OPNFV Copper Project

Release draft (f18addd)

OPNFV

February 25, 2016

CHAPTER

ONE

INTRODUCTION

Note: This is the working documentation for the Copper project.

The OPNFV Copper project aims to help ensure that virtualized infrastructure deployments comply with goals of the VNF designer/user, e.g. re affinity and partitioning (e.g. per regulation, control/user plane separation, cost...). This is a "requirements" project with initial goal to assess "off the shelf" basic OPNFV platform support for policy management, using existing open source projects such as OpenStack Congress and OpenDaylight Group-Based Policy (GBP). The project will assess what policy-related features are currently supported through research into the related projects in OpenStack and ODL, and testing of integrated vanilla distributions of those and other dependent open source projects in the OPNFV's NFVI platform scope.

1.1 Configuration Policy

As focused on by Copper, configuration policy helps ensure that the NFV service environment meets the requirements of the variety of stakeholders which will provide or use NFV platforms. These requirements can be expressed as an *intent* of the stakeholder, in specific terms or more abstractly, but at the highest level they express:

- what I want
- what I don't want

Using road-based transportation as an analogy, some examples of this are shown below.

Table 1.1: Configuration Intent Example

Who I Am	What I Want	What I Don't Want
user	a van, wheelchair-accessible, electric powered	someone driving off with my van
road provider	keep drivers moving at an optimum safe speed	four-way stops
public safety	shoulder warning strips, center media barriers	speeding, tractors on the freeway

According to their role, service providers may apply more specific configuration requirements than users, since service providers are more likely to be managing specific types of infrastructure capabilities. Developers and users may also express their requirements more specifically, based upon the type of application or how the user intends to use it. For users, a high-level intent can be also translated into a more or less specific configuration capability by the service provider, taking into consideration aspects such as the type of application or its constraints. Examples of such translation are:

Table 1.2: Intent Translation into Configuration Capability

Intent	Configuration Capability
network security	firewall, DPI, private subnets
compute/storage security	vulerability monitoring, resource access controls
high availability	clustering, auto-scaling, anti-affinity, live migration
disaster recovery	geo-diverse anti-affinity
high compute/storage performance	clustering, affinity
high network performance	data plane acceleration
resource reclamation	low-usage monitoring

Although such intent to capability translation is conceptually useful, it is unclear how it can address the variety of aspects that may affect the choice of an applicable configuration capability. For that reason, the Copper project will initially focus on more specific configuration requirements as fulfilled by specific configuration capabilities, and how those requirements and capabilities are expressed in VNF and service design and packaging, or as generic poicies for the NFVI.

1.2 Release 1 Scope

OPNFV Brahmaputra will be the initial OPNFV release for Copper, with the goals:

- Add the OpenStack Congress service to OPNFV, through at least one installer project
- If possible, add Congress support to the OPNFV CI/CD pipeline for all Genesis project installers (Apex, Fuel, JOID, Compass)
- Integrate Congress tests into Functest and develop additional use case tests for post-OPNFV-install
- Extend with other OpenStack components for testing, as time permits

CHAPTER

TWO

DEFINITIONS

Table 2.1: Definitions

Term	Meaning
State	Information that can be used to convey or imply the state of something, e.g. an application, resource, entity, etc. This can include data held inside OPNFV components, “events” that have occurred (e.g. “policy violation”), etc.
Event	An item of significance to the policy engine, for which the engine has become aware thr ough some method of discovery e.g. polling or notification.

CHAPTER

THREE

ABBREVIATIONS

Table 3.1: Abbreviations

Term	Meaning
CRUD	Create, Read, Update, Delete (database operation types)
FCAPS	Fault, Configuration, Accounting, Performance, Security
NF	Network Function
SFC	Service Function Chaining
VNF	Virtual Network Function

CHAPTER

FOUR

USE CASES

4.1 Resource Requirements

4.1.1 Workload Placement

Affinity

Ensures that the VM instance is launched "with affinity to" specific resources, e.g. within a compute or storage cluster. This is analogous to the affinity rules in VMWare vSphere DRS. Examples include: "Same Host Filter", i.e. place on the same compute node as a given set of instances, e.g. as defined in a scheduler hint list.

As implemented by OpenStack Heat using server groups:

Note: untested example...

```
resources:
  servgrp1:
  type: OS::Nova::ServerGroup
  properties:
    policies:
    - affinity
    serv1:
    type: OS::Nova::Server
    properties:
      image: { get_param: image }
      flavor: { get_param: flavor }
      networks:
        - network: {get_param: network}
    serv2:
    type: OS::Nova::Server
    properties:
      image: { get_param: image }
      flavor: { get_param: flavor }
      networks:
        - network: {get_param: network}
```

Anti-Affinity

Ensures that the VM instance is launched "with anti-affinity to" specific resources, e.g. outside a compute or storage cluster, or geographic location. This filter is analogous to the anti-affinity rules in vSphere DRS. Examples include: "Different Host Filter", i.e. ensures that the VM instance is launched on a different compute node from a given set of instances, as defined in a scheduler hint list.

As implemented by OpenStack Heat using scheduler hints:

Note: untested example...

```
heat template version: 2013-05-23
parameters:
  image:
  type: string
  default: TestVM
  flavor:
  type: string
  default: m1.micro
  network:
  type: string
  default: cirros_net2
resources:
  serv1:
  type: OS::Nova::Server
  properties:
    image: { get_param: image }
    flavor: { get_param: flavor }
    networks:
      - network: {get_param: network}
    scheduler_hints: {different_host: {get_resource: serv2}}
  serv2:
  type: OS::Nova::Server
  properties:
    image: { get_param: image }
    flavor: { get_param: flavor }
    networks:
      - network: {get_param: network}
    scheduler_hints: {different_host: {get_resource: serv1}}
```

DMZ Deployment

As a service provider, I need to ensure that applications which have not been designed for exposure in a DMZ zone, are not attached to DMZ networks.

4.1.2 Configuration Auditing

As a service provider or tenant, I need to periodically verify that resource configuration requirements have not been violated, as a backup means to proactive or reactive policy enforcement.

4.2 Generic Policy Requirements

4.2.1 NFVI Self-Service Constraints

As an NFVI provider, I need to ensure that my self-service tenants are not able to configure their VNFs in ways that would impact other tenants or the reliability, security, etc of the NFVI.

Network Access Control

Networks connected to VMs must be public, or owned by someone in the VM owner's group.

This use case captures the intent of the following sub-use-cases:

- Link Mirroring: As a troubleshooter, I need to mirror traffic from physical or virtual network ports so that I can investigate trouble reports.
- Link Mirroring: As a NFVaaS tenant, I need to be able to mirror traffic on my virtual network ports so that I can investigate trouble reports.
- Unauthorized Link Mirroring Prevention: As a NFVaaS tenant, I need to be able to prevent other tenants from mirroring traffic on my virtual network ports so that I can protect the privacy of my service users.
- Link Mirroring Delegation: As a NFVaaS tenant, I need to be able to allow my NFVaaS SP customer support to mirror traffic on my virtual network ports so that they can assist in investigating trouble reports.

As implemented through OpenStack Congress:

Note: untested example...

```
error :-
nova:vm(vm),
neutron:network(network),
nova:network(vm, network),
neutron:private(network),
nova:owner(vm, vm-own),
neutron:owner(network, net-own),
-same-group(vm-own, net-own)

same-group(user1, user2) :-
ldap:group(user1, g),
ldap:group(user2, g)
```

Storage Access Control

Storage resources connected to VMs must be owned by someone in the VM owner's group.

As implemented through OpenStack Congress:

Note: untested example...

```
error :-
nova:vm(vm),
cinder:volumes(volume),
nova:volume(vm, volume),
nova:owner(vm, vm-own),
neutron:owner(volume, vol-own),
-same-group(vm-own, vol-own)

same-group(user1, user2) :-
ldap:group(user1, g),
ldap:group(user2, g)
```

4.2.2 Resource Management

Resource Reclamation

As a service provider or tenant, I need to be informed of VMs that are under-utilized so that I can reclaim the VI resources. (example from RuleYourCloud blog)

As implemented through OpenStack Congress:

```
reclaim_server(vm) :-
ceilometer:stats("cpu_util",vm, avg_cpu),
lessthan(avg_cpu, 1)

error(user_id, email, vm_name) :-
reclaim_server(vm),
nova:servers(vm, vm_name, user_id),
keystone:users(user_id, email)
```

Resource Use Limits

As a tenant or service provider, I need to be automatically terminate an instance that has run for a pre-agreed maximum duration.

As implemented through OpenStack Congress:

```
terminate_server(vm) :-
ceilometer:statistics("duration",vm, avg_cpu),
lessthan(avg_cpu, 1)

error(user_id, email, vm_name) :-
reclaim_server(vm),
nova:servers(vm, vm_name, user_id),
keystone:users(user_id, email)
```

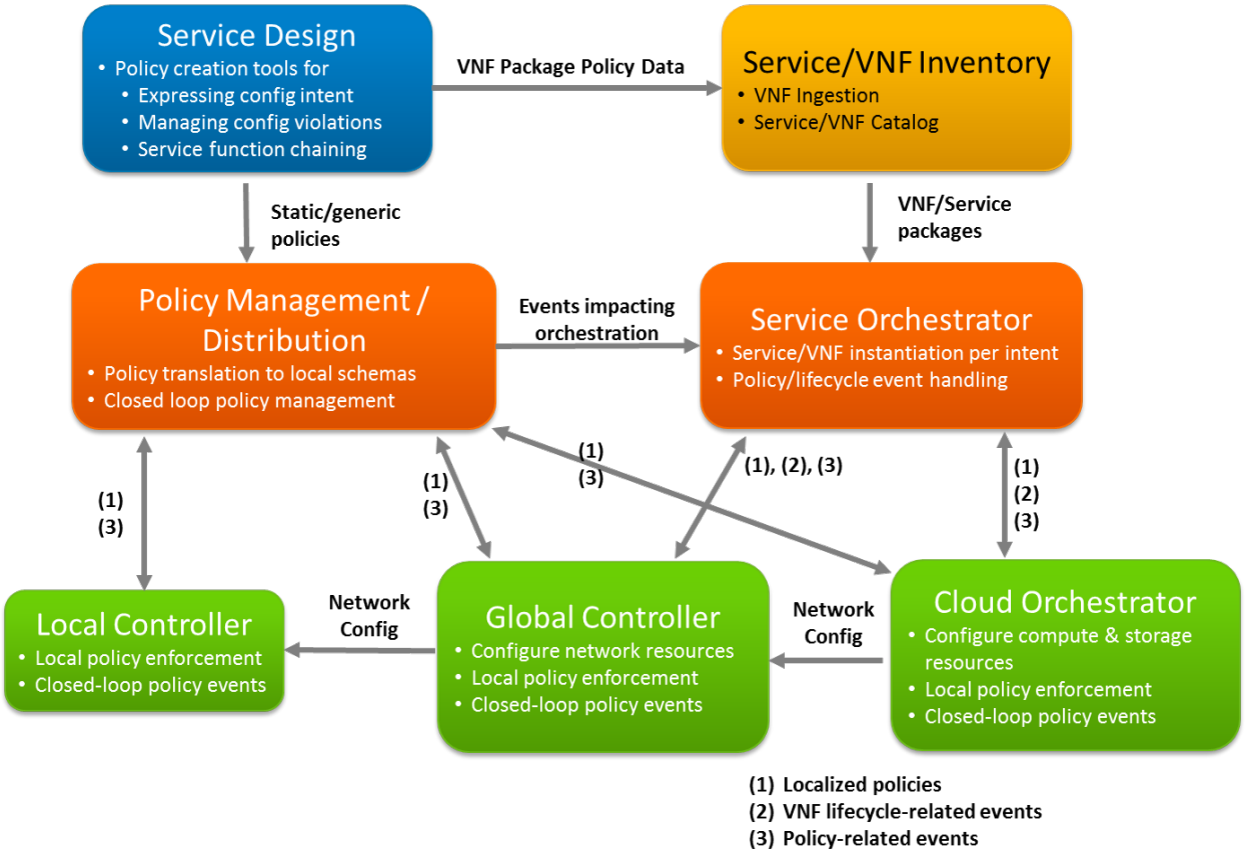
CHAPTER

FIVE

ARCHITECTURE

5.1 Architectural Concept

The following example diagram illustrates a "relationship diagram" type view of an NFVI platform, in which the roles of components focused on policy management, services, and infrastructure are shown. This view illustrates that a large-scale deployment of NFVI may leverage multiple components of the same "type" (e.g. SDN Controller), which fulfill specific purposes for which they are optimized. For example, a global SDN controller and cloud orchestrator can act as directed by a service orchestrator in the provisioning of VNFs per intent, while various components at a local and global level handle policy-related events directly and/or feed them back through a closed-loop policy design that responds as needed, directly or through the service orchestrator.



(source of the diagram above: https://git.opnfv.org/cgit/copper/plain/design_docs/images/policy_architecture.pptx)

5.2 Architectural Aspects

- Policies are reflected in two high-level goals
  - Ensure resource requirements of VNFs and services are applied per VNF designer, service, and tenant intent
  - Ensure that generic policies are not violated, e.g. *networks connected to VMs must either be public or owned by the VM owner*
- Policies are distributed through two main means
  - As part of VNF packages, customized if needed by Service Design tools, expressing intent of the VNF designer and service provider, and possibly customized or supplemented by service orchestrators per the intent of specific tenants
  - As generic policies provisioned into VIMs (SDN controllers and cloud orchestrators), expressing intent of the service provider re what states/events need to be policy-governed independently of specific VNFs
- Policies are applied locally and in closed-loop systems per the capabilities of the local policy enforcer and the impact of the related state/event conditions
  - VIMs should be able to execute most policies locally
  - VIMs may need to pass policy-related state/events to a closed-loop system, where those events are relevant to other components in the architecture (e.g. service orchestrator), or some additional data/arbitration is needed to resolve the state/event condition
- Policies are localized as they are distributed/delegated
  - High-level policies (e.g. expressing "intent") can be translated into VNF package elements or generic policies, perhaps using distinct syntaxes
  - Delegated policy syntaxes are likely VIM-specific, e.g. Datalog (Congress), YANG (ODL-based SDNC), or other schemas specific to other SDNCs (Contrail, ONOS)
- Closed-loop policy and VNF-lifecycle event handling are //somewhat// distinct
  - Closed-loop policy is mostly about resolving conditions that can't be handled locally, but as above in some cases the conditions may be of relevance and either delivered directly or forwarded to service orchestrators
  - VNF-lifecycle events that can't be handled by the VIM locally are delivered directly to the service orchestrator
- Some events/analytics need to be collected into a more "open-loop" system which can enable other actions, e.g.
  - audits and manual interventions
  - machine-learning focused optimizations of policies (largely a future objective)

Issues to be investigated as part of establishing an overall cohesive/adaptive policy architecture:

- For the various components which may fulfill a specific purpose, what capabilities (e.g. APIs) do they have/need to
  - handle events locally
  - enable closed-loop policy handling components to subscribe/optimize policy-related events that are of interest
- For global controllers and cloud orchestrators
  - How do they support correlation of events impacting resources in different scopes (network and cloud)
  - What event/response flows apply to various policy use cases

- What specific policy use cases can/should fall into each overall class
  - locally handled by NFVI components
  - handled by a closed-loop policy system, either VNF/service-specific or VNF-independent

CHAPTER

SIX

REQUIREMENTS

This section outlines general requirements for configuration policies, per the two main aspects in the Copper project scope:

- Ensuring resource requirements of VNFs and services are applied per VNF designer, service, and tenant intent
- Ensuring that generic policies are not violated, e.g. *networks connected to VMs must either be public or owned by the VM owner*

6.1 Resource Requirements

Resource requirements describe the characteristics of virtual resources (compute, storage, network) that are needed for VNFs and services, and how those resources should be managed over the lifecycle of a VNF/service. Upstream projects already include multiple ways in which resource requirements can be expressed and fulfilled, e.g.:

- OpenStack Nova * the image feature, enabling

  "VM templates" to be defined for NFs, and referenced by name as a specific NF version to be used

  – the flavor feature, addressing basic compute and storage requirements, with extensibility for custom attributes

- OpenStack Heat * the Heat Orchestration Template feature,

  enabling a variety of VM aspects to be defined and managed by Heat throughout the VM lifecycle, notably * alarm handling (requires Ceilometer) * attached volumes (requires Cinder) * domain name assignment (requires Designate) * images (requires Glance) * autoscaling * software configuration associated with VM "lifecycle hooks (CREATE, UPDATE, SUSPEND, RESUME, DELETE" * wait conditions and signaling for sequencing orchestration steps * orchestration service user management (requires Keystone) * shared storage (requires Manila) * load balancing (requires Neutron LBaaS) * firewalls (requires Neutron FWaaS) * various Neutron-based network and security configuration items * Nova flavors * Nova server attributes including access control * Nova server group affinity and anti-affinity * "Data-intensive application clustering" (requires Sahara) * DBaaS (requires Trove) * "multi-tenant cloud messaging and notification service" (requires Zaqar)

- OpenStack Group-Based Policy * API-based grouping of endpoints with associated contractual expectations for data flow processing and

  service chaining

- OpenStack Tacker * "a fully functional ETSI MANO based general purpose NFV Orchestrator and VNF Manager for OpenStack"
- OpenDaylight Group-Based Policy * model-based grouping of endpoints with associated contractual expectations for data flow processing

- OpenDaylight Service Function Chaining (SFC) * model-based management of "service chains" and the infrastucture that enables them
- Additional projects that are commonly used for configuration management, implemented as client-server frameworks using model-based, declarative, or scripted configuration management data. * Puppet * Chef * Ansible * Salt

6.2 Generic Policy Requirements

Generic policy requirements address conditions related to resource state and events which need to be monitored for, and optionally responded to or prevented. These conditions are typically expected to be VNF/service-independent, as VNF/service-dependent condition handling (e.g. scale in/out) are considered to be addressed by VNFM/NFVO/VIM functions as described under Resource Requirements or as FCAPS related functions. However the general capabilities below can be applied to VNF/service-specific policy handling as well, or in particular to invocation of VNF/service-specific management/orchestration actions. The high-level required capabilities include:

- Polled monitoring: Exposure of state via request-response APIs.
- Notifications: Exposure of state via pub-sub APIs.
- Realtime/near-realtime notifications: Notifications that occur in actual or near realtime.
- Delegated policy: CRUD operations on policies that are distributed to specific components for local handling, including one/more of monitoring, violation reporting, and enforcement.
- Violation reporting: Reporting of conditions that represent a policy violation.
- Reactive enforcement: Enforcement actions taken in response to policy violation events.
- Proactive enforcement: Enforcement actions taken in advance of policy violation events, e.g. blocking actions that could result in a policy violation.
- Compliance auditing: Periodic auditing of state against policies.

Upstream projects already include multiple ways in which configuration conditions can be monitored and responded to:

- OpenStack Congress provides a table-based mechanism for state monitoring and proactive/reactive policy enforcement, including (as of the Kilo release) data obtained from internal databases of Nova, Neutron, Ceilometer, Cinder, Glance, Keystone, and Swift. The Congress design approach is also extensible to other VIMs (e.g. SDNCs) through development of data source drivers for the new monitored state information. See Stackforge Congress Data Source Translators, congress.readthedocs.org, and the Congress specs for more info.
- OpenStack Ceilometer provides means to trigger alarms upon a wide variety of conditions derived from its monitored OpenStack analytics.
- Nagios "offers complete monitoring and alerting for servers, switches, applications, and services".

6.3 Requirements Validation Approach

The Copper project will assess the completeness of the upstream project solutions for requirements in scope though a process of:

- developing configuration policy use cases to focus solution assessment tests
- integrating the projects into the OPNFV platform for testing
- executing functional and performance tests for the solutions

- assessing overall requirements coverage and gaps in the most complete upstream solutions

Depending upon the priority of discovered gaps, new requirements will be submitted to upstream projects for the next available release cycle.