CS236635
Network Functions Virtualization (NFV)

Class 8

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Last week

- NFV – Operator perspective

This week

- The shift to NFV SDN
- ETSI NFV ISG
  - Terminology
  - Use cases
- Moving an NF to the cloud
The Network

- Basically
  - Transport information from place to place
  - Transport bits from place to place
  - Transport packets from place to place
The Network

- **Basically**
  - Transport information from place to place
  - Transport bits from place to place
  - Transport packets from place to place

- **Actually**
  - People can talk (video-conf)
  - People can text (or Whatsapp)
  - Communities can be formed
  - Machines can share state
  - Applications can .... (real time traffic, public transportation, ....)
Much more than just
- Transport packets from place to place

Actually
- People can talk (video-conf)
- People can text (or whatsup)
- Communities can be formed
- Machines can share state
- Applications can .... (real time traffic, public transportation, ....)
The Network is a Service

- A Network Service
  - Composed of one or more network functions
  - Service function chaining

- Currently
  - Functions (and services) are implemented via dedicated hardware located on the flow path
The Network is a Service

- A Network Service
  - Composed of one or more network functions
  - Service function chaining

- Distributed Cloud Networking
  - Functions (and services) are implemented on COTS servers located at mini) data centers distributed within the network
  - Traffic is send to these servers using the control mechanism of SDN
Dramatic Change in the Newtwork

FROM: Hardware Based separate networks and separate services
INTO: Software Based Virtual Integrated Network
NFV + SDN
Distributed cloud networking = NFV + SDN

- Key enablers
  - Network function virtualization (NFV)
  - Software defined networking (SDN)

Distributed cloud networking = NFV + SDN

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- Ideal for next generation services
  1) Network services
     - NFV
  2) Automation services
     - Smart X, IoT
  3) Augmented experience
     - Virtual X, Augmented X

Lots to gain
- Use COTS silicon - Reduced Capex
- Easy provisioning - reducing time to market
- Easier operation – reduced Opex

Not so simple
- Can we get the performance we (want) need
- Can we get the reliability we (want) need
- Isn’t this too complex (to operate)
- Can we achieve agility despite of:
  - Vendors and operators
  - multi vendors environment
- Full, end to end, carrier-grade telco NFV
The Process of NFV

- Moving to a Cloud-based operation is a major change
  - Internal – Employee re-training, long-term planning
  - External – Suppliers, supply chain

- Even more complex when involving the entire industry
  - All the networks are interconnected
    - Changes in one Service Provider directly affects all others
  - Different possibilities of how to migrate to new approach
    - Looking for setting standards
The Process of NFV

Why are standards important?
- Uniform behavior simplifies analysis and planning
- Clarity of inter-SP business communication
  - Terminology means the same for everyone
- Limits the impact of business borders on operational concerns
  - Better abstraction 😊
- Focus energy of industry in one main direction
  - Reduce cost of products via economy of scale
  - Reduce time to migration
The Process of NFV

- ETSI = European Telecommunications Standards Institute

- ETSI NFV ISG
  - ISG – Industry Specification Group
  - Meetings several times a year
  - Comprised of researchers and industry experts
    - **Operators**: AT&T, British Telecom, Telefonica, Verizon, Deutsche Telekom...
    - **Vendors**: Alcatel-Lucent, Cisco, Juniper, HP
    - And many more... - see [http://portal.etsi.org/NFV/NFV_List_members.asp](http://portal.etsi.org/NFV/NFV_List_members.asp)
ETSI NFV activities

- From the ETSI-NFV site:
  - “The purpose of the NFV ISG is to
    - Define the requirements and architecture for the virtualization of network functions, and
    - To address [a set of] technical challenges [involved in NFV]”
  - Started in 2012, and is still working....
    - “Four years and over 50 publications later, the ISG NFV community has evolved through several phases, its publications have moved from pre-standardization studies to detailed specifications (see Release 2 and Release 3) and the early Proof of Concepts (PoCs) efforts have evolved and led to interoperability events”
ETSI NFV ISG – White Papers

- October 2012 – First white paper
  - Defined what is needed from NFV, motivations and initial directions
ETSI NFV ISG – White Papers

- October 2013 – Second white paper
  - Terminology
  - Example use cases
  - Management architecture

- **Network Function (NF)**
  - Functional building block within a network infrastructure
  - Well-defined external interfaces
  - Well-defined functional behavior

- **Physical Network Function (PNF)**
  - Implementation of a NF via tightly coupled software and hardware

- **Virtual Network Function (VNF)**
  - Implementation of a NF that can be deployed on NFV Infrastructure (NFVI)

- **Network Service**
  - A composition of Network Functions
  - Defined by it’s functional and behavioral patterns
ETSI NFV ISG – White Papers

- October 2013 – Second white paper
  - Terminology
  - Example use cases
  - Management
ETSI NFV ISG – White Papers

- October 2013 – Second white paper
  - Terminology
  - Example use cases
  - Reference architecture framework

*Figure 4: NFV Architectural Framework*
ETSI NFV Architecture

VNF is the software implementation of a network function which is capable of running over the NFVI. Can be accompanied by an Element Management System (EMS) for an individual VNF. Delivered as pure software free from hardware dependency.

Virtual resources required to support the execution of the VNFs. Includes Commercial-Off-The-Shelf (COTS) hardware, accelerator components where necessary, and a software layer which virtualises and abstracts the underlying hardware.

Why do we need Orchestration?
Covers the orchestration and lifecycle management of physical and/or software resources that support the infrastructure virtualisation, and the lifecycle management of VNFs.
Also interacts with the (NFV external) OSS/BSS landscape, which allows NFV to be integrated into an already existing network-wide management landscape.

The cloud operating system (e.g., OpenStack)
ETSI NFV ISG – White Papers

- October 2014 3rd white paper
  - Reliability / availability
  - Performance
  - Proof of concepts (PoC)

Figure 3: Performance Illustration
ETSI NFV ISG – White Papers

- October 2014 3rd white paper
  - Reliability / availability
  - Performance
  - Proof of concepts (PoC)
Communities – open source

- Open Source MANO (OSM)
- Open Platform for NFV (OPNFV)
- Open Network Automation Platform (ONAP): Open-Source ECOMP and Open-O
- Tacker: Purpose VNFM (and Templatized NFVO) from OpenStack
Open Platform for NFV (OPNFV) facilitates the development and evolution of NFV components across various open source ecosystems. Through system level integration, deployment and testing, OPNFV constructs a reference NFV platform to accelerate the transformation of enterprise and service provider networks. Goals include accelerating time to market for NFV solutions, ensuring the platform meets the industry’s needs, and enabling end user choice in specific technology components based on their use cases and deployment architectures.

OPNFV Platform Overview
Open Source MANO (OSM)

Current OSM architecture (MWC’16)
Proposed ONAP Merged Architecture

- ONAP Portal
  - VNF SDK
    - Service Design & Creation
    - Policy Creation
    - Analytic Application Design
    - Recipe/Engineering Rules & Policy Distribution
  - Design Functions

- ONAP Controller
  - Operational Functions
    - Data Collection & Analytics
    - Common Services, Data Movement, Access Control & APIs
    - Controllers
      - SDN Agent
      - Infra. Cont
      - network Cont
      - App. Cont
      - VF Cont
    - 3rd Party Controller
    - VNFM / EMS
  - Storage
  - Compute
  - Networking
  - VNFs / Applications

- Dashboard
  - OA&M
    - Operation Administration & Maintenance
  - Active & Available Inventory
  - External Data Movement & APIs
  - Service Orchestrator

- Services
  - E - Services
  - BSS / OSS
  - Big Data
Tacker - OpenStack NFV Orchestration

Tacker is an official OpenStack project building a Generic VNF Manager (VNFM) and a NFV Orchestration (NFVO) to deploy and operate Network Services and Virtual Network Functions (VNFs) on an NFV infrastructure platform like OpenStack. It is based on ETSI MANO Architectural Framework and provides a functional stack to orchestrate Network Services end-to-end using VNFs.
OpenStack: who?

- Launched in 2010 by Rackspace & NASA
  - Rackspace – a competitor of Amazon
- Purpose
  - To provide a free cloud platform for public and private clouds
  - To become the de-facto industry standard for Cloud management
    - “Cloud Operating System”
- Workflow
  - New release every 6-months
  - Support from 200+ companies
  - Primarily written in Python
Remember the services we wanted?

- We want to run **services**
  - Compute – VM to run programs
  - Block Storage – attach to VM, store data from VM operation
  - Object Storage – upload content (e.g. Dropbox)
  - Run full applications
  - Connect to existing infrastructure

- We need **supporting services**
  - Monitoring
  - Image management
  - Network management
  - Identity management (authentication)
OpenStack Projects

- **Nova**
  - Compute service (IaaS)
  - Support for XEN, KVM and other hypervisors

- **Swift**
  - **Object** Storage service
  - Supports replication for sake of data integrity

- **Glance**
  - Image Service
  - Includes support for snapshots, registration, distribution of images...
OpenStack Projects – Cont.

- **Horizon**
  - Openstack Dashboard (“GUI”)
  - Can be customized for different customers

- **Keystone**
  - Identity service – authentication, access control
  - Many Openstack procedures will start with Keystone as a first step

- **Neutron** (formerly Quantum)
  - Network management
  - Can support also VPN construction, SDN
OpenStack Projects – Cont.

- Cinder
  - Block storage service
- Heat
  - Application management
- Ceilometer
  - Monitoring
  - Counters management
- Tempest
  - Openstack integration testing service
## OpenStack Releases

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OpenStack Structure

- Deployed per datacenter
  - Amanda (Cloud owner) decides which projects to deploy
- Distributed projects
  - No need to be in same location (server), but usually are
- Projects distinguished via port number in API
  - Default Nova port = 8774
  - Allows API overlap
    - E.g., both Nova and Glance have an api call for listing images
OpenStack API - example

http://<NOVA-IP>:8774/v2

- OpenStack has also a Command Line Interface (CLI) for easy cloud management
- All commands
  - First access Keystone to get authentication credentials
  - Then access specific project with request

```xml
<?xml version='1.0' encoding='UTF-8'?>
<versions xmlns:atom="http://www.w3.org/2005/Atom" xmlns="http://docs.openstack.org/common/api/v1.0">
  <version status="CURRENT" updated="2011-01-21T11:33:21Z" id="v2.0">
    <atom:link href="http://openstack.example.com/v2/" rel="self"/>
  </version>
  <version status="EXPERIMENTAL" updated="2013-07-23T11:33:21Z" id="v3.0">
    <atom:link href="http://openstack.example.com/v3/" rel="self"/>
  </version>
</versions>
```
OpenStack - Summary

- Growing product, taking over the industry
- Gives Amazon competitors a better starting point
- Still lacks much desired functionality
- Try it out for yourself
  - [http://devstack.org/](http://devstack.org/)
  - [http://trystack.org/](http://trystack.org/)
ETSI NFV use cases

Figure 3: Overview of NFV Use Cases
Home environment examples - Current

- Setup box
- Residential Gateway
- Broadband Network Gateway
Home environment examples
Future (long term)
Home environment examples

Future (transition)
VNFaaS – VNF as-a-Service

- **CPE** - Customer Premises Equipment; **PE** – Provider Edge
Both CPE and PE are very expensive
- CPE includes not only high-speed connection, but additional services
- PEs need to support high speed communications on the provider side

Virtualizing this “border” holds potential for win-win
- Enterprises do not need to manage system
- Service providers can multiplex resources for several enterprises
VNFs - Summary

- Challenges for VNFs (compared to standard apps)
  - Virtualizing legacy software (10s of years old!)
  - Need to support multiple protocols and layers
    - Not just IP
  - Need to work during long transition period
    - Possible transitory steps
  - High performance, industry standard
    - Moving to cloud is nice and cost-efficient – but customers should not pay a price
  - Highly complex structure
    - In worst case, all network services are inter-linked
So what did we do today?

- NFV- SDN
- Etsi – open projects
- Open Stack
- Home use case (CPE)

Next week – more on implementation details and containers