Abstract

Current efforts in the scope of Network Function Virtualisation (NFV) propose YAML-based descriptors for Virtual Network Functions (VNFs). These descriptors are human-readable but hardly understandable by humans. On the other hand, there has been an effort proposed to the IETF to define a human-readable (and understandable) representation for networks, known as NEMO. In this draft, we propose a simple extension to NEMO to accommodate VNFDs in a similar manner as inline assembly is integrated in higher-level programming languages.

This approach enables the creation of recursive VNF forwarding graphs in Service Descriptors, practically making them recursive.

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1. Introduction

Currently, there is a lot of activity going on to use NFV in the network. From the point of view of the orchestration, Virtual Network Functions are blocks that are deployed in the infrastructure as independent units. They provide for one layer of components (VNFCs) below, i.e. a set of VNFCs accessible to a VNF provider can be composed into VNFs. However, there is no simple way to use existing VNFs as components in VNFs with a higher degree of complexity. In addition, VNFDs used in different open source MANO frameworks are YAML-based files, which despite being human readable, are not easy to understand.

On the other hand, there has been recently an attempt to work on a modelling language for networks (NEMO). This language is human-readable and provides a NodeModel construct to describe nodes that supports recursiveness. In this draft, we propose an addition to NEMO to make it interact with VNFDs supported by a NFV MANO framework. This integration creates a new language for VNFDs that is...
recursive, allowing VNFs to be created based on the definitions of existing VNFs.

This draft uses OpenMANO and OSM descriptor references as an example for the lowest level descriptors that are imported into NEMO. Conceptually, other descriptor formats like TOSCA can also be used at this level.

2. Terminology and abbreviations

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in [RFC2119].

3. Prior art

3.1. Virtual network function descriptors

Virtual network function descriptors (VNFDs) are used in the Management and orchestration (MANO) framework of the ETSI NFV to achieve the optimal deployment of virtual network functions (VNFs). The Virtual Infrastructure Manager (VIM) uses this information to place the functions optimally. VNFDs include information of the components of a specific VNF and their interconnection to implement the VNF, in the form of a forwarding graph. In addition to the forwarding graph, the vnfd includes information regarding the interfaces of the VNF. These are then used to connect the VNF to either physical or logical interfaces once it is deployed.

There are different MANO frameworks available. For this draft, we will concentrate on the example of OpenMANO [1], which uses YAML [2]. Taking the example from the (public) OpenMANO github repository, we can easily identify the virtual interfaces of the sample VNFs in their descriptors:
3.2. NEMO

The Network Modeling (NEMO) language is described in [I-D.xia-sdnrg-nemo-language]. It provides a simple way of describing network scenarios. The language is based on a two-stage process. In the first stage, models for nodes, links and other entities are defined. In the second stage, the defined models are instanciated. The NEMO language also allows for behavioural
A variant of the NEMO language is used in the OpenDaylight NEMO northbound API [3].

NEMO allows to define NodeModels, which are then instantiated in the infrastructure. NodeModels are recursive and can be build with basic node types or with previously defined NodeModels. An example for a script defining a NodeModel is shown below:

```
CREATE NodeModel dmz
    Property string: location-fw, string: location-n2,
    string: ipprefix, string: gatewayip, string: srcip,
    string: subnodes-n2;
Node fw1
    Type fw
    Property location: location-fw,
    operating-mode: layer3;
...
```

Figure 2: Creating a NodeModel in NEMO

4. Additional requirements on NEMO

In order to integrate VNFDs into NEMO, we need to take into account two specifics of VNFDs, which cannot be expressed in the current language model. Firstly, we need a way to reference the file which holds the VNFD provided by the VNF developer. This will normally be a universal resource identifier (URI). Additionally, we need to make the NEMO model aware of the virtual network interfaces.

4.1. Referencing VNFDs in a NodeModel

As explained in the introduction, in order integrate VNFDs into the NEMO language in the easiest way we need to reference the VNFD as a Universal Resource Identifier (URI) as defined in RFC 3986 [RFC3986]. To this avail, we define a new element in the NodeModel to import the VNFD:

```
CREATE NodeModel NAME <node_model_name>
    IMPORT VNFD FROM <vnfd_uri>
```

4.2. Referencing the network interfaces of a VNF in a NodeModel

As shown in Figure 1, VNFDs include an exhaustive list of interfaces, including the interfaces to the management network. However, since these interfaces may not be significant for specific network scenarios and since interface names in the VNFD may not be adequate
in NEMO, we propose to define a new element in the node model, namely the ConnectionPoint.

CREATE NodeModel NAME <node_model_name>
    DEFINE ConnectionPoint <cp_name> FROM VNFD:<iface_from_vnfd>

4.3. An example

Once these two elements are included in the NEMO language, it is possible to recursively define NodeModel elements that use VNFDs in the lowest level of recursion. Firstly, we create NodeModels from VNFDs:

CREATE NodeModel NAME SampleVNF
    IMPORT VNFD from https://github.com/nfvlabs/openmano.git/openmano/vnfs/examples/dataplaneVNF1.yaml
    DEFINE ConnectionPoint data_inside as VNFD:ge0
    DEFINE ConnectionPoint data_outside as VNFD:ge1

Import from a sample VNFD from the OpenMANO repository

Then we can reuse these NodeModels recursively to create complex NodeModels:

CREATE NodeModel NAME ComplexNode
    Node InputVNF TYPE SampleVNF
    Node OutputVNF TYPE ShaperVNF
    DEFINE ConnectionPoint input
    DEFINE ConnectionPoint output
    CONNECTION input_connection FROM input TO InputVNF:data_inside
        TYPE p2p
    CONNECTION output_connection FROM output TO ShaperVNF:wan
        TYPE p2p
    CONNECTION internal FROM InputVNF:data_outside TO ShaperVNF:lan
        TYPE p2p

Create a composed NodeModel

This NodeModel definition creates a composed model linking the SampleVNF created from the VNFD with a hypothetical ShaperVNF defined elsewhere. This definition can be represented graphically as follows:
In ETSI NFV, a network service is described by one or more VNFs that are connected through one or more network VNFFGs. This is no more than what is defined in the composed NodeModel shown in Figure 3. By using NEMO, we provide a simple way to define VNF forwarding graphs (VNF-FGs) in network service descriptors in a recursive way.

5. Conclusion

With the strategy defined in this document, we are able to link a low-level VNF description into a high-level description language for networks like NEMO. Effectively, we are introducing recursiveness in VNFDs, allowing complex service descriptors to be built by reusing previously tested descriptors graphs as building blocks.

Although we have used the OpenMANO descriptor format in this document, other descriptors and concepts (i.e. as those used by TOSCA [4]) can also be used as the lowest level in this extension to the NEMO language.

6. IANA Considerations

This draft includes no request to IANA.

7. Security Considerations

The IMPORT construct allows referencing external resources. Developers using it in NEMO scripts are advised to verify the source of those external resources, and whenever possible, rely on sources with a verifiable identity through cryptographic methods.

8. Acknowledgement

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9. References

9.1. Normative References


9.2. Informative References


9.3. URIs

[1] https://github.com/nfvlabs/openmano

[2] yaml.org


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