ETSI GR NFV-EVE 022 V5.1.1 (2022-12)

Network Functions Virtualisation (NFV) Release 5; Architectural Framework; Report on VNF configuration

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Foreword

This Group Report (GR) has been produced by ETSI Industry Specification Group (ISG) Network Functions Virtualisation (NFV).

Modal verbs terminology

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1 Scope

The present document provides guidelines on the use of the VNF configuration options enabled by the NFV architectural framework. It identifies gaps in NFV specifications preventing interoperability between VNFs and independently-developed VNF configuration management functions, and/or preventing easy integration of VNF configuration management in VNF lifecycle management processes. The present document provides recommendations on normative work to be carried out to fill these gaps.

2 References

2.1 Normative references

Normative references are not applicable in the present document.

2.2 Informative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

NOTE: While any hyperlinks included in this clause were valid at the time of publication, ETSI cannot guarantee their long term validity.

The following referenced documents are not necessary for the application of the present document but they assist the user with regard to a particular subject area.

[i.1] ETSI GR NFV 003: "Network Functions Virtualisation (NFV); Terminology for main concepts in NFV".

[i.2] Recommendation ITU-T M.3400 (02/2000):"Telecommunications management network: TMN management functions".

[i.3] IETF RFC 6241 (06/2011): "Network Configuration Protocol (NETCONF)".

NOTE: Available at https://www.rfc-editor.org/rfc/rfc6241.

[i.4] gNMI - gRPC Network Management Interface.

NOTE: Available at: https://github.com/openconfig/gnmi.

[i.5] ETSI GS NFV-SOL 001: "Network Functions Virtualisation (NFV) Release 4; Protocols and Data Models; NFV descriptors based on TOSCA specification".

[i.6] ETSI GS NFV-SOL 002: "Network Functions Virtualisation (NFV) Release 4; Protocols and Data Models; RESTful protocols specification for the Ve-Vnfm Reference Point".

[i.7] ETSI GS NFV-SOL 003: "Network Functions Virtualisation (NFV) Release 4; Protocols and Data Models; RESTful protocols specification for the Or-Vnfm Reference Point".

[i.8] ETSI GS NFV-SOL 004: "Network Functions Virtualisation (NFV) Release 4; Protocols and Data Models; VNF Package and PNFD Archive specification".

[i.9] ETSI GS NFV-SOL 005: "Network Functions Virtualisation (NFV) Release 4; Protocols and Data Models; RESTful protocols specification for the Os-Ma-nfvo Reference Point".

[i.10] ETSI GS NFV-SOL 006: "Network Functions Virtualisation (NFV) Release 4; Protocols and Data Models; NFV descriptors based on YANG specification".

[i.11] ETSI GS NFV-SOL 014: "Network Functions Virtualisation (NFV) Release 4; Protocols and Data Models; YAML data model specification for descriptor-based virtualised resource management".

[i.12] ETSI GS NFV-SOL 018: "Network Functions Virtualisation (NFV) Release 4; Protocols and Data Models; Profiling specification of protocol and data model solutions for OS Container management and orchestration".

[i.13] ETSI GS NFV-IFA 006: "Network Functions Virtualisation (NFV) Release 4; Management and Orchestration; Vi-Vnfm reference point - Interface and Information Model Specification".

[i.14] ETSI GS NFV-IFA 007: "Network Functions Virtualisation (NFV) Release 4; Management and Orchestration; Or-Vnfm reference point - Interface and Information Model Specification".

[i.15] ETSI GS NFV-IFA 008: "Network Functions Virtualisation (NFV) Release 4; Management and Orchestration; Ve-Vnfm reference point - Interface and Information Model Specification".

[i.16] ETSI GS NFV-IFA 009: "Network Functions Virtualisation (NFV); Management and Orchestration; Report on Architectural Options".

[i.17] ETSI GS NFV-IFA 011: "Network Functions Virtualisation (NFV) Release 4; Management and Orchestration; VNF Descriptor and Packaging Specification".

[i.18] ETSI GS NFV-IFA 013: "Network Functions Virtualisation (NFV) Release 4; Management and Orchestration; Os-Ma-nfvo reference point - Interface and Information Model Specification".

[i.19] ETSI GR NFV-IFA 029: "Network Functions Virtualisation (NFV) Release 3; Architecture; Report on the Enhancements of the NFV architecture towards "Cloud-native" and "PaaS"".

[i.20] ETSI GR NFV-IFA 039: "Network Functions Virtualisation (NFV) Release 5; Architectural Framework; Report on Service Based Architecture (SBA) design".

[i.21] ETSI GS NFV-IFA 040: "Network Functions Virtualisation (NFV) Release 4; Management and Orchestration; Requirements for service interfaces and object model for OS container management and orchestration specification".

[i.22] ETSI GR NFV-EVE 019: "Network Functions Virtualisation (NFV) Release 4; Architectural Framework; Report on VNF generic OAM functions".

[i.23] ETSI Registry for non-MANO artifact sets. .

NOTE: Available at https://nfvwiki.etsi.org/index.php?title=Non_MANO_artifact_sets.

[i.24] IETF RFC 7396: JSON Merge Patch.

[i.25] IETF RFC 8040: "RESTCONF Protocol".

NOTE: Available at https://www.rfc-editor.org/rfc/rfc8040.

[i.26] IETF RFC 8526: "NETCONF Extensions to Support the Network Management Datastore Architecture".

NOTE: Available at https://www.rfc-editor.org/rfc/rfc8526.

[i.27] Kubernetes® Documentation: "API Reference".

NOTE: Available at https://kubernetes.io/docs/reference/.

3 Definition of terms, symbols and abbreviations

3.1 Terms

Void.

3.2 Symbols

Void.

3.3 Abbreviations

For the purposes of the present document, the abbreviations given in ETSI GR NFV 003 [i.1] and the following apply:

DSL	Domain Specific Language
gNMI	gRPC Network Management Interface
NETCONF	Network Configuration
OSI	Open Systems Interconnection
SSH	Secure SHell
TMN	Telecommunications Management Network

4 VNF configuration

4.1 General

Configuration management is one of the five functional areas of the Telecommunications Management Network (TMN) model. Recommendation ITU-T M.3400 [i.2] defines configuration management as a management functional area that provides functions to exercise control over, identify, collect data from and provide data to network elements. The present document focuses on configuration management for providing configuration data to VNFs and collecting such data from these VNFs.

4.2 VNF configuration items

A VNF instance is a set of software instances and virtualised resources needed for these software instances to execute. The scope of VNF configuration includes the configuration of both the software and the resources. Resource configuration is part of the VNF lifecycle management and relies on configuration data available in VNF descriptors and configuration data generated at runtime. The present document focuses on the configuration of the VNF software, also known as VNF application configuration.

NOTE 1: In the context of the present document the term "application configuration" should be understood in a wider sense than the configuration of the application layer of the OSI model.

EXAMPLE: The configuration of forwarding rules in a VNF that provides the functionality of a firewall falls in the "application configuration" category.

The data items configured as part of the VNF software configuration process can be classified in two broad categories, as illustrated in figure 4.2-1: virtualisation-dependent items and virtualisation-independent items:

- Virtualisation-dependent items are those items whose value is dependent on decisions made by the NFV infrastructure and/or the NFV management and orchestration functions. An example of such items is the VNF's VNFM IP address. Another example is the IP address assigned to a connection point of a VNFC instance to be configured on another VNFC of the same VNF that needs to communicate with the former (e.g. a load balancer VNFC).

- Virtualisation-independent items are all other items. Their values are typically determined in the OSS/BSS, as for a PNF. An example of such items is a forwarding rule for a VNF that provides the functionality of a firewall.

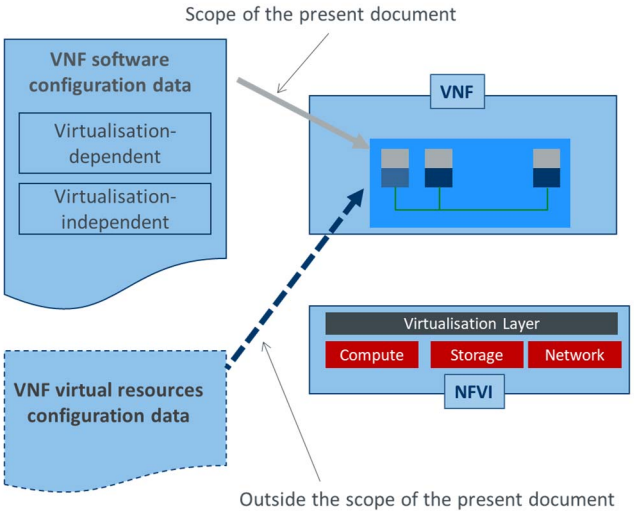

Figure 4.2-1: Overview of VNF configuration data

The data items configured as part of the VNF software configuration process can be further classified according to when to configure them. Some items are intended to be configured during the instantiation process, typically when the VNF instance cannot be fully up and running without the corresponding values being configured. Others can be configured at any time once the VNF instance is created and operational. The configuration of the first category of items is often known as "Day-0" configuration, while the configuration of items in the second category is often designated as "Day-1" (configured right after instantiation) or "Day-2" configuration (any time after "Day-1" configuration).

NOTE 2: This classification has to be understood from a VNFC instance viewpoint, e.g. scaling-out a VNF instance can require Day-0 configuration of the new VNFC instances.

4.3 VNF configuration methods

4.3.1 Overview

Clause 4.3 of the present document provides a description of the configuration methods supported by the NFV architectural framework at the time of publication. These methods are not mutually exclusive.

4.3.2 Method #A

4.3.2.1 General description

With this configuration method, the VNF receives configuration data directly from the OSS/BSS or from its EM. In the latter case the data can be originated in the EM or received by the EM from the OSS/BSS.

This method is only applicable to Day-1 and Day-2 configuration as it assumes that the VNF instance can communicate with the OSS/BSS or an EM. At least one VNFC instance is expected to act a configuration management agent in the VNF.

The configuration procedure can follow a push (configuration data pushed to the VNF by the OSS/BSS or EM) or pull model (configuration data retrieved by the VNF instance from the OSS/BSS or EM).

The specification of the interfaces between the VNF and its EM, as well as the specification of the interfaces between the OSS/BSS and EMs are outside the scope of NFV standardization.

NOTE 1: NETFCONF [i.3], gNMI [i.4] are examples of protocol solutions used in the industry on these interfaces.

VNF-specific data models for configuration (e.g. YANG data models) can be provided as non-MANO artefacts in the VNF package for use by the OSS and/or EM.

NOTE 2: onap_yang_modules [i.23] is an example of a set of non-MANO-artefacts registered for that purpose.

When used for configuring virtualisation-independent data, this method is like conventional methods applicable to a PNF as there is no involvement of NFV-MANO.

Use of this method for configuring virtualisation-dependent configuration data assumes that the OSS and/or EM retrieves the virtualisation-dependent values from the NFVO or the VNFM, prior to configuring the VNF. The OSS and/or EM will then map the retrieved information to the appropriate configuration items for the VNF.

Figure 4.3.2.1-1 illustrates this configuration method.

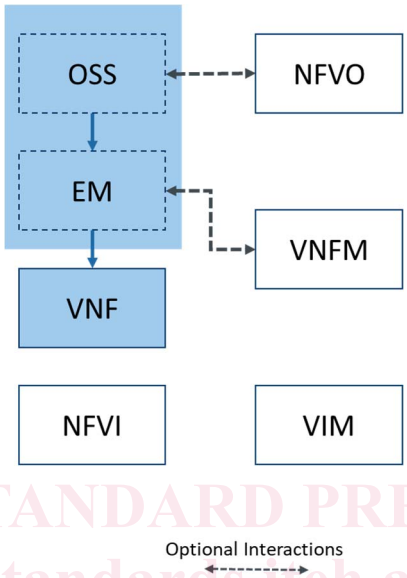

Figure 4.3.2.1-1: VNF configuration method #A

4.3.2.2 Detailed description

4.3.2.2.1 Push mode

4.3.2.2.1.1 OSS-initiated

In this mode the OSS can push configuration data to a VNF instance in direct mode or indirect mode. In direct mode the OSS connects to the VNF instance to push the configuration data. In indirect mode the OSS connects to the EM which in turn can push the configuration data to the VNF instance (see clause 4.3.2.2.1.2) or can wait for the VNF instance to pull these data from the EM.

The OSS can decide to push configuration data at any time once the VNF instance has been created or when specific lifecycle management events occur. To determine when to push configuration data, the OSS subscribes to receive notifications from the NFVO about the creation or modification of a VNF instance. ETSI GS NFV-IFA 013 [i.18] specifies the operations of the NS Lifecycle Management (LCM) interface for subscribing to notifications and for sending notifications.

If the configuration data to be pushed to the VNF instance includes virtualisation-dependent configuration items, or if a direct mode is used, a preamble procedure is used to retrieve VNF instance information from the NFVO, using the QueryNs operation of the NS LCM interface defined in ETSI GS NFV-IFA 013 [i.18]. If the configuration data to be pushed to the VNF instance includes virtualisation-dependent configuration items, the retrieved VNF instance information is used to obtain the values assigned to these items. If the direct mode is used, the retrieved VNF instance information is used to obtain the address(es) assigned to the VNF external connection point(s) where to push the configuration data.

For the case of virtualisation-independent configuration items an approach similar to the case of a PNF, with no NFV-MANO involvement, can be used.

Figure 4.3.2.2.1.1-1 provides an overview of the OSS-initiated push mode procedure in indirect mode with a preamble to retrieve VNF instance information from the NFVO. The following steps are identified:

1) The OSS sends a QueryNs request to the NFVO, as defined in clause 7.3.6 of ETSI GS NFV-IFA 013 [i.18], with a filter set on the VNF instance identifier and an attribute selector set to VnfInfo.

2) The NFVO provides the contents of the VnfInfo information element for the VNF instance, as specified in clause 8.3.3 of ETSI GS NFV-IFA 013 [i.18], in a QueryNs response.

3) The OSS pushes the VNF configuration data to the EM.

4) The EM forwards the received information to the VNF.

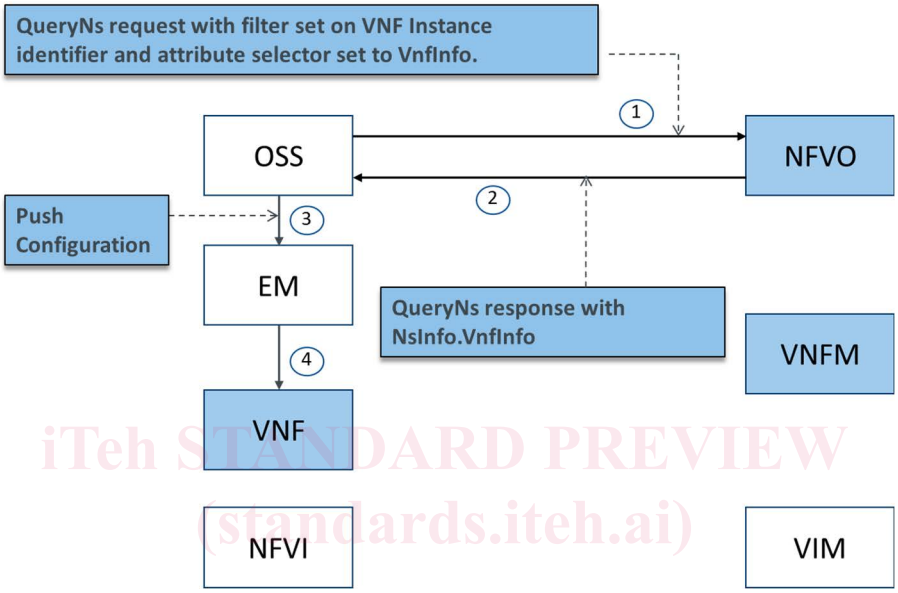

Figure 4.3.2.2.1.1-1: OSS-initiated push mode procedure

ETSI GS NFV-SOL 005 [i.9] specifies the Restful API for implementing the NS LCM interface including the QueryNs operation used in the preamble and the operations for managing notifications. The protocol used by the OSS for communicating with the VNF/EM and the protocol used between the EM and the VNF are outside the scope of the NFV specifications referenced in clause 2 of the present document.

4.3.2.2.1.2 EM-initiated

This mode can be used as part of the OSS-initiated procedure in push mode or independently (e.g. to push EM-generated configuration data or when the OSS is not responsible for VNF configuration management).

In the second case, the EM can push configuration data at any time once the VNF instance has been created or when specific lifecycle management events occur. To determine when to push configuration data, the EM subscribes to receive notifications from the VNFM about the creation or modification of a VNF instance. ETSI GS NFV-IFA 008 [i.15] specifies the operations of the VNF LCM interface for subscribing to notifications and for sending notifications.

If the configuration data to be pushed to the VNF instance includes virtualisation-dependent configuration items, a preamble procedure is used to retrieve VNF instance information from the VNFM, using the QueryVnf operation of the VNF LCM interface defined in ETSI GS NFV-IFA 008 [i.15], to obtain the values assigned to these items.

Figure 4.3.2.2.1.2-1 provides an overview of the EM-initiated push mode procedure with a preamble. The following steps are identified:

1) The EM sends a QueryVnf request to the VNFM, as defined in clause 7.2.9 of ETSI GS NFV-IFA 008 [i.15], with a filter set on the VNF instance identifier.

2) The VNFM provides the contents of the VnfInfo information element, as specified in clause 9.4.2 of ETSI GS NFV-IFA 008 [i.15], in a QueryVnf response.

3) The EM pushes the VNF configuration data to the VNF.

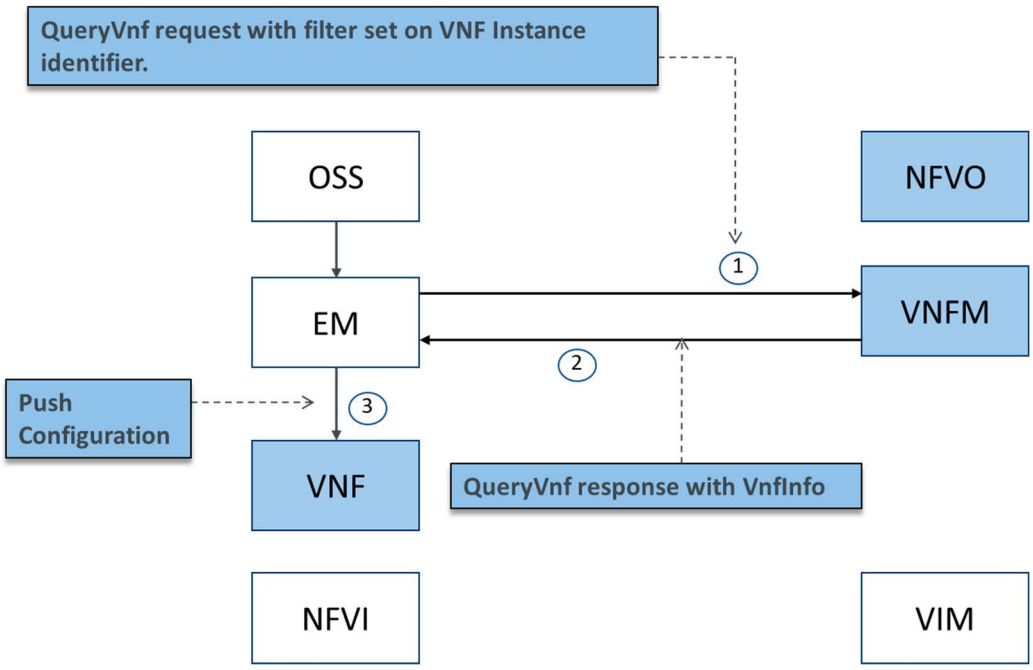

Figure 4.3.2.2.1.2-1: EM-initiated push mode procedure

ETSI GS NFV-SOL 002 [i.6] specifies the Restful API for implementing the VNF LCM interface including the QueryVnf operation used in the preamble and the operations for managing notifications. The protocol used by the EM for communicating with the VNF is outside the scope of the NFV specifications referenced in clause 2 of the present document.

4.3.2.2.2 Pull mode

In this mode the VNF pulls configuration data from the OSS or from the EM. The address where to send a pull request is either preconfigured in the VNF software (e.g. pre-agreed FQDN communicated at design time) or can provided to the VNF instance as a VNF configurable property set by the OSS or the EM, using configuration method #B or #C described in clauses 4.3.3 and 4.3.4.

4.3.2.2.3 Hybrid modes

The push and pull modes can be combined as follows:

- The EM can pull configuration data from the OSS upon receipt of a notification from the VNFM about the creation or modification of a VNF instance and push these configuration data to the VNF.
- The OSS can push configuration data from the EM and the EM can wait for the VNF instance to pull these data.

4.3.3 Method #B

4.3.3.1 General description

With this configuration method, a VNF instance receives configuration data from the VNFM in charge of managing its lifecycle.

This method is only applicable to Day-1 and Day-2 configuration as it assumes that the VNF instance can communicate with the VNFM. At least one VNFC instance is expected to act a configuration management agent in the VNF.

The configuration data values can be originated from the VNFM or received by the VNFM from the VIM, the EM or the NFVO. In the latter case they can be determined by the NFVO or received by the NFVO from the OSS/BSS.

The configuration procedure can follow a push (configuration data pushed to the VNF by the VNFM) or pull model (configuration data retrieved by the VNF instance from the VNFM).

The specifications of the interfaces between the VNF and the VNFM are contained in ETSI GS NFV-IFA 008 [i.15] (functional requirements) and ETSI GS NFV-SOL 002 [i.6] (API specification).

The items that can be configured using this method are VNF configurable properties declared in the VNFD and connection point configuration data.

NOTE: VNF configurable properties are not the same as modifiable attributes (i.e. extensions and metadata).

Figure 4.3.3.1-1 illustrates this configuration method.

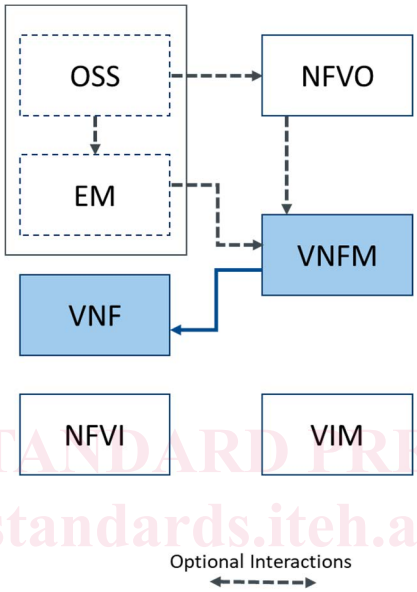

Figure 4.3.3.1-1: VNF configuration method #B

4.3.3.2 Detailed description

4.3.3.2.1 General

Within the VNFD, configurable properties can be declared at the VNF level (VnfConfigurableProperties) and/or at the VDU level (VnfcConfigurableProperties), as specified in clauses 7.1.12 and 7.1.6.7 of ETSI GS NFV-IFA 011 [i.17], respectively.

VNF-level configuration properties include:

- Standard properties to enable/disable auto scaling and auto healing for a VNF instance, to configure OAuth server identities and information to access the APIs produced by the VNFM.
- Additional VNF-specific configuration properties defined by VNF providers.

All VNFC-level configuration properties are VNF-specific properties defined by VNF providers.

While all configurable properties are declared in the VNFD, their values can be:

- Set in the VNFD (default values).
- Computed by an LCM script executed by the VNFM.
- Received by the VNFM from the NFVO or the EM using the following operations of the VNF lifecycle management interface defined in ETSI GS NFV-IFA 007 [i.14] and ETSI GS NFV-IFA 008 [i.15], respectively:
  - Instantiate VNF.