OASIS

TOSCA

Topology and Orchestration Specification for Cloud Applications (TOSCA) Standard

How TOSCA Adds Value in the NFV world

OASIS TOSCA Presentation for the ETSI NFV Information Modeling Workshop

Overview and Proposal for a way forward

Agenda - *How TOSCA Adds Value in the NFV world*

I. **TOSCA Overview**
   - **What is TOSCA?**
   - **TOSCA Key Modeling Concepts**
     - Topology, Composition, Lifecycle (management), Portability
   - **Interesting Features**
     - Containers, Portability, Network modeling

II. **A Way Forward**
   - **TOSCA Modeling Applied to NFV**
     - Topology & Composition Concepts applied to NFV (NSD, VNF, VNFFG, NFP)
   - **Open Source Implementations**
     - Openstack (*Heat-Translator, Tacker, Senlin*), alien4cloud, Cloudify, etc.
   - **Backup slides**
     - Layering, Lifecycle sequencing, Policy model

TOSCA

Overview

Key Modeling Concepts & Features

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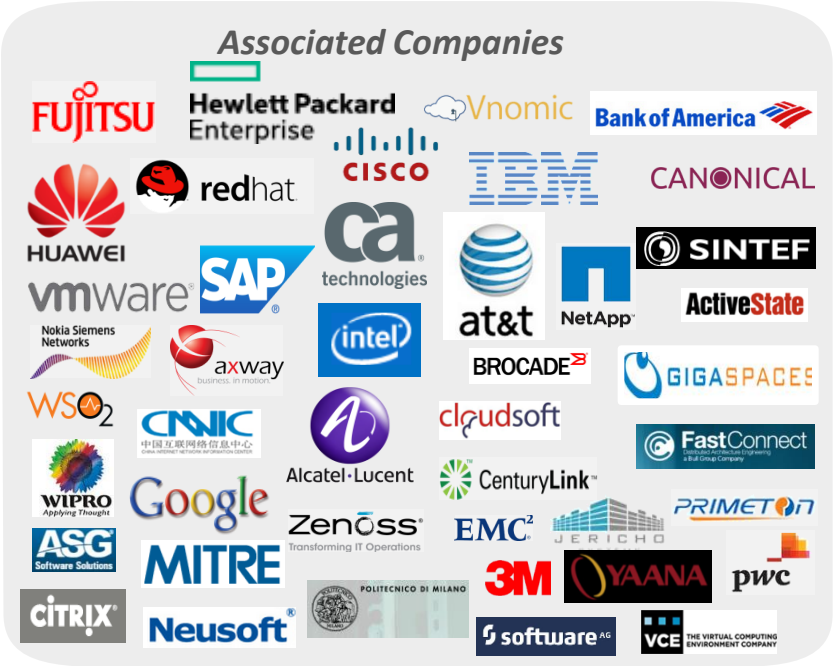
What is TOSCA?

TOSCA is an important **new open cloud standard,** that is enabling a unique eco-system, supported by a large and growing number of international industry leaders…

- **TOSCA Version 1.0 Specification approved as an OASIS Standard** *(published Nov 2013)*
- **TOSCA Simple Profile v1.0 Specification (YAML)** *final public review draft, Aug 2014)*
- **Government and Corporate Awareness**:
  - **OASIS**: 600+ participant organizations. 5000+ participants spanning 65+ countries
  - **TOSCA Committee**: 170+ people 45+ companies/orgs
  - **International Standards & Research**: ETSI NFV liaison, EU FP7, etc.
  - **Industry Analysts**: Forrester names TOSCA as a top four cloud open standard *(Mar 2014)*
- **Multi-company Interoperability Demonstrated**:
  - **OSCON 2015, Open Data Center Alliance 2014, EuroCloud 2013**



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Topology

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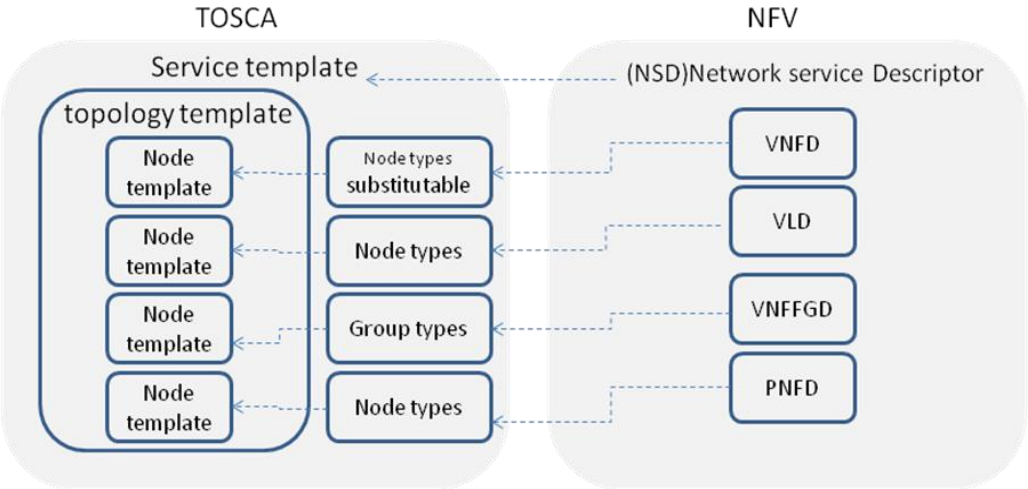
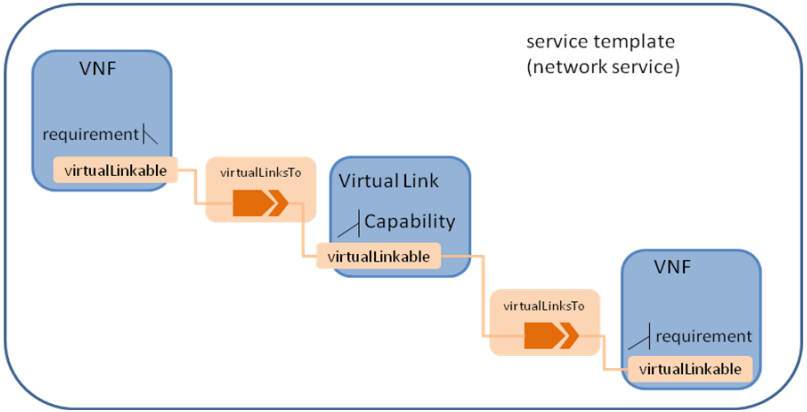
- ✓ Defining **Node templates** to describe components in the topology structure
- ✓ Defining **Relationship templates** to describe connections, dependencies, deployment ordering



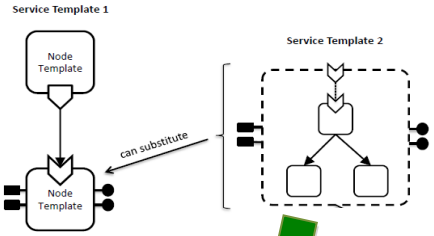


TOSCA can be used to describe the topology of a Network service or VNF as defined by ETSI NFV.

VNF, VL can be defined as node templates in TOSCA. A new virtualLinksTo relationship type can be defined to connect VNF and VL.

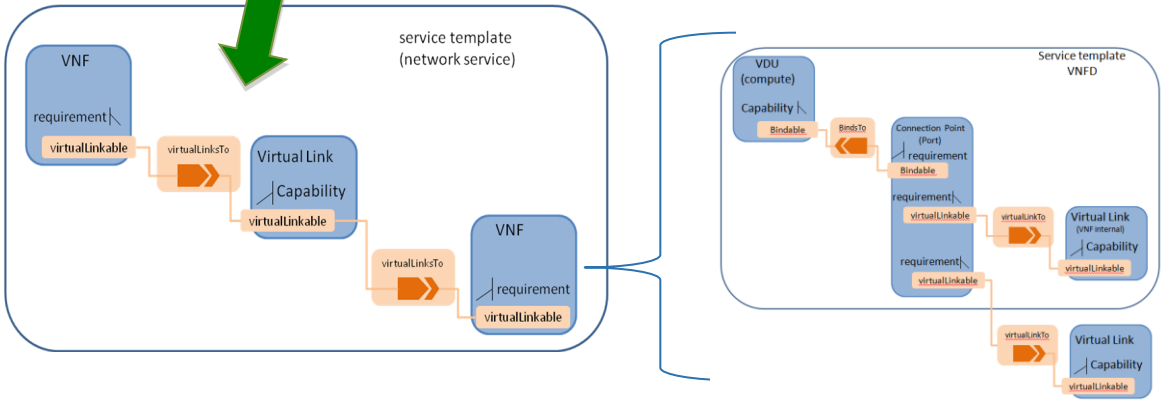
Composition

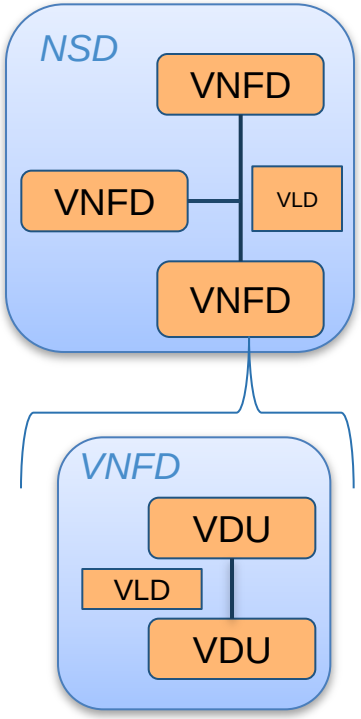
Any node in a TOSCA topology can be an abstraction of another layer or sub-topology



NFV information model has such a layered structure:

- ✓ ***NSDs are composed of VNFDs, VLDs, PNFDs, etc.***
- ✓ ***VNFDs are composed of VDUs, VLDs, etc.***





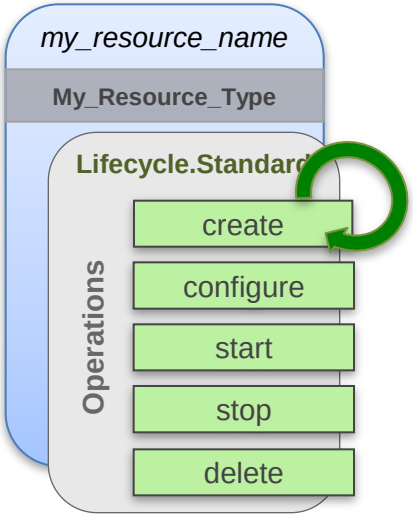
Using the TOSCA substitution feature, NFV information model can be described by using multiple TOSCA service templates

Lifecycle

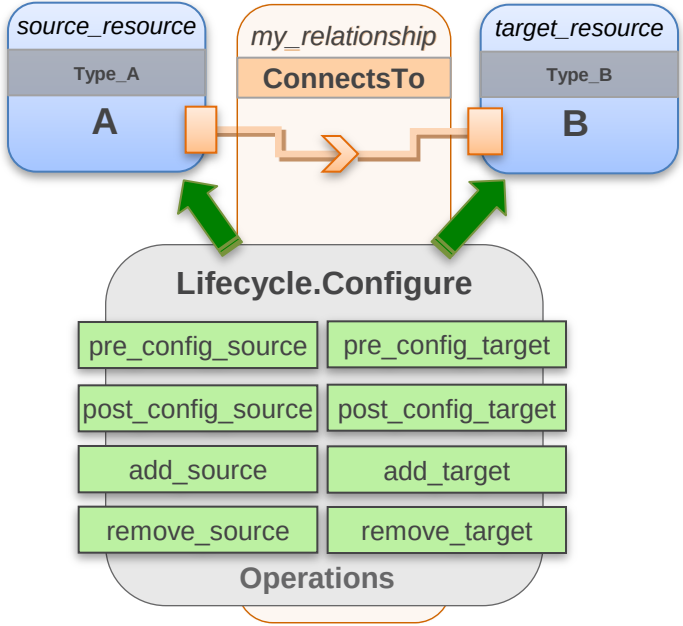
TOSCA models have a consistent view of state-based lifecycle

- ✓ have **Operations** (implementations) that can be sequenced against state of any dependent resources
- ✓ *fits into any* ***Management Framework*** *or* ***Access Control System***

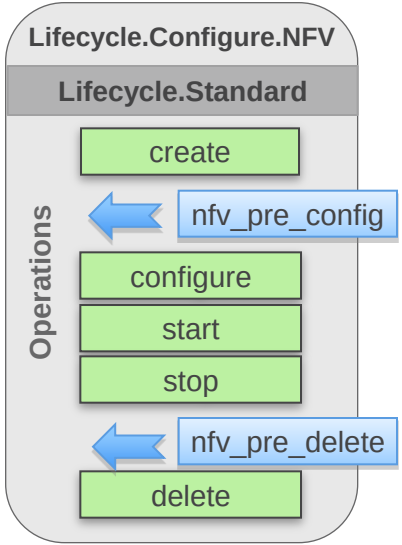
Standardize Resource Lifecycle



Standardize Relationship Lifecycle



Lifecycle Customization

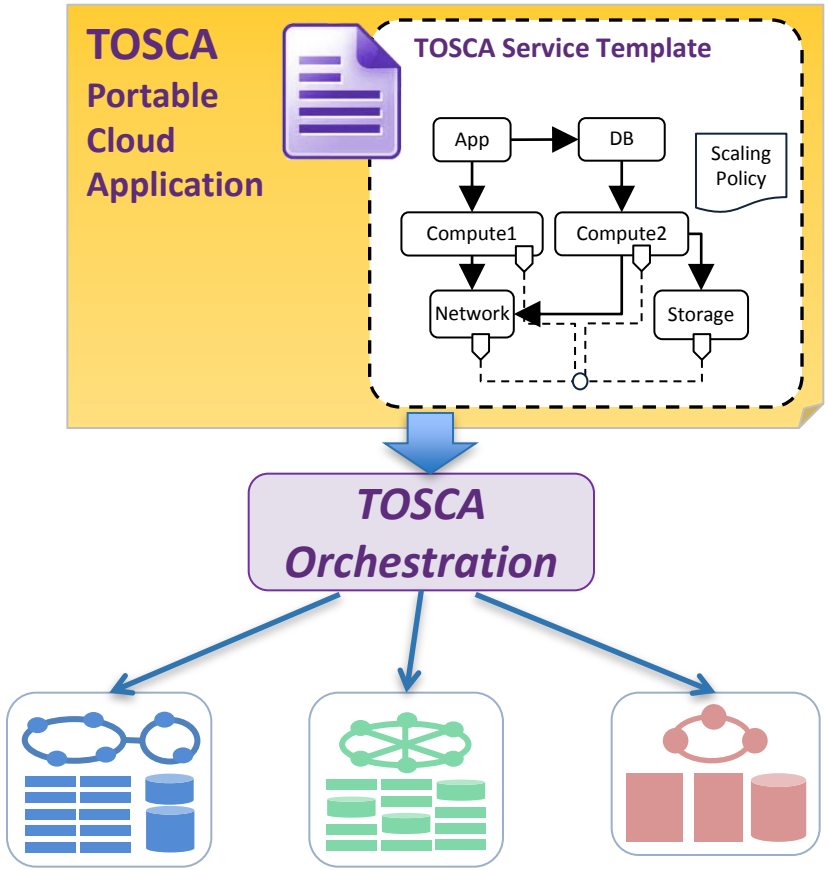


Create new NFV Lifecycles or Augment existing (via subclassing)

- ✓ **Parameters** and **Policies** can be supplied to operations to affect resource behavior (state)
- ✓ **Workflow** - TOSCA is developing workflow to allow handling complex state changes, configurations, etc.

TOSCA Lifecycle can be customized for NFV Resources and Relationships

Portability



By expressing application *Requirements* independently from cloud *Capabilities* and implementation, TOSCA provides:

- ✓ Robust set of **Normative Types** for different domains (including NFV)
- ✓ ***NFV Profile and Types applied to TOSCA enable our Way Forward.***
- ✓ Multi VIM Support
- ✓ Portability of services across clouds
- ✓ Declarative model spanning infrastructure and service
- ✓ Manipulate the orchestration declaratively instead of dealing with disparate cloud APIs *(leave to the TOSCA Orchestrator)*

TOSCA enables NFV applications flexible movement between different cloud infrastructures.

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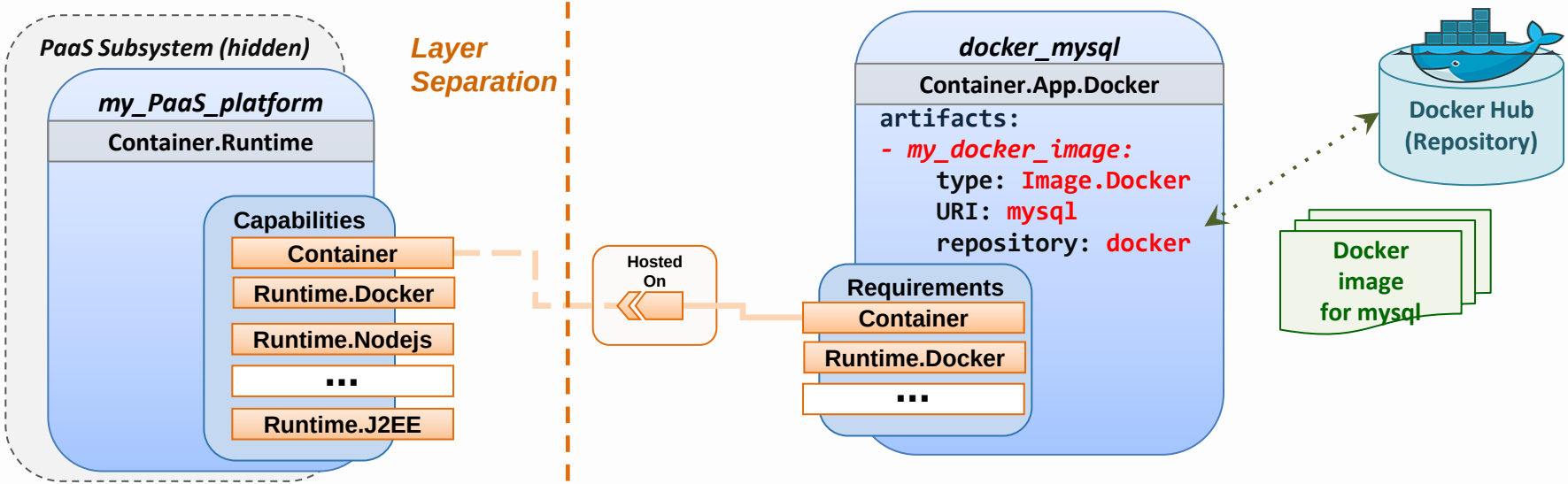
TOSCA Model for Containers leveraging Repositories

PaaS Modeling

- *Provider chooses to expose or hide underlying runtime topology & implementation*

Container Application Modeling

- ***Agnostic of PaaS Cloud Provider***
  - *PaaS on OpenStack, Cloud Foundry, Azure, etc.*



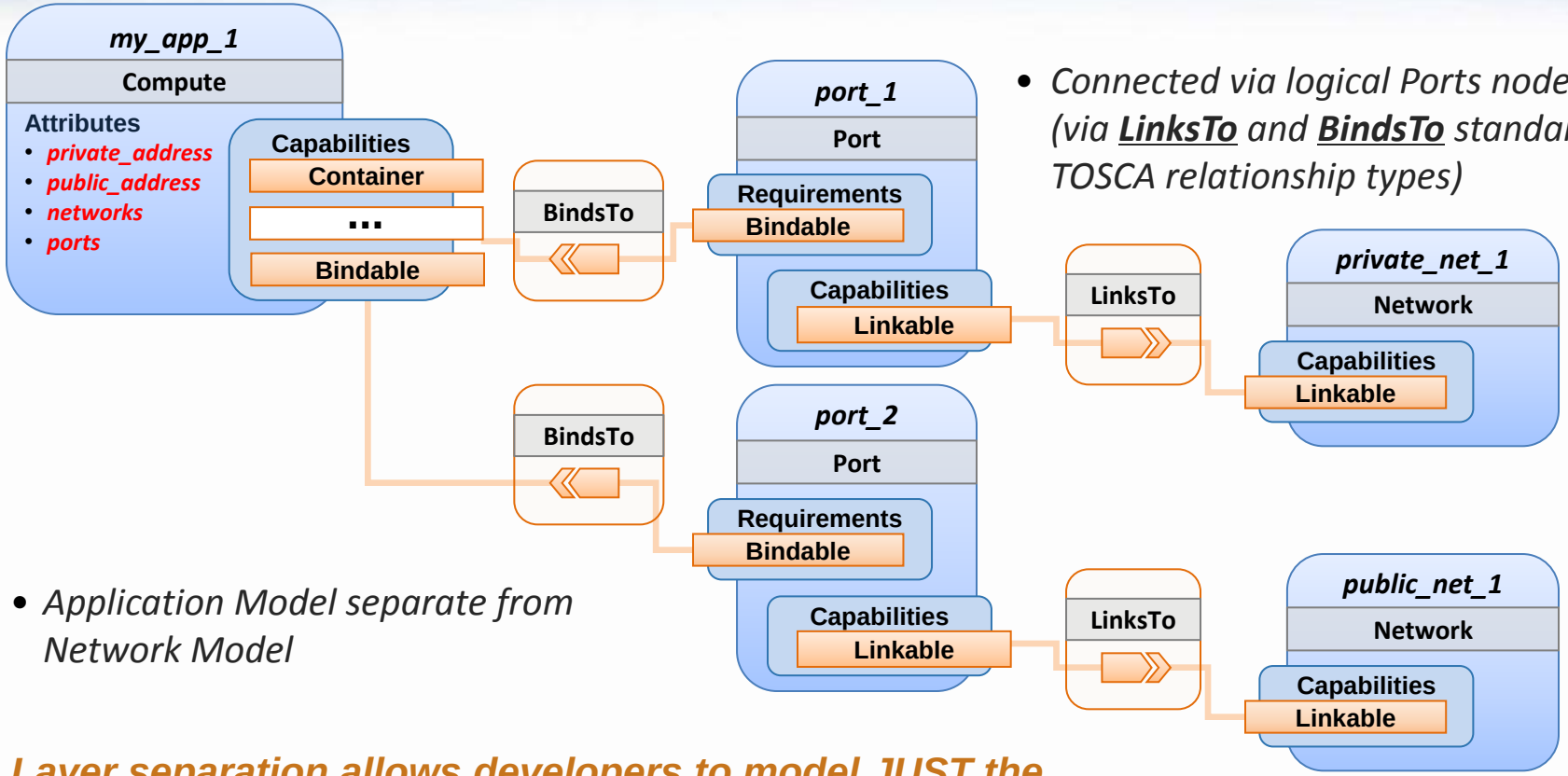
PaaS Layer exposes "runtimes" as TOSCA Capabilities

- *Docker, Nodejs, JSP, J2EE, etc.*

Orchestrators could automatically retrieve and deploy a Docker image from a declared Repository

- *TOSCA Templates can model repositories*
- *Orchestrators could dynamically "pull" from multiple repositories*

TOSCA Model for Logical Public & Private Cloud Networks



- *Connected via logical Ports nodes (via **LinksTo** and **BindsTo** standard TOSCA relationship types)*

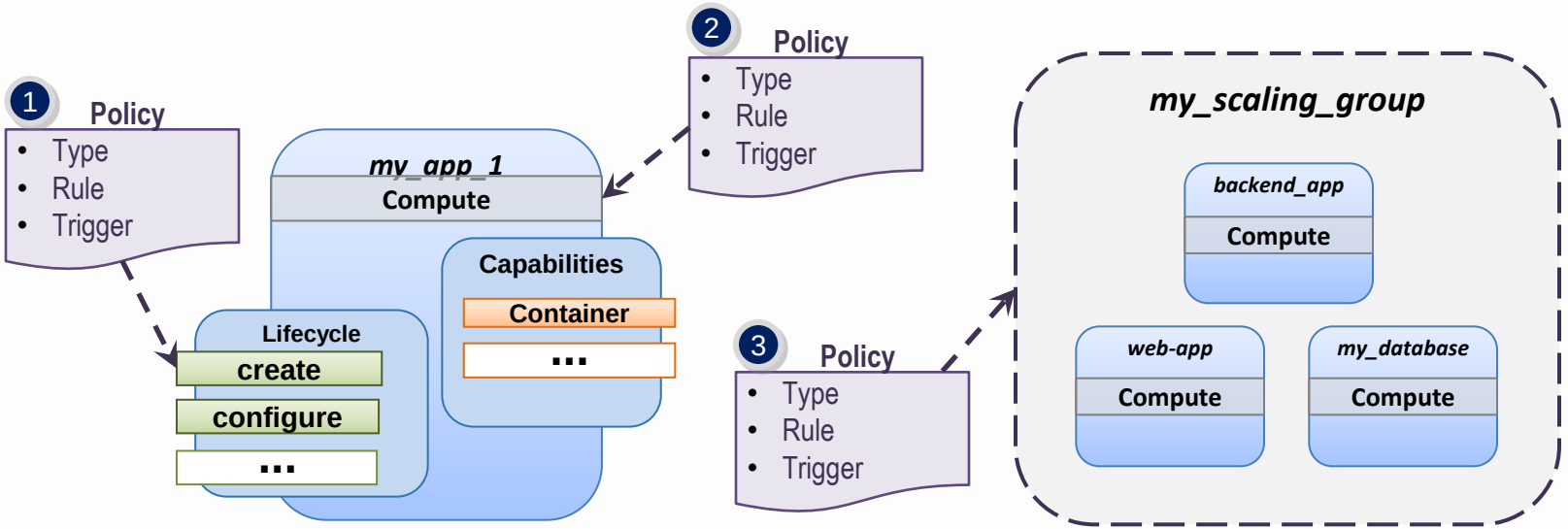
- *Application Model separate from Network Model*

Layer separation allows developers to model JUST the application & bind later to existing tenant networks *(Layer 4)*

TOSCA Direction to model Policies

TOSCA defines policies using an Event-Condition-Action model

- ✓ Operational policy focus: **Placement** (Affinity), **Scaling** and **Performance**
  - *with **Rules** that are evaluated to execute Automatic and Imperative **Triggers***



Policies modeled as ***Requirements*** using *Capability Types that can be attached to*

1. *Interfaces for specific **Operations***
2. ***Nodes** and*
3. ***Groups** of Nodes*

End Part 1
TOSCA Overview

TOSCA

The Way forward

TOSCA Concepts Applied to NFV

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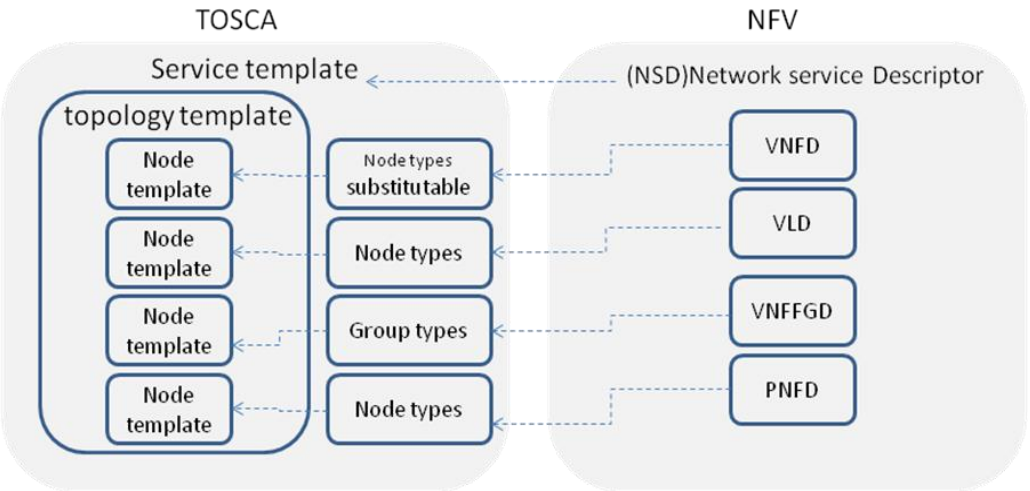

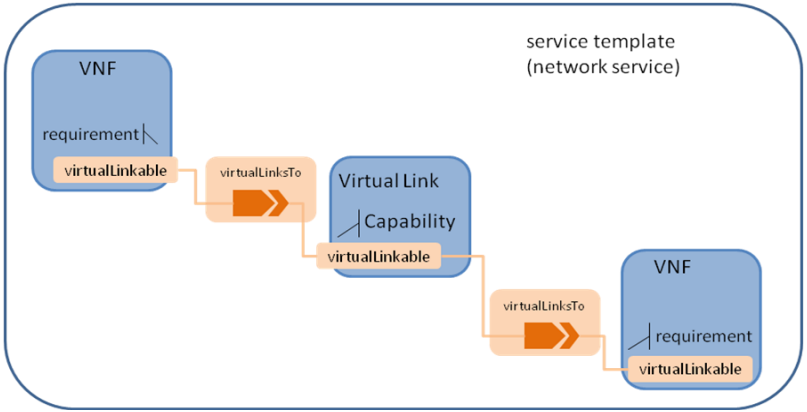

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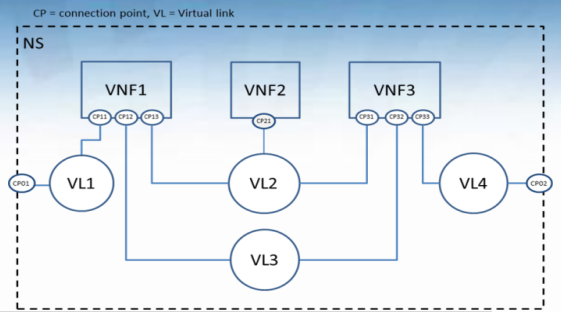
NSD example




```
tosca_definitions_version:      tosca_simple_profile_for_nfv_1_0_0
tosca_default_namespace:    # Optional. default namespace (schema, types version)
template_name:                  # Optional name of this service template
template_author:                # Optional author of this service template
template_version:               # Optional version of this service template
description: example for a NSD.
service_properties:
    ID:                                 # ID of this Network Service Descriptor
    vendor:                             # Provider or vendor of the Network Service
    version:                            # Version of the Network Service Descriptor
imports:
    - tosca_base_type_definition.yaml
    # list of import statements for importing other definitions files
```

```
topology_template:
    inputs:
        flavor ID:
    VNF1:
        type: tosca.nodes.nfv.VNF.VNF1
        properties:
            Scaling methodology:
            Flavour ID:
            Threshold:
            Auto-scale policy value:
            Constraints:
        requirements:
            virtualLink: VL1
            virtualLink: VL2
            virtualLink: VL3
```

```
VNF2:
        type: tosca.nodes.nfv.VNF.VNF2
        properties:
            Scaling methodology:
            Flavour ID:
            Threshold:
            Auto-scale policy value:
            Constraints:
        requirements:
            virtualLink: VL2
VNF3:
        type: tosca.nodes.nfv.VNF.VNF3
        properties:
            Scaling methodology:
            Flavour ID:
            Threshold:
            Auto-scale policy value:
            Constraints:
        requirements:
            virtualLink: VL2
            virtualLink: VL3
            virtualLink: VL4
CP01            #endpoints of NS
        type: tosca.nodes.nfv.CP
```

```
        properties:
            type:
        requirements:
            virtualLink: VL1
CP02            #endpoints of NS
        type: tosca.nodes.nfv.CP
        properties:
            type:
        requirements:
            virtualLink: VL4
```

```
VL1
        type: tosca.nodes.nfv.VL.Eline
        properties:
            # omitted here for brevity
        capabilities:
            -virtual linkable
              occurrences: 2

VL2
        type: tosca.nodes.nfv.VL.ELAN
        properties:
            # omitted here for brevity
        capabilities:
            -virtual linkable
              occurrences: 5
VL3
        type: tosca.nodes.nfv.VL.Eline
        properties:
            # omitted here for brevity
        capabilities:
            -virtual linkable
              occurrences: 2
```

```
VL4
        type: tosca.nodes.nfv.VL.Eline
        properties:
            # omitted here for brevity
         capabilities:
```

```
            -virtual linkable
              occurrences: 2
```

Composition

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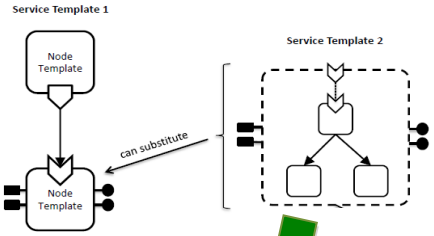

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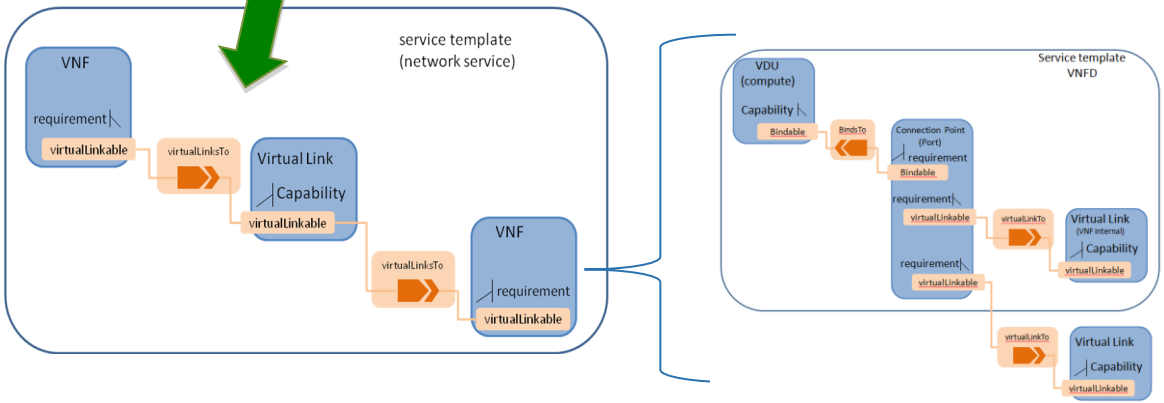

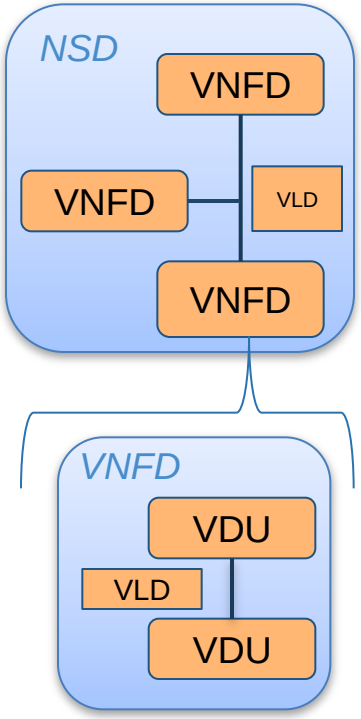

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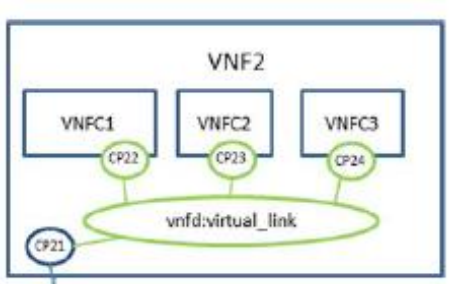
VNFD example




```
tosca_definitions _version:      tosca_simple_profile_for_nfv_1_0_0
tosca_default_namespace :    # Optional. default namespace (schema, types version)
template_name:                    # Optional name of this service template
template_author:                  # Optional author of this service template
template_version:                 # Optional version of this service template
description: example for VNF2
service_properties:
    ID:                                  # ID of this VNF Descriptor
    vendor:                              # Provider or vendor of the VNF
    version:                             # Version of VNF software, described by the
descriptor under consideration
imports:
    - tosca_base_type_definition.yaml
  # list of import statements for importing other definitions files
topology_template:

inputs:

subsititution_mappings:
     node_type: tosca.nodes.nfv.VNF.VNF2
     requirements:

       virtualLinkable: [CP21, virtualLinkable]
```

```
node_templates:
    VDU1:
       type: tosca.nodes.nfv.VDU
       properties:
          # omitted here for brivity
       requirements:
          - host:
            node_filter:
              capabilities:
                # Constraints for selecting “host” (Container Capability)
                - host
                   properties:
                     - num_cpus: { in_range: [ 1, 4 ] }
                     - mem_size: { greater_or_equal: 2 GB }
                # Constraints for selecting “os” (OperatingSystem Capability)
                - os:
                   properties:
                     - architecture: { equal: x86_64 }
                     - type: linux
                     - distribution: ubuntu       Interfaces:
                      # omitted here for brevity
       artifacts:
          VM_image:vdu1.image  #the VM image of VDU1
       Interface:
         Standard:
         create:vdu1_install.sh
         configure:
           implementation: vdu1_configure.sh
VDU2:
   type: tosca.nodes.nfv.VDU
   properties:
     # omitted here for brivity

VDU3:
   type: tosca.nodes.nfv.VDU
   properties:
     # omitted here for brivity
```

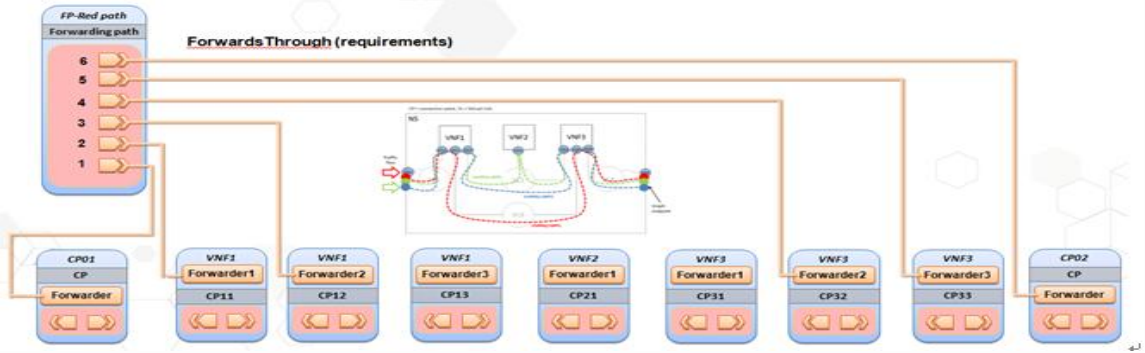
```
CP21:          #endpoints of VNF2

   type: tosca.nodes.nfv.CP
   properties:
     type:
   requirements:
     virtualbinding: VDU1

CP22:
   type: tosca.nodes.nfv.CP
   properties:
     type:
   requirements:
     virtualbinding: VDU1
     virtualLink: internal_VL
CP23
    type: tosca.nodes.nfv.CP
    properties:
      type:
    requirements:
      virtualbinding: VDU2
      virtualLink: internal_VL

CP24
    type: tosca.nodes.nfv.CP
    properties:
      type:
    requirements:
      virtualbinding: VDU3
      virtualLink: internal_VL
internal_VL
   type: tosca.nodes.nfv.VL.ELAN
   properties:
     # omitted here for brivity
   capabilities:
     -virtual_linkable
        occurrences: 5
```

Network forwarding path as defined by **ETSI NFV** is an order list of connection points forming a chain of network functions (VNFs or PNFs). A new "Forwarder" requirement is defined in this specification to model the network forwarding path by using ordered list of multiple "Forwarder" requirements. Each "Forwarder" requirement points to a single connection point.

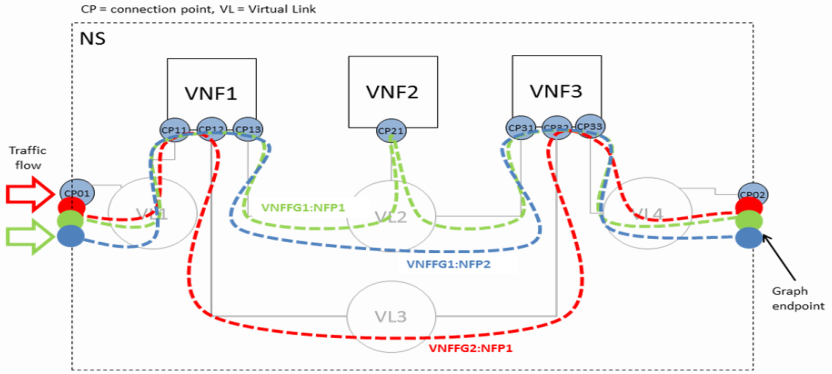



```
Forwarding path1:
      type: tosca.nodes.nfv.FP
      description: the path (CP01→CP11→CP13→CP21→CP31→CP33→CP02)
      properties:
         policy:
      requirements:
         -forwarder: CP01
         -forwarder: VNF1
           capability: forwarder1          #CP11
         -forwarder: VNF1
           capability: forwarder3          #CP13
         -forwarder: VNF2
           capability: forwarder1          #CP21
         -forwarder: VNF3
           capability: forwarder1          #CP31
         -forwarder: VNF3
           capability: forwarder3          #CP33
         -forwarder: CP02
```

Using TOSCA **Group** element to describe forwarding graphs

```
Groups:
    VNFFG1:
      type: tosca.groups.nfv.vnffg
      description: forwarding graph 1
      properties:
        vendor:
        version:
        vl: [VL1,VL2,VL4]
        vnf: [VNF1,VNF2,VNF3]
      targets: [Forwarding path1, Forwarding path2]

    VNFFG2:
      type: tosca.groups.nfv.vnffg
      description: forwarding graph 2
      properties:
        vendor:
        version:
        vl: [VL1,VL3,VL4]
        vnf: [VNF1,VNF2]
      targets: [Forwarding path3]
```



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TOSCA in Open Source

openstack

Heat-Translator

TOSCA Template Translation
to other Domain Specific Languages (DSLs)
https://wiki.openstack.org/wiki/Heat-Translator

Senlin

Clustering
+ Placement & Scaling Policies
https://wiki.openstack.org/wiki/Senlin

Tacker

NFV MANO

https://wiki.openstack.org/wiki/Tacker

Cloudify

Service Orchestration & Management
http://getcloudify.org/

alien4cloud

Topology, Type & LCM Design
http://alien4cloud.github.io/

Seaclouds

Open, Multi-Cloud Managemnt

www.seaclouds-project.eu/media.html

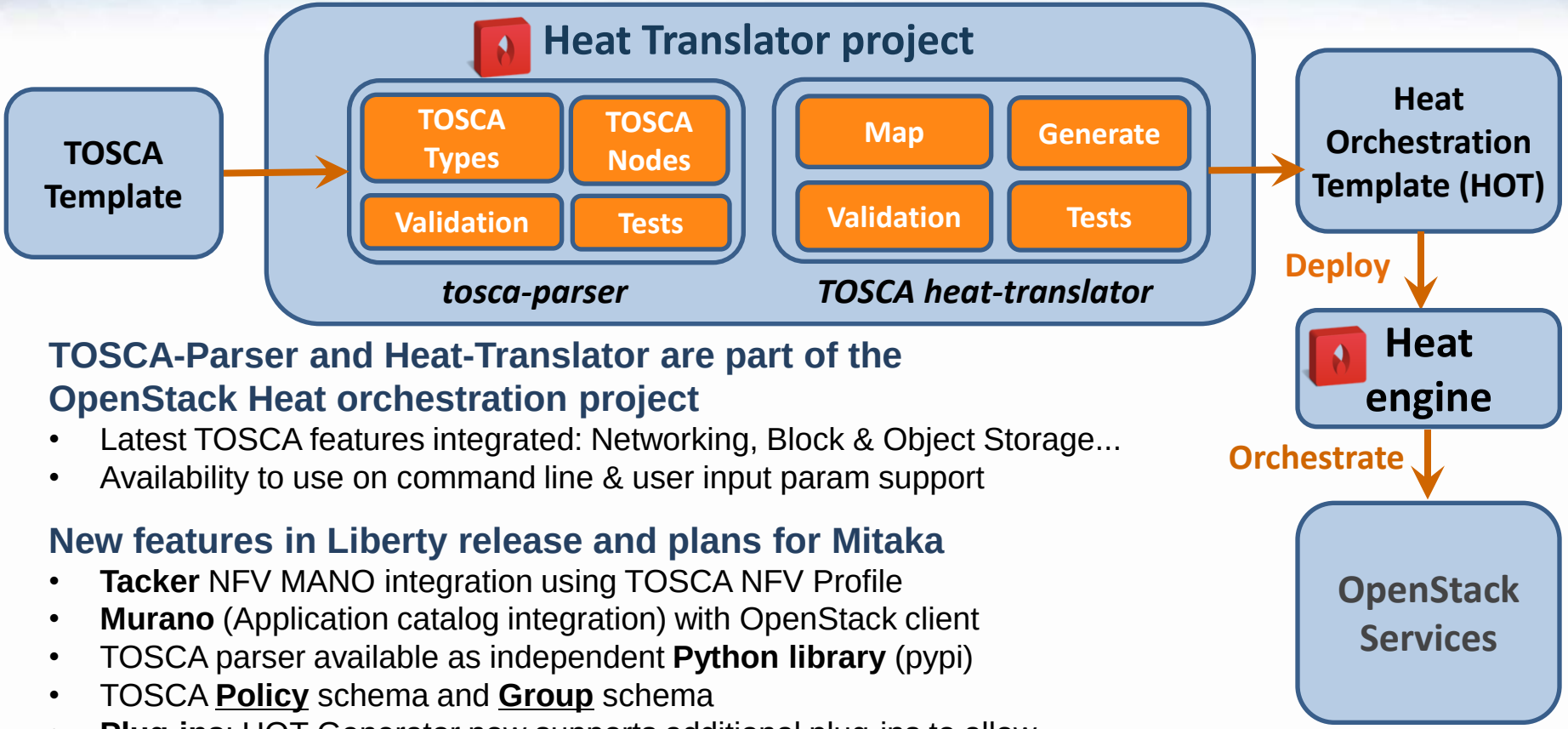
CERN
Indigo-DataCloud

Data/computing platform targeted at scientific communities
http://information-technology.web.cern.ch/about/projects/eu/indigo-datacloud

OPNFV
Parser

Deployment Template Translation

Automated TOSCA-based Orchestration Now Part of OpenStack



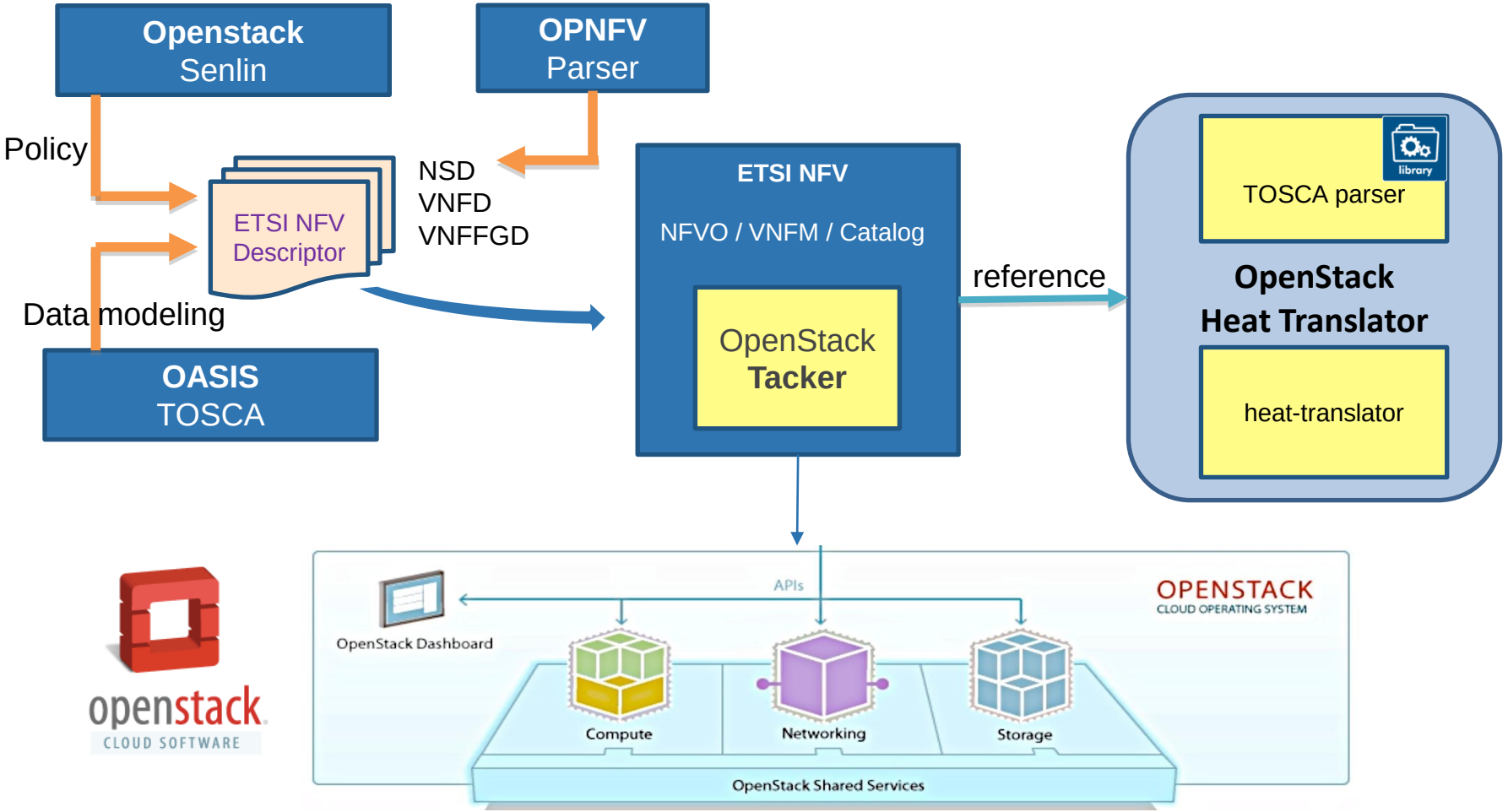
TOSCA-Parser and Heat-Translator are part of the OpenStack Heat orchestration project

- Latest TOSCA features integrated: Networking, Block & Object Storage...
- Availability to use on command line & user input param support

New features in Liberty release and plans for Mitaka

- **Tacker** NFV MANO integration using TOSCA NFV Profile
- **Murano** (Application catalog integration) with OpenStack client
- TOSCA parser available as independent **Python library** (pypi)
- TOSCA **Policy** schema and **Group** schema
- **Plug-ins**: HOT Generator now supports additional plug-ins to allow translation to other DSLs besides HOT, such as ***Kubernetes***

OpenSource related to ETSI NFV and OASIS TOSCA



TOSCA Resources – Learn More

- **TOSCA Technical Committee Public Page** *(latest documents, updates, and more)*
  - https://www.oasis-open.org/committees/tc_home.php?wg_abbrev=tosca
- **OASIS YouTube Channel, TOSCA Playlist**
  - https://www.youtube.com/user/OASISopen , http://bit.ly/1BQGGHm
- **TOSCA Simple Profile in YAML v1.0** *(latest committee approved draft)*
  - http://docs.oasis-open.org/tosca/TOSCA-Simple-Profile-YAML/v1.0/TOSCA-Simple-Profile-YAML-v1.0.pdf
- **TOSCA Simple Profile for NFV v1.0** *(latest committee approved draft)*
  - http://docs.oasis-open.org/tosca/tosca-nfv/v1.0/csd02/tosca-nfv-v1.0-csd02.pdf
- **Contact the Technical Committee Co-Chairs:**
  - Paul Lipton, **paul.lipton@ca.com**; Simon Moser, **smoser@de.ibm.com**
- **Today's Presenters from the TOSCA TC**:
  - **Shitao Li, lishitao@huawei.com**
  - **Matt Rutkowski, mrutkows@us.ibm.com**
  - **Chris Lauwers, lauwers@ubicity.com**
  - **Sridhar Ramaswamy , sramasw@Brocade.com**
  - **Sivan Barzily, sivan@gigaspaces.com**

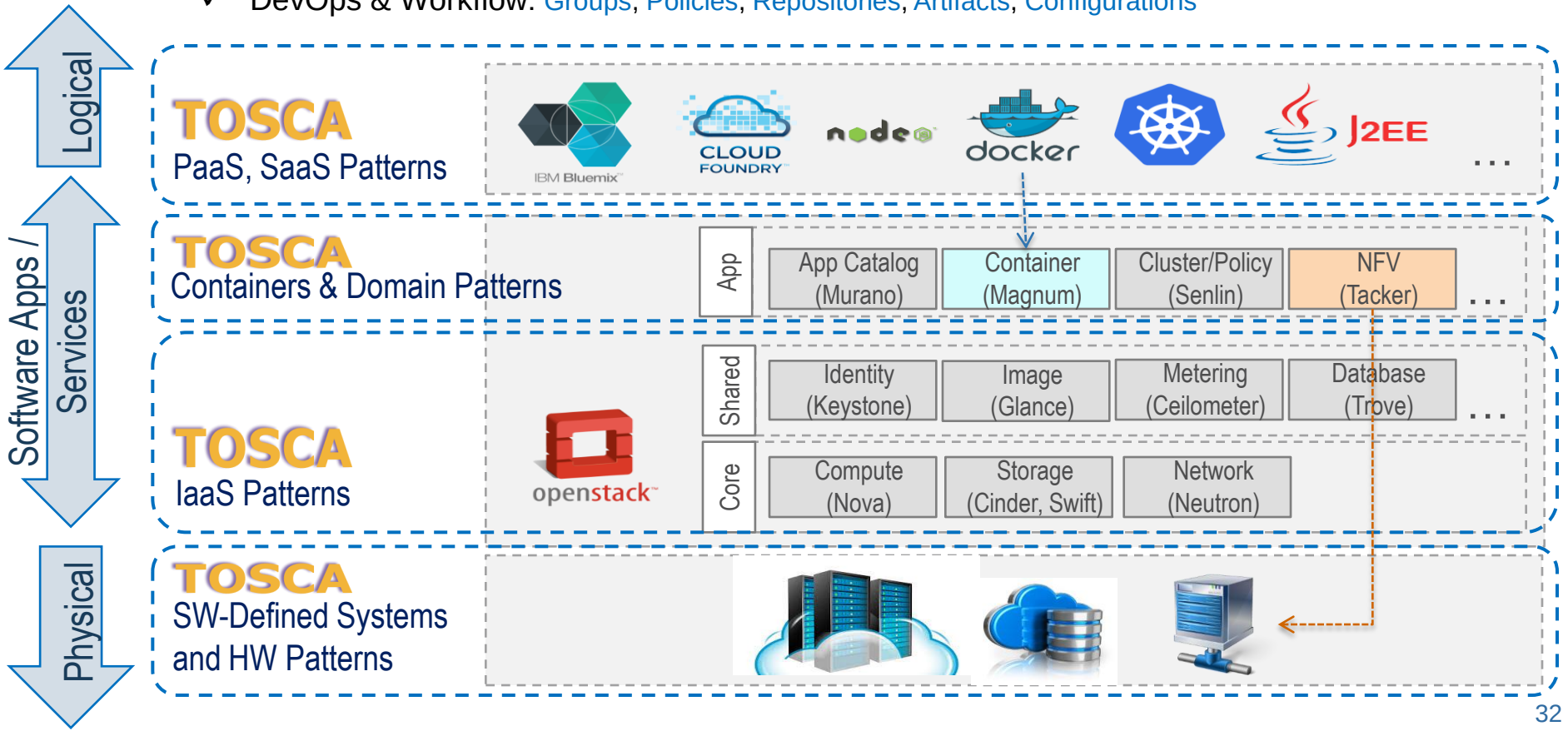
End Part 2
A Way Forward

TOSCA

Backup Slides

TOSCA Pattern Domains: IaaS, PaaS, NFV, HW and more

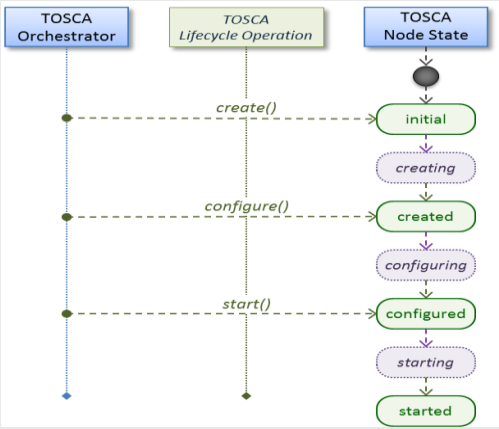
- TOSCA's Simple Profile Specification (YAML) Primary Goal was to
  - ✓ Simplify Application-Centric modeling, but also supports modeling of
  - ✓ DevOps & Workflow: Groups, Policies, Repositories, Artifacts, Configurations



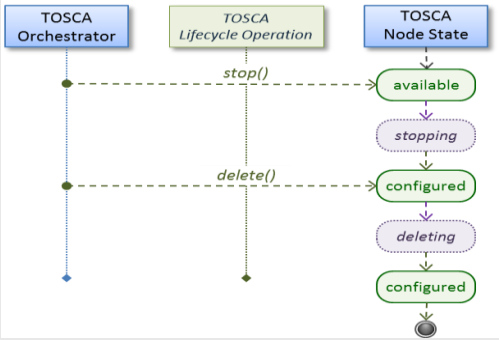
TOSCA Orchestrators - Standardized Lifecycle Sequencing

Lifecycle.Standard

Deploy Sequencing

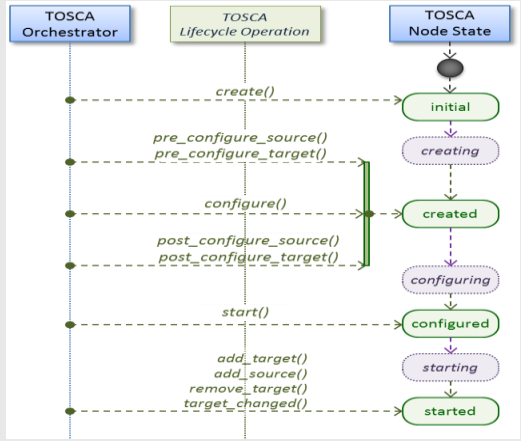


Undeploy Sequencing

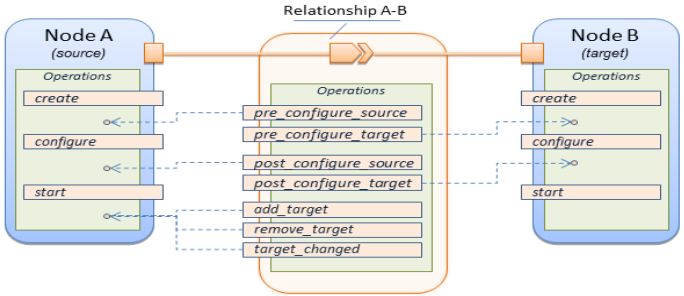


Lifecycle.Configure

Source-Target Sequencing



Combined Sequencing



TOSCA Policies Sample: Event-Condition-Action

Event

- Name of a normative TOSCA Event Type
- That describes an event based upon a Resource “state” change.
- Or a change in one or more of the resources attribute value.

Condition

Identifies:

- the resource (Node) in the TOSCA model to monitor.
- Optionally, identify a Capability of the identified node.
- Describe the attribute (state) of the resource to evaluate (condition)

Action

Describes:

- An Operation (name) to invoke when the condition is met
- within the declared Implementation
- Optionally, pass in Input parameters to the operation along with any well-defined strategy values.

– Allows Triggers to be declared based upon an *Event*, *Condition*, *Action* model

TOSCA Policy Definition:

```
<policy_name>:
  type: <policy_type_name>
  description: <policy_description>
  properties: <property_definitions>
  # allowed targets for policy association
  targets: [ <list_of_valid_target_resources> ]
  triggers:
    <trigger_symbolic_name_1>:
      event: <event_type_name>
      # Identify node (resource) to monitor
      target_filter:
        node: <node_template_name> | <node_type>
        # (optional) reference to a related node
        # via a requirement
        requirement: <requirement_name>
        # (optional) Capability within node to monitor
        capability: <capability_name>
      # Describes an attribute-relative test that
      # causes the trigger’s  action to be invoked.
       condition: <constraint_clause>
      action:
        # implementation-specific operation name
        <operation_name>:
          description: <optional description>
          inputs: <list_of_parameters>
          implementation: <script> | <service_name>
    ...
    <trigger_symbolic_name_n>:
        ...
```

1..N Triggers can be declared