Network Service Lifecycle management & API (NFV-SOL 005)

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Agenda

- Section 1: Introduction
- Section 2: VNF Package, Physical Network Function Descriptor and Network Service Descriptor interfaces
- Section 3: Network Service Lifecycle Management
- Section 4: Network Service API realization (NFV SOL-005)
- Section 5: APIs Work progress and future plans
- Section 6: Conclusion
Section 1

Introduction
ETSI NFV ISG’s objective: Standardise templates and APIs that facilitate automated deployment, management, modification and removal of Network Services in an NFV environment.

Key enablers:

- Define the components of a Network Service,
- Define network composition of a Network Service,
- Control the lifecycle management of a Network Service,
- Monitor what is happening,
- Instigate appropriate actions in response to events.
Different OSS/BSS components can consume different APIs.
Section 2

VNF Package, PNFD and NSD interfaces
Management and Orchestration (MANO) of Network Services and VNFs

- **NS Descriptor**
- **NSD Management**
- **Onboarded NS Descriptor**
- **NS Lifecycle Management**
- **NS Instance 1..n**
- **NS FM/PM**

- **VNF Package**
- **VNF Package Management**
- **Onboarded VNF Package**
- **VNF Lifecycle Management**
- **VNF Instance 1..n**
- **VNF FM/PM/CM**

References, invokes, includes relationships are depicted in the diagram.
VNF Package management overview

Over time new VNFs will be developed and existing VNFs superseded.

ETSI GS NFV-IFA 013 specifies:

- Operations to enable the OSS/BSS to on-board VNF Packages to the NFVO.
- The VNF Package Management interface to enable the management of VNF Packages on the NFVO.

<table>
<thead>
<tr>
<th>Mandatory VNF Package Operations for the NFVO</th>
</tr>
</thead>
<tbody>
<tr>
<td>On-board VNF Package</td>
</tr>
<tr>
<td>Enable VNF Package</td>
</tr>
<tr>
<td>Disable VNF Package</td>
</tr>
<tr>
<td>Delete VNF Package</td>
</tr>
<tr>
<td>Query On-boarded VNF Package Information</td>
</tr>
<tr>
<td>Fetch On-boarded VNF Package</td>
</tr>
<tr>
<td>Fetch On-boarded VNF Package Artifacts</td>
</tr>
<tr>
<td>Abort VNF Package deletion</td>
</tr>
<tr>
<td>Subscribe</td>
</tr>
<tr>
<td>Notify</td>
</tr>
</tbody>
</table>
The **Physical Network Function Descriptor (PNFD)** is a template to describe connectivity aspects of Physical Network functions.

PNFD contains:

- Identification and version information.
- Connection Point Descriptor (CPD) specifying how to connect PNFs to Virtual Links.

**ETSI GS NFV-IFA 014** specifies:

- Physical Network Function Descriptor (PNFD)

**ETSI GS NFV-IFA 013** specifies:

- Operations to enable the OSS/BSS to on-board PNFDs to the NFVO.
- A management interface to manage PNFDs on the NFVO

<table>
<thead>
<tr>
<th>Mandatory PNFD Management Operations for the NFVO</th>
</tr>
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<tbody>
<tr>
<td>On-board PNFD</td>
</tr>
<tr>
<td>Update PNFD</td>
</tr>
<tr>
<td>Delete PNFD</td>
</tr>
<tr>
<td>Query PNFD</td>
</tr>
</tbody>
</table>
What is a Network Service? A look inside

- **NS** has constituent **VNFs** and **PNFs**.
- **Composite NS** can have **Nested NS** included as reference.
- **Virtual Link** (VL) provides the connectivity between constituent VNFs and PNFs.
- **VNF Forwarding Graph** (VNFFG) is composed of **Network Forwarding Paths** (NFP), each one as a sequence of connection points and a classification and selection rule.
- A NS has **Service Access Points** (SAP) used to access the NS from the outside.
The **Network Service Descriptor (NSD)** is defined in ETSI GS NFV-IFA 014 and contains:

- References to **VNF Descriptor** (VNFD) for the VNFs that are part of this NS,
- References to **PNF Descriptor** (PNFD) for the PNFs that are part of this NS,
- References to **NSD for the nested NS** of this NS,
- **VNF Forwarding Graph Descriptor** (VNFFGD) and **Network Forwarding Path Descriptor** (NFPD) describing the topology of the NS,
- **Virtual Link Descriptor** (VLD) used by NFVO to deploy Virtual Links.

The NS Descriptor is stored by the NFVO and can be accessed by OSS/BSS.
NS Descriptor (NSD) management overview

Over time new Network Services will be developed and existing ones superseded.

**ETSI GS NFV-IFA 013** specifies:

- Operations to enable the OSS/BSS to on-board NS Descriptors to the NFVO.
- The NSD management interface to manage NSDs in the NFVO.

<table>
<thead>
<tr>
<th>Mandatory NSD Management operations for the NFVO</th>
</tr>
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<tbody>
<tr>
<td>On-board NSD</td>
</tr>
<tr>
<td>Enable NSD</td>
</tr>
<tr>
<td>Disable NSD</td>
</tr>
<tr>
<td>Update NSD</td>
</tr>
<tr>
<td>Delete NSD</td>
</tr>
<tr>
<td>Query NSD</td>
</tr>
<tr>
<td>Subscribe</td>
</tr>
<tr>
<td>Notify</td>
</tr>
</tbody>
</table>
Section 3

Network Service Lifecycle Management
Management and Orchestration (MANO) of Network Services and VNFs

- NS Descriptor
- NSD Management
- Onboarded NS Descriptor
- references
- NS Lifecycle Management
- NS Instance 1..n
- NS FM/PM

- VNF Package
- VNF Package Management
- Onboarded VNF Package
- invokes
- VNF Lifecycle Management
- VNF Instance 1..n
- VNF FM/PM/CM
Managing the NS lifecycle: NS lifecycle management (LCM) overview

After the necessary descriptors have been on-boarded to the NFVO, the OSS/BSS may deploy, manage, modify and then remove a NS.

**ETSI GS NFV-IFA 013** specifies:
- Operations to enable the OSS/BSS to manage the Lifecycle of Network Services

Typically, **LCM operations are long-running operations** (minutes, hours):
- Tracking is essential
- Each individual NS LCM operation occurrence can be identified and has a status that can be queried.
- NFVO will notify the start and completion of each operation.

<table>
<thead>
<tr>
<th>Mandatory NS LCM Operations for the NFVO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Create NS Identifier</td>
</tr>
<tr>
<td>Instantiate NS</td>
</tr>
<tr>
<td>Scale NS</td>
</tr>
<tr>
<td>Update NS</td>
</tr>
<tr>
<td>Query NS</td>
</tr>
<tr>
<td>Terminate NS</td>
</tr>
<tr>
<td>Delete NS Identifier</td>
</tr>
<tr>
<td>Heal NS</td>
</tr>
<tr>
<td>Get Operation Status</td>
</tr>
<tr>
<td>Subscribe</td>
</tr>
<tr>
<td>Notify</td>
</tr>
<tr>
<td>Terminate Subscription</td>
</tr>
<tr>
<td>Query Subscription</td>
</tr>
</tbody>
</table>

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Principles related to VNF lifecycle management over Os-Ma-nfvo ref point

- For an OSS/BSS to influence a VNF, that VNF must be associated with at least one Network Service Instance under its control.

- A simplified mapping of NS LCM operations to VNF operations.

<table>
<thead>
<tr>
<th>NS LCM operation(s)</th>
<th>VNF operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Instantiate NS or Update NS</td>
<td>VNF instantiation</td>
</tr>
<tr>
<td>Scale NS</td>
<td>VNF Scaling</td>
</tr>
<tr>
<td>Heal NS</td>
<td>VNF Healing</td>
</tr>
<tr>
<td>Terminate NS or Update NS</td>
<td>VNF Termination</td>
</tr>
<tr>
<td>Update NS</td>
<td>Other VNF operations (e.g. changing: VNF deployment flavour, VNF operational state, configurable properties...)</td>
</tr>
</tbody>
</table>
Section 4

Network Service APIs realization (NFV SOL-005)
REST (Representational State Transfer) design applied to ETSI NFV

- **HTTP-based** incarnation of REST (HTTP/1.1)
- **JSON** used as the format for resource representations
- Manipulation of resources using **CRUD(*)** operations
  - POST – create resource
  - GET – read resource / query resources
  - PATCH/PUT – update resource
  - DELETE – delete resource
- **Special resources** for
  - notification management (notification endpoint)
  - complex and/or long-running operations
    - task resources providing an RPC-like service
    - operation occurrences
    - task resources for error handling on operation occurrences

(*) CRUD = Create, Read, Update, Delete
Resource URI structure of the VNF Package Management Interface

/apiRoot/vnfpkgm/v1

/vnf_packages
  /{vnfPkgId}
    /vnfd
    /package_content
      /upload_from_uri
      /artifacts
        /{artifactPath}
    /artifacts
  /subscriptions
    /{subscriptionId}

- **VNF packages** (POST | GET)
- Individual VNF package (GET | PATCH | DELETE)
- VNFD of an individual VNF Package (GET)
- VNF package content (GET | PUT)
- Upload VNF package from URI task
- Individual VNF package artifact (GET)
- **Subscriptions** for VNF package notifications (POST | GET)
- Individual subscription (GET | DELETE)
Resource URI structure of the NSD Management Interface

{apiRoot}/nsd/v1

- /ns_descriptors
  - /{nsdInfoId}
    - /nsd_content
      - NSDs (POST | GET)
      - Individual NSD (GET | PATCH | DELETE)
      - NSD content (GET | PUT)

- /pnfd_descriptors
  - /{pnfdInfoId}
    - /pnfd_content
      - PNFDs (POST | GET)
      - Individual PNFD (GET | PATCH | DELETE)
      - PNFD content (GET | PUT)

- /subscriptions
  - /{subscriptionId}
    - Subscriptions for NSD/PNFD notifications (POST | GET)
    - Individual subscription (GET | DELETE)
Resource URI structure of the Network Service Lifecycle Management interface

- **NS Instances** (POST | GET)
  Individual NS Instance (GET | DELETE)

- **Task Resources for NS lifecycle management** (POST)

- **NS LCM operation occurrences** (GET)
  Individual VNF LCM operation occurrence (GET)

- **Task Resources for LCM operation error handling** (POST)

- **Subscriptions** for NS lifecycle notifications (POST | GET)
  Individual subscription (GET | DELETE)
NS Lifecycle Management Example:
NS Instantiation

1. POST _/ns_instances (CreateNsRequest)
2. 201 Created (NSInstance)
3. Send NSIdentifierCreationNotification
4. POST _/ns_instances/nsInstanceId/instantiate (InstantiateNsRequest)
5. 202 Accepted ()
6. Send NsLcmOperationOccurrenceNotification (STARTING)
7. Allocate Virtualised Network Resource(s)

for each new VNF instance
8. POST _/vnf_instances (CreateVnfRequest)
9. 201 Created (VnfInstance)
10. Send VnfIdentifierCreationNotification
11. POST _/vnf_instances/vnfInstanceId/instantiate (InstantiateVnfRequest)
12. 202 Accepted ()
13. Send VnfLcmOperationOccurrenceNotification (STARTING)
14. POST _/grants (GrantRequest)
15. 201 Created (Grant)
16. Send VnfLcmOperationOccurrenceNotification (PROCESSING)
17. Allocate Virtualised Storage Resource(s)
18. Allocate Virtualised Network Resource(s)
19. Allocate Virtualised Compute Resource(s)
20. Send VnfLcmOperationOccurrenceNotification (COMPLETED)
21. Send NsLcmOperationOccurrenceNotification (COMPLETED)
Section 5

APIs Work progress and future plans (SOL WG)
RESTful APIs in the ETSI NFV MANO Architecture

- The ETSI Group Specifications (GS) NFV-SOL 002, NFV-SOL 003 and NFV-SOL 005 define RESTful APIs for the Ve-Vnfm, Or-Vnfm, and Os-Ma-nfvo reference points, respectively.
- They enable multi-vendor integration on these reference points.
OpenAPI descriptions publically available for all APIs specified in GS NFV-SOL 002/003 (version 2.4.1)

- 1st publication of GS NFV-SOL 005 (version 2.4.1).
- Publication of revised versions of GS NFV-SOL 002/003 (Version 2.4.1)

- 1st publication of GS NFV-SOL 002 (version 2.3.1).
- 1st publication of GS NFV-SOL 003 (version 2.3.1).
OpenAPI for NFV-MANO

[Image: ETSI logo]

https://nfvwiki.etsi.org/index.php?title=API_specifications#OpenAPIs

- OpenAPI descriptions available for GS NFV-SOL 002 and 003. Under development for GS NFV-SOL 005.
- OpenAPI descriptions available as YAML, JSON and PDF form.
- Direct Links to open YAML files in the Swagger UI or Editor.
- In case of discrepancies the published ETSI Group Specification (GS) takes precedence.
- Bugs can be reported using Bugzilla
API FUTURE work plan

2018H1 maintenance ongoing for NFV-SOL002, 003 and 005
  • Bug fixing
  • Consolidation of the API framework by addressing version management.

Enhance existing APIs to support NFV Release 3 features.

Develop OpenAPI descriptions for the NFV-SOL 005 APIs.

Specifications of new APIs on new reference points identified as part of the Release 3 specification effort (e.g. NFVO-NFVO).

Work started on conformance testing specifications for MANO APIs. A Specialists Task Force (STF) is about to be set-up to accelerate the work.
Section 6

Conclusion
Conclusion

Covered in this presentation....

• What a NFV Network Service is, and the NSD template used to describe NSs to the NFVO,

• The NFVO interfaces used to on-board NS Descriptors, PNF Descriptors and VNF Package,

• Network Service lifecycle management interface on the NFVO,

• ETSI NFV SOL specifications provide standardized APIs for implementing NFV management and orchestration interfaces,

  • With OpenAPI support definition files for these APIs to ease adoption
More information

- NFV Technology Page (information) [http://www.etsi.org/nfv](http://www.etsi.org/nfv)
- NFV Portal (working area) [http://portal.etsi.org/nfv](http://portal.etsi.org/nfv)
- NFV Proofs of Concept (information) [http://www.etsi.org/nfv-poc](http://www.etsi.org/nfv-poc)
- NFV Plugtest (information & registration) [http://www.etsi.org/nfvplugtest](http://www.etsi.org/nfvplugtest)

Open Area:

- Published Docs: [https://docbox.etsi.org/ISG/NFV/Open/Publications_pdf](https://docbox.etsi.org/ISG/NFV/Open/Publications_pdf)
Backup material
The NS Performance Management (PM) interface allows measurement results collection and notifications related to a network service.

Collection and reporting of performance information is controlled by creation of “PM job”.

PM notifications indicate:
- The crossing of a threshold
- Availability of PM information

**ETSI GS NFV-IFA 013** specifies:
- Operations to enable the OSS/BSS to create PM Jobs and subscribe to Performance related notifications for a Network Service
The NS Fault Management interface instructs the NFVO to provide alarms related to the NSs visible to the OSS/BSS.

**ETSI GS NFV-IFA 013** specifies:

- Operations to enable the OSS/BSS to subscribe to fault alarm notifications for a Network Service

<table>
<thead>
<tr>
<th>Mandatory Fault Management Operations for NFVO</th>
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</thead>
<tbody>
<tr>
<td>Subscribe</td>
</tr>
<tr>
<td>Notify</td>
</tr>
<tr>
<td>Get Alarm List</td>
</tr>
</tbody>
</table>
RESTful APIs in the ETSI NFV MANO architecture

NFV-SOL 005
- NSD Management
- NS Lifecycle Management
- NS Performance Management
- NS Fault Management
- VNF Package Management

OSS/BSS
- NFV-SOL 002
  - VNF Indicator
  - VNF Lifecycle Management
  - VNF Performance Management
  - VNF Fault Management

EM
- NFV-SOL 002
  - VNF Indicator
  - VNF Configuration

VNF
- NFV-SOL 002
  - VNF Indicator
  - VNF Lifecycle Management
  - VNF Performance Management
  - VNF Fault Management

NFVO
- Os-Ma-nfvo
- Or-Vnf

NFVM
- Ve-Vnf
- Ve-Vnfm-em
- Ve-Vnfm-vnf

NFV-SOL 003
- VNF Lifecycle Operation Granting
- VNF Package Management
- Virtualised Resources Quota Available Notification

NFV-SOL 003
- VNF Lifecycle Management
- VNF Performance Management
- VNF Fault Management
- VNF Indicator

NFVO = NFV Orchestrator
VNF = Virtualised Network Functions
VNFM = VNF Manager
EM = Element Manager
OSS = Operations Support Systems
BSS = Business Support Systems
NFV-SOL002/003
- Support of API client authentication/authorization based on TLS-supported certificates as an alternative to Oauth
- Clarifying normative statements regarding the support of the resources and HTTP methods
- Various small bug fixes and editorial corrections

NFV-SOL 003
- Major bug fix to the configuration parameters for external connection points
- Update of the VNF Package Management interface to allow consistent cross-API design in NFV-SOL 005

NFV-SOL 002
- Fixing misalignment between stage 2 and stage 3 w.r.t. treatment of VNFC in PM interface