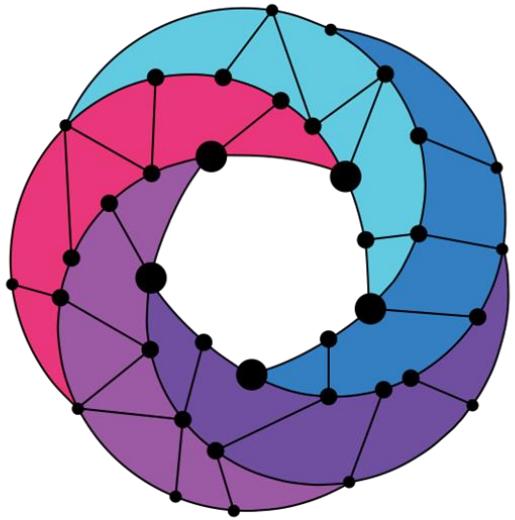

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Network Functions & Network Services Modeling

Gerardo García (Telefónica)

ETSI

Network Function Virtualization provides a mean to make the network more flexible by minimizing dependence on HW constraints

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Network functions are fully defined by SW, minimising dependence on HW constraints

Traditional Network Model: APPLIANCE APPROACH


DPI


BRAS


GGSN/SGSN


PE Router


Firewall

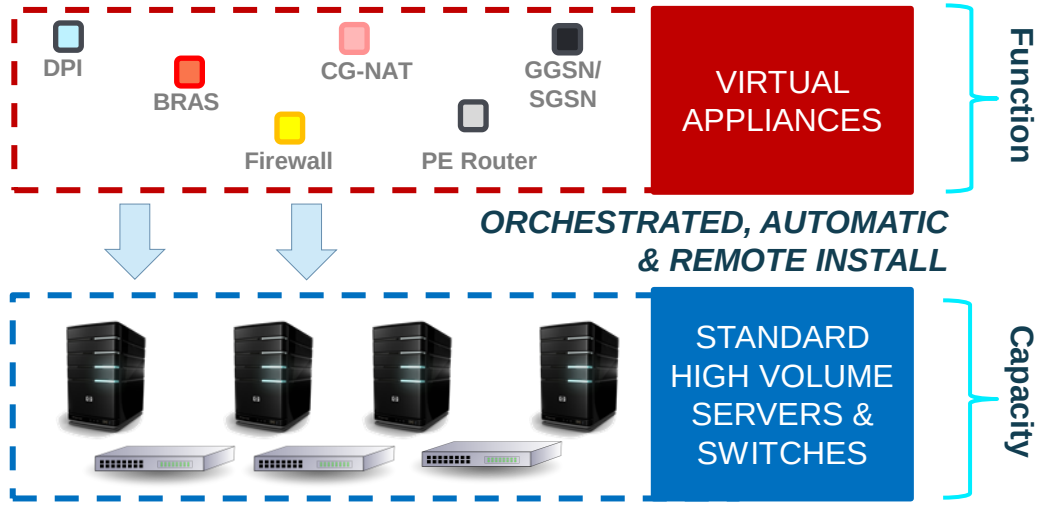

CG-NAT


Session Border Controller


STB

- Network functionalities are **based on specific HW with specific SW linked to HW vendors**
- **One physical node per role**

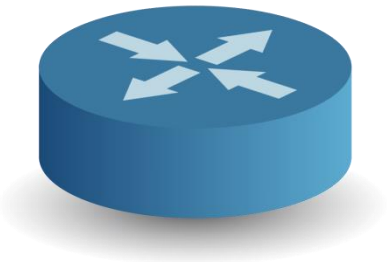
Virtualised Network Model: VIRTUAL APPLIANCE APPROACH



- Network functionalities are **SW-based over COTS HW**
- **Multiple roles over same HW**

Network Functions

- One or many nodes in a Network Infrastructure that has well defined interfaces and functional networking capability.
- Examples: Firewall, Router, EPC, IMS, etc.
- Different types of Network Functions
  - Virtual Network Function
  - Cloud Native/Container Network Function
  - Physical Network Function
  - Hybrid Network Function



Network Functions can be composed of VMs, containers and/or physical elements

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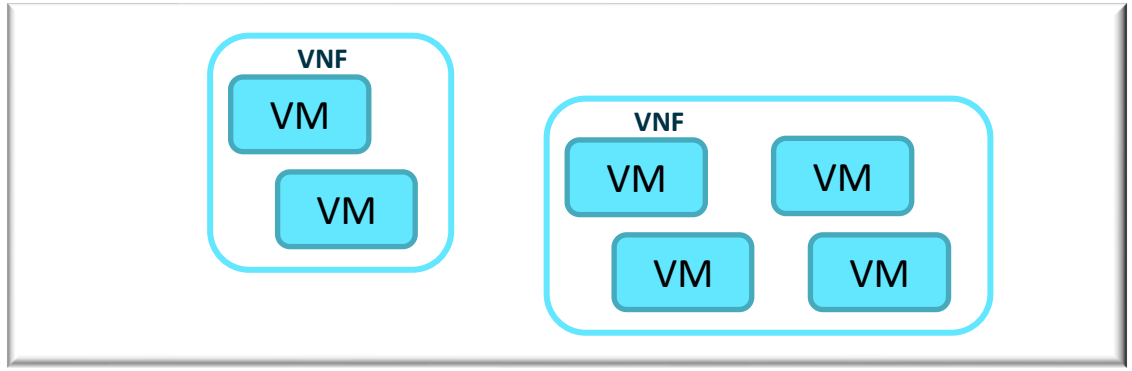
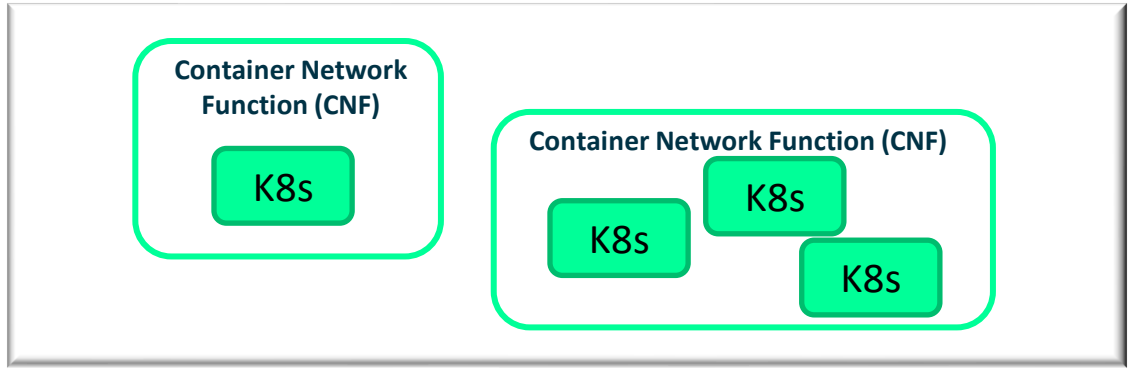
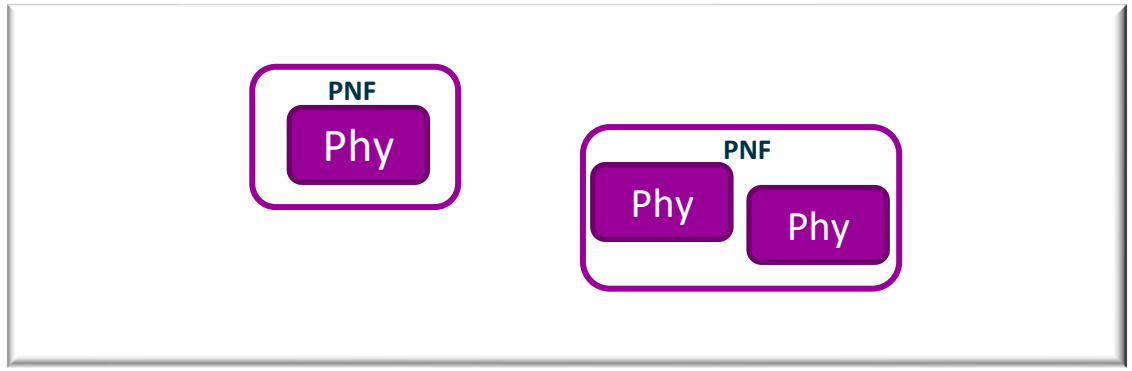
a) All VMs (VDU)



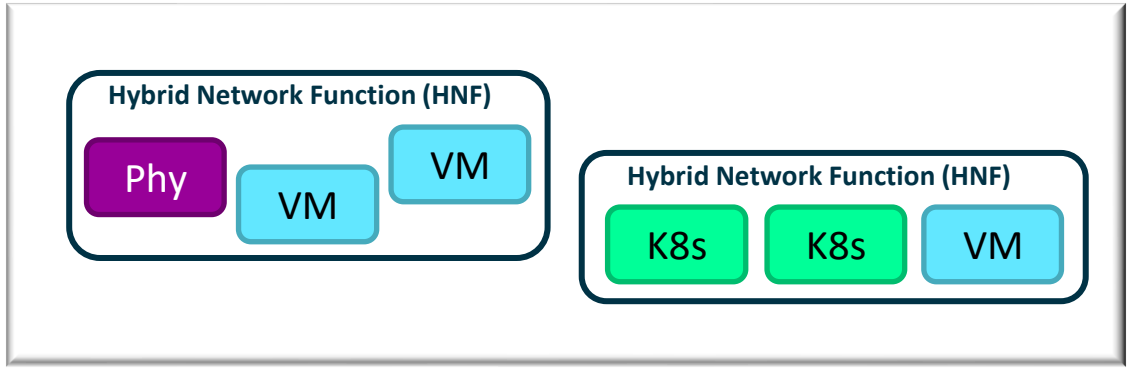
b) All Containers (KDU)



c) All Physical (PDU)

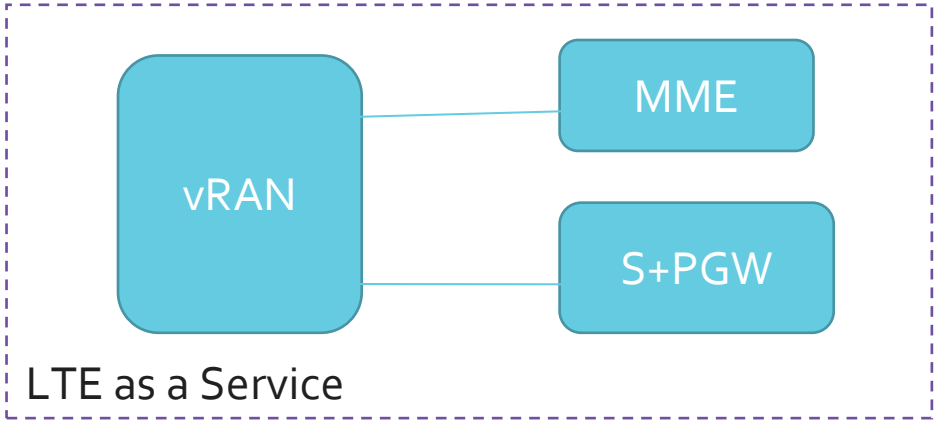


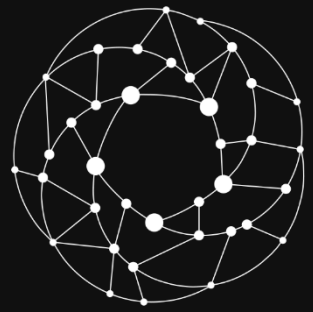
d) Hybrid cases (VDU, KDU and/or PDU)



Network Service

- The Network Service (NS)is a topology of interconnected NF
  - ABSTRACTION (NS definition): The topology is agnostic from the place where NF Will be deployed
  - PARTICULARIZATION (NS instance): When instantiating it, parameters are provided specific for those NF instances
- It is deployed and operated as a whole
- Examples: LTE, VPN, LAN internet, etc.





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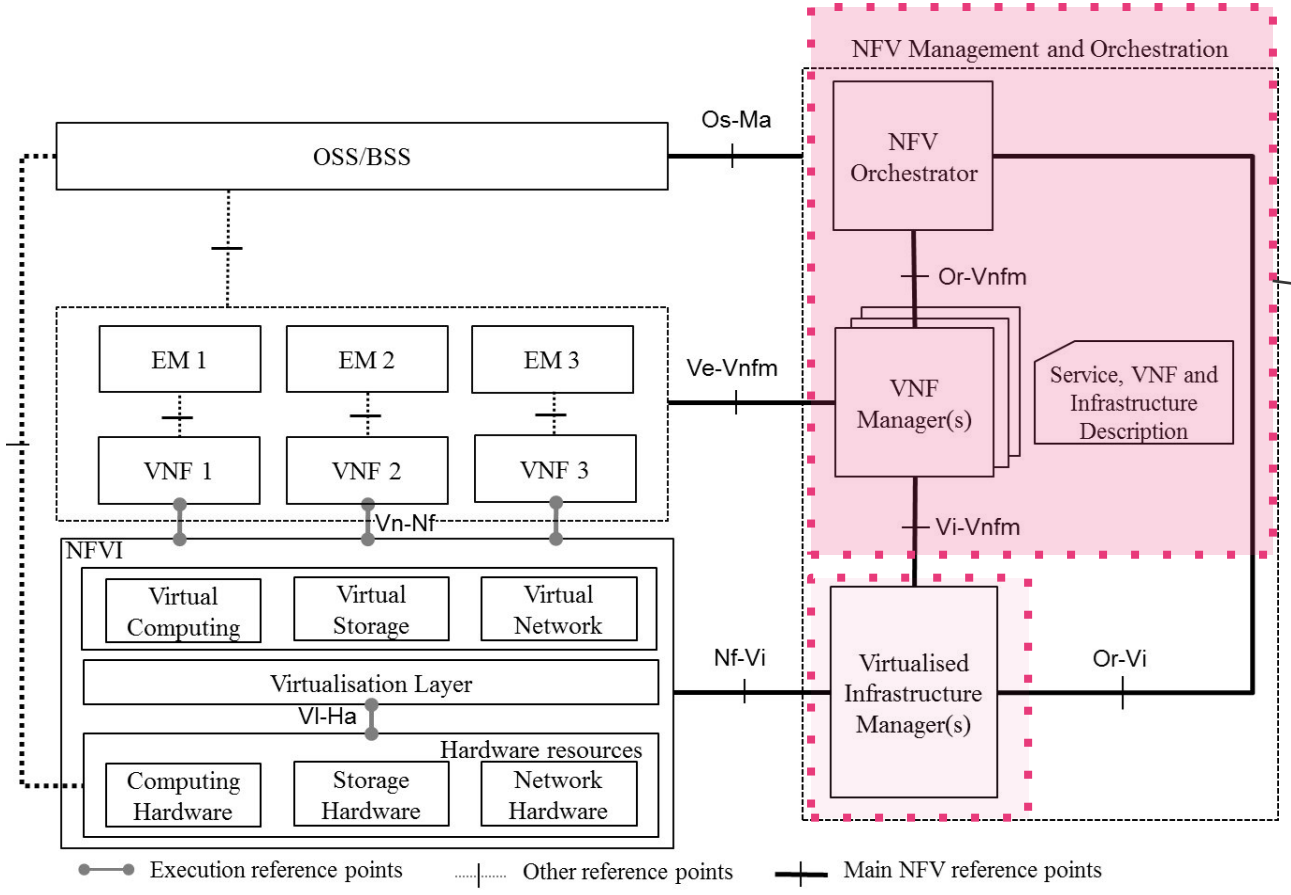
Relation to ETSI NFV

Where does OSM fit in ETSI NFV architecture?

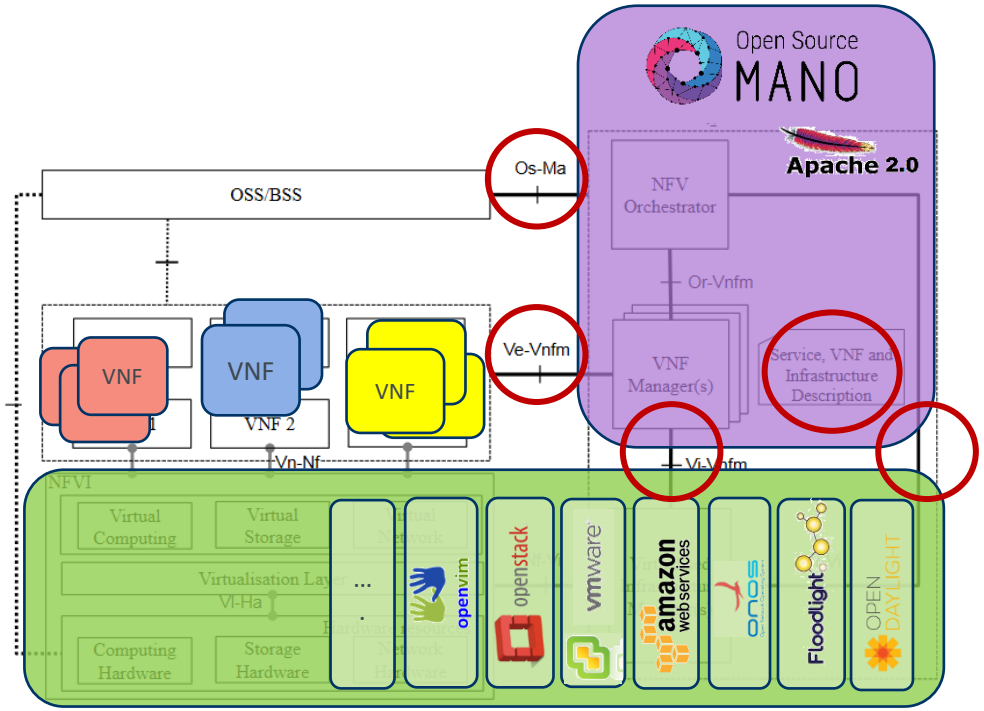


We are here!
Open Source MANO is an ETSI-hosted project to develop an Open Source NFV Management and Orchestration (MANO) software stack aligned with ETSI NFV.

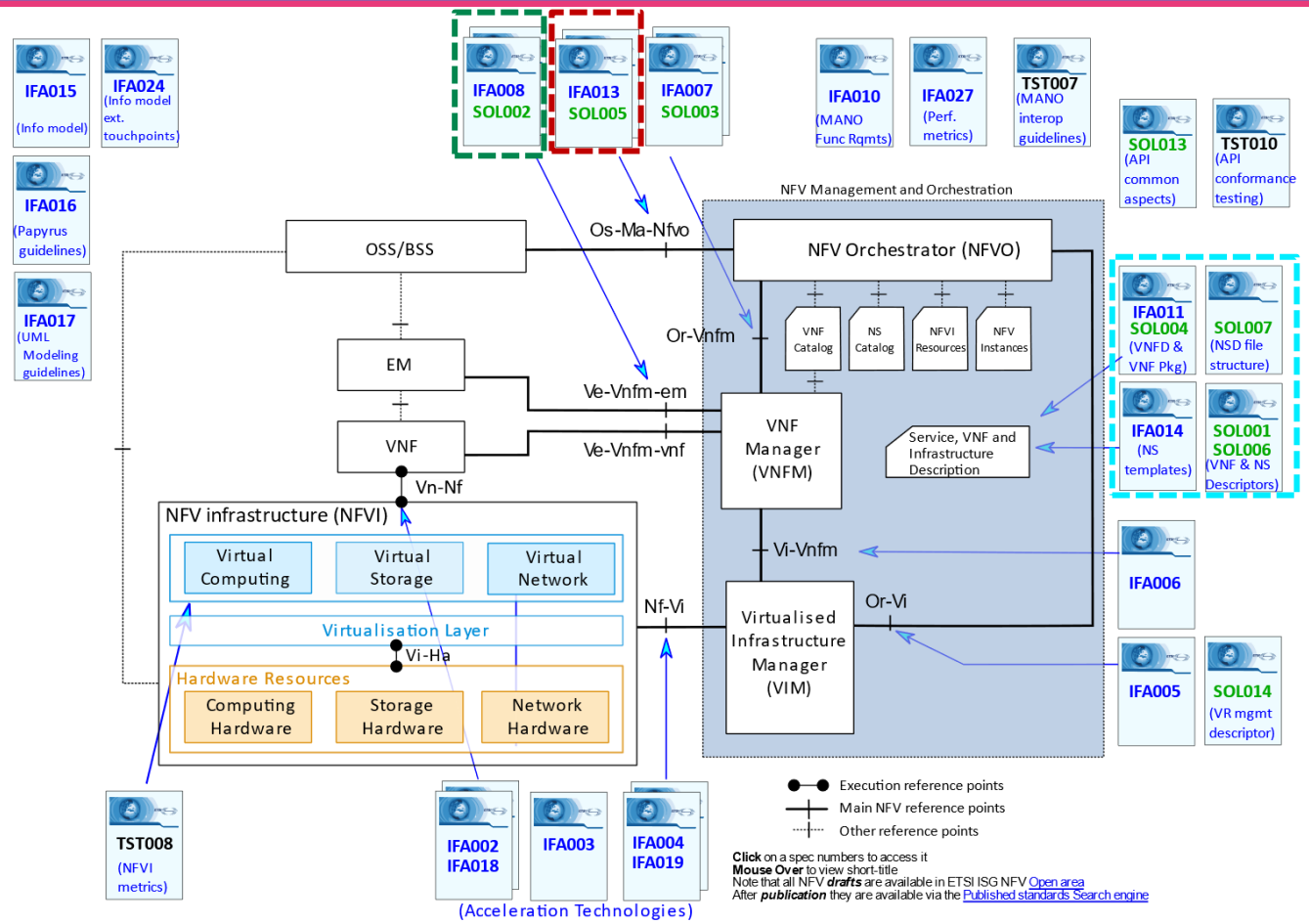
OSM and NFV are different organizations in ETSI, and they complement each other

ETSI NFV: Industry Specification Group that elaborates specifications on Network Functions Virtualization

ETSI OSM: Open Source Group developing a Management and Orchestration (MANO) stack aligned with ETSI NFV Architectural Framework and Information Models



ETSI NFV architecture and specifications
All you need is a map



Os-Ma-Nfvo reference point (interface between OSS/BSS and NFVO)

Ve-Vnfm-em/vnf reference points (interface between VNFM and EM/VNF)

VNF and NS descriptors and packages

Source: ETSI. https://www.etsi.org/images/articles/NFV%20Architecture.svg
IFA (stage 2 specifications): development of architecture, interfaces and information model aspects
SOL (stage 3 specifications): specification of the implementable protocol and data model solutions

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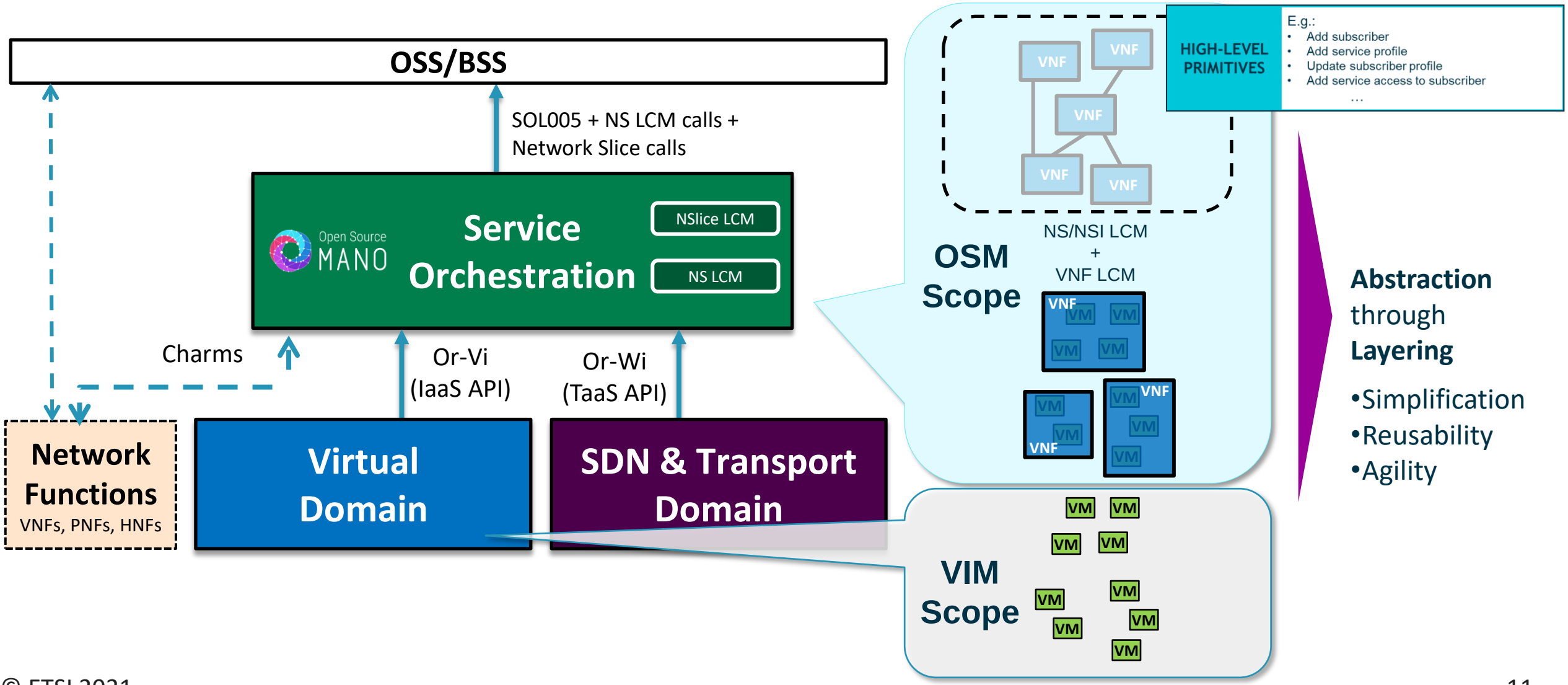
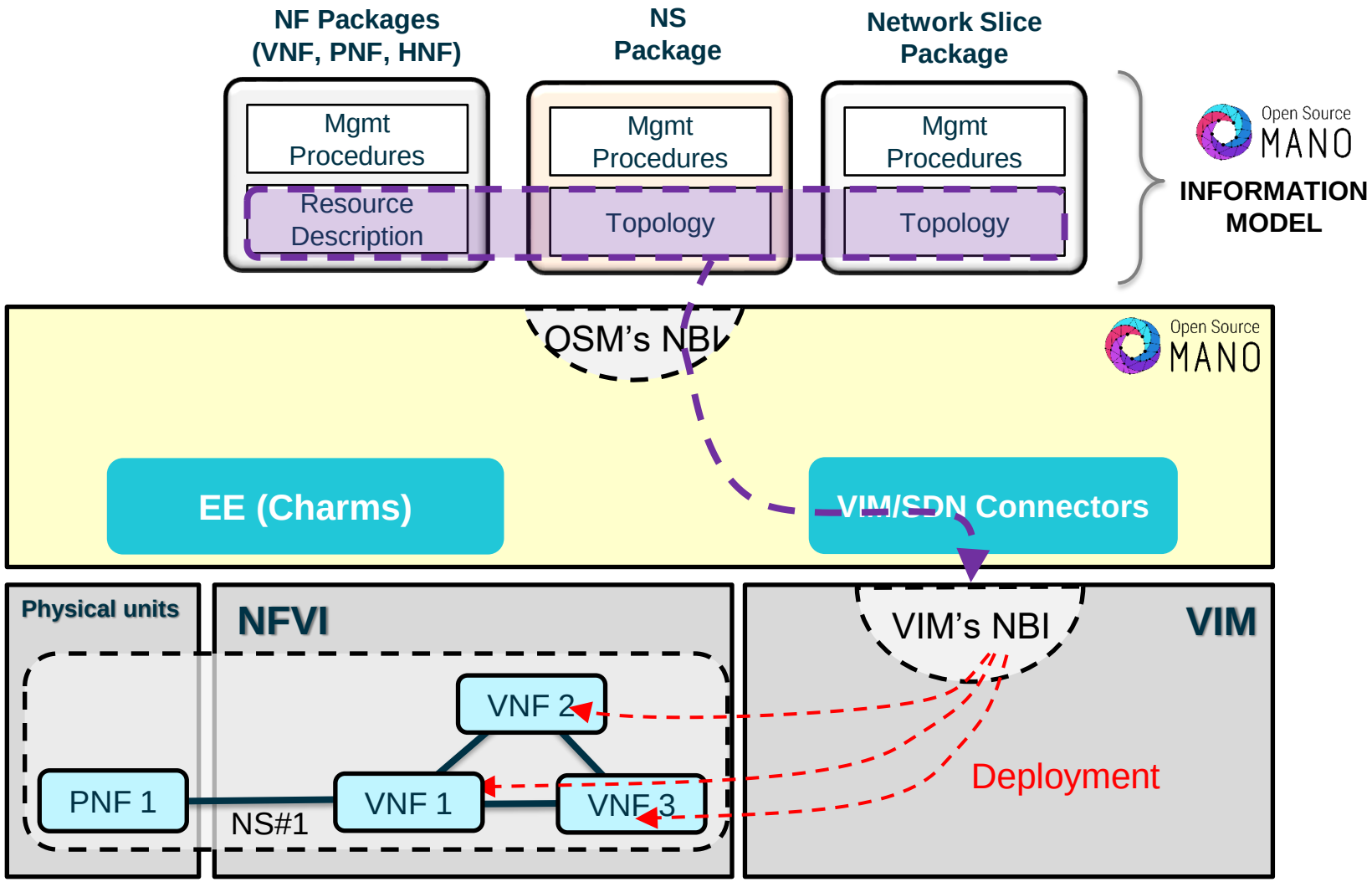
OSM
Model-driven NaaS platform

ETSI

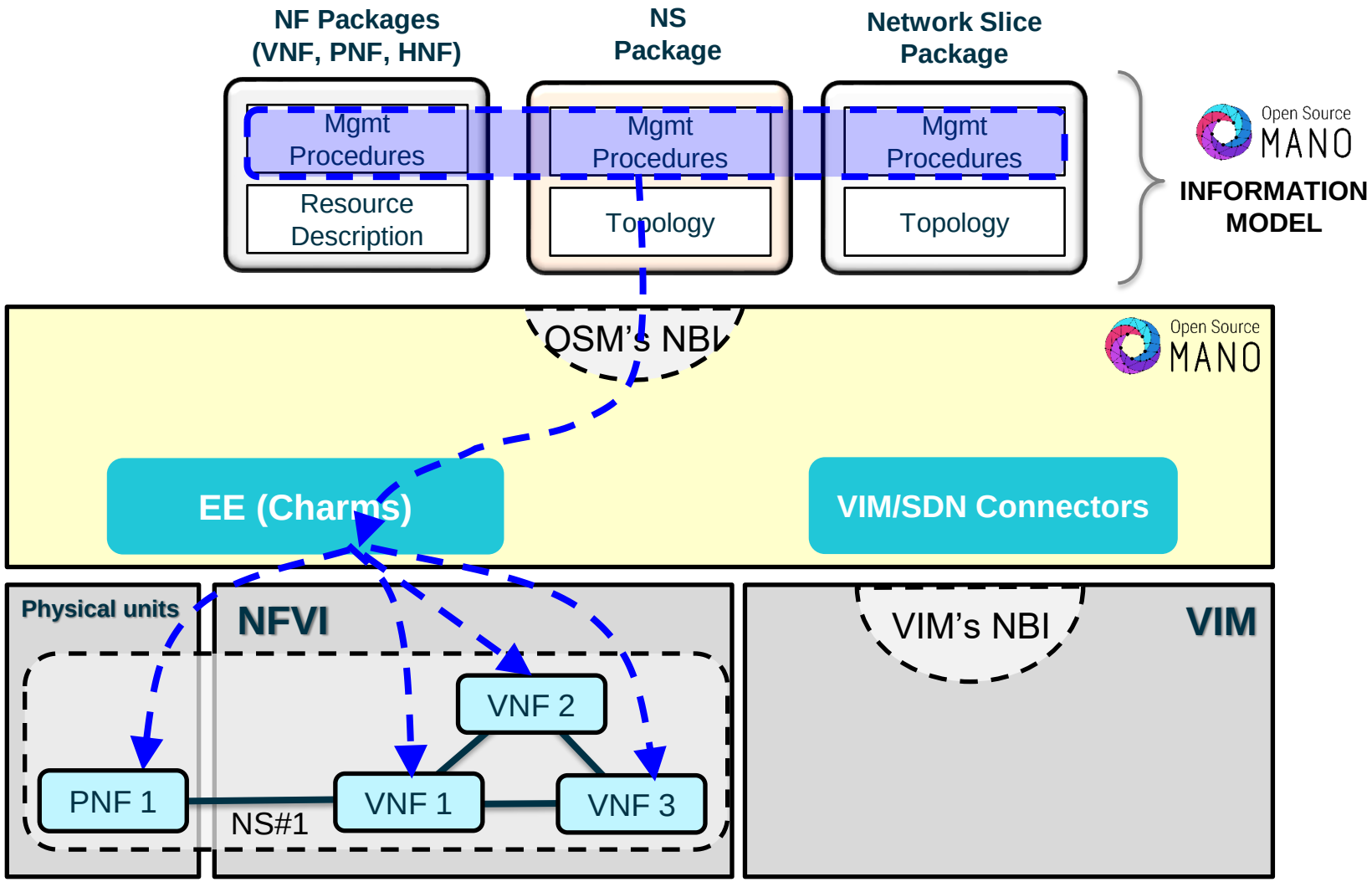
OSM provides a platform to create Networks as a Service (NaaS) and to manage them conveniently



Packages embed resource description and operational procedures

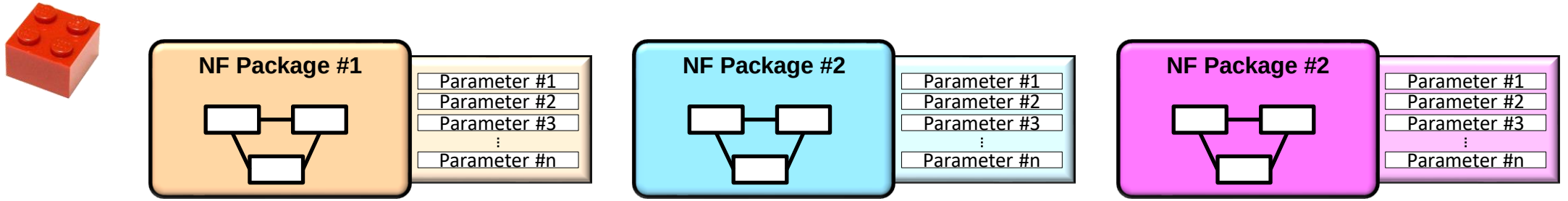


Packages embed resource description and operational procedures



All in OSM is model-driven to make VNFs and NS as portable and reusable as possible

(V)NF PACKAGES:



- **Provided by the vendor**, fully describe their own product:
  - Topology
  - Parametrized
  - Actions for Day-0, Day-1, and Day-2
- **Doesn't** need to know any detail about :
  - The target infrastructure
  - Other components that will be part of the scenario

All in OSM is model-driven to make VNFs and NS as portable and reusable as possible

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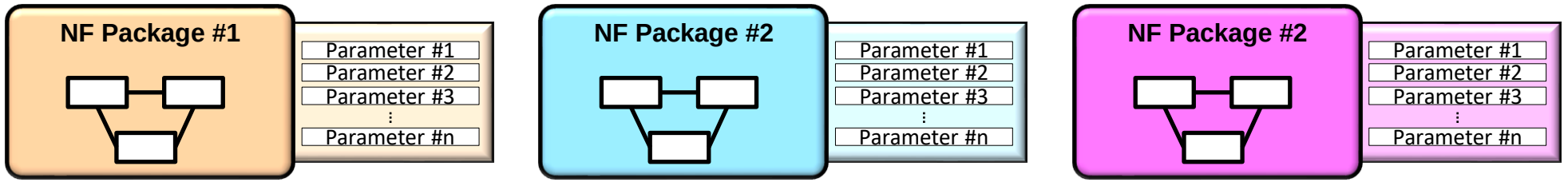
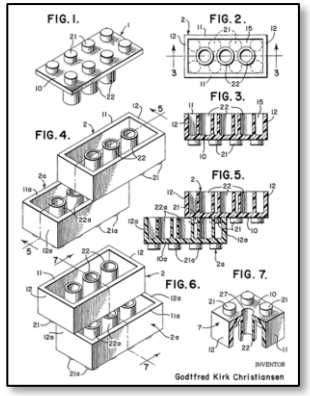
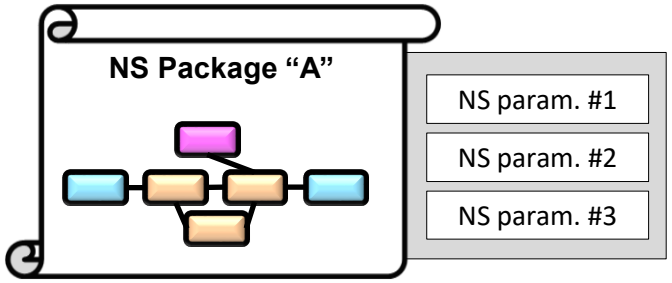
(V)NF PACKAGES:



NS PACKAGES / SLICE PACKAGES:





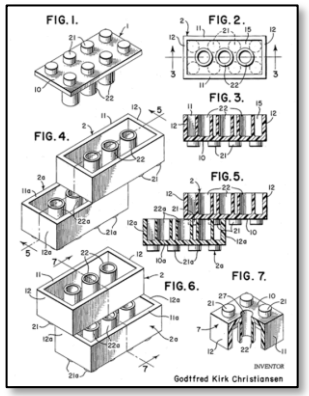
- Describes how to combine a set of NF packages to create a specific scenario.
- Parametrized.
- Have actions for Day-0, Day-1, and Day-2.

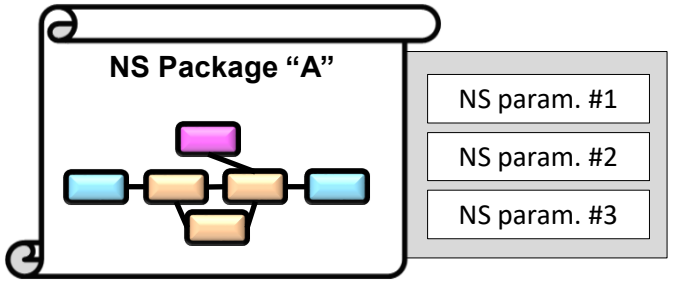
Slice Packages work similarly, but using NS as building blocks(*)

(*) NS instances play the role of Slice Subnets of a given slice. Some of them may be shared by more than one slice instance. This is taken into account by OSM, so a slice is more sophisticated than just a "NS of NS".

All in OSM is model-driven to make VNFs and NS as portable and reusable as possible

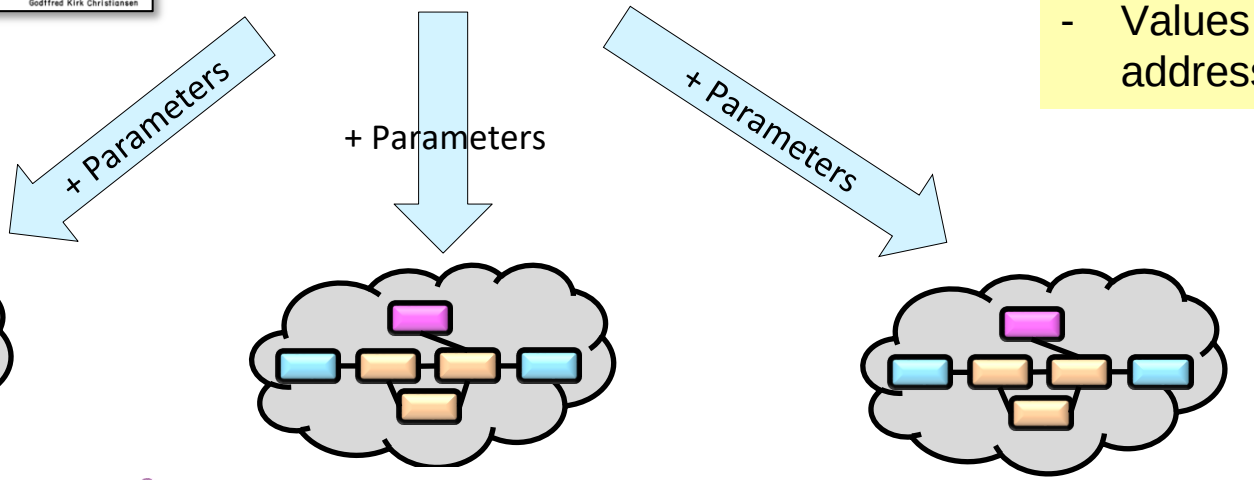
NS PACKAGES / SLICE PACKAGES:



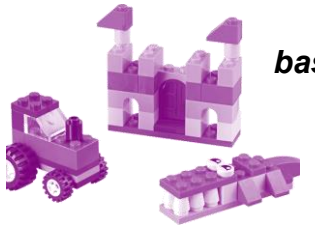


Upon instantiation, you just need to decide:
- The target VIM (or VIMs)
- Values for the parameters (IP addresses, keys, etc.)

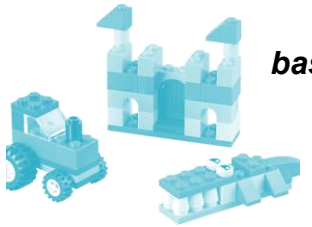
DEPLOYED INSTANCES:



Instance #1 based on NS "A"



Instance #2 based on NS "A"



Instance #3 based on NS "A"

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OSM Information Model

ETSI

What is OSM IM?

- Information model (IM) to define the different descriptor templates:
  - Network Function (NF)
  - Network Service (NS)
  - Network Slice (NST)
- OSM IM is based on YANG*.
- OSM IM aligned with ETSI NFV, derived from SOL006 (which, in turn, derives from IFA011 and IFA014).
  - IFA011 describes the VNF descriptor specification whereas IFA014 on NS descriptor.
- SOL006 alignment since OSM Release NINE (now available!)

(*) IETF RFC6020 YANG https://tools.ietf.org/html/rfc6020

OSM IM and SOL006

- OSM IM augments ETSI NFV SOL006 by adding the support of PDU, the support of Kubernetes applications, Network Slices, day-1 and day-2 primitives at VNF and NS level, and enhancements for dataplane workloads
- OSM IM:
  - User guide: https://osm.etsi.org/docs/user-guide/11-osm-im.html
  - Navigable versions: http://osm-download.etsi.org/ftp/osm-doc/rel9
  - OSM repo (Gitlab mirror): https://osm.etsi.org/gitlab/osm/im
- SOL006:
  - ETSI Gitlab: https://forge.etsi.org/rep/nfv/SOL006
- More details in next session

We need to differentiate between different stages

Design Time

- Building NF and NS descriptors by referencing the OSM Information Model.
- Building Day-1/Day-2 logic to complete the packages
- Testing your packages

Provisioning Time

- Onboarding: package validation and uploading

Run Time (see your VNF and NS in action)

- Instantiation (Deployment + Day 0 + Day 1). Here is where the operator decides:
  - In which VIM to deploy
  - What instantiation parameters to provide (specific IP addresses, configuration params)
- Operation phase (Day 2)

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Network Function and Network Service Modeling

ETSI

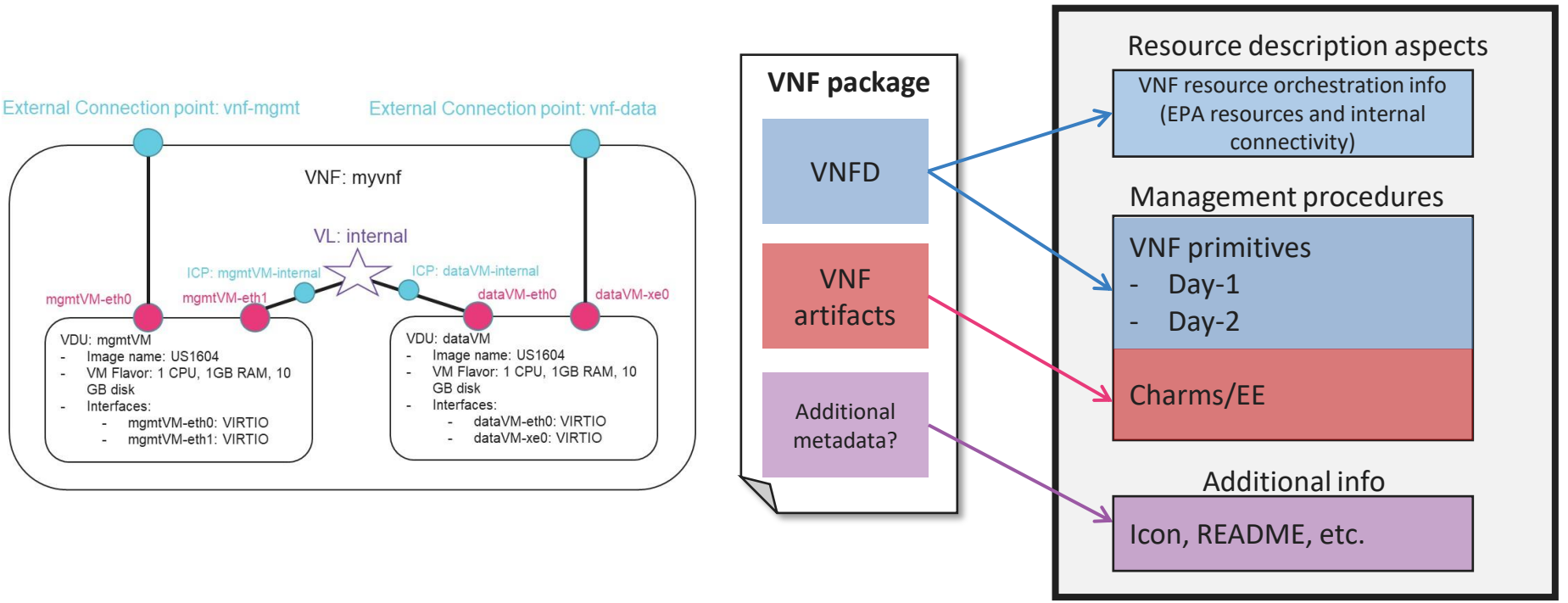
Modeling NF
NF package

xNF are modeled with a NF package, which consists of:

- Descriptor:
- Other files:
  - Charms
  - Helm-charts
  - KDU objects (juju bundle, helm chart)
  - Day-0 configuration files (i.e. cloudinit)
  - Checksums file

```
hackfest_virtual-pc_vnfd/
├── charms
│   ├── virtual-pc
├── cloud_init
│   └── virtual-pc_init
├── checksums.txt
└── virtual-pc_vnfd.yaml
```

Modeling NF
NF package vs NF descriptor



Modeling NF
VNF descriptor

Open Source MANO

Descriptors are written in YAML and contain:

- Topology description (VDU, internal VLD, Connection Points)
- Scaling-groups
- Monitoring params
- Reference to day-0 configuration file
- Execution environment list (e.g. charms, monitoring environments)
- Day-1 primitives (sequence)
- Day-2 primitives

```
vnfd:
  description: Virtual Desktop Computer
  ext-cpd:
  - id: virtual-pc-private-ext
    int-cpd:
      cpd: eth0-int
      vdu-id: virtual-pc
  id: hackfest_virtual-pc_vnf
  mgmt-cp: virtual-pc-mgmt-ext
  product-name: hackfest_virtual-pc_vnf
  sw-image-desc:
  - id: ubuntu20.04
    image: ubuntu20.04
  vdu:
  - cloud-init-file: virtual-pc_init
    description: virtual-pc
    id: virtual-pc
    int-cpd:
    - id: eth0-int
      virtual-network-interface-requirement:
      - name: eth0
        virtual-interface:
          type: PARAVIRT
    - id: eth1-int
  version: '1.0'
  virtual-compute-desc:
  - id: virtual-pc-vdu-compute
    virtual-cpu:
      num-virtual-cpu: 8
    virtual-memory:
      size: 32.0
  virtual-storage-desc:
  - id: virtual-pc-vdu-storage
```

Modeling NF
CNF descriptor

CNF descriptors must contain:

- List of KDU (and their associated helm-chart or juju-bundle)
- K8s cluster requirements

```
vnfd:
  description: CNF with single KDU
  df:
  - id: default-df
  ext-cpd:
  - id: mgmt-ext
    k8s-cluster-net: mgmtnet
  id: openldap_knf
  k8s-cluster:
    nets:
    - id: mgmtnet
  kdu:
  - name: ldap
    helm-chart: stable/openldap
  mgmt-cp: mgmt-ext
  product-name: openldap_knf
  provider: Telefonica
  version: '1.0'
```

Modeling NF
PNF descriptor

PNF descriptors must contain:

- List of PDU (VDU with a pdu-type)

Available PDU must be registered to OSM upfront, since they are physical elements already available in the network

```
vnfd:
  description: PNF entry for a firewall router
  df:
  - id: default-df
    instantiation-level:
    - id: default-instantiation-level
      vdu-level:
      - number-of-instances: 1
        vdu-id: vyos-VM
    vdu-profile:
    - id: vyos-VM
      min-number-of-instances: 1
  ext-cpd:
  - id: gateway_public
    int-cpd:
      cpd: gateway_public
      vdu-id: vyos-VM
  - id: vnf_internal
    int-cpd:
      cpd: vnf_internal
      vdu-id: vyos-VM
  id: hackfest_firewall_pnf
  mgmt-cp: gateway_public
  product-name: hackfest_firewall_pnf
  vdu:
  - id: vyos-VM
    pdu-type: gateway
    int-cpd:
    - id: gateway_public
      virtual-network-interface-requirement:
      - name: gateway_public
    - id: vnf_internal
      virtual-network-interface-requirement:
      - name: vnf_internal
    name: vyos-VM
```

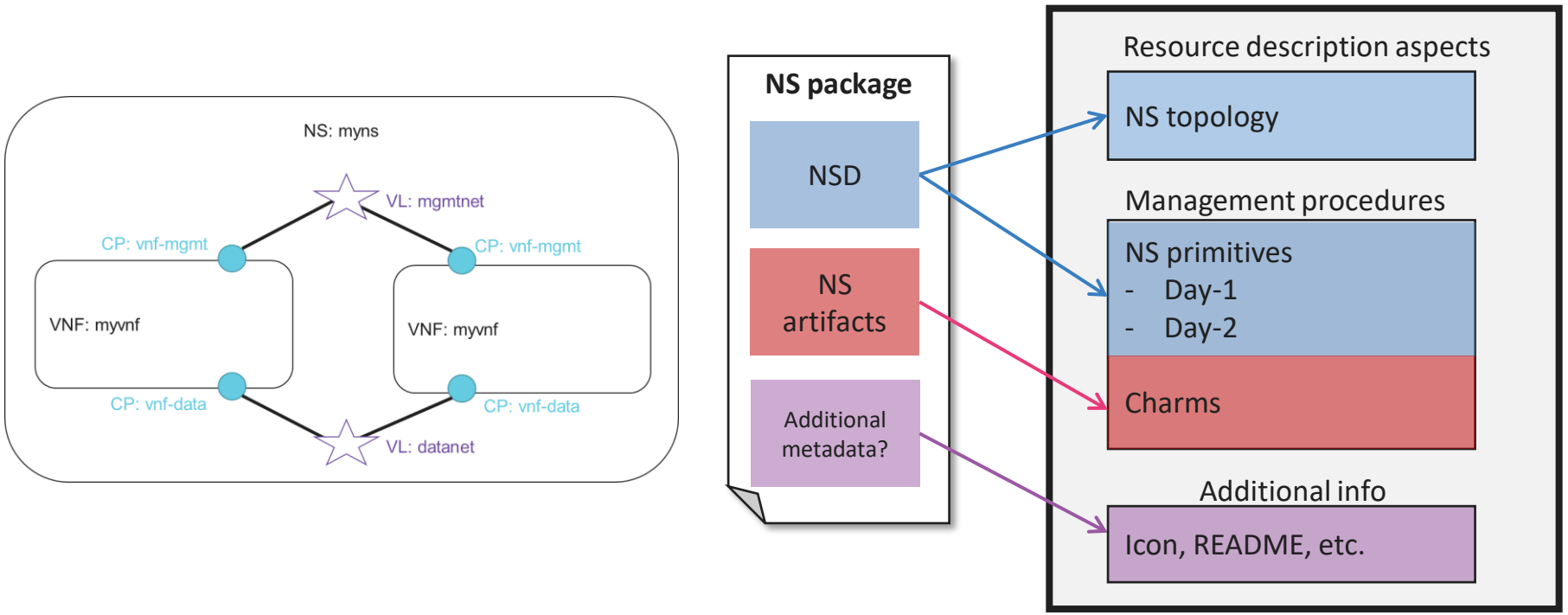
Modeling NS
NS package

Network Services are modeled with a NS package, which consists of:

- Descriptor:
- Other files:
  - Charms
  - Checksums file

```
hackfest_virtual-pc_ns
├── README.md
├── checksums.txt
└── hackfest_virtual-pc_nsd.yaml
```

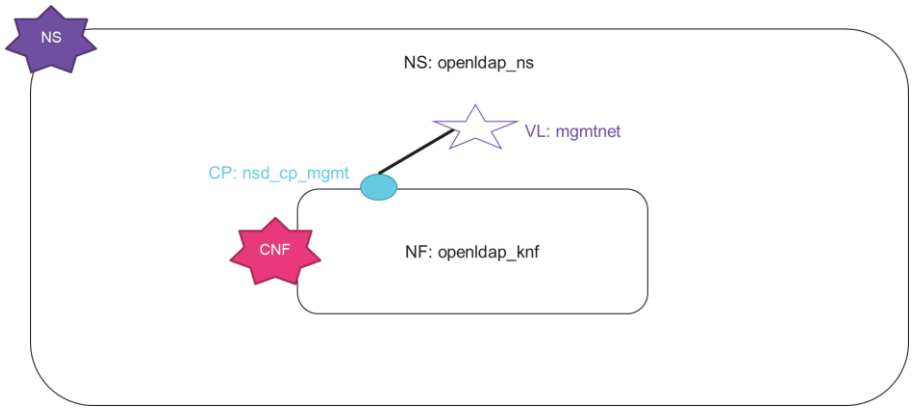
Modeling NS
NS package vs NS descriptor



Modeling NS
NS descriptor

Descriptors are written in YAML and contain:

- Topology description (NF, VL)
- Execution environment list (e.g. charms)
- Day-1 primitives (sequence)
- Day-2 primitives




```
vnfd:
  description: Virtual Desktop Computer
  ext-cpd:
  - id: virtual-pc-private-ext
    int-cpd:
      cpd: eth0-int
      vdu-id: virtual-pc
  id: hackfest_virtual-pc_vnf
  mgmt-cp: virtual-pc-mgmt-ext
  product-name: hackfest_virtual-pc_vnf
  sw-image-desc:
  - id: ubuntu20.04
    image: ubuntu20.04
  vdu:
  - cloud-init-file: virtual-pc_init
    description: virtual-pc
    id: virtual-pc
    int-cpd:
    - id: eth0-int
      virtual-network-interface-requirement:
      - name: eth0
        virtual-interface:
          type: PARAVIRT
    - id: eth1-int
  version: '1.0'
  virtual-compute-desc:
  - id: virtual-pc-vdu-compute
    virtual-cpu:
      num-virtual-cpu: 8
    virtual-memory:
      size: 32.0
  virtual-storage-desc:
  - id: virtual-pc-vdu-storage
```

Modeling Network Slices
Network Slice Templates(NST)

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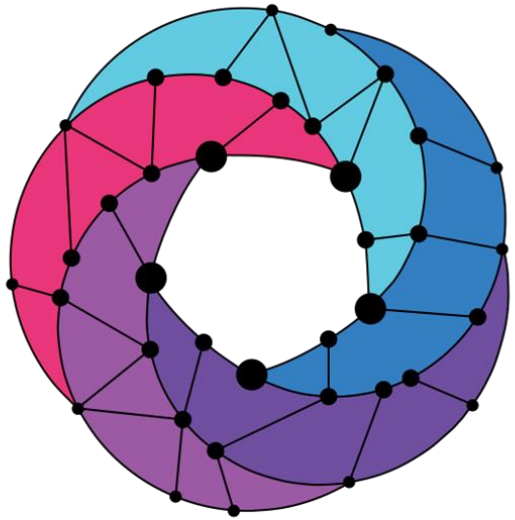
NST are written in YAML and contain:

- List of netslice subnets
  - References to Network Services
  - Whether they are shared or not
- List of netslice vlds (networks interconnecting the subnets)

```
nst:
-   id: slice_basic_nst
    name: slice_basic_nst
    netslice-subnet:
    -   id: slice_basic_nsd_1
        is-shared-nss: false
        description: NetSlice Subnet (service) composed by 1 vnf with 2 cp
        nsd-ref: slice_basic_ns
    -   id: slice_basic_nsd_2
        is-shared-nss: true
        description: NetSlice Subnet (service) composed by 1 vnf with 2 cp
        nsd-ref: slice_basic_middle_ns
    netslice-vld:
    -   id: slice_vld_mgmt
        name: slice_vld_mgmt
        type: ELAN
        mgmt-network: true
        nss-connection-point-ref:
        -   nss-ref: slice_basic_nsd_1
            nsd-connection-point-ref: nsd_cp_mgmt
        -   nss-ref: slice_basic_nsd_2
            nsd-connection-point-ref: nsd_cp_mgmt
-   id: slice_vld_data1
        name: slice_vld_data1
        type: ELAN
        nss-connection-point-ref:
        -   nss-ref: slice_basic_nsd_1
            nsd-connection-point-ref: nsd_cp_data
        -   nss-ref: slice_basic_nsd_2
            nsd-connection-point-ref: nsd_cp_data
```



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