

# Network Function Virtualization - Architecture and Principles – 3 days

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## CONTENTS

This course is designed for students who want to acquire detailed knowledge of the NFV architecture, its development phases and its relation to SDN and Cloud Technology. The different parts (MANO, NFVI and VNFs) are explained as well as their interaction and use cases are examined to bring the whole picture together. Networking in a world of virtual machines is given extra attention, as this is an area that can be difficult for newcomers in the world of virtualization.

## PREREQUISITES

General telecom knowledge is optional while computer science (how computers work, on a fundamental level) and familiarity with TCP/IP networking is very beneficial for the understanding of the contents of this course.

## Virtualization

- Cloud Technology
- Hypervisors
- Linux Containers
- COTS hardware
- Virtual Machines
- vCPU and vNICs

## Network Functions Virtualization and Software-Defined Networking (SDN)

- The function and benefits of NFV
- The function and benefits of SDN
- How NFV and SDN fit together
- How SDN and NFV are controlled
- Distributed VNFs
- Functions of MANO (NFV Management and Orchestration)
- NFVI (NFV Infrastructure)

## NFV Building Blocks

- VNFs
- VNF Components (VNFC)
- Virtual Machines
- The relation between VNF, VNFC and VM

## NFV Flexibility

- What scaling is and why we do it
- Horizontal scaling (scale in and out)
- Vertical scaling (up and down)
- Live migration functionality and reasons to do it

## NFV Reference Architecture

- The whole ETSI NFV Reference Picture
- NFVI, VNFs
- Element Managers (EM)
- The inside of the MANO (NFVO, VNFM and VIM)
- Interaction with OSS/BSS

- Reference points / interfaces
- Example: VNF Instantiation Procedure

## NFVI Domains

- The Hypervisor Domain
- The Compute Domain
- The Infrastructure Network Domain
- NFVI-PoPs (NFVI Point-of-Presence)
- What “Virtual Compute” really is, according to ETSI
- What “Virtual Storage” really is, according to ETSI
- What “Virtual Networks” really is, according to ETSI

## Networking for Virtual Machines

- Concrete Networking Examples
- Both Physical and Logical representations of all examples
- With Protocol Stacks for all examples
- Examples include elements such as:
  - Virtual switches and NICs (vSwitch and vNIC)
  - Physical switches and NICs
  - Embedded switch (eSwitch)
  - DHCP
  - NAT
  - VLAN
  - VxLAN
- All examples are routed together to show-case all possible combinations

## Networking in Live Migration

- Different Live Migration Examples
- Examples without SDN (intra-LAN and inter-LAN)
- Example with OpenFlow-based SDN
- Example with VxLAN-based SDN
- VxLAN is explained with detailed protocol stacks

## NFV Networking Terminology

- The different networking terms used by the ETSI documents
- The data model for an NFV Network Service, from top to bottom
- Example terms that are shown in relation to each other:
  - NS (Network Service)
  - VNF / PNF (Physical Network Function)
  - VNFC
  - VL (Virtual Link)
  - VNFFG (VNF Forwarding Graph)
  - NFP (Network Forwarding Path)
  - CP (Connection Point)
- Network Types
  - E-LINE
  - E-LAN
  - E-TREE

## Management and Orchestration

- A detailed look inside the NFV MANO
- NFVO (NFV Orchestrator)
- VNFM (VNF Manager)
- VIM (Virtualized Infrastructure Manager)
- Interaction between the internal functions
- MANO Catalogues and Databases

## NFV Use Cases

- A walk-through of the nine NFV use cases chosen by ETSI
- NFVlaaS, VNFaaS and VNPaaS
- VNF Forwarding Graph
- Virtual Mobile Core & IMS
- Virtual Mobile Base Station
- Virtual Home Environment
- Virtual CDNs
- Fixed Access NFV