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Network Functions Virtualisation (NFV) Release 2; Protocols and Data Models; VNF Package specification

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1 Scope

The present document specifies the structure and format of a VNF package file and its constituents, fulfilling the requirements specified in ETSI GS NFV-IFA 011 [1] for a VNF package.

2 References

2.1 Normative 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.

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The following referenced documents are necessary for the application of the present document.

[1] ETSI GS NFV-IFA 011: "Network Functions Virtualisation (NFV); Management and Orchestration; VNF Packaging Specification".

[2] TOSCA-Simple-Profile-YAML-v1.1-csprd01: "TOSCA Simple Profile in YAML Version 1.1".

[3] IETF RFC 3339: "Date and Time on the Internet: Timestamps".

[4] IANA register for Hash Function Textual Names.

NOTE: Available at https://www.iana.org/assignments/hash-function-text-names/hash-function-text-names.xhtml.

[5] IETF RFC 5652 (September 2009): "Cryptographic Message Syntax (CMS)".

[6] IETF RFC 7468: "Textual Encodings of PKIX, PKCS, and CMS Structures".

[7] IANA register for Media Types.

NOTE: Available at https://www.iana.org/assignments/media-types/media-types.txt.

[8] Recommendation ITU-T X.509: "Information technology - Open Systems Interconnection - The Directory: Public-key and attribute certificate frameworks".

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.

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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] TOSCA-v1.0-os: "TOSCA Version 1.0".

[i.2] TOSCA-Simple-Profile-YAML-v1.0-csprd02: "TOSCA Simple Profile in YAML Version 1.0".

[i.3] ETSI GS NFV 003: "Network Functions Virtualisation (NFV); Terminology for Main Concepts in NFV".

[i.4] ETSI GS NFV-SOL 001: "Network Functions Virtualisation (NFV) Release 2; Protocols and Data Models; NFV Descriptors based on TOSCA".

[i.5] ETSI NFV registry of non-MANO artifact sets.

NOTE: Available at http://register.etsi.org/NFV.

3 Definitions and abbreviations

3.1 Definitions

For the purposes of the present document, the terms and definitions given in ETSI GS NFV 003 [i.3] and the following apply:

non-MANO artifact: artifact for use by functional blocks beyond NFV-MANO

non-MANO artifact set: set of related non-MANO artifacts which are intended to be used together

3.2 Abbreviations

For the purposes of the present document, the following abbreviations apply:

CA	Certificate Authority
CMS	Cryptographic Message Syntax
CSAR	Cloud Service Archive
NFVI	NFV Infrastructure
NFVO	NFV Orchestrator
TOSCA	Topology and Orchestration Specification for Cloud Applications
URI	Universal Resource Identifier
UTF	Unicode Transformation Format
VNF	Virtualised Network Function
VNFC	VNF Component
VNFD	VNF Descriptor
YAML	YAML Ain't Markup Language

4 VNF package

4.1 TOSCA YAML Cloud Service Archive (CSAR) overview

4.1.1 CSAR structure

TOSCA YAML CSAR file is an archive file using the ZIP file format whose structure complies with the TOSCA Simple Profile YAML v1.1 Specification [2]. The CSAR file may have one of the two following structures:

- CSAR containing a *TOSCA-Metadata* directory, which includes the *TOSCA.meta* metadata file providing an entry information for processing a CSAR file as defined in TOSCA v1.0 Specification [i.1].
- CSAR containing a single yaml (.yml or .yaml) file at the root of the archive. The yaml file is a TOSCA definition template that contains a metadata section with *template_name* and *template_version* metadata. This file is the CSAR Entry-Definitions file.

In addition, the CSAR file may optionally contain other directories with bespoke names and contents.

4.1.2 CSAR with TOSCA-Metadata directory

The TOSCA.meta metadata file includes *block_0* with the *Entry-Definitions* keyword pointing to a TOSCA definitions YAML file used as entry for parsing the contents of the overall CSAR archive.

Any TOSCA definitions files besides the one denoted by the *Entry-Definitions* keyword can be found by processing respective *imports* statements in the entry definitions file (or in recursively imported files).

Any additional artifacts files (e.g. scripts, binaries, configuration files) can be either declared explicitly through blocks in the *TOSCA.meta* file as described in TOSCA v1.0 Specification [i.1] or pointed to by relative path names through artifact definitions in one of the TOSCA definitions files contained in the CSAR file.

In order to indicate that the simplified structure (i.e. not all files need to be declared explicitly) of TOSCA.meta file allowed by TOSCA Simple profile YAML 1.0 [i.2] is used, the *CSAR-Version* keyword listed in block_0 of the meta-file denotes the version 1.1 as described in the below example. Otherwise the CSAR-Version keyword denotes the version 1.0 and all files are declared explicitly.

EXAMPLE:

```
TOSCA-Meta-File-Version: 1.0
CSAR-Version: 1.1
Created-by: Onboarding portal
Entry-Definitions: Definitions/ MainServiceTemplate.yaml
```

END OF EXAMPLE.

4.1.3 CSAR zip without TOSCA-Metadata directory

The yaml file at the root of the archive is the *CSAR Entry-Definition* file. The CSAR-Version is defined by the *template_version* metadata as can be seen in the below example.

EXAMPLE:

```
tosca_definitions_version:  tosca_simple_yaml_1_1
metadata:
   template_name: MainServiceTemplate
   template_author: Onboarding portal
   template_version: 1.0
```

END OF EXAMPLE.

4.2 VNF package structure and format

The structure and format of a VNF package shall conform to the TOSCA Simple Profile YAML v1.1 Specification of the CSAR format [2].

NOTE: This implies that the VNF package can be structured according to any of the two options described in clause 4.1.

4.3 VNF package file contents

4.3.1 General

A VNF Package shall contain the VNFD as the main TOSCA definitions YAML file, and additional files, and shall be structured according to one of the CSAR structure options described in clause 4.1.

NOTE: ETSI GS NFV-SOL 001 [i.4] specifies the structure and format of the VNFD based on TOSCA specifications.

If the option with a TOSCA-Metadata directory is used and the CSAR-Version parameter indicates version 1.0, all files that are contained in the archive shall be referenced from the TOSCA.meta file. If the CSAR-Version parameter indicates version 1.1, the files that are referenced and pointed to by relative path names through artifact definitions in one of the TOSCA definitions files (e.g. the VNFD) contained in the CSAR need not be declared in the TOSCA.meta file.

Examples of VNF package options are described in annex A.

4.3.2 VNF package manifest file

A CSAR VNF package shall have a manifest file. The manifest file shall have an extension .mf and the same name as the main TOSCA definitions YAML file and be located at the root of the archive (archive without TOSCA-Metadata directory) or in the location specified by the TOSCA.meta file (archive with a TOSCA-Metadata directory). In the latter case, the corresponding entry shall be named "Entry-Manifest".

The manifest file shall start with the VNF package metadata in the form of a name-value pairs. Each pair shall appear on a different line. The "name" and the "value" shall be separated by a colon. The name shall be one of those specified in table 4.3.2-1 and the values shall comply with the provisions specified in table 4.3.2-1.

Table 4.3.2-1: List of valid names and values for VNF package metadata

Name	Value
vnf_provider_id	A sequence of UTF-8 characters See note.
vnf_product_name	A sequence of UTF-8 characters0 See note.
vnf_release_data_time	String formatted according to IETF RFC 3339 [3].
vnf_package_version	A sequence of groups of one or more digits separated by dots. See note.
NOTE: The value shall be identical to those specified in the VNFD.	

An example of valid manifest file metadata entries follows.

EXAMPLE:

```
metadata:
vnf_product_name: vMRF-1-0-0
vnf_provider_id: Acme
vnf_package_version: 1.0
vnf_release_data_time: 2017.01.01T10:00+03:00
```

END OF EXAMPLE.

If the VNF package refers to external files, the manifest file shall contain digests of individual files in the package, both local files contained in the package and external files referenced in the package.

If the VNF package does not refer to external files, the manifest files may contain digests of individual files contained in the package. If the manifest file does not include digests, the complete CSAR file shall be digitally signed by the VNF provider. A consumer of the VNF package verifies the digests in the manifest file by computing the actual digests and comparing them with the digests listed in the manifest file.

The manifest file, or alternatively, the signature of the CSAR file, is the key for decision regarding a VNF package integrity and validity in terms of its contained artifacts. The specification of the manifest file and specific algorithms used in digest creation and validation is described in the security related sub-clause.

4.3.3 VNF package change history file

A CSAR VNF package shall have a humanly readable text file describing any change in the constituency of the VNF package. All the changes in the VNF package shall be versioned, tracked and inventoried in the change history file.

The VNF package change history file shall be named "ChangeLog.txt" and be located at the root of the archive (archive without TOSCA-Metadata directory) or in the location specified by the TOSCA.meta file (archive with a TOSCA-Metadata directory). In the latter case, the corresponding entry shall be named "Entry-Change-Log".

4.3.4 VNF package testing files

To enable VNF package validation, a VNF Provider should include in a VNF package files containing necessary information (e.g. test description) in order to perform VNF testing. The contents of VNF testing information is outside the scope of the present document.

The VNF testing information shall be located in a directory named "Tests" located at the root of the archive (archive without TOSCA-Metadata directory) or in the location specified by the TOSCA.meta file (archive with a TOSCA-Metadata directory). In the latter case, the corresponding entry shall be named "Entry-Tests".

4.3.5 VNF package licensing information

As required in ETSI GS NFV-IFA 011 [1] the VNF package shall contain license information for the released VNF. The license information shall include a single license term for the whole VNF. In addition the license information may also include license terms for each of the VNF package artifacts if different from the one of the released VNF.

The VNF licensing information shall be located in a directory named "Licenses" located at the root of the archive (archive without TOSCA-Metadata directory) or in the location specified by the TOSCA.meta file (archive with a TOSCA-Metadata directory). In the latter case, the corresponding entry shall be named "Entry-Licenses".

4.3.6 Certificate file

If the manifest file is signed by the VNF provider (see option 1 in clause 5.1), the CSAR VNF package shall contain a certificate file if the certificate is not included in the signature container (see note) within the manifest file. In this case, the certificate file shall have an extension .cert and the same name as the main TOSCA definitions YAML file and be located at the root of the archive (archive without TOSCA-Metadata directory) or in the location specified by the TOSCA.meta file (archive with a TOSCA-Metadata directory). In the latter case, the corresponding entry shall be named "Entry-Certificate".

NOTE: Signature container refers to a structure in a standard format (e.g. CMS) which contains signature and additional data needed to process the signature (e.g. certificates, algorithms, etc.).

If the complete CSAR file is signed by the VNF provider (see option 2 in clause 5.1), the certificate file shall be contained in a zip file together with the CSAR file and the signature file if the certificate is not included in the signature file. The certificate file shall have an extension .cert and the same name as the CSAR file.

4.3.7 Non-MANO artifact sets in a VNF package

As required in ETSI GS NFV-IFA 011 [1] the VNF package shall allow to store and identify non-MANO artifact sets in the VNF package file.

Every non-MANO artifact set shall be identified by a non-MANO artifact set identifier which shall be registered in the registry (specified in annex B). A non-MANO artifact set identifier shall be a string that consists of sub-strings which shall not contain characters other than the following: digits (0-9), lowercase ASCII characters (a-z), and the special characters underscore "_" and dash "-". Sub-strings shall be separated by the dot "." character.

All files belonging to the same non-MANO artifact set shall share a common path prefix other than the root of the package.

Non-MANO artifact sets shall be declared in the manifest file. If the package contains at least one non-MANO artifact set, an entry named "non_mano_artifact_sets:" shall be present in the package on its own line after the "metadata" section that is defined in clause 4.3.2. The section defined by the "non_mano_artifact_sets" keyname shall have the following structure:

- Every non-MANO artifact set shall be declared on its own line, by a key name that is equal to the non-MANO artifact set identifier.
- Below the key name, all artifacts that belong to the non-MANO artifact set shall be listed, each on its own line, starting with key name "Source", followed by a colon (":") and a blank, and further followed by a file name with path for a file in the CSAR archive that is not contained in the root of this archive.

If the Manifest file provides the integrity assurance of the VNF package (option 1 in clause 5.1), these artifacts shall also appear in the list of blocks of name-value pairs specified in clause 5.3.

An example of the section that declares the non-MANO artifact sets in the package is provided below.

EXAMPLE:

```
non_mano_artifact_sets:
   foo_bar:
      Source: foobar/foo/foo.yaml
      Source: foobar/foo/foo.script
      Source: foobar/bar/descriptor.xml
   prv.happy-nfv.cool:
      Source: happy/cool/123.html
      Source: happy/cool/cool.json
      Source: happy/cool/hot/hot_or_cool.json
```

END OF EXAMPLE.

5 Adding security to TOSCA CSAR

5.1 VNF package authenticity and integrity

As specified in ETSI GS NFV-IFA 011 [1] a VNF package shall support a method for authenticity and integrity assurance.

In order to provide the public key based authenticity and integrity for the whole VNF package one of the two following options shall be followed:

Option 1: The VNF package shall contain a Digest (a.k.a. hash) for each of the components of the VNF package. The table of hashes is included in the manifest file, which is signed with the VNF provider private key. In addition, the VNF provider shall include a signing certificate that includes the VNF provider public key, following a pre-defined naming convention and located either at the root of the archive or in a predefined location (e.g. directory).

The certificate may also be included in the signature container, if the signature format allows that. For example, the CMS format allows to include the certificate in the same container as the signature.

Option 2: The complete CSAR file shall be digitally signed with the VNF provider private key. The VNF provider delivers one zip file consisting of the CSAR file, a signature file and a certificate file that includes the VNF provider public key. The certificate may also be included in the signature container, if the signature format allows that.

In option 2, the VNF package delivered would therefore be according to figure 5.1-1.

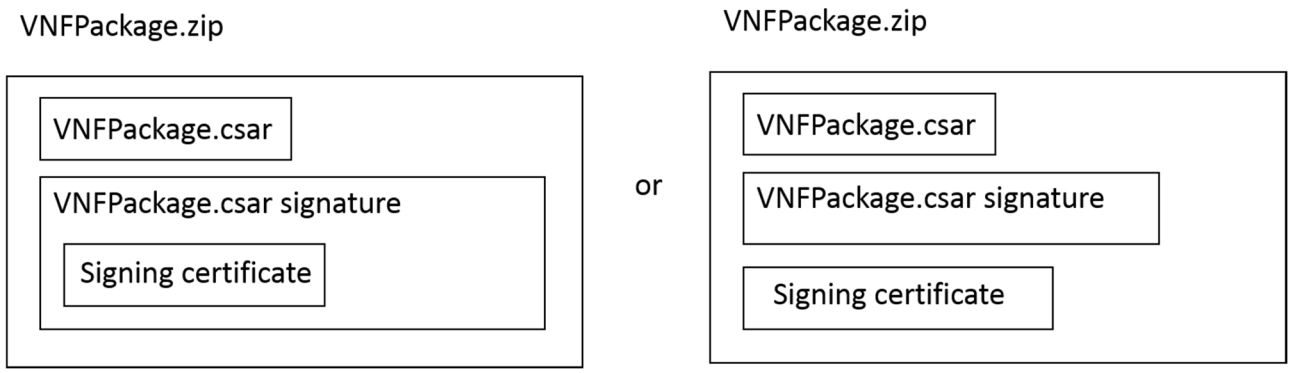

Figure 5.1-1: Composition of the VNF Package zip file in option 2

Option 2 is only valid if all artifacts are included in the package, i.e. no external artifacts are referenced in the package.

This solution, either option 1 or option 2, relies on the existence in the NFVO of a root certificate of a trusted CA that shall have been delivered via a trusted channel that preserves its integrity (separate from the VNF package) to the NFVO and be pre-installed in the NFVO before the on-boarding of the VNF package.

NOTE: The present document makes no assumption on who this trusted CA is. Furthermore, it does not exclude that the root certificate be issued by the VNF vendor or by the NFVI provider.

5.2 VNF package manifest and certificate files

When the manifest file provides the VNF package integrity assurance (option 1 in clause 5.1) it contains the digests (hashes) for each individual file locally stored within the VNF package or referenced from it. Each file related entry of the manifest file includes the path or URI of the individual file, the hash algorithm and the generated digest. A consumer of the VNF package shall verify the digests in the manifest file by computing the actual digests and comparing them with the digests listed in the manifest file.

The VNF package authenticity is ensured by signing the manifest file with the VNF provider private key. The digital signature is stored in the manifest file itself (see clause 5.3). The VNF provider shall include an X.509 certificate [8] in the VNF Package. The certificate shall be either placed in a certificate file with extension .cert or, if the chosen signature format allows it, the certificate may be included in the signature container itself. The certificate provides the VNF provider public key. In a CSAR file without metadata directory the .cert file shall have the same name as the TOSCA definitions YAML file and be located at the root of the archive (archive without TOSCA-Metadata directory). In a CSAR file with a metadata directory, the .cert file shall be placed or in the location specified by the TOSCA.meta file (archive with a TOSCA-Metadata directory). In the latter case, the corresponding entry shall be named "Entry-Certificate".

Alternatively, the VNF package authenticity and integrity is ensured by signing the CSAR file with the VNF provider private key (option 2 in clause 5.1). The digital signature is stored in a separate file. The VNF provider shall also include an X.509 certificate in a separate file with extension .cert or, if the signature format allows it, in the signature file itself. The VNF provider creates a zip file consisting of the CSAR file, signature and certificate files. The signature and certificate files shall be siblings of the CSAR file with extensions .sm and .cert respectively.

In this alternative (option 2 in clause 5.1) it is not required to include digests (hashes) per each individual file or artefact in the manifest file.

A consumer of the VNF package can verify the signature of the complete CSAR package with the VNF provider public key.

Table 5.2-1 summarizes the characteristics of the two possible options for integrity assurance.

Table 5.2-1: Options for VNF Package integrity assurance: summary of characteristics

Options	Digest per artifact	Support external artifacts	Signature as part of the manifest file	External Signature file for the whole CSAR	Certificate may be part of the signature	Certificate may be in a separate file
Option 1	Yes	Yes	Yes	No	Yes	Yes
Option 2	No	No	No	Yes	Yes	Yes

The X.509 certificate may contain one single signing certificate or a complete certificate chain. The root certificate that may be present in this X.509 certificate file shall not be used for validation purposes. Only trusted root certificate pre-installed in NFVO shall be used for validation (see clause 5.1).

5.3 Conventions in the manifest file

When the Manifest file provides the integrity assurance of the VNF package (option 1 in clause 5.1) it shall contain a list of blocks of name-value pairs, where each block is related to one file in the VNF package, where name and value are separated by a colon. Each block shall contain the following three name-value pair attributes:

- Source: identifier of the file used as input to the hash generation algorithm. The source can be either:
  - A file name for a file that is contained in the root of the CSAR archive.

  - A file name with path for a file in the CSAR archive that is not contained in the root of this archive.
  - A URI to an externally accessible artifact.

- Algorithm: name of a well-known algorithm used to generate the hash.
- Hash: text string corresponding to the hexadecimal representation of the hash.

The value for the Algorithm name-value pair shall be among those registered by IANA for hash function textual names [4]. VNF packages that comply with the present document shall either use "sha-256" or "sha-512".

Including the hash algorithm in each entry is optional if it is communicated by other means.

If option 1, as defined in clause 5.1, applies, the manifest file shall be signed. Otherwise signing the manifest file is optional. When the manifest file is signed, the signature shall be included at the end of the file. The signature and all necessary data to interpret it (algorithm used to generate the hash and encryption method) shall be included in a structure in a standard format following digital signatures best practices and encoded in a textual representation according to IETF RFC 7468 [6]. The format shall be among those registered by IANA for mime types [7] (e.g. "cms", "pkcs8", etc.).

Example of valid manifest file entries including manifest signature in CMS format.

EXAMPLE:

```
Source: MRF.yaml
Algorithm: SHA-256
Hash: 09e5a788acb180162c51679ae4c998039fa6644505db2415e35107d1ee213943

Source: scripts/install.sh
Algorithm: SHA-256
Hash: d0e7828293355a07c2dccaaa765c80b507e60e6167067c950dc2e6b0da0dbd8b

Source: https://www.vendor_org.com/MRF/v4.1/scripts/scale/scale.sh
Algorithm: SHA-256
Hash: 36f945953929812aca2701b114b068c71bd8c95ceb3609711428c26325649165

-----BEGIN CMS-----
MIGDBgsqhkiG9w0BCRABCaB0MHICAQAwDQYLKoZIhvcNAQkQAwgwXgYJKoZIhvcN
AQcBoFEET3icc87PK0nNK9ENqSxItVIoSa0o0S/ISczMs1ZIzkgsKk4tsQ0N1nUM
dvb05OXi5XLPLEtViMwvLVLwSE0sKlFIVHAqSk3MBkkBAJv0Fx0=
-----END CMS-----
```

END OF EXAMPLE.

5.4 Signature of individual artifacts

The VNF provider may optionally digitally sign some artifacts individually, in particular software images. In this case a signature file in standard format (e.g. CMS, PKCS#7) and a certificate file with extension .cert will accompany the signed artifact. The signature and certificate files shall have the same name (different extension) as the signed artifact and be siblings of it, i.e. placed in the same folder in the archive, which could also be the root of the archive. If the signature format allows it, the certificate may be included in the signature file.

Signing software images allows the VNF provider to ensure their integrity and authenticity until they are loaded in a VNFC instances at boot time.

If software images or other artifacts are not signed by the VNF provider, the service provider has the option, after having validated the VNF Package, to sign them before distributing the different package components to different function blocks or the NFVI in order to preserve their integrity within the cloud domain.

5.5 Support for security sensitive artifacts

If an artifact is security sensitive, the whole artifact may be encrypted by the VNF provider with an artifact specific key. In case of asymmetric encryption this key is a public key provided by the party who is responsible to on-board and validate the VNF package or to use the artifact, and the VNF provider uses it to encrypt the security sensitive artifact. The consumer of this artifact then decrypts the artifact with its own private key.

In case of symmetric encryption, the public key provided by the party responsible to on-board and validate the VNF package or to use the artifact is used to encrypt a key generated by the VNF provider. The artifact is encrypted with this latter key, which is to be shared with the consumer of the artifact and shall be included in encrypted form in the VNF package. The consumer of the artifact decrypts the shared key with its own private key and then uses the obtained shared key to decrypt the artifact.

In this scenario the encrypted artifact shall be delivered in a CMS file [5], which provides all necessary information to decrypt it: algorithm used for the artifact encryption, encrypted key used for artifact encryption and algorithm used to encrypt the key.

The encryption of an artifact occurs prior to the generation of a digest (hash) for the artifact.

Annex A (informative): TOSCA CSAR examples

A.1 CSAR with the TOSCA-Metadata directory

Below is an example of a CSAR directory structure for NFV including the TOSCA-Metadata, Definitions, Files and Scripts directories. The TOSCA-Metadata directory contains the TOSCA.meta file as specified in [i.1]. The VNFD (MRF.yaml) and other templates files, if any, are included in the Definitions directory. The Files directory contains the change log file, images and other artifact files. The Scripts directory includes the scripts files that may be called from the VNFD. The manifest file (MRF.mf) is located at the root level of the archive.

EXAMPLE:

```
!------TOSCA-Metadata
         !------TOSCA.meta

!------Definitions
         !----- MRF.yaml
         !----- OtherTemplates (e.g., type definitions)

!------Files
         !----- ChangeLog.txt
         !----- MRF.cert
         !----- image(s)
         !----- other artifacts
         !------Tests
         !----- file(s)
         !------Licenses
         !----- file(s)
!------Scripts
         !----- install.sh
!----- MRF.mf
```

END OF EXAMPLE.

A.2 CSAR without the TOSCA-Metadata directory

Below is the example of CSAR including the VNFD (MRF.yaml), manifest, certificate, testing, licensing and change log files located at the root level of the CSAR. The Artifacts directory includes the two scripts files that may be called from the VNFD.

EXAMPLE:

```
!--------- MRF.yaml

!---------  MRF.mf

!---------  MRF.cert

!---------  ChangeLog.txt

!--------- Tests

         !----- file(s)

!--------- Licenses

         !----- file(s)

!--------- Artifacts

         !----- install.sh

         !----- start.yang
```

END OF EXAMPLE.

Annex B (normative): Non-MANO artifact sets registry

B.1 General

Non-MANO artifact set identifiers shall be registered in the ETSI NFV registry of VNF package non-MANO artifact sets [i.5]. The registry has a private and a public part.

In the private part of the registry, e.g. vendor and product specific non-MANO artifact sets are registered. The private part is open to anybody.

In the public part, non-MANO artifact sets that have been documented by a standards-developing organization or industry forum in a publicly available specification are registered.

The allocation of the non-MANO artifact set identifiers is made on a first-come first-served basis.

B.2 Non-MANO artifact set identifier format

A non-MANO artifact set identifier shall be a string that shall comply with the following rules:

- For private non-MANO artifact sets , the identifier shall be the concatenation of: `"prv." <registrant> "." <specificPart>`.
- For public non-MANO artifact sets , the identifier shall be: `<specificPart>`.
- <registrant> and <specificPart> shall be strings that comply with the provisions defined in clause 4.3.7.
- <registrant> shall be a string that represents the registrant (e.g., the company or organization name) chosen at registration time.
- <specificPart> shall be a string that represents the non-MANO artifact set. For private non-MANO artifact sets, this string is scoped by <registrant>.

NOTE: The registration authority has the final right to accept or reject <registrant> and <specificPart> strings as part of the registry governance.

B.3 Registered information

The primary elements of the registry are:

Registered identifier

- nonManoArtifactSetId: Identifier of the non-MANO artifact set (mandatory). This identifier includes information whether the identifier is in the "public" or "private" part of the registry.

Registrant information

- Registrant Name: Name of the company or organization registering the non-MANO artifact set (mandatory).
- Previous Registrant Name(s): Name or names of the company or organization to whom the registered identifier has belonged previously, e.g. due to buyout, merger, acquisition (optional).

NOTE: It is assumed that the registration authority will manage further information related to the identity of the registrant (e.g. contact information).

Additional information

- Non-MANO Artifact Set Name: Name of the non-MANO artifact set (any string, mandatory).
- Description: General description of the non-MANO artifact set (any string, optional).
- Specification URI: Publically reachable URI of the specification that defines the non-MANO artifact set. Needs to be long-lived. (Mandatory for the public part, recommended for the private part).
- Registration Date: Date of the registration (mandatory).

Annex C (informative): Authors & contributors

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Annex D (informative): Change History

Date	Version	Information about changes
November 2016	0.0.1	Initial version based on - NFVSOL(16)000150r2_ETSI_GS_NFV_SOL004_ToC - NFVSOL(16)000151R1_ETSI_GS_NFV_SOL004_Scope - NFVSOL(16)000152R1_ETSI_GS_NFV_SOL004_Normative_References
Jan 2017	0.0.2	Second version based on - NFVSOL(17)000025r2_ETSI_GS_NFV_SOL004_ Normative text for CSAR Structure options - NFVSOL(16)000188R4_ETSI_GS_NFV_SOL004_Adding content to 4.1 TOSCA YAML Cloud Service Archive (CSAR) Overview - NFVSOL(16)000189R1_ETSI_GS_NFV_SOL004_ Adding Informative References
Feb 2017	0.0.3	Third version based on - NFVSOL(17)000018r5_ SOL004 6. Adding Security to TOSCA CSAR - NFVSOL(17)000063r4_ SOL004 Optionl Support for Security Sensitive Artifacts - NFVSOL(17)000068r3_ SOL004 CSAR Format and Conventions - NFVSOL(17)000069r2_ SOL004 Consistency between TOSCA CSAR file contents and TOSCA VNFD content - NFVSOL(17)000108r3_ SOL004 - Adding Security to VNF package - merge of contributions 71r1 and 75
March 2017	0.0.4	Fourth version based on - NFVSOL(17)000117r1_ SOL004 Annex A: CSAR example without the TOSCA-Metadata directory - NFVSOL(17)000070r4_ SOL004 Test Files in VNF package - NFVSOL(17)000140r4_ SOL004 Manifest File Signature - NFVSOL(17)000134r2_SOL004 Annex A: CSAR example with the TOSCA-Metadata directory - NFVSOL(17)000164r1_SOL004 Licensing Agreement in VNF package
May 2017	0.0.5	Fifth version based on - NFVSOL(17)000248r1_SOL004_-_Editorial_changes - NFVSOL(17)000249r1_SOL004_-_Clause_3_-_Fixing_Definitions_and_Abbreviations - NFVSOL(17)000250_SOL004_-_Clause_5_-_Removal_of_the_clause 5 - NFVSOL(17)000253r2_SOL004_VNF_manifest_metadata - NFVSOL(17)000259r1_SOL004_-_Clause_6_3_-_Hash_Algorithms - NFVSOL(17)000272r3_SOL004_symmetric_encryption - NFVSOL(17)000273r1_SOL004_Description_of_signature_field - NFVSOL(17)000274_SOL004_-_Clause_6_4_-_Removal_of_superfluous_text - NFVSOL(17)000275_SOL004_-_Clause_6_3_-_Miscellaneous_improvements - NFVSOL(17)000277r1_SOL004_-_Clause_4_1_-_Miscellaneous_improvements - NFVSOL(17)000278r1_SOL004_-_Clause_4_2_-_4_3__-_Miscellaneous_improvements - NFVSOL(17)000353_SOL004__Removing_The_Note - NFVSOL(17)000279r3_SOL004_-_Clause_4__-_Clause_6_-_Naming_conventions_and_file_ - NFVSOL(17)000357_SOL004_Naming_Conventions_for_Testing_Files - NFVSOL(17)000290r2_SOL004_Clause_4_3_4_VNF_package_testing - NFVSOL(17)000215r3_SOL004_Signature_of_the_CSAR_file - NFVSOL(17)000216r2_SOL004_Signature_of_individual_artifacts - NFVSOL(17)000251r1_SOL004_-_Annex_A_-_Harmonization
May 2017	0.1.0	Sixth version based on - NFVSOL(17)000286R2SOL004_Clause_4_3_2_others_VNF_Package_user_consumer - NFVSOL(17)000287R3SOL004_Clause_2_1_normative_reference_missing - NFVSOL(17)000369R2 SOL004 5.4 shared key for symmetric encryption - NFVSOL(17)000184r3 - SOL004 Root Certificate
December 2017	2.3.2	A first maintenance version is based on - NFVSOL(17)000585r3_SOL004 3rd party VNF Package extensions

History

Document history		
V2.3.1	July 2017	Publication
V2.4.1	February 2018	Publication