileDownloadJobProcessMonitor'

```

The schema describing what is supported on the MnS producer does not include it.

```

FileDownloadJob-Single:
  allOf:
    - $ref: 'TS28623_GenericNrm.yaml#/components/schemas/Top'
    - type: object
      properties:
        attributes:
          type: object
          properties:
            fileLocation:

```

```

    type: string
  cancelJob:
    type: string
  enum:
    - TRUE
    - FALSE
  jobMonitor:
    $ref: '#/components/schemas/FileDownloadJobProcessMonitor'

```

The following example shows possible URIs for accessing the MnS producer specific schema of the Generic NRM, the file that always needs to be retrieved first.

```

https://example.com/management/ProvMnS/1800/schemas/TS28623_GenericNrm_VS.yaml
sftp://example.com/management/ProvMnS/1800/schemas/TS28623_GenericNrm_VS.yaml

```

NtfSubscriptionControl

The format of the value of the attribute "dataNodeSelector" shall be a Jex expression that is compliant to either the Jex basic profile specified in clause 7.4 of TS 32.161 [20]) or to the Jex advanced profile specified in clause 7.5 of TS 32.161 [20]). The value of the attribute "notificationFilter" shall be a Jex expression that is compliant to the Jex conditions profile specified in clause 7.6 of TS 32.161 [20]). The accessible data nodes of the Jex expressions are equal to the nodes in the tree starting at the parent object of the "NtfSubscriptionControl" object.

Examples:

The following example demonstrates how an "NtfSubscriptionControl" object can be used for monitoring quality of service alarm notifications from all "YxzFunction" objects under all "ManagedElement" objects in a specific "SubNetwork".

```

PUT /3gpp-management/SubNetwork=SN1/NtfSubscriptionControl=NSC1 HTTP/1.1
Host: example.org
Content-Type: application/json

{
  "notificationRecipientAddress": "example.org/3gpp-management/alarm-notification-sink",
  "notificationTypes": [
    "notifyNewAlarm",
    "notifyChangedAlarmGeneral",
    "notifyClearedAlarm"
  ],
  "scope": {
    "dataNodeSelector": "/SubNetwork[id='SN1']/ManagedElement/XyzFunction"
  },
  "notificationFilter": "alarmType=\"QUALITY_OF_SERVICE_ALARM\""
}

```

The next example shows how the operational state and administrative state attributes of all "YxzFunction" objects under all "ManagedElement" objects in a specific "SubNetwork" can be monitored.

```

PUT /3gpp-management/SubNetwork[id='SN1']/NtfSubscriptionControl=NSC1 HTTP/1.1
Host: example.org
Content-Type: application/json

{
  "notificationRecipientAddress": "http://example.org/3gpp-management/cm-notification-sink",
  "notificationTypes": [
    "notifyMOIChanges"
  ],
  "scope": {
    "dataNodeSelector": "/SubNetwork[id='SN1']/ManagedElement/XyzFunction/attributes\
      (operationalState | administrativeState)"
  }
}

```

ConditionMonitor

The value of the attribute "conditions" shall be a Jex expression that is compliant to the Jex conditions profile specified in clause 7.6 of TS 32.161 [20]). The accessible data nodes of the Jex expressions are equal to the nodes in the tree starting at the parent object of the "ConditionMonitor" object.

Examples:

The following example demonstrates how the "ConditionMonitor" can be used for monitoring alarm lists. The condition below evaluates to true, when an alarm is raised on the object instance identified by "DN1".

```
"condition": \
"/SubNetwork[id="SN1"]/AlarmList[id="AL1"]/attributes/alarmRecords/*/objectInstance="DN1"
```

The occurrence of this condition may for example switch on a "PerfMetricJob" to start collecting performance metrics on the alarmed object instance. To do so the "conditionMonitorRef" attribute of the "PerfMetricJob" must specify the DN of the "ConditionMonitor".

In the next example the condition in the example above is modified to include the status of a "Scheduler". The modified condition evaluates to true, when an alarm is raised on the object instance identified by "DN1", but only in the time periods specified in the "Scheduler".

```
"condition": \
"/SubNetwork[id="SN1"]/AlarmList[id="AL1"]/attributes/alarmRecords/*/objectInstance="DN1\
and /SubNetwork[id="SN1"]/Scheduler[id="S1"]/attributes/schedulerStatus=true"
```

E.2 YANG/Netconf-based solution set

E.2.1 NRM properties supported

The YANG module "ietf-yang-library" (RFC 8525 [18]) is available via NETCONF at the "mnsAddress". This YANG module lists the supported YANG modules and related information. The individual supported YANG modules are accessible either via the "ietf-yang-library module" as specified by the leaves "/modules-state/module/schema", "/yang-library/module-set/import-only-module/location" and "/yang-library/module-set/module/location" or via the "ietf-netconf-monitoring module" (RFC 6022 [19]) with the "<get-schema>" operation.

E.2.2 Common data types

Data types in YANG have the same name as in stage 2 also considering the mapping rule in TS 32.160 [14] clause 6.2.16.1. There are some data types that do not conform to this rule because the data type was defined by an external organisation (e.g. IETF) or pre-existing YANG definitions exist. Table E.2.2-1 lists the mapping for these exceptions.

Table E.2.2-1: Mapping of common data types

Stage-2 Type Name	YANG type	Description
FullTime	yang:time-with-zone-offset	Defined in ietf-yang-types.yang
Float	Decimal64	Defined in RFC 7950
DnList	types3gpp:DistinguishedName	A list or leaf-list of type types3gpp:DistinguishedName Defined in _3gpp-common-yang-types.yang
Fqdn	inet:host-name	Defined in ietf-inet-types.yang
Ipv4Addr	inet:ipv4-address	Defined in ietf-inet-types.yang
Ipv6Addr	inet:ipv6-address	Defined in ietf-inet-types.yang
Ipv6Prefix	inet:ipv6-prefix	Defined in ietf-inet-types.yang
Uri	inet:uri	Defined in ietf-inet-types.yang

Annex F (informative): Change history

Change history							
Date	TSG #	TSG Doc.	CR	Rev	Subject/Comment	Old	New
2012-12					New version after approval	2.0.0	11.0.0
2013-06	SA#60	SP-130304	002	2	Correction of XML schema	11.0.0	11.1.0
2014-06	SA#64	SP-140332	003	1	upgrade XSD	11.1.0	11.2.0
		SP-140358	004	-	remove the feature support statements		
2014-09	SA#65	SP-140560	005	-	Update the link from Solution Set to Information Service due to the end of Release 12	11.2.0	12.0.0
2015-12	SA#70	SP-150691	006	1	Add missing id attribute	12.0.0	12.1.0
2016-01					Upgrade to Rel-13 (MCC)	12.1.0	13.0.0
2016-03	SA#71	SP-160031	010	1	Make the XML schema well formed	13.0.0	13.1.0

Change history							
Date	Meeting	TDoc	CR	Rev	Cat	Subject/Comment	New version
2016-06	SA#72	SP-160407	0011	-	F	Update the link from IRP Solution Set to IRP Information Service	13.2.0
2017-03	SA#75	-	-	-	-	Promotion to Release 14 without technical change	14.0.0
2017-06	SA#76	SP-170510	0015	2	B	Modifications to align with IS to support Configuration Management for mobile networks that include virtualized network functions	14.1.0
2018-03	SA#79	SP-180060	0016	1	B	Add attribute peeParametersList to Solution Set definitions	15.0.0
2018-12	SA#82	SP-181042	0018	1	F	Update NRM root IOCs Solution Set to support priority	15.1.0
2019-03	SA#83	SP-190121	0020	1	F	Update Generic NRM Solution Set to support JSON	15.2.0
2019-06	SA#84	SP-190371	0021	-	B	Add IOCs for threshold monitoring control	16.0.0
2019-09	SA#85	SP-190745	0026	1	F	generate JSON definition for generic NRM based on new style guideline	16.1.0
2019-09	SA#85	SP-190744	0027	-	A	Add IDL XML YANG solutions	16.1.0
2019-09	SA#85	SP-190751	0029	-	A	Correct references and remove not need abbreviations	16.1.0
2019-12	SA#86	SP-191166	0031	1	F	Correct XML solution set for generic NRM	16.2.0
2019-12	SA#86	SP-191166	0035	-	B	Updates to YANG SS	16.2.0
2019-12	SA#86	SP-191173	0037	1	A	Add the definition of attribute measurementsList	16.2.0
2019-12	SA#86	SP-191166	0039	-	B	Add heartbeat control NRM fragment - Stage 3	16.2.0
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2020-03	SA#87E	SP-200163	0041	2	B	Add configurable KPI control NRM	16.3.0
2020-03	SA#87E	SP-200163	0042	-	B	Add configurable FM - YANG Solution	16.3.0
2020-03	SA#87E	SP-200230	0043	1	F	Add OpenAPI definitions required by the ProvMnS	16.3.0
2020-03	SA#87E	SP-200169	0045	-	F	Correct errors in yang solution set	16.3.0
2020-03	SA#87E					Correction in the implementation of CR0041	16.3.1
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2020-07	SA#88E	SP-200489	0047	-	F	Correct OpenAPI definition for notificationTypes	16.4.0
2020-07	SA#88E	SP-200483	0079	2	B	Add trace control NRM fragment stage 3	16.4.0
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2020-07	SA#88E	SP-200493	0081	-	B	Stage3 add the NRM fragment for SON management	16.4.0
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2020-09	SA#89e	SP-200729	0095	-	F	Correction of YANG errors	16.5.0
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2020-09	SA#89e	SP-200729	0102	-	B	YANG SS for Trace Control	16.5.0
2020-09	SA#89e	SP-200724	0103	-	F	Add missing definitions to comDefs.yaml (OpenAPI definitions)	16.5.0
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2020-09	SA#89e	SP-200729	0106	-	F	Update HeartbeatControl YANG definition	16.5.0
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2020-12	SA#90e	SP-201063	0109	1	F	Add new MDT specific parameter collection period for NR aligning with 28.622 for stage 3	16.6.0
2020-12	SA#90e	SP-201057	0110	-	F	Remove thresholdLevel attribute from ThresholdMonitor (OpenAPI definition)	16.6.0
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2020-12	SA#90e	SP-201050	0112	1	F	Use comDefs.yaml instead of local definitions in genericNrm.yaml (OpenAPI definition)	16.6.0
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History

Document history		
V18.6.0	May 2024	Publication
V18.7.0	July 2024	Publication
V18.8.0	October 2024	Publication